THE BUILDING REGULATIONS

EXPLAINED AND ILLUSTRATED

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14TH EDITION

M.J. Billington

S.P. Barnshaw

K.T. Bright

A. Crooks

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Contents

About the author xi
Preface to the fourteenth edition xiii
Acknowledgements xvii

I Legal and administrative

1 Building control: An overview 1.1
1.1 Introduction 1.1
1.2 The Building Act 1984 1.2
1.3 The linked powers 1.3
1.4 Building Regulations 1.4
1.5 Building Regulations: Exemptions 1.6
1.6 Dangerous structures, etc. 1.10
1.7 Other legislation 1.12
2 The Building Regulations and Approved Documents 2.1
2.1 Introduction 2.1
2.2 Division of the Regulations 2.1
2.3 Approved Documents 2.6
2.4 Definitions in the Regulations 2.10
2.5 Exempt buildings and work 2.17
2.6 Application of the Regulations 2.19
2.7 Regulation requirements 2.24
2.8 Schedule 1: Technical requirements 2.25
2.9 Relaxation of regulation requirements 2.26
2.10 Type relaxations 2.27
2.11 Continuing requirements 2.28
2.12 Testing and sampling 2.28
2.13 Testing and Commissioning 2.29
2.14 Unauthorised building work 2.30
2.15 Contravening works 2.31
3 Local authority control 3.1
3.1 Introduction 3.1
3.2 The local authority 3.2
3.3 Building notice procedure 3.2
3.4 Exemptions from the requirement to give a building notice or deposit full plans 3.4
3.5 Deposit of plans 3.4
3.6 Notice requirements 3.7
3.7 Completion certificate 3.9

4	Private certification	4.1
4.1	Introduction	4.1
4.2	Insurance requirements	4.2
4.3	Approval of inspectors	4.4
4.4	Approved persons and self-certification by competent persons	4.8
4.5	Self-certification schemes and the Approved Inspector	4.8
4.6	Independence of Approved Inspectors	4.9
4.7	Approval of public bodies	4.9
4.8	Private certification procedure	4.10
4.9	Plans certificates	4.19
4.10	Final certificates	4.20
4.11	Public body's notices and certificates	4.21
4.12	Prescribed forms	4.21
5	Work under the supervision of a competent person	5.1
5.1	Introduction	5.1
5.2	Principles of self-certification	5.2
5.3	Benefits of competent person schemes	5.2
5.4	Joining a competent person scheme	5.5
5.5	Legislative background	5.6
5.6	Building regulation requirements	5.6
5.7	Self-assessment	5.11
5.8	Non-notification	5.12
5.9	Regulation 20 applied to local authorities	5.14
5.10	Regulation 20 applied to Approved Inspectors	5.14
5.11	Approval of competent person schemes	5.14

II Technical

6	Structural stability (Part A)	6.1
6.1	Introduction	6.1
6.2	Loading	6.2
6.3	Ground movement	6.3
6.4	Guidance on structural design in buildings of all types	6.3
6.5	Structural requirements in existing buildings subject to change of use	6.7
6.6	Design of structural members in houses and other small buildings	6.8
6.7	Buttressing walls, piers and chimneys	6.25
6.8	External wall cladding	6.48
6.9	Replacement of roof coverings	6.51
6.10	Disproportionate collapse	6.52
7	Part 7 – Fire (Part B)	7.1
7.1	Introduction	7.1
7.2	Terminology	7.6
7.3	Occupancy classifications: Purpose groups etc.	7.16
7.4	Rules for measurement	7.21
7.5	Means of warning and escape in case of fire	7.25
7.6	Means of escape	7.26

7.7 Interpretation of AD B1 7.28
7.8 General requirements for means of warning and escape 7.31
7.9 Rules for measurement for means of escape 7.33
7.10 Fire alarm and fire detection systems 7.37
7.11 Sprinkler systems 7.44
7.12 Means of escape in dwellinghouses 7.46
7.13 Flats and maisonettes 7.54
7.14 Means of escape from buildings other than dwellinghouses, flats and maisonettes 7.73
7.15 General recommendations common to all buildings except dwellinghouses 7.96
7.16 Alternative approach to the provision of means of escape in selected premises 7.103
7.17 Internal fire spread (linings) 7.112
7.18 Internal fire spread (structure) 7.125
7.19 Fire resistance and structural stability 7.125
7.20 Compartment walls and floors: Construction details 7.143
7.21 Concealed spaces (cavities) 7.155
7.22 Pipes, ventilation ducts and flues 7.162
7.23 Variations to the provisions of parts relating to B3 in the ADs 7.166
7.24 External fire spread 7.168
7.25 External walls 7.168
7.26 Special provisions relating to shopping complexes and buildings used as car parks 7.196
7.27 Shopping complexes 7.199
7.28 Access and facilities for the fire service 7.199
7.29 Firefighting and the use of insulating core panels for internal structures 7.212
7.30 Regulation 38: Provision of information 7.215
8 Materials, workmanship, site preparation and moisture exclusion (Part C) 8.1
8.1 Materials and workmanship 8.1
8.2 The influence of European standards 8.2
8.3 The Construction Products Regulations 2011 8.3
8.4 Materials and workmanship 8.4
8.5 Site preparation and moisture exclusion 8.8
9 Toxic substances (Part D) 9.1
9.1 Introduction 9.1
9.2 Cavity insulation 9.1
10 Sound insulation (Part E) 10.1
10.1 Introduction 10.1
10.2 Performance standards 10.4
10.3 Pre-completion testing 10.9
10.4 Separating walls and their flanking constructions: New buildings 10.14
10.5 Separating floors and their flanking constructions: New buildings 10.37
10.6 Dwelling houses and flats formed by material change of use 10.53
10.7 Internal walls and floors for new buildings 10.61
10.8 Rooms for residential purposes 10.66

	10.9	Robust Details: An alternative to pre-completion testing	10.69
	10.10	Reverberation in common parts of buildings	10.73
	10.11	School acoustics	10.79
	10.12	Calculation of sound transmission indices	10.79
	10.13	The calculation of mass	10.86
	10.14	Explanation of important terms	10.89
11	Ventilation (Part F)		11.1
	11.1	Introduction	11.1
	11.2	Definition and interpretation of terms	11.2
	11.3	General principles	11.5
	11.4	Part F: The requirements and their applicability	11.8
	11.5	The ventilation of new dwellings	11.11
	11.6	The ventilation of new buildings other than dwellings	11.29
	11.7	Work on existing buildings	11.37
	11.8	Performance-based ventilation	11.39
	11.9	Passive stack ventilation (PSV) system design	11.44
	11.10	Ingress of external pollution	11.46
12	Sanitation, hot water safety and water efficiency (Part G)		12.1
	12.1	Introduction	12.1
	12.2	Definition and interpretation of terms	12.3
	12.3	Part G1: Cold water supply	12.7
	12.4	Part G2 and Regulation 36: Water efficiency	12.9
	12.5	Part G3: Hot water supply and systems	12.12
	12.6	Part G4: Sanitary conveniences and washing facilities	12.24
	12.7	Part G5: Bathrooms	12.27
	12.8	Part G6: Food preparation areas	12.27
13	Drainage and waste disposal (Part H)		13.1
	13.1	Introduction	13.1
	13.2	Repairs, alterations and discontinued use of drains and sewers	13.1
	13.3	Sanitary pipework and drainage	13.4
	13.4	Wastewater treatment systems and cesspools	13.38
	13.5	Greywater and rainwater storage tanks	13.51
	13.6	Rainwater drainage	13.52
	13.7	Rainwater drainage below ground	13.60
	13.8	Building over existing sewers	13.66
	13.9	Separate systems of drainage	13.70
	13.10	Solid waste storage	13.72
14	Combustion appliances and fuel storage systems (Part J)		14.1
	14.1	Introduction	14.1
	14.2	Interpretation	14.3
	14.3	Rules for measurement	14.11
	14.4	Checking the condition of combustion installations before use	14.11
	14.5	Requirement J1: Air supply	14.13
	14.6	Requirement J2: Discharge of products of combustion	14.23
	14.7	Requirement J4: Protection of building against fire and heat	14.47
	14.8	Repair and reuse of existing flues	14.62

14.9 Test methods 14.65
14.10 Requirement J5: Provision of information 14.69
14.11 Alternative means of compliance 14.71
14.12 Requirement J6: Protection of liquid fuel storage systems 14.72
14.13 Requirement J7: Protection against pollution 14.77
15 Protection from falling, collision and impact (Part K) 15.1
15.1 Introduction 15.1
15.2 Stairways, ladders and ramps (K1) 15.2
15.3 Application 15.2
15.4 Interpretation 15.3
15.5 General recommendations for stairways and ramps 15.5
15.6 Stairway construction 15.7
15.7 Internal and external ramps which form part of a building 15.13
15.8 Guarding of stairways, ramps and landings 15.14
15.9 Access to maintenance areas 15.16
15.10 Alternative approach to stairway design 15.17
15.11 Protection from falling 15.17
15.12 Vehicle barriers and loading bays 15.18
15.13 Protection against impact (with glazing) 15.19
15.14 Protection from collision with open windows, skylights or ventilators 15.22
15.15 Manifestation of glazing 15.25
15.16 Safe use of windows, skylights and ventilators 15.25
15.17 Safe access for cleaning glazed surfaces 15.27
15.18 Generally 15.28
15.19 Safe use of doors 15.29
15.20 Sources of further guidance 15.30
16 Conservation of fuel and power (Part L) 16.1
16.1 Introduction 16.1
16.2 Definition and interpretation of terms 16.2
16.3 The Buildings Regulations 2010 relevant to Part L 16.10
16.4 Part L: Exemptions and relaxations from Part L 16.18
16.5 Part L: The requirement and general applicability 16.25
16.6 Approved Document L1A: Conservation of fuel and power in new dwellings 16.26
16.7 Part L1B: Conservation of fuel and power in existing dwellings 16.46
16.8 Part L2A: Conservation of fuel and power in new buildings other than dwellings 16.57
16.9 Part L2B: Conservation of fuel and power in existing buildings other than dwellings 16.80
16.10 U-values 16.95
16.11 Part L 2010 Wales 16.126
16.12 References 16.127
17 Access to and use of buildings (Part M) 17.1
17.1 Introduction 17.1
17.2 Interpretation 17.6
17.3 Application 17.9

17.4	Volume 1: Dwellings	17.10
17.5	Volume 2: Buildings other than dwellings	17.20
17.6	Means of escape in case of fire	17.50
17.7	In conclusion	17.50
17.8	Sources of further guidance	17.50
18	Electrical safety (Part P)	18.1
18.1	Introduction	18.1
18.2	Requirement P1	18.2
18.3	Design and installation	18.3
18.4	Application of Part P	18.4
18.5	Certification, inspection and testing	18.6
18.6	Interpretation	18.8
19	Security (Part Q)	19.1
19.1	Introduction	19.1
19.2	Interpretation	19.2
19.3	Requirement Q1: Unauthorised access	19.3
19.4	Requirement Q1: Performance	19.3
19.5	Doors	19.4
19.6	Windows	19.6
19.7	Bespoke timber secure doorsets	19.6
	Index	I.1

About the author

M.J. Billington, BSc, MRICS, MIoR, who has worked on various editions of this book since 1986, is a Chartered Building Surveyor. He was formerly Senior Lecturer in building control and construction at De Montfort University, Leicester, before leaving to join the private sector, where he continued to act as visiting lecturer at a number of universities. Currently he is Managing Director of Construction Auditing Services Ltd, a company that specialises in latent defects technical auditing, and is Chairman of Certass Ltd, one of the leading Building Regulations Competent Persons Schemes for building fabric. Mike is a regular contributor to Knights Building Regulations and is widely published in the fields of building control and building surveying.

S.P. Barnshaw, *BSc(Hons), MRICS, C.Build E, FCABE* is Associate Director - Technical at jhai Limited. Qualified as a Chartered Surveyor and Chartered Building Engineer, Stephen has 30 years experience in the building surveying and building control profession. He has managed services within the private and public sectors and worked on a wide range of high profile buildings and frameworks. He has also been involved in professional training for many years and is Chair of an RICS professional membership panel.

K.T. Bright, *MSc, FRICS, FBEng, MCIOB, NRAC (Consultant)*, is Emeritus Professor of Inclusive Environments at the University of Reading and Visiting Professor of Inclusive Environments in the School of Art and Design at the University of Ulster. He has published widely in academic and practice journals and is the author and editor of several highly regarded reference books related to the development of inclusive environments.

A. Crooks, *MA, FRICS, C.BuildE, FCABE, MIFireE* is Chief Executive at jhai limited, one of the UK's largest approved inspectors. Andrew is a Chartered Surveyor, Chartered Building and Fire Engineer and has 25 years of industry experience delivering services within the private and public sectors on a wide range of buildings and frameworks. He is an RICS and CABE professional membership Chairman and Assessor and a member of the CICAIR Ltd Committees relating to the regulation of Approved Inspectors.

Preface to the fourteenth edition

The thirteenth edition of this book was published in 2007. Since then the Building Regulations have been consolidated and recast and published as the Building Regulations 2010. They came into force on 1 October 2010 and subsequently have been amended no fewer than 10 times. At the same time the Approved Inspector Regulations were also revised and consolidated, coming into force on 1 October 2010 and like the Principal Regulations, these have also been amended several times. To complicate matters further from, 31 December 2011 the responsibility for Building Regulations in Wales was transferred to the Welsh Government. From this date the Welsh Government has been able to amend the Building Regulations specifically for Wales.

At the same time as these changes to the Principal Regulations, many amendments have been made to the Approved Document guidance including the removal of Part N and Approved Document N (except in Wales!) and the inclusion of a new Part Q Security – Dwellings.

For this edition, we are delighted to welcome two new authors to the editorial team - Andy Crooks and Stephen Barnshaw, both of jhai Ltd. With the Regulations becoming ever more complicated it was thought necessary to enlist the expertise of practising professionals in the field of building control and we are grateful for all the hard work they have put in. Specifically, Andy has completely re-written Chapter 7 (Part B - Fire) and Stephen has revised and updated Chapter 10 (Sound Insulation – Part E), Chapter 11 (Ventilation – Part F), Chapter 12 (Sanitation, hot water safety and water efficiency – Part G), Chapter 14 (Combustion Appliances and Fuel Storage Systems – Part J) and Chapter 16 (Conservation of Fuel and Power – Part L).

In detail the following chapters have been completely re-written:

Chapter 5: Work under the supervision of a competent person – revised to take account of the expansion of the types of work now covered by competent person schemes, the consequent increase in their number and complexity and the revisions to the Government terms and conditions that control such schemes.

Chapter 6: Structural Stability – revised to reflect the increased reference to European codes and standards. In order to assist our readers by providing, where possible, as complete a guide to the regulations and Approved Documents as we can in one place, in the previous editions of this book we reproduced the original timber sizing tables from the 1992 edition of AD A. For copyright reasons we are unable to reproduce the Tables from the TRADA document that replaced those earlier AD A Tables and unfortunately, the tables from the 1992 edition no longer comply with Eurocode 5. For these reasons we have decided, reluctantly, not to reproduce the old Approved Document Tables.

Chapter 7: Fire. Fire safety legislation throughout England and Wales was consolidated between 2005 and 2013 with amendments to both the Building Regulations and a great deal of other fire legislation. Reliance solely on Approved Document B (Volumes 1 and 2) can produce solutions that are unnecessarily complicated and/or expensive, therefore this chapter, whilst concentrating on the Approved Document B guidance, where applicable draws parallels with British Standard 9999 to illustrate the different approaches to design that exist. In December 2011, responsibility for building regulations was transferred to the Welsh Government. Therefore as discussed in some other chapters, the legislation, supporting guidance and enforcement standards in Wales will start to change in the next few years.

In respect of fire safety, this process has already started. The Domestic Fire Safety (Wales) Measure 2011, after being passed by the National Assembly for Wales, received Royal Assent on 7 April 2011. This Measure provides the Welsh Government with the ability to require that new homes are fitted with 'an effectively operating fire suppression system'.

Chapter 8: Materials, workmanship, site preparation and moisture exclusion – for materials and workmanship this chapter has been revised to reflect full implementation of European Regulation 305/2011/EU-CPR covering construction products, referred to as the Construction Products Regulations 2011.

Chapter 12: Sanitation, hot water safety and water efficiency. This chapter covering Part G and Approved Document G, came into force on 6 April 2010 and contained many significant changes from its predecessor to both the legal requirements and the technical guidance. These changes were reflected in a new format, in which AD G now consists of an introduction, six parts and three appendices. Part G now includes guidance on cold water supply and water efficiency in addition to the updated recommendations for hot water supply and systems and sanitary conveniences and washing facilities.

Chapter 14: Combustion appliances and fuel storage systems – revised to reflect the expansion of Part J in 2010 to seven parts with a new requirement covering the provision of carbon monoxide alarms in dwellings where solid fuel appliances are installed. To incorporate this requirement adjacent to the existing requirement for the discharge of products of combustion involved a reordering of the numbering in respect of the various parts.

Chapter 15: Protection from falling, collision and impact. This chapter now incorporates the changes to the Building Regulations in 2013 which extended the Approved Document to Part K (AD K) to incorporate some of the provisions for stairs and ramps previously included in the 2004 edition of Approved Document to Part M (AD M 2004). The new 2013 edition of AD K was also extended to include all of the requirements for manifestation that had previously been shared by AD M and the Approved Document to Part N (AD N). These changes to AD K and AD M in 2013 and a rationalisation of the overlapping guidance covered within them, allowed the withdrawal of AD N.

The changes to AD M in 2013 have subsequently been subsumed into the 2015 edition of Part M and the 2015 edition of Approved Document M. However, caution should be exercised since the changes made in 2013 to Parts K and M and the withdrawal of Part N and the introduction of Part M 2014 and its Approved Document (AD M 2015) apply only to England. They do not apply to Wales. Whilst Wales is in the process of reviewing these and other Regulations, the versions of Parts K, M and N that are relevant in Wales at the time of publication of this book are those that were in force in England and Wales prior to April 2013.

Chapter 16: Conservation of fuel and power. This chapter has been revised to describe the continuing trend towards higher standards of energy conservation thereby ensuring compatibility with the European Energy performance of Buildings Directive (EPBD) and the national government's stated objective to achieve a zero carbon standard for new dwellings by 2016 and in new non-domestic buildings by 2019.

Chapter 17: Access to and use of buildings. See the paragraph on chapter 15 above to see the main changes brought about in Part M and chapter 17. All the substantive changes made in AD M relate to the guidance for 'Buildings other than dwellings' (Regulations M1, M2 and M3). The guidance relating to 'dwellings' (Regulation M4) has been amended to reflect the baseline mandatory requirements only and does not address the optional enhanced requirements.

Chapter 18: Electrical safety – renumbered from the former chapter 19 to reflect the deletion of Part N and its inclusion in chapter 15. The latest 2013 revision of Approved Document P came into force on 6 April 2013. The main changes brought about by the 2013 amendment include changes in the legal requirements as follows:

- The range of electrical installation work that is notifiable (where there is a requirement to certify compliance with the Building Regulations) has been reduced.
- An installer who is not a registered competent person may use a registered third party to certify notifiable electrical installation work as an alternative to using a building control body.
- Approved Document P now refers to BS 7871:2008 incorporating Amendment No. 1:2011.

Chapter 19: Security – this chapter covers the new Part Q of Schedule 1 to the 2010 Regulations (as amended) and is concerned with the prevention of unauthorised access to new dwellings. It was introduced in the Building Regulations &c. (Amendment) Regulations 2015 (SI 2015 No. 767). The amendment regulations came into force generally on 18 April 2015; however, Part Q did not come into force until 1 October 2015. It follows the lead of the Scottish Executive where security provisions have been part of the Scottish Building Regulations and Standards for a number of years.

Appendix: Local Acts of Parliament- this appendix has been omitted from the 14th edition of this book as all of the former local act provisions have now been incorporated into the building regulations or have been repealed.

As always, the aim of this book is to provide a convenient and straightforward guide and reference to a complex and constantly evolving subject. It must be stressed that this book is a guide to the Regulations and approved and other documents, and is not a substitute for them. We hope that it may shed light on some of the more obscure and difficult to understand parts of the source documents. It should also be stressed that the guidance in the Approved Documents is not mandatory and differences of opinion can quite legitimately exist between controllers and developers or designers as to whether a particular detail in a building design does actually satisfy the mandatory functional requirements of the Building Regulations.

The intended readers of this book are all those concerned with building work – architects and other designers, building control surveyors, members of competent person schemes, building surveyors, clerks of works, services engineers and contractors etc. – as well as their potential successors, the current generation of students on built environment and architectural courses. This book is designed to be of use to both students and teachers and it is gratifying that successive editions are widely adopted by various academic institutions and professional bodies.

We are grateful to Tim Burgin at jhai Ltd for his invaluable help with the diagrams for Chapter 7. As always, we are especially grateful to Paul Sayer, Publisher (Civil Engineering and Construction) at John Wiley & Sons Ltd and his editorial team, for their help, patience and interest during the production of this edition.

The law is stated on the basis of cases reported and other material available to us on 1 October 2016.

M.J. Billington
S.P. Barnshaw
K.T. Bright
A. Crooks

Stop press

As often happens, as we were about to go to press a new Part R – *Physical infrastructure for high-speed electronic communications networks* came into force on 1 January 2017. It applies in England and to building work carried out on excepted energy building in Wales as defined in the Welsh Ministers (Transfer of Functions) (No.2) Order 2009.

It contains one regulation R1 entitled '*In-building physical infrastructure*'

R1 states:

(1) Building work must be carried out so as to ensure that the building is equipped with a high-speed-ready in-building physical infrastructure, up to a network termination point for high-speed electronic communications networks.
(2) Where the work concerns a building containing more than one dwelling, the work must be carried out so as to ensure that the building is equipped in addition with a common access point for high-speed electronic communications networks.

The requirement applies to building work that consists of:

(a) The erection of a building; or
(b) Major renovation works to a building.

The practical effect of R1 is that a duct must be provided from the service provider's access point in the building to where the occupier's network termination point is sited. Where a standard copper telephone cable is installed and connected to the service provider's fibre network this will satisfy the requirement.

Acknowledgements

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All other documents referred to in the text are fully cited and may be obtained from the usual technical bookshops.

I Legal and administrative

1 Building control: An overview

1.1 Introduction

The building control system in England and Wales was radically revised in 1985. After a long period of gestation, Building Regulations were laid before Parliament and came into general operation on 11 November 1985. They applied to Inner London from 6 January 1986. Subject to specified exemptions, all building work (as defined in the regulations) in England and Wales is governed by Building Regulations.

Wales has its own regulations, and from 31 December 2011, the responsibility for Building Regulations in Wales was transferred to the Welsh Government. From this date the Welsh Government is able to amend them specifically for Wales.

The current regulations are the Building Regulations 2010 which came into force on 1 October 2010. The 2010 Regulations have been amended ten times since then, the latest being the Building Regulations &c. (Amendment) Regulations 2015 (SI 2015/767) which came into force at various times between 18 April 2015 and 31 December 2015, and the provisions of all these amendments are reflected in this book. It should be noted that SI 2015/767 does not apply in relation to any building in Wales other than an 'excepted energy building' as defined in the Schedule to the Welsh Ministers (Transfer of Functions) (No. 2) Order 2009.

A separate system of building control applies in Scotland and in Northern Ireland.

The power to make Building Regulations is vested in the Secretary of State by section 1 of the Building Act 1984 which sets out the basic framework. Building Regulations may be made for the following broad purposes:

- Securing the health, safety, welfare and convenience of people in or about buildings and of others who may be affected by buildings or matters connected with buildings.
- Furthering the conservation of fuel and power.
- Preventing waste, undue consumption, misuse or contamination of water.

The 2010 Regulations are relatively short and contain no technical detail. That is found in a series of Approved Documents and certain other non-statutory guidance, all of which refer to other non-statutory documents such as National Standards, European Standards, European Technical Approvals or Technical Specifications (e.g. British Standards, Agrément Certificates), with the objective of making the system more flexible and easier to use.

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

The 2010 Regulations implement the final conclusions of a major review of both the technical and procedural requirements.

A significant feature of the system is that there are alternative systems of building control – one by local authorities and the other a private system of certification which relies on 'approved inspectors' operating under a separate set of regulations called The Building (Approved Inspectors, etc.) Regulations 2010. These regulations have also been amended since 2010. These set out the detailed procedures for operating the system of private certification and came into effect at the same time as the main regulations. Since April 2002 a further system of approval has been added whereby certain competent persons can self-certify their work as complying with the Building Regulations. This system is fully discussed in Chapter 5.

1.2 The Building Act 1984

The Building Act 1984 received the Royal Assent on 31 October 1984 and the majority of its provisions came into force on 1 December 1984. It consolidated most, but not all, of the primary legislation relating to building which was formerly scattered in numerous other Acts of Parliament. Since 1984 the Act has been amended on numerous occasions by a variety of other statutory provisions. The comments in this section reflect the state of the Act at the date of this publication.

Part I of the Building Act 1984 is concerned with Building Regulations and related matters, whilst Part II deals with the system of private certification discussed in Chapter 4. Other provisions about buildings are contained in Part III which, amongst other things, covers drainage and the local authority's powers in relation to dangerous buildings, defective premises, etc.

The provisions of the 1984 Act are of the greatest importance in practice, and many of them are referred to in this and the subsequent chapters.

'Building' is defined in the 1984 Act in very wide terms. A building is 'any permanent or temporary building, and, unless the context otherwise requires, it includes any other structure or erection of whatever kind or nature (whether permanent or temporary)'. 'Structure or erection' includes a vehicle, vessel, hovercraft, aircraft or other movable object of any kind in such circumstances as may be prescribed by the Secretary of State. The Secretary of State's opinion is, however, qualified. The circumstances must be those which 'in [his] opinion … justify treating it … as a building'.

The result of this definition is that many things which would not otherwise be thought of as a building may fall under the Act – fences, radio towers, silos, air-supported structures and the like.

In the past, doubt has been cast over the status of structures such as residential park homes and marquees. Provided that a residential park home conforms to the definition given in the Caravan Sites and Control of Development Act 1960 (as augmented by the Caravan Sites Act 1968), it is exempt from the definition of 'building' contained in the regulations, and according to the *Manual to the Building Regulations*, a marquee is not regarded as a building.

Happily, as will be seen, there is a more restrictive definition of 'building' for the purposes of the 2010 Regulations, but a comprehensive definition is essential for general purposes, e.g. in connection with the local authority's powers to deal with dangerous structures. Hence the statutory definition is necessarily couched in the widest possible terms. In general usage (and at common law) the word 'building' ordinarily means 'a structure of considerable size intended to be permanent or at least to last for a considerable time' (*Stevens* v. *Gourely* (1859) 7 CBNS 99), and considerable practical difficulties arose as to the scope of earlier Building Regulations which the 1984 definition has removed.

In *Seabrink Residents Association* v. *Robert Walpole Campion and Partners* (1988) (6-CLD-08–13; 6-CLD-08–10; 6-CLD-06–32), for example, the High Court held that walls and bridges on a residential development were not subject to the then Building Regulations 1972 because they were not part of 'a building'. The development was not to be considered as a homogenous whole. The then regulations, said Judge Esyr Lewis QC, were 'concerned with structures which have walls and roofs into which people can go and in which goods can be stored'. Each structure in the development must be looked at separately to see whether the regulations applied. 'Obviously a wall may be part of a building and so, in my view, may be a bridge.'

1.3 The linked powers

Local authorities exercise a number of statutory public health functions in conjunction with the process of building control, although these have been reduced in recent years, for example, controls on construction of drains and sewers. These provisions are commonly called 'the linked powers' because their operation is linked with the local authority's building control functions, both in checking deposited plans or considering a building notice, and under the approved inspector system of control. Many of the former linked powers have been brought under the Building Regulations, but local authorities are responsible for certain functions now found in the 1984 Act. In those cases, the local authority must reject the plans (or building notice) or the approved inspector's initial notice if relevant compliance is not achieved or else must impose suitable safeguards. The relevant provisions are:

(a) Section 21 – Provision of drainage. Although subsections (1) and (2) of this section have been replaced by requirement H1 of Schedule 1 to the Building Regulations 2010 (see Chapter 13, section 13.3), a local authority (or on appeal a magistrates' court) may still require a proposed drain to connect with a sewer where that sewer is within 100 feet of the site of the building. In cases where the sewer is located more than 100 feet from the site of the building, the local authority may still require connection to that sewer if they undertake to bear the additional cost (i.e. for the length of drain in excess of 100 feet) of construction, maintenance and repair. Disputes regarding the cost of the additional work may be referred to the magistrates' court. Additionally, the local authority can insist that the drainage connects to a nearby public sewer. Disputes under section 21 are dealt with by a magistrates' court. A related provision is section 98 of the Water Industry Act 1991 under which owners or occupiers of premises can require the water authority to provide a public sewer for domestic purposes in their area, subject to various conditions which can include in an appropriate case the making of a financial contribution.

(b) Section 22 – Drainage of building in combination. The powers of a local authority under section 21 are extended by this section so that, where two or more buildings are involved, the local authority may require them to be drained in combination (instead of each making a separate connection) into an existing sewer. As for section 21, the drain may be constructed by the owners (or by the local authority on their behalf) and the expenses of construction, maintenance and repair may be proportioned between each owner and the local authority as appropriate. Disputes regarding the cost of the apportionment may be referred to the magistrates' court.
(c) Section 25 – Provision of water supply. This section requires the local authority to reject plans of a house submitted under the Building Regulations unless they are satisfied with the proposals for providing the occupants with a sufficient supply of wholesome water for domestic purposes, by pipes or otherwise. The water supply can be provided in any of the following ways:
    - by connecting the house to a water supply provided by a water undertaker (i.e. a mains supply);
    - where it is not reasonable to connect to a mains supply (in remote country districts there may be no mains supply) by taking the water into the house by means of a pipe (e.g. from a well or spring);
    - where circumstances exist which make either of the foregoing solutions unreasonable, the supply of water may be located within a reasonable distance of the house.

This last solution is interesting when considered against the requirements of paragraph G5 of Schedule 1 to the Building Regulations. G5 demands that in a dwelling a '*bathroom must be provided containing a wash basin and either a fixed bath or shower bath*'. It is difficult to see how this could be achieved if a water supply is not provided in the dwelling.

The wholesomeness of water is judged by reference to section 67 of the Water Industry Act 1991 (standards of wholesomeness of water) as read with regulations made under that Act (i.e. the Water Supply (Water Quality) Regulations 2001). Disputes are determined by the magistrates' court. A related provision is section 37 of the Water Industry Act 1991, which enables a landowner who proposes to erect buildings to require the water authority to lay necessary mains for the supply of water for domestic purposes to a point which will enable the buildings to be connected to the mains at a reasonable cost, a provision which is of considerable use to developers.

1.4 Building Regulations

The Secretary of State is given power to make comprehensive regulations about the provision of services, fittings and equipment in or in connection with buildings, as well as about the design and construction of buildings. A very comprehensive list of the subject matter of Building Regulations is contained in Schedule 1 of the 1984 Act. The Regulations are supported by Approved Documents, giving 'practical guidance' (see section 2.3).

Building Regulations may include provision as to the deposit of plans of executed, as well as the proposed work, for example, where work has been done without the deposit of plans or there has been a departure from the approved plans. Broad powers are given to make Building Regulations about the inspection and testing of work and the taking of samples.

Prescribed classes of buildings, services, etc. may be wholly or partially exempted from regulation requirements. Similarly, the Secretary of State may, by direction, exempt any particular building or buildings at a particular location.

Schedule 1 of the 1984 Act is a flexible provision and covers the application of the regulations to existing buildings. It enables regulations to be made regarding not only alterations and extensions but also the provision, alteration or extension of services, fittings and equipment in or in connection with existing buildings. It also enables the regulations to be applied on a *material change of use* as defined in the regulations and, very importantly, makes it possible for the regulations to apply where reconstruction is taking place, so that the regulations can deal with the whole of the building concerned and not merely with the new work.

The 1984 Act contains enabling powers for the making of regulations on a number of procedural matters (Fig. 1.1).

The regulations made and currently in force are:

- The Building Regulations 2010 (as amended)
- The Building (Approved Inspectors, etc.) Regulations 2010 (as amended)
- The Building (Local Authority Charges) Regulations 2010
- The Building (Inner London) Regulations 1985

Most of these regulations have been amended, in some cases several times, and care should be taken to ensure that the most recent amendments are being used.

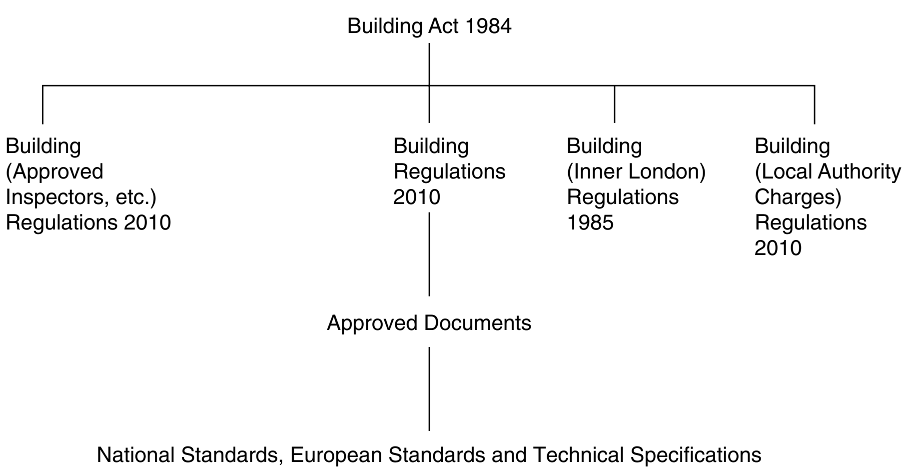


Fig. 1.1 Building control: the legislative scheme.

1.5 Building Regulations: Exemptions

1.5.1 Crown immunity

The Building Regulations do not apply to premises which are occupied by the Crown. It is an established rule of statutory interpretation that the Crown is not bound by an Act of Parliament except by express provision or necessary implication. Therefore, an Act of Parliament must specifically state that the Crown is covered by the provisions in order that it be bound by them, and, in fact, there is a provision in section 44 of the Building Act 1984 to apply the substantive requirements of the regulations to Crown buildings but this has never been activated.

In practice, it is normal for government department building work to be designed and constructed in accordance with the Building Regulations. In some areas the plans and particulars may even be submitted to the local authority for comment, although it is more usual for these to be scrutinised by specialist companies (replacing the service which was formally given by the Property Services Agency) who will also carry out on-site inspections of the works in progress. Even so, such companies have no legal control over the work and cannot take enforcement action in the event of a breach of the Regulations.

Interestingly, Crown premises are not exempt from control under the Regulatory Reform (Fire Safety) Order 2005, which replaced the former fire certification system under the Fire Precautions Act 1971. However, where independent inspection is needed of such premises, they are inspected *not* by the relevant fire and rescue authority but by the Crown Premises Inspection Group within the Home Office Fire Service Inspectorate, a bureaucratic anomaly, which has attracted much criticism. Unfortunately, the powers of entry to premises contained in the former 1971 Act (and now contained in the Regulatory Reform (Fire Safety) Order 2005) do not apply to premises occupied by the Crown.

According to the Building Act 1984, a Crown building is defined as '*a building in which there is a Crown interest or a Duchy interest*'. This definition necessitates the following additional definitions:

Crown interest means – '*an interest belonging to Her Majesty in right of the Crown, or belonging to a government department, or held in trust for Her Majesty for the purposes of a government department*'

Duchy interest means – '*an interest belonging to Her Majesty in right of the Duchy of Lancaster, or belonging to the Duchy of Cornwall*'.

Examples of Crown buildings include not only the Royal Palaces, the Houses of Parliament, 10 Downing Street, etc. but also all government offices (such as local Job Centres) across England and Wales.

Over the years a number of bodies have lost Crown immunity. These include:

- Health Service Premises – under the provisions of section 60 of the National Health Service and Community Care Act 1990, health service bodies are no longer regarded as the servant or agent of the Crown in respect of land over which they have powers of disposal or management or which is otherwise used or occupied by them. Subsection

(7) of section 60 defines *Health Service Bodies* in relation to England and Wales as a Family Health Services Authority, the Dental Practice Board and the Public Health Laboratory Service Board. In practice, this covers regional, district and special health authorities and means that health service buildings are now subject to the full substantive and procedural provisions of building, planning and fire precautions legislation enforceable by local authorities.
- The Metropolitan Police – although no longer regarded as servants or agents of the Crown, the Metropolitan Police Authority has been exempted from having to comply with the procedural requirements of the Building Regulations, using the powers available under section 5 of the Building Act 1984 (exemption of public bodies from the procedural requirements and enforcement of Building Regulations). However, it is still required to comply with the substantive or technical requirements of the Regulations. As an exempt body the Metropolitan Police Authority is also exempt from enforcement procedures by local authorities. Instead, the Metropolitan Police Authority as a '*Public Body*' is bound by the provisions of the Building Act 1984, section 54 (Supervision of their own work by public bodies) and by Part VII (Public Bodies) of the Building (Approved Inspectors, etc.) Regulations 2010 (as amended).

Finally, the reorganisation of the Post Office has meant that, whilst the Royal Mail was regarded as Crown property after privatisation in 2013 this is no longer the case. Post Office Counters is not regarded as Crown property.

1.5.2 Building Act exemptions

Taken together, the Building Act 1984 and the Building Regulations 2010 (as amended) exempt certain uses of buildings and many categories of work from control as is illustrated by the following examples.

- As a result of the repeal of regulation 8 of the Education (Schools and Further and Higher Education) Regulations 1989, maintained schools in England ceased to have exemption from the Building Regulations from 1 April 2000. A similar situation has existed in Wales since 1 January 2002 following the passing of the Education (Schools and Higher and Further Education) (Amendment) (Wales) Regulations 2001. As a result, building works at schools are now treated in the same way as in other user groups and are subject to normal building control procedures. This is a change in the approval process, meaning that building regulation submissions in respect of work to maintained schools now have to be made to the appropriate building control body (local authority or Approved Inspector) but does not affect the standards applicable to schools. The change does not affect in any way the status of the Education (School Premises) Regulations 1999, which continues to apply to all schools. These regulations cover general standards of provision of facilities, such as:
  - in day schools, accommodation for washrooms, medical purposes, staff, cloakrooms, canteens, etc.;
  - in boarding schools, accommodation for sleeping, washing (including bathrooms), living (for study outside school hours and for social purposes), preparing and consuming meals, medical purposes, staff and storage.

They also cover general constructional requirements such as:

- structural stability;
- weather protection;
- means of escape in case of fire and other health, safety and welfare issues;
- acoustics, lighting, heating and ventilation;
- water supplies and drainage.

For many years, constructional standards for schools were set by the former Department for Education and Science (DfES) in England (now the Department for Education (DfE)) and the National Assembly for Wales in Wales, the most recent ones being the School Premises Regulations 2012 which came into force on 31 October 2102. Virtually all of the requirements of these standards for school buildings have now been incorporated into the building regulation Approved Documents, which sometimes refer to DfE *Building Bulletins* as alternatives to the normal Approved Document guidance. For example:

- Ventilation provisions in schools can be made in accordance with the guidance in DfE Building Bulletin 101, *Ventilation of school buildings* (http://www.nfan.co.uk/pdfs/building_bulletin_school_buildings.pdf), and in The Education (School Premises) Regulations 1999. In spaces where noxious fumes may be generated, additional provision for ventilation should be made and may require the use of fume cupboards. Fume cupboards in schools should comply with DfE Building Bulletin 88, *Fume cupboards in schools*, 1998.
- For acoustics, Approved Document E (*Resistance to the passage of sound*) refers the reader to Building Bulletin 93 (*The acoustic design of schools*) for guidance on acoustic conditions and disturbance by noise (see Chapter 10, section 10.11).

Care should be taken to use the most recent edition of these alternative sources of guidance since they are regularly updated by DfE.

Further information on alternative sources of guidance can be obtained from the Schools Assets Team, Education Funding Agency, Area D, Ground Floor, Mowden Hall, Staindrop Road, Darlington, Co Durham DL3 9BG. Tel (01325) 735791. E-mail: schoolsassets.EFAcapital@education.gsi.gov.uk.

- *Statutory undertakers and other public bodies* – Under section 4 of the Building Act 1984, a building belonging to a statutory undertaker, the United Kingdom Atomic Energy Authority, or the Civil Aviation Authority is exempt from the application of Building Regulations, provided that the building in question is held or used by them for the purposes of their undertaking.

  'Statutory undertaker' as defined in section 126 of the Building Act 1984 (as amended) means '*persons authorised by an enactment or statutory order to construct, work or carry on a railway, canal, inland navigation, dock harbour, tramway or other public undertaking*'.

  From this definition it is clear that Post Offices (i.e. the actual high street 'shops' where the public resort for postal services) are no longer regarded as statutory undertakers within the meaning of section 126; consequently they are now required to comply with the Building Regulations, including submissions of work to the appropriate building control body. Interestingly, Royal Mail (which deals with the collection, sorting and delivery of mail) was still regarded as a Crown body until privatisation in 2013 and is therefore no longer exempt from compliance with the Building Regulations.

The status of statutory undertakers has been complicated by the fact that a number of former public bodies are now in private hands. This has meant that it has been necessary to pass additional legislation in order to clarify the status of some of these bodies. As a consequence, the following bodies are deemed to be statutory undertakers:

- public gas suppliers (see sections 67(3) and 67(4) of the Gas Act 1986);
- electricity suppliers (see section 112(4) of the Electricity Act 1989);
- the National Rivers Authority (see section 190(1) of the Water Act 1989);
- water and sewerage undertakers (see section 190(1) of the Water Act 1989).

The building of the statutory undertaker must be one which is held or used by them for the purposes of the undertaking; therefore the exemption from the application of Building Regulations granted by virtue of section 4 of the Building Act 1984 is subject to the following exceptions, in respect of which Building Regulations do apply:

(1) a house
(2) a building used as offices or showrooms unless:
it forms part of a railway station, or
in the case of the Civil Aviation Authority, it is on an aerodrome owned by the Authority.

A further class which enjoys an exemption under section 4 is a building belonging to a person who holds a license under Chapter I of Part I of the Transport Act 2000 (air traffic services) and held or used by the person for the purpose of carrying out activities authorised by the license. Section 4 applies in relation to a relevant body as it applies to a statutory undertaker, subject to the following variations:

(1) houses are not exempt from compliance with the regulations;
(2) offices and showrooms are not exempt from compliance with the regulations.

It should be noted that local authority buildings are *not* exempt from either the procedural or substantive requirements of the Building Regulations.

1.5.3 Miscellaneous

Under section 16 of the Building Act 1984, there is power to approve the plans of a proposed building by stages. Usually, the initiative will rest with the applicant as to whether to seek approval by stages – subject to the local authority's agreement.

However, local authorities may – of their own initiative – give approval by stages; they might, for example, await further information. In giving stage approval, local authorities will be able to impose a condition that certain work will not start until the relevant information has been produced.

Plans may also be approved subject to agreed modifications, e.g. where there is a minor defect in the plans.

Section 19 of the Building Act 1984 deals with the use of short-lived materials. The provision applies where plans, although conforming to the regulations, include the use of items listed in the regulations for the purpose of section 19. In such circumstances the local authority has discretion:

- to pass the plans;
- to reject the plans; or
- to pass them subject to the imposition of a time limit, whether conditionally or otherwise.

Interestingly, the Building Regulations 2010 (as amended) contain no specific references to any particular materials; however, as will be seen, regulation 7 of the 2010 Regulations requires that building work which must comply with the Schedule 1 requirements must be carried out 'with proper materials which are appropriate for the circumstances in which they are used …', and the supporting approved document deals with the use of short-lived materials.

The local authority may impose a time limit either on the whole of a building or on particular work. Additionally, they may impose conditions as to the use of a building or the particular items concerned. Appeal against the local authority's decision lies to the Secretary of State.

Eventually, section 19 will cease to have effect when section 20, which is wider in scope, is brought into force by the Secretary of State.

Under section 2, Building Regulations may impose continuing requirements on the owners and occupiers of buildings, including buildings which were not, at the time of their erection, subject to Building Regulations. These requirements are of two kinds.

Continuing requirements may be imposed, *first,* in respect of designated provisions of the regulations to ensure that their purpose is not frustrated, e.g. the keeping clear of fire escapes and, *second,* in respect of services, fittings and equipment, e.g. a requirement for the periodical maintenance and inspection of lifts in flats.

Type relaxations are dealt with in section 11. They may be granted by the Secretary of State whereby he may dispense with or relax some regulation requirement generally. A type relaxation can be made subject to conditions or for a limited period only. It should be noted that before granting a type relaxation the Secretary of State must consult such bodies as appear to him to be representative of the interests concerned and he has to publish notice of any relaxations issued.

The Building Act 1984, sections 39 to 43, contains the appeal provisions. The principal appeals to the Secretary of State are:

- appeals against rejection of plans by a local authority; and
- appeals against a local authority's refusal to give a direction dispensing with or relaxing a requirement of the regulations or against a condition attached by them to such a direction.

Interestingly, section 38 of the Building Act 1984 is concerned with civil liability but has yet to be activated. Under this section, breach of duty imposed by the regulations will be actionable at civil law, where damage is caused, except where the regulations otherwise provide. 'Damage' is defined as including the death of, or injury to, any person (including any disease or any impairment of a person's physical or mental condition). The regulations themselves may provide for defences to such a civil action, and section 38 will not, when operative, prejudice any right which exists at common law.

1.6 Dangerous structures, etc.

Local authorities have power to deal with a building or structure which is in a dangerous condition or is overloaded. The procedure is for the local authority to apply to the magistrates' court for an order requiring the owner to carry out remedial works or, at his option, to demolish the building or structure and remove the resultant rubbish. The court may restrict the use of the building if the danger arises from overloading. If the owner fails to comply with the order within the time limit specified by the court, the local authority may execute the works themselves and recover the expenses incurred from the owner, who is also liable to a fine (Building Act 1984, section 77).

Under section 78 of the Building Act 1984, the local authority may take immediate action in an emergency so as to remove the danger, e.g. if a wall is in danger of imminent collapse. Where it is practicable to do so, they must give notice of the proposed action to the owner and occupier. The local authority may recover expenses which they have reasonably incurred in taking emergency action, unless the magistrates' court considers that they might reasonably have proceeded under section 77. An owner or occupier who suffers damage as a result of action taken under section 78 may in some circumstances be entitled to recover compensation from the local authority.

Section 79 of the 1984 Act empowers local authorities to deal with ruinous and dilapidated buildings or structures and neglected sites 'in the interests of amenity', which is a term of wider significance than 'health and safety': *Re Ellis and Ruislip* v. *Northwood UDC* [1920] 1 KB 343. (Section 76 of the Act enables them to deal with defective premises which are 'prejudicial to health or a nuisance'.)

Under section 79, where a building or structure is in such a ruinous or dilapidated condition as to be seriously detrimental to the amenities of the neighbourhood, the local authority may serve notice on the owner requiring him to repair or restore it or, at his option, demolish the building or structure and clear the site.

Demolition is itself subject to control. Section 80 requires a person who intends to demolish the whole or part of a building to notify the local authority, the occupier of any adjacent building and the gas and electricity authorities of his intention to demolish. He must also comply with any requirements which the local authority may impose by notice under section 82.

The demolition notice procedure does not apply to the demolition of:

- an internal part of an occupied building where it is intended that the building should continue to be occupied;
- a building with a cubic content (ascertained by external measurement) of not more than 1750 cubic feet ($50\,m^3$) or a greenhouse, conservatory, shed or prefabricated garage which forms part of a larger building;
- an agricultural building unless it is contiguous to a non-agricultural building or falls within the preceding paragraph.

The local authority may by notice require a person undertaking demolition to carry out certain works:

- To shore up any adjacent building.
- To weatherproof any surfaces of an adjacent building exposed by the demolition.
- To repair and make good any damage to any adjacent building caused by the demolition.
- To remove material and rubbish resulting from the demolition and clearance of the site.
- To disconnect and seal and/or remove any sewers or drains in or under the building.
- To make good the ground surface.

- To make arrangements with the gas, electricity and water authorities for the disconnection of supplies.
- To make suitable arrangements with the fire authority (and Health and Safety Executive, if appropriate) with regard to burning of structures or materials on site.
- To take such steps in connection with the demolition as are necessary for the protection of the public and the preservation of public amenity.

1.7 Other legislation

Although the Building Act 1984 attempted to rationalise the main controls over buildings, there are in fact a great many pieces of legislation, in addition to the Building Act and the Building Regulations, which affect the building, its site and environment and the safety of working practices on and within the building. Reference to some of this additional legislation is made throughout this book in subsequent chapters.

2 The Building Regulations and Approved Documents

2.1 Introduction

Although the statutory framework of building control is found in the Building Act 1984, the 2010 Regulations, as amended, contain the detailed rules and procedures. The regulations are comparatively short because the technical requirements have mostly been cast in a functional form.

Each technical requirement is supported by a document approved by the Secretary of State intended to give practical guidance on how to comply with the requirements. The Approved Documents refer to British Standards and other guidance material such as BRE publications and thus give designers and builders a great degree of flexibility.

The 2010 Regulations became effective on 1 October 2010 and have since been amended ten times, the latest being the Building Regulations &c. (Amendment) Regulations 2015 (SI 2015/767) which came into force at various times between 18 April 2015 and 31 December 2015, and the provisions of all these amendments are reflected in this book. It should be noted that SI 2015/767 does not apply in relation to any building in Wales other than an 'excepted energy building' as defined in the Schedule to the Welsh Ministers (Transfer of Functions) (No. 2) Order 2009.

2.2 Division of the Regulations

There are 54 regulations, arranged logically in ten parts. The division is as follows:

PART 1: GENERAL

Reg. 1. Citation and commencement.
Reg. 2. Interpretation.

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

PART 2: CONTROL OF BUILDING WORK

Reg. 3. Meaning of building work.
Reg. 4. Requirements relating to building work.
Reg. 5. Meaning of material change of use.
Reg. 6. Requirements relating to material change of use.
Reg. 7. Materials and workmanship.
Reg. 8. Limitation on requirements.
Reg. 9. Exempt buildings and work.
Reg. 10. Exemption of the Metropolitan Police Authority from procedural requirements.
Reg. 11. Power to dispense with or relax requirements.

PART 3: NOTICES, PLANS AND CERTIFICATES

Reg. 12. Giving of a building notice or deposit of plans.
Reg. 13. Particulars and plans where a building notice is given.
Reg. 14. Full plans.
Reg. 15. Consultation with sewerage undertaker.
Reg. 16. Notice of commencement and completion of certain stages of work.
Reg. 17. Completion certificates.
Reg. 17A. Certificate for building occupied before work is complete.
Reg. 18. Unauthorised building work.

PART 4: SUPERVISION OF BUILDING WORK OTHERWISE THAN BY LOCAL AUTHORITIES

Reg. 19. Supervision of building work otherwise than by local authorities.

PART 5: SELF-CERTIFICATION SCHEMES

Reg. 20. Provisions applicable to self-certification schemes.

PART 6: ENERGY EFFICIENCY REQUIREMENTS

Reg. 21. Application of energy efficiency requirements.
Reg. 22. Requirements relating to a change of energy status.
Reg. 23. Requirements relating to thermal elements.
Reg. 24. Methodology of calculation and expression of energy performance.
Reg. 25. Minimum energy performance requirements for new buildings.
Reg. 25A. Consideration of high-efficiency alternative systems for new buildings.

Reg. 25B. Nearly zero-energy requirements for new buildings.
Reg. 26. CO_2 emission rates for new buildings.
Reg. 26A. Target Fabric Energy Efficiency Standard for new dwellings.
Reg. 27. CO_2 emission rate calculations.
Reg. 28. Consequential improvements to energy performance.
Reg. 29. Energy performance certificates.
Reg. 29A. Recommendation reports.
Reg. 30. Energy assessors.
Reg. 31. Related party disclosures.
Reg. 32. Duty of care.
Reg. 33. Right to copy documents.
Reg. 34. Application of building regulations to educational buildings and buildings of statutory undertakers.
Reg. 35. Interpretation of Part 6.

PART 7: WATER EFFICIENCY

Reg. 36. Water efficiency of new dwellings.
Reg. 37. Wholesome water consumption calculation.

PART 8: INFORMATION TO BE PROVIDED BY THE PERSON CARRYING OUT WORK

Reg. 38. Fire safety information.
Reg. 39. Information about ventilation.
Reg. 40. Information about use of fuel and power.

PART 9: TESTING AND COMMISSIONING

Reg. 41. Sound insulation testing.
Reg. 42. Mechanical ventilation air flow rate testing.
Reg. 43. Pressure testing.
Reg. 44. Commissioning.

PART 10: MISCELLANEOUS

Reg. 45. Testing of building work.
Reg. 46. Sampling of material.
Reg. 47. Contravention of certain regulations not to be an offence.
Reg. 48. Electronic service of documents.
Reg. 49. Transitional provisions: interpretation.
Reg. 50. Transitional provisions: work already started before the first of October.

Reg. 51. Transitional provisions: work for which notification is not required.
Reg. 52. Transitional provisions: notice given or plans deposited before 1 October 2010.
Reg. 53. Transitional and saving provisions: earlier Building Regulations.
Reg. 54. Revocations and consequential amendments.

There are also six schedules:

SCHEDULE 1 – REQUIREMENTS

This contains technical requirements which are almost all expressed in functional terms and grouped in 15 parts set out in tabular form:

PART A: STRUCTURE – Covers loading, ground movement and disproportionate collapse.

PART B: FIRE SAFETY – Covers means of warning and escape, internal and external fire spread and access and facilities for the fire service.

PART C: SITE PREPARATION AND RESISTANCE TO CONTAMINANTS AND MOISTURE – Covers preparation of site and resistance to contaminants, subsoil drainage and resistance to weather, interstitial and surface condensation and ground moisture.

PART D: TOXIC SUBSTANCES – Deals with cavity insulation.

PART E: RESISTANCE TO THE PASSAGE OF SOUND – Protection against sound from other parts of a building and adjoining buildings, protection against sound emanating within relevant buildings, reverberation in the common internal parts of relevant buildings and acoustic conditions in schools.

PART F: VENTILATION – Covers means of ventilation in dwellings and buildings other than dwellings.

PART G: SANITATION, HOT WATER SAFETY AND WATER EFFICIENCY – Deals with cold water supply, water efficiency, hot water supply and systems, sanitary conveniences and washing facilities, bathrooms, kitchens and food preparation areas.

PART H: DRAINAGE AND WASTE DISPOSAL – Deals with foul water drainage, wastewater treatment systems and cesspools, rainwater drainage, building over sewers, separate systems of drainage and solid waste storage.

PART J: COMBUSTION APPLIANCES AND FUEL STORAGE SYSTEMS – Covers air supply, discharge of products of combustion, warning of release of carbon monoxide, protection of the building, provision of information, protection of liquid fuel storage systems and protection against pollution.

PART K: PROTECTION FROM FALLING, COLLISION AND IMPACT – Covers stairs, ladders and ramps, protection from falling, vehicle barriers and loading bays, protection against impact with glazing, protection from collision with open windows, manifestation of glazing, safe opening and closing of windows, safe access for cleaning windows and protection against impact from trapping by doors.

PART L: CONSERVATION OF FUEL AND POWER – Now divided into four separate documents dealing with conservation of fuel and power in new dwellings, existing dwellings, new buildings other than dwellings and existing buildings other than dwellings.

PART M: ACCESS TO AND USE OF BUILDINGS – Requires that buildings and the facilities provided within them are reasonably accessible. Specifically mentioned are sanitary conveniences in dwellings and means to ensure that extensions to buildings do not reduce the level of access and use. Dwellings are now divided into three categories: Category 1, visitable dwellings; Category 2, accessible and adaptable dwellings; and Category 3, wheelchair user dwellings. It should be noted that Category 2 and 3 requirements come under the definition of optional requirement (see definition in the succeeding text).

It should be noted that the provisions in the former PART N: GLAZING – SAFETY IN RELATION TO IMPACT, OPENING AND CLEANING have now been transferred to PART K, and PART N has been withdrawn although it is still in force in Wales.

PART P: ELECTRICAL SAFETY – Covers design, installation and inspection of electrical installations.

PART Q: SECURITY – Requires that reasonable provision must be made to resist unauthorised access to any dwelling and any part of a building from which access can be gained to a flat within the building. Part Q only applies to new dwellings.

SCHEDULE 2 – EXEMPT BUILDINGS AND WORK

This lists exempt buildings and work in seven classes, and one of its effects is significantly to reduce the extent of control by giving complete exemptions for certain buildings and extensions.

SCHEDULE 3 – SELF-CERTIFICATION SCHEMES AND EXEMPTIONS FROM REQUIREMENT TO GIVE BUILDING NOTICE OR DEPOSIT FULL PLANS

This schedule lists certain types of work (for example, the installation of various kinds of combustion appliances or the installation of replacement windows, doors and roof lights) and gives details of certain classes of people who can carry out the work without giving a building notice or depositing full plans with the local authority. Such individuals will need to be registered under various industry schemes appropriate to the work in order to benefit from the exemption. This is fully covered in Chapter 5.

SCHEDULE 4 – DESCRIPTIONS OF WORK WHERE NO BUILDING NOTICE OR DEPOSIT OF FULL PLANS REQUIRED

This lists types of work which can be carried out without notifying the local authority. This is mainly concerned with minor electrical work but also includes some work on heating or cooling systems, the replacement of an external door which is not substantially glazed and the replacement of sanitary fittings under certain defined conditions. The schedule is fully described in Chapter 5.

SCHEDULE 4A – GREEN DEAL INFORMATION

Part 1 of this schedule lists the green deal information to be included in energy performance certificates. Part 2, interpretation, gives definitions which apply to green deal work.

SCHEDULES 5 AND 6

The former schedules 5 and 6 have been revoked.

2.3 Approved Documents

There are 19 Approved Documents issued by the Department for Communities and Local Government (DCLG) (20 in Wales, where Approved Document N is still current) intended to give practical guidance on how the technical requirements of Schedule 1 may be complied with. They are written in straightforward technical terms with accompanying diagrams and the intention is that they will be quickly updated as necessary.

Additionally, there are two other privately published guidance documents covering, respectively, *Eurocode 5 Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings*, 4th edition, published by TRADA available from Chiltern House, Stocking Lane, Hughenden Valley, High Wycombe, Bucks, HP14 4ND, and *The Building Regulations 2010 – Basements for Dwellings – Guidance Document, Practical guidance on helping to meet the relevant requirements in Schedule 1 to the Building Regulations* published by the Basement Information Centre (www.tbic.org.uk or www.basements.org.uk).

The status and use of Approved Documents are prescribed in sections 6 and 7 of the Building Act 1984. Section 6 provides for documents giving 'practical guidance with respect to the requirements of any provision of Building Regulations' to be approved by the Secretary of State or somebody designated by him. The documents so far issued have been approved by the Secretary of State, although they refer to other non-statutory material.

The legal effect of 'Approved Documents' is specified in section 7. Their use is not mandatory, and failure to comply with their recommendations does not involve any civil or criminal liability, but they can be relied upon by either party in any proceedings about an alleged contravention of the requirements of the regulations. If the designer or contractor proves that he has complied with the requirements of an Approved Document, in any proceedings which are brought against him, he can rely upon this 'as tending to negative liability'. Conversely, failure to comply with an Approved Document may be relied on by the local authority 'as tending to establish liability'. In other words, the onus will be upon the designer or contractor to establish that he has met the functional requirements in some other way.

The position is illustrated by *Richards* v. *Kerrier District Council* (1987) CILL 345, 4-CLD-04–26 where it was held that if the local authority proved that the works did not comply with the Approved Document, it was then for the appellant to show compliance with the regulations. If the designer fails to follow an Approved Document, it is for him to prove (if prosecuted) that he used an equally effective method or practice.

All the Approved Documents are in a common format, and their provisions are considered in subsequent chapters. They may be summarised as follows:

A: STRUCTURE – This supports Schedule 1, A1, A2 and A3. Section 1 gives details of codes and standards that can be used for all building types and emphasises certain basic principles which must be taken into account if other approaches are adopted. Section 2, which deals with houses and other small buildings, contains guidance on the sizing of timber members, wall thicknesses, masonry chimneys and concrete foundations. Sections 3 and 4 cover wall claddings and roof coverings, respectively, and section 5 deals with disproportionate collapse and is relevant to all types of building.

B: FIRE SAFETY – This supports Schedule 1, B1, B2, B3, B4 and B5 and is probably the most complex part of the regulations. Part B has been spread over two Approved Documents. Volume 1 covers fire safety in dwelling houses and Volume 2 deals with fire safety in buildings other than dwelling houses. Both volumes are structured in the same way as follows:

- B1 deals with means of warning and escape (fire alarm systems and the design of buildings to permit rapid evacuation in the event of fire).
- B2 and B3 cover the ability of the building to resist fire spread over the surfaces of internal walls and ceilings, the ability of a building to stand up to the effects of a fire so that it will not collapse before people have had a chance to escape and the way a building can be designed so that fire is prevented from spreading through its internal structure (in floor, ceiling and wall voids and past party walls).
- B4 deals with the prevention of external fire spread across an open space where it might affect a neighbouring building.
- B5 covers ways of making buildings accessible for firefighters when they need to save lives.

C: SITE PREPARATION AND RESISTANCE TO CONTAMINANTS AND MOISTURE – Read in conjunction with Schedule 1, Part C, it deals with the necessary basic requirements. Section 1 covers clearance or treatment of unsuitable materials. Section 2 deals with contaminants, including the erection of buildings on sites affected by radon gas or the landfill gases, methane and carbon dioxide. Additionally, it covers any substances in the ground which might cause a danger to health, and its provisions effectively replace those of the repealed section 29 of the Building Act 1984. Section 3 deals with subsoil drainage and sections 4 to 6 describe the measures necessary in order to prevent the passage of moisture to the inside of the building including resistance to damage from the effects of interstitial and surface condensation.

D: TOXIC SUBSTANCES – This supports Schedule 1, Part D, and is very short. It gives advice on guarding against fumes from urea formaldehyde foam.

E: RESISTANCE TO THE PASSAGE OF SOUND – This supports Schedule 1, Part E, and deals with the ability of a building to prevent the passage of unwanted sound from internal sources (sound penetration through external walls is covered by planning legislation, not Building Regulations). The details apply to dwellings and to rooms in other buildings which are used for residential purposes (like hotel bedrooms and similar rooms in hostels and residential homes for the elderly). This means, for example, that it is now necessary to insulate walls between hotel bedrooms and also to apply lining materials to wall surfaces of common access stairs and corridors in such buildings. E4 gives guidance on how to improve acoustic conditions in schools.

F: VENTILATION – Supporting Part F of Schedule 1, this covers means of ventilation and applies to all building types. Some guidance is also given on work to existing buildings caused by the addition of extensions.

G: SANITATION, HOT WATER SAFETY AND WATER EFFICIENCY – Supporting Part G of Schedule 1, it includes the requirements of certain repealed sections (sections 26 to 28) of the Building Act 1984 dealing with water closets and bathrooms. Additionally, it deals with hot and cold water supply and systems, the design and scale of provision for sanitary conveniences and washing facilities and food preparation areas.

H: DRAINAGE AND WASTE DISPOSAL – This supports Part H of Schedule 1 and covers above- and belowground drainage, wastewater treatment systems and cesspools. Other sections deal with building over sewers and separate systems of drainage, thereby replacing the repealed section 18 and some subsections of section 21 of the Building Act 1984, and solid waste storage.

J: COMBUSTION APPLIANCES AND FUEL STORAGE SYSTEMS – Supporting Part J of Schedule 1, this deals with gas appliances up to 70 kW, solid fuel appliances up to 50 kW and oil fuel appliances up to 45 kW, as well as protection of liquid fuel storage systems and protection against pollution caused by heating oil leakage.

K: PROTECTION FROM FALLING, COLLISION AND IMPACT – This supports Part K of Schedule 1 and covers the design and construction of stairs, ramps and guarding. It was extended in the 1998 edition to cover vehicle loading bays; protection from collision with open windows, skylights and ventilators; and protection against impact from and trapping by doors. In the 2010 edition of Approved Document K, the provisions of Approved Document N covering safe operation and access for cleaning windows, in addition to measures designed to reduce the risks of accidents caused by contact with glazing, were amalgamated into Approved Document K in England, although Approved Document N is still valid in Wales.

L: CONSERVATION OF FUEL AND POWER – Supporting Part L, Approved Document L is now divided into four separate documents dealing with conservation of fuel and power in new dwellings, existing dwellings, new buildings other than dwellings and existing buildings other than dwellings. This is mainly concerned with making sure that buildings are reasonably efficient in their use of energy and that carbon dioxide emissions are kept to a minimum.

M: ACCESS TO AND USE OF BUILDINGS – Supporting Part M of Schedule 1, this gives practical guidance on means of access, use of buildings, sanitary conveniences, passenger lifts and common stairs and accessible switches and socket outlets. Additionally, for simplification general guidance for stairs and ramps (that do not form part of the external principal entrances and alternative accessible entrances), guarding and handrails and manifestation for glass doors and glazed screens has been updated and moved to Approved Document K.

Dwellings are now divided into three categories: Category 1, visitable dwellings; Category 2, accessible and adaptable dwellings; and Category 3, wheelchair user dwellings. Category 2 and 3 requirements are classed as optional and only apply where planning permission for the development makes it a condition that these requirements must be complied with.

N: GLAZING – SAFETY IN RELATION TO IMPACT, OPENING AND CLEANING – Supporting Part N, this covers safe operation and access for cleaning windows, in addition to measures designed to reduce the risks of accidents caused by contact with glazing. This document has been amalgamated into Approved Document K in England but is still valid in Wales.

P: ELECTRICAL SAFETY – Supporting Part P, this Approved Document gives guidance on design, installation, certification, inspection and testing of electrical installations.

PART Q: SECURITY – Supporting Part Q of Schedule 1, this Approved Document gives guidance on the provisions that must be made to resist unauthorised access to any dwelling and any part of a building from which access can be gained to a flat within the building. Part Q only applies to new dwellings.

There is a further Approved Document – MATERIALS AND WORKMANSHIP to support regulation 7 – and it is phrased in very general terms. It deals with ways of establishing the fitness of materials to be incorporated into the permanent parts of buildings and ways of establishing adequacy of workmanship.

Relaxations of the mandatory requirements may be given only by local authorities in appropriate cases, with the possibility of an appeal against refusal to the Secretary of State. A relaxation can only be granted for a Building Regulation requirement and not an Approved Document provision, since, as has been explained, the latter provisions are not mandatory. An approved inspector cannot grant a relaxation.

2.4 Definitions in the Regulations

Regulation 2 provides a number of general definitions, but not all of them are equally important or helpful. In this section full definitions are given for purposes of ease of reference, although the various special definitions will be referred to again in later chapters. The definitions are as follows:

THE ACT – This means the Building Act 1984.

AMENDMENT NOTICE – This is a notice given by an approved inspector under section 51A of the Building Act 1984 where the scope of the work has changed to such an extent that the original initial notice no longer truly reflects the work actually being carried out.

BUILDING – The regulations apply only to buildings as defined. There is a narrow definition of 'building' for the purposes of the regulations:

- A building is 'any permanent or temporary building but not any other kind of structure or erection'. When 'a building' is referred to in the regulations, this includes a part of a building.

The effect of this definition is to exclude from control under the regulations such things as garden walls, fences, silos, air-supported structures and so forth.

BUILDING NOTICE – A notice in prescribed form given to the local authority under regulations 12(2)(a) and 13 informing the authority of proposed works.

BUILDING WORK – The regulations apply only to building work as defined in regulation 3(1); any work not coming within the definition is not controlled. Building work means:

- the erection or extension of a building;
- the provision, extension or material alteration of services or fittings required by Schedule 1, Parts G, H, J, L or P (and called 'controlled services or fittings');
- the material alteration of a building;

- work required by regulation 6 – which sets out the requirements relating to 'material change of use' (see below);
- the insertion of insulating material into the cavity wall of a building;
- work involving the underpinning of a building;
- work required by regulation 22 (requirements relating to a change of energy status);
- work required by regulation 23 (requirements relating to thermal elements);
- work required by regulation 28 (consequential improvements to energy performance).

CHANGE TO A BUILDING'S ENERGY STATUS – Any change which results in a building becoming a building to which the energy efficiency requirements of the regulations apply, where previously it was not.

CONTROLLED SERVICE OR FITTING – This means services or fittings required by Parts G, H, J, L or P, i.e. bathrooms, hot water storage systems, sanitary conveniences, drainage and waste disposal, heat-producing appliances, replacement doors, windows and roof lights, space heating and hot water boilers, hot water vessels and electrical installations.

DAY – Any period of 24 hours commencing at midnight. It does not include weekends, bank holidays or public holidays.

DWELLING – This includes a dwelling house and a flat.

DWELLING HOUSE excludes a flat or building containing a flat.

ELECTRICAL INSTALLATION – This means fixed electrical cables or fixed electrical equipment located on the consumer's side of the electricity supply meter.

ENERGY EFFICIENCY REQUIREMENTS – This means the requirements of regulations 23, 25A, 25B, 26, 26A, 28, 29 and 40 and Part L of Schedule 1.

ENERGY PERFORMANCE CERTIFICATE means a certificate which complies with the requirements of regulation 29.

EXCEPTED ENERGY BUILDING has the meaning given in the Schedule to the Welsh Ministers (Transfer of Functions) (No. 2) Order 2009.

EXTRA-LOW VOLTAGE – Voltage which is less than or equal to:

- 50 volts between conductors and earth for alternating current or
- 120 volts between conductors for direct current.

FINAL CERTIFICATE – A certificate given by an approved inspector to a local authority under section 51 of the Building Act 1984 to indicate that a project has been successfully completed.

FIXED BUILDING SERVICES – Any part of or any controls associated with:

- fixed internal or external lighting systems (but not including emergency escape lighting or specialist process lighting) or
- fixed systems for heating, hot water service, air conditioning or mechanical ventilation or
- any combination of systems of the kinds referred to in paragraph (a) or (b).

FLAT – Separate and self-contained premises (including a maisonette) constructed or adapted for residential purposes and forming part of a building divided horizontally from some other part (see Fig. 2.1).

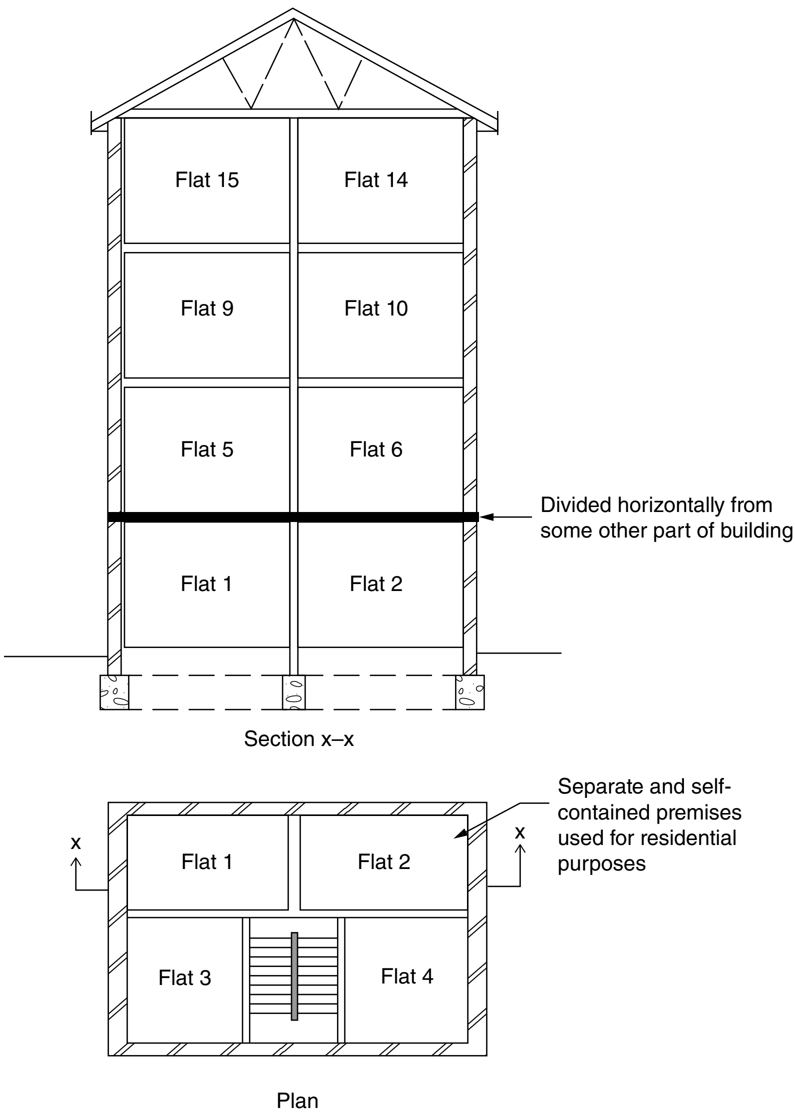


Fig. 2.1 Flat – regulation 2.

FLOOR AREA – This means the aggregate area of every floor in a building or extension. The area is to be calculated by reference to the finished internal faces of the enclosed walls or, where there is no enclosing wall, to the outermost edge of the floor (see Fig. 2.2).

FULL PLANS – Plans deposited with a local authority in accordance with regulations 12(2)(b) and 14. The Building Act 1984, section 126, gives a definition of 'plans' as including drawings of any description and specifications or other information in any form.

GREEN DEAL DISCLOSURE OBLIGATIONS means the obligations to provide an energy performance certificate in section 12 of the Energy Act(b) and Part 7 of the Green Deal Framework Regulations.

GREEN DEAL PROPERTY has the meaning given in section 12(5)(b) of the Energy Act 2011 which states that a property is a green deal property if there is a green deal plan in respect of the property and payments are still to be made under that plan.

HEIGHT – This means the height of a building measured from the mean level of the ground adjoining the outside external walls to a level of half the vertical height of the roof or to the top of any walls or parapet, whichever is higher (see Fig. 2.2).

INDEPENDENT ACCESS to an extension or part of a building means access to that part which does not pass through the rest of the building.

INITIAL NOTICE – A notice given by an approved inspector to a local authority under section 47 of the Building Act 1984.

INSTITUTION – This means a hospital, home, school and so on used as living accommodation for, or for the treatment, care or maintenance of, people suffering from disabilities due to illness or old age or other physical or mental disability or who are under five years old. Those concerned must sleep on the premises and so daycare centres are not included.

LOW VOLTAGE – Voltage which is less than or equal to:

- 1000 volts between conductors or 600 volts between conductors and earth for alternating current or
- 1500 volts between conductors or 900 volts between conductors and earth for direct current.

MATERIAL ALTERATION – This is defined in regulation 3(2) and is described fully in section **2.6**.

MATERIAL CHANGE OF USE – This is defined by reference to regulation 5 and there are ten cases:

- where a building becomes a dwelling when it was not one before;
- where a building will contain a flat for the first time;

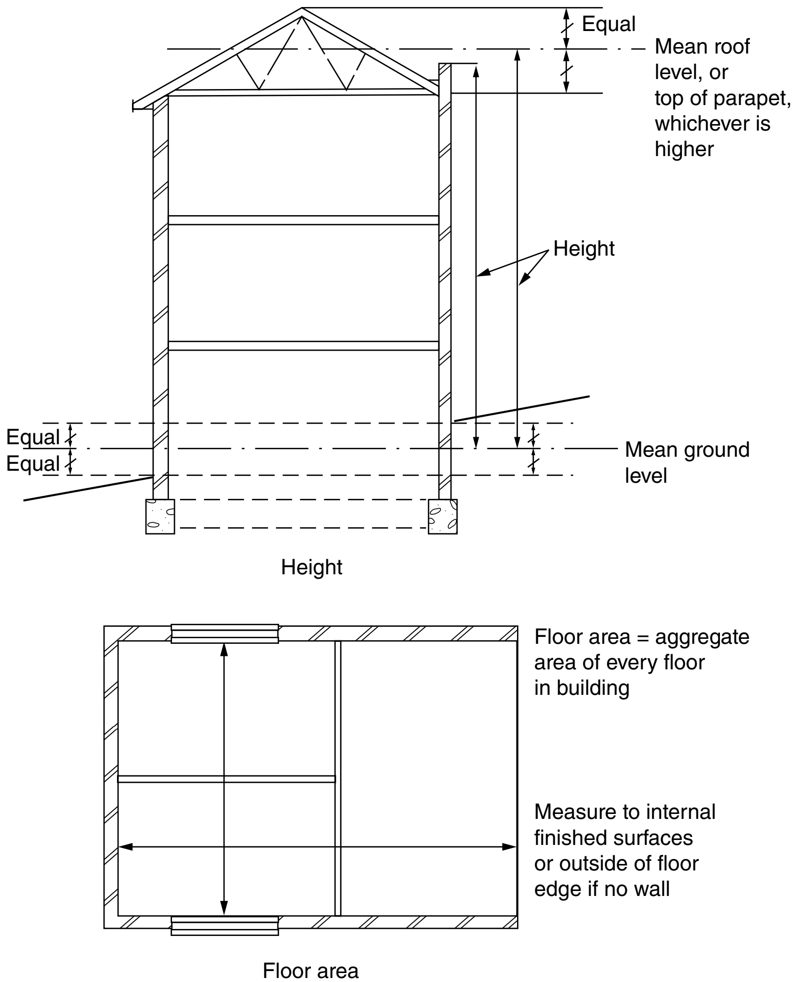


Fig. 2.2 Floor area and height – regulation 2.

- where a building becomes a hotel or boarding house, where it previously was not;
- where a building becomes an institution, where it previously was not;
- where a building becomes a public building and it was not before;
- where a building was previously exempt from control (see Schedule 2, below), but is no longer so exempt;
- where a building containing at least one dwelling is altered so that it provides more or less dwellings than before;
- where the building contains a room for residential purposes, where previously it did not;

- where a building containing at least one room for residential purposes is altered so that it contains more or less of such rooms than it did before;
- where a building becomes a shop where it previously was not.

MICROGENERATION means the use for the generation of electricity or the production of heat or cooling of any plant (which for this purpose includes any equipment, apparatus or appliance) which, in generating electricity or (as the case may be) producing heat or cooling, relies wholly or mainly on a source of energy or a technology mentioned in section 26(2) of the Climate Change and Sustainable Energy Act 2006. Those sources of energy and technologies are:

(a) biomass,
(b) biofuels,
(c) fuel cells,
(d) photovoltaics,
(e) water (including waves and tides),
(f) wind,
(g) solar power,
(h) geothermal sources,
(i) combined heat and power systems.

NEW DWELLING includes, except in Parts 6 and 7, a dwelling that is formed by a material change of use of a building within the meaning of regulation 5(a) (the building is used as a dwelling, where previously it was not), (b) (the building contains a flat, where previously it did not) or (g) (the building, which contains at least one dwelling, contains a greater or lesser number of dwellings than it did previously).

OPTIONAL REQUIREMENT means an optional requirement as described in regulation 4(1A)(b) (requirements relating to building work) or in regulation 36(2)(b) (water efficiency of new dwellings). Certain optional requirements of the regulations (mainly to do with disabled access to dwellings) have been introduced by virtue of SI 2015/767. These mainly come into effect where they have been made a condition of planning permission for the dwelling.

PAYMENT PERIOD has the meaning given in regulation 2(1) of the Green Deal Framework Regulations, i.e. the period for which instalments are to be paid under a green deal plan.

PLANNING PERMISSION has the meaning given in section 336(1) (interpretation) of the Town and Country Planning Act 1990.

PUBLIC BODY'S FINAL CERTIFICATE – This means a certificate given under paragraph 3 of Schedule 4 to the Building Act 1984.

PUBLIC BODY'S NOTICE – This means a notice given under section 54 of the Building Act 1984.

PUBLIC BUILDING – This means a building which consists of or contains:

- a theatre, public library, hall or other place of public resort;
- a school or other educational establishment which is not exempt under the 1984 Act, section 4(1)(a);
- a place of public worship.

The definition is restrictive because occasional visits by the public to shops, stores, warehouses or private houses do not make the building a public building.

RENOVATION – This means the provision of a new layer in a thermal element (but not including a new layer provided solely to repair a flat roof) or the replacement of an existing layer, but excludes decorative finishes.

ROOM FOR RESIDENTIAL PURPOSES – This means a room (or suite of rooms) which is not in a dwelling house or flat and which is used by people to live and sleep in. It includes a room in a hotel, hostel, boarding house, hall of residence or a residential home, but does not include a room in a hospital, or other similar establishment, used for patient accommodation.

SHOP – This includes premises used by members of the public:

- for sales of food or drink for consumption on or off the premises,
- for retail sales by auction,
- as a barber's or hairdresser's business,
- for the hiring of any item,
- for the treatment or repair of goods.

SOFTENED WHOLESOME WATER means water which would be regarded as wholesome for the purposes of regulations made under section 67 of the Water Industry Act 1991(9) (standards of wholesomeness) as they apply for the purposes of Part G of Schedule 1 in accordance with paragraph (5) but for the presence of sodium in excess of the level specified in those regulations if it is caused by a water softener or water softening process which reduces the concentrations of calcium and magnesium.

THERMAL ELEMENT – This means a wall, floor or roof (but not windows, doors, roof windows or roof lights) which separates a thermally conditioned part of the building (referred to as the 'conditioned space' in the regulations) from:

- the external environment (including the ground) or
- in the case of floors and walls, another part of the building which is:
  - unconditioned,
  - an extension falling within Class VII in Schedule 2 (i.e. conservatories, porches, covered yards or ways or a carport open on at least two sides),
  - conditioned to a different temperature.

The term covers all parts of the thermal element between the surface bounding the conditioned space and the external environment or other part of the building as appropriate.

2.5 Exempt buildings and work

With the exception of the work listed at the end of this section, certain buildings and extensions are granted complete exemption from control. The exempt buildings and work fall into seven classes listed in Schedule 2:

CLASS I – BUILDINGS CONTROLLED UNDER OTHER LEGISLATION

- Any building in which explosives are manufactured or stored under a licence granted under the Manufacture and Storage of Explosives Regulations 2005.
- Buildings (other than dwellings, offices or canteens) on a site licensed under the Nuclear Installations Act 1965.
- Buildings scheduled under section 1 of the Ancient Monuments and Archaeological Areas Act 1979.

CLASS II – BUILDINGS NOT FREQUENTED BY PEOPLE

- Detached buildings into which people do not normally go.
- Detached buildings housing fixed plant or machinery, normally visited only intermittently for the purpose of inspecting or maintaining the plant. Such buildings are only exempt where they are at least one and a half times their own height from the boundary of the site or any other building frequented by people.

CLASS III – GREENHOUSES AND AGRICULTURAL BUILDINGS

- A building used as a greenhouse.
  A greenhouse is not exempted if the main purpose for which it is used is retailing, packing or exhibiting, e.g. one at a garden centre.
- A building used for agriculture or principally for the keeping of animals which is:
  - sited at a distance not less than one and a half times its own height from any building containing sleeping accommodation,
  - provided with a fire exit not more than 30 m from any point within the building.

The definition of 'agriculture' includes horticulture, fruit growing, seed growing and fish farming. Agricultural buildings are not exempted if the main purpose for which they are used is retailing, packing or exhibiting.

CLASS IV – TEMPORARY BUILDINGS

- A building intended to remain where it is erected for 28 days or less, e.g. exhibition stands.

CLASS V – ANCILLARY BUILDINGS

- Buildings on a site intended to be used only in connection with the disposal of buildings or building plots on that site.
- Site buildings on all construction and civil engineering sites, provided they contain no sleeping accommodation.

- Buildings, except those containing a dwelling or used as an office or showroom, erected in connection with a mine or quarry.

CLASS VI – SMALL DETACHED BUILDINGS

- Detached single storey buildings of up to 30 m^2 floor area, with no sleeping accommodation.

  For the exemption to apply, such buildings must either be:
  - situated more than 1 m from the boundary of their curtilage *or*
  - constructed substantially of non-combustible material.

- Detached buildings of up to 30 m^2 intended to shelter people from the effects of nuclear, chemical or conventional weapons and not used for any other purpose. The excavation for the building must be no closer to any exposed part of another building or structure than a distance equal to the depth of the excavation plus 1 m.
- Detached buildings with a floor area not exceeding 15 m^2 and which do not contain sleeping accommodation, e.g. garden sheds.

CLASS VII – EXTENSIONS

- Ground-level extensions of up to 30 m^2 floor area which are conservatories, porches, covered yards or ways or a carport open on at least two sides, provided that in the case of a conservatory or porch, which is wholly or partly glazed, the glazing satisfies the requirements of Part K4, K5.1, K5.2, K5.3 and K5.4 of Schedule 1.

The regulations do not apply to the erection of any building set out in Classes I to VI or to extension work in Class VII. Furthermore, they have no application at all to *any* work done to or in connection with buildings in Classes I to VII provided, of course, that the work does not involve a change of use which takes the building out of exemption, e.g. a barn conversion.

Exceptions to the general exemption granted by Schedule 2

The following work carried out to certain buildings falling within Schedule 2 must comply with the requirements indicated:

(1) A conservatory or porch which is wholly or partly glazed must satisfy the following requirements of Part K (protection from falling, collision and impact): K4, K5.1, K5.2, K5.3 and K5.4.

(2) Any greenhouse, any small detached building falling within Class VI and any extension falling within Class VII must satisfy the requirements of Part P (electrical safety) where such buildings receive their electricity from a source shared with or located inside a dwelling.

(3) In general, and taking account of the exceptions listed below, the energy efficiency requirements of the regulations (Part L) apply to:

  (a) the erection of any building falling within Schedule 2;

  (b) the extension of any such building, other than an extension falling within Class VII in Schedule 2. However, in the case of a conservatory, it depends on the space separation and when the conservatory was built. For example the conservatory or porch will be exempt from the requirements of Part L unless:

- any wall, door or window separating the conservatory or porch from a building has been removed and not replaced with a wall, door or window,
- the building's heating system has been extended into the conservatory (see Chapter 16 for full details);

(c) the carrying out of any work to or in connection with any such building or extension.

It should be noted that the term 'building' means the building as a whole or parts of it that have been designed or altered to be used separately.

In order for these requirements to be applied, the building must be of roofed construction having walls and must use energy to condition the indoor climate. Even with these conditions certain categories of building which might come under Schedule 2 do not have to comply with the energy efficiency requirements of the regulations. These are:

- buildings where compliance with the energy efficiency requirements would unacceptably alter their character or appearance, such as:
  - buildings listed in accordance with section 1 of the Planning (Listed Buildings and Conservation Areas) Act 1990,
  - buildings in a conservation area designated in accordance with section 69 of the Planning (Listed Buildings and Conservation Areas) Act 1990,
  - buildings included in the schedule of monuments maintained under section 1 of the Ancient Monuments and Archaeological Areas Act 1979;
- buildings which are used primarily or solely as places of worship;
- temporary buildings with a planned time of use of two years or less, industrial sites, workshops and non-residential agricultural buildings with low energy demand;
- stand-alone buildings other than dwellings with a total useful floor area of less than 50 m^2.

It should be noted that the terms 'industrial sites', 'low energy demand', 'non-residential agricultural buildings', 'places of worship', 'stand-alone', 'total useful floor area' and 'workshops' have the same meaning as in European Parliament and Council Directive 2002/91/EC on the energy performance of buildings.

2.6 Application of the Regulations

The 2010 Regulations apply only to 'building work' or to a 'material change of use', i.e. use for a different purpose. Work or a change of use not coming under these headings is not controlled.

Meaning of 'building work'

The definition of 'building work' means that the regulations apply in nine cases:

ERECTION OR EXTENSION OF A BUILDING
Subject to the exemptions set out in the preceding section, the regulations apply to the erection or extension of all buildings. No attempt is made to define what is meant by 'erection of a building', nor is any definition really necessary. There is a good deal of obscure case law under other legislation as to what amounts to 'erection of a building', but none of it is particularly helpful in the light of section 123 of the Building Act 1984.

This gives a relevant statutory definition. For the purposes of Part II of the Act and for building regulation purposes, erection will include related operations 'whether for the reconstruction of a building, [and] the roofing over of an open space between walls or buildings'.

For the purposes of Part III of the 1984 Act (other provisions about buildings) which is also relevant to building control, *certain* building operations are 'deemed to be the erection of a building'. These are as follows:

(1) Re-erection of any building or part of a building when an outer wall has been pulled or burnt down to within ten feet (3 m) of the surface of the ground adjoining the lowest storey of the building.
    It follows that the outer wall must have been demolished throughout its length to within ten feet (3 m) of ground level to constitute re-erection.
(2) The re-erection of any frame building when it has been so far pulled or burnt down that only the framework of the lowest storey remains.
(3) Roofing over any space between walls or buildings. Clearly other operations could be 'the erection of a building'.

PROVISION OR EXTENSION OF CONTROLLED SERVICES AND FITTINGS – Controlled services and fittings are those required by specified parts of Schedule 1:

- G1 – Cold water supply
- G2 – Water efficiency
- G3 – Hot water supply and systems
- G4 – Sanitary conveniences and washing facilities
- G5 – Bathrooms
- G6 – Kitchens and food preparation areas
- H – Drainage and waste disposal systems including above- and belowground drainage, wastewater treatment systems and cesspools
- J – Fixed heat-producing appliances burning solid or oil fuel or gas or incinerators. Liquid fuel storage systems
- L – In non-domestic buildings, heating and hot water systems, lighting, air-conditioning and mechanical ventilation systems. In dwellings, replacement windows, doors and roof lights, space heating or hot water service boilers and hot water vessels
- P – Electrical safety, design installation, inspection and testing

MATERIAL ALTERATION OF A BUILDING OR OF A CONTROLLED SERVICE OR FITTING
The material alteration of an existing building falls within the definition of building work and is subject to the regulation requirements. Other alterations are not controlled.

There are two cases where an alteration is material, namely, an alteration to a building or controlled service or fitting, or part of the work involved, which would at any stage result *either*:

- in the building or controlled service or fitting not complying with the relevant requirements of Schedule 1 where it previously did comply or
- in the building or controlled service or fitting, which did not comply with such requirements before work started, being made worse in relation to the requirement after the alteration.

The specified requirements (called 'relevant requirements' in the regulations) are:

- Part A (structure),
- B1 (means of warning and escape),
- B3 (internal fire spread – structure),
- B4 (external fire spread),
- B5 (access and facilities for the fire service),
- Part M (access to and use of buildings).

The work done must, of course, comply with all the requirements of Schedule 1. In general, it is not necessary to bring the existing building up to regulation standards. However, it should not be made worse when measured against the standards of the relevant requirements in Schedule 1.

WORK IN CONSEQUENCE OF A MATERIAL CHANGE OF USE
When there is a material change of use, as defined in regulation 5 (see section 2.4), work must be done to make the building comply with some of the regulations, as explained below. Such work is, of course, then subject to control, just as the material change of use is itself controlled. In practical terms, change of use is only subject to control if the change involves the provision of sleeping accommodation or use as a public building or where the building was previously exempt.

'*Material change of use*' *requirements*
Material change of use has already been defined (see section 2.4), and in the ten cases falling within that definition, specific technical requirements from Schedule 1 are made to apply in the interests of health and safety, which is the philosophy behind building control. Interestingly, there is no requirement applicable in respect of surface water drainage or stairs, nor is there any definition of 'part' of a building. The parts of the regulations applicable are set out in Table 2.1.

INSERTION OF INSULATING MATERIAL INTO A CAVITY WALL
When there is the insertion of cavity fill in an existing wall in a building, the work done must comply with certain specific regulation requirements, namely, C2 and D1 (toxic substances).

Table 2.1 Requirements applicable according to material change of use.

Case	Schedule 1 requirements
[1A]	
All cases (dwellings including conversion of single dwelling to provide greater number, flats, hotels, shops, boarding houses, institutions and public buildings, no longer exempt, rooms for residential purposes) where there is a change of use to the whole of the building	B1 (means of warning and escape) B2 and B3 (internal fire spread) B4(2) (external fire spread – roofs) B5 (access for fire services) C2(c) (interstitial and surface condensation) F1 (ventilation) G1 (cold water supply) G3(1) to (3) (hot water supply and systems) G4 (sanitary conveniences and washing facilities) G5 (bathrooms) G6 (kitchen and food preparation areas) H1 (foul water drainage) H6 (solid waste storage) J1 to J4 (combustion appliances) L1 (conservation of fuel and power) P1 (electrical safety)
[1B]	
Exempt building to non-exempt, hotel, boarding house, institution, public building	As in [A] plus A1 to A3 (structure)
[1C]	
Building more than 15 m in height	As in [**A**] plus B4(1) (external fire spread – walls)
[**1D**]	
Building used as a dwelling, hotel, boarding house or institution or containing a flat where it did not before; where more or less dwellings are provided than was originally the case; where the building contains a room for residential purposes, where previously it did not; where a building containing at least one room for residential purposes is altered so that it contains more or less of such rooms than it did before; building no longer exempt under Schedule 2, Classes I to VI, where previously it was, where the material alteration provides new residential accommodation	As in [**A**] plus C1(2) resistance to contaminants
[**1E**]	
Building used as a dwelling, where previously it was not	As in [**A**] plus C2 (resistance to moisture)

Table 2.1 (*Continued*)

Case	Schedule 1 requirements
[**1F**]	
Building used as a dwelling, hotel, boarding house or containing a flat where it did not before; where more or less dwellings are provided than was originally the case; where the building contains a room for residential purposes, where previously it did not; where a building containing at least one room for residential purposes is altered so that it contains more or less of such rooms than it did before	As in [**A**] plus E1 to E3 (resistance to passage of sound)
[**1G**]	
Change of use to public building consisting of or containing a school	As in [**A**] plus E4 (acoustic conditions in schools)
[**1H**]	
Change of use to dwelling or flat	G2 (water efficiency) and G3(4) (hot water supply and systems: hot water supply to fixed baths)
[**1I**]	
Change of use to hotel, boarding house, shop, institution or public building	As in [**A**] plus M1 (access to and use of buildings other than dwellings)
[**1J**]	
Change of use to dwelling or flat or increase in the number of dwellings in the building	Q1 security
[**2A**]	
Change of use of part only of a building in cases [**1A**]	The part itself must comply with the relevant requirements as [**1A**]
[**2B**] and [**2C**]	
Change of use of part only of a building in cases [**1B**], [**1E**], [**1F**], [**1G**] or [1**H**]	The part itself must comply with the relevant requirements as [**1B**], [**1E**], [**1F**], [**1G**] and [**1H**]. In [**1C**] the whole building must comply with B4(1)
[**2D**]	
Change of use of part only of a building in case [**1I**]	M1 (access to and use of buildings) applied to the part being changed and to any sanitary conveniences provided in or in connection with the part being changed Whole building complies with requirement M1(a) of Schedule 1 to the extent that reasonable provision is made to provide either suitable independent access to the part being changed or suitable access through the building to that part
[**2E**]	
Change of use of part only of a building in case [1J]	Where the change of use applies to the extent that a flat is provided or there is an increase in the number of dwellings in the building, only the part of the building altered has to comply with Part Q

UNDERPINNING OF A BUILDING
Work involving the underpinning of an existing building is 'building work' for the purposes of the regulations and so comes under control.

WORK REQUIRED BY REGULATION 22 (REQUIREMENTS RELATING TO A CHANGE OF ENERGY STATUS)
When a building is changed so that it becomes a building to which the energy efficiency requirements of the regulations apply, where previously it was not, such work, if any, must be carried out so as to ensure that the building complies with the applicable requirements of Part L of Schedule 1. In this case 'building' means the building as a whole or parts of it that have been designed or altered so that they can be used separately.

WORK REQUIRED BY REGULATION 23 (REQUIREMENTS RELATING TO THERMAL ELEMENTS)
When renovating a thermal element, sufficient work must be carried out so as to ensure that the whole thermal element complies with the requirements of paragraph L1(a)(i) of Schedule 1 (i.e. to the extent of limiting gains and losses through the thermal elements and other parts of the building fabric). When replacing a thermal element, the new thermal element must also comply with the requirements of paragraph L1(a)(i) of Schedule 1.

WORK REQUIRED BY REGULATION 28 (CONSEQUENTIAL IMPROVEMENTS TO ENERGY PERFORMANCE)
Where an existing building with a total useful floor area over 1000 m^2:

- is extended or
- has fixed building services installed for the first time or
- has an increase to the installed capacity of any fixed building services.

Such work, if any, must be carried out so as to ensure that the building complies with the requirements of Part L of Schedule 1. However, the work only needs to be carried out if it is technically, functionally and economically feasible.

2.7 Regulation requirements

The regulations impose broad general requirements on the builder. Breach of these requirements does not, of itself, involve the builder in any civil liability, although such liability may arise, quite independently, at common law.

Compliance with Schedule 1 is mandatory. All building work (except work carried out to improve energy performance; see below) must be carried out so that it complies with the requirements set out in that schedule. The method adopted for compliance must not result in the contravention of another requirement.

The work must also be carried out so that, after completion,

- an existing building which has been extended or to which a material alteration has been carried out or

- an existing building which has had a controlled service or fitting provided extended or materially altered or
- any controlled service or fitting

to which work has been done continues to comply with the specified requirements if it previously did so comply or, if it did not so comply before in any respect, it must not be more unsatisfactory afterwards.

The special case concerning energy performance referred to above is for work carried out:

- to thermal elements,
- where there is a change in the building's energy status and
- where there are consequential improvements to a building's energy performance.

Provided that the work does not constitute a material alteration, then it only needs to comply with the applicable requirements of Part L of Schedule 1.

2.8 Schedule 1: Technical requirements

Schedule 1 contains the technical requirements, which are discussed in Chapters 6 to 18 and which are almost all expressed functionally, e.g. C1 dealing with site preparation states that 'the ground to be covered by the building shall be reasonably free from any material that might damage the building or affect its stability, including vegetable matter, topsoil and pre-existing foundations'. These requirements cannot be subject to relaxation.

Which requirements apply depends on the type of building being constructed, but the majority of them are of universal application.

Materials and workmanship

Regulation 7(1) provides that any building work which is required to comply with any relevant requirement of Schedule 1:

'shall be carried out:
(a) with adequate and proper materials which
  (i) are appropriate for the circumstances in which they are used,
  (ii) are adequately mixed and prepared,
  (iii) are applied, used or fixed so as adequately to perform the functions for which they are designed
(b) in a workmanlike manner.'

This is a general statutory obligation imposed on the builder. Guidance on how the obligation may be met is contained in Approved Document to support regulation 7 'materials and workmanship', although that guidance is of a very general nature.

This statutory obligation is akin to a building contractor's obligation at common law when, in the absence of a contrary term in the contract, the builder's duty is to do the work in a good and workmanlike manner, to supply good and proper materials and to provide a building reasonably fit for its intended purpose: *Hancock* v. *B.W. Brazier (Anerley) Ltd* (1966) [1966] 1 WLR 1317; [1966] 2 All ER 901, CA. This threefold obligation would normally be implied in any case where a contractor was employed to both design and build, but the third limb of the duty would not arise, for example, where the client employs his own architect (*Lynch* v. *Thorne* (1956) [1956] 1 WLR 303; [1956] 1 All ER 744, CA), although the other two limbs remain.

The principal object of the regulations is to ensure that buildings meet reasonable standards of health and safety, and this is spelled out in regulation 8:

> 'Parts A to D, F to K, and P (except for paragraphs G2, H2 and J7) of Schedule 1 shall not require anything to be done except for the purpose of securing *reasonable standards of health and safety* for persons in or about buildings (and any others who may be affected by buildings, or matters connected with buildings).'

The obligations imposed by the regulations are not therefore absolute obligations, but rather a duty to use reasonable skill and care to secure reasonable standards of health and safety of people using the building and others who may be affected by failure to comply with the requirements of the regulations.

2.9 Relaxation of regulation requirements

Section 8 of the Building Act 1984 enables the Secretary of State to dispense with or relax any requirement of the regulations 'if he considers that the operation of [that] requirement would be unreasonable in relation to the particular case'. This power has been delegated to the local authority which may grant a relaxation if, because of special circumstances, the terms of a requirement cannot be fully met.

However, the majority of regulation requirements cannot be relaxed because they require something to be provided at an 'adequate' or 'reasonable' level and to grant a relaxation might mean acceptance of something that was 'inadequate' or 'unreasonable'.

It should be noted that a relaxation of the requirements of the Building Regulations cannot be sought in order to thwart:

- reg. 23(1)(a) where the renovation of an individual thermal element constitutes a major renovation or
- reg. 25A where the minimum energy performance requirements must be approved by the Secretary of State, in accordance with the methodology given in regulation 24, for new buildings (including new dwellings), in the form of target CO_2 emission rates or
- reg. 26 where a building's target CO_2 emission rate has been approved pursuant to regulation 25 or
- reg. 29 the provision of energy performance certificates.

The application procedure is laid down in sections 9 and 10 of the 1984 Act. There is no prescribed form. Only the local authority (or the Secretary of State on appeal) can grant a relaxation; approved inspectors have no power to do so.

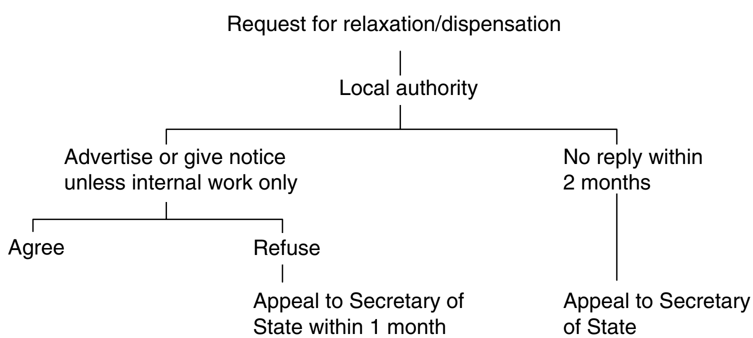
At least 21 days before giving a decision on an application for dispensation or relaxation of any requirement, the local authority must advertise the application in a local newspaper unless the application relates only to internal work. The notice must indicate the situation and nature of the work and the requirement which it is sought to relax or dispense with. Objections may then be made on grounds of public health or safety. No notice need be published if the effect of the proposal is confined to adjoining premises only, but notice must then be given to the owner and occupier of those premises.

Where a local authority refuses an application, it must notify the applicant of his right of appeal to the Secretary of State. This must be exercised within one month of the date of refusal. The grounds of the appeal must be set out in writing, and a copy must be sent to the local authority, who must send it to the Secretary of State with a copy of all relevant documents and any representations it wishes to make. The applicant must be informed of the local authority's representations. There is no time limit prescribed for the Secretary of State's decision on the appeal.

Where a local authority fails to give a decision on an application within two months, it is deemed to be refused and the applicant may appeal forthwith.

Neither the Secretary of State nor the local authority may give a direction for any relaxation of the regulations where, before the application is made, the local authority has become statutorily entitled to demolish, remove or alter any work to which the application relates, i.e. as a result of service of a notice under section 36 of the 1984 Act. The same prohibition applies where a court has issued an injunction requiring the work to be demolished, altered or removed.

The procedure may be summarised as follows:



2.10 Type relaxations

The local authority's power of dispensation and relaxation must be distinguished from that of the Secretary of State to grant a type relaxation, i.e. to dispense with a requirement of the regulations generally under section 2 of the Building Act 1984. A type relaxation can be made subject to conditions and can be for a limited period only. It can be issued on application to the Secretary of State, e.g. from a manufacturer, in which case a fee may be charged. The Secretary of State may also make a type relaxation of his own accord. Before granting a relaxation the Secretary of State must consult such bodies as appear to him to be representative of the interests concerned and must publish notice of any relaxation issued. No such type relaxations have been granted under the current legislation.

2.11 Continuing requirements

Under section 2 of the Building Act 1984, Building Regulations can impose continuing requirements on owners and occupiers of buildings. These requirements are of two kinds:

- Continuing requirements in respect of designated provisions of the Building Regulations, to ensure that the purpose of the provision is not frustrated.

For example, where an item is required to be provided, there could be a requirement that it should continue to be provided or kept in working order. Examples of the possible use of the power are the operation of mechanical ventilation which is necessary for health reasons or the operation of any lifts required to be provided in blocks of flats.

- Requirements with regard to services, fittings and equipment. This enables requirements to be imposed on buildings whenever they were erected and independently of the normal application of Building Regulations to a building.

A possible use of this power would be to require the maintenance and periodic inspection of lifts in flats if they are to be kept in use. This power of continuing requirements has, as yet, not been used.

2.12 Testing and sampling

Regulations 45 and 46 empower the local authority to test building work to ensure compliance with the requirements of regulation 7 and any applicable parts of Schedule 1 and to take samples of materials *to be used* in the carrying out of building work. The wording does not appear to cover materials which are already incorporated in the building, but this may prove to be of little importance if the provisions of section 33 of the Building Act 1984 are ever activated.

In fact the power of testing is given to 'a duly authorised officer of the local authority'. 'Authorised officer' is defined in section 126 of the Building Act 1984 as:

> '… an officer of the local authority authorised by them in writing, either generally or specially, to act in matters of any special kind, or in any specified matter; or … by virtue of his appointment and for the purpose of matters within his province, a proper officer of the local authority.'

Section 95 of the 1984 Act confers upon an authorised officer appropriate powers of entry, and penalties for obstructing any person acting in the execution of the regulations are provided by section 112.

A duly authorised officer of the local authority must also be permitted to take samples of the materials used in works or fittings, to see whether they comply with the requirements of the regulations. In practice, the authorised officer may ask the builder to have the tests carried out and to submit a report to the local authority. In any event, the builder should be notified of the result of the tests.

It should be noted, however, that regulations 45 and 46 do not apply where the work is supervised by an approved inspector (see Chapter 4) or is done under a public body's notice; however, similar powers exist in the Building (Approved Inspectors, etc.) Regulations 2010 (as amended).

2.13 Testing and Commissioning

Sound insulation testing

In circumstances where paragraph E1 of Schedule 1 applies, regulation 41 of the Building Regulations 2010 (as amended) and regulation 20 of the Building (Approved Inspectors, etc.) Regulations 2010 (as amended) also apply. These additional regulations impose a requirement to pursue one of two courses of action:

(i) To undertake an approved programme of sound insulation testing and provide the appropriate authority with a copy of the test results. In the case of both regulations, there are specific time limits within which the results must be presented to the building control body. It is stated in Approved Document E that the normal way of satisfying regulation 41 or 20 will be to undertake this programme of testing (known as pre-completion testing) in accordance with section 1 of Approved Document E.

(ii) Only in the case of a dwelling house or a building containing flats, to use one or more of the design details approved by Robust Details Limited. This is an alternative to undertaking a programme of testing and is subject to observing specified procedures.

Mechanical ventilation air flow rate testing

Where, in the case of the creation of a new dwelling by building work, paragraph F1(1) of Schedule 1 applies, regulation 42 of the Building Regulations 2010 (as amended) and regulation 20 of the Building (Approved Inspectors, etc.) Regulations 2010 (as amended) also apply.

They require that the person carrying out the work shall:

(a) ensure that testing of the mechanical ventilation air flow rate is carried out in accordance with a procedure approved by the Secretary of State,

(b) give notice of the results of the testing to the local authority.

The notice must record the results and the data upon which they are based in a manner approved by the Secretary of State and be given to the local authority not later than five days after the final test is carried out.

Pressure testing

Where, in the case of the erection of a building, paragraph L1(a)(i) of Schedule 1 applies, regulation 43 of the Building Regulations 2010 (as amended) and regulation 20 of the Building (Approved Inspectors, etc.) Regulations 2010 (as amended) also apply.

They require that the person carrying out the work shall:

(a) ensure that pressure testing is carried out in such circumstances and in accordance with an approved procedure as are approved by the Secretary of State,
(b) give notice of the results of the testing to the local authority.

A local authority is authorised to accept, as evidence that the requirements have been satisfied, a certificate to that effect by a person who is registered by the British Institute of Non-Destructive Testing or the Air Tightness Testing and Measurement Association in respect of pressure testing for the air tightness of buildings.

Commissioning

Regulation 44 of the Building Regulations 2010 (as amended) and regulation 20 of the Building (Approved Inspectors, etc.) Regulations 2010 (as amended) apply to building work involving the installation of mechanical ventilation systems covered by paragraph F1(2) of Schedule 1 and to building work involving the provision of fixed building services covered by paragraph L1(b) of Schedule 1.

Where this regulation applies the person carrying out the work must give to the local authority a notice confirming that the fixed building services have been commissioned in accordance with a procedure approved by the Secretary of State.

The notice must given to the local authority:

(a) not later than five days after the work has been completed if regulation 16(4) applies or
(b) where that regulation does not apply, not more than 30 days after completion of the work.

2.14 Unauthorised building work

Regulation 18 allows local authorities retrospectively to certify unauthorised building work carried out on or after 11 November 1985. The regulation became effective on 1 October 1994 and there are prescribed fees payable. It applies to building work which should have been subject to control, but the person who carried out the work failed to deposit plans with the authority, to give a building notice or to give an initial notice jointly with an approved inspector. The regulation enables the owner of the building (the applicant) to make a written application to the authority for a regularisation certificate.

The applicant's notice should describe the unauthorised work and, if reasonably practicable, include a plan of it as well as a plan showing any additional work needed to ensure compliance with the regulations. It should be noted that the giving of such plans is not deemed to be the deposit of plans under section 16 of the Building Act 1984. On receipt of the notice and the accompanying plans, the council may require the applicant to take reasonable steps to enable them to inspect the work, e.g. opening up, testing and sampling. The local authority will then notify the applicant of any work required to ensure compliance, with or without relaxation, and when this has been carried out to their satisfaction, they may issue a regularisation certificate. This is stated to be evidence (but not conclusive evidence) that the relevant specified requirements have been complied with.

2.15 Contravening works

Under section 36 of the Building Act 1984 where a building is erected, or work is done contrary to the regulations, the local authority may require its removal or alteration by serving notice on the owner of the building. Where work is required to be removed or altered, and the owner fails to comply with the local authority's notice within a period of 28 days, the local authority may remove the contravening work or execute the necessary work itself so as to ensure compliance with the regulations, recovering its expenses in so doing from the defaulter.

A section 36 notice may not be given after the expiration of 12 months from the date on which the work was completed. A notice cannot be served where the local authority has passed the plans and the work has been carried out in accordance with the deposited plans.

The recipient of a section 36 notice has a right of appeal to the magistrates' court. The burden of proving non-compliance with the regulations lies on the authority, but if it shows that the works do not comply with an Approved Document (under section 7), then the burden shifts. The appellant against the notice must then prove compliance with the regulations: *Richards* v. *Kerrier District Council* (1987) CILL 345, 4-CLD-04–26.

Section 37 provides an alternative to the ordinary appeal procedure. Under that section, the owner may notify the local authority of his intention to obtain from 'a suitably qualified person' a written report about the matter to which the section 36 notice relates. Such notices are served where the local authority considers that the technical requirements of the regulations have been infringed.

The expert's report is then submitted to the local authority. In light of it the local authority may withdraw the section 36 notice and *may* pay the owner the expenses which he has reasonably incurred in consequence of the service of the notice, including his expenses in obtaining the report. Adopting this procedure has the effect of extending the time for compliance with the notice or appeal against it from 28 to 70 days.

If the local authority rejects the report, it can then be used as evidence in any appeal under section 40, and section 40(6) provides that:

> 'if, on appeal … there is produced to the court a report that has been submitted to the local authority … the court, in making an order as to costs, may treat the expenses incurred in obtaining the report as expenses for the purposes of the appeal.'

Thus, in the normal course of events, if the appeal was successful, the owner would recover the cost of obtaining the report as well as his other costs.

The local authority – or anyone else – may also apply to the civil courts for an injunction requiring the removal or alteration of any contravening works. This power

Table 2.2 Current levels of fines for summary offences.

Level on standard scale	Amount of fine
Level 1	£200
Level 2	£500
Level 3	£1000
Level 4	£2500
Level 5	£5000

is exercisable even in respect of work which has been carried out in accordance with deposited plans, e.g. oversight or mistake on the part of the local authority. In such a case the court might well order the local authority to pay compensation to the owner. The 12 months' time limit does not apply to this procedure, which is, however, unusual and rarely invoked in practice. The attorney general, as guardian of public rights, may seek an injunction in similar circumstances and in practice proceedings for an injunction must be taken in his name and with his consent.

Where a person contravenes any provision in the Building Regulations, he renders himself liable to prosecution by the local authority. The case is dealt with in the magistrates' court. Such a person is liable on summary conviction to a fine not exceeding level 5 on the 'standard scale' and to a further fine not exceeding £50 per day for a continuing offence (Building Act 1984, section 35).

The standard scale of fines for summary offences was introduced by section 37 of the Criminal Justice Act 1982 (as amended by section 17 of the Criminal Justice Act 1991). The current levels of fines are as shown in Table 2.2.

In *Torridge District Council* v. *Turner* (1991) 9-CLD-07–21, it was held, for reasons which are not entirely clear, that breach of 'do' provisions such as requirement A1 which requires that a building 'shall be so constructed' as to meet the specified standards does not constitute a continuing offence, which means that the proceedings must be commenced within six months of the commission of the alleged offence. This six-month limitation period is specified by *s 127(1)* of the *Magistrates' Court Act 1980* and obliges local authorities to bring prosecutions for breaches of Building Regulations within six months of the completion of the offending work. However, the introduction of *s 35A* of the *Building Act 1984*, inserted by the *Climate Change and Sustainable Energy Act 2006*, allows for an increase in time limit of two years to apply to the prosecution of breaches of certain Building Regulations. These are if the regulations were made:

- for the purpose of furthering the conservation of fuel and power or otherwise in connection with the use of fuel and power or
- for the purpose of reducing emissions of greenhouse gases (within the meaning of the Climate Change and Sustainable Energy Act 2006).

However, as it only applies to breaches occurring on or after 6 April 2008, it has no retrospective effect.

3 Local authority control

3.1 Introduction

Local authorities have exercised control over buildings in England and Wales since 1189, but it was not until 1965 that uniform national Building Regulations were made applicable throughout the country generally. Inner London retained its own system based on the London Building Acts 1930 to 1978 and the bye-laws made thereunder until 6 January 1986. Building Regulations now apply to Inner London, although many provisions of the London Building Acts continue to apply in modified form. The Building Regulations 1985 introduced a number of substantive changes to the system of local authority control, and there have been several modifications to the system since then, culminating in the Building Regulations 2010, which came into force on 1 October 2010. These in turn have been amended ten times, the latest being the Building Regulations &c. (Amendment) Regulations 2015 (SI 2015/767) which came into force at various times between 18 April 2015 and 31 December 2015.

Part 3 of the Building Regulations 2010, as amended, contains the procedural requirements which must be observed where a person proposes to undertake building work covered by the regulations and opts for local authority control. Although a great deal of building work continues to be under local authority control and supervision, an increasing volume of work is now dealt with under an alternative system – private control and supervision by an approved inspector, as explained in Chapter 4. Until January 1997 the private system was confined to housebuilders under the National House Building Council (NHBC) scheme; however, it is now possible to use an approved inspector for any class of building work.

Two main procedural options are available under the local authority system of control:

- control based on service of a building notice; and
- control based on the deposit of full plans.

There are also a number of cases – where the work relates to the installation of gas, solid fuel or oil-fired combustion appliances, drainage and plumbing works, electrical work, the recovering of roofs and the installation of replacement windows, doors and roof lights – where neither notice nor deposit of plans is required. This relates to work carried

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

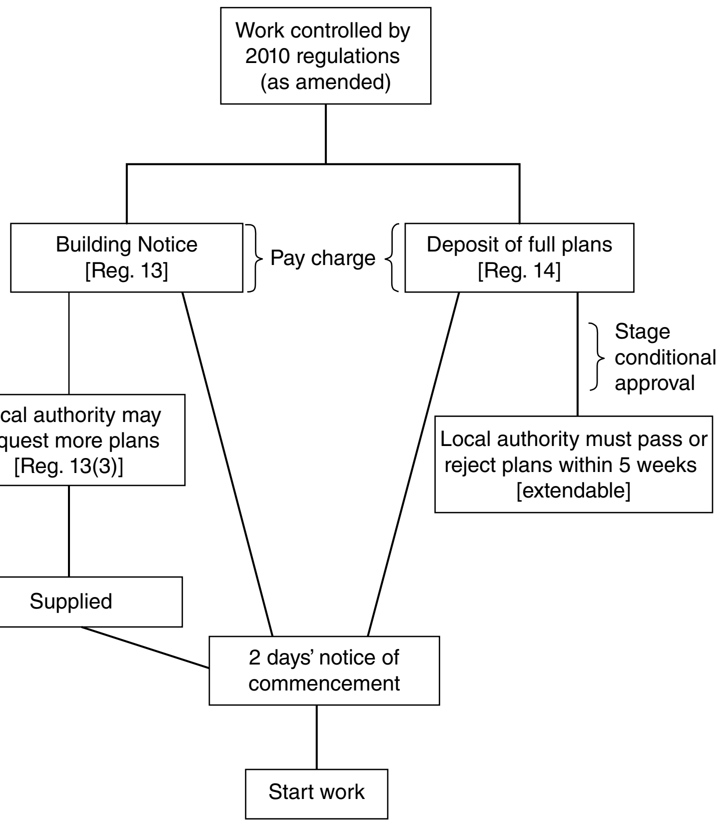


Fig. 3.1 Local authority supervision.

out by 'Competent Persons' under a registered Competent Person Scheme and is covered in detail in Chapter 5. It is also possible to have an intermediate situation where plans may be passed in stages.

3.2 The local authority

The local authority for the purposes of the regulations is the district council, a London borough council, the Common Council of the City of London, the Sub-Treasurer of the Inner Temple, the Under Treasurer of the Inner Temple and the Council of the Isles of Scilly (Fig. 3.1).

3.3 Building notice procedure

The major procedural innovation introduced in 1985, and now to be found in the 2010 Regulations, is based on service of a building notice. There is no approval of plans. Interestingly, this is copied from the former Inner London system.

A person intending to carry out building work, replace or renovate a thermal element in a building to which the energy efficiency requirements apply, make a change to a building's energy status or make a material change of use of a building, may give a building notice to the local authority except in the following cases:

(1) where it is intended to carry out building work in relation to a building to which the Regulatory Reform (Fire Safety) Order 2005 applies or will apply after the completion of the building work (essentially, all fixed workplaces in England and Wales but excluding locations such as mineshafts, boreholes and open areas outside buildings in forestry and farming);
(2) where it is intended to carry out work which includes the erection of a building fronting onto a private street;
(3) where the work involves the building over of any sewers, disposal mains or drains shown on any map of sewers kept by a sewerage undertaker under section 199 of the Water Industry Act 1991 (i.e. when paragraph H4 of Schedule 1 imposes a requirement).
(4) a person intending to carry out building work in relation to which Part P (Electrical Safety – Dwellings) of Schedule 1 imposes a requirement is required to give a building notice or deposit full plans where the work consists of:
    (a) the installation of a new circuit;
    (b) the replacement of a consumer unit; or
    (c) any addition or alteration to existing circuits in a special location.

Normally, the building notice should be given at least two clear days before commencement of work. However, since there may be occasions when it is necessary to carry out emergency repairs on a building (especially with regard to building services where the work is subject to control), a building notice may be given to the local authority as soon as reasonably practicable after the work has started in these circumstances. This would not, of course, be necessary if the work was being carried out by a competent person (see section 3.4).

There is no prescribed form of building notice. The notice must be signed by the person intending to carry out the work or on his behalf and must contain or be accompanied by the following information:

- The name and address of the person intending to carry out the work.
- A statement that it is given in accordance with regulation 12(2)(a).
- A description of the proposed building work, renovation or replacement of a thermal element, change to the building's energy status or material change of use.
- A description of the location of the building to which the proposal relates and the use or intended use of that building.
- In the case of a new dwelling:
  (i) a statement whether or not any optional requirement applies to the building work, and if so which, or
  (ii) a statement that planning permission has not yet been granted for the work, and that the information required by subparagraph (i) will be supplied before the end of a period of 28 days beginning on the day after that permission is granted.

- If it relates to the erection or extension of a building, it must be supported by a plan to a scale of not less than 1:1250, showing size and position of the building; its own boundaries and its relationship with adjoining boundaries; the size, position and use of every other building within its boundaries; the width and position of any streets on or within its boundaries; the number of storeys and the provisions to be made for its drainage. Where any local legislation applies, the notice must state how it will be complied with.

The local authority is not required to approve or reject the building notice and, indeed, has no power to do so. However, it is entitled to ask for any plans it thinks are necessary to enable it to discharge its building control functions and may specify a time limit for their provision.

The regulations make plain that the building notice and plans shall not be 'treated as having been *deposited* in accordance with the Building Regulations'. In some ways this is an odd provision because the relevant building control sections of many of the local Acts of Parliament – which provide for special local requirements – are triggered off by the 'deposit' of plans. At first sight, therefore, this would render such requirements inoperative, but presumably it is thought that compliance will be ensured through the requirement that the building notice must contain a statement of the steps to be taken to comply with any local enactment.

Once a building notice has been given, work can be commenced, although there is a requirement (see below) that the local authority be notified at least two days before work commences.

A building notice remains in effect for a period of three years from the date on which it was given to the local authority. If the work has not been commenced within that period or the change to the building's energy status has not been made or the material change of use has not been made, the building notice lapses automatically.

3.4 Exemptions from the requirement to give a building notice or deposit full plans

A person who intends to carry out building work consisting only of the work described in the first column of Schedule 3 (see Chapter 5) is not required to give a building notice or deposit full plans if the work is to be carried out by a person described in the corresponding entry in the second column of the Schedule. Additionally, this same exemption exists for work described in Schedule 4 (see Chapter 5).

3.5 Deposit of plans

This is the traditional system of building control by which full plans are deposited with the appropriate local authority in accordance with section 16 of the Building Act 1984, as supplemented by regulation 14. Section 16 imposes a duty on the building control authority to either pass or reject plans deposited for the proposed work.

In *Murphy* v. *Brentwood District Council* (1990) 20 ConLR 1, CA, the Court of Appeal held that the duty is imposed on the local authority itself either to pass or reject the deposited plans, and it cannot discharge its duty by delegating performance to outside consultants. If the local authority leaves it to outside consultants to decide whether plans are passed or rejected, the local authority is vicariously responsible if the consultants are negligent, subject to proof of recoverable damage.

However, the Court of Appeal proceeded on the basis that *Anns* v. *London Borough of Merton* [1978] AC 728; [1977] 2 All ER 492, HL; 5 BLR 1 was rightly decided, and in light of the fact that *Anns* was subsequently overruled, it is thought that the local authority could only be vicariously liable in these circumstances (if at all) where personal injury was suffered by the occupier or there was damage to other property. Indeed, it is probable that in the current climate of judicial opinion the local authority would be held able to discharge its section 16 duty by reliance on competent outside expertise.

If the plans submitted are not defective, the authority has no alternative but to approve them unless, of course, they contravene the linked powers discussed in Chapter 1.

Where the proposed works are subject to the regulations, and it is proposed to deposit full plans, the provisions of section 16 and regulation 14 must be observed. The local authority must give notice of approval or rejection of plans within five weeks unless the period is extended by written agreement. The extended period cannot be later than two months from the deposit of plans, and any extension must be agreed before the five-week period expires. However, the five-week period does not begin to run unless the applicant submits a 'reasonable estimate' of the cost of the works (where applicable) and pays the plan charge at the same time as the plans are deposited.

The approval lapses if the work is not commenced within a period of three years from the date of the deposit of the plans, provided the local authority gives formal notice to this effect. The local authority must pass the plans of any proposed work deposited with them in accordance with the regulations unless the plans are defective or show that the proposed work would contravene the regulations. The notice of rejection must specify the defects or nonconformity, and the applicant may then ask the Secretary of State to determine the issue. His decision is then final. The Secretary of State may refer questions of law to the High Court and must do so if the High Court so directs.

The local authority may pass plans by stages, and, where it does, it must impose conditions as to the deposit of further plans. It may also impose conditions to ensure that the work does not proceed beyond the authorised stage. It has the power to approve plans subject to agreed modifications, e.g. where the plans are defective in a minor respect or show a minor contravention. However, it should be noted that local authorities are not obliged to pass plans conditionally or in stages, and the applicant must agree in writing to these procedures.

The 'full plans' required under the deposit method are the same as those required under the building notice procedure, together with such other plans as are necessary to show that the work will comply with the Building Regulations.

Regulation 14 specifies that the plans must be deposited in duplicate; the local authority retains one set of plans and returns the other set to the applicant. They must be accompanied by a statement that they are deposited in accordance with regulation 12(2)(b) of the 2010 Regulations and also a statement as to whether the Regulatory Reform (Fire Safety) Order 2005 applies to the building or will apply after the completion of the building work. Two additional copies of the plans must be submitted where Part B (Fire Safety) imposes a requirement in relation to the work and both additional plans may be retained

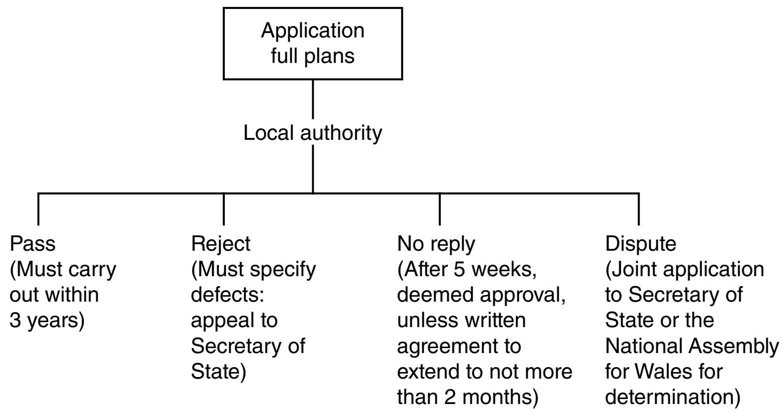


Fig. 3.2 The full plans procedure.

by the local authority, although it is not necessary to provide additional copies of the plans where the proposed work relates to the erection, extension or material alteration of a dwelling house or flat. Where it is proposed to build over a sewer and regulation H4 applies, particulars of the precautions to be taken must be provided.

Work may be commenced as soon as plans have been deposited – although the local authority must be given notice of commencement at least two days before work commences – but it is an unwise practice to commence work before notice of approval is received.

If the applicant wants the authority to issue a completion certificate (see section 3.7) in due course, a request to that effect should accompany the plans.

The advantage of the full deposit of plans method of control is that, if the work is carried out exactly in conformity with the plans as passed by the local authority, they cannot take any action in respect of an alleged contravention under section 36 of the Building Act 1984.

The deposit of full plans procedure and the possible alternative solutions are shown diagrammatically in Fig. 3.2.

3.5.1 Consultation with the sewerage undertakers

Regulation 15 requires that where full plans have been deposited with the local authority and there are proposals to build over a sewer (as covered by paragraph H4 of Schedule 1 to the Building Regulations 2010), the local authority must consult the sewerage undertaker:

- as soon as practicable after the plans have been deposited; and
- before issuing any completion certificate in relation to the building work in accordance with regulation 17 or 17A.

The local authority must give the sewerage undertaker sufficient plans to show whether the work would comply with the requirements of paragraph H4 and have regard to any views it expresses. The local authority must not pass plans or issue a completion certificate until 15 days have elapsed from the date on which the sewerage undertaker was consulted (unless, of course, the sewerage undertaker has expressed its views to the local authority before the 15 days has expired).

3.6 Notice requirements

Wherever the work is to be supervised by the local authority, in addition to the building notice or deposit of plans, the person undertaking the work must pay an inspection charge and give certain notices to the local authority.

The 2010 regulations regarding the giving of notice to the local authority for the completion of certain stages of work were substantially revised in the Building Regulations &c. (Amendment) Regulations 2012 (*SI 2012/3119*). Amendment regulation 9 amends regulation 16 of the Building Regulations by removing the statutory requirement to notify a local authority at specific stages of building work. Instead, regulation 16 enables a local authority to set out at what stages it requires those undertaking the building work to notify them. The regulation also requires that these stages be based on the intention to inspect and the assessed risk of non-compliance with building regulations.

Although regulation 16 is couched in somewhat complicated legalistic terms, the essentials of it are relatively straightforward and can be stated as follows:

- On receipt of a written notice of commencement from the person carrying out the work (they must give at least two days clear notice to the LA), the LA must carry out a risk assessment and issue a schedule to the applicant stating:
  (a) The specified stages of work at which the LA requires to carry out an inspection, and
  (b) When those stages must be made available for inspection.
- The time periods specified will depend on the type of work being carried out. Therefore they may relate to a period before or after the work has been carried out within which the notification must be made and/or a period during which the work concerned must not be covered up.

In addition to this the LA will in any case require the following periods of notice related to completion of a project:

- not more than five days after the work has been completed and
- at least five days notice before the building or any part of it is occupied where a building is being erected to which the Regulatory Reform (Fire Safety) Order 2005 applies, or will apply after the completion of the work, and that building (or any part of it) is to be occupied before completion.

Interestingly, a local authority may only specify a stage of the building work in accordance with (a) above if at the time they do so they intend to carry out an inspection of that stage.

Failure to give the required notices is a criminal offence, punishable on summary conviction by a substantial fine.

In practice the majority of local authorities do not seek to enforce the penalty but rely on their powers to serve written notice requiring the person concerned within a reasonable time to cut into, lay open or pull down so much of the work as is necessary to enable them to check whether it complies with the regulations.

Where the person carrying out the work is advised in writing by the local authority of contravening works and has rectified these as required by the local authority, he must give the authority written notice within a reasonable time after the completion of the further work.

'Reasonable time' is not defined in either situation; it is a question of fact in each case. The phrase has been judicially defined as being 'reasonable under ordinary circumstances': *Wright* v. *New Zealand Shipping Co*. [1878] AC 23.

There is no definition of the term 'person carrying out building work' in the regulations, but in *Blaenau Gwent Borough Council* v. *Khan* (1993) 35 ConLR 65, the High Court held that the owner of a building who authorises a contractor to carry out building works on his behalf fell within the term. The court took the view that those words should not be confined so as to restrict the meaning of the phrase to the person who physically performs the work 'but includes the owner of the premises on which the works are being performed and who had authorised the work'.

There is now a definition of *day*. It means a period of 24 hours commencing at midnight, i.e. a calendar day, but Saturdays, Sundays and Bank or public holidays are excluded.

The procedure outlined above requires that the local authority's intention to carry out an inspection of a stage of building work must be based on their assessment of the risk of breach of the Regulations if they do not inspect the work. Guidance to local authorities has been issued in a document entitled *Risk assessment decision making tool for building control bodies – Final risk assessment guidance* (January 2012).

The document covers both common projects such as loft conversions and more complex and larger undertakings, such as hospitals. Section 2 of the document provides guidance on the risk assessment of common projects and section 3 provides guidance for more complex projects. The document provides guidance on achieving a site inspection regime of 'appropriate intensity and frequency'.

Risk is defined in the context of identifying construction stages to be notified to Building Control Bodies:

(1) as the likelihood of non-compliance with Building Regulations; and
(2) the potential extent of harm to:
   (a) current and future users of buildings; and
   (b) the environment caused by non-compliance. The risk to the environment includes the aggregate impact on the use of buildings on rates of climate change.

The new risk assessment approach to site inspection mirrors that already carried out by Approved Inspectors (see Chapter 5).

In addition to the notice periods outlined above, there are a number of other notice periods related to thermal calculations and energy performance certificates which are covered in detail in Chapter 16.

3.7 Completion certificate

The local authority must issue a completion certificate within a specified time period when they are satisfied, after having taken all reasonable steps, that the building complies with the relevant provisions of Schedule 1.

The specified time period is eight weeks starting from the date on which the person carrying out the building work notifies the local authority that the work has been completed.

The relevant provisions referred to above are any applicable requirements of the following:

(a) regulation 25A (high energy alternative systems for new buildings),
(b) regulation 26 (target CO_2 emission rates for new buildings),
(c) regulation 29 (energy performance certificates),
(d) regulation 36 (water efficiency of new dwellings),
(e) regulation 38 (fire safety information) and
(f) Schedule 1.

Additionally, a local authority must give a completion certificate within four weeks of being notified by the person carrying out the work in respect of part or all of a building where building work is being carried out and where all of the following circumstances apply:

(a) part or all of the building is to be occupied before the work is completed;
(b) the building is subject to the Regulatory Reform (Fire Safety) Order 2005; and
(c) the authority is satisfied, after taking all reasonable steps, that, regardless of completion of the current building work, those parts of the building which are to be occupied before completion of the work currently comply with regulation 38 (Fire Safety Information) and Part B (Fire Safety) of Schedule 1.

The completion certificate is evidence – but not *conclusive* evidence – that the requirements specified in the certificate have been complied with.

It should be noted that the local authority cannot be held liable for a fine if it contravenes this regulation by failing to give a completion certificate (see regulation 47).

4 Private certification

4.1 Introduction

One of the Government's aims in reforming the previous system of building control was to provide an opportunity for self-regulation by the construction industry through a scheme of private certification. This is not a complete substitute for local authority control, because local authorities will always remain responsible for taking any enforcement action which may be necessary. Indeed, in certain closely defined circumstances, they may resume their control functions.

The developer is given the option of having the work supervised privately rather than relying on the local authority control system described in Chapter 4. Essentially, the private certification scheme is based on the proposals set out in a Government White Paper *The future of building control in England and Wales* published by HMSO in February 1981.

The statutory framework of the alternative system is contained in Part II of the Building Act 1984. In broad terms, this provides that the responsibility for ensuring compliance with Building Regulations may, at the option of the person intending to carry out the work, be given to an approved inspector instead of to the local authority. It also enables approved public bodies to supervise their own work. Various supplementary provisions deal with appeals, offences and registration of certain information.

The detailed rules and procedures relating to private certification are to be found in the Building (Approved Inspectors, etc.) Regulations 2010, as amended, which also contain prescribed forms that must be used.

It has taken some considerable time for the private certification system to become fully operational even though the first approved inspector, the National House Building Council (NHBC), was approved on 11 November 1985. Their original approval related only to dwellings of not more than four storeys, but this was later extended to include residential buildings up to eight storeys, and this was further extended in 1998 to include any buildings.

The approval of further corporate bodies as approved inspectors was held up by a number of factors but was due mainly to the difficulty posed in obtaining the level of insurance cover which was required by the then Department of the Environment. After a period of consultation, new proposals for insurance requirements were agreed and these were implemented on 8 July 1996. At the same time the Construction Industry Council

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

(CIC) was designated as the body for approving non-corporate inspectors, although the Secretary of State reserved the right to approve corporate bodies. Furthermore, from 1 March 1999 the CIC became responsible also for the approval of corporate approved inspectors.

Three further corporate bodies were approved by the Secretary of State on 13 January 1997. Others (including a number of non-corporate approved inspectors) have continued to be approved since that date (at the time of writing, 90 Approved Inspectors were entered on the CIC register), but until 31 October 2005, NHBC Building Control Services Ltd remained the only body insured to deal with speculative domestic construction (i.e. self-contained houses, flats and maisonettes built for sale to private individuals).

In this context, the DTLR issued insurance guidelines on 23 October 2001 that allowed approved inspectors to carry out their building control function on a range of different dwelling types, except so-called 'non-exempt' dwellings. This definition excluded speculative dwellings constructed by house-building companies for sale to the public. During 2004 the ODPM consulted on proposals for a 'Warranty Link Rule' whereby Approved Inspectors requiring to perform building control duties on new dwellings built for private sale or renting could carry out this function provided that the dwelling also carried an approved housing warranty from an approved provider. This resulted, on 31 October 2005, in the opening up of the private housing market to Approved Inspectors and ended the NHBC's monopoly of this area of work.

In January 2012 the Department for Communities and Local Government (DCLG) consulted on changes to the Building Regulations in England which included the proposal to remove the Warranty Link Rule. The majority of those who responded were in favour of the proposal. The removal of the Warranty Link Rule took effect on 6 April 2013 in respect of initial notices or combined initial notices and plans certificates given on or after 6 April 2013 and applied to England only. From 6 April 2013 Approved Inspectors are no longer required to check if new dwellings were registered with a designated warranty scheme provider before undertaking the building control function on building work involving the creation by new build or conversion of any new dwellings for sale or private renting. In Wales the Warranty Link Rule was withdrawn on 1 September 2013.

Further information on corporate and non-corporate approved inspectors may be obtained from The Association of Consultant Approved Inspectors, c/o 17 Campbell Mews, Sovereign Harbour North, Eastbourne, East Sussex, BN23 5AH or from their website: http://approvedinspectors.org.uk.

4.2 Insurance requirements

The approval process of the CIC ensures that all Approved Inspectors are well qualified to carry out the building control function. However, Approved Inspectors do not have the financial strength of local authorities as permanent, statutory bodies. For this reason, one of the safeguards provided for in the legislation is that an Approved Inspector must have professional indemnity insurance approved by the Secretary of State.

This indirectly protects clients and others who may be adversely affected by any negligence on the part of the Approved Inspector, by ensuring that, subject to the limits on cover, the Approved Inspector has the financial resources to comply with any award of damages or out of court settlement.

Until 6 April 2013 in England and 1 September 2013 in Wales, Approved Inspectors were obliged to give details of their approved insurance scheme each time they interacted with a local authority. In effect, this statement of approved insurance had to be made whenever they served an initial notice, amendment notice, plans certificate, combined initial notice and plans certificate or a final certificate on the local authority. *The Building Regulations etc (Amendment) Regulations 2012 (SI 2012/3119)* ended this obligation provided that the Approved Inspector had supplied its declaration of insurance to the person that had approved it (i.e. the Secretary of State or the CIC) before the service of the notices referred to above. The insurance cover provided under these schemes indemnifies the approved inspector in respect of claims arising from the conduct of their building control functions.

A 17 September 1997 circular letter to local authorities and Approved Inspectors from the then Department for the Environment, Transport and the Regions reminded addressees that NHBC Building Control Services Ltd is insured by its parent, the NHBC, under two schemes approved in 1985 and 1996, respectively. These two schemes together cover all descriptions of building control work. The approvals of those schemes remain in place.

Since the NHBC deals mainly with dwellings, the insurance cover required is more extensive than that needed for other types of buildings. In fact, the NHBC has to provide two different types of insurance policy:

- *Ten-year no-fault insurance* against breaches of the Building Regulations relating to site preparation and resistance to moisture, structure, fire, drainage and heat-producing appliances. The limit on cover is related to the original cost of the work allowing for inflation during the ten-year period up to a maximum of 12% per annum compound.
- *Insurance against the approved inspector's liabilities in negligence for* 15 years from the issue of the Final Certificate for each dwelling. The limit of cover is twice the cost of the building work (unless there is a simultaneous claim made under the no-fault policy), together with cover against claims made for personal injury (which is normally £100,000 per dwelling). This is also proof against inflation up to 12% compound per annum and is subject to a minimum of £1 million per site.

The Secretary of State has approved, under section 47(6) of the Building Act 1984, the following additional insurance schemes:

- Howden Insurance Brokers Limited t/a Howden Windsor scheme, Howden Insurance Brokers Limited, 71 Fenchurch Street, London EC3M 4BS, tel: 020 7133 1400, email: info@howdengroup.com
- Griffiths & Armour, 145 Leadenhall Street, London EC3V 4QT, tel: 020 790 1100, email: piinsurance@griffithsandarmour.com

These schemes are governed by the following criteria.

Criteria for schemes of insurance for Approved Inspectors pursuant to section 47(6) of the Building Act 1984 – October 2005

(a) **Professional Indemnity cover**
Schemes must provide for professional indemnity insurance covering the AI for losses arising from claims on him/it in respect of negligence, or alleged negligence, in the performance of his/its duties as an AI.

The following minimum limits apply to such cover:

(i) for claims against the AI in respect of personal injury (including illness, disease and death) an aggregate limit of £5m per claim (all claims attributable to one occurrence shall be treated as one claim).

(ii) for other claims against the AI, a limit of £1m per claim (all claims attributable to one occurrence shall be treated as one claim) subject to a minimum aggregate limit of £15m for all claims against the AI in respect of his or its work carried out in any one period of 12 months.

(b) **Defence costs**
Cover is to extend to the AI's defence costs, which are to be treated on a 'costs in addition basis', that is, such costs will not be taken into account for the per claim limits, though they will count towards the aggregate limit of £15m.

(c) **Automatic run-off cover**
In relation to:

(i) any personal injury claims; and

(ii) non-injury claims brought by an owner–occupier in relation to his/her only or main residence, other than under the law of contract,

cover must be provided in respect of claims notified to the insurer within ten years of the date of completion of the AI's work in respect of the relevant building project, whether that date is that of acceptance of a final certificate, or of some other event marking the practical termination of the AI's involvement in the project.

The minimum per claim limits set out in (a)(i) and (ii) above apply in respect of this cover, as does the minimum aggregate limit of £15m.

(d) **Index linking**
Not required.

(e) **Excess**
Not more than £5000 per claim.

(f) **Voiding of cover**
In line with commercial practice, reasonable provisions for voiding of cover will be allowed.

It should be noted that the schemes operated by PYV Limited and Zurich Building Control Services Ltd have been withdrawn.

4.3 Approval of inspectors

Section 49 of the Building Act 1984 defines an 'approved inspector' as being a person approved by the Secretary of State or a body designated by him for that purpose.

The rules which govern the duties, responsibilities and activities of Approved Inspectors are contained principally in *Part II* of the *Building Act 1984* and the *Building (Approved Inspectors etc.) Regulations 2010 (SI 2010/2215)* (the AI Regulations), as amended.

The Building Act has been amended many times since its inception, and these amendments are incorporated in the text below. The current AI Regulations were made on 6 September 2010 and came into force on 1 October 2010. They revoked and replaced, with amendments, the *Building (Approved Inspectors etc.) Regulations 2000 (SI 2000/2532)* and consolidated all subsequent amendments to those regulations. They have been further amended several times since coming into force, the principal amendments being contained in the *Building Regulations etc (Amendment) Regulations 2012 (SI 2012/3119)* and the *Building regulations &c. (Amendment) Regulations 2015 (SI 2015/767)* and the text below reflects these amendments.

Part 2 of the AI Regulations sets out the detailed arrangements and procedures for the grant and withdrawal of approval.

There are two types of Approved Inspector:

- corporate bodies, such as the NHBC or JHAI Ltd; and
- individuals, not firms.

Approval may limit the description of work in relation to which the person or company concerned is an Approved Inspector.

Approval of an inspector is not automatic. Any individual or corporate body wishing to operate as an Approved Inspector must satisfy several criteria. They must hold suitable professional qualifications, have adequate practical experience and carry suitable indemnity insurance as outlined above. They must also be registered with a body designated for that purpose by the Secretary of State. The CIC established the Construction Industry Council Approved Inspectors Register Ltd (CICAIR Ltd) to maintain and operate the Approved Inspector Register in accordance with the responsibilities entailed by CIC's appointment as a designated body on 8 July 1996. On 13 March 2014 the Secretary of State announced that CICAIR Ltd had become the designated body for the approval of Approved Inspectors.

The CICAIR route to qualification for Approved Inspectors involves the following stages of assessment.

4.3.1 Application

To ensure that professional standards are maintained, Approved Inspectors must undergo a robust application process and repeat this application process every five years to maintain their Approved Inspector status. Applications will be processed within six months of receipt and, to meet the requirements of the EU Services Directive, if an application has not been processed within this six month period, it will be deemed to have been successful.

There are four stages involved in the assessment process to become an Approved Inspector or be reapproved:

(1) **Application**
The applicant completes an application form including a detailed knowledge base. The knowledge base is the heart of the application and requires demonstration of

how the applicant's knowledge and experience equip them for the duties and responsibilities of an Approved Inspector. The knowledge base addresses six key areas:

- Legislation and Building Control
- Business Management and Professional Ethics
- Construction Technology and Sustainability
- Fire Studies
- Structural Design
- Building Services and Environmental Engineering

(2) **Pre-qualification verification**
On receipt of an application, the CICAIR Ltd Registrar will check if all the information requested on the form has been provided and the application is in the required format. Applicants will be asked to provide anything found to be missing or clarify any queries before the application can be progressed further.

(3) **Admissions panel**
On successful completion of the pre-qualification verification, the application is considered by professional Assessors who decide whether the applicant has demonstrated the necessary experience and knowledge to merit a professional interview. Assessors include both qualified Approved Inspectors and experts nominated from across the range of disciplines represented by CIC members.

(4) **Professional interview**
Successful completion of all the application assessment stages will result in the applicant being invited to register, subject to their adoption of the Building Control Performance Standards in their working practices, the Code of Conduct for Approved Inspectors and insurance restrictions for minor works, which are pre-requisites for entry onto the Register. Approved Inspector registration is valid for a period of five years, after which time reapproval is required.

Applicants' attention is drawn to a letter proscribing franchising dated 26 September 2012 and a follow-up letter dated 14 May 2013 whereby persons working for Approved Inspectors must be directly employed by them as defined by HM Revenue and Customs.

Application fee

The fee to cover the approval or reapproval process is £3500 (plus VAT).

Registration fee

(1) **New applicant** – a registration fee of £500 annually prior to the anniversary of registration.
(2) **Reapproval** – the registration fee following reapproval is 0.8% (plus VAT) of the Approved Inspector's average turnover for the five years prior to reapproval.

If the fee is less than £5000, it must be paid in full prior to the registration renewal. If the fee is more than £5000, it may be paid in five equal instalments, with the first instalment to be paid prior to the registration renewal and the subsequent instalments paid annually prior to the anniversary of registration.

The minimum registration fee is £2000 (plus VAT).

Application forms for new applicants

Standard application forms are provided for both corporate (companies) and non-corporate (individuals and sole traders) applicants.

Application forms for reapproval

Forms are also provided for:

- Approved inspector reapproval applications
- Approved inspector turnover declaration (this must be submitted with the reapproval application)

Change of name

There is a charge of £150 (plus VAT), payable to the CIC, to change the registered name of an Approved Inspector. When requesting a change, an Approved Inspector should submit copies of the change of name certificate issued by Companies House and the revised insurance documentation. CICAIR Ltd will issue a new certificate, amend the Register and notify the relevant authorities.

Code of conduct

All Approved Inspectors are required to sign up to the CIC's Code of Conduct for Approved Inspectors.

If an applicant/candidate is unsuccessful at any stage in the assessment, he/she will be given reasons and, on application to the Registrar, any advice CICAIR is able to give. Opportunities for appeals against decisions are provided.

The CIC can withdraw its approval – for example, if the inspector has contravened any relevant rules of conduct or shown that he or she is unfitted for the work.

More seriously, where an approved inspector is convicted of an offence under section 57 of the 1984 Act (which deals with false or misleading notices and certificates), the CIC may withdraw its approval. In this case the convicted person's name would be removed from the list for a period of five years. There is no provision for appeals or reinstatement.

The Secretary of State may withdraw approval of any designated body, thus ensuring that the designated bodies act responsibly in giving approvals. Such action would not necessarily prejudice any approvals given by the designated body, but the Secretary of State can, if so desired, withdraw any approvals given by the designated body.

Provision is made for the Secretary of State to keep lists of designated bodies and inspectors approved by him and for their supply to local authorities. He must also keep the lists up to date (if there are withdrawals or additions to the list) and must notify local authorities of these changes.

In a similar manner, designated bodies are required to maintain a list of inspectors whom they have approved. There is no express provision for these lists to be open to public inspection, although the designated body is bound to inform the appropriate local authority if it withdraws its approval from any inspector.

In approving any inspector, either the Secretary of State or a designated body may limit the description of work in relation to which the person concerned is approved. Any limitations will be noted in the official lists, as will any date of expiry of approval.

4.4 Approved persons and self-certification by competent persons

The following bodies, together with the Chartered Institution of Building Services Engineers, have been designated to approve private individuals who wish to become approved persons who can certify plans to be deposited with the local authority as complying with the energy conservation requirements:

- The Chartered Institute of Constructors
- The Faculty of Architects and Surveyors
- The Association of Building Engineers
- The Institution of Building Control Officers
- The Institution of Civil Engineers
- The Institution of Structural Engineers
- The Royal Institute of British Architects
- The Royal Institution of Chartered Surveyors

Additionally, the Institution of Civil Engineers and the Institution of Structural Engineers have been designated to approve persons to certify plans as complying with the structural requirements. Approved *Persons* under section 16(9) of the Building Act should not be confused with Approved *Inspectors* under sections 47 to 56 or *Competent Persons* operating under self-certification schemes discussed in Chapter 5. As yet however, no approved persons have been designated in England and Wales.

4.5 Self-certification schemes and the Approved Inspector

Since April 2002 a number of self-certification schemes have existed for relatively minor work where the person carrying out the work (known as a Competent Person under the Regulations) has been able to self-certify to the local authority (or other registration body such as CERTASS Ltd) that the work complies with the requirements of the relevant Building Regulations (see Chapter 5).

Until the coming into force of the Building and Approved Inspectors (Amendment) Regulations 2006, this process only involved local authorities and did not apply to Approved Inspectors. A new regulation 11A introduced by the aforementioned regulations has applied this process to Approved Inspectors and has, at the same time, increased the number of such Competent Person Schemes. Approved Inspectors are now authorised to accept, as evidence that the requirements of regulations 4 and 7 of the Building Regulations 2000 have been satisfied, a certificate to that effect by a person carrying out the building work. The person must be registered under the relevant Competent Person Scheme, and the details of these may be found in the Table in Schedule 3 attached to the Building regulations 2010 (as amended) and reproduced in Chapter 5. The certificate must be given to the occupier of the property and the Approved Inspector not more than 30 days after completion of the work.

4.6 Independence of Approved Inspectors

An Approved Inspector cannot supervise work in which he or she has a professional or financial interest, unless it is 'minor work'. In this context, 'minor work' means:

(1) The material alteration or extension of a dwelling house (not including a flat or a building containing a flat) which has two storeys or less before the work is carried out and which afterwards has no more than three storeys. A basement is not regarded as a storey.
(2) The provision, extension or material alteration of controlled services or fittings (see section 2.4 for definition of controlled services or fittings).
(3) Work involving the underpinning of a building.

Independence is not required of an inspector supervising minor work, but the limitation on the number of storeys should be noted.

There is a broad definition of what is meant by having a professional or financial interest in the work, the effect of which is to debar the following:

- anyone who is or has been responsible for the design or construction of the work in any capacity, e.g. the architect;
- anyone who or whose nominee is a member, officer or employee of a company or other body which has a professional or financial interest in the work, e.g. a shareholder in a building company; and
- anyone who is a partner or employee of someone who has a professional or financial interest in the work.

However, involvement in the work as an approved inspector on a fee basis is not a debarring interest!

4.7 Approval of public bodies

Public bodies are able to supervise their own building work by following a special procedure, which is detailed in the regulations. For the purposes of the Building Act, a Public Body is a corporate or unincorporated body that acts under an enactment for public purposes and not for its own profit and is, or is of a description that is, approved by the Secretary of State in accordance with building regulations. It is doubtful if any Public Bodies actually carry out their own building control procedures at present. Formerly, the British Airports Authority acted as a Public Body, but they established their own Approved Inspector Company some years ago as BAA Building Control Services Ltd (now known as LHR Building Control Services Ltd).

Regulation 21 empowers the Secretary of State (or the Welsh Ministers) to approve public bodies for this purpose, although, curiously, no criteria have been laid down as to the qualification and experience of the personnel involved. The regulation confers wide discretionary powers on the Secretary of State or the Welsh Ministers, but clearly approval will be limited to those bodies which may reasonably be expected to operate responsibly without detailed supervision. The regulations relating to notices, consultation with the fire authority and the sewerage undertaker, plans certificates and final certificates mirror those of Part II of the Building Act 1984 dealing with Approved Inspectors. The grounds on which the local authority may reject a public body's notice, etc. mirror those applicable to the approved inspector system, except that:

- there is no provision for cancellation of a public body's notice;
- there is no requirement that there should be an approved insurance scheme in force; and
- unlike Approved Inspectors, public bodies do not have to be independent of the work they are supervising under the regulations (i.e. they can carry out a building control service on projects which they have designed and are building themselves).

To date, only the Metropolitan Police Authority has been prescribed as a public body under the provisions of the Building Act 1984, section 5, although it is exempt from the procedural requirements, so it does not have to submit notices etc. to the local authority. However, it must still comply with the substantive requirements of the regulations.

4.8 Private certification procedure

The procedures which operate when using an approved inspector are illustrated in Fig. 4.1. The left column shows the steps applicable to the person carrying out the building work (i.e. the client) and the right column indicates the duties and responsibilities of the approved inspector. Joint actions are indicated in the centre column.

4.8.1 Initial notice

If the developer decides to employ an Approved Inspector, whether an individual or a corporate body, the first formal step in the process is for the applicant and the approved inspector jointly to give to the local authority in whose area the work is to be carried out an initial notice in the prescribed form. The purpose of the initial notice is to make the local authority aware that building work in their area is being properly controlled under the regulations and to notify them of certain linked powers that they have under the Building Act 1984 and any local Acts of Parliament.

The initial notice must be signed by the Approved Inspector and the 'person intending to carry out the work'. This is not usually the builder but the person on whose behalf the work is being carried out (i.e. the client).

The initial notice must be in a prescribed form, and it is a contravention of the regulation to start work before the notice has been accepted. Figure 4.2 shows a typical initial notice. It must contain:

- A description of the work.
- A declaration that an approved scheme of insurance applies to the work, which must be signed by the insurer.

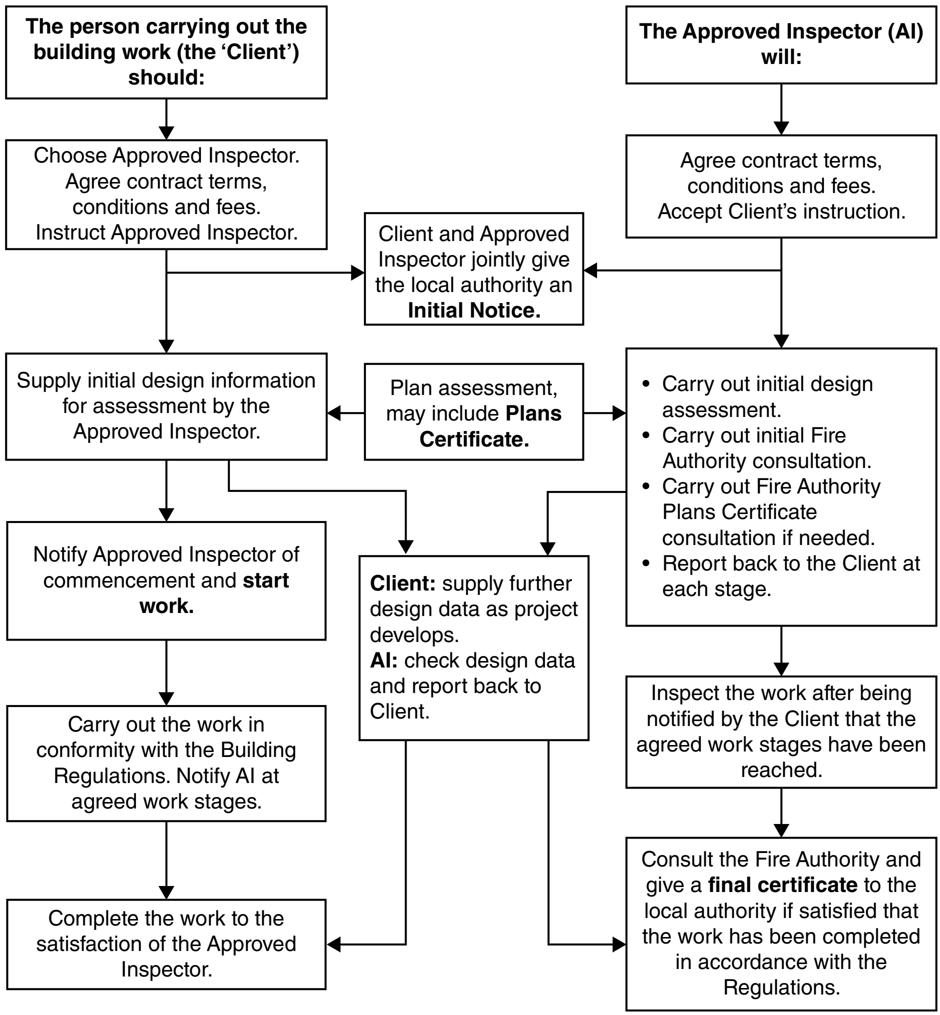


Fig. 4.1 Private certification procedure.

- A copy of the notice of approval.
- In the case of a new building or extension, a site plan to a scale of not less than 1:1250 showing the boundaries and location of the site.
- Where the work includes the construction of a new drain or private sewer, a statement:
  (1) as to the approximate location of the proposed connection that is to be made to the sewer; or
  (2) where no connection is to be made to a sewer, as to the method of discharge of the proposed drain or private sewer. This could include, for example, the location of any septic tank and secondary treatment system or any wastewater treatment system or cesspool.

- A statement of any local legislation relevant to the work and the steps to be taken to comply with it.
- A statement confirming that the work is not minor work.
- A declaration that the Approved Inspector has no financial or professional interest in the work (other than for minor work).

A N APPROVED INSPECTORS LTD
Initial Notice

This notice is issued pursuant to section 47 of the Building Act 1984 ("the Act") and the Building (Approved Inspectors etc.) Regulations 2010 as amended

To:- Building Control Manager
Local Authority:- ....
Address:- ....
....

Person intending to carry out the work:-	Agent / Architect / Contractor:-
Name	Name ....
Address	Address ....
....	....
....	....
Telephone	Telephone ....

This notice relates to the following work:-
Description of work ....
....
Address ....
....
Use of buildings ....

With this notice are the following documents, which are those relevant to the work described in this Notice:-

(a) In the case of the erection or extension of a building, a plan to scale of not less than 1:1250 showing the boundaries and location of the site and (where the work includes the construction of a new drain or private sewer) a statement – (i) as to the approximate location of any proposed connection to be made to a sewer, or (ii) if no connection is to be made to a sewer, as to the proposals for the discharge of the proposed drain or private sewer including the location of any septic tank and associated secondary treatment system, or any wastewater treatment system or cesspool;

(b) In the case of a new dwelling –

(i) A statement whether or not one or more, and if so which, of the following optional requirements in the Building Regulations 2010 applies to the building work –

- regulation 36(2)(b) (optional water efficiency requirement of 110 litres per person per day),
- Schedule 1 Part M optional requirement M4(2) (category 2 – accessible and adaptable dwellings),
- Schedule 1 Part M optional requirement M4(3) (category 3 – wheelchair user dwellings), or

(ii) a statement that planning permission has not yet been granted for the work, and that the information required by (a) will be supplied as soon as is reasonably practicable after that permission is granted.

If applicable a statement of any local enactment relevant to the work, and of the steps to be taken to comply with it

Fig. 4.2 Typical initial notice.

A N Approved Inspectors Ltd declares that:

(i) The work does/does not concern a new dwelling.
(ii) The work is/is not minor work (regulation 9(5) of the 2010 Regulations).
(iii) It does not and will not while this Notice is in force, have any financial or professional interest in the work described (regulation 9(i) to 9(iv) of the 2010 Regulations).
(iv) It will/will not be obliged to consult the fire and rescue authority by regulation 12 of the 2010 Regulations.
(v) It undertakes that before giving a Plans Certificate in accordance with section 50 of the Act or a Final Certificate in accordance with section 51 of the Act it will consult the fire and rescue authority in respect of any of the work described above.
(vi) It will/will not be obliged by regulation 13 of the 2010 Regulations to consult the sewerage undertaker.
(vii) It undertakes that before giving plans a Plans Certificate in accordance with section 50 of the Act, or a Final Certificate in accordance with section 51 of the Act, it will consult the sewerage undertaker in respect of any of the work described above.
(viii) It is aware of the obligations laid upon it by Part 2 of the Act and by regulation 11 of the 2010 Regulations.

A N Approved Inspectors Ltd is an approved inspector for the purpose of Part 2 of the Act in respect of the work described in this notice.

Copies of the notice of approval and of a declaration of insurance relevant to the work described in this notice are on the register kept by the body designated under regulation 3 of the 2010 regulations.

Signed ……………………..…………………………….. Name……...
For and on behalf of A N Approved Inspectors Ltd Position…………………………………………………
Date……………………………………………………...

Signed …………………………………………………… Name……………………………………………………
For and on behalf of the person intending to carry out the work Position…………………………………………………
Date…………………………………………………..……

Fig. 4.2 (*Continued*)

- An undertaking that the Approved Inspector will consult the Fire and Rescue Authority where obliged to do so.
- An undertaking that the Approved Inspector will consult the sewerage undertaker where obliged to do so (i.e. where the works involve building over or near a sewer).

It is essential that the initial notice is fully completed, because the local authority must reject it unless they are satisfied that the notice contains sufficient information. The local authority has five working days in which to consider the notice and may only reject it on prescribed grounds. These are:

- The notice is not in the prescribed form.
- The notice has been served on the wrong local authority.
- The person who signed the notice as an Approved Inspector is not an Approved Inspector.
- The information supplied is deficient because neither the notice nor plans show the location or contain a description of the work (including the use of any building to which the work relates).
- The notice fails to state whether or not the work concerns a new dwelling.

- Where the notice applies to a new dwelling, it fails to contain a statement:
  (1) whether or not one or more, and if so which, of the following optional requirements applies to the building work:
    (i) regulation 36(2)(b) (optional water efficiency requirement of 110 litres per person per day),
    (ii) Schedule 1 Part M optional requirement M4(2) (category 2 – accessible and adaptable dwellings),
    (iii) Schedule 1 Part M optional requirement M4(3) (category 3 – wheelchair user dwellings), or
  (2) a statement that planning permission has not yet been granted for the work and that the information required by (a) will be supplied as soon as is reasonably practicable after that permission is granted.
- The notice is dated on or after 6 April 2013, and after having taken all reasonable steps, the Local Authority is unable to establish that a named scheme of insurance approved by the Secretary of State is in place.
- The Approved Inspector is obliged to consult the sewerage undertaker before giving a plans certificate or final certificate, and the initial notice does not contain an undertaking to do so.
- Where it is intended to erect or extend a building, the local authority considers that a proposed drain must connect to an existing sewer, but no such arrangement is indicated in the initial notice.
- The notice does not contain an undertaking to consult the fire authority (where this is appropriate).
- The notice does not contain a declaration that the Approved Inspector has no financial or professional interest in the work (this does not apply to minor work).
- Local legislative requirements will not be complied with.
- An earlier initial notice has been given for the work, which is still effective. This ground for rejection does not apply if:
  (1) the earlier notice has ceased to be in force and the local authority have taken no positive steps to supervise the work described in it; or
  (2) the initial notice is accompanied by an undertaking from the Approved Inspector who gave the earlier notice such that the earlier notice will be cancelled when the new notice is accepted.

If the local authority does not reject the initial notice within five working days (beginning on the day the notice is given to the local authority), it is presumed to have accepted it without imposing requirements. Therefore, an initial notice comes into force when it has been accepted by a local authority (or is deemed to have been accepted by the passing of five days). So long as the initial notice remains in force, the function of enforcing the Building Regulations, which is conferred on a local authority under the Building Act 1984, is not exercisable in relation to the work described in the initial notice.

Generally, the initial notice remains in force during the currency of the works. However, in certain circumstances, it may be cancelled or cease to have effect after the lapse of certain defined periods of time where there has been a failure to give a final certificate to the local authority. The time periods depend on the circumstances, but the position may be summarised as follows:

- If a final certificate is rejected – four weeks from the date of rejection.
- Where there is a failure to give a final certificate:
  (1) Eight weeks from the date of occupation for the erection, extension or material alteration of a building. This period of time is reduced to four weeks where the building is considered to be a 'relevant building' under the terms of the Regulatory Reform (Fire Safety) Order 2005.
  (2) Eight weeks after the change of use takes place where the work relates to a material change of use.

The local authority is given power to extend these time periods.

It is possible to give a final certificate for part of a building or extension if it is needed to be occupied before overall completion of the project. In these circumstances the initial notice is not cancelled but remains in force until final completion of the work.

Sometimes it may be necessary to vary work which is the subject of an initial notice (e.g. it may be decided to change the number of units being erected). In such circumstances the person who is carrying out the work and the approved inspector should give an amendment notice to the local authority.

There is a prescribed form for an amendment notice, and it must contain the information which is required for an initial notice (see above) plus either:

- a statement to the effect that all plans submitted with the original notice remain unchanged; or
- amended plans are submitted with the amendment notice plus a statement that any plans not included remain unchanged.

The local authority has five working days in which to accept or reject the notice, and it may only reject it on prescribed grounds. The procedure is identical to that for acceptance or rejection of an initial notice.

4.8.2 Cancellation of initial notice

In the following cases, the Approved Inspector must cancel the initial notice by issuing to the local authority a cancellation notice in a prescribed form. The grounds on which the initial notice must be cancelled are:

- The Approved Inspector has become or expects to become unable to carry out (or continue to carry out) his functions.
- The Approved Inspector believes that because of the way in which the work is being carried out, he cannot adequately perform his functions.
- The Approved Inspector is of the opinion that the requirements of the regulations are being contravened, and despite giving notice of contravention to the person carrying out the work, that person has not complied with the notice within the three-month period allowed (Approved Inspector Regulations, regulation 18).

It is also possible for the person carrying out the work to cancel the initial notice. This arises if it becomes apparent that the approved inspector is no longer willing or able to carry out his functions (through bankruptcy, death, illness, etc.). This must be done in the prescribed form and must be served on the local authority and (where practicable) on the Approved Inspector.

Alternatively, it is possible for the person carrying out the work to give a new initial notice jointly with a new Approved Inspector, provided that the new notice is accompanied by an undertaking by the original Approved Inspector that he will cancel the earlier notice as soon as the new notice is accepted. Once the initial notice has ceased to have effect, the approved inspector will be unable to give a final certificate, and the local authority's powers to enforce the Building Regulations can revive. In this case the local authority becomes responsible for enforcing the regulations, and it must be provided on request with plans of the building work so far carried out. Additionally, it may require the person carrying out the work to cut into, lay open or pull down work so that it may ascertain whether any work not covered by a final certificate contravenes the regulations.

If it is intended to continue with partially completed work, the local authority must be given sufficient plans to show that the work can be completed without contravention of the Building Regulations. A fee, which is appropriate to that work, will be payable to it.

Where the work covered by the initial notice has not commenced within three years from the date on which the initial notice was accepted, the local authority may (not must) cancel the initial notice.

4.8.3 Functions of approved inspectors

The fees payable to an approved inspector are a matter for negotiation; there is no prescribed scale. The Approved Inspector is under an obligation to '*take such steps (which may include the making of tests of building work and the taking of samples of material) as are reasonable to enable him to be satisfied within the limits of professional care and skill*' that the Building Regulations are complied with.

The approved inspector must be satisfied that the requirements relating to:

- building work (reg. 4),
- material change of use (reg. 6),
- materials and workmanship (reg. 7),
- requirements relating to a change of energy status (reg. 22),
- requirements relating to thermal elements (reg. 23),
- CO_2 emission rates for new buildings (reg. 26),
- consequential improvements to energy performance (reg. 28),
- water efficiency of new dwellings (reg. 36),
- Fire safety information (reg. 38),
- information about ventilation (reg. 39), and
- information about use of fuel and power (reg. 40)

of the Principal Regulations (the Building Regulations 2010 as amended) are complied with.

Additionally, the following requirements of the Principal Regulations apply in relation to building work which is the subject of an initial notice as if references to the local authority were references to the approved inspector:

- Regulation 20 – Provisions applicable to self-certification schemes (see Chapter 5)
- Regulation 27 – CO_2 emission rate calculations. This specifies that various calculations and other information must be given to the Approved Inspector. This is normally before work starts and not later than five days after it is completed, with the proviso that where an initial notice has ceased to be in force, notice of the various calculations must be given at the cessation date
- Regulation 29 – Energy Performance Certificates (EPC). This specifies that an EPC must be given to the Approved Inspector for certain categories of building work within five days of the completion of the work, with the proviso that where an initial notice has ceased to be in force, the EPC must be given at the cessation date
- Regulation 37 – Wholesome water consumption calculation. This specifies that the person carrying out the work must give the Approved Inspector a notice which specifies the potential consumption of wholesome water per person per day calculated in accordance with the methodology referred to in regulation 36 of the Principal Regulations in relation to the completed dwelling with the proviso that where an initial notice has ceased to be in force, the water calculation must be given at the cessation date
- Regulation 41 – Sound insulation testing must be complied with. This means that the person carrying out the building work must supply a copy of the sound insulation testing results (see Chapter 10) to the approved inspector not more than five days after completion of the work to which the initial notice relates.
- Regulation 44 – Commissioning. This specifies that a notice must be provided to the Approved Inspector confirming that the fixed building services (mostly ventilation in Part F and services covered by Part L1(b)) have been commissioned in accordance with a procedure approved by the Secretary of State. The normal period for service of the commissioning certificate is not more than five days after the work has been completed or the date on which a certificate is given by a Competent Person (see Chapter 5). Where an initial notice has ceased to be in force, the commissioning certificate must be given at the cessation date

An approved inspector is liable for negligence, and it is suggested that he *must* inspect the work to ensure compliance, in contrast to local authorities who have discretion as to whether or not to inspect.

In *NHBC Building Control Services Ltd* v. *Sandwell Borough Council* (1990) 50 BLR 101, the Divisional Court emphasised that regulation 11 (of the regulations in force at that time) does not require a system of individual inspection of every detail covered by the substantive requirements of the regulations. In principle, random sampling is sufficient, although in case of dispute, it is for the Approved Inspector to show that adopting a system of random or selective sampling is a satisfactory way of discharging his duties.

The approach of the court to this important matter was indicated by Lord Justice Leggatt:

> 'Any system of inspection that is selective involves consideration not only of the importance of a risk against which the inspection is designed to guard, but of the likelihood of its occurrence. In my judgement the justices' conclusion that the [approved inspector's] system is an inadequate precaution is not one that can properly be based solely upon the fact that the risk was obvious and potentially fatal. That amounts to saying that failure in relation to an individual house to detect the absence of rockwool in the gap between the ceiling and wall of its garage could not have occurred unless the system was inadequate or the inspector had shown want of professional skill and care in operating the system. But the liability imposed is not absolute. The system has been impliedly approved by the Secretary of State. In the light of its experience the [inspector] determines the extent and closeness of the inspections to be conducted in respect of the work of any particular builder. Inherent in any selected system is the risk that some defects may escape detection. Except [for] the fact that the defect … was not spotted, there is no criticism to be made of the system. It follows that the mere fact that an important defect escaped detection in a particular instance cannot … constitute a proper basis for concluding beyond reasonable doubt that there was any failure to undertake the functions of supervision so as to render false the statement that the [inspector] had performed those functions.'

The Approved Inspector may arrange for plans or work to be inspected on his behalf by someone else (although only the Approved Inspector can give plans or final certificates), but delegation does not affect any civil or criminal liability. In particular, the 1984 Act states that:

> '… an approved inspector is liable for negligence on the part of a person carrying out an inspection on his behalf in like manner as if it were negligence by a servant of his acting in the course of his employment.'

Consultation with the fire and rescue authority

Where an initial notice or an amendment notice is to be given (or has been given) in relation to the erection, extension, material alteration or change of use of a building which is or will become a 'relevant building' covered by the terms of the Regulatory Reform (Fire Safety) Order 2005 and the Building Regulations 2010, Schedule 1, Part B (Fire safety) also applies; the Approved Inspector is required, before or as soon as practicable after giving the notice, to consult the fire and rescue authority. He must give them sufficient plans and/or other information to show that the work described in the notice will comply with the applicable parts of the Building Regulations 2010, Schedule 1, Part B and must have regard to any views they express.

Additionally, before giving a plans certificate or final certificate to the local authority, the Approved Inspector must allow the fire and rescue authority 15 working days to comment and have regard to the views they express. Some local Acts of Parliament also impose extensive fire authority consultation requirements. The Approved Inspectors must undertake any consultation required by local legislation.

Consultations with the sewerage undertaker

Where an initial notice or amendment notice is to be given (or has been given) and it is intended to erect, extend or carry out underpinning works to a building which is:

(a) over a drain, sewer or disposal main, which is shown on any map of sewers and to which the Building Regulations 2010, Schedule 1, paragraph H4 applies, or
(b) on any site or in such a manner as may result in interference with the use of, or obstruction of the access of any person to, any drain, sewer or disposal main, which is shown on any map of sewers and to which the Building Regulations 2010, Schedule 1, paragraph H4 applies,

the Approved Inspector must consult the sewerage undertaker. The procedures and time periods involved parallel those described for fire authority consultations above.

4.9 Plans certificates

A plans certificate is a certificate issued by an Approved Inspector certifying that the design has been checked and that the plans comply with the 2010 Regulations. Its issue is entirely at the option of the person carrying out the work and is issued by the Approved Inspector to the local authority and the building owner.

If the approved inspector is asked to issue a plans certificate and declines to do so on the grounds that the plans do not comply with the Building Regulations, the building owner can refer the dispute to the Secretary of State for a determination. A plans certificate can be issued at the same time as the initial notice or at a later stage, provided the work has not been carried out. There are two prescribed forms of plans certificate. There are three preconditions to its issue:

- The Approved Inspector must have inspected the plans specified in the initial notice.
- He must be satisfied that the plans are neither defective nor show any contravention of the regulation requirements.
- He must have complied with any requirements about consultation, etc.

If a plans certificate is issued and accepted and, at a later stage, the initial notice ceases to be effective, the local authority cannot take enforcement action in respect of any work described in the plans certificate if it has been done in accordance with those plans.

The local authority has five working days in which to reject the plans certificate but may only do so on certain specified grounds:

- The plans certificate is not in the prescribed form.
- It does not describe the work to which it relates.
- It does not specify the plans to which it relates.
- Unless it is combined with an initial notice, that no initial notice is in force.
- The certificate is not signed by the approved inspector who gave the initial notice or that he is no longer an Approved Inspector.

- In the case of a certificate dated on or after 6 April 2013, having taken all reasonable steps to establish whether there is a named scheme of insurance approved by the Secretary of State in relation to the work described in the notice, the local authority believe that this is not the case. There is no declaration that the fire authority has been consulted (if appropriate).
- The Approved Inspector was obliged to consult the sewerage undertaker before giving the certificate, but the certificate does not contain a declaration that he has done so.
- There is no declaration of independence (except for minor work).
- The certificate does not contain:
  (a) information whether or not the work concerns a new dwelling; or
  (b) in the case of a new dwelling, information whether or not one or more, and if so which, of the following optional requirements applies to the building work:
    (i) regulation 36(2)(b) (optional water efficiency requirement of 110 litres per person per day),
    (ii) Schedule 1 Part M optional requirement M4(2) (category 2 – accessible and adaptable dwellings),
    (iii) Schedule 1 Part M optional requirement M4(3) (category 3 – wheelchair user dwellings); or
  (c) in the case of a plans certificate relating to a new dwelling, a statement that it relates only to such part of the work to which no requirement under regulation 36 of, or requirements M4(1), (2) or (3) of Schedule 1 to, the Building Regulations 2010 may apply.

When combined with an initial notice, the grounds for rejecting an initial notice specified in Schedule 3 (see section 4.8.1) also apply.

Plans certificates may be rescinded by a local authority if the work has not been commenced within three years from the date on which the certificate was accepted.

4.10 Final certificates

The final certificate should be issued by the Approved Inspector to the relevant local authority by whom the initial notice was accepted when the work is completed, but curiously there are no sanctions against an approved inspector who fails to issue a final certificate. The final certificate need not relate to all the work covered by the initial notice; it can, for example, be given in respect of part of a building which complies with the 2010 Regulations or one or more of the houses on a development covered by an initial notice. Once given and accepted, the initial notice ceases to apply.

It is to be issued, in a prescribed form, where an Approved Inspector is satisfied that any work specified in an initial notice given by him has been completed and certifies that ‘the work described … has been completed’ and that the inspector has performed the functions assigned to him by the regulations. If the local authority does not reject the final certificate within ten working days, it is deemed to have accepted it. A final certificate can only be rejected on limited grounds. These are:

- The certificate is not in the prescribed form.
- It does not describe the work to which it relates.

- No initial notice relating to the work is in force.
- The certificate is not signed by the Approved Inspector who gave the notice, or he is no longer an approved inspector.
- In the case of a certificate dated on or after 6 April 2013, having taken all reasonable steps to establish whether there is a named scheme of insurance approved by the Secretary of State in relation to the work described in the notice, the local authority believe that this is not the case.
- There is no declaration of independence (except for minor works).
- The certificate does not contain information:
  (a) whether or not the work concerns a new dwelling; or
  (b) in the case of a new dwelling, information on whether or not one or more, and if so which, of the following optional requirements applies to the building work:
    (i) Regulation 36(2)(b) (optional water efficiency requirement of 110 litres per person per day),
    (ii) Schedule 1 Part M optional requirement M4(2) (category 2 – accessible and adaptable dwellings),
    (iii) Schedule 1 Part M optional requirement M4(3) (category 3 – wheelchair user dwellings).

Once the final certificate is accepted by a local authority, its powers to take proceedings against a person for contravention of Building Regulations in relation to the work referred to in the final certificate are cancelled.

4.11 Public body's notices and certificates

Part 5 of the Building (Approved Inspectors, etc.) Regulations 2010 is concerned with public bodies, and, read in conjunction with section 54 of the Building Act 1984, its effect is to enable designated public bodies to self-certify their own work.

Public bodies are approved by the Secretary of State, and the regulations, relating to notices, consultation with the fire authority, plans certificates and final certificates mirror those of Part II dealing with Approved Inspectors. The grounds on which the local authority may reject a public body's notice, etc., mirror those applicable to private certification, except that:

- There is no provision for cancellation of a public body's notice.
- There is no requirement that there should be an approved insurance scheme in force.

4.12 Prescribed forms

Twelve prescribed forms are set out in Schedule 1 of the Building (Approved Inspectors, etc.) Regulations 2010. Regulation 2(2) provides that where the regulations require the use of one of the numbered forms set out in Schedule 2, 'a form substantially to the like effect may be used'. Approved Inspectors, public bodies, local authorities, etc. may therefore have their own forms printed, provided they follow the precedents laid down in Schedule 1.

5 Work under the supervision of a competent person

5.1 Introduction

In October 1997, the then Department of the Environment, Transport and the Regions issued proposals for reducing the administrative burden of the Building Regulations by allowing self-certification of compliance by enterprises and individuals judged as competent.

There followed a lengthy process of consultation including a further consultation document (the 1999 consultation, *Taking forward self-certification under the Building Regulations*) during the course of which the government asked building industry representatives, consumer associations and other interested parties for their opinions of the proposed competent person schemes.

The consultation showed general support for the proposals for schemes in sectors where the health and safety risk to people was low.

In recent years, the Government has been keen to extend control over work that can affect the energy efficiency of buildings. In April 2002, new requirements came into force bringing under control replacement windows, rooflights, roof windows and doors, and hot-water vessels. At the same time, the Government was conscious of the fact that the new requirements would increase the administrative burden on local authorities and Approved Inspectors for what was, in fact, fairly minor work. As a result, it was thought appropriate to introduce new ways of controlling such work by means of 'self-certification' schemes and 'non-notification'.

By establishing such schemes, the government hoped that the move towards self-certification would:

- significantly enhance compliance with the requirements of the Building Regulations,
- reduce costs for firms joining recognised schemes, and
- promote training and competence within the industry.

It was hoped that it would also help tackle the problem of 'cowboy builders' and assist local authorities with enforcement of the Building Regulations.

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

5.2 Principles of self-certification

The principles of self-certification are based on giving people who are competent in their field the ability to self-certify that their work complies with the Building Regulations, without the need to submit a building notice or deposit full plans and thus incur local authority or Approved Inspector inspections or fees. The essence of such systems is that they are self-policing. The difference between them is that self-certification schemes require the person carrying out the work to notify the local authority on completion (a certificate of compliance has also to be given to the client), whereas for non-notification no such requirement exists. One such non-notification system has been in existence for many years whereby a gas appliance could be installed by a person, or an employee of a person, approved in accordance with regulation 3 of the Gas Safety (Installation and Use) Regulations 1998. This non-notification system has now been extended to a range of building operations covered by the regulations and described more fully below.

The first self-certification scheme, the Fenestration Self-Assessment Scheme (FENSA), came into force on 1 April 2002. Subsequent changes to the regulations have resulted in a wide range of self-certification schemes being licensed by the Government and this trend is continuing. Such schemes are now more commonly referred to as 'competent person schemes' since members are deemed to possess the necessary competences to ensure that their work complies with the relevant regulations. It should be noted that the term 'person' can refer either to an individual or to a company employing individuals. All Competent Person Schemes register the company as being the legal entity and the body responsible for issuing data to local authorities and to clients; however, some schemes also require individuals working for the approved company to be separately assessed under the scheme.

5.3 Benefits of competent person schemes

The rationale behind the schemes is to authorise, on the basis of risk to health and safety, schemes whose members are adjudged sufficiently competent in their work to self-certify that their work has been carried out in compliance with all applicable requirements of the Building Regulations (Table 5.1). The assumed benefits offered by the schemes to consumers are that they result in:

- lower prices, as Building Control fees are not payable;
- reduced delays, as full local authority administrative procedures do not need to be followed; and
- the ability to identify competent firms.

The assumed benefits offered by the schemes to firms are:

- the time and expense of submitting a building notice or full plans is avoided by firms who join, and
- they allow LABC departments to concentrate their resources on the areas of highest risk.

Table 5.1 Schedule 3 – Self-certification schemes and exemptions from requirement to give building notice or deposit full plans.

Column 1	**Column 2**
Type of work	**Person carrying out work**
1. Installation of a heat-producing gas appliance. This paragraph does not apply to the provision of a masonry chimney.	A person, or an employee of a person, who is a member of a class of persons approved in accordance with regulation 3 of the Gas Safety (Installation and Use) Regulations 1998.
2. Installation of: (a) an oil-fired combustion appliance, or (b) oil storage tanks and the pipes connecting them to combustion appliances. This paragraph does not apply to the provision of a masonry chimney.	A person registered in respect of that type of work by Association of Plumbing and Heating Contractors (Certification) Limited, Blue Flame Certification Ltd, Building Engineering Services Competence Assessment Limited, Certsure LLP, HETAS Limited, NAPIT Registration Limited, Oil Firing Technical Association Limited or Stroma Certification Limited.
3. Installation of a solid fuel-burning combustion appliance other than a biomass appliance. This paragraph does not apply to the provision of a masonry chimney.	A person registered in respect of that type of work by Association of Plumbing and Heating Contractors (Certification) Limited, Building Engineering Services Competence Assessment Limited, Certsure LLP, HETAS Limited, NAPIT Registration Limited, Oil Firing Technical Association Limited or Stroma Certification Limited.
4. Installation of a heating or hot-water system, or its associated controls.	A person, or an employee of a person, who is a member of a class of persons approved in accordance with regulation 3 of the Gas Safety (Installation and Use) Regulations 1998, or a person registered in respect of that type of work by Association of Plumbing and Heating Contractors (Certification) Limited, Benchmark Certification Limited, Blue Flame Certification Ltd, Building Engineering Services Competence Assessment Limited, Certsure LLP, HETAS Limited, NAPIT Registration Limited, Oil Firing Technical Association Limited or Stroma Certification Limited.
5. Installation of a mechanical ventilation or air-conditioning system or associated controls, in a building other than a dwelling, that does not involve work on a system shared with parts of the building occupied separately.	A person registered in respect of that type of work by Blue Flame Certification Ltd, Building Engineering Services Competence Assessment Limited, Certsure LLP, NAPIT Registration Limited or Stroma Certification Limited.
6. Installation of an air-conditioning or ventilation system in a dwelling that does not involve work on a system shared with other dwellings.	A person registered in respect of that type of work by Blue Flame Certification Ltd, Building Engineering Services Competence Assessment Limited, Certsure LLP, NAPIT Registration Limited or Stroma Certification Limited.
7. Installation of an energy efficient lighting system or electric heating system, or associated electrical controls, in buildings other than dwellings.	A person registered in respect of that type of work by Blue Flame Certification Ltd, Building Engineering Services Competence Assessment Limited, Certsure LLP, NAPIT Registration Limited or Stroma Certification Limited.

(*Continued*)

Table 5.1 (*Continued*)

Column 1	Column 2
Type of work	**Person carrying out work**
8. Installation of fixed low or extra-low voltage electrical installations in dwellings.	A person registered in respect of that type of work by BSI Assurance UK Limited, Benchmark Certification Limited, Blue Flame Certification Ltd, Building Engineering Services Competence Assessment Limited, Certsure LLP, NAPIT Registration Limited, Oil Firing Technical Association Limited or Stroma Certification Limited.
9. Installation of fixed low or extra-low voltage electrical installations in dwellings, as a necessary adjunct to or arising out of other work being carried out by the registered person.	A person registered in respect of that type of work by Association of Plumbing and Heating Contractors (Certification) Limited, Benchmark Certification Limited, Blue Flame Certification Ltd, Building Engineering Services Competence Assessment Limited, Certsure LLP, NAPIT Registration Limited or Stroma Certification Limited.
10. Installation, as a replacement, of a window, rooflight, roof window or door in an existing dwelling.	A person registered in respect of that type of work by BM Trada Certification Limited, BSI Assurance UK Limited, Blue Flame Certification Ltd, CERTASS Limited, Certsure LLP, by Fensa Limited under the Fenestration Self- Assessment Scheme, by NAPIT Registration Limited, Network VEKA Limited or Stroma Certification Limited.
11. Installation, as a replacement, of a window, rooflight, roof window or door in an existing building other than a dwelling. This paragraph does not apply to glass which is load bearing or structural or which forms part of glazed curtain walling or a revolving door.	A person registered in respect of that type of work by BM Trada Certification Limited, Blue Flame Certification Ltd, CERTASS Limited, Certsure LLP, by Fensa Limited under the Fenestration Self-Assessment Scheme, by NAPIT Registration Limited, Network VEKA or Stroma Certification Limited.
12. Installation of a sanitary convenience, sink, washbasin, bidet, fixed bath, shower or bathroom in a dwelling that does not involve work on shared or underground drainage.	A person registered in respect of that type of work by Association of Plumbing and Heating Contractors (Certification) Limited, Benchmark Certification Limited, Building Engineering Services Competence Assessment Limited, Certsure LLP, HETAS Limited, NAPIT Registration Limited or Stroma Certification Limited.
13. Installation of a wholesome cold-water supply or a softened wholesome cold-water supply.	A person registered in respect of that type of work by Association of Plumbing and Heating Contractors (Certification) Limited, Benchmark Certification Limited, Building Engineering Services Competence Assessment Limited, Certsure LLP, HETAS Limited, NAPIT Registration Limited or Stroma Certification Ltd.
14. Installation of a supply of non-wholesome water to a sanitary convenience fitted with a flushing device that does not involve work on shared or underground drainage.	A person registered in respect of that type of work by Association of Plumbing and Heating Contractors (Certification) Limited, Benchmark Certification Limited, Building Engineering Services Competence Assessment Limited, Certsure LLP, HETAS Limited, NAPIT Registration Limited or Stroma Certification Limited.

Table 5.1 (*Continued*)

Column 1	Column 2
Type of work	**Person carrying out work**
15. Installation in a building of a system to produce electricity, heat or cooling: (a) by microgeneration, or (b) from renewable sources (as defined in Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources).	A person registered in respect of that type of work by Association of Plumbing and Heating Contractors (Certification) Limited, Benchmark Certification Limited, Building Engineering Services Competence Assessment Limited, Certsure LLP, HETAS Limited, NAPIT Registration Limited, Oil Firing Technical Association Limited or Stroma Certification Limited.
16. Installation, as a replacement, of the covering of a pitched or flat roof and work carried out by the registered person as a necessary adjunct to that installation. This paragraph does not apply to the installation of solar panels.	A person registered in respect of that type of work by NAPIT Registration Limited or the National Federation of Roofing Contractors Limited.
17. Insertion of insulating material into the cavity walls of an existing building.	A person registered in respect of that type of work by Blue Flame Certification Limited, Cavity Insulation Guarantee Agency Limited under the Cavity Wall Insulation Self Certification Scheme, by Certsure LLP, NAPIT Registration Limited or Stroma Certification Limited.
18. Installation of insulating material to the internal walls of a building, not including the installation of flexible thermal linings.	A person registered in respect of that type of work by Blue Flame Certification Limited, British Board of Agrément, CERTASS Limited, Certsure LLP, NAPIT Registration Limited or Stroma Certification Limited.
19. Installation of insulating material to the external walls of a building, not including insulation of demountable-clad buildings.	A person registered in respect of that type of work by Blue Flame Certification Limited, British Board of Agrément, CERTASS Limited, Certsure LLP, NAPIT Registration Limited or Stroma Certification Limited.
20. Installation of insulating material to the external and internal walls of a building ('hybrid insulation'), not including insulation of demountable-clad buildings, and not including the installation of flexible thermal linings.	A person registered in respect of that type of work by Blue Flame Certification Limited, British Board of Agrément, CERTASS Ltd, Certsure LLP, NAPIT Registration Limited or Stroma Certification Limited.

5.4 Joining a competent person scheme

Apart from the Gas Safe Register, membership of a competent person scheme is not compulsory. Businesses carrying out work covered by the Building Regulations may choose to join the schemes if they judge membership to be beneficial. Alternatively, they may choose to continue to use Local Authority Building Control or to employ a private sector Approved Inspector.

If a company or individual chooses to join a competent person scheme, they are first vetted to ensure they meet the conditions of membership, including appropriate and relevant levels of competence. Each scheme has its own procedures and requirements for vetting potential members. If they meet the conditions imposed by the relevant scheme, they are classified as 'competent persons'.

The work of organisations or individuals accepted as members of a scheme is not subject to Building Control inspection. Instead, the competent person self-certifies that the work is in compliance with the Building Regulations. They issue a certificate to the consumer to this effect. In some schemes, they then report the work to the scheme organisers who in turn inform the local authority that work has taken place. In others, the organisers will inform the local authority that the work has been completed and also send a Building Control Compliance Certificate to the consumer on behalf of the competent person.

Details of the schemes including contact details are shown in Table **5.2**.

5.5 Legislative background

The powers used to set up schemes are in *Sch 1, para 4(a)* to the *Building Act 1984*. The current schemes were originally set up under the *Building Regulations 2000 (SI 2000/2531)* as amended by the *Building (Amendment) Regulations 2001 (SI 2001/3335)* and the *Building (Amendment) Regulations 2002 (SI 2002/440)* and the *Building (Amendment) Regulations 2009 (SI 2009/466)* using powers in *Sch 1, para 4(a)* to the *Building Act 1984*.

These provisions were consolidated into the *Building Regulations 2010 (SI 2010/2214)* in *Part 3, reg 12(6)(a)* and in *Part 5, reg 20*. With regard to competent person schemes, the 2010 regulations were amended by virtue of the *Building (Amendment) Regulations 2013 (SI 2013/1105)* and *the Building Regulations &c. (Amendment) Regulations 2014 (SI 2014/579)*.

5.6 Building regulation requirements

In the case of both self-certification schemes and non-notification, the authorisation for the procedures is given in regulation 12 – Giving of a building notice or deposit of plans. Sub-paragraph (6) states that

> 'A person intending to carry out building work is not required to give a building notice or deposit full plans where the work consists only of work – described in column 1 of the Table in Schedule 3 if the work is to be carried out by a person described in the corresponding entry in column 2 of that Table; or

(a) described in Schedule 4.'

Schedules 3 and *4* are shown below. It should be noted that although the work described in *Schedule 4* is not notifiable to the local authority, it must still comply with the Building Regulations and the local authority retains powers to inspect the work if it suspects that the work has been done without due regard to public health and safety or the conservation of fuel and power. Schedule 3 was totally recast and simplified by virtue of the *Building Regulations &c. (Amendment) Regulations 2014 (SI 2014/579)* (see Table 5.2).

Table 5.2 Organisations referred to in *Schedule 3*, together with their contact details.

Schedule 3 row containing reference	Scheme and contact details	Comments
1	Gas Safe Register PO BOX 6804 Basingstoke RG24 4NB Tel: 0800 408 5500 Website: www.gassaferegister.co.uk	Gas Safe Register is run by Capita Gas Registration and Ancillary Services Limited, a division of Capita Group plc. Gas Safe Register is the official gas registration body for the United Kingdom, Isle of Man and Guernsey appointed by the relevant Health and Safety Authority for each area. Gas Safe Register replaced CORGI as the gas registration body in Great Britain and Isle of Man on 1 April 2009 and Northern Ireland and Guernsey on 1 April 2010.
2, 3, 9, 12 to 15 inclusive	Association of Plumbing and Heating Contractors (Certification) Limited (APHC) 12 The Pavilions Cranmore Drive Solihull B90 4SB Tel: 0121 711 5030 Website: www.competentpersonsscheme.co.uk	Set up in 2007, the APHC's competent person scheme allows members to self-certify work falling under the scope of Building Regulations including: ● Gas appliances (separate registration with Gas Safe Register is required) ● Oil appliances ● Solid fuel appliances ● Defined scope electrical Part P ● Sanitary appliances including bathroom installation ● Open vented and unvented hot-water systems ● Open vented and sealed central heating systems ● Renewable technologies including solar, heat pump installations.
4, 8, 9, 12 to 15 inclusive	Benchmark Certification Limited 1st Floor, Hadfield House Gordon Street Stockport, SK4 1RR Tel: 02380 517069 Website: www.benchmark-cert.co.uk	In May 2010 the CORGI memberships were taken over by Benchmark Certification under new director John Martin. Benchmark made a series of promises on what they would deliver to CORGI members as they resurrected the membership schemes. These included increased customer service, new schemes, installer events and other benefits.
2, 4 to 11 inclusive, 17 to 20 inclusive	Blue Flame Certification Ltd, Chatterley Whitfield Enterprise Centre Chatterley Whitfield Stoke on Trent Staffordshire, ST6 8UW Tel: 0845 194 9031 Website: Blueflamecertification.com	Blue Flame Certification Ltd is a UKAS Accredited Certification Body offering certification services in the Gas, Oil, Electrical, Building Services, Renewable Technologies and Building Energy Efficiency fields. It is also able to offer ISO 17024:2012 Accredited Certification for the following measures in its certification scheme: Competent Person Scheme ● Category BSM (Building Services Mechanical) ● Category BFM (Building Fabric Measures) Category BSE (Building Services Electrical).

(*Continued*)

Table 5.2 (*Continued*)

Schedule 3 row containing reference	Scheme and contact details	Comments
2 to 9 inclusive, 12 to 15 inclusive	Building Engineering Services Competence Assessment Ltd (BESCA) Old Mansion House Eamont Bridge Penrith Cumbria CA10 2BX Tel: 0800 652 5533 Website: www.besca.org.ok	BM TRADA Certification (see below) carries out all of the inspection audits on behalf of BESCA to verify that business systems and technical competence are sufficient to meet the self-certification standards required by the Building Regulations.
1	Capita Gas Registration and Ancillary Services Limited 17 Rochester Row London SW1P 1QT Tel: 0800 408 5577	Capita Gas Registration and Ancillary Services Limited is registered as a data controller for the purposes of the Gas Safe Register (see row 1). There is no need to contact Capita direct as all callers are merely referred to the Gas Safe Register website (given in row 1).
2 to 9, 12 to 15 inclusive	Certsure LLP Warwick House Houghton Hall Park Dunstable LU5 5ZX	The Electrical Contractors Association (ECA) which owns ELECSA and the consumer charity the Electrical Safety Council (ESC) which owns NICEIC have established a joint venture company named Certsure LLP, which owns and operates the ELECSA, ECA certification and NICEIC schemes the NICEIC, ELECSA and Electrical Safety Register brands, serving over 36,000 enterprises. Certsure LLP is the trade name for the Electrical Safety Register. The register will form a definitive database of NICEIC- and ELECSA-registered contractors, as well as ECA members. Certsure will start to operate from 1 April 2013.
See Certsure LLP	ECA Certification Limited (ECA) ESCA House 34 Palace Court London W2 4HY Tel: 020 7313 4800 Website: www.eca.co.uk	Founded in 1901, the Electrical Contractors Association (ECA) is a trade association representing the interests of contractors who design, install, inspect, test and maintain electrical and electronic equipment and services. From 1 April 2013, the certification of electrical installations became the responsibility of Certsure LLP (see above).
2, 3, 4, 12 to 15 inclusive	HETAS Limited Orchard Business Centre Stoke Orchard Cheltenham Gloucestershire GL52 7RZ Tel: 0845 634 5626 Website: www.hetas.co.uk	HETAS covers biomass and solid fuel domestic heating appliances, fuels and services.

Table 5.2 (*Continued*)

Schedule 3 row containing reference	Scheme and contact details	Comments
2 to 10 inclusive, 11 to 20 inclusive	NAPIT Registration Limited 4th Floor, Mill 3 Pleasley Vale Business Park Mansfield Nottinghamshire NG19 8RL Tel: 0845 543 0330 Website: www.napit.org.uk	NAPIT was formed in 1992 as the National Association for Professional Inspectors and Testers, with the aim of setting standards for industry. Since then NAPIT's role has evolved and expanded to become one of the competent person schemes for Part P Registered Domestic Electrical Installers (both full and defined scope) whilst continuing to serve the needs of those carrying out equipment testing and electrical installation and testing in commercial and industrial sectors.
2, 3, 4, 8, 15	Oil Firing Technical Association Limited (OFTEC) Foxwood House Dobbs Lane Kesgrave Ipswich IP5 2QQ Tel: 0845 65 85 080 Website: www.oftec.org	OFTEC is the technical and marketing body for the oil-firing industry in the UK and the Republic of Ireland. OFTEC Registration Services is responsible for managing the OFTEC training and registration process for technicians in the oil heating and cooking industry. The aim of the OFTEC Training and Registration System is to provide technicians with government-recognised professional status and competency. OFTEC Registration aims to raise safety standards and increase environmental protection. For technicians it aims to produce financial benefits through customer service, fewer accidents and greater product reliability and efficiency.
2, 3, 4 to 13 inclusive, 15, 17 to 20 inclusive	Stroma Certification Limited Pioneer Way Castleford West Yorkshire WF10 5QU Tel: 0845 621 1111 Website: www.stroma.com	Becoming a member of Stroma Certification's competent person scheme ensures that operatives can design and install, and issue self-certification certificates for compliance with the Building Regulations for the installation of, heating and hot-water systems, microgeneration and renewable technologies.
10, 11	Fenestration Self-Assessment Scheme (FENSA) Fensa Limited 54 Ayres Street London SE1 1EU Tel: 020 7645 3700 Website: www.fensa.org.uk	FENSA has been set up by the Glass and Glazing Federation (GGF) and other industry bodies in response to Building Regulations, for double glazing companies in England and Wales.
10, 11	BM Trada Certification Limited Chiltern House Stocking Lane Hughenden Valley, High Wycombe Bucks HP14 4ND Tel: 01494 569700 Website: www.bmtrada.com	BM Trada Certification Limited was registered as a competent person scheme for the replacement of windows and doors on 1 October 2010. A search of the website has failed to identify any reference to the scheme as yet which does not appear to be up and running.

(*Continued*)

Table 5.2 (*Continued*)

Schedule 3 row containing reference	Scheme and contact details	Comments
10	British Standards Institution BSI Healthcare and Testing Services Kitemark House Maylands Avenue Hemel Hempstead Hertfordshire HP2 4SQ Tel: 08450 765600 Website: www.kitemark.com	BSI runs its competent person scheme through its already established Kitemark scheme for window installations. This has been developed to combat poor installation and finishing of double-glazed windows and doors. Based on BS 8213-4, the Kitemark scheme for window installations sets parameters to encourage quality workmanship and covers design, surveying, installation practice, staff training, property care, Building Regulations compliance, material quality and inspection.
10, 11, 18, 19, 20	Certass Limited 37 Carrick Street Ayr KA7 1NS Tel: 0845 094 8025 Website: www.certass.co.uk	Certass, which stands for Certification and Self-assessment, was formed several years ago and was one of the original Quality Mark certification bodies. It is therefore a natural progression for Certass to move into the self-assessment market for the installation, as a replacement, of a window, rooflight, roof window or door in an existing dwelling of windows, doors, rooflights and roof windows in any building. Certass also runs a self-certification scheme for the installation of internal and external wall insulation in buildings. Unlike some other schemes, Certass will carry out their own vetting procedures on all applicants.
10, 11	Network VEKA Limited Farrington Road Rossendale Road Industrial Estate Burnley Lancashire BB11 5BD Tel: 0800 80 00 80 Website: www.networkveka.co.uk	Advertised as the Network VEKA Assure Scheme, the scheme is open only to Network VEKA member companies who carry out the installation, as a replacement, of a window, rooflight, roof window or door in an existing dwelling. To join the scheme they must be committed to upholding the strict standards laid out in Network VEKA's Customer Charter.
17	Cavity Insulation Guarantee Agency Limited CIGA House 3 Vimy Court, Vimy Road Leighton Buzzard Bedfordshire LU7 1FG Tel: 01525 853300 Website: www.ciga.co.uk	Cavity Wall Insulation Self Certification Scheme by Cavity Insulation Guarantee Agency Limited (CIGA). CIGA operates and administers the Cavity Wall Insulation Self Certification Scheme (CWISC) in association with the British Board of Agrément. The scheme provides homeowners with the comfort of knowing that work by registered contractors complies with the requirements of the Building Regulations.

Table 5.2 (*Continued*)

Schedule 3 row containing reference	Scheme and contact details	Comments
16	Competent Roofer First Floor, Spendale House The Runway Ruislip Middlesex HA4 6SE Tel: 0844 318 8888 Website: www.competentroofer.co.uk	The National Federation of Roofing Contractors Limited (NFRC Limited) administers the Competent Roofer scheme for the installation, as a replacement, of the covering of a pitched or flat roof and work carried out by the registered person as a necessary adjunct to that installation.

5.7 Self-assessment

5.7.1 Provisions applicable to self-certification schemes (competent person schemes)

Regulation 20 of the Building Regulations 2010 (as amended) authorises local authorities to accept certificates given by certain persons, as evidence that the requirements of regulations 4 and 7 have been met in relation to work described in Schedule 3 and discussed below. Such persons must be suitably qualified and experienced and/or registered persons under a recognised scheme as described in Schedule 3. Whether the local authority is prepared to accept the certificate is optional. However, if the authority does not accept it and decides to inspect the work, it may incur certain obligations and liabilities attendant upon exercising its building control function.

Under regulation 20, local authorities must either be informed within 30 days of completion of the work by the person carrying it out or must be given the certificate referred to above. A copy of the certificate must also be given to the occupier of the building where the work is carried out.

The need to notify completion or give a certificate to the local authority and the occupier does not apply to building work described in Schedule 4 (see Table **5.3**).

Interestingly, a parallel notification procedure exists where the person carrying out the building work is using an Approved Inspector instead of a local authority for building control. This is discussed in Chapter 4.

In general, self-certification schemes can be divided into:

- Part L Schemes featuring work to:
  - replacement windows, doors, rooflights and roof windows;
  - heating and hot-water service systems and associated controls;
  - mechanical ventilation or air-conditioning systems and associated controls; and
  - lighting systems.
- Part J Schemes where the work is concerned with the installation (as well as replacement of) heat-producing appliances (gas, oil and solid fuel).
- Part P Schemes covering work to electrical installations.

- Part G and Part H Schemes dealing with the installation of sanitary appliances (not involving work on underground drainage).
- Building work in connection with work carried out under the aforementioned schemes (but not the provision of a masonry chimney).

5.8 Non-notification

The difference between self-certification schemes and non-notification of work is that self-certification schemes require the person carrying out the work to notify the local authority on completion (a certificate of compliance has also to be given to the client), whereas for non-notification no such requirement exists. Therefore, any of the work items described in Schedule 4 can be carried out without notifying any statutory or regulatory bodies although the work carried out must still comply with the building regulations. This is somewhat analogous to the Building Warrant system in Scotland where certain works are exempt from control but must still comply with the Regulations.

It should be noted that *Regulation 32* of the *Building Regulations etc. (Amendment) Regulations 2012 (SI 2012/3119)* made changes to *Schedule 4*. A number of definitions were removed to take account of altered regulations elsewhere, and a new *paragraph (3A)* dealing with thermal insulation to suspended timber floors was added. Therefore, it will be seen that the numbering is no longer consecutive in Table **5.3**.

Much of the non-notifiable work is concerned with electrical installations, and Part P of the Building Regulations 2010 (as amended) applies to electrical installations that are intended to operate at low or extra-low voltage (see Chapters 2 and 19 for definitions). Such installations are generally associated with dwellings (including common parts in flats, sheds and greenhouses, and outdoor lighting), and Part P is restricted to such uses. In general, the self-certification option is available as described above for installations covered by Part P. However, this is further extended to a 'non-notification' system of control for the work described in Schedule 4. Therefore, all work to electrical installations in or associated with dwellings must now comply with Part P of the Building Regulations 2010 (as amended).

5.8.1 Other non-notifiable work

Certain plumbing installations are non-notifiable including:

- Replacing:
  - a sanitary convenience with one that uses no more water than the one it replaces,
  - a washbasin, sink or bidet,
  - a fixed bath,
  - a shower,
  - a rainwater gutter, or
  - a rainwater downpipe,

where the work does not include any work to underground drainage and includes no work to the hot- or cold-water system or above-ground drainage, which may prejudice the health or safety of any person on completion of the work;

Table 5.3 Schedule 4 – Descriptions of work where no building notice or deposit of full plans is required.

1. Work consisting of:
   (f) in relation to an existing fixed building service, which is not a fixed internal or external lighting system:
   (i) replacing any part which is not a combustion appliance,
   (ii) adding an output device, or
   (iii) adding a control device,
   where [testing] and adjustment of the work is not possible or would not affect the use by the fixed building service of no more fuel and power than is reasonable in the circumstances;
   (g) providing a self-contained fixed building service, which is not a fixed internal or external lighting system, where:
   (i) it is not a combustion appliance,
   (ii) any electrical work associated with its provision is exempt from the requirement to give a building notice or to deposit full plans by virtue of regulation 9 or 12(6)(b),
   (iii) testing and adjustment is not possible or would not affect its energy efficiency, and
   (iv) in the case of a mechanical ventilation appliance, the appliance is not installed in a room containing an open-flued combustion appliance whose combustion products are discharged through a natural draught flue;
   (h) replacing an external door (where the door together with its frame has not more than 50% of its internal face area glazed);
   (i) in existing buildings other than dwellings, providing fixed internal lighting where no more than 100 m^2 of the floor area of the building is to be served by the lighting;
   (j) replacing:
   (i) a sanitary convenience with one that uses no more water than the one it replaces;
   (ii) a washbasin, sink or bidet,
   (iii) a fixed bath,
   (iv) a shower,
   (v) a rainwater gutter, or
   (vi) a rainwater downpipe,
   where the work does not include any work to underground drainage and includes no work to the hot- or cold-water system or above-ground drainage, which may prejudice the health or safety of any person on completion of the work;
   (k) in relation to an existing cold-water supply:
   (i) replacing any part,
   (ii) adding an output device, or
   (iii) adding a control device;
   (l) providing a hot-water storage system that has a storage vessel with a capacity not exceeding 15 litres, where any electrical work associated with its provision is exempt from the requirement to give a building notice or to deposit full plans by virtue of regulation 9 or 12(6)(b);
   installation of thermal insulation in a roof space or loft space where:
   (i) the work consists solely of the installation of such insulation, and
   (ii) the work is not carried out in order to comply with any requirement of these Regulations.

   (m) 3A. Installation of thermal insulation to suspended timber floors where the work:
   (i) consists of the installation of such insulation only, and
   (ii) the work is not carried out in order to comply with any requirements of these Regulations.

4. For the purposes of this Schedule:
   'self-contained' in relation to a fixed building service means consisting of a single appliance and any associated controls which is neither connected to nor forms part of any other fixed building service.

- In relation to an existing cold-water supply:
  - replacing any part,
  - adding an output device, or
  - adding a control device;

- Providing a hot-water storage system that has a storage vessel with a capacity not exceeding 15 litres, where any electrical work associated with its provision is exempt from the requirement to give a building notice or to deposit full plans;
- installation of thermal insulation in a roof space or loft space where:
  - the work consists solely of the installation of such insulation, and
  - the work is not carried out in order to comply with any requirement of the Regulations
- Installation of thermal insulation to suspended timber floors where the work:
  - consists of the installation of such insulation only, and
  - the work is not carried out in order to comply with any requirements of the Regulations.

5.9 Regulation 20 applied to local authorities

It should be noted that this regulation places a duty on the '*person carrying out the work*' (the courts have held that this can include both the competent person and the consumer; however, in a competent person scheme, it would normally be taken as the competent person) to notify the local authority within 30 working days of completion of the work. The notification is in the form of a certificate which is given to the occupier of the premises which confirms that *regs 4* and *7* of the *Building Regulations 2010* have been complied with. The competent person can choose whether to give the local authority the certificate or merely to notify them that the work is complete. Be aware that although the local authority is authorised to accept such a certificate, it is not legally bound to, since circumstances might exist whereby the local authority doubts the authenticity or veracity of the certificate or it may have reason to believe that the work did not comply with the Regulations.

5.10 Regulation 20 applied to Approved Inspectors

By virtue of *regulation 20* of the *Building (Approved Inspectors etc.) Regulations 2010, regulation 20* (Provisions applicable to self-certification schemes) of the Principal Regulations (i.e. the *Building Regulations 2010*) applies in relation to building work which is the subject of an initial notice as if references to the local authority were references to the Approved Inspector. In other words, the notices must be given to the Approved Inspector, where one is engaged, in the same way as for the local authority.

In practice, the different competent person schemes discharge this duty in different ways on behalf of their members. Reference has been made above to the different procedures that can apply. Most schemes receive notifications of completion from their members and they then notify the relevant local authorities or Approved Inspectors electronically in an approved form.

5.11 Approval of competent person schemes

The DCLG operates the approval system for new or amended schemes. For the present, the DCLG has stopped accepting applications to operate new or extended competent person self-certification schemes.

5.11.1 DCLG application procedure for new competent person schemes

Applicants are required to study the criteria set out and then complete an application form. The application is acknowledged by the DCLG on receipt of the application. Applications are then processed as follows:

(1) First, the DCLG will decide, in consultation with other government departments, the Welsh Assembly Government and various Building Control Bodies (local authorities and Approved Inspectors), whether it considers the type of work suitable for a competent person scheme. This is decided largely on the basis of level of risk to the consumer. If it is judged not to be suitable, the organisation concerned is informed and no further action taken.
(2) Where the type of work is considered to be suitable, a detailed scrutiny of the proposed scheme will begin. The application is then vetted internally against the criteria. The DCLG then consults as widely as necessary, e.g. government departments, trade associations, local government representatives and/or consumer groups may be invited to comment on the proposed scheme.
(3) After any necessary revisions have been made, the application will be referred to the Building Regulations Advisory Committee (BRAC) for its view. The proposal will then be submitted to the Minister responsible for the Building Regulations who will decide whether the scheme is to be approved. The consideration of the application should take a maximum of six months from receipt to decision on approval.
(4) Formal authorisation is by means of an amendment to the *Building Regulations 2010*. Amendments to legislation normally take effect on what are known as common commencement dates, which are 6 April and 1 October each year. Once a scheme has received approval, it will be authorised at the next available common commencement date.

5.11.2 Criteria for management of a competent person scheme under the Building Regulations

The DCLG's expectation is that an applicant must demonstrate ability to comply with all the criteria but the weight attached to each would depend on the particular circumstances of the sector concerned and the requirements laid on that sector by the Building Regulations. The criteria are as follows:

- Financial probity and a proven track record in the field
- Demonstrable understanding of what is involved in managing a scheme of this type and the administrative systems to do so
- Sufficient knowledge of the Building Regulations by both scheme organisers and scheme members
- Absence of, or methods for avoiding, conflicts of interest between the commercial interests of sponsoring or member organisations and management of the scheme
- A minimum standard of technical competence, independently assessed where practicable, for all prospective members of a scheme (such standards will vary from sector to sector and may be based on National Occupational Standards, formal qualifications and/or experience, taking account of any British or European Standards)

- Effective means of vetting prospective members against the minimum standard
- Robust procedures in place to deal with complaints from members and disputes between members and customers
- A rigorous system of monitoring members' compliance with the Building Regulations
- Effective sanctions in place for dealing with non-compliance by members of the scheme
- A system for ensuring that certificates of compliance are issued to consumers
- Where information on work completed under the scheme is to be sent to local authorities, appropriate methods to ensure rapid transfer of the information
- Adequate consumer protection through an insurance-backed warranty, professional indemnity insurance or bond
- Commitment to publicising the scheme and its rules as widely as possible, including the names of members of the scheme and the type of work for which they have been assessed as competent
- Commitment to allow the DCLG to monitor the scheme periodically to ensure that it delivers compliance with the Building Regulations and is following the scheme rules
- Commitment to comply with the proposals in the recent Building Regulations Competent Person Self-certification Schemes consultation exercise

New terms and conditions for the running and management of Competent Person Schemes came into force on 6 June 2012 and replaced the former terms and conditions which were not consistent across the industry.

II Technical

6 Structural stability (Part A)

6.1 Introduction

Part A of Schedule 1 to the 2010 Regulations (as amended) is concerned with the strength, stability and resistance to deformation of the building and its parts. The loads to be allowed for in the design calculations are specified, and recommendations as to construction are given in Approved Document A (AD A). The discussion below is based on the 2004 edition of AD A as amended in 2010 and 2013.

In line with the government's intention to remove from the regulations, those matters which are not directly concerned with public health and safety or the conservation of fuel and power, the previous requirements regarding the ability of a building structure or foundation to resist *damage* due to settlement, etc. have been omitted.

Additionally, control of deflection or deformation of the building structure under normal loading conditions is only relevant if it would impair the stability of another building.

It is conceivable, therefore, that a building constructed under the regulations could be safe and stable but could settle and deflect to such an extent that it would be unusable. In that event, of course, the owner would probably have redress against the designer and/or builder under the general law by way of an action for damages. Insurance cover might be somewhat hard to obtain for such a building.

The section of the regulations dealing with disproportionate collapse was simplified by the revocation (in the 1994 amendment) of paragraph A4 of Schedule 1. This was concerned with maintaining structural stability in public buildings and shops in the event of roof failures, where roof spans exceeded 9 m. The original requirements concerning the failure of long span roof structures were introduced in response to a number of roof collapses which occurred in the 1970s and which led to the banning of high alumina cement in structural work. As this ban still exists, the problem of such failures seems largely to have been solved without additional regulatory safeguard.

Structural safety depends on the successful interrelationship between design and completed construction, particularly with regard to:

- the design – involving identification of the hazards to which the structure is likely to be subjected and assessment of the likely risks and the selection of relevant critical situations reflecting the conditions that can reasonably be foreseen during future use;

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

- degree of loading – dead, imposed and wind loads should be assessed in accordance with the current Codes of Practice referred to in section 1 of AD 1/2 and referred to in section 6.4;
- the properties of the materials chosen;
- the detailed design and structural assembly;
- safety factors; and
- standards of workmanship.

It is essential that the numeric values of the safety factors which are used are derived from a consideration of the above factors, since a change in any one of these could disturb the safety of the structure as a whole.

Additionally, loads used in calculations should take account of possible dynamic, concentrated and peak loads which may arise. For example, grandstands (and other similar structures erected in places of public assembly) may need to carry the synchronous or rhythmical movement caused by large numbers of people. These factors should be taken into account in the design of the structure so that it will not be impaired or cause alarm to the people using it. For interim guidance on the design of grandstands, see *Dynamic performance requirements for permanent grandstands subject to crowd action: Recommendations for management, design and assessment* published by the Institution of Structural Engineers on December 2008.

AD A is arranged in five sections and gives guidance that may be adopted, if relevant, at the discretion of the designer. Where precise guidance is not given, due regard should be paid to the factors listed above:

- Section 1 lists various codes and standards for structural design and construction and is relevant to all types of buildings. Further information sources are included regarding landslip and structural appraisal of existing buildings subject to a change of use.
- Section 2 allows the sizes of certain structural members to be assessed in certain small residential buildings and other small buildings of traditional construction.
- Section 3 gives guidance on the fixing and support of external wall cladding.
- Section 4 makes it clear that certain roof re-covering operations may constitute a material alteration to the building and gives guidance to that effect.
- Section 5 gives guidance on reducing the sensitivity of a building to disproportionate collapse in the event of an accident.

6.2 Loading

Paragraph A1 of Schedule 1 to the Building Regulations 2010 requires buildings to be constructed so that all dead, imposed and wind loads are sustained and transmitted to the ground:

- safely; and
- without causing such settlement of the ground, or such deflection or deformation of the building, as will impair the stability of any part of another building.

The imposed and wind loads referred to above are those to which the building is likely to be subjected in the normal course of its use and for the purpose for which it is intended.

6.3 Ground movement

In addition to the provisions of paragraph Al above regarding loading, there are requirements in paragraph A2 of Schedule 1 that the building shall be so constructed that movement of the ground caused by:

- swelling, shrinking or freezing of the subsoil; or
- landslip or subsidence (other than subsidence arising from shrinkage)

will not impair the stability of any part of the building.

It should be noted that the requirement as to landslip and subsidence applies to the extent that the risk can be reasonably foreseen.

6.4 Guidance on structural design in buildings of all types

6.4.1 Geotechnical work, foundations and ground movement

Geotechnical work and foundations should be designed in accordance with the following parts of Eurocode 7: Geotechnical design:

- BS EN 1997-1:2004 Eurocode 7: Geotechnical design – Part 1: General rules, with UK National Annex to BS EN 1997-1:2004; and
- BS EN 1997-2:2007 Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing, with UK National Annex to BS EN 1997-2: 2004.

The current edition of AD A also includes references to seismic aspects in Eurocode 8: Design of structures for earthquake resistance as follows:

- BS EN 1998-1:2004+A1:2013 Eurocode 8: Design of structures for earthquake resistance – Part 1: General rules, seismic actions and rules for buildings, with UK National Annex to BS EN 1998-1:2004;
- BS EN 1998-5:2004 Eurocode 8: Design of structures for earthquake resistance – Part 5: Foundations, retaining structures and geotechnical aspects, with UK National Annex to BS EN 1998-5:2004; and
- BSI PD 6698:2009 Published Document – Recommendations for the design of structures for earthquake resistance to BS EN 1998.

Paragraph A2 of Schedule 1 to the 2010 Regulations requires that ground movement caused by landslip or subsidence must not impair the stability of any part of the building.

When developing a site it is always essential that a site investigation is carried out. This is discussed fully in Chapter 8 (sections 8.5.2 and 8.5.3). The desk study and site reconnaissance and walkover survey should reveal conditions of ground instability (e.g. arising from landslides, disused mines or unstable strata), which, if ignored, can very seriously affect the safety of a building and its environs. The design of the building and its foundations should take such conditions into account. Guidance on the broad planning and technical issues relating to development on unstable land can be found in DOE Planning Policy Guidance Note 14: *Development on unstable land*, which may be obtained from HM Stationery Office.

For guidance on determining the scale and nature of problems arising from mining instability, natural underground cavities and adverse foundation conditions, the DOE has sponsored a series of reviews. These contain databases of both subsidence incidents and subsidence potential and may be obtained from the following licence holders:

- British Geological Survey, Sir Kingsley Dunham Centre, Keyworth, Nottingham NG12 5GG;
- Landmark, 7 Abbey Court, Eagle Way, Exeter, Devon EX2 7HY;
- Peter Brett Associates, 16 Westcote Road, Reading, Berkshire RG20 2DE; and
- Catalytic Data Ltd, The Spinney, 19 Woodlands Road, Bickley, Kent BR1 2AD.

The reports from these reviews which include 1:250,000 scale maps showing the distribution of the physical constraints are available from the following organisations:

- Arup Geotechnics, 1991. *Review of mining instability in Great Britain*. Obtainable from Arup Geotechnics, Bede House, All Saints, Newcastle-upon-Tyne NE1 2EB;
- Applied Geology Ltd, 1994. *Review of instability due to natural underground cavities in Great Britain*. Obtainable from Kennedy & Donkin Ltd, 14 Calthorpe Road, Edgbaston, Birmingham Bl5 1TH; and
- Wimpey Environmental Ltd and National House Building Council, 1995. *Foundation conditions in Great Britain, a guide for planners and developers*. Obtainable from ESNR International Ltd, 16 Frogmore Road, Hemel Hempstead, Hertfordshire HP3 9RW.

6.4.2 Basis of structural design and loading

Dead, imposed, snow and wind loads may be assessed by reference to a series of Eurocodes.

Basis of structural design – Eurocode

- BS EN 1990:2002+A1:2005 Eurocode: Basis of structural design, with UK National Annex to BS EN 1990:2002+A1:2005.

Actions on structures – Eurocode 1

- BS EN 1991-1-1:2002 Eurocode 1: Actions on structures – Part 1.1: General actions – Densities, self-weight, imposed loads for buildings, with UK National Annex to BS EN 1991-1-1:2002;

- BSI PD 6688-1-1:2011 Published Document – Recommendations for the design of structures to BS EN 1991-1-1;
- BS EN 1991-1-3:2003 Eurocode 1: Actions on structures – Part 1.3: General actions – snow loads, with UK National Annex to BS EN 1991-1-3:2003;
- BS EN 1991-1-4:2005+A1:2010 Eurocode 1: Actions on structures – Part 1.4: General actions – Wind actions, with UK National Annex to BS EN 1991-1-4:2005+A1:2010;
- BSI PD 6688-1.4:2009 Published Document – Background information to the National Annex to BS EN 1991-1-4 and additional guidance;
- BS EN 1991-1-5:2003 Eurocode 1: Actions on structures – Part 1.5: General actions – Thermal actions, with UK National Annex to BS EN 1991-1-5:2003;
- BS EN 1991-1-6:2005 Eurocode 1: Actions on structures – Part 1.6: General actions – Actions during execution, with UK National Annex to BS EN 1996-1-6:2005;
- BS EN 1991-1-7:2006 Eurocode 1: Actions on structures – Part 1.7: General actions – Accidental actions, with UK National Annex to BS EN 1991-1-7:2006;
- BSI PD 6688-1-7:2009 Published Document – Recommendations for the design of structures to BS EN 1991-1-7; and
- BS EN 1991-3:2006 Eurocode 1: Actions on structures – Part 3: Actions induced by cranes and machinery, with UK National Annex to BS EN 1991-3:2006.

6.4.3 Structure above foundations

Structural work of reinforced, prestressed or plain concrete should comply with Eurocode 2: Design of concrete structures as follows:

- BS EN 1992-1-1:2004 Eurocode 2: Design of concrete structures – Part 1.1: General rules and rules for buildings, with UK National Annex to BS EN 1992-1-1:2004;
- BSI PD 6687-1:2010 Published Document – Background paper to the UK National Annexes to BS EN 1992-1 and BS EN 1992-3; and
- BS EN 13670:2009 Execution of concrete structures.

Structural work of aluminium should comply with Eurocode 9: Design of aluminium structures as follows:

- BS EN 1999-1-1:2007+A1:2009 Eurocode 9: Design of aluminium structures – Part 1.1: General structural rules, with UK National Annex to BS EN 1999-1-1:2007+A1:2009;
- BS EN 1999-1-3:2007+A1:2011 Eurocode 9: Design of aluminium structures – Part 1.3: Structures susceptible to fatigue, with UK National Annex to BS EN 1999-1-3:2007+A1:2011;
- BSI PD 6702-1:2009 Published Document – Structural use of aluminium – Part 1: Recommendations for the design of aluminium structures to BS EN 1999;
- BS EN 1999-1-4:2007+A1:2011 Eurocode 9: Design of aluminium structures – Part 1.4: Cold-formed structural sheeting, with UK National Annex to BS EN 1999-1-4:2007;
- BS EN 1999-1-5:2007 Eurocode 9: Design of aluminium structures – Part 1.5: Shell structures, with UK National Annex to BS EN 1999-1-5:2007;
- BS EN 1 090-3:2008 Execution of steel structures and aluminium structures – Part 3: Technical requirements for aluminium structures; and

- BSI PD 6705-3:2009 Published Document – Structural use of steel and aluminium – Part 3: Recommendations for the execution of aluminium structures to BS EN 1090-3BS.

Structural work of masonry should comply with Eurocode 6: Design of masonry structures as follows:

- BS EN 1996-1-1:2005+A1:2012 Eurocode 6: Design of masonry structures – Part 1.1: General rules for reinforced and unreinforced masonry structures, with UK National Annex to BS EN 1996-1-1:2005+A1:2012;
- BS EN 1996-2:2006 Eurocode 6: Design of masonry structures – Part 2: Design considerations, selection of materials and execution of masonry, with UK National Annex to BS EN 1996-2:2006;
- BSI PD 6697:2010 Published Document – Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2;
- BS EN 1996-3:2006 Eurocode 6: Design of masonry structures – Part 3: Simplified calculation methods for unreinforced masonry structures, with UK National Annex to BS EN 1996-3:2006;
- BS 8103-1:2011 Structural design of low-rise buildings – Part 1: Code of Practice for stability, site investigation, foundations, precast concrete floors and ground floor slabs for housing; and
- BS 8103-2:2005 Structural design of low-rise buildings – Part 2: Code of practice for masonry walls for housing.

Structural work of timber should comply with Eurocode 5: Design of timber structures as follows:

- BS EN 1995-1-1:2004+A1:2008 Eurocode 5: Design of timber structures – Part 1.1: General – Common rules and rules for buildings, with UK National Annex to BS EN 1995-1-1:2004+A1:2008;
- BSI PD 6693-1:2012 Published Document – Recommendations for the design of timber structures to Eurocode 5: Design of timber structures – Part 1: General – Common rules and rules for buildings; and
- BS 8103-3:2009 Structural design of low-rise buildings – Part 3: Code of practice for timber floors and roofs for housing.

Structural work of steel should comply with Eurocode 3: Design of steel structures as follows:

- BS EN 1993-1-1:2005 Eurocode 3: Design of steel structures – Part 1.1: General rules and rules for buildings, with UK National Annex to BS EN 1993-1-1:2005;
- BS EN 1993-1-3:2006 Eurocode 3: Design of steel structures – Part 1.3: General rules – Supplementary rules for cold-formed members and sheeting, with UK National Annex to BS EN 1993-1-3:2006;
- BS EN 1993-1-4:2006 Eurocode 3: Design of steel structures – Part 1.4: General rules – Supplementary rules for stainless steels, with UK National Annex to BS EN 1993-1-4:2006;

- BS EN 1993-1-5:2006 Eurocode 3: Design of steel structures – Part 1.5: Plated structural elements, with UK National Annex to BS EN 1993-1-5:2006;
- BS EN 1993-1-6:2007 Eurocode 3: Design of steel structures – Part 1.6: Strength and stability of shell structures;
- BS EN 1993-1-7:2007 Eurocode 3: Design of steel structures – Part 1.7: Plated structures subject to out of plane loading;
- BS EN 1993-1-8:2005 Eurocode 3: Design of steel structures – Part 1.8: Design of joints, with UK National Annex to BS EN 1993-1-8:2005;
- BS EN 1993-1-9:2005 Eurocode 3: Design of steel structures – Part 1.9: Fatigue, with UK National Annex to BS EN 1993-1-9:2005;
- BSI PD 6695-1-9:2008 Published Document – Recommendations for the design of structures to BS EN 1993-1-9;
- BS EN 1993-1-10:2005 Eurocode 3: Design of steel structures – Part 1.10: Material toughness and through-thickness properties, with UK National Annex to BS EN 1993-1-10:2005;
- BSI PD 6695-1-10:2009 Published Document – Recommendations for the design of structures to BS EN 1993-1-10;
- BS EN 1993-1-11:2006 Eurocode 3: Design of steel structures – Part 1.11: Design of structures with tension components, with UK National Annex to BS EN 1993-1-11:2006;
- BS EN 1993-1-12:2007 Eurocode 3: Design of steel structures – Part 1.12: Additional rules for the extension of EN 1993 up to steel grades S 700, with UK National Annex to BS EN 1993-1-12:2007;
- BS EN 1993-5:2007 Eurocode 3: Design of steel structures – Part 5: Piling, with UK National Annex to BS EN 1993-5:2007+A1:2012;
- BS EN 1993-6:2007 Eurocode 3: Design of steel structures – Part 6: Crane supporting structures, with UK National Annex to BS EN 1993-6:2007;
- BS EN 1 090-2:2008+A1:2011 Execution of steel structures and aluminium structures – Part 2: Technical requirements for the execution of steel structures; and
- BRE Digest 437: *Industrial platform floors: Mezzanine and raised storage*.

Structural work of composite steel and concrete should comply with Eurocode 4: Design of composite steel and concrete structures as follows:

- BS EN 1994-1-1:2004 Eurocode 4: Design of composite steel and concrete structures – Part 1.1: General rules and rules for buildings, with UK National Annex to BS EN 1994-1-1:2004.

6.5 Structural requirements in existing buildings subject to change of use

In certain circumstances, the structural requirements of Part A apply to buildings subject to a material change of use (see section 2.4, regulations 5 and 6). In these cases it is necessary to carry out structural appraisals of the existing buildings to see if they are capable of coping with the changed loading conditions necessitated by the change of use. Guidance concerning this may be found in the following documents:

- BRE Digest 366: *Structural appraisal of existing buildings for change of use*, 2012; and
- The Institution of Structural Engineers' Report, *Appraisal of Existing Structures* (3rd edition), 2010.

The Institution of Structural Engineers' Report contains an item on design checks where a choice of various partial factors should be made to suit the individual circumstances of each case.

6.6 Design of structural members in houses and other small buildings

6.6.1 Definitions

The following definitions apply throughout section 2 of AD Al/2.

BUTTRESSING WALL – A wall which provides lateral support, from base to top, to another wall perpendicular to it.

CAVITY WIDTH – The horizontal distance between the leaves in a cavity wall.

COMPARTMENT WALL – A wall constructed to meet the requirements of regulation B3(2) (see Chapter 7, Fire).

DEAD LOAD – The load due to the weight of all roofs, floors, walls, services, finishes and partitions, i.e. all the permanent construction.

IMPOSED LOAD – The load assumed to be produced by the intended occupancy or use, including movable partitions, distributed, concentrated, impact, inertia and snow loads, but *excluding* wind loads.

PIER – An integral part of a wall which consists of a thickened section occurring at intervals along a wall to which it is bonded or securely tied so as to afford lateral support.

SEPARATING WALL – A wall which is common to two adjoining buildings and constructed to meet the requirements of regulation B3(2) (see Chapter 7, Fire).

SPACING – The centre-to-centre distance between two adjacent timbers measured in a plane parallel to the plane of the structure of which they form part.

SPAN – The distance measured along the centre line of a member between centres of adjacent bearings. (However, it should be noted that the spans given in the tables in the document *Span tables for solid timber members in floors, ceilings and roofs (excluding* *trussed rafter roofs) for dwellings*, published by TRADA, are *clear spans*, i.e. measured between the faces of supports.)

SUPPORTED WALL – A wall which is supported by buttressing walls, piers or chimneys, or floor or roof lateral support arrangements.

WIND LOAD – Any load due to the effect of wind pressure or suction.

6.6.2 Structural stability

The basic stability of a small house of traditional masonry construction is largely dependent on the provision of intermediate floors and a braced roof structure which are adequately anchored to walls restrained laterally by buttressing walls, piers or chimneys. In effect, the floors and roof act as horizontal diaphragms, which are capable of transmitting forces from the wind to the buttressing elements of the building. If this can be achieved, then it should not be necessary to take additional precautions against wind loading.

To achieve the necessary transfer of wind loading, the following conditions should be met:

- the internal and external walls must be adequately connected to each other using masonry bonding or mechanical connections;
- the layout of the walls must be such that a robust three-dimensional box structure is created with limitations placed on the maximum size of rooms; and
- the overall size and proportions of the building are limited.

A traditionally constructed cut timber roof generally provides inbuilt resistance to instability from features such as hipped ends, tiling battens, rigid sarking boards, etc. However, where this is not provided, then extra wind bracing may be required in a similar manner to that provided for trussed rafter roofs (see below) and especially in the case of single-hipped or non-hipped roofs to detached houses with pitches greater than 40°.

Trussed rafter roofs have, in the past, been susceptible to collapse during high winds. If this form of construction is used, it should be braced in accordance with BS EN 1995-1-1:2004 with its National Annex and additional guidance given in Published Document PD 6693-1:2012 and BS 8103-3:2009 *Structural design of low-rise buildings*: Part 3: 1996 *Code of practice for timber floors and roofs for housing.*

6.6.3 Structural work of timber in single-occupancy dwellings

Section 2B of AD Al/2 provides that if the work concerned is in a floor, ceiling or roof of a single-occupancy dwelling of not more than three storeys, that work will be satisfactory if the grades and dimensions of the timbers used are at least equal to those given in Tables l to 45 of the TRADA publication *Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings.* Although this document is quoted in AD A, it has now been renamed as *Eurocode 5 span tables for solid timber members in floors, ceilings and roofs for dwellings* and is now in its 4th edition. The table numbers have been changed so that they now run from Tables 4.1 to 7.6 although they still cover the same timber members. The span table document is obtainable from TRADA Technology Ltd, Chiltern House, Stocking Lane, Hughenden Valley, High Wycombe, Buckinghamshire HP14 4ND.

The TRADA span tables have been derived in accordance with BS EN 1995-1-1:2004+A1:2008 Eurocode 5: Design of timber structures. General – Common rules and rules for buildings and its UK National Annexes. Additional guidance is also given in BSI Published Document PD 6693-1:2012 and in BS 8103-3 *Structural design of low-rise buildings:* Part 3: 1996 *Code of Practice for timber floors and roofs for dwellings* may be used.

The span tables in the TRADA publication replace Tables A1 to A24, which were included in previous editions (up to 1992) of AD A. The advantage of using such span tables is that it is not necessary to calculate the size of joists, rafters, purlins, etc.; one merely selects the appropriate sizes from the tables.

The decision by the government to outsource the preparation of these tables means that it is now necessary for designers, etc. to purchase another guidance document (in addition to AD A) with resulting increases in costs to the consumer. Since one of the original purposes of the Approved Documents was to provide relatively simple solutions to building regulation compliance issues (especially for dwellings) in single documents, it is to be regretted that the government now deems it necessary to reduce the content and worth of the Approved Documents by placing ever-increasing reliance on guidance documents produced by other non-governmental bodies.

In order to assist our readers by providing, where possible, as complete a guide to the regulations and Approved Documents as we can in one place, in the previous editions of this book, we reproduced the original tables from the earlier edition of AD A. For copyright reasons we are unable to reproduce the tables from the TRADA document, and unfortunately, the tables from the 1992 edition of AD A no longer comply with Eurocode 5. For these reasons we have decided not to reproduce the old Approved Document Tables. They can still be used as a general guide when choosing timber members, but caution should be exercised since the sizes chosen may not be accepted by building control bodies.

The following notes refer to the use of Tables 4.1 to 7.6 of the TRADA document:

(1) Tables 4.l to 7.6 apply to all floor, ceiling and roof timbers in a single-occupancy house of three storeys or less.

(2) The timber used for any binder, beam, joist, purlin or rafter must be of a species, origin and grade specified in Table 2.1 of the TRADA document.

(3) When using the tables, the following points should also be taken into account:
The imposed load to be sustained by the floor, ceiling or roof of which the member forms part should not exceed:

- (a) In the case of a floor: 1.5 kN/m^2 – see Tables 4.l and 4.2 with a concentrated load limitation of 2.0 kN.
- (b) In the case of a ceiling: 0.25 kN/m^2 and a concentrated load of 0.9 kN acting with the imposed load – see Tables 5.1 and 5.4. (For loft spaces floor joist loadings should be used.)
- (c) In the case of a flat roof with access not limited to the purposes of maintenance or repair: 1.5 kN/m^2 or a concentrated load of 2.0 kN – see Tables 7.5 and 7.6.

Table 6.1 Softwood floorboards (tongued and grooved).

Finished thickness of board (mm)	Maximum span of board (centre to centre of joists) (mm) up to
16	505
19	600

(d) In all other cases with access only for maintenance: 0.60 kN/m^2 or 1.02 kN/m^2 or a concentrated load of 0.9 kN – see Tables 6.1 to 7.4 inclusive.

The loading variations on the roofs mentioned in (d) above are due to the different imposed snow loadings which vary with altitude and location in England and Wales. Diagram 3.1 and Table 3.1 from the TRADA document show how the different snow loading values are chosen.

(4) Information on floorboarding can be found in BS 8103: Part 3 1996 *Code of practice for timber floors and roofs for housing*. Table 6.1 is based on Table 2 from BS 8103 and shows typical thicknesses and spans of tongued and grooved softwood floorboards for use in dwellings.

(5) Generally speaking the section sizes of timber members given in TRADA tables should be machined on the width of the member, i.e. to reduce its depth, to the tolerance classes specified in *BS EN 336:2003*, or be ALS or CLS (e.g. this allows floors and ceilings to be laid to a level finish).

(6) Notches and holes in floor and roof joists should comply with Fig. 6.1. However, no notches or holes should be cut in rafters except for birdsmouths at supports. The rafter may be birdsmouthed to a depth of up to one third the rafter depth. The TRADA document restates these recommendations but adds that 'notches or holes should not be cut in rafters, purlins or binders unless approved by the building designer'.

(7) The TRADA document states that the minimum bearing length at supports for floor joists should be 40 mm unless justified by specialist calculation. Sometimes for practical reasons, it may be necessary to provide a longer bearing length. Where this is required due to high bearing stresses (e.g. for larger sections), the TRADA tables indicate this by shading.

(8) If the spans of purlins or rafters are unequal, the section sizes chosen should relate to the longer span.

(9) On floor joists, no allowances have been made for additional loadings due to baths or partitions. It is recommended that all joists under baths should be doubled up, but no advice is given regarding partition loads in AD A. (TRADA recommends that for lightweight non-load-bearing partitions weighing not more than 1.0 kN/m run placed parallel to floor joists, one or two extra joists can be placed immediately below them depending on the dead load of the floor.) Similarly, when choosing ceiling joist sizes, no account has been taken of trimming or of other additional loads such as water tanks. Therefore, in these cases joist sizes should be subject to calculation by a competent person.

(10) Purlins are assumed to be placed perpendicular to the roof slope, and adequate connections between the various roof members should be provided as appropriate.

(11) The TRADA tables are not applicable to trussed rafter roofs.

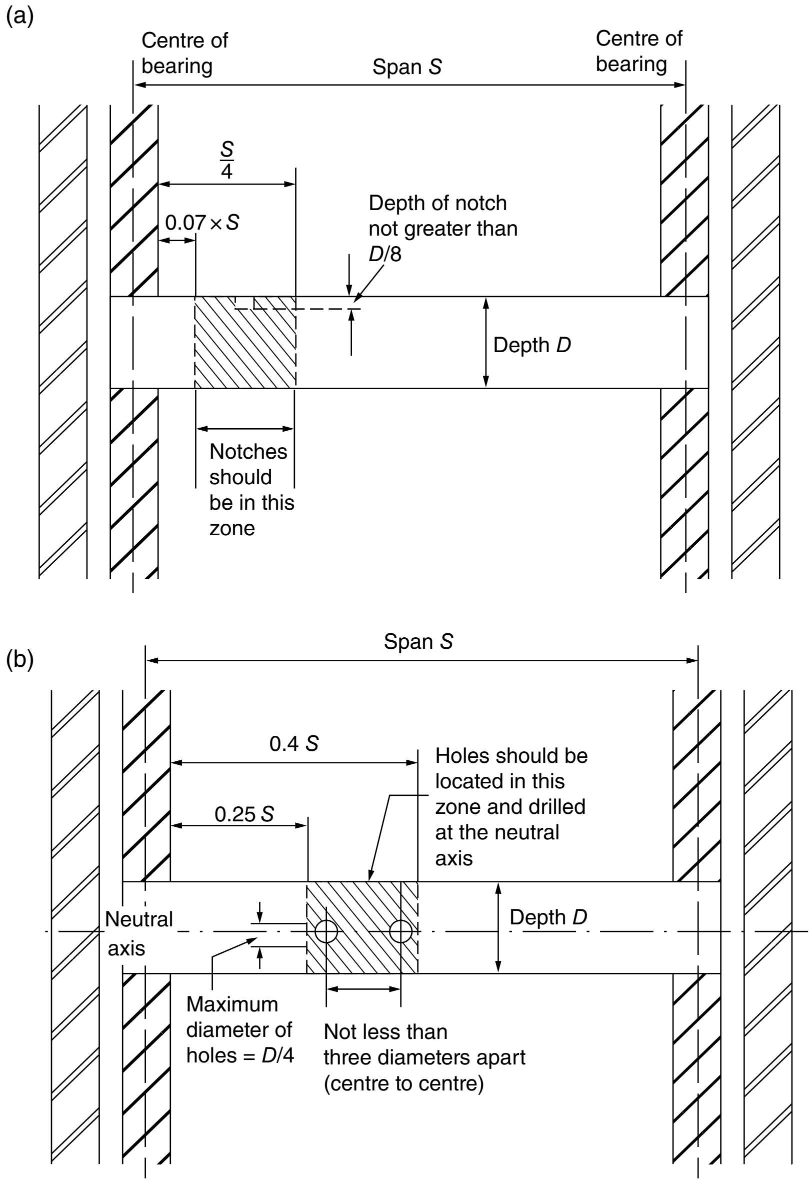


Fig. 6.1 Notches (a) and holes (b) in floor and roof joists.

(12) Strutting of joists – where floor joists span more than 2.5 m they should be strutted with one or more rows of:

- solid timber at least 38 mm wide; or
- herringbone strutting in 38 mm × 38 mm timber except where the distance between the joists is greater than three times the joist depth.

Strutting and solid blocking should extend at least 0.75 times the joist depth.

Proprietary herringbone strutting systems are permitted if used in accordance with manufacturer's instructions.

One row of strutting at mid-span is recommended for joist spans between 2.5 m and 4.5 m. Above 4.5 m, two rows of strutting at the one third positions would be required.

The outer joist should be solidly blocked to the perimeter wall at the end of each row of strutting.

6.6.4 Special treatment against house longhorn beetle infestation

In specified areas in the south of England, all softwood roof timbers, including ceiling joists, should be treated with a suitable preservative against the house longhorn beetle (*Hylotrupes bajulus* L).

The specified areas are as follows:

- in the Borough of Bracknell Forest, the parishes of Sandhurst and Crowthorne;
- the Borough of Elmbridge;
- in the District of Hart, the parishes of Hawley and Yateley;
- the District of Runnymede;
- the Borough of Spelthorne;
- the Borough of Surrey Heath;
- in the Borough of Rushmoor, the area of the former district of Farnborough; and
- the Borough of Woking.

No specific forms of treatment are recommended; however, guidance on suitable preservative treatment may be found in The Wood Protection Association's manual *Industrial wood preservation: Specification and practice* (2012) available from 5C Flemming Court, Castleford, West Yorkshire, WF10 5HW.

6.6.5 Structural work of bricks, blocks and plain concrete

If a wall of these materials comes within the scope of section 2C of AD A1/2, it is not necessary to calculate loads or wall thicknesses, provided that the wall is built with the thicknesses required by section 2C and complies with the rules therein.

Section 2C may be applied to any wall which is:

- an external wall, compartment wall, internal load-bearing wall or separating wall of a residential building of not more than three storeys; *and*
- an external wall or internal load-bearing wall of a small single-storey non-residential building or small annexe to a residential building (such as a garage or outbuilding) provided that:
  - (a) the building design complies with the requirements of paragraphs 2C5 to 2C13 of section 2C; and
  - (b) the wall construction details comply with the relevant requirements of BS EN 1996-2:2006 with its UK National Annex and additional guidance given in BSI Published Document PD 6697:2010, except as regards the conditions given in paragraphs 2C4 and 2C14 to 2C38 of section 2C.

It should be noted that when the guidance for section 2C was formulated, the worst combination of circumstances likely to arise was taken into account. This may therefore result in a somewhat conservatively designed structure. AD A 1/2 makes it clear that where a particular requirement is considered to be too onerous, it may be appropriate to consider a minor departure from the recommendations of section 2C on the basis of judgement and experience. Alternatively, calculations may be carried out to show adequacy in respect of the aspect of the wall which is subject to the departure rather than for the entire wall.

The guidance given is based on the compressive strengths of bricks and blocks shown in section 6.6.7.

Where the suitability for use of masonry units of other compressive strengths is being considered, design strengths for walls may be found in BS EN 1996-1-1:2005 with its National Annex.

6.6.6 Building design requirements (section 2C, paragraphs 2C4, 2C14 to 2C16 and 2C38)

These are concerned with the maximum allowable height of the building (which is related to the maximum wind load), the maximum imposed load, the building proportions and the plan area of each storey or subdivision.

MAXIMUM ALLOWABLE HEIGHT OF THE BUILDING. AD A 1/2 gives a simplified way of determining the maximum allowable height of a building from a map (Diagram 6 of AD A 1/2 reproduced below) and a series of tables (tables a, b and c in Diagram 7 (also reproduced below)). This method is based on BS EN 1991-1-4:2005 with its National Annex.

In order to determine the maximum height of a building, use the following procedure:

- Use Diagram 6 Figure 1 (Map showing wind speeds in m/s for maximum height of buildings) to determine the wind speed (*V*) relative to the location of the building.
- Find the orographic zone for the site from Diagram 6 Figure 2 and use this in Table **a** of Diagram 7 to obtain Factor *O*.
- Use the site altitude in metres to determine Factor *A* in Table **b** of Diagram 7.
- Calculate factor *S* from the formula $S = V \times O \times A$.
- Using the calculated factor *S* look up the maximum allowable building height permitted in Table **c** (maximum allowable building height).

The height obtained should not be exceeded in the building design.

A more accurate determination of the orography factor O can be gained by using Figure 3a and 3b in Diagram 6.

IMPOSED LOADS. These should not exceed:

- on any floor, 2.0 kN/m^2 distributed;
- on any ceiling, 0.25 kN/m^2 distributed and 0.9 kN concentrated; *and*
- on any roof, 1.00 kN/m^2 for spans not exceeding 12 m, or 1.5 kN/m^2 for spans not exceeding 6 m.

These recommendations are illustrated in Fig. 6.2.

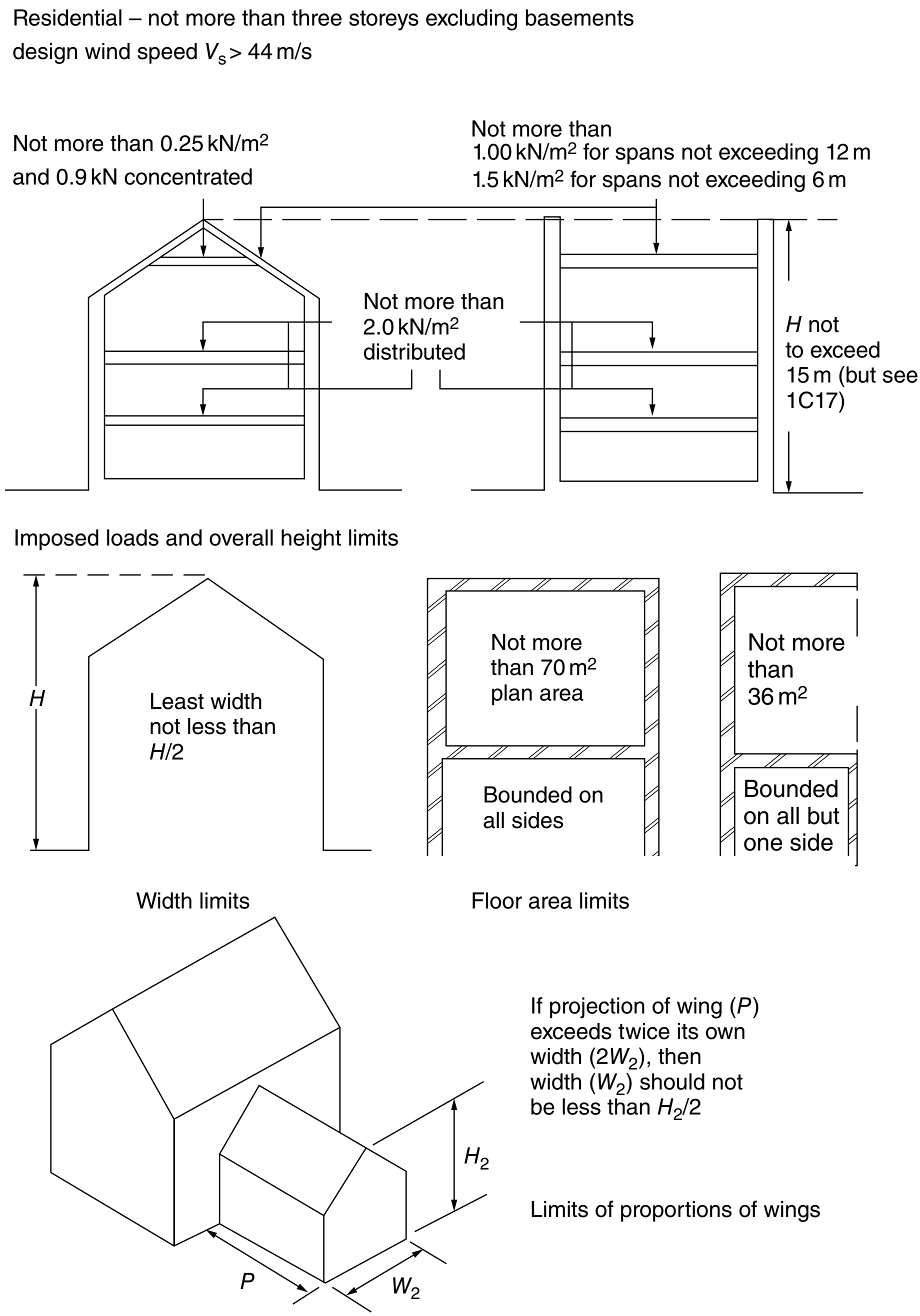


Fig. 6.2 Building design requirements for residential buildings not exceeding three storeys in height.

BUILDING PROPORTIONS. For residential buildings of not more than three storeys:

- The maximum height of the building should not exceed 15 m (and may need to be less than this as it will be subject to the calculation shown above under 'maximum allowable height of building'). The height is measured from the lowest finished ground level adjacent to the building to the highest point of any wall or roof.
- The width of the building should not be less than at least half the height of the building.
- Any wing of the building which projects more than twice its own width from the remainder of the building should have a width at least equal to half its height.

These recommendations are illustrated in Fig. 6.2.

(a) Small single-storey non-residential buildings

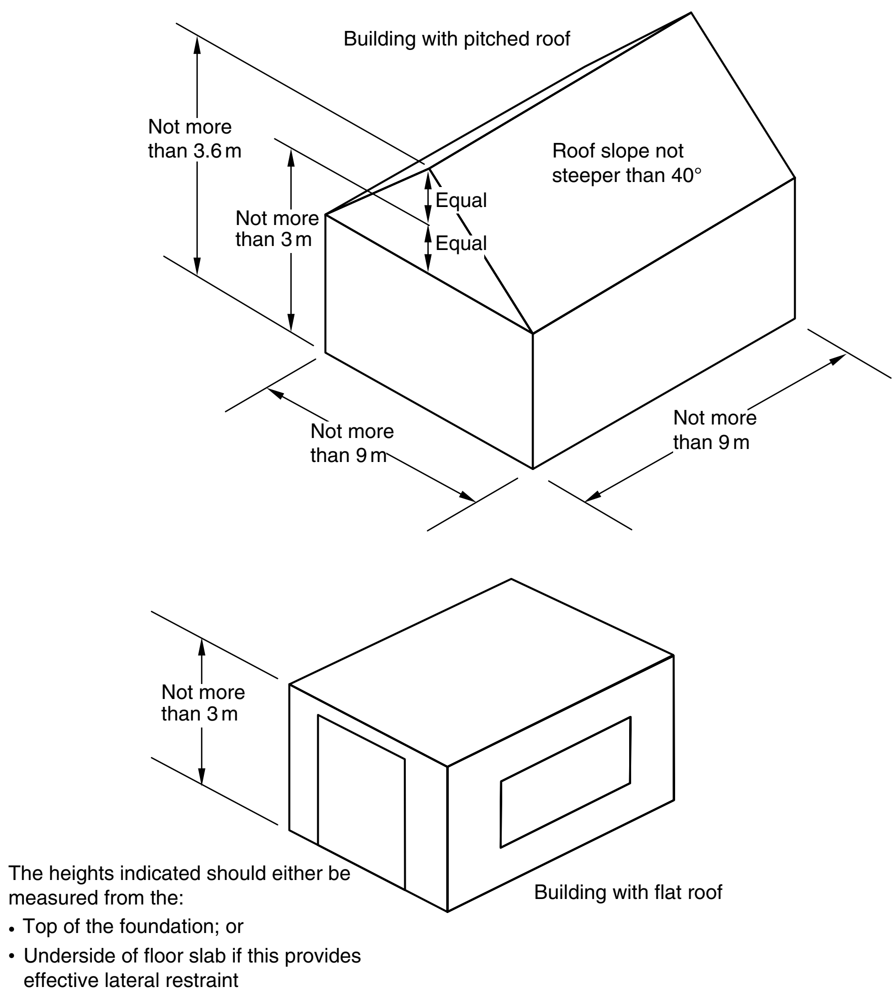


Fig. 6.3 Building design requirements for small non-residential buildings and annexes.

(b) Annexes attached to residential buildings

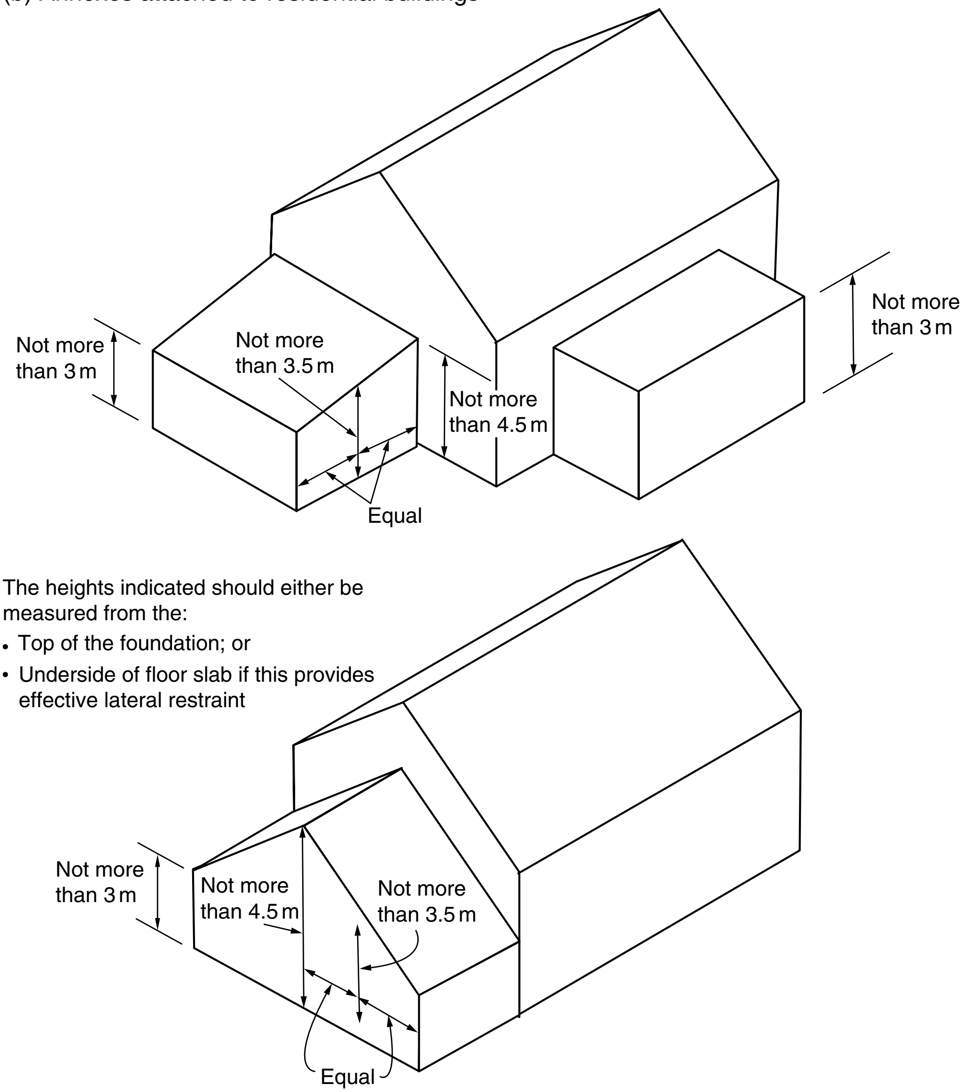


Fig. 6.3 (*Continued*)

For small single-storey non-residential buildings:

- The height of the building should not exceed the dimensions shown in Fig. 6.3(a).
- The greatest length or width of the building should not exceed 9 m.

For annexes attached to residential buildings, the height of any part should not exceed the dimensions shown in Fig. 6.3(b).

THICKNESS OF WALLS IN CERTAIN SMALL BUILDINGS — A1/2

Diagram 6 showing wind speeds in m/s for maximum height of buildings

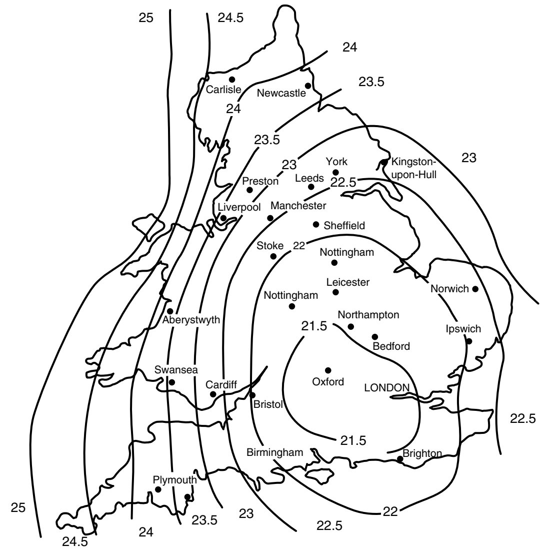


Figure 1 map of wind speeds (V) in m/s

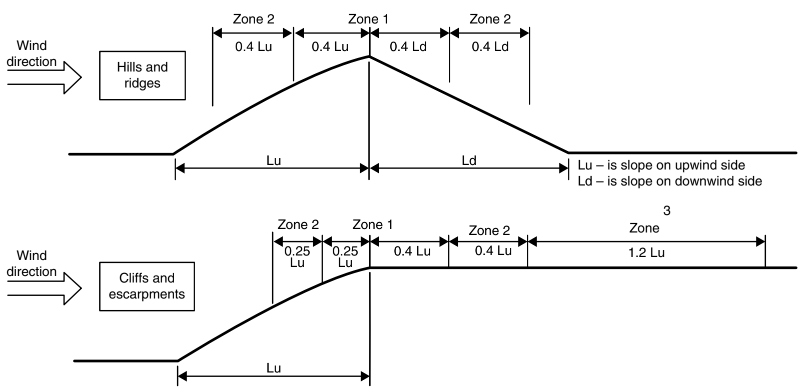


Figure 2 orographic zones for factor O

Note: a more detailed approch for obtaining factor O is give by figure 3 diagram 6.

Diagram 6 Map showing wind speeds in m/s for maximum height of buildings

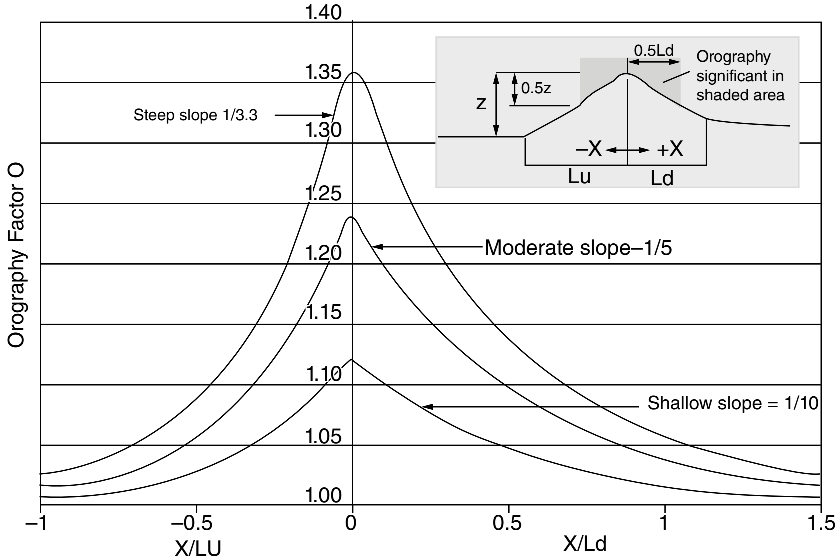


Figure 3a orography Factor O for hills and ridges

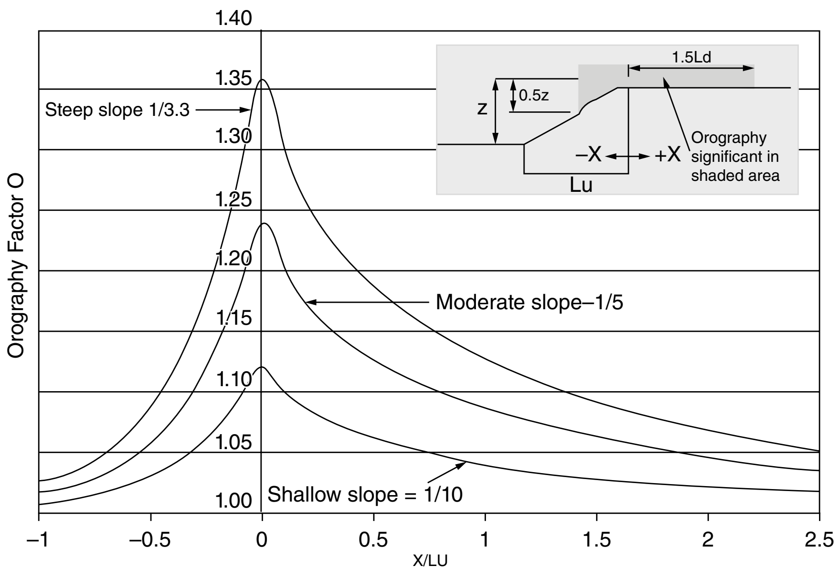


Figure 3b orography factor O for cliffs and escarpments
(interpolation between curves may be used)

Figure 3 Alternative graphical method for determining Orography Factor O

Diagram 7 Maximum height of buildings

Read map wind speed V from Figure 1 Diagram 6 → Find the orographic zone for the site from Figure 2 Diagram 6 and obtain Factor O from **Table a** (or use Figure 3 Diagram 6) → Obtain value of Factor A from **Table b** → Calculate value of Factor S from: S–V × O × A → Obtain maximum allowable building height form **Table c**

Table a Factor O

Orographic category and average slope of whole hillside, ridge cliff or escarpment	Factor O Zone 1	Zone 2	Zone 3
Category 1: Nominally flat terrain, average slope < 1/20	1.0	1.0	1.0
Category 2: Shallow terrain average slope < 1/10	1.12	1.07	1.05
Category 3: Moderately steep terrain, average slope < 1/5	1.24	1.13	1.10
Category 4: Steep terrain, average slope > 1/5	1.36	1.20	1.15

Table b Factor A

Site attitude (m)	Factor A
0	1.00
50	1.06
100	1.10
150	1.15
200	1.20
300	1.30
400	1.40
500	1.50

Table c Maximum allowable building height in metres

	Country sites			Town sites		
Factor S	Distance to the coast <2km	2 to 20km	>50 km	Distance to the coast <2 km	2 to 20 km	>50 km
≤ 25	15	15	15	15	15	15
26	11.5	13.5	15	15	15	15
27	8	11	14.5	15	15	15
28	5.5	8	11	15	15	15
29	4	6.5	8.5	12.5	15	15
30	3	5	6.5	10	12.5	15
31		4	5.5	8.5	11	13.5
32		3.5	4.5	7	9.5	11.5
33		3	3.5	6	8	10
34			3	5.5	7	87.5
35				4.5	8.5	7.5
36				4	5.5	6.5
37				3.5	6	8
38				3	4.5	5.5
39					4	5
40					3.5	4.5
41					3	4
42						3.5
43						3.5
44						3

Notes: Table a – Outside of the zones shown in Table a, Factor O – 1.0.
Table b – For elevated sites where orography is significant a more accurate assessment of Factor A can be obtained by using by using the altitude at the base of the topographic feature instead of the attitude at the side, see Figure 2 Diagram 6 or, alternatively, Figure 3 Diagram 6.
Table c – i) Sites in town less then 300m from the edge of the town should be assumed to be in country terrain.
ii) Where a side is closer then 1km to an inland area of water which extends more than 1km in the wind direction, the distance to the coast should be taken as < 2km.
interpolation may be used in Tables b and c.

PLAN AREA OF STOREY. The plan area of each storey which is completely bounded by structural walls on all sides should not be more than 70 m^2. However, if the storey is bounded in this way on all sides but one, the limiting area is 36 m^2 (see Fig. 6.2).

6.6.7 Wall construction requirements (section 2C, paragraphs 2C17 to 2C38)

These are concerned with height and length, materials and workmanship, buttressing, loading conditions, openings and recesses and lateral support.

Height and length

The height or length of a wall should not be more than 12 m and together with storey heights should be measured in accordance with the following rules:

- The height of the ground storey of a building is measured from the base of the wall to the underside of the next floor above.
- The height of an upper storey is measured from the level of the underside of the floor of that storey, in each case to the level of the underside of the next floor above.
- For a top storey which comprises a gable wall, measure to a level midway between the gable base and the top of the roof lateral support along the line of the roof slope, but if there is also lateral support at about ceiling level, to the level of that lateral support.
- Where an internal or separating wall comprises a gable and is built up to the underside of the roof, measure the height from its base to the base of the gable.
- Any external wall which includes a gable should be measured from its base to half the height of the gable.
- Any external wall which is not a gable wall should be measured from its base to its highest part, excluding any parapet not exceeding 1.2 m in height.
- Walls are regarded as being divided into separate lengths by securely tied buttressing walls, piers or chimneys for the purposes of measuring their length.

These separate lengths are measured centre to centre of the piers, buttressing walls and chimneys. These special requirements are noted in Fig. 6.4.

Materials and workmanship

BRICKS AND BLOCKS. The wall should be constructed of bricks or blocks, properly bonded and solidly put together with mortar. The materials should comply with the following standards:

- clay bricks or blocks to BS EN 771-1;
- calcium silicate bricks or blocks to BS EN 771-2;
- concrete bricks or blocks to BS EN 771-3 or BS EN 771-4;
- manufactured stone to BS EN 771-5; and
- square dressed natural stone to the relevant parts of BS EN 771-6.

BRICKS AND BLOCKS – COMPRESSIVE STRENGTH. AD A1/2 addresses the minimum strength requirements for masonry units in a rather complex manner when it attempts to analyse the guidance given in the various British Standards and BS EN Standards which cover this issue. It is probably best to consider the requirements for bricks and blocks separately, and these are defined as follows:

BRICK: a masonry unit having work sizes not greater than 337.5 mm in length and 112.5 mm in height.

BLOCK: a masonry unit which exceeds either of the two work sizes given for bricks and has a minimum bed height of 190 mm. Where a block has a smaller bed height than

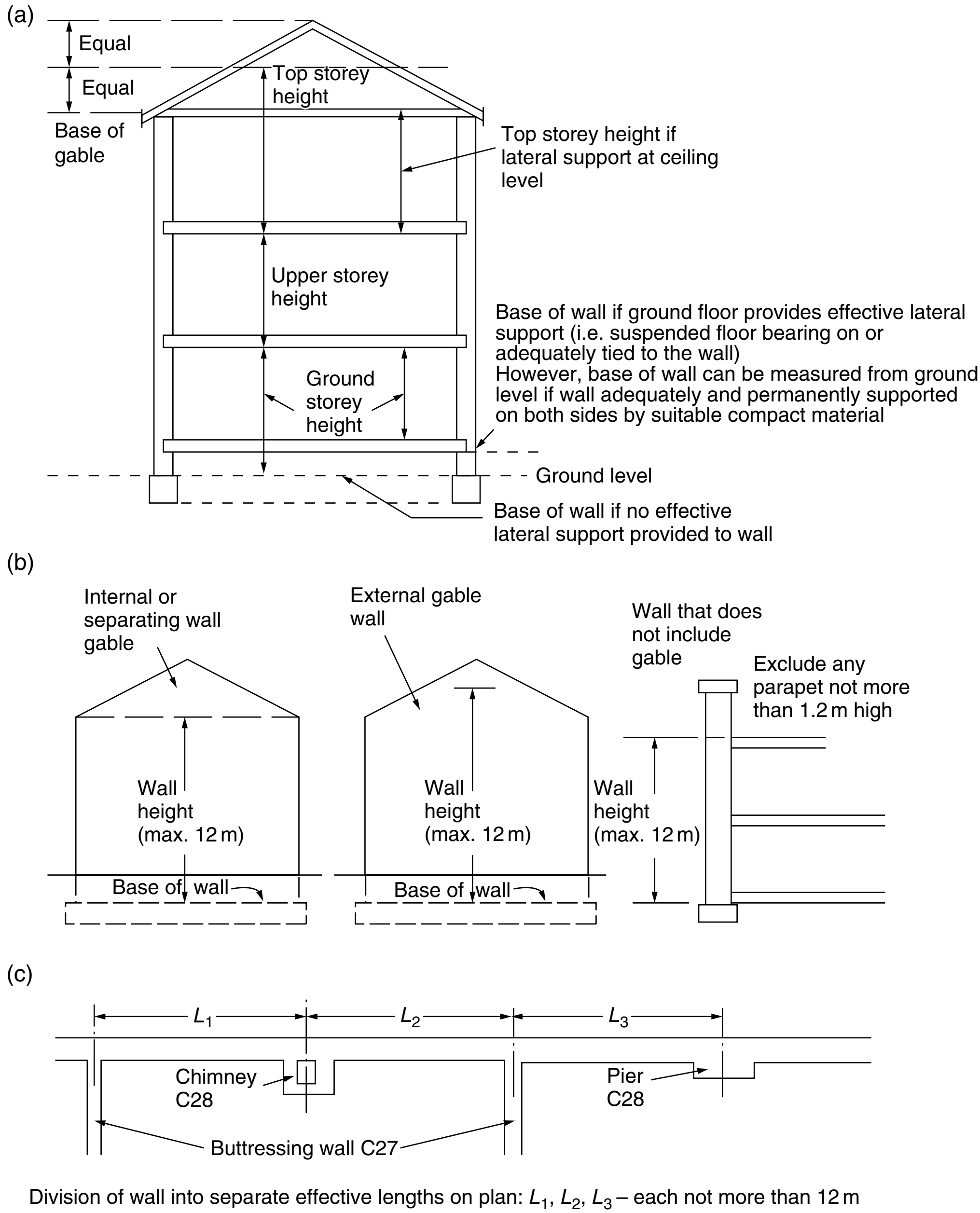


Fig. 6.4 Rules for measurement, 2C17, 2C18: (a) storey heights, (b) wall height and (c) wall length.

190 mm (excluding cuts or makeup units), the strength requirements for bricks should be adopted. The only exception to this is in the case of a solid external wall. If blocks are used in this situation, they should have a compressive strength equivalent to that shown for a block inner leaf of a cavity wall in the same position.

Table 6.2 Declared compressive strength* of masonry units (bricks) complying with BS EN 771: Parts 1 to 5 (N/mm²).

Masonry unit	Clay masonry units to BS EN 771: Part 1		Calcium silicate masonry units to BS EN 771: Part 2		Aggregate concrete masonry units to BS EN 771: Part 3	Autoclaved aerated conc. masonry units to BS EN 771: Part 4	Manufactured masonry units to BS EN 771: Part 5
Condition A (see diagram)							Any unit complying with BS EN 771: Part 5 will be acceptable for conditions A, B and C
Brick	Group 1	Group 2	Group 1	Group 2	6.0	–	
	6.0	9.0	6.0	9.0			
Condition B (see diagram)							
Brick	Group 1	Group 2	Group 1	Group 2	9.0	–	
	9.0	13.0	9.0	13.0			
Condition C (see diagram)							
Brick	Group 1	Group 2	Group 1	Group 2	18.0	–	
	18.0	25.0	18.0	25.0			

Note:
* The values of declared compressive strengths given above are mean values.

Reference is also made in AD A1/2 to Group 1 and Group 2 units. These are defined as follows:

GROUP 1 UNITS: masonry units having up to 25% formed voids (for frogged bricks the limit is 20%).

GROUP 2 UNITS: masonry units having formed voids between 25% and 55%.

When establishing the compressive strength of masonry units, this can be achieved by selecting masonry units with declared compressive strengths of at least the values given in Table 6.2 for brick units or Table 6.3 for block units for Conditions A, B and C as appropriate (see Fig 6.5).

MORTAR. The mortar used in any wall to which section 2C of AD A1/2 applies should be one of the following:

- mortar designation (iii) according to BS EN 1996-1-1:2005 with its UK National Annex;
- strength class M4 from BS EN 998 *Specification for mortar for masonry*: Part 2: 2010;
- at least equal in strength to a 1:1:5 or 6 CEM1/lime/fine aggregate mortar measured by volume of dry materials; or
- of equivalent or greater strength and durability than any of the specifications previously referred to.

Table 6.3 Normalised compressive strength of block masonry units (blocks) complying with BS EN 771: Parts 1 to 5 (N/mm²).

Masonry unit	Clay masonry units to BS EN 771: Part 1		Calcium silicate masonry units to BS EN 771: Part 2		Aggregate concrete masonry units to BS EN 771: Part 3	Autoclaved aerated conc. masonry units to BS EN 771: Part 4	Manufactured masonry units to BS EN 771: Part 5
Condition A (see diagram)							Any unit complying with BS EN 771: Part 5 will be acceptable for conditions A, B and C
Block	Group 1	Group 2	Group 1	Group 2	3.1*	3.1	
	5.0	8.0	5.0	8.0			
Condition B (see diagram)							
Block	Group 1	Group 2	Group 1	Group 2	7.7*	7.7	
	7.5	11.0	7.5	11.0			
Condition C (see diagram)							
Block	Group 1	Group 2	Group 1	Group 2	7.7*	7.7	
	15.0	21.0	15.0	21.0			

Notes:

* These values are dry ground strengths to BS EN 771: Part 1.

1. This table applies to masonry units where the work size is greater than 337.5 mm in length or 112.5 mm in height.
2. Values in this table are normalised compressive strengths (N/mm²). Compressive strengths of masonry units should be derived according to BS EN 772: Part 1.

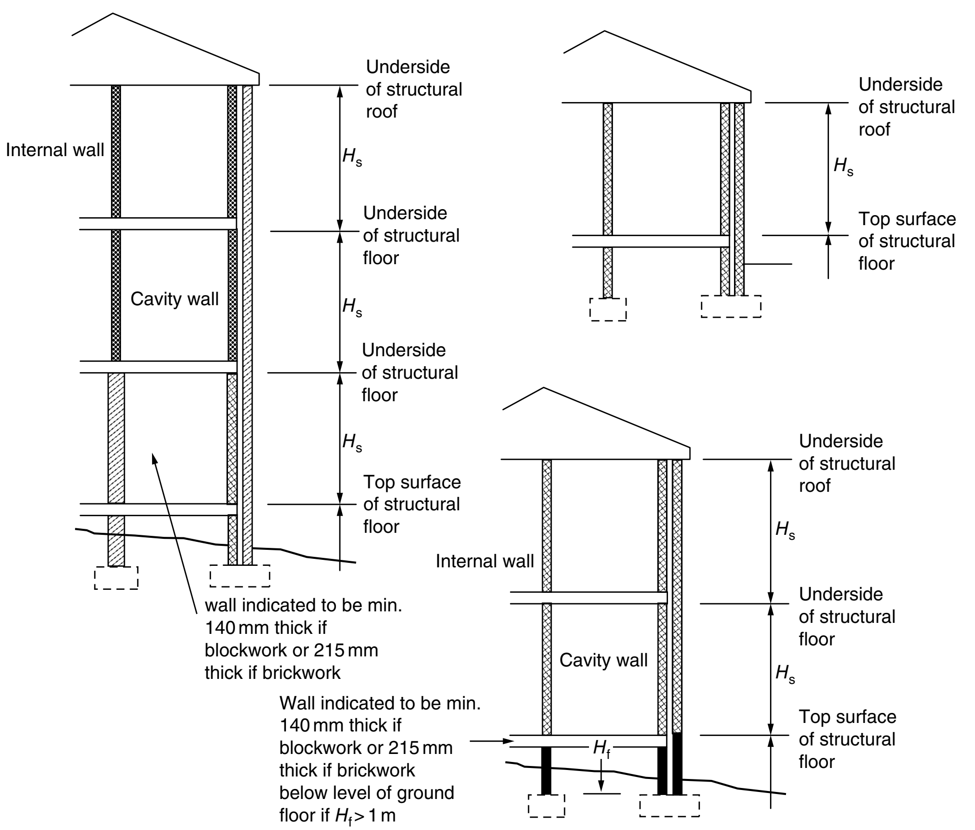


Fig. 6.5 Compressive strengths of masonry units.

The statement that the mortar should be compatible with the masonry units and the position of use contained in the previous edition of AD A1/2 has been omitted from the current edition even though it is sound advice.

WALL TIES. These should comply with BS EN 845 *Specification for ancillary components for masonry:* Part 1: 2001 *Ties, tension straps, hangers and brackets*. AMD 14736 2003, AMD 15539 2006.

Additionally, they should be material references 1 or 3 in BS EN 845 Table A1 (austenitic stainless steel) and should be selected in accordance with Table 5 from AD A1/2 which is reproduced below. The effect of this recommendation is to make it necessary to use stainless steel wall ties in all houses irrespective of where those houses are located. Previously, stainless steel wall ties were only required if a house was sited where conditions of severe exposure occurred. Wall ties should be selected in accordance with Table 5 of AD A1/2 which is reproduced below.

Table 5 Cavity wall ties.

Nominal cavity width mm (Note 1)	Tie length mm (Note 2)	BS EN 845-1 tie
50 to 75	200	Type 1, 2, 3 or 4 to BSI PD 6697:2010 and selected on the basis of the design loading and design cavity width.
76 to 100	225	
101 to 125	250	
126 to 150	275	
151 to 175	300	
176 to 300	(See Note 3)	

Notes:

1. Where face insulated blocks are used the cavity width should be measured from the face of the masonry unit.
2. The embedment depth of the tie should not be less than 50 mm in both leaves.
3. For cavities wider than 175 mm calculate the length as the nominal cavity width plus 125 mm and select the nearest stock length. For wall ties requiring embedment depths in excess of 50 mm, increase the calculated tie length accordingly.

6.7 Buttressing walls, piers and chimneys

6.7.1 Introduction

Every wall should be bonded or securely tied at each end to a buttressing wall, pier or chimney. These supporting elements should be of such dimensions as to provide effective lateral support over the full wall height from its base to its top.

If, additionally, such supporting elements are bonded or securely tied to the supporting wall at intermediate points in the length of the wall within each storey, then the wall may be regarded as being divided into separate distinct lengths by these buttressing walls, piers or chimneys. Each of the distinct lengths may then be regarded as a supported wall, and the length of any wall is the distance between adjacent supporting elements. The intermediate buttressing walls, piers or chimneys should provide lateral restraint for the full height of the supported wall, but they may be staggered within each storey.

Buttressing walls should have:

- one end bonded or securely tied to the supported wall;
- the other end bonded or securely tied to another buttressing wall, pier or chimney;
- no opening or recess greater than 0.1 m^2 in area within a horizontal distance of 550 mm from the junction with the supported wall and openings and recesses generally disposed so as not to impair the supporting effect of the buttressing wall;
- a length of not less than one sixth of the height of the supported wall;
- the minimum thickness required by the appropriate rule, according to whether the buttressing wall is actually an external, compartment, separating or internal load-bearing wall or a wall of a small building or annexe; but if the buttressing wall is none of these and is not itself a supported wall, then a thickness, *t* (see Fig. 6.4), of not less than:
  - half the thickness required of an external or separating wall of similar height and length as the buttressing wall, less 5 mm; or
  - if the buttressing wall is part of a dwelling house and is not more than 6 m high and 10 m in length, 75 mm; or
  - in any other case, 90 mm (see Fig. 6.6).

Piers may project on either or both sides of the supported wall and should:

- run from the base to the top of the supported wall;
- have a thickness, measured at right angles to the length of the supported wall and including the thickness of that wall, of at least three times the thickness required of the supported wall; and
- measure at least 190 mm in width (the measurement being parallel to the length of the supported wall).

Chimneys should have:

- a horizontal cross-sectional area, excluding any fireplace opening or flue, of not less than the area required of a pier in the same wall; and
- a thickness overall of at least twice the thickness required of the supported wall.

The requirements for piers and chimneys are shown in Fig. 6.7.

It should be noted that requirements in respect of plan dimensions of piers do not apply to piers in walls of small buildings and annexes, for which there are special rules (see Fig. 6.19).

6.7.2 Loading conditions

FLOOR SPANS. The wall should not support any floor members with a span of more than 6 m. (Span is measured centre to centre of bearings.)

LATERAL THRUST. Where the levels of the ground or oversite concrete on either side of a wall differ, the thickness of the wall as measured at the higher level should not be less

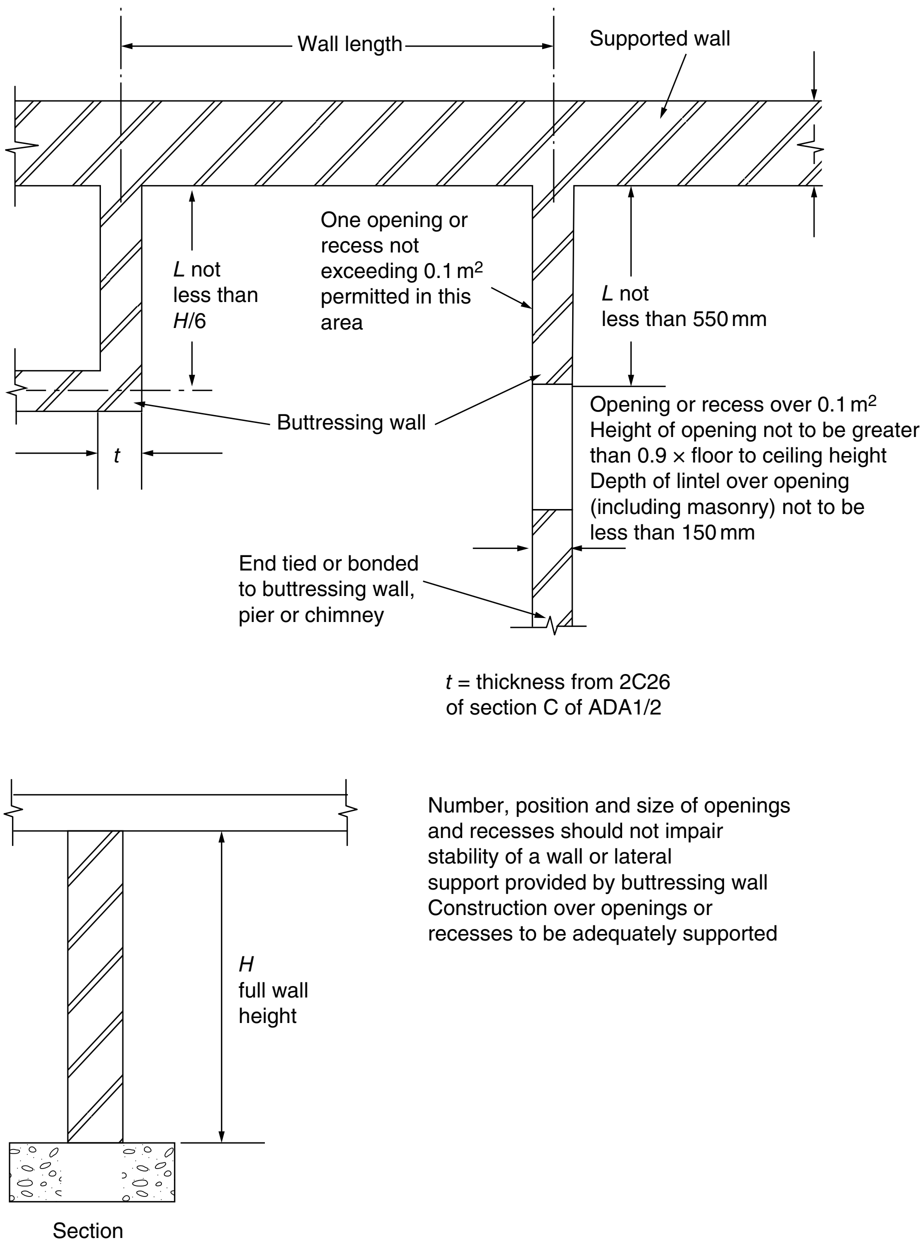


Fig. 6.6 Buttressing walls.

than one quarter of the difference in level or 1 m whichever is the least. In the case of a cavity wall, the thickness is taken as the sum of the leaf thicknesses. However, if the cavity is filled with fine concrete, the overall thickness may be taken.

The recommendations described above and illustrated in Fig. 6.8(b) apply equally where the retained soil is internal (i.e. the soil under the building is at a higher level than

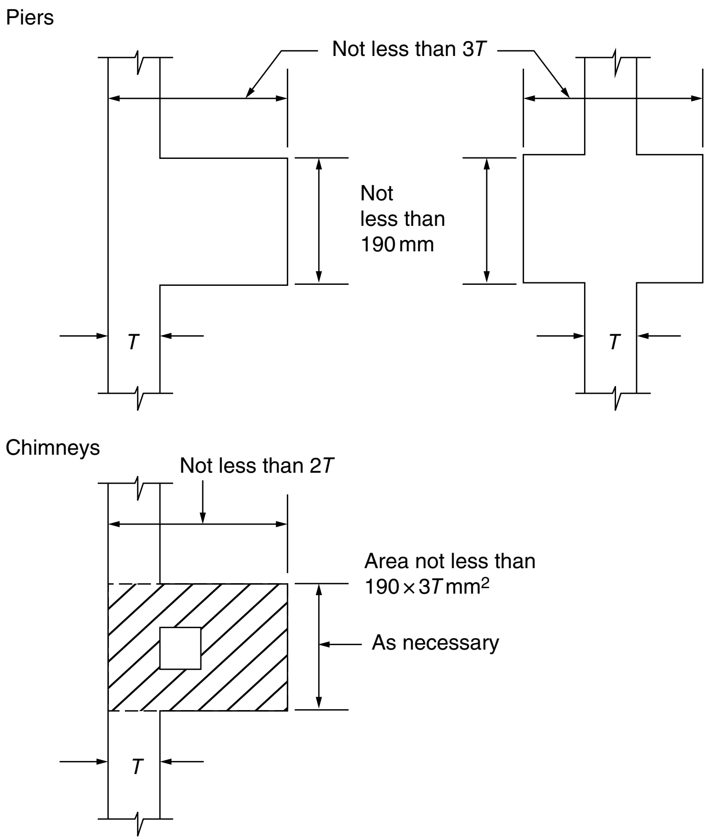


Fig. 6.7 Piers and chimneys.

the outside ground) or external (i.e. the soil under the building is at a lower level than the outside ground). In the latter case (e.g. on sloping sites), the ground level adjacent to the building on the higher side should be maintained for a distance of not less than $1.25 \times H$ (H is defined in Fig. 6.8).

The lateral thrust occasioned in these circumstances is the only one which a wall must be expected to sustain, apart from that due to direct wind load and the transmission of wind load.

VERTICAL LOADING. The total dead and imposed load transmitted by a wall at its base should not exceed 70 kN/m. All vertical loads carried by a wall should be properly distributed. This may be assumed for precast concrete floors, concrete floor slabs and timber floors complying with section 2B of AD Al/2. Distributed loading may also be assumed for lintels with a bearing length of 150 mm or more. Where the clear span of the lintel is 1200 mm or less, the bearing length may be reduced to 100 mm. These recommendations are summarised in Fig. 6.8.

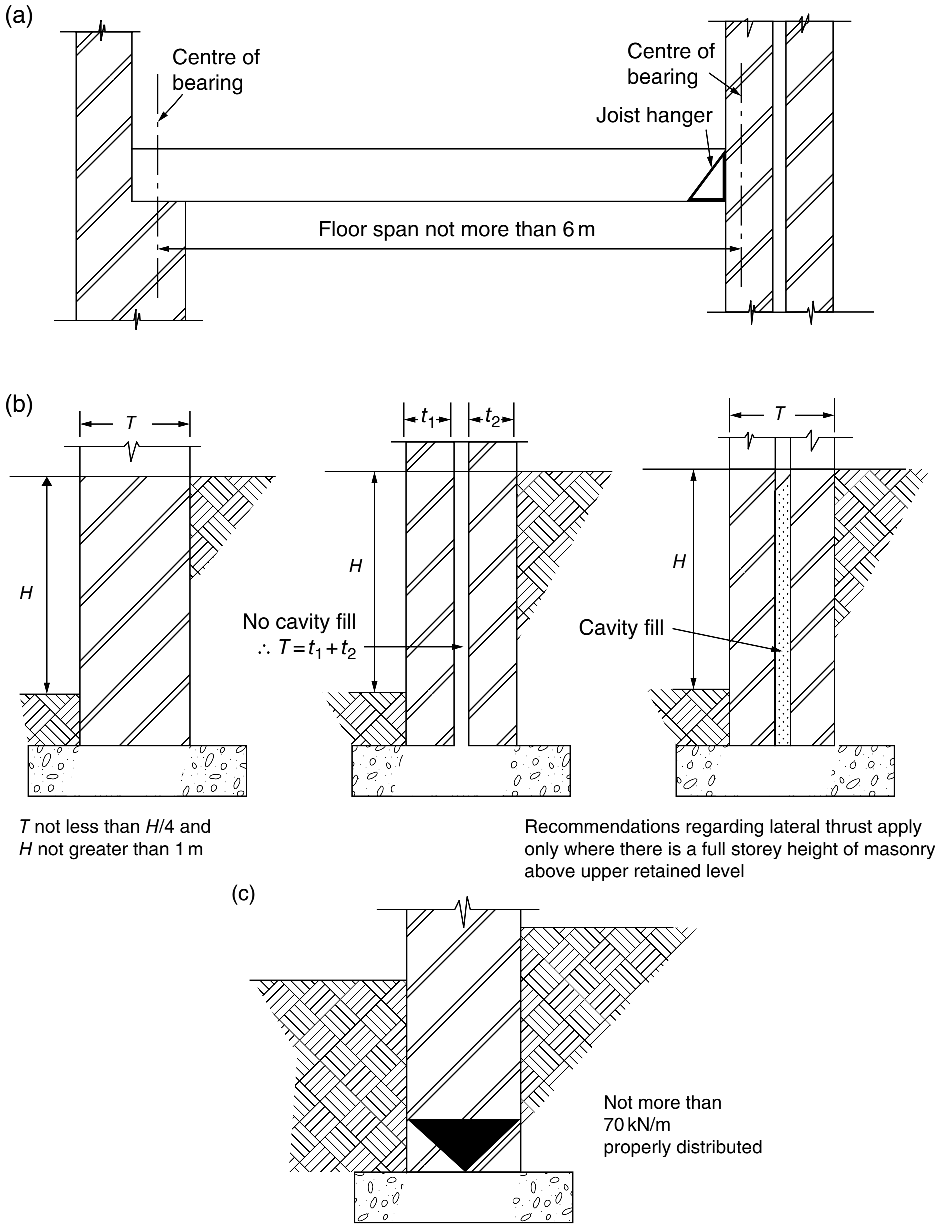


Fig. 6.8 Loading requirements: (a) floor span, (b) lateral thrust and (c) vertical loading.

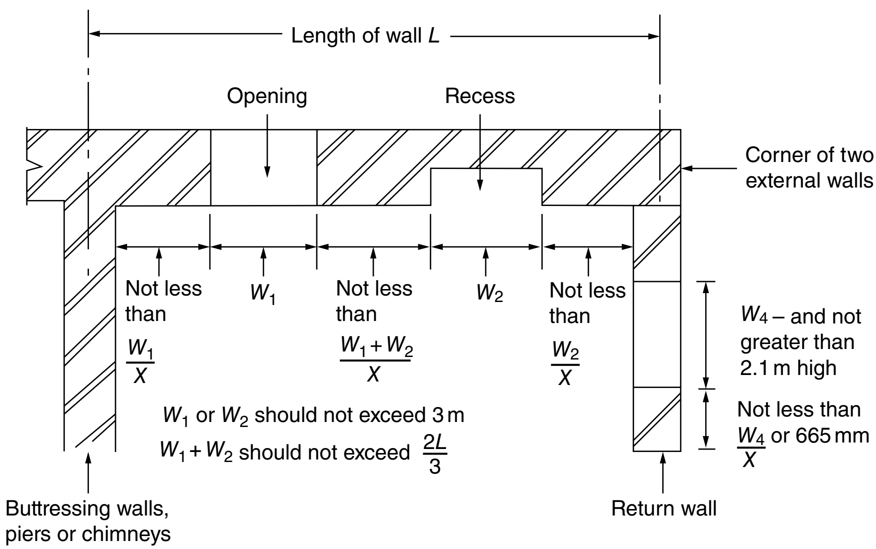
6.7.3 Openings and recesses

Openings or recesses in a wall should not be placed in such a manner as to impair the stability of any part of it or to adversely affect the lateral restraint offered to the wall by a buttressing wall. Adequate support for the superstructure should be provided over every opening and recess.

AD A1/2, section 2C

Table 8 value of factor 'X'

Nature of roof span	Maximum roof span [m]	Minimum thickness of wall inner leaf [mm]	Span of floor is parallel to wall	Span of timber floor into wall		Span of concrete floor into wall	
				max 4.5 m	max 6.0 m	max 4.5 m	max 6.0 m
			Value of factor 'X'				
Roof span parallel to wall	Not applicable	100	6	6	6	6	6
		90	6	6	6	6	5
Timber roof spans into wall	9	100	6	6	5	4	3
		90	6	4	4	3	3



Note: Value of X comes from Table 8 of section 2C of AD A1/2 which is reproduced above OR it may be given the value 6 provided that the compressive strength of the blocks or bricks (or cavity wall loaded leaf) is not less than 7 N/mm^2

Fig. 6.9 Openings and recesses.

As a general rule, any opening or recess in a wall should be flanked on each side by a length of wall equal to at least one sixth of the width of the opening or recess in order to provide the required stability. Accordingly, the minimum length of wall between two openings or recesses should not be less than one sixth of the *combined* width of the two openings or recesses.

However, where long span roofs or floors bear onto a wall containing openings or recesses, it may be necessary to increase the width of the flanking portions of wall. Table 8 of section 2C of AD A1/2 (see above) contains factors that enable this to be done.

Where several openings and/or recesses are formed in a wall, their total width should, at any level, be not more than two thirds of the length of the wall at that level

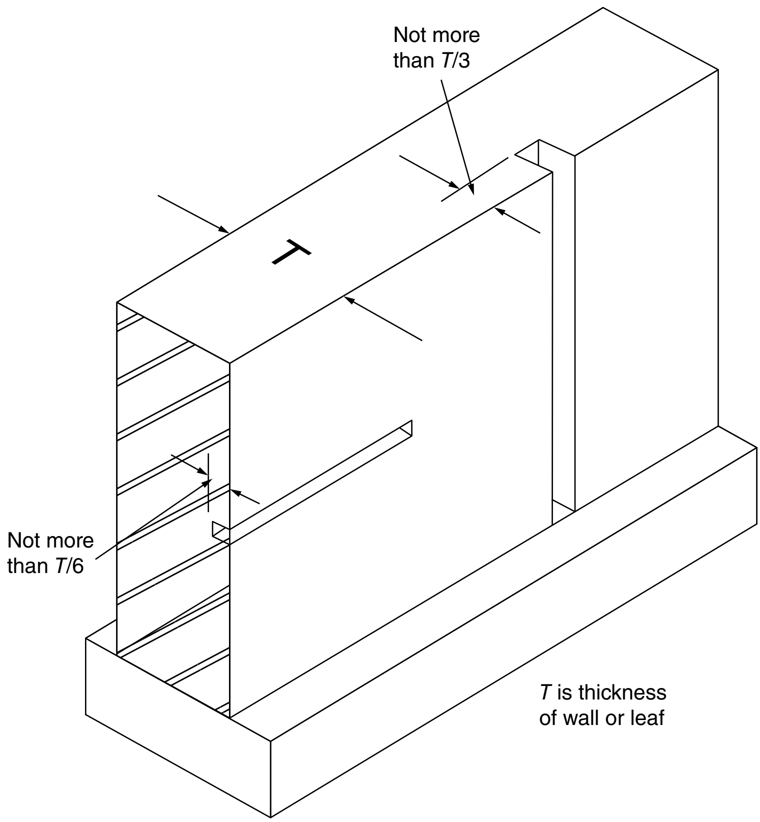


Fig. 6.10 Chases.

and should not in any case exceed 3 m in total. The only openings permitted in walls below ground floor level are small holes for services and ventilation. These should not exceed 0.1 m^2 in area and should be at least 2 m apart. These requirements are illustrated in Fig. 6.9.

6.7.4 Chases

The depth of vertical chases should not be more than one third the thickness of the wall or, in a cavity wall, one third the thickness of the leaf concerned. Depth of horizontal chases should be not more than one sixth the thickness of the wall or leaf. Chases should not be placed in such a manner as to impair the stability of the wall, particularly where hollow blocks are used (see Fig. 6.10).

6.7.5 Overhanging

Where a wall overhangs a supporting structure beneath it, the amount of the overhang should not be such as to impair the stability of the wall. No limits are specified, but this would generally be interpreted as allowing an overhang of one third the thickness of the wall (see Fig. 6.11).

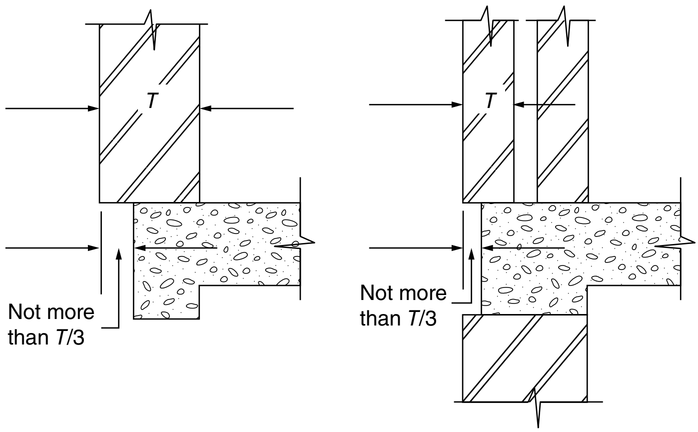


Fig. 6.11 Overhanging.

6.7.6 Lateral support

Floor or roof lateral support is horizontal support or stiffening, intended to stabilise or stiffen a wall by restraining its movement in a direction at right angles to the wall length. At least one wall in each storey of a building should extend to the full height of that storey, and this should be provided with restraint or support by connecting a floor or roof to the wall in such a way that the floor or roof acts as a stiffening frame or diaphragm transferring the lateral forces to walls, buttressing walls, piers or chimneys.

ROOF LATERAL SUPPORT. This should be provided for all external, compartment, separating and internal load-bearing walls irrespective of their length, at the point of junction between the roof and supported wall (i.e. at eaves level and along the verges).

Walls should be strapped to roofs at not exceeding 2 m centres using galvanised mild steel or other durable metal straps (referred to as tension straps conforming to BS EN 845 *Specification for ancillary components for masonry:* Part 1: 2001 *Ties, tension straps, hangers and brackets* in AD A1/2), with a minimum cross section of 30 mm × 5 mm and a minimum length of 1 m for eaves strapping. Durable metal straps are defined (for corrosion resistance purposes) as being of material reference 14 or 16.1 or 16.2 (galvanised steel) or other more resistant specifications including material references 1 or 3 (austenitic stainless steel) with a declared tensile strength of at least 8 kN.

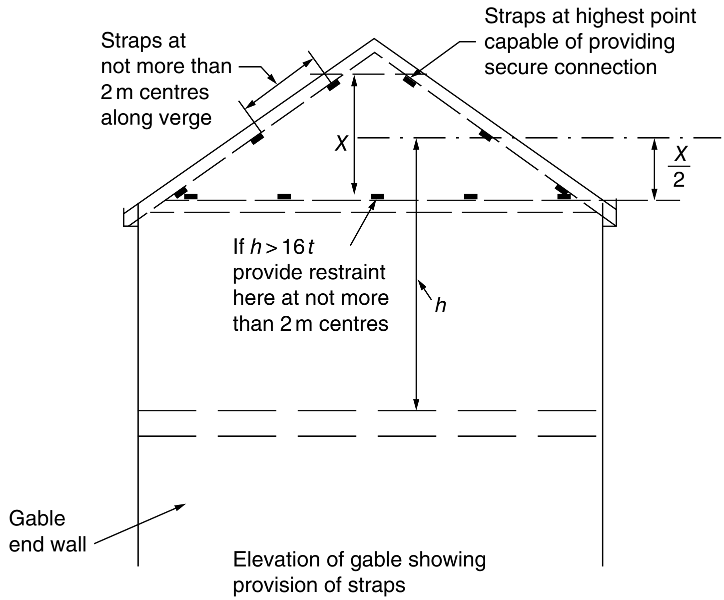
Eaves strapping need not be provided for a roof which:

- has a pitch of 15° or more;
- is tiled or slated;
- is of a type known by local experience as being resistant to damage by wind gusts; or
- has main timber members spanning onto the supported wall at intervals of not more than 1.2 m.

Figure 6.12 shows the methods of providing satisfactory lateral support at separating or gabled end wall positions.

FLOOR LATERAL SUPPORT. This should be provided for any external, compartment or separating wall which exceeds 3 m in length.

(a) Section through gable at roof level showing method of strapping



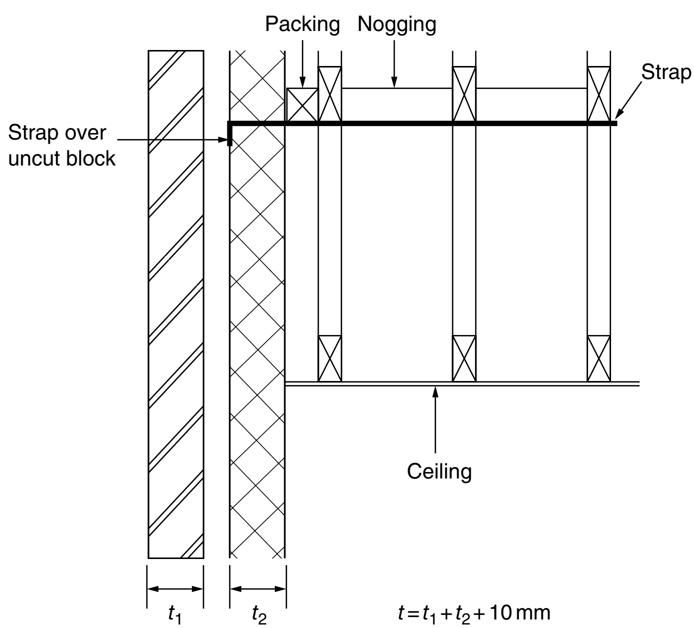
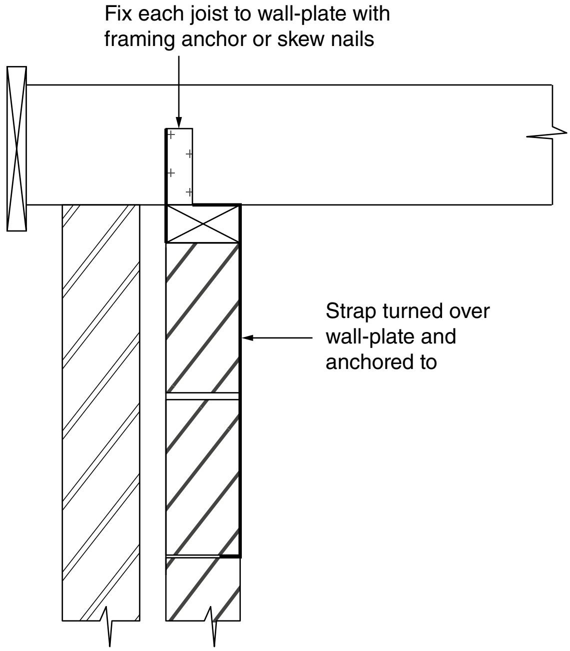
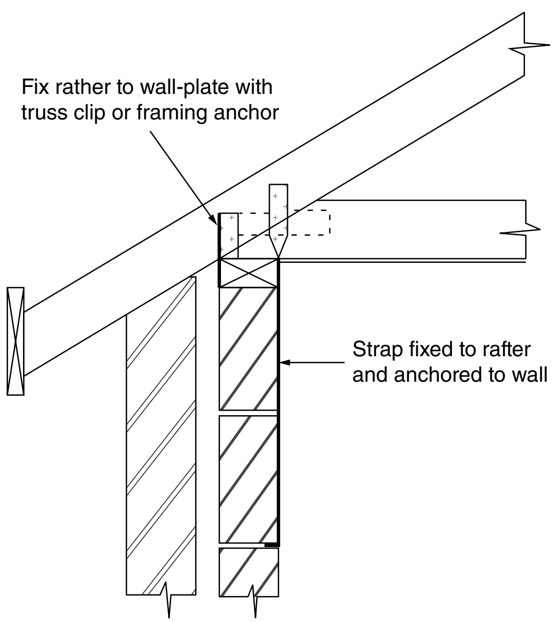


Fig. 6.12 Lateral support for roof.

(b) Section at eaves level showing method of strapping



Flat roof



Pitched roof

Fig. 6.12 (*Continued*)

It should also be provided for any internal load-bearing wall (which is not compartment or separating wall) at the top of each storey, irrespective of length.

Walls should be strapped to floors above ground level at not exceeding 2 m centres using galvanised mild steel or other durable metal straps, with a minimum cross section of 30 mm × 5 mm.

There are certain cases where, because of the nature of the floor construction, it is not necessary to provide restraint straps:

- Where a floor forms part of a house having not more than two storeys and:
  - (a) has timber members spanning so as to penetrate into the supported wall at intervals of not more than 1.2 m with at least 90 mm bearing directly on the walls or 75 mm bearing onto a timber wall plate; or
  - (b) the joists are carried on the supported wall by *restraint* type joist hangers to BS EN 845: Part 1: 2008, as described in BSI Published Document PD 6697:2010, at not more than 2 m centres.
- Where a concrete floor has a bearing onto the supported wall of at least 90 mm.

Where two floors are at or about the same level on either side of a supported wall, contact between floors and wall may be continuous or intermittent. If intermittent, the points of contact should be at or about the same positions on plan at intervals not exceeding 2 m. Figure 6.13 summarises these provisions.

6.7.7 Interruption of lateral support

It is clear that in certain circumstances it may be necessary to interrupt the continuity of lateral support for a wall. This occurs chiefly where a stairway or similar structure adjoins a supported wall and necessitates the formation of an opening in a floor or roof. This is permitted provided certain precautions are taken:

- The opening extends for a distance not exceeding 3 m measured parallel to the supported wall.
- If the connection between wall and floor or roof is provided by means of mild steel anchors, these should be spaced closer than 2 m on either side of the opening so as to result in the same number of anchors being used as if there were no opening.
- Other forms of connection (i.e. than mild steel anchors) should be provided throughout the length of each part of the wall on either side of the opening.
- There should be no other interruption of lateral support (see Fig. 6.14).

6.7.8 Thickness of walls

Provided the building design and wall construction requirements discussed above are satisfied, it is permissible to determine the thickness of a wall without calculation.

The minimum thicknesses required depend upon the wall height and length, and the rules applying to walls of bricks or blocks are set out in Table 3 of section 2C of AD A1/2 (see below) and illustrated in Fig. 6.15.

These thicknesses do not apply to parapet walls, for which there are special rules (see below) or to bays, and gables over bay windows above the level of the lowest window sill.

As a general rule, the thickness in any storey of a solid coursed brick or block wall should not be less than one sixteenth of the height of that storey. However, walls of uncoursed stone, flints, clunches of bricks or other burnt or vitrified material should have a thickness of at least 1⅓ times the thickness required of brick or block walls. Irrespective of the materials used in construction, no part of a wall should be thinner than any other part of the wall that it supports.

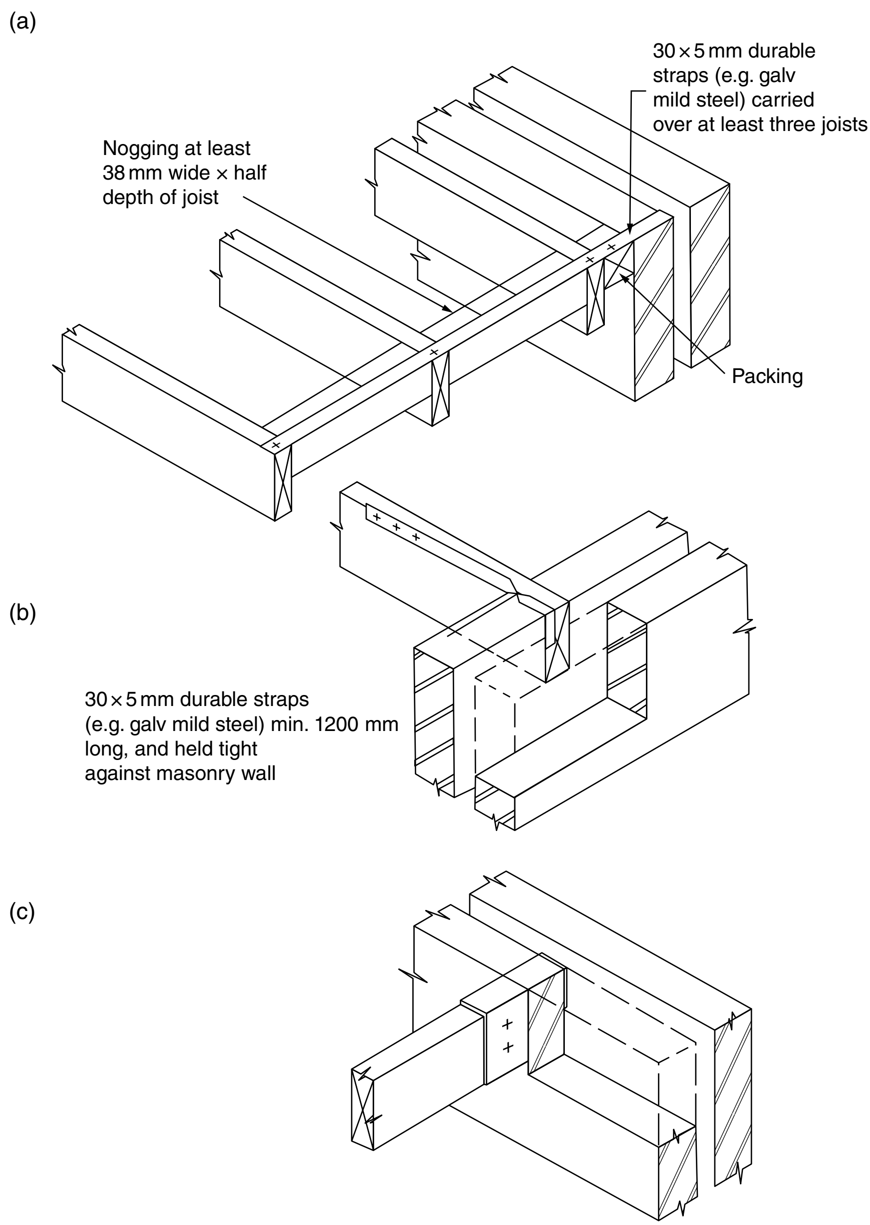
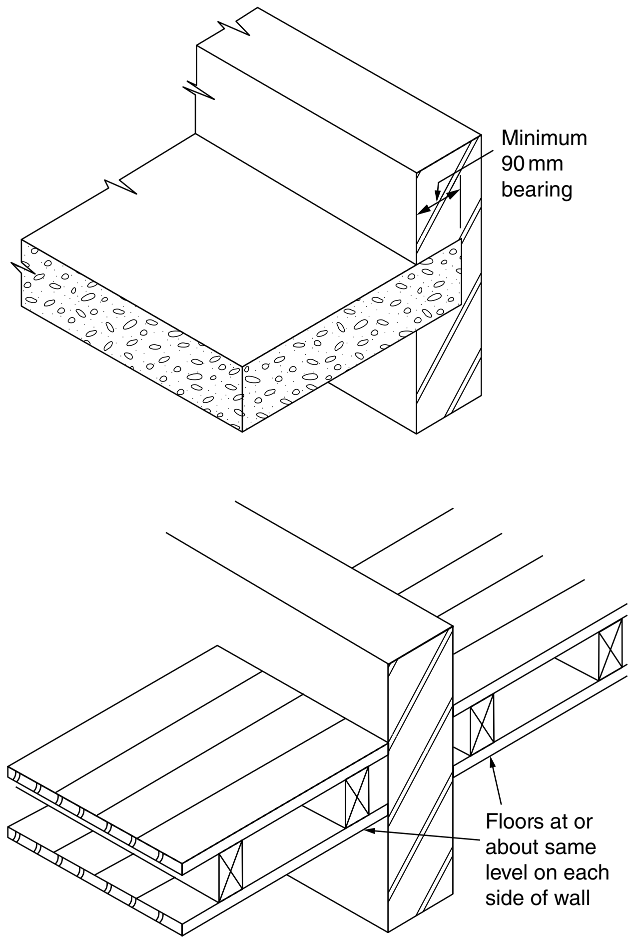


Fig. 6.13 Floor lateral support: (a) joists parallel to supported wall, (b) joists at right angles to supported wall, (c) restraint-type joist hanger, (d) concrete floor and (e) internal wall restraint.

(d)



(e)

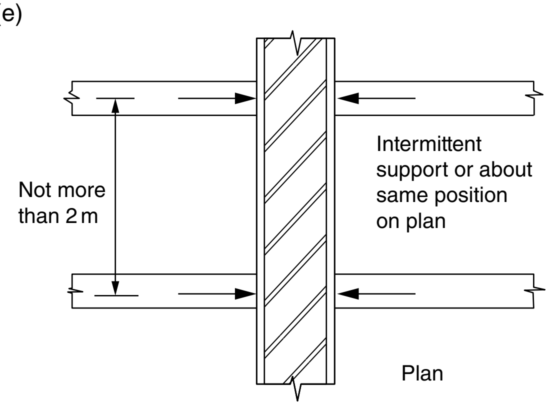


Fig. 6.13 (*Continued*)

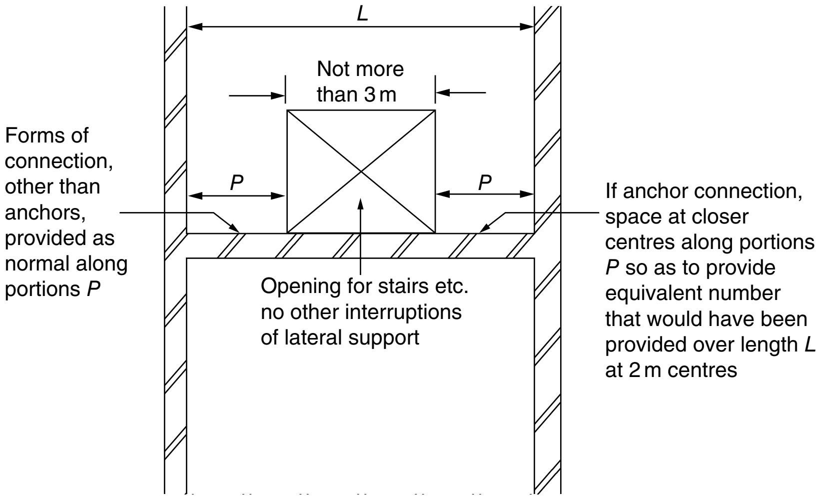


Fig. 6.14 Interruption of lateral support.

Table 3 Minimum thickness of certain external walls, compartment walls and separating walls.

Height of wall	Length of wall	Minimum thickness of wall
Not exceeding 3.5 m	Not exceeding 12 m	190 mm for whole of Its height
Exceeding 3.5 m but not exceeding 9 m	Not exceeding 9 m	190 mm for whole or Its height
	Exceeding 9 m but not exceeding 12 m	290 mm from the base for the height of one storey and 190 mm for the rest of its height
Exceeding 9 m but not exceeding 12 m	Not exceeding 9 m	290 mm from the base for the height of one storey and 190 mm for the rest of its height
	Exceeding 9 m but not exceeding 12 m	290 mm from the base for the height of two storeys and 190 mm for the rest of its height

6.7.9 Solid internal load-bearing walls which are not compartment or separating walls

For these walls, the wall thickness should be at least equal to half the thickness that would be required by Table 3, minus 5 mm, for an external wall, compartment wall or separating wall of the same height and length.

Where a wall forms the lowest storey of a three-storey building and it carries loading from both upper storeys, its thickness should not be less than the thickness calculated above or 140 mm, *whichever is greater.* Thus there is an absolute minimum thickness of 140 mm for such walls.

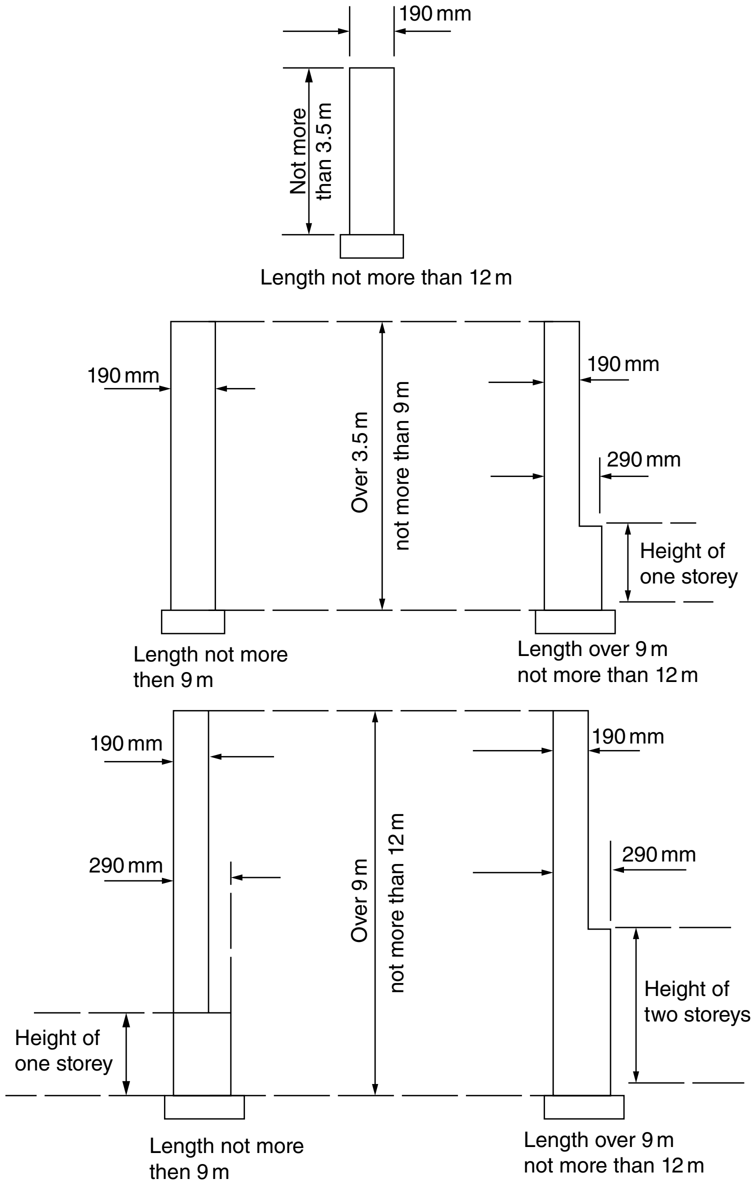


Fig. 6.15 Thickness of solid external, compartment and separating walls (see Table 3).

6.7.10 Cavity walls

Any external, compartment or separating wall which is built as a cavity wall should consist of two leaves, each leaf built of coursed bricks or blocks.

The leaves of these walls should be properly tied together with wall ties in compliance with Table 5 of section 2C of AD A1/2 (see section 6.6.7). Ties should be placed at centres 900 mm horizontally and 450 mm vertically (i.e. 2.5 ties/m^2), and at any opening, movement joint or roof verge, at least one tie should be provided for each 300 mm of height

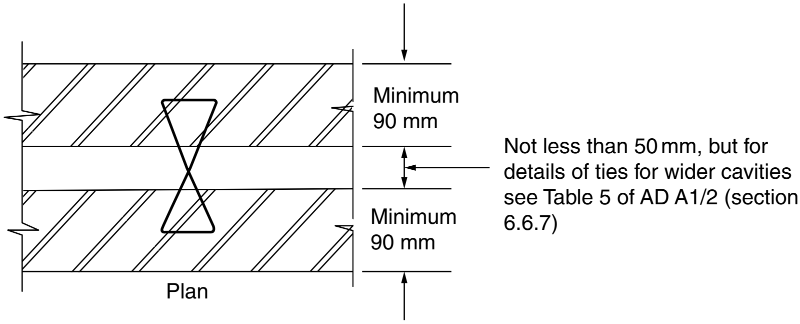


Fig. 6.16 Cavity walls.

within 225 mm of the opening. The cavity should be at least 50 mm wide, and each leaf should be at least 90 mm thick at any level.

The sum of the thicknesses of the two leaves, plus 10 mm, should not be less than the thickness required for a solid wall of the same height and length by Table 3 (see also Fig. 6.16).

6.7.11 Parapets

The minimum thicknesses for both solid and cavity parapet walls are related to their heights as is shown in Fig. 6.17.

6.7.12 External walls of small buildings and annexes

The external walls of small single-storey non-residential buildings and of annexes have to comply with special rules. The external walls of such buildings may be not less than 90 mm thick if:

- piers are provided at intervals and sizes as shown in Fig. 6.19, tied (using flat stainless steel min 20 mm × 30 mm in cross section, placed in pairs minimum 300 mm vertical centres) or bonded to walls if length of wall exceeds 2.5 m;
- the enclosed floor area does not exceed 36 m^2;
- the walls are solidly constructed of bricks and blocks using materials described in section 6.6.7;
- for buildings or annexes with floor areas greater than 10 m^2 the walls have a mass of at least 130 kg/m^2 (it should be noted that this surface mass limitation does not apply where the floor area is less than 10 m^2);
- roof access is for the purposes of maintenance and repair only;
- the only lateral loads are wind loads (e.g. the roof does not transmit a lateral load to the walls);
- the building or annexe has a maximum length or width which does not exceed 9 m;
- the height of the building or annexe does not exceed the lower value derived from Fig. 6.3(a) and (b) in section 6.6.6;

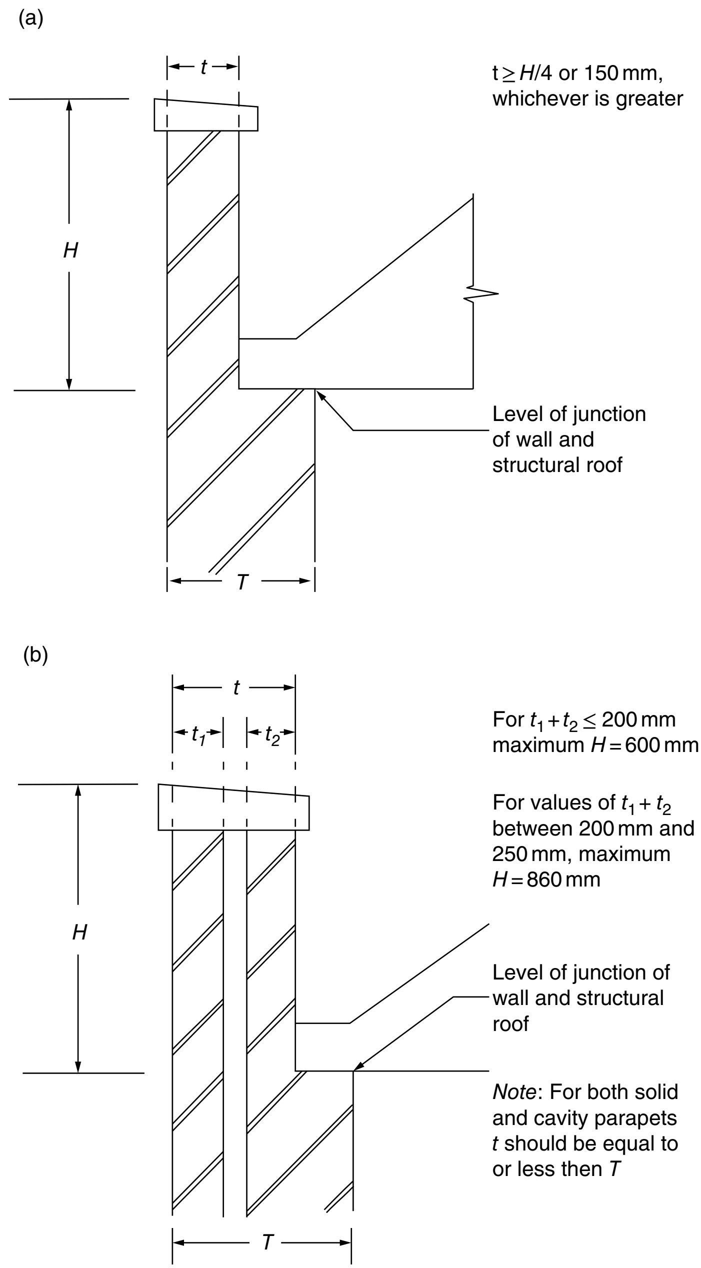


Fig. 6.17 Height of parapet walls: (a) solid parapet walls and (b) cavity parapet walls.

- Bracing is provided to the roof:
  - at rafter level,
  - horizontally at eaves level, and
  - at the base of any gable

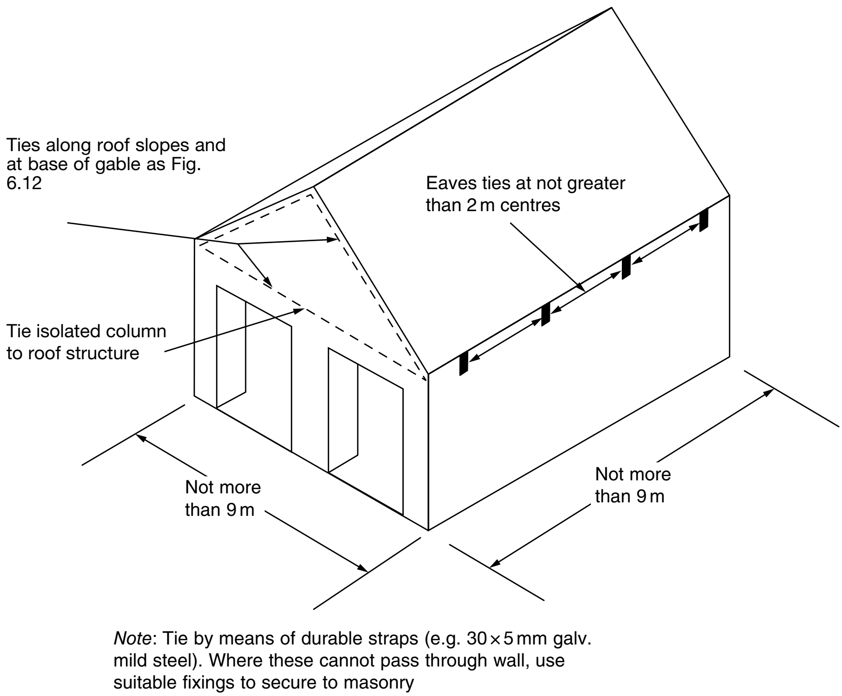


Fig. 6.18 Small buildings and annexes – lateral restraint at roof level.

by rigid sarking, timber roof decking or diagonal bracing, etc., in accordance with BS EN 1995-1-1:2004 with its UK National Annex and additional guidance given in BSI Published Document PD 6693-1:2012 or BS 8103:2009.

- the walls are tied to the roof structure vertically and horizontally in accordance with section 6.7.6;
- horizontal lateral restraint is provided at roof level as is shown in Fig. 6.18;
- for an annexe, the roof structure is fixed to the structure of the main building at both rafter and eaves level; and
- the size and location of any openings is restricted to those shown in Fig. 6.19.

6.7.13 Dimensions of chimneys

The wholly external part of a chimney, constructed of masonry and not supported by adequate ties or otherwise stabilised, will be deemed satisfactory if the width of the chimney, at the level of the highest point in the line of junction with the roof and at any higher level, is such that its height as measured from that level to the top of the external part of the chimney is not more than 4½ times that width. That height includes any pot or flue terminal on a chimney. Additionally, the masonry should have a density greater than 1500 kg/m^3.

The width of chimney at any level is taken as the smallest width which can be shown on an elevation of the chimney from any direction. This is illustrated in Fig. 6.20.

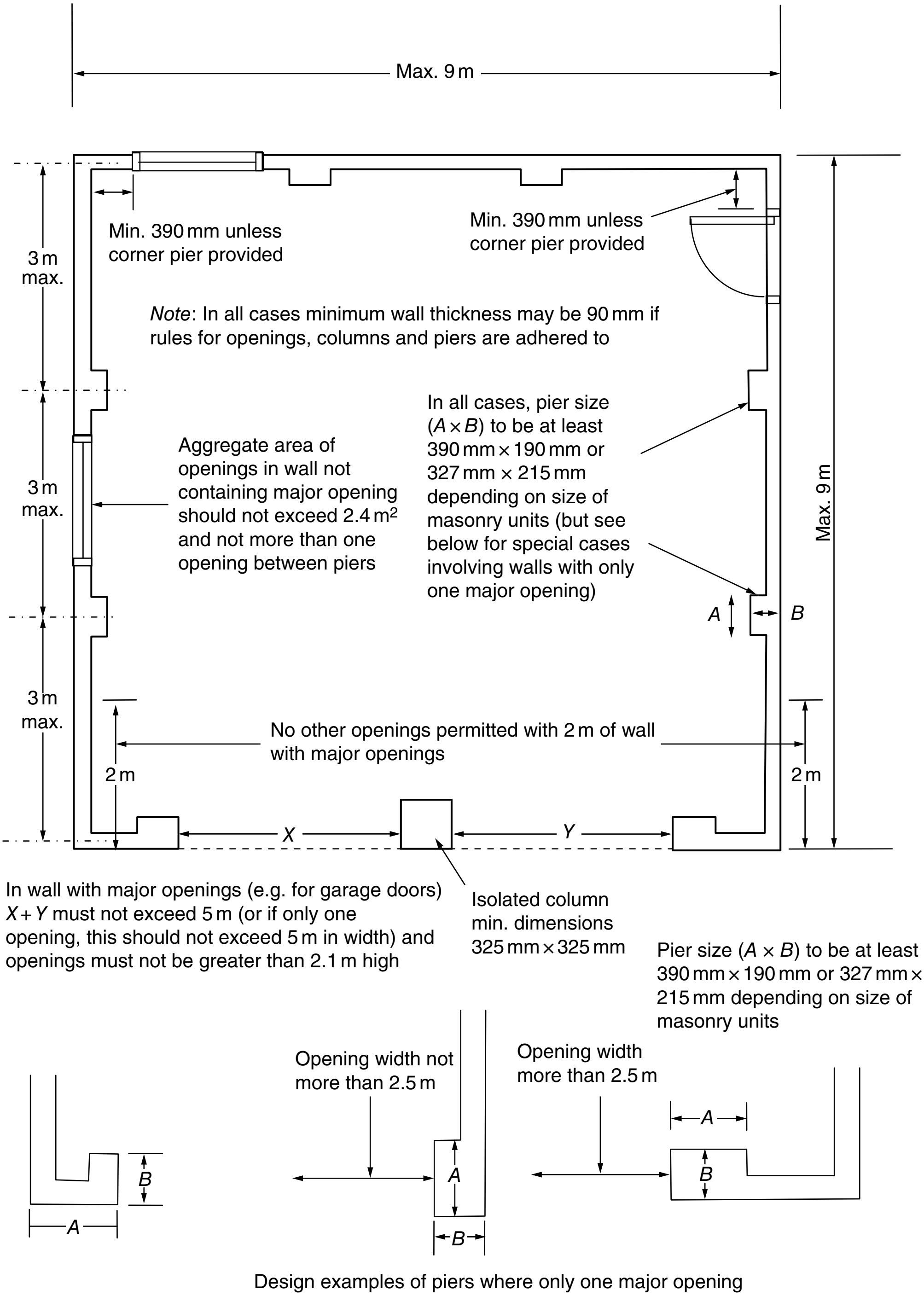


Fig. 6.19 Small buildings and annexes – design of openings, piers and columns.

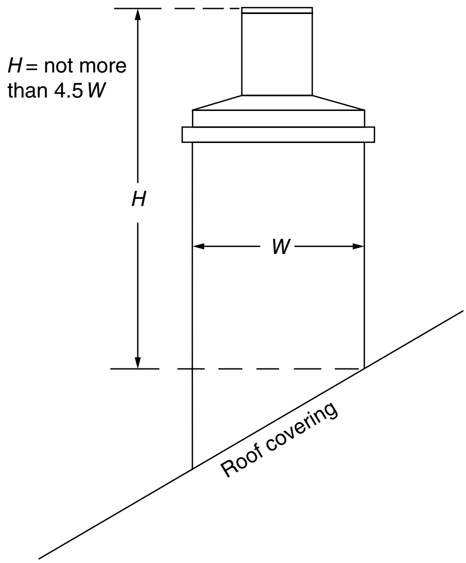


Fig. 6.20 External part of chimneys, 2D1.

6.7.14 Foundation recommendations

Section 2E of AD A1/2 provides rules for the construction of strip foundations and trench fill foundations of plain concrete. It should be remembered that section 2 applies to certain residential buildings of not more than three storeys, small single-storey non-residential buildings and annexes. Strictly speaking, the guidance given in section 2 of AD A1/2 should not be used for any other building types.

Strip foundations

Strip foundations of plain concrete placed centrally under the walls will be satisfactory if they comply with the following rules:

- There is no non-engineered fill (see BRE Digest 427) or wide soil strength variation in the loaded area or weak soil patches likely to cause instability in the supported structure.
- The width of foundation strip is in accordance with Table 10 to section 2E of AD A1/2 which is reproduced below.
- In chemically non-aggressive soils, the concrete should be composed of:
  - Portland cement to BS EN 197 *Cement:* Part 1: 2011 *Composition, specifications and conformity criteria for common elements* and Part 2: 2000 *Conformity evaluation*; and
  - coarse and fine aggregate to BS EN 12620:2002 *Aggregates for concrete* plus A1:2008.

- For foundations in chemically aggressive soils, the guidance in BS 8500 *Concrete – Complementary British Standard* to BS EN 206-1: Part 1 *Method of specifying and guidance for the specifier* should be followed.
- The concrete mix is:
  - in the proportion 50 kg of Portland cement: 0.1 m^3 (but not more than 200 kg) fine aggregate: 0.2 m^3 (but not more than 400 kg) coarse aggregate, i.e. 1:3:6 or better; *or*
  - Grade ST2 concrete or grade GEN 1 concrete to BS 8500: Part 2: 2006 *Specification for constituent materials and concrete.*
- The concrete strip thickness is equal to or greater than the projection from the wall face and never less than 150 mm.
- The upper level of a stepped foundation overlaps the lower level by twice the height of the step, by the thickness of the foundation or 300 mm, whichever is the greater.
- The height of a step is not greater than the thickness of the foundation.
- The foundation strip projects beyond the faces of any pier, buttress or chimney forming part of a wall by at least as much as it projects beyond the face of the wall proper.

Strip foundations should be laid to the following minimum depths:

- On rock – no minimum depth.
- On other soils except shrinkable clays – 450 mm to avoid the action of frost. However, in areas subject to long periods of frost or in order to transfer the loading onto satisfactory ground, this depth will commonly need to be increased.
- On clay soils subject to volume change on drying (commonly known as 'shrinkable clays', i.e. clays having a plasticity index greater than or equal to 10%) – a minimum of the following:
  - 750 mm for low shrinkage clay soils;
  - 900 mm on medium shrinkage clay soils; and
  - 1000 mm on high shrinkage clay soils.

  However, this depth will very often need to be increased in order to transfer the loading onto satisfactory ground. The actual depth decided upon will be based on an assessment of all site conditions including the influence of vegetation and trees in order that ground movements can be anticipated and will not impair the stability of any part of the building. Additionally

Table 10 to section 2E3 of AD A1/2 specifies seven subsoil types, and the minimum strip widths to use vary according to the calculated load per metre run of the wall at foundation level. The table is reproduced below.

Where a wall load exceeds 70 kN/m run, the foundation will be outside the scope of section 2E and must be properly designed on structural principles.

Table 10 Minimum width of strip footings.

Type of ground (including engineered fill)	Condition of ground	Field test applicable	Total load of load-bearing walling not more than (kN/linear metre)					
			20	**30**	**40**	**50**	**60**	**70**
			Minimum width of strip foundations (mm)					
I Rock	Not inferior to sandstone, limestone or firm chalk	Requires at least a pneumatic or other mechanically operated pick for excavation	In each case equal to the width of wall					
II Gravel or sand	Medium dense	Requires pick for excavation. Wooden peg 50 mm square in cross section hard to drive beyond 150 mm	250	300	400	500	600	650
III Clay Sandy clay	Stiff Stiff	Can be indented slightly by thumb	250	300	400	500	600	650
IV Clay Sandy clay	Firm Firm	Thumb makes impression easily	300	350	450	600	750	850
V Sand Silty sand Clayey sand	Loose Loose Loose	Can be excavated with a spade. Wooden peg 50 mm square in cross section can be easily driven	400	600	Note: Foundations on soil types V and VI do not fall within the provisions of this section if the total load exceeds 30 kN/m.			
VI Sit Clay Sandy clay Clay or silt	Soft Soft Soft Soft	Finger pushed in up to 10 mm	450	650				
VII Silt Clay Sandy clay Clay or silt	Very soft Very soft Very soft Very soft	Finger easily pushed in up to 25 mm	Refer to specialist advice					

Note:
The table is applicable only within the strict terms of criteria described within it.

Trench fill foundations

Trench fill foundations are permitted as an alternative to strip foundations. Where used, the overlap at a step should be the greater of twice the height of the step or 1 m.

These recommendations are illustrated in Fig. 6.21.

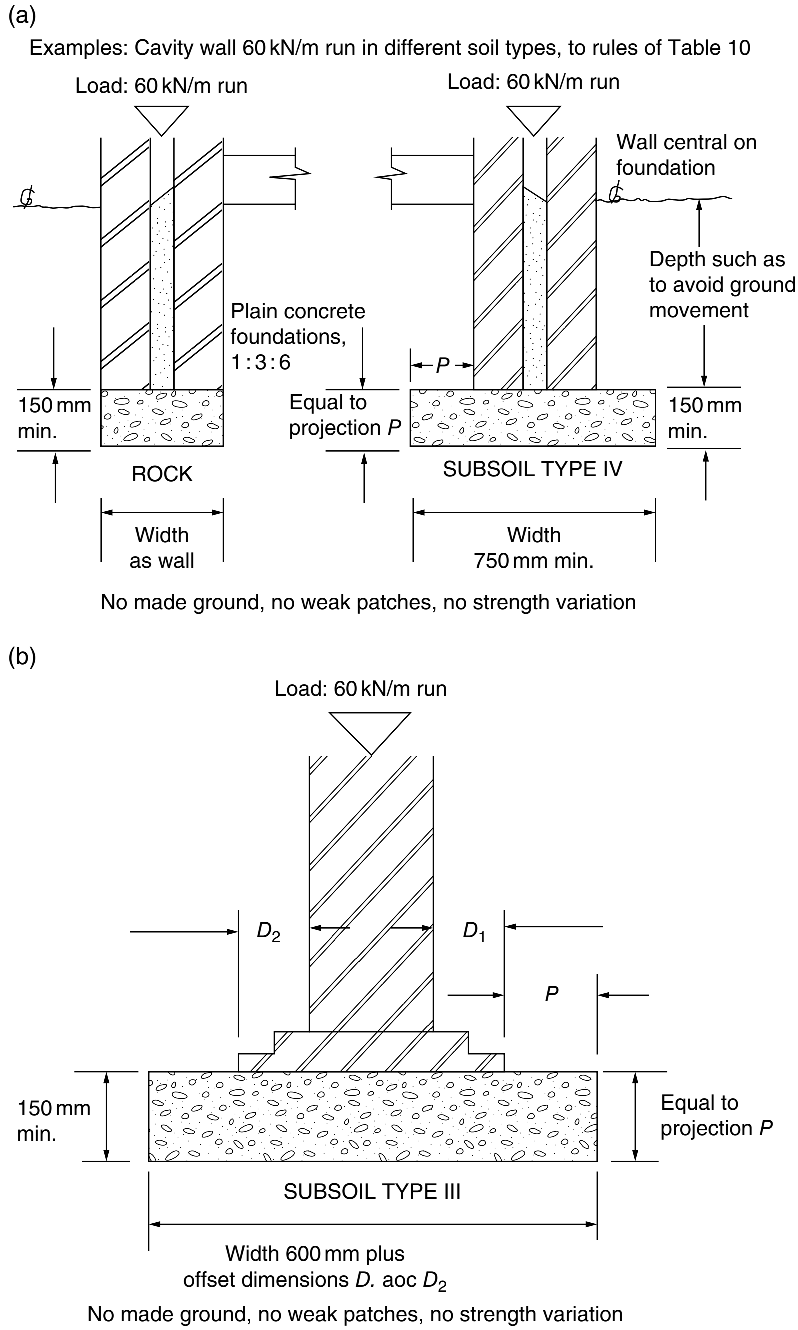


Fig. 6.21 Strip foundations of plain concrete: (a) plain strip foundation and (b) strip foundation with footing.

6.8 External wall cladding

6.8.1 Introduction

In recent years a number of accidents have occurred involving heavy concrete cladding panels. Failure of the fixings and deterioration of the concrete has resulted in parts and, in some cases, whole panels becoming detached with the resultant danger to people in the street below. There have also been instances of glazing failures endangering the public.

Guidance is provided in section 3 of AD A1/2 which relates to all forms of cladding including curtain walling and glass façades.

Weather resistance of wall cladding is not covered by the guidance in AD A1/2; Approved Document C (Site preparation and resistance to contaminants and moisture) should be consulted for this. Additionally, Approved Document B (Fire safety) should be consulted for guidance on resistance to fire spread, and Approved Document E (Resistance to the passage of sound) should be consulted in relation to sound insulation.

6.8.2 Performance

Wall cladding should be:

- capable of safely carrying and transmitting to the structure of the building the combined dead, imposed and wind loads;
- securely fixed to and supported by the structure of the building, the fixing comprising both vertical support and lateral restraint;
- capable of accommodating differential movement between the cladding and the building support structure; and
- manufactured of durable materials (including any fixings and associated support components which should also have an anticipated life at least equal to that of the cladding).

Any fixings should resist corrosion and should be of a material type appropriate for the local environment.

6.8.3 Loading

Apart from the dead load of the cladding itself, the following loads should also be taken into account:

- Wind loading – see BS EN 1991-1-4:2005 with its UK National Annex. Due consideration should be given to the funnelling effect of the wind through gaps between buildings since this can give rise to local increases in wind suction.
- An assessment of the imposed forces from maintenance equipment such as ladders or access cradles which should be based on the actual equipment likely to be used.
- Loading from fixtures such as handrails and fittings (e.g. antennae or signboards) supported by the cladding.

- Lateral loads where the cladding is required to act as pedestrian guarding to stairs, ramps and open wells or as a vehicle barrier. Refer to Approved Document K (Protection from falling, collision and impact) for loading requirements (see Chapter 15).
- Lateral pressures from crowds where the wall cladding is required to act as a barrier. Appropriate design loadings are given in BS EN 1991-1-1:2002 with its UK National Annex and in the publication entitled *Guide to safety at sports grounds* (4th edition, 1997) where the wall cladding is required to act as spectator barriers at sports stadia requiring a safety certificate.

6.8.4 Design and testing of fixings and anchors

The guidance given in section 3 of AD A1/2 regarding the design and testing of fixings and anchors is only of a very general nature. Certain principles are stated and reference is made to a large number of 'further guidance' documents. This reflects the specialist nature of the products, since most cladding systems are or have been the subject of a great deal of research and development involving extensive *in situ* testing before they are deemed safe to use.

When a fixing or anchor is selected for a particular cladding support application, it is necessary to consider not only the proven performance of the fixing but also the risks associated with the particular application. Thus the required reliability of the fixing or anchor will depend on whether the application is considered as being redundant (i.e. where failure or excessive movement of one fixing results in load sharing by adjacent fixings) or non-redundant (i.e. where failure of a single fixing could lead to detachment of the cladding). In this regard it is possible to obtain fixings and anchors with a European Technical Approval (ETA) gained in accordance with the requirements of ETAG 001:1997 *Guideline for European technical approvals of metal anchors for use in concrete* Parts 1–6 (covering both redundant and non-redundant applications). ETAG 001 Part 6 contains, in an annex, the UK definition of 'multiple use'. The way in which this definition is framed allows all applications to be validated as to whether or not they conform to this category without calculation. Copies of all ETAG parts may be downloaded in English from www.eota.be.

The strength of a fixing is a function of the fixing itself and the material into which it is fixed. Therefore, its strength should be derived from tests using materials which are representative of the true *in situ* condition. In this way, inherent weaknesses in the support structure, such as shrinkage or flexure cracks in concrete and voids in masonry, will be highlighted and may be taken into account in the final design of the fixing. Design loads can usually be obtained from manufacturer's test data either determined from a ETA (see definition in Chapter 8) or from a British Standard.

It should be noted that ETA are available which cover use in:

- cracked and non-cracked concrete (higher loads being allowed for non-cracked concrete); or
- non-cracked concrete only.

In determining whether a particular concrete section may be regarded as cracked or non-cracked, reference should be made to the publication *Use of anchors with European technical* *approvals. UK guidance – distinction between cracked and non-cracked concrete*. This allows the distinction to be made without reverting to stress calculations. The publication may be obtained from the BBA website www.bbacerts.co.uk by clicking the 'ETA' tab.

6.8.5 Wall claddings – further guidance

Large glass panels – Special consideration needs to be given to the use of large panels of glass in the cladding of walls and roofs (i.e. where the cladding is not divided into small areas by load-bearing framing). Guidance is given in the following:

- *Structural use of glass in buildings* (1999 edition), published by the Institution of Structural Engineers, available from 11 Upper Belgrave Street, London SW1X 8BH; and
- *Nickel sulfide in toughened glass* (2000 edition), published by the Centre for Window and Cladding Technology.

Cladding – Further guidance on cladding is given in the following:

- *Aspects of cladding* (1995 edition), published by the Institution of Structural Engineers;
- *Guide to the structural use of adhesives* (1999 edition), published by the Institution of Structural Engineers;
- BS 8297:2000 *Code of practice for the design and installation of non-loadbearing precast concrete cladding*; and
- BS 8298:2010 *Code of practice for the design and installation of natural stone cladding and lining*.

Fixings – Additional guidance on fixings is given in the following:

- ETAG No. 001:1997 *Guideline for European technical approvals of metal anchors for use in concrete*, European Organisation for Technical Approvals (EOTA) (see section 6.8.4 for further details). An English version of this document may be downloaded from www.eota.be. ETAG 001 contains the following parts:
  - Part 1 Anchors in general
  - Part 2 Torque controlled anchors
  - Part 3 Undercut anchors
  - Part 4 Deformation controlled anchors
  - Part 5 Bonded anchors
  - Part 6 Metal anchors for redundant use in concrete for lightweight systems.

  It should be noted that all EOTA parts may be downloaded in English from www.eota.be.
- BS 5080 *Structural fixings in concrete and masonry:* Part 1: 1993 *Method of test for tensile loading*. This standard describes a method for testing fixings, such as expanding anchors installed in solid materials either on-site or for comparative purposes in a standard material.
- CIRIA Report RP 566 *Cladding fixings: Good practice guidance*, available from Griffin Court, 15 Long Lane, London EC1A 9PN.

- CIRIA Reports C579 and C589 *Retention of masonry facades – Best practice guide*, available from Griffin Court, 15 Long Lane, London EC1A 9PN.
- The following guidance notes are published by the Construction Fixings Association, 3 Glebe Close, Long Clawson, Melton Mowbray, LE14 4NY:
  - *Procedure for site testing construction fixings* (2012)
  - *European technical approvals for construction fixings* (2012)
  - *Anchor selection* (1995)
  - *Fixings and fire* (1998)
  - *Anchor installation* (1996)
  - *Resin bonded anchors* (2000)
  - *Heavy duty expansion anchors* (1997)
  - *Fixings for brickwork and blockwork* (1997)
  - *Undercut anchors* (2002)
  - *Fixings and corrosion* (2002).

They may all be downloaded free from the Association's website at www.fixingscfa.co.uk.

6.9 Replacement of roof coverings

6.9.1 Introduction

It is possible that the reroofing of a building may result in the existing roof structure having to carry substantially more or less load than it did before the works were carried out. This may be due to the inclusion of underdrawing, additional insulation or lighter or heavier roof covering materials (such as the replacement of slate with plain tiles). Section 4 of AD A1/2 indicates that, where the work involves a significant change in the applied loading, the replacement works (including any necessary strengthening of the existing support structure) would constitute a material alteration under the provisions of regulation 3(2). A significant change is defined as 'when the loading upon the roof is increased by more than 15%'. This is curious since it would appear that where there is a substantial decrease in roof loading, then the work would not be regarded as a material alteration and the requirements of the regulations would not apply to it, even though AD A1/2 recommends that the roof structure and its anchorage to the supporting structure should be checked to ensure that an adequate factor of safety is maintained against roof uplift under imposed wind loading. In any event, all the materials used to cover a roof must be capable of safely withstanding the concentrated imposed loads that are placed on the roof as specified in BS EN 1991-1-1:2002 with its UK National Annex. It should be noted that this requirement does not apply to transparent or translucent materials which are not accessible except for normal maintenance and repair, if they are non-fragile or otherwise suitably protected against collapse. Also excluded from the requirement are windows of glass in residential buildings where the roof pitch is greater than or equal to 15°.

6.9.2 Checking the roof structure

As is indicated in section 6.9.1, a significant change in the applied loading may constitute a material alteration under the regulations. This will mean that the roof structure and its supporting structure will need to be checked to ensure that the completed work will be no less compliant with requirement A1 than the original roof was before the work was carried out. If such a check reveals that the existing construction is unable to sustain the new loading without the need for strengthening of the roof structure (or replacement of some roof members, etc.), then this will constitute a material alteration, and an application under the regulations will have to be made. It is possible that a check on the roof structure may reveal that some existing roof members are carrying greater loads than they were before (with resultant increase in stresses). This does not necessarily mean that the roof structure is less compliant than it was originally if it can be shown that an adequate factor of safety is still being maintained.

AD A1/2 no longer contains guidance on how the existing roof structure may be assessed to see if it is capable of coping with the changed loading conditions. Past editions of AD A did contain such guidance, and this is repeated below since it gives an indication of the assessment stages involved in the checking procedure.

There are three stages to the assessment procedure:

Stage 1 Compare the proposed and original roof loadings.

This should include an allowance for the increase in loading due to water absorption which may be only 0.3% for oven dry slates but up to 10.5% for plain clay or concrete tiles. These figures are based on the dry mass per unit area of roof coverings.

Stage 2 Carry out a structural inspection on the original roof.
The roof structure must be checked to see if:

- it is capable of sustaining the increased load; *or*
- it contains sufficient vertical restraints to cope with the wind uplift forces as a result of the lighter roof covering or addition of underlay.

Stage 3 Carry out appropriate strengthening measures. These may include:

- replacement of defective parts of the roof, such as structural members, nails or other fixings and vertical restraints;
- provision of additional structural members as necessary to take the increased loads, such as rafters, purlins, binders or trusses, etc.;
- provision of additional restraint straps, ties or fixings to walls as necessary to resist wind uplift forces.

6.10 Disproportionate collapse

6.10.1 Introduction

In May 1968 a gas explosion on the 18th floor of a block of flats in London, known as Ronan Point, caused a large portion of the corner of the block to collapse. Following on from the subsequent tribunal and public enquiry into the disaster, new Building Regulations were formulated and introduced in 1970 with the express purpose of preventing further similar occurrences of this kind where the extent of the collapse is disproportionate to its cause.

These regulations have been updated and revised in line with current experience and knowledge, the main requirement being stated in paragraph A3 of Schedule 1 to the 2010 Regulations.

Buildings are required to be constructed so that in the event of an accident, they will not suffer collapse to an extent disproportionate to the cause of that collapse.

Approved Document A3 contains guidance on measures designed to reduce the sensitivity of a building to disproportionate collapse in the event of an accident.

The approach now adopted in section 5 of AD A is to divide buildings into three consequence classes categorised by building type and occupancy, as defined in Table 11 (reproduced below). A building falling within a particular class can then be assessed as shown in sections 6.10.3 to 6.10.7 to determine whether it is sufficiently robust to sustain damage or failure to a limited extent, without collapse.

6.10.2 Definitions

The following definitions apply in section 5 of AD A:

NOMINAL LENGTH OF LOAD-BEARING WALL – This should be taken as follows, where *H* is the storey height in metres:

- reinforced concrete wall – the distance between lateral supports but with a maximum length of 2.25*H*;
- external masonry wall, timber stud wall, steel stud wall – the length measured between vertical lateral supports;
- internal masonry wall, internal timber stud wall, internal steel stud wall – a maximum length of 2.25*H*.

It should be noted that Annex A of BS EN 1991-1-7:2006 with its UK National Annex gives corresponding guidance.

KEY ELEMENTS – These should be capable of sustaining an accidental design loading of 34 kN/m^2. It is assumed that this loading will be applied to the member and any attached components (e.g. cladding) in the horizontal and vertical directions taking one direction at a time. Regard must be paid to the ultimate strength of such components and their connections. Such accidental design loading is assumed to act simultaneously with all other design loadings (such as wind and imposed loading) in accidental loading combination. BS EN 1990:2002+A1:2005 with its UK National Annex provides guidance on accidental design loading and accidental action loading combination for 'key elements', and expressions 6.11a and 6.11b of that Standard are relevant. It should be noted that Annex A of BS EN 1991-1-7:2006 with its UK national Annex provides corresponding guidance for 'key elements'.

LOAD-BEARING WALL CONSTRUCTION – This term includes walls consisting of close centred timber or lightweight steel section studs and masonry cross-wall construction.

6.10.3 Consequence Class 1 buildings

For buildings that have been designed and constructed in accordance with the guidance rules for meeting compliance with requirements A1 and A2 in normal use given in this chapter (including the other guidance referred to in sections 6.4 and 6.5), additional measures are unlikely to be necessary.

6.10.4 Consequence Class 2A buildings

In addition to the Consequence Class 1 measures, provide effective horizontal ties, or effective anchorage of suspended floors to walls, as described in the following codes and standards for framed and load-bearing wall construction (see definition in section 6.10.2):

- BS EN 1990:2002+A1:2005 Eurocode: Basis of structural design, with UK National Annex to BS EN 1990:2002+A1:2005;
- BS EN 1991-1-7:2006 Eurocode 1: Actions on structures – Part 1.7: General actions – Accidental actions, with UK National Annex to BS EN 1991-1-7:2006;
- BS EN 1992-1-1:2004 Eurocode 2: Design if concrete structures – Part 1.1: General rules and rules for buildings, with UK National Annex to BS EN 1992-1-1:2004 and BSI PD 6687-1:2010;
- BS EN 1993-1-1:2005 Eurocode 3: Design of steel structures – Part 1.1: General rules and rules for buildings, with UK National Annex to BS EN 1993-1-1:2005;
- BS EN 1994-1-1:2004 Eurocode 4: Design of composite steel and concrete structures – Part 1.1: General rules and rules for buildings, with UK National Annex to BS EN 1994-1-1:2004;
- BS EN 1995-1-1:2004+A1:2008 Eurocode 5: Design of timber structures – Part 1.1: General – Common rules and rules for buildings, with UK National Annex to BS EN 1995-1-1:2004+A1:2008 and BSI PD 6693-1:2012;
- BS EN 1996-1-1:2005+A1:2012 Eurocode 6: Design of masonry structures – Part 1.1: General rules for reinforced and unreinforced masonry structures, with UK National Annex to BS EN 1996-1-1:2005+A1:2012 and BSI PD 6697:2010; and
- BS EN 1999-1-1:2007+A1:2009 Eurocode 9: Design of aluminium structures – Part 1.1: General structural rules, with UK National Annex to BS EN 1999-1-1:2007+A1:2009 and BSI PD 6702-1:2009.

It should be noted that in addition to details of effective horizontal and vertical ties, these codes and standards also contain details of the design approaches that can be adopted for checking the integrity of a building following the notional removal of vertical members and the design of key elements as described in sections 6.10.5 and 6.10.6.

6.10.5 Class 2B buildings

In addition to the Consequence Class 1 measures, for framed and load-bearing wall construction, provide effective horizontal ties as described in the codes and standards listed in section 6.10.4, together with one of the following alternatives:

- effective vertical ties, as defined in the same codes and standards, in all supporting columns and walls; or

- check that upon the notional removal of the following structural elements (i.e. one element at a time in each storey of the building):
  (a) each supporting column and each beam supporting one or more columns, or
  (b) any nominal length of load-bearing wall (see definition in section 6.10.2),
  the building remains stable and that the area of floor at any storey at risk of collapse does not exceed 15% of the floor area of that storey or 100 m^2, whichever is smaller, and does not extend further than the immediate adjacent storeys.
  If the area and storeys put at risk cannot be limited as described above when a structural element is notionally removed, then the structural element should be designed as a 'key element' (see definition in section 6.10.2).

6.10.6 Class 3 buildings

For class 3 buildings it will be necessary to undertake a systematic risk assessment of the building. This should take into account all the normal hazards that may reasonably be foreseen, together with any abnormal hazards.

This will entail selecting critical situations for design that reflect the conditions that can reasonably be foreseen as possible during the life of the building. After this the structural form and concept of the building can be chosen, including any protective measures. The detailed design of the structure and its elements can then be undertaken in accordance with the recommendations given in the codes and standards listed in section 6.10.4.

Further guidance may be found in Annexes A and B to BS EN 1991-1-7:2006 Eurocode 1: Actions on structures – Part 1.7: General actions – Accidental actions, with UK National Annex to BS EN 1991-1-7:2006 and BS EN 1990:2002+A1:2005 Eurocode: Basis of structural design, with the UK National Annex to BS EN 1990:2002+A1:2005.

6.10.7 Alternative approach for other buildings

Clearly, not all building types will fall into the classes listed under Table 11, or there may be some buildings for which the consequences of collapse may warrant particular examination of the risks involved. In these cases the performance may be met by the recommendations given in the following reports:

- 'Guidance on Robustness and Provision against Accidental Actions' dated July 1999; and
- 'Proposed Revised Guidance on meeting Compliance with the Requirements of Building Regulation Part A3'. Revision of the Allott and Lomax proposals. Project Report No. 205966.

Both of the above documents are available on the www.planningportal.gov.uk:

- 'Practical Guide to Structural Robustness and Disproportionate Collapse in Buildings', published by the Institution of Structural Engineers, October 2010.

6.10.8 Seismic design

Buildings in Consequence Classes 1, 2a and 2b of Table 11 are not usually required to be subject to seismic design considerations. For Consequence Class 3 buildings, it is recommended that a risk assessment be carried out to consider if there is any need to carry out seismic design; however it is not an explicit requirement for these buildings.

Table 11 Building consequence classes.

Consequence Classes	Building type and occupancy
1	Houses not exceeding 4 storeys Agricultural buildings Buildings into which people rarely go, provided no part of the building is closer to another building, or area where people do go, than a distance of 1.5 times the building height
2a Lower Risk Group	5 storey single occupancy houses Hotels not exceeding 4 storeys Flats, apartments and other residential buildings not exceeding 4 storeys Offices not exceeding 4 storeys Industrial buildings not exceeding 3. storeys Retailing premises not exceeding 3 storeys of less than 2000 m^2 floor area in each storey Single-storey educational buildings All buildings not exceeding 2 storeys to which members of the public are admitted aid which contain floor areas not exceeding 2000 m^2 at each storey
2b Upper Risk Group	Hotels, blocks of flats, apartments and other residential buildings greater than 4 storeys but not exceeding 15 storeys Educational buildings greater than 1 storey but not exceeding 15 storeys Retailing premises greater than 3 storeys but not exceeding 15 storeys Hospitals not exceeding 3 storeys Offices greater than 4 storeys but not exceeding 15 storeys All buildings to which members of the public are admitted which contain floor areas exceeding 2000 m^2 but less than 5000 m^2 at each storey Car parking not exceeding 6 storeys
3	All buildings defined above as Consequence Class 2a and 2b that exceed the limits on area and/or number of storeys Grandstands accommodating more than 5000 spectators Buildings containing hazardous substances and/or processes

Notes:

1. For buildings Intended for more than one type of the Consequence Class should be that pertaining to the most onerous type.
2. In determining the number of storeys in a building, basement storeys may be excluded provided such basement storeys fulfill the robustness requirements of Consequence Class 2b buildings.
3. BS EN 1991-1-7:2006 with its UK National Annex also provides guidance that is comparable to Table 11.

7 Part 7 – Fire (Part B)

7.1 Introduction

Part B of the Schedule 1 to the Building Regulations 2010 states that the building shall be designed and constructed so that the following provisions are secured:

- Early warning of fire;
- Appropriate means of escape in case of fire from the building to a place of safety; which should be available at all material times;
- To limit the spread of fire within and between buildings; and
- Reasonable access and facilities for the fire service.

Building Regulation 10 states that Schedule 1 standards will not require anything to be done except for the purpose of securing reasonable standards of health and safety of persons in or about buildings (and any others who may be affected by buildings or matters connected with buildings). Therefore, the building regulations are only concerned with life safety.

Three standards are commonly adopted to aid the designer when designing to provide fire safety measures:

1.	Approved Document B – *Fire safety – Volume 1 Dwellinghouses* (2006 edition incorporating 2010 and 2013 amendments) (only applicable in England) (2011), DCLG	Most commonly used by designers for relatively simple buildings
	Approved Document B – *Fire safety – Volume 2 Buildings other than dwellinghouses* (2006 edition incorporating 2007, 2010 and 2013 amendments) (**only applicable in England**) (2010), DCLG	Note that the Welsh Government has developed their own versions of the approved documents as legislation to incorporate increased use of sprinklers in certain buildings continues to develop (see below for more information)
	Approved Document B – *Fire safety – Volume 1 Dwellinghouses* (2006 edition incorporating 2010 amendments) (**For use in Wales**) (2010), DCLG	
	Approved Document B – *Fire safety – Volume 2 – Buildings other than dwellinghouses* (2006 edition incorporating 2010 and 2013 amendments) (2013), **Welsh Government**	

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

2.	*BS 9999:2008* *Code of practice for fire safety in the design, management and use of buildings* *BS 9991:2011* *Code of practice for fire safety in the design, management and use of residential buildings*	Risk-based design guidance for simple to complex buildings
3.	*BS 7974:2001* *Application fire safety engineering principles to the design of buildings – code of practice*	A series of eight published documents that set the standards in support of fire engineers working on complex buildings

This chapter will concentrate on the government's Approved Document B volumes. Where applicable, parallels will be drawn to the British Standards to illustrate the different approaches to design that exist.

This chapter follows a logical sequence that will aid the Designer's ability to meet the requirements of Part B to Schedule 1 of the Building Regulations when using the Approved Documents as the basis for compliance.

The Building Regulations do not aim to secure property protection. This remains the province of insurers who may require additional measures that provide higher standards of protection before accepting the insured risk. Further guidance is provided by the RISCAuthority's version of *Approved Document B: Fire safety (volume 2): Buildings other than dwellinghouses: Incorporating insurers requirements for property protection*, published by the RIBA (2008). The Loss Prevention Council also publishes a series of documents that stipulate the requirements for the performance criteria which apply to building elements and also requirements for certification. For the protection of assets in the Civil and Defence Estates, reference may be made to the *Crown fire standards* published by the Property Advisers to the Civil Estate. More detailed research of this series of documents may be undertaken by reference to Crown Fire Standards Part 0: 1997, which provides reference to their various standards. Property protection standards will not be discussed further in this chapter.

Within the introduction to both volumes of Approved Document B, attention is drawn to the need for both designers and building control professionals to consider the proposed complete fire safety system. This approach supports the 'functional' ethos of the building regulations guiding professionals to follow a disciplined analytical framework. The basis for this framework follows general fire engineering principles. When considering a scheme design and its acceptability, certain factors should be taken into account. These include:

- the likelihood of a fire occurring;
- the anticipated severity of the fire;
- the ability of the building to resist the spread of fire and smoke; and
- the consequential danger to people.

Such a risk-based assessment can help when the proposal involves building work within the historical environment. A number of fire safety measures are suggested in the Approved Documents which may be incorporated into the design. These measures include:

- fire prevention;
- early warning and/or detection;

- means of escape adequacy;
- smoke control features of design;
- features that control fire growth rates;
- structural fire protection measures;
- the building's ability to contain fire;
- fire separation within or from other buildings;
- active measures for control or extinguishment of fire;
- facilities to assist firefighters;
- legislative control, e.g. licensing and registration control under The Licensing Act 2006; and
- management control, such as regimes adopted to meet the requirements of Building Regulation 38 and the Regulatory Reform (Fire Safety) Order 2005.

Some factors in the measures listed above may be assessed using quantitative techniques and may require a Fire Engineer's justification in some circumstances. Not all aspects of these measures are discussed in the Approved Documents.

The aim of the controlling legislation is to encourage collaboration between the designer, the building control surveyor and the fire authority to ensure that the design of the building meet the general fire safety principles set by the regulations and standards expected by the occupier to allow the building's continued use in occupation. Careful risk assessment must be adopted in all instances.

7.1.1 Legislative control

Fire safety legislation throughout England and Wales was consolidated between 2005 and 2013 with amendments to both the Building Regulations and a great deal of other fire legislation. In most cases newly constructed, extended and altered buildings have to meet the design standards for fire safety enshrined within the Building Regulations. Within all buildings, other than dwellings which do not contain common areas, Building Regulation 38 places a duty on the person carrying out the building work to provide the responsible person (see definition below) with all relevant fire safety information (see section 7.30). This information should contain details of the building's construction, services, fittings and equipment. This will assist the responsible person to operate and maintain the building in reasonable safety. The information should be provided no later than the date of completion of the work or the date of occupation of the building, whichever is earlier.

This responsible person is obliged under the Regulatory Reform (Fire Safety) Order 2005 to ensure that a fire risk assessment is undertaken; the aim of which is to ensure that all building occupants can escape safely in the event of a fire. This differs from previous legislative control of such premises in that it places the duty on the occupier of the building to manage the fire risk in buildings. The Fire Authority is no longer required to issue Fire Certificates or inspect property unless they have cause for concern. The Fire Authority does have enforcement powers under the Order and it may take action against the responsible person found to be in breach of their duty to the Order. This can result in the closure of the building, a fine and/or the imprisonment of the responsible person.

The Responsible Person is defined in the Order as anyone who has control of the whole or part of the building and its systems. The responsible person could be:

- an employer of staff who use the building;
- the person responsible for common parts of the building or shared fire safety equipment, such as fire detection or sprinklers; and
- any occupier or manager of a building with a degree of control over part of the premises.

In most cases the identity of the responsible person will be obvious to the fire authority. The duties of the responsible person will include:

- undertaking and documenting a fire risk assessment which identifies any possible risks or dangers;
- giving consideration to those especially at risk;
- removal and reduction of the risk as much as possible. Fire precautionary measures must be provided to deal with any risk that remains;
- taking measures to ensure the safe storage and use of flammable or explosive material;
- creation of a plan to deal with any emergency;
- the obligation to maintain records of the regular testing regimes for all active fire precautions in accordance with the relevant standards; and
- the need to regularly review the assessment.

A number of risk assessment aids are published by the Department for Communities and Local Government (DCLG) that are available free of charge on line from https://www.gov.uk/government/publications.

It should be noted that the Approved Documents are not always a suitable tool to be used in all buildings (e.g. Hospitals are covered by design guidance in the form of Health and Technical Memoranda (HTM)). The guidance is consistent with that given in BS 7974: *Code of practice on the application of fire safety engineering principles to the design of buildings* (2001). The HTM are prepared in conjunction with the Department of Health National Fire Policy Advisory Group. The HTM relevant to fire safety are:

- HTM 05-02: *Firecode – Guidance and support to functional provisions for healthcare premises* (2014); and
- *HTM 05-03: Firecode – Fire safety in the NHS. Operational provisions – Part A: General fire safety* (2013).

The guidance recognises the special requirements for fire precautions in the design of healthcare premises, making reference to a series of other guides, which if followed should allow the current statutory regulations to be applied sensibly.

7.1.2 Building Regulation developments in Wales

In December 2011, responsibility for building regulations was transferred to the Welsh Government. Therefore as discussed in other chapters, the legislation, supporting guidance and enforcement standards in Wales will start to change in the next few years.

In respect to fire safety, this process has already started. The Domestic Fire Safety (Wales) Measure 2011, after being passed by the National Assembly for Wales, received Royal Assent on 7 April 2011. This Measure provides the ability to the Welsh Government with the ability to require that new homes are fitted with 'an effectively operating fire suppression system', although at the time of writing, the requirement cannot be enforced. However, extensive consultation has already begun which are likely to result in the following changes where due to be introduced in April 2014.

Regulation 37A of the Welsh Building Regulations will require the following residential properties required to fit automatic fire suppression systems:

- Care homes (as defined in the Care Standards Act 2000);
- Children's residential homes;
- Hospices;
- Boarding houses;
- Halls of residence; and
- Hostels, other than hostels intended for temporary accommodation for leisure purposes (e.g. not Youth Hostels or backpacker's hostels).

It is envisaged that from 1 January 2016, the fire suppression systems will be extended to apply to new and converted:

- houses;
- flats; and
- any other residential purpose.

Welsh versions of Approved Documents B1 and B2 can be found at:

Approved Document B1 – http://wales.gov.uk/docs/desh/publications/130205building-regs-approved-document-b1-fire-en.pdf; and
Approved Document B2 – http://wales.gov.uk/docs/desh/publications/141104building-regs-approved-document-b2-fire-en.pdf.

Further amendments are due to both documents in 2015 to reflect the requirements for houses and flats.

7.1.3 Local Acts repealed

Up until 9 January 2013, about 23 local Acts existed that contained provisions which gave local authorities discretionary powers to require additional fire precautionary measures over and above the requirements of the building regulations. Such requirements were normally applied in tall buildings, warehouses or car parks. For a storey above ground level, requirements often included the need for sprinkler systems, suppression systems or smoke ventilation. In other areas considered to be a special fire risk, such as basements, additional facilities may have been required.

All of these requirements have now been repealed. A large amount of these requirements have been incorporated into the ADs.

For work planned within buildings which have been subject to the provisions by local Acts, the Designer and Developer needs to exercise a cautionary approach when planning for fire safety. Simply switching off a previously required system is not an option that can be taken without careful consideration. Any change to an adopted fire safety strategy needs to be carefully evaluated and changes should not be incorporated without careful review of existing fire risk assessments. The Fire Brigade will have a record of previous requirements and compensatory measures allowed in the building design. If change is considered a material alteration of the existing building, then the benchmark for compliance will be the requirements of Part B. The building may not as a result of the additional measures have complied with the regulations had the additional measures not been incorporated. A few examples are listed below.

It is often the case that measures such as sprinkler protection may have been required and used to offset or compensate for other aspects of the building's design strategy. Such areas could have included:

- lessening of the designated periods of structural fire resistance requirements;
- larger allowance for distance considered appropriate in concealed cavities dependent on the level of sprinkler protection provided;
- greater than normal permissible unprotected areas to a relevant boundary; and
- an increased travel distance allowance for occupants due to the resultant decrease in fire severity.

This list is not exhaustive and does not consider other requirements that Local Acts can impose such as compensatory features for smoke control, reduced firefighting provisions, smoke control systems, stairway pressurisation systems, etc.

As a rule of thumb, if a building was subject to or may have been subject to local Acts which are likely to have been enacted at the time of relevant building work being undertaken, then the systems should not be switched off or decommissioned unless under the instruction of a suitably qualified person, who has consulted with the Fire and Rescue Service and sorted Building Regulation consent to do so.

7.2 Terminology

Terms which apply generally throughout this chapter are defined here. Certain other terms are defined in the specific section to which they apply.

BASEMENT STOREY – A storey which has some part of the perimeter of its floor more than 1200 mm below the highest level to ground adjoining that part of the floor. When establishing appropriate structural fire resistance, provided that one side at ground floor level is available for firefighting or smoke venting, the basement storey may be treated as being at ground level (see Fig. 7.1).

BOUNDARY – The legal boundary of the building. When considering external fire protection, the relevant boundary is taken to the centre of any abutting railway, street, canal or river *(see also notional and relevant boundaries below).*

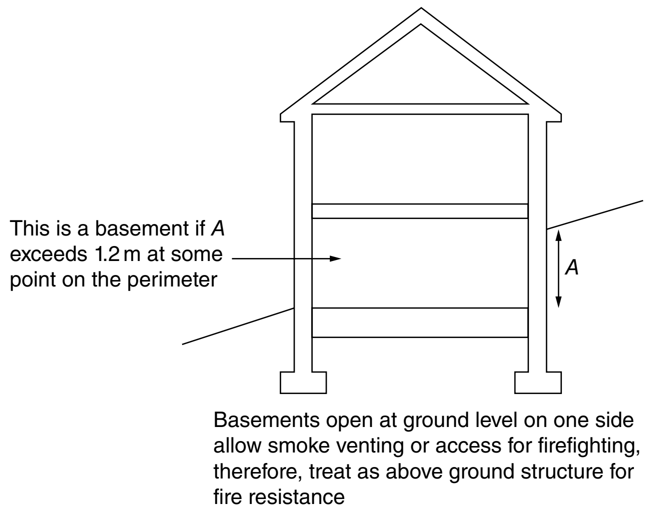


Fig. 7.1 Basement storey.

BUILDING – Any or all parts of a permanent or temporary building.

BUILDING CONTROL BODY – A term used to include either Approved Inspectors or Local Authority Building Control.

CAVITY BARRIER – Part of the construction provided to stop or restrict the movement of fire and smoke from penetrating concealed spaces.

CEILING – The uppermost surface of any room, circulation space, protected shaft, soffit and rooflight within a building. Note that a rooflight's frames or any upstand's are considered to be part of the wall.

COMMON STAIR – An escape stair serving more than one flat.

COMPARTMENT – Any part of a building (including rooms, spaces or storeys) which is constructed to prevent the spread of fire to or from another part of the same building or an adjoining building. This includes the roof space of the topmost compartment. See also 'Separated part' below (see Fig. 7.2).

COMPARTMENT WALL OR FLOOR – Fire-resistant element separating one compartment from another.

CONCEALED CAVITY OR SPACE – Any space such as a cavity wall, suspended ceiling or roof void which is hidden from view by elements of the construction. This definition excludes a room, cupboard, circulation space, protected shaft or space within a flue, chute, duct, pipe or conduit.

DEAD END – Area from which escape is only possible in one direction.

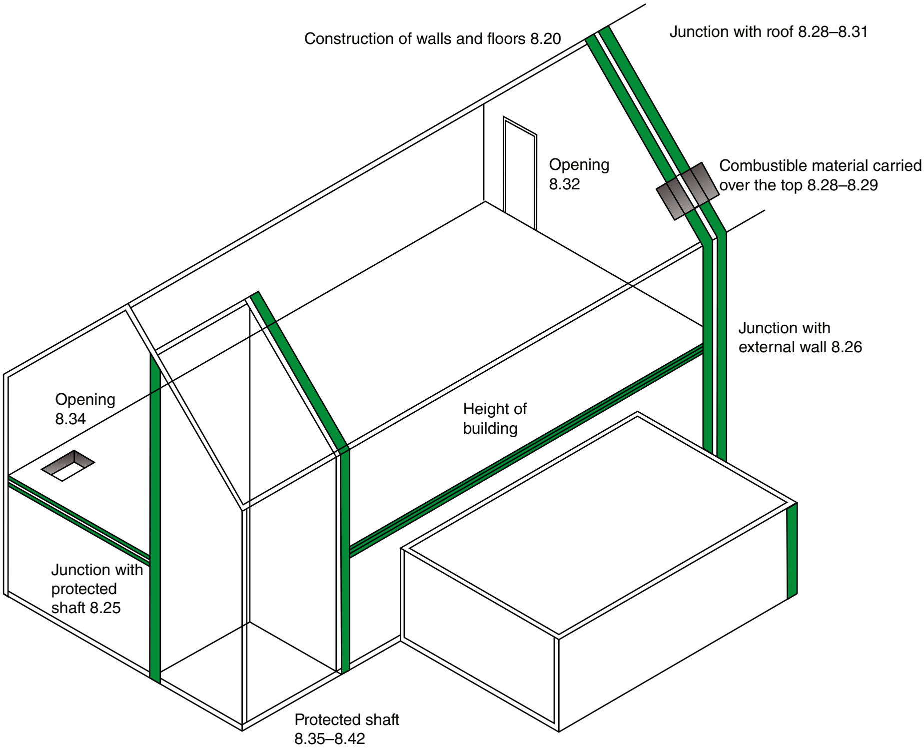


Fig. 7.2 Division of buildings into compartments.

DWELLING or DWELLINGHOUSE – A unit of residential accommodation used:

- by an individual or by people living together as a family; or
- by not more than 6 people living as a single household. A household includes where an element of care is provided.

Note that a 'dwellinghouse' does not include a flat or a building containing a flat.

ELEMENTS OF STRUCTURE:

- Any member forming part of the structural frame of a building or any other beam or column (This does not normally include members which form part of a roof structure only unless the roof performs the function of a floor or the roof structure provides stability for fire-resisting walls.);
- A floor (but not the lowest floor in a building or a platform floor);
- An external wall;
- A compartment wall (including a wall which is common to two or more buildings);
- A load-bearing wall or the load-bearing part of a wall; and
- A gallery (but not a loading gallery, fly gallery, lighting bridge, stage grid or any gallery provided for similar purposes or for maintenance and repair).

These elements are illustrated in Fig. 7.3.

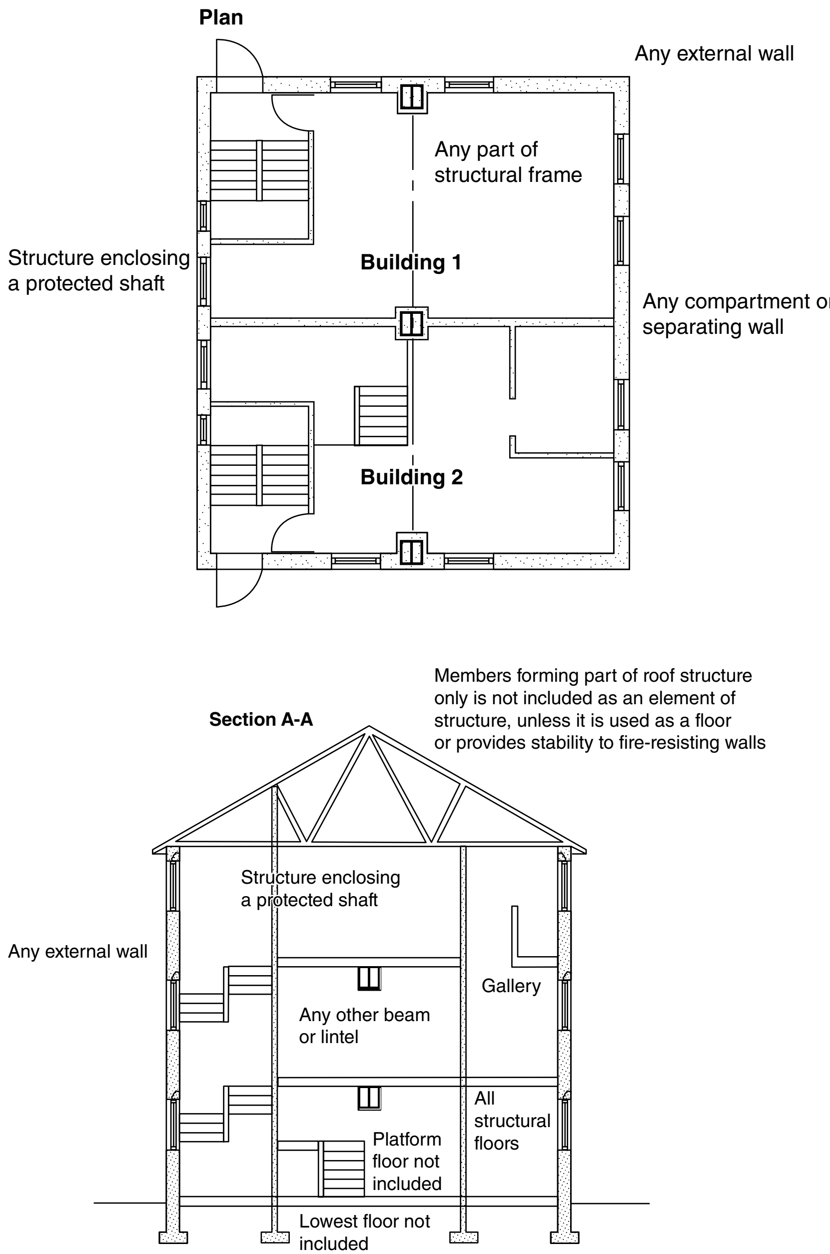


Fig. 7.3 Elements of structure.

EMERGENCY LIGHTING – Lighting used to illuminate critical parts of the means of escape route when normal lighting fails.

ESCAPE LIGHTING – Emergency lights that illuminate means of escape routes at all material times.

EUROPEAN TECHNICAL APPROVAL (ETA) – A construction product's technical assessment of fitness for intended use issued for the purpose of the Construction Products Directive. ETAs may be issued by an authorised body whose approval has been notified to the European Commission. A body's approval may be verified by reference to the '*C*' *series of the Official Journal of the European Communities.*

EVACUATION LIFT – A lift that can be used for the evacuation of people during a fire.

EXTERNAL WALL – Includes a portion of roof sloping at 70° or more to the horizontal if it adjoins a space within a building to which people have access other than for occasional maintenance and repair (see Fig. 7.4).

FINAL EXIT – The final part of the escape route from a building where people would no longer be in danger from fire or smoke. Normally a street, passageway, walkway or open space.

Note that 'escape windows' are not classified as final exits.

FIRE DAMPER – Intumescent of mechanical device in a ventilation opening or duct that is operated automatically to prevent the passage of fire. Dampers are measured to ensure that their integrity meets the recommendations of either E or ES classifications of BS EN 13501-3:2005 when tested to BS EN 1366-2:1999. Intumescent dampers may be tested to ISO 10294-5.

FIRE AND SMOKE DAMPER – Like a fire damper but a device tested in accordance with BS EN 1366-2:1999 that will meet the ES classification of BS EN 13501-3:2005. The fire resistance integrity of the device the damper should achieve should be the same as the element of structure through which it passes. Intumescent dampers may be tested to ISO 10294-2.

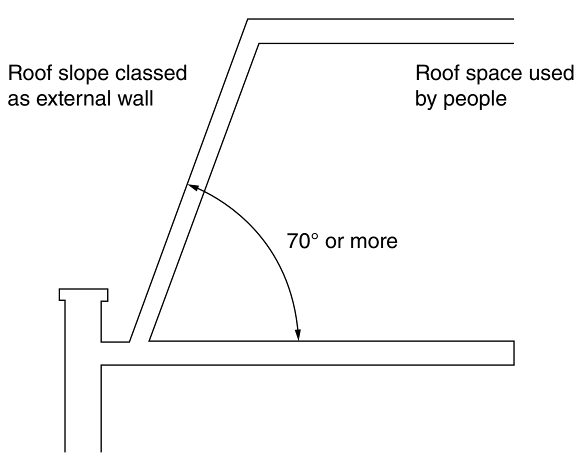


Fig. 7.4 Steeply pitched roofs.

FIRE DOOR – Includes any form of protection in a fire-resistant element of construction through which people may pass (see section 7.20.3).

FIREFIGHTING LIFT – A lift designed to have additional protection and controls for use by the Fire Brigade (see section 7.28).

FIREFIGHTING LOBBY – A protected lobby providing access from a firefighting stair to any associated lift or the accommodation area.

FIREFIGHTING SHAFT – A protected enclosure containing the firefighting shaft, stair, lobbies and if provided lift and motor room.

FIREFIGHTING STAIR – A protected stairway accessing accommodation via a firefighting lobby.

FIRE RESISTANCE – A Measure of an element's ability to resist fire for a stated period. To a great or lesser degree, it is normally a measure of:

STABILITY – the ability of an element to resist the passage of fire;
INTEGRITY – the ability to resist the passage of smoke; and
INSULATION – the ability to resist the passage of heat.

FIRE-SEPARATING ELEMENT – Includes a compartment wall, floor, cavity barrier and any construction that separates a protected escape route or an area of special fire hazard.

FIRE STOPPING – Seals provided to close an imperfect fit or tolerance between elements that are designed to restrict the passage of fire and smoke.

FLAT – A separate and self-contained residential unit horizontally divided from a different use within the building.

GALLERY – Floor (or raised storage platform) which projects into the floor or space below. Normally less than 50% of the space below in floor area.

HABITABLE ROOM – Any room with a dwelling (including a kitchen but not a bathroom).

INNER ROOM – A room from which escape is possible only by passing through another room (the access room).

LIVE/WORK UNIT – A dwelling or flat used as a workplace for people who are not resident at the property.

MEANS OF ESCAPE – The provision of safe routes for people to travel from any point of the building to a place of safety.

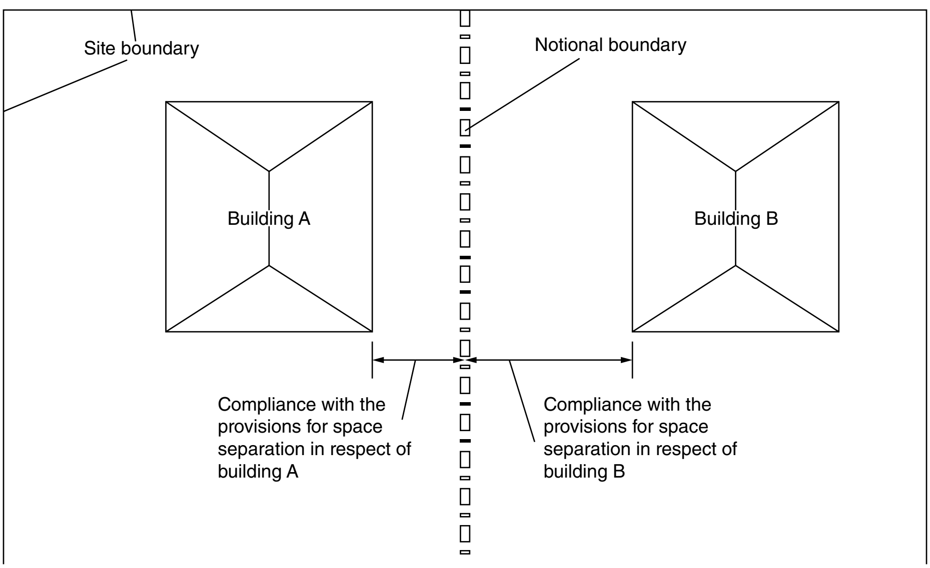
OCCUPANCY TYPE – Part of the purpose group (see section 7.3).

OPEN SPATIAL PLANNING – The internal arrangements of a building in which more than one storey or level is contained in one undivided volume. This is distinct from an atrium space.

NOTIONAL BOUNDARY – A boundary which is assumed to exist between two buildings in the residential and assembly and recreation purpose groups on the same site where there is no actual boundary. The notional boundary line should be envisaged so that neither building contravenes any of the requirements of approved Document B relevant to the external walls facing each other (see Fig. 7.5).

PLACES OF SPECIAL FIRE HAZARD – Oil-filled switchgear and transformer rooms, boiler rooms, stores for fuel or other highly flammable substances and rooms containing fixed internal combustion engines. Additionally, in schools, laboratories, technology rooms with open heat sources, kitchens, and stores for PE mats or chemicals.

PLATFORM (ACCESS OR RAISED) FLOOR – A floor over a concealed space intended to house services, which is supported by a structural floor.



The notional boundary should be set in the area between the two buildings using the following rules:

1. The notional boundary is assumed to exist in the space between the buildings and is positioned so that one of the buildings would comply with the provisions for space separation having regard to the amount of its unprotected area. In practice, if one of the buildings is existing, the position of the boundary will be set by the space separations factors for that building
2. The siting of the new building, or the second building if both are new, can then be checked to see that it also complies, using the notional boundary as the relevant boundary for the second building

Fig. 7.5 Notional boundary.

PROTECTED CIRCUIT – An electrical circuit protected against fire.

PROTECTED CORRIDOR/LOBBY – A corridor or lobby protected from fire in adjacent accommodation by fire-resisting construction.

PROTECTED ENTRANCE HALL/LANDING – A circulation area consisting of a Hall or space within a flat, enclosed with fire-resisting construction. Excluding any part which is an external wall.

PROTECTED SHAFT – A shaft enclosed with fire-resisting construction which enables people, things or air to pass between different compartments.

PROTECTED STAIRWAY – A stair housed within fire-resisting materials with discharges to a place of safety through a final exit. This includes the area between the final step and the final exit.

PURPOSE GROUP – The classification of the building according to its proposed use (see section 7.3).

RELEVANT BOUNDARY – The boundary in which the side of the building faces that is either parallel, coincidental or at an angle of not more than 80° to the side of the building. A notional boundary can also be a relevant boundary (see Fig. 7.6).

ROOFLIGHT – Any part of the roof intended to admit daylight.

ROOM – An enclosed space in a building but not one used solely as a circulation space. This term would also include cupboards that were not fittings and large rooms such as warehouses and auditoria. Excluded within this definition are voids such as ducts, roof spaces and ceiling.

SCHOOL – Any premises defined in the Education Act 1996 attended by children between the ages of 2 and 19 years. For the purposes of approved Document B, this includes any Local Education Authority nursery, primary or secondary school.

SELF-CLOSING DEVICE – A device which is capable of closing the door from any angle and against any latch fitted to the door. Note that rising butt hinges are only acceptable where the door is in a cavity barrier.

SEPARATING PART (OF THE BUILDING) – Where a compartment wall completely divides a building from top to bottom and is in one plane, the divided sections of the building are referred to as separating parts. The height of each SEPARATING part may then be treated individually (see Fig. 7.7 and section 7.4).

SHELTERED HOUSING – This includes two or more dwellings in the same building or on adjacent sites that in each case are constructed for the purpose of providing residential accommodation for elderly or vulnerable people receiving support service.

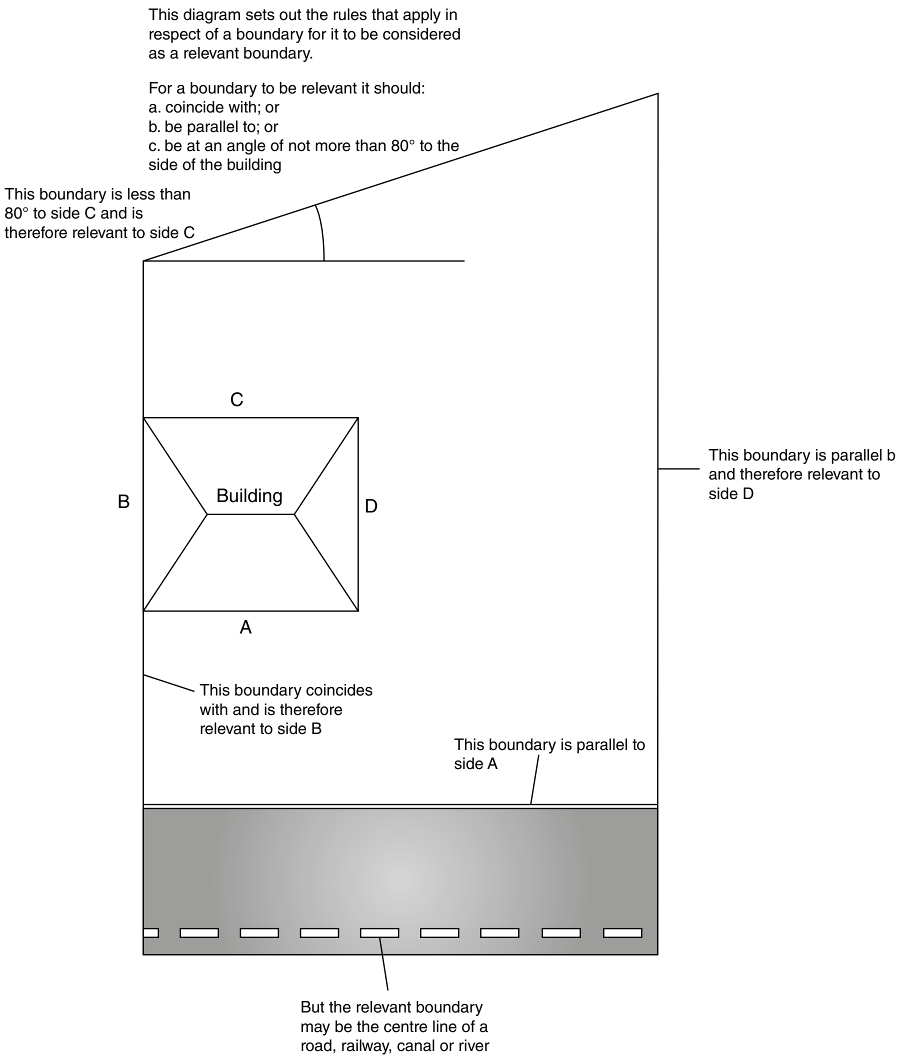


Fig. 7.6 Relevant boundary.

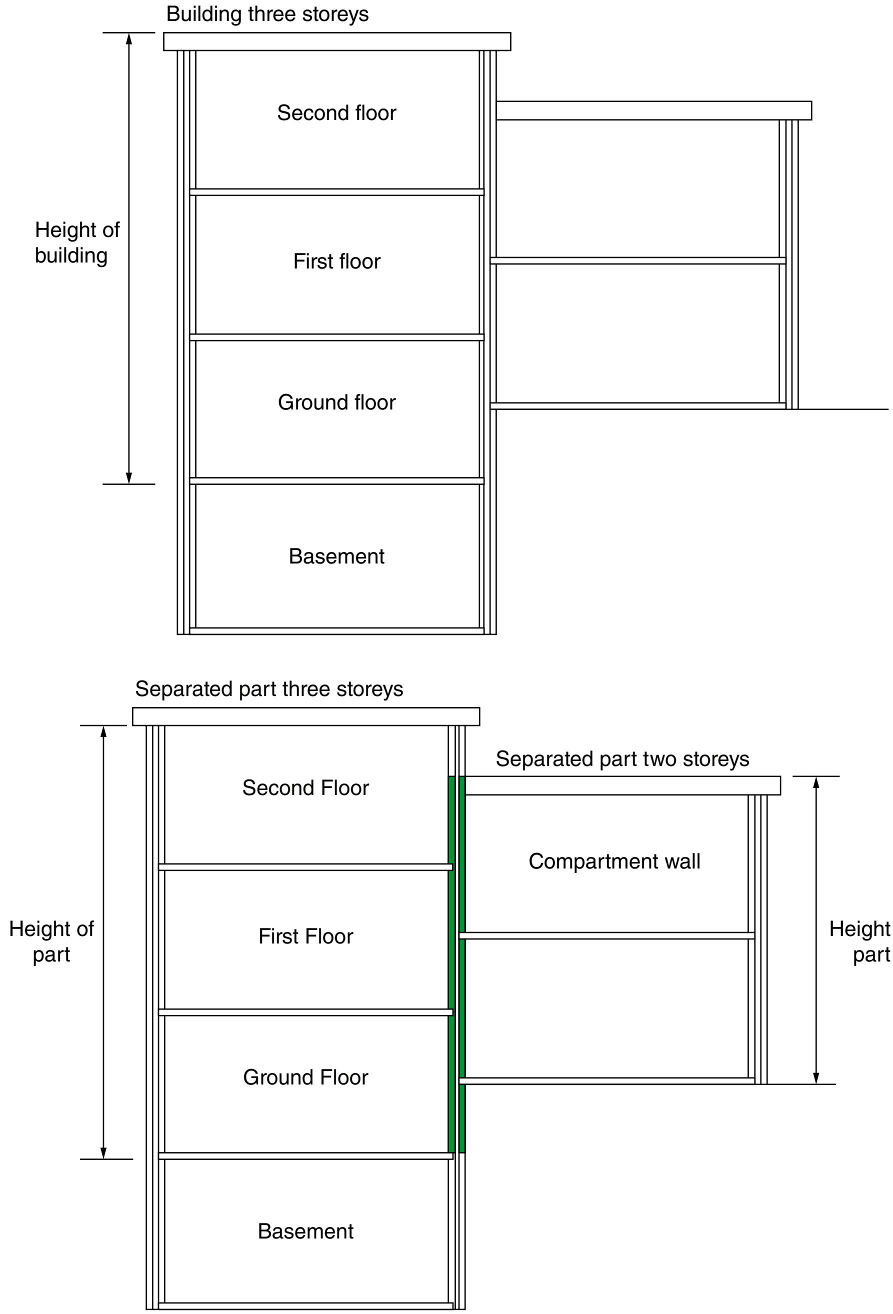
SINGLE-STOREY BUILDING – A building which consists of a ground storey only (roof space for maintenance access only). Refer also to the definition of basements.

SMOKE ALARM – A self-contained device, except possibly the energy source, necessary for detecting smoke and given audible alarm.

STOREY – includes:

- any gallery in an assembly building (purpose group 5);
- a gallery in any other building which exceeds half that of the space into which it projects; and
- a roof, unless used only for maintenance or repair.

To count the number of storeys in a building, or in a separated part of a building, count only at the position which gives the greatest number and exclude any basement storeys



Notes:
In assembly buildings, a gallery is included as a storey but not if it is a loading gallery, fly gallery, stage grid, lighting bridge or any gallery provided for similar purposes or for maintenance or repair.

In other purpose group buildings, galleries are not counted as a storey.

Fig. 7.7 Number of storeys and separating parts.

TECHNICAL SPECIFICATION – Document against which technical compliance with the relevant European Technical Approval Guide is referenced.

UNPROTECTED AREA – In relation to an external wall or side of the building means:

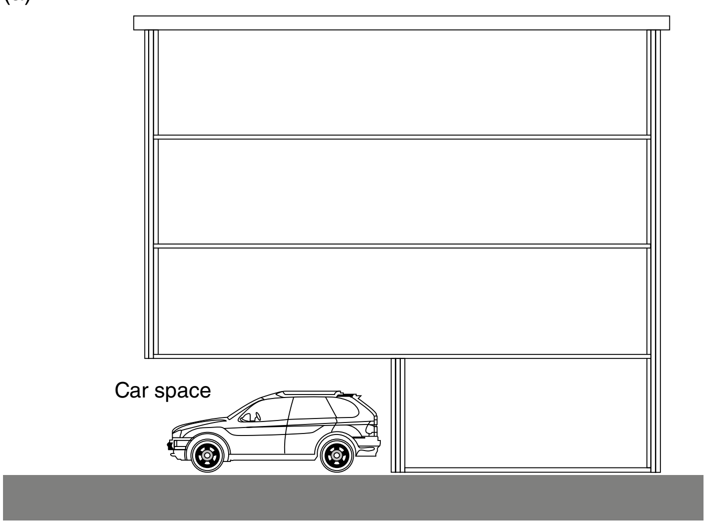
- a window, door or other opening (excluding any suitably fire-resistant window which is not openable and recessed car parking areas are not regarded as unprotected areas) (see Fig. 7.8(a));
- any part of an external wall of fire resistance less than that required by reference to section 7.25 and Fig. 7.8(b); and
- any part of an external wall with external facing attached or applied, whether as cladding or not. The external facing being of combustible material not exceeding 1 mm in thickness.

7.3 Occupancy classifications: Purpose groups etc.

7.3.1 Different approaches to classification

The fire risk presented in a building will depend upon the use to which the building is put. Within the introduction to this chapter, various different design guidance were introduced. This book concentrates on the DCLG's approved document volumes. They remain the primary design/compliance benchmark tool used by designers/building control bodies, respectively.

(a)



Notes:
The parking area should be:
a. Open fronted
b. Separated from the remainder of the building by a compartment wall(s) and floor(s) having not less than the period of fire resistance specified in Table A2 in Appendix A

Fig. 7.8 (a) Recessed car parking area.

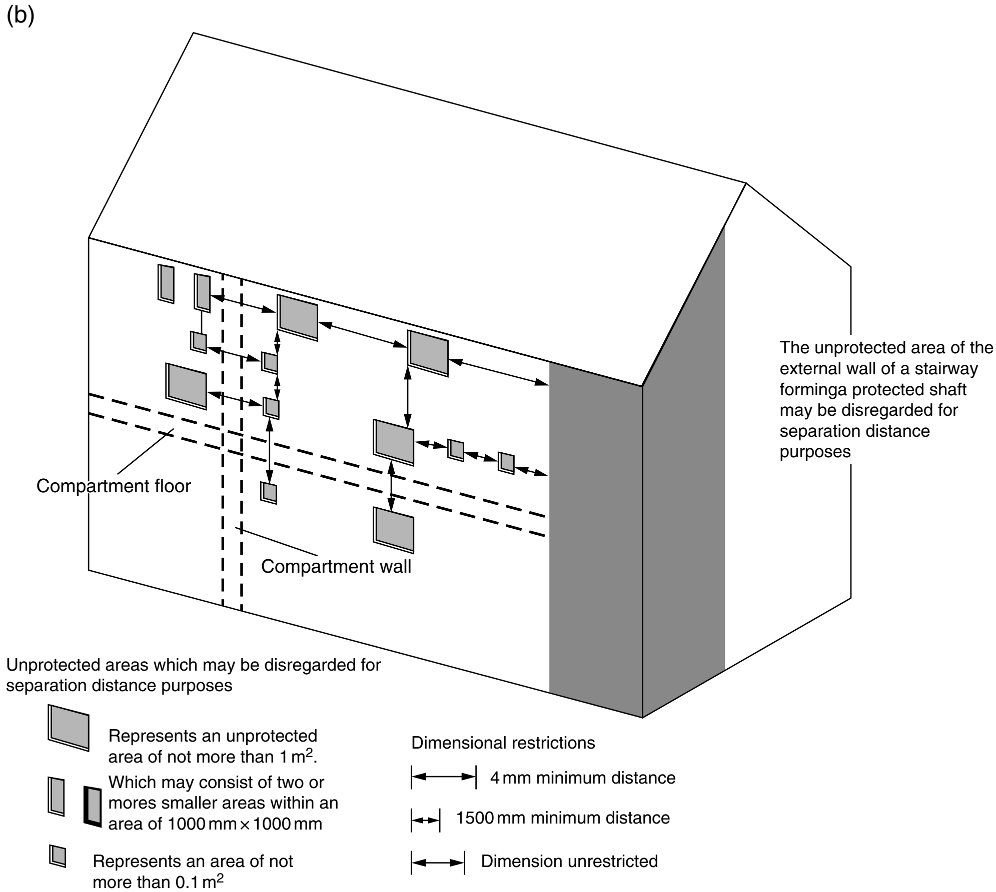


Fig. 7.8 (b) Unprotected area which may be disregarded in assessing separation distance from the boundary.

The Approved Document volumes classify occupancy by allocating a building's proposed use a 'purpose group'. These purpose groups will be discussed in more detail.

The reader's attention is drawn to the usefulness of BS 9999:2008 – *Code of practice for fire safety in the design, management and use of buildings.* Occupancy classifications within this document differ from the purpose groups in the Approved Documents. Instead of categorising based on the generic use of building, BS 9999 introduces the concept of the 'risk profile'. The risk profile is a means of categorising the risks for a range of occupancies based on the occupant's characteristics. The risk profile is completed by estimating the likely rate of fire growth to which people may be exposed when in occupation.

BS 9999 sets out allowable travel distances, escape widths, etc. if a minimum package of precautionary measures are to be provided. The code permits variations to increased favourable travel distance criteria, based on the extent of additional fire protection measures. Additional measures can include the level of management, automatic sprinkler provision, active smoke management systems or provision of additional levels of automatic fire detection.

For example, in an administrative office the travel distance allowances within the approved document suggest a maximum travel distance of 45 m if escape is available in two directions. Criteria for the same environment when considered using BS 9999 will allow a travel distance of 55 m with minimum fire precautionary measures provided. When additional measures are incorporated into the design, the maximum travel distance in two directions can be as much as 90 m.

The section will concentrate on the way the Approved Documents categorise occupancy and will explain the purpose groups.

7.3.2 Purpose groups

Both volumes of the approved document relate the various provisions to the use of the building. These groups are called Purpose Groups (PGs). Provisions vary based on the generic risk each presented by the respective groups.

Where different uses are separated within compartments, the criteria to meet the relevant means of escape provisions for each purpose group may be followed. If no compartments are provided, then the main purpose group criteria should be followed.

Purpose groups are described in *Appendix D to Approved Document volumes B1 and B2*. They are as follows.

The group to which a particular property belongs is normally quite obvious. But the following list gives as many examples as possible.

PG 1 – Residential (dwellings)

This includes parts of dwelling used live/work units (see definition above) where it is less than 18 m to a final exit where the ‘work area’ does not exceed 50 m^2 in floor area.

Group 1 is split into three different categories:

PG 1(a) flat or maisonette;
PG 1(b) dwellinghouse which contains a habitable storey level above 4.5 m from ground floor level; and
PG 1(c) dwellinghouse which does not contain a habitable storey level above 4.5 m from ground floor level. This group includes detached garages or carports, whether or not associated with the dwelling.

PG 2(a) – Residential (institutional)

A premises used as residential sleeping accommodation for or in connection with treatment, care or maintenance of any hospital, home, school or other similar establishment whose occupants are:

- disabled whether registered or not;
- children under the age of five years; and
- lawfully detained.

PG 2(b) – Residential (other)

Includes a hotel, boarding house, residential college, hall of residence, hostel and any other purpose not described above.

PG 3 – Office

Includes any premises used for:

- administration;
- any clerical work;
- bank or building society work; and
- any work or control of communication work (i.e. postal, radio, film, studio or performance) not open to the public

PG 4 – Shop and commercial

Shops or restaurants used for retail trade or business used for:

- sale of food or drink for immediate consumption;
- any retail premises;
- libraries;
- hairdressers and barber shops; and
- premises where the public may go to deliver or collect goods in connection with their hire, repair or treatment or where the public may be admitted to carry out such repairs of treatment themselves. Note that this excludes motor vehicles.

PG 5 – Assembly and recreation

Places of assembly, entertainment or recreation including:

- broadcasting, recording and film studios open to the public;
- bingo halls, casinos and dance halls;
- entertainment, conference, exhibition and leisure centres;
- funfairs and amusement arcades;
- museums and art galleries;
- non-residential clubs;
- theatres, cinemas and concert halls;
- educational establishments;
- dancing schools, gymnasia, swimming pool buildings, riding schools, skating rinks, sports pavilions and sports stadia;
- law courts;
- churches and other buildings of worship;
- crematoria;
- libraries open to the public;
- non-residential day centres, clinics, health centres and surgeries;
- passenger stations and termini for air, rail, road or sea travel;

- public toilets; and
- zoos and menageries.

PG 6 – Industrial

Factories and other premises used for:

- manufacturing, altering, repairing, cleaning, washing, breaking up, adapting or processing any article;
- generating power; and
- slaughtering livestock.

PG 7 – Storage and other non-residential

This group is further subdivided into:

PG 7(a) – Place for the storage or deposit of goods or materials (other than described under 7(b)) and any building not within any of the purpose groups 1 to 6; and
PG 7(b) – Car parks designed to admit and accommodate only cars, motorcycles and passenger or light goods vehicles weighing no more than 2500 kg gross.

Normally the purpose group is applied to the whole building or (where a building is compartmented) to a compartment in the building. The PG is the main use of the building or compartment. Parts of the building put to different uses can be treated as ancillary to the main use. A different use in the same building is not regarded as ancillary and is therefore treated as belonging to a PG in its own right:

- Where the ancillary use is a flat or maisonette;
- Where the building or compartment exceeds 280 m^2 in area **and** the ancillary used exceeds one-fifth of the total floor area of the building or compartment; and
- Where the building is a shop or commercial building or compartment of PG 4 and contains a storage area which exceeds one-third of the total floor area of the building or compartment **and** the building or compartment is more than 280 m^2 in area.

Where a building contains different main uses which are not ancillary to one another, each use should be considered as belonging to a purpose group in its own right.

Some large buildings, such as shopping complexes, may involve complicated mixes of purpose groups. In these cases special precautions may need to be taken to reduce any additional risks caused by the interaction of the different purpose groups. When considering work within such buildings, the designer or building control body should have regard to special measures that may be required in the overall fire strategy relating to the building. More often than not, buildings such as these may form part of a fire-engineered solution requiring additional precautions to be taken.

7.4 Rules for measurement

Many of the requirements concerning compartmentation and fire resistance, etc. in the AD volumes are based on the height, area and cubic capacity of the building, compartment or separated part. For consistency, it is necessary to have a standard way of measuring these proportions (Appendix C of AD B1 and B2). These rules can be summarised as follows:

- HEIGHT – The height of the building or part is measured from the mean level of the ground adjoining the outside of the building's external walls to the level of half the vertical height of the roof or to the top of the walls or parapet, whichever is the higher. This rule applies to double pitch-, monopitch-, flat- and mansard-type roofs (see Fig. 7.9(a)).

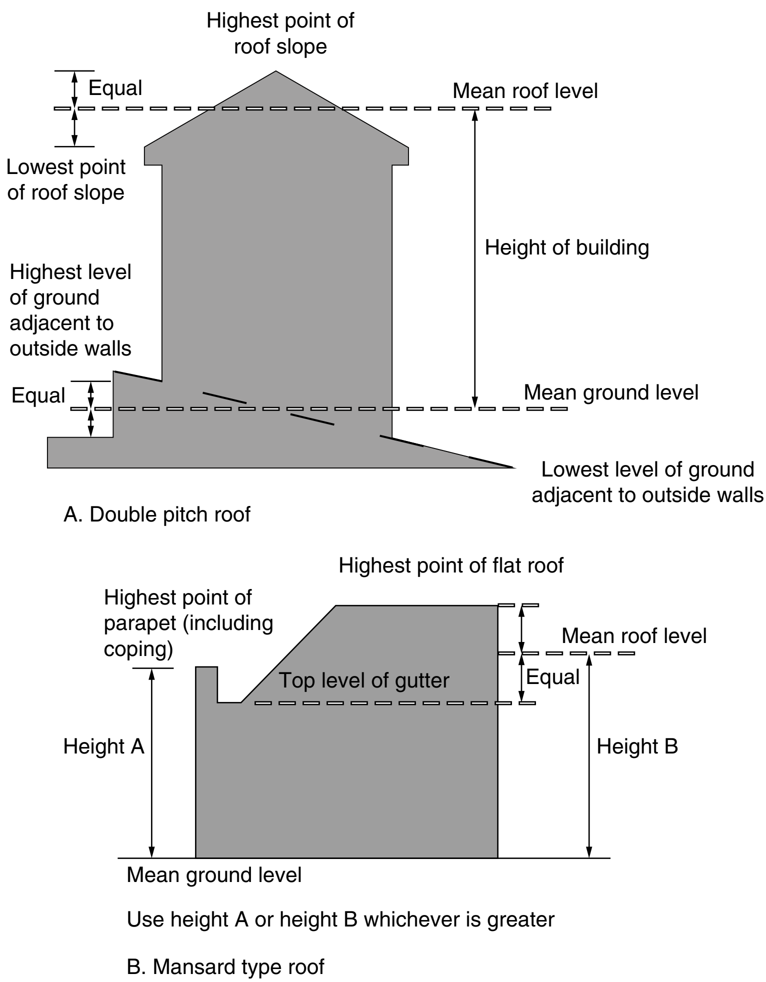
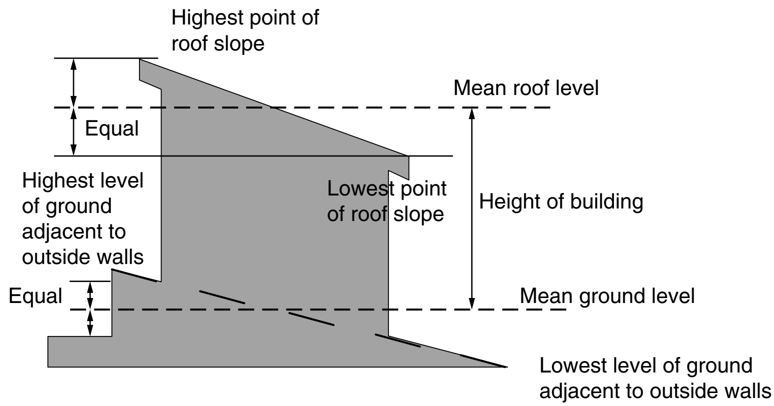


Fig. 7.9 (a) Rules for measurement – height.



C. Flat or monopitch roof

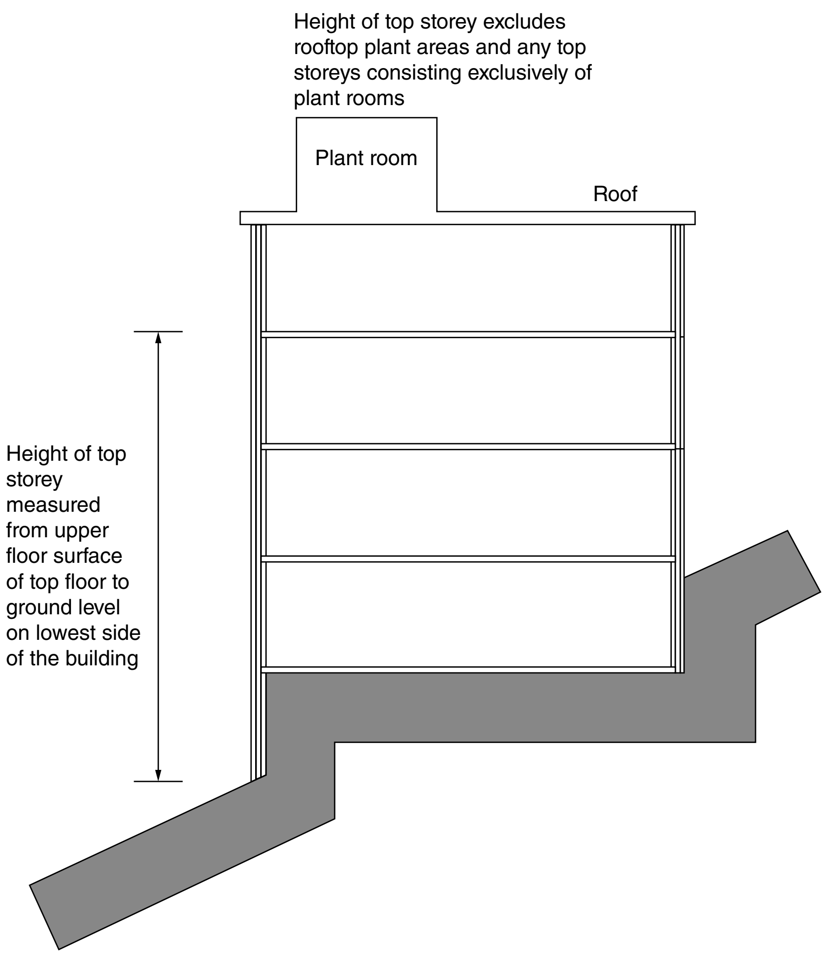


Fig. 7.9 (a) (*Continued*)

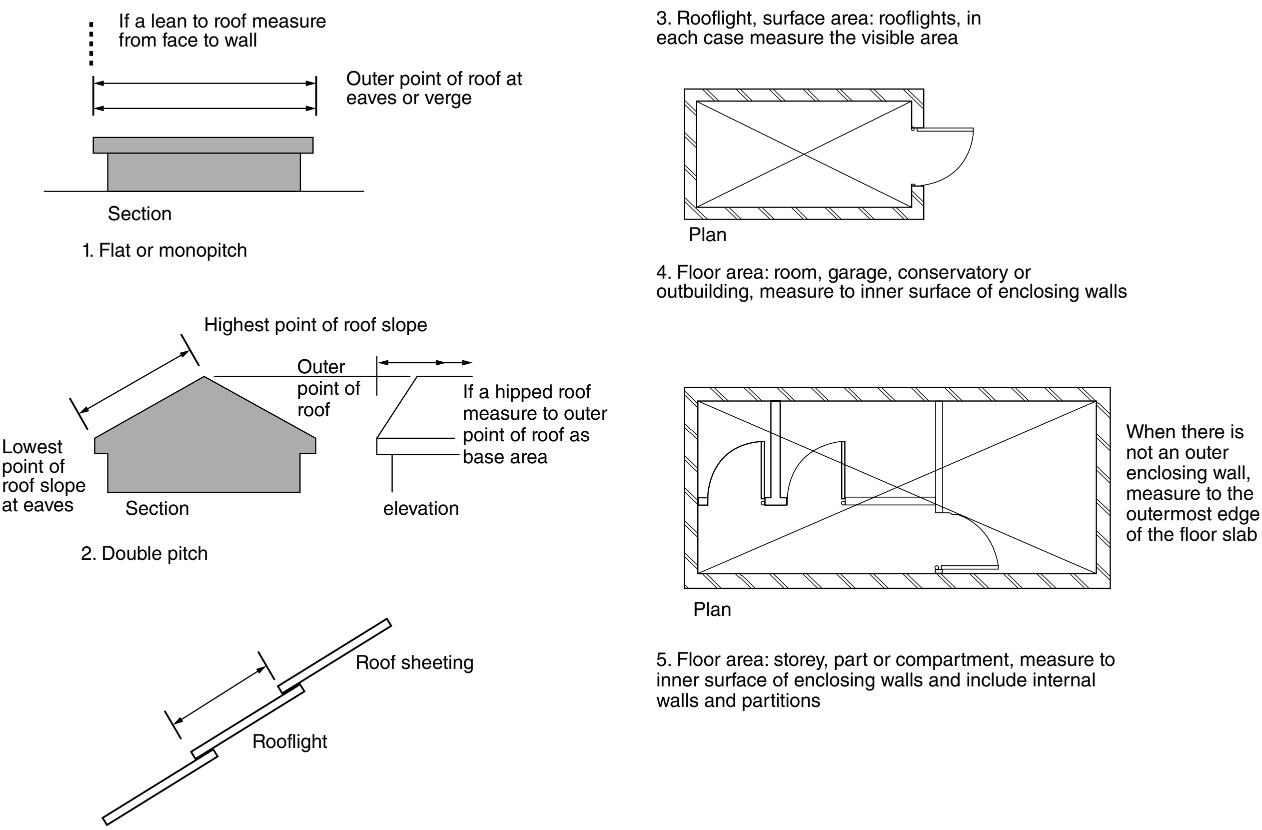
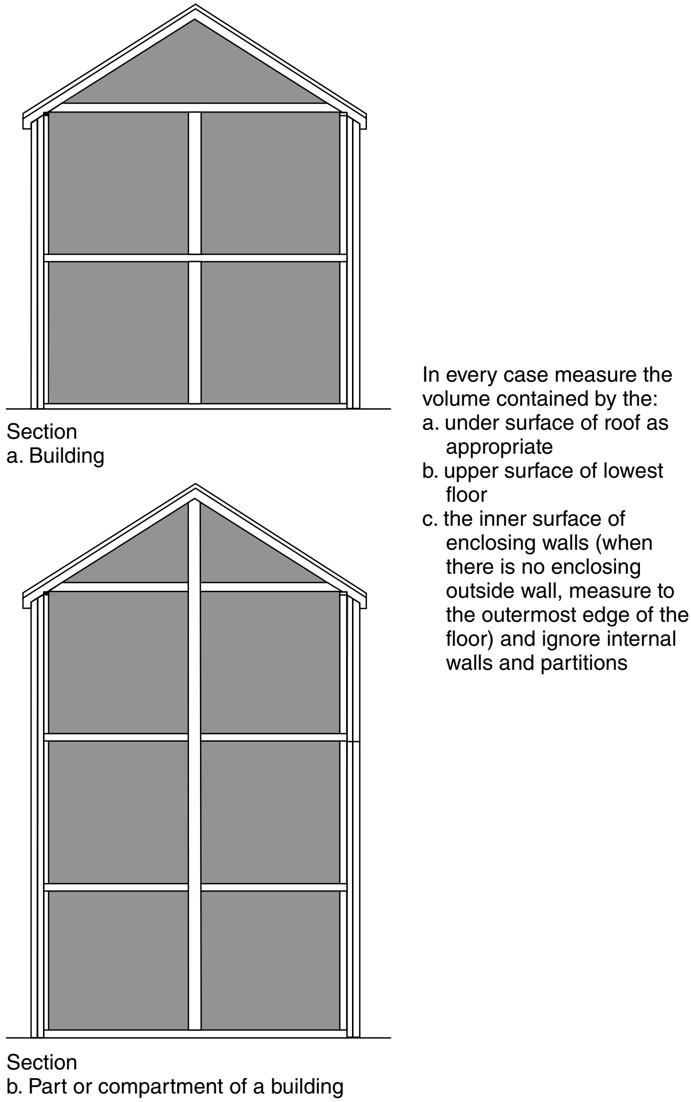


Fig. 7.9 (*Continued*) (b) Rules of measurement – area.



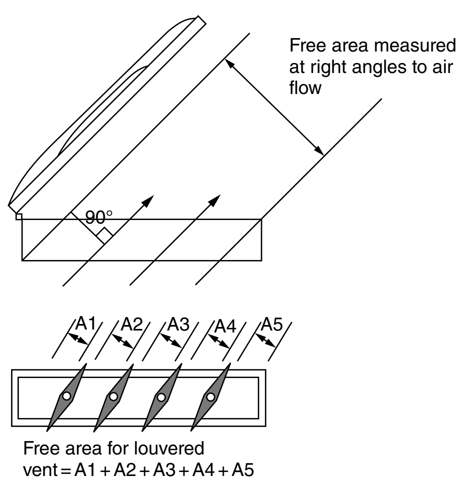


Fig. 7.9 (*Continued*) (c) Rules of measurement – cubic capacity. (d) Rules of measurement – free area of smoke ventilators.

- AREA – The area of any storey of a building, compartment or separated part should be calculated as the total area in that storey within the finished inner surfaces of the enclosing walls. If there is no enclosing wall, the area is measured to the outermost edge of the floor on that side. The area should include any internal walls or partitions.
  The area of a room, garage, conservatory or outbuilding is calculated by measuring the inner surface of the enclosing walls.
  The area of any part of a roof should be calculated as the actual visible area of that part, as measured on a plane parallel to the roof slope. For a lean-to roof, the measurement should be taken from the wall face to the outer edge of the roof slope. For a hipped roof, the measurement should be to the outer point of the roof as a base area (see Fig. 7.9(b)).

- CUBIC CAPACITY – The cubic capacity of a building, compartment or separated part should be calculated as the volume of the space between the finished surfaces of the enclosing walls, the upper surface of its lowest floor and the under surface of the roof or ceiling surface as appropriate. If there is no enclosing wall, the measurement should be taken to the outermost edge of the floor on that side. The cubic capacity should again include space occupied by other walls, shafts, ducts or structures within the measured space (see Fig. 7.9(c)).

- NUMBER OF STOREYS – The number of storeys in a building or separated part should be calculated at the position which gives the maximum number. Basement storeys are not counted. In most purpose group buildings, galleries are also not counted as storeys. However, in assembly buildings, a gallery is included as a storey unless it is a fly gallery, loading gallery, stage grid, lighting bridge or other similar gallery or is for maintenance and repair purposes. (The common factor here is that these excluded galleries are not generally accessible to the public.) (See Fig. 7.7.)

- HEIGHT OF TOP STOREY – This is measured from ground level on the lowest side of the building to the upper surface of the top floor. Rooftop plant areas are excluded from this measurement as are any top storeys consisting exclusively of plant rooms (see Fig. 7.7).

- FREE AREA OF SMOKE VENTILATORS – This may be measured by either:
  - the declared aerodynamic-free area in accordance with BS EN 12101-2:2003 *Smoke and heat control systems. Specification for natural smoke and heat exhaust ventilators*; or
  - the total unobstructed cross-sectional area, measured in the plane where the area is at a minimum and at right angles to the direction of air flow (see Fig. 7.9(d)).

7.5 Means of warning and escape in case of fire

7.5.1 The mandatory requirement

Buildings must be designed and constructed so that appropriate provisions for the early warning of fire are available. The building must be designed to provide safe means of escape in case of fire and capable of being used safely and effectively at all times. In most instances the means of escape must be to a place of safety outside the building. However, it will be seen below that for certain classes of buildings, the place of safety may be within the building itself. This requirement applies to all buildings except prisons provided under section 33 of the Prisons Act 1952.

7.5.2 Standard of performance to meet the mandatory requirement

Dependent on the size, height and use of the building, the mandatory requirement may be met by providing adequate:

- escape routes which are suitably located and of sufficient number and size to enable the occupants to escape to a place of safety in the event of fire;
- illuminated escape routes that are signed to provide direction for evacuation;
- facilities to limit the spread of smoke to the escape route or to restrict the fire and remove smoke; and
- enclosed escape routes where necessary so that they are sufficiently protected from the effects of fire.

There must be sufficient means for giving early warning of fire for the building's occupants.

Both volumes of the Approved Documents contain details of practical ways to satisfy the mandatory requirement and the performance standard referred to above. It does this in two ways:

- By giving actual recommendations in the text (described in detail below); and
- By reference to other sources of guidance.

Generally, BS 9999:2008 *Code of practice for fire safety in the design, management and use of buildings* and BS 9991:2011 *Code of practice for fire safety in the design, management and use of residential buildings* both contain references to a great many codes and guides dealing with means of escape provision. If it is decided to use one of these codes or guides, the parts which are relevant to means of escape should be followed rather than a mixture of the specific publication and the relevant sections of the ADs.

Having said this, it may still be necessary to supplement the Approved Document information with guidance from another publication where insufficient information is provided. Some buildings which house particular industrial or commercial activities may present special fire hazards (e.g. filling stations or similar buildings) and may need additional fire precautions to those detailed in Approved Document volumes. When faced with such circumstances, the ADs recommend that the local fire service should be consulted (even if there is no formal requirement).

7.6 Means of escape

In addition to building regulations, there is a large amount of other legislation covering means of escape in case of fire. Since 2006, the legislative control of means of escape in case of fire has been consolidated and simplified. These measures were discussed in brief in section 7.1.

7.6.1 Premise for design approval

The statute itself is a set of functional requirements that must demonstrate that the building complies in principle with the standards expected. These are described in *Schedule 2 of the Building Regulations.* The approved documents set out some solutions, which if adopted tend to demonstrate that compliance will be achieved. The duties placed on the responsible person under *the Regulatory Reform (Fire Safety) Order 2005* (RRFSO) have already been discussed. This person must in all buildings put to a relevant use undertake a documented risk assessment to demonstrate that any and all occupants may escape safely. No allowance is taken when considering compliance or risk assessment that the Fire and Rescue Service will provide timely assistance. The approved document is written in such a way that escape provision must be as intuitive as possible, and people within the building should be able to evacuate safely. There is an assumption that good management exists.

If a design is reliant upon a particular management regime, then this information should be passed on to the responsible person to incorporate into their risk assessments. This obligation comes from *Regulation 38 of the Building Regulations 2010* (see section 7.30).

For example, a wheelchair user will not be able to use a staircase without assistance. Provision is required in the design for their partial escape. But their eventual escape will require an approach from the responsible person to facilitate a management solution. This should therefore be one aspect of the information required to be passed on under Regulation 38.

To better coordinate the relationship between the Designers BCBs and FRSs, the government publish procedural guidance to coordinate the relationship between all parties. This is currently published in DCLG's web-based *Planning Portal* that may be found by following this link: http://www.planningportal.gov.uk/uploads/br/BR_PDFs_firesafety.pdf. This document is currently subject to public consultation to further improve the coordination of roles.

Other legislative requirements

7.6.2 Houses in multiple occupation

Defined within the Housing Act 2004, a 'House in Multiple Occupation (HMO)' is considered a relevant use under the RRFSO, and therefore each of this type of property should be risk assessed accordingly. Provided that there are no more than six residents, it is appropriate to use the Approved Document B1 as the appropriate design guide.

If the property has more than six residents or is over two storeys in height, it will need a license from the Local Authority. Fire statistics show that there is a higher risk of a fire occurring inside this type of environment. The Local Authority generally requires a higher standard of fire precautions. They will likely request self-closing devices and on occasion a higher level of detection.

Guidance is provided within the *Housing health and safety rating system operating guidance* (2006) published by the body representing local government and the Association of Chief Fire Officers and the Local Government Association's Local Authority Regulatory and Related Services (LACORS).

7.6.3 The Workplace (Health, Safety and Welfare) Regulations 1992

These regulations apply to common parts of flats and similar buildings when caretakers, wardens and cleaners are employed to work. The Workplace (Health, Safety and Welfare) Regulations 1992 do not apply to the private residents within the buildings affected. Most of the requirements are covered within this guidance. Further guidance may be found in *The workplace (health, safety and welfare) regulations* (1992), *Approved code of practice and guidance*, 2nd edition (2013).

7.6.4 The Construction (Design and Management) Regulations 2007

Guidance contained within the Approved Documents is intended to address the fire precautions within the completed property. It does not provide guidance for construction sites. This is covered by the Construction (Design and Management) Regulations 2007 (CDM) and The Regulatory Reform (Fire Safety) Order 2005 (RRFSO). The Health and Safety Executive (HSE) provides guidance in the *Construction Information Sheet No. 51 Construction fire safety* and *HSG 168 Fire safety in construction work*, 2nd edition (2010).

During the construction phase, the site is a workplace and therefore controlled under the RRFSO if the building is occupied. The RRFSO is then policed by the Fire and Rescue Service. When the building is unoccupied, the HSE is responsible for enforcement action during the construction phase.

7.6.5 Environmental protection

As discussed in the introduction of the chapter, the building regulations are only concerned with protected people and not the environment. Although not a requirement of the building regulations, the Environment Agency publishes guidance to provide environmental protection to minimise the risk of the water used as a result of firefighting in medium to large commercial and industrial property. Guidance is set out in the Environment Agency's publication: *Pollution prevention guidelines (PPG18): Managing fire water and major spillages* (2000).

7.7 Interpretation of AD B1

A large number of terms are used in Approved Document B1 which relate specifically to means of escape:

ACCOMMODATION STAIR – A stair which is provided for the convenience of the occupants of a building and is additional to those required for means of escape. (When calculating the number of stairs required in a building, accommodation stairs are generally ignored.)

ALTERNATIVE ESCAPE ROUTES – Routes which are sufficiently separated from one another by fire-resisting construction or space and direction so that one route will still be available even if the other is affected by fire. In most buildings this will mean alternative protected corridors and stairs; however, in dwellings an alternative escape route could be via a second stair, balcony or flat roof if it enabled a person to reach a place free from danger of fire.

ALTERNATIVE EXIT – One of two or more exits, each of which is separate from the other. (There are rules in ADs for determining whether exits are sufficiently far enough apart to be considered as alternatives, and these are illustrated in section 7.15.2 (Fig. 7.22).)

ATRIUM – A space in a building (not necessarily vertically aligned) which passes through one or more structural floors. (Enclosed escalator wells, enclosed lift wells, building services ducts or stairways are not classified as atria.)

COMMON BALCONY – An escape route from more than one flat or maisonette which is formed by a walkway open to the air on one or more sides.

COMMON STAIR – An escape stair which serves more than one maisonette or flat.

CORRIDOR ACCESS – A common horizontal internal access or circulation space which serves each dwelling in a building containing flats. It may include a common entrance hall.

DEAD END – An area from which it is only possible to escape in one direction.

DIRECT DISTANCE – The shortest distance which can be measured from within the floor area of the inside of the building to the storey exit. All internal walls, partitions and fittings are ignored when measuring the direct distance, except the walls enclosing the protected stairway.

DWELLING – A unit of residential accommodation which is occupied by:

- a single person or family; or
- not more than six residents living together as a single household, including a household where the residents receive care.

The dwelling needs not be the sole or main residence of the occupants. (This is an important definition since it shows the difference, for the purposes of means of escape, between a dwelling and a house in multiple occupations (HMO). It also appears to indicate that certain buildings, where people receive care, may be regarded as dwellings and not institutional buildings, again, for the purposes of means of escape. Both HMOs and Residential Care properties will be subject to consideration under the RRFSO, and additional precautions may be required.)

EMERGENCY LIGHTING – Lighting which is provided to be used when the normal lighting fails.

ESCAPE LIGHTING – Part of the emergency lighting which is provided specifically to light escape routes.

ESCAPE ROUTE – That part of the means of escape from any point in the building to the final exit.

EVACUATION LIFT – A lift used to evacuate disabled people in the event of fire.

FINAL EXIT – The termination of an escape route from a building sited so that people may be able to rapidly get clear of any danger from smoke or fire in the vicinity of the building. It should give direct access to a street, passageway, walkway or open space. (It should be noted that windows are not acceptable as final exits.)

INNER ROOM – A room contained within another room (termed the access room). Escape is only possible by passing through the access room.

MAISONETTE – A 'flat' on more than one level.

MEANS OF ESCAPE – Structural means whereby a safe route or routes is or are provided for persons to travel to a place of safety from any point in the building in the event of fire.

OPEN SPATIAL PLANNING – The internal arrangements of a building whereby a number of floors are contained within one undivided space, e.g. split-level floors. AD B volume 2 makes a distinction between an atrium space and open spatial planning.

PROTECTED CIRCUIT – An electrical circuit which is protected against fire.

PROTECTED ENTRANCE HALL/LANDING – A hall or circulation space in a dwelling which is protected by fire-resisting construction (other than any part of the wall which is external).

SMOKE ALARM – A device for detecting smoke which gives an audible alarm. All the components will be contained within one housing (except possibly the energy source).

STOREY EXIT – A doorway giving direct access to:

- a protected stairway (defined in section 7.2);
- a firefighting lobby (defined in section 7.28); and
- an external escape route.

Also the following:

- a final exit (see above for definition); and
- a door in a compartment wall in an institutional building if the building is planned for progressive horizontal evacuation (see section 7.16.3).

TRAVEL DISTANCE – The actual distance travelled by a person from any point in the floor area to the nearest storey exit. In this case the layout of the floor in terms of walls, partitions and fittings *is* taken into account (cf. DIRECT DISTANCE).

7.8 General requirements for means of warning and escape

There are certain basic principles which govern the design of means of warning and escape in buildings and which apply to all building types. In general the design should be based on an assessment of the risk to the occupants should a fire occur and should take account of:

- the use of the building (and the activities of the users);
- the nature of the building structure;
- the processes undertaken and/or the materials stored in the building;
- the potential fire sources;
- the potential for fire spread throughout the building; and
- the standard of fire safety management to be installed.

In assessing the above, judgments regarding the likely level of provision may have to be made when the exact details are unknown. It should be noted that the designer is obliged under *Building Regulation 38* to pass on any design assumptions made to the responsible person in order that the fire strategy is workable (see sections 7.6.1 and 7.30).

The following assumptions must be made in order that a safe and economical design may be achieved:

- In general, when a fire occurs, the occupants should be able to escape safely, without external assistance or rescue from the fire service or anyone else. Obviously, there are some institutional buildings where it is not practical to expect the occupants to escape unaided, and special arrangements are necessary in these cases. Similar considerations apply to disabled people. Aided escape is also permitted in certain low-rise dwellings.
- Fires do not normally break out in two different parts of a building at the same time.
- Fires are most likely to occur in the furnishings and fittings of a building or in other items which are not controlled by the Building Regulations.
- Fires are less likely to originate in the building structure, and accidental fires in circulation spaces, corridors and stairways are unlikely due to the restriction on the use of combustible materials in these areas.
- When a fire breaks out, the initial hazard is to the immediate area in which it occurs, and it is unlikely that a large area will be affected at this stage. When fire spread does occur, it is usually along circulation routes.
- The primary danger in the early stages of a fire is the production of smoke and noxious gases. These obscure the way to escape routes and exits and are responsible for the most casualties. Therefore, limiting the spread of smoke and fumes is vital in the design of a safe means of escape.
- Buildings covered are assumed to be properly managed. Where there is a failure of management responsibility, the building owner or occupier may be prosecuted under the RRFSO or the Health and Safety at Work etc. Act, which may result in prohibition of the use of the building.

7.8.1 Alternative escape routes

When a fire occurs it should be possible for people to turn their backs on it and travel away from it to either a final exit or a protected escape route leading to a place of safety. This means that alternative escape routes should be provided in most situations.

The basic criteria governing the design of means of escape are as follows.

- The first part of the escape route will be within the accommodation or circulation areas and will usually be unprotected. It should be of limited length so that people are not exposed to fire and smoke for any length of time. Where the horizontal escape route is protected, it should still be of limited length since there is always the risk of premature failure.
- The second part of the escape route will usually be in a protected stairway designed to be virtually 'fire sterile'. Once inside it should be possible to proceed direct to a place of safety without rushing. Therefore, flames, smoke and gases must be excluded from these routes by fire-resisting construction or adequate smoke control measures or by both these methods. This does not preclude the use of unprotected stairs for normal everyday use; however their relative vulnerability to fire situations means that they can only be of limited use for escape purposes.
- The protected stairway should lead direct to a place of safety or it may do this via a protected corridor. The ultimate place of safety is open air clear of the effects of fire; however in certain large and complex buildings, reasonable safety may be provided within the building if suitable planning and protection measures can be included in the design.

7.8.2 Dead ends

Ideally, alternative escape routes should be provided from all points in a building, since there is always the possibility that the path of a single escape route may become impassable due to the presence of fire, smoke or fumes. Escape in one direction only (a dead end) is acceptable under certain conditions depending on:

- the use of the building;
- its associated fire risk;
- its size and height;
- the length of the dead end; and
- the number of people accommodated in the dead end.

7.8.3 Unacceptable means of escape

Certain paths of travel are not acceptable as means of escape, including the following:

- Lifts, unless designed and installed as evacuation lifts for disabled people in the event of fire;
- Portable or throw-out ladders;
- Manipulative apparatus and appliances such as fold-down ladders and chutes;

- Escalators. These should not be counted as additional escape routes due to the uneven nature of the top and bottom steps; however it is likely that people would use them in the event of a fire. Mechanised walkways can be acceptable if they are properly assessed for capacity as a walking route in the static mode.

7.8.4 Security

It is possible that security measures intended to prevent unauthorised access to a building may hinder the entry of the fire services when they need access to fight a fire or rescue trapped occupants. Advice may be sought from architectural liaison officers attached to most police forces so that possible conflicts between security and access may be solved at the design stage.

AD B1 does not deem it appropriate to control, under the Building Regulations, the type of lock used on the front doors to dwellings. Guidance on door security in buildings other than dwellings is given in section 7.12.2.

7.8.5 Inclusive design

Fire safety design must account for people with disabilities.

The Equalities Act 2010 places a duty of service providers and employers to consider barriers created by the physical features of a building. People regardless of age, gender and disability should be able to gain access to buildings and use their facilities. Further guidance is considered in Part M of Schedule 1 to the Building Regulations. Designers should have regard to facilitate inclusive design when considering fire safety in all but the most exceptional circumstances. Further guidance on fire safety design is contained in section 7.16.1.

7.9 Rules for measurement for means of escape

In addition to the rules for measurement described in section 7.4, which apply to all parts of ADs, there are certain rules which relate only to Part B2. These are concerned with assessing the length and capacity of escape routes which may, in turn, have a bearing on the quantity of routes and the number of stairways that it is necessary to provide.

7.9.1 Occupant capacity

In order to design a safe means of escape, it is necessary to assess the number of people who are likely to be present in the different parts of the building (i.e. the occupant capacity). Occupant capacity is the total number of people that a building, storey or room is designed to contain, and it depends partly on the use (or purpose group) of the building and partly on the use of individual rooms in the building. It has a direct effect on the numbers and widths of:

- the exits from any room, storey or tier; and
- escape stairs and final exits from the building.

For some building uses (such as theatres or restaurants), occupant capacity can be calculated by totalling the number of seats and then adding an allowance for staff.

In other buildings (such as speculative office developments, shops and supermarkets), the designer will not be able to do this since he will never be sure how intensively the building will be used. In these circumstances, Table 1 of Approved Document B1 provides floor space factors (expressed in m^2 per person) which will give a value for the occupant capacity when divided into the relevant floor area.

The table is based on the type of accommodation contained in the building (i.e. the use of individual rooms), and therefore the following procedure could be adopted to calculate the occupant capacity for the building:

- Choose the top floor and inspect each room to determine its use.
- For each room calculate its floor area and divide it by the relevant floor space factor to determine the occupant capacity for the room.
- Add together the individual room capacities to obtain the occupant capacity for the floor.
- Repeat this process for each floor.
- Total the occupants of all floors to obtain the occupant capacity for the building.

Floor space factors based on Table 1 of AD B are given in Table 7.1. The following should also be noted when using the floor space factors:

- It is not necessary to calculate occupancy capacities for stair enclosures, lifts or sanitary accommodation, and fixed parts of the building structure may also be excluded from the calculation (although the area taken up by counters and display units, etc. should not be excluded).
- Where the descriptions do not completely cover the accommodation, it is acceptable to use a value based on a similar use.
- Where any part of the building is likely to have multiple uses (for example, a multipurpose hall might be used for a low-density activity like gymnastics or a high-density use such as a disco), the most onerous floor space factor should be used.

As an example, take an exhibition hall with a floor area (excluding stair enclosures, lifts and sanitary accommodation) of $2250\,m^2$. From Table 7.1, the floor space factor is $1.5\,m^2$ per person. Therefore, the occupant capacity is 2250 divided by 1.5, i.e. 1500 people.

Alternatively, some designers or developers may be able to obtain actual data relating to occupancy numbers, taken from existing premises which are similar to those being designed. Where this data is available, it should reflect the average occupant density at a peak trading time of year. This is a legitimate approach which when considered by the Responsible person in accordance with the ethos of the RRFSO can be self-policed and its fitness for purpose continually reviewed. BS 9999 contains recommendations for the suggested management regimes appropriate for properties. The standard lists that concerns which should be addressed.

Table 7.1 Floor space factors.

Floor space factor (m^2/person)	Type of accommodation/use of room	Notes
0.3	Standing spectator areas. Bars and other similar refreshment areas, without seating	
0.5	Amusement arcade, assembly hall (including a general purpose place of assembly), bingo hall, crush hall, dance floor or hall, venue for pop concert or similar events	
0.7	Concourse, queuing area or shopping mall	See also section 4 of BS 9999 or BS 7974 for detailed guidance on the calculation of occupancy in common public areas in shopping complexes
1.0	Committee room, common room, conference room, dining room, licensed betting office (public area), lounge or bar (other than above), meeting room, reading room, restaurant, staff room or waiting room	In many of these uses, the occupants will normally be seated. In such cases occupant capacity may be taken as the number of *fixed* seats provided
1.5	Exhibition hall or studio (film, radio, television, recording)	
2.0	Skating rink, shop sales area (1)	(1) Shops, such as supermarkets and the main sales areas of department stores; shops for personal services (e.g. hairdressers); shops for the delivery or collection of goods for cleaning, repair or other treatment either by the company or by the public themselves. For other shops see (2) below
5.0	Art gallery, dormitory, factory production area, museum or workshop	
6.0	Office	
7.0	Kitchen or library, shop sales area (2)	(2) Shops trading in large items such as furniture, floor coverings, cycles, prams, large domestic appliances or other bulky goods, or cash and carry wholesalers. For other shops see (1) above
8.0	Bedroom or study bedroom	
10.0	Bedsitting room, billiards or snooker room or hall	
30.0	Storage and warehousing car park	Occupant capacity based on two persons per parking space

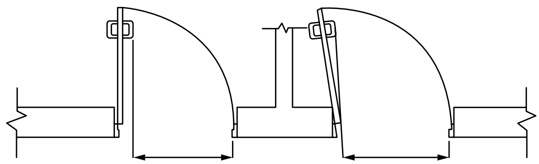


Fig. 7.10 Door width measurement.

7.9.2 Travel distance

This is measured along the shortest, most direct route. Where there is fixed seating or other fixed obstructions, the travel distance is measured along the centreline of the seating or gangways. If a stair (such as an accommodation stair) is included in the escape route, the travel distance is measured along the pitch line on the centre line of travel.

7.9.3 Width

Usually, the narrowest part of an escape route will be at the door openings which form the room or storey exits. These are measured as shown in Fig. 7.10.

Escape route widths are measured at a height of 1500 mm above floor level where the route is defined by walls. Elsewhere, the width will be measured between any fixed obstructions.

Stair widths are measured clear between walls and balustrades. Strings may be ignored as may handrails which project less than 100 mm. Additionally, where a stairlift is installed, the guide rail may be ignored; however, the chair or carriage must be capable of being parked where it does not obstruct either the stair or the landing.

7.9.4 Other considerations

The above solutions will not fit every instance. When assessing a solution's suitability, the following factors should be considered:

- The likelihood of a fire occurring;
- The anticipated severity of the fire;
- The ability of the building to resist the spread of fire and smoke;
- The consequential danger to people;

The supporting suggested measures to the above are not all considered by taking a traditional approved document compliant approach. The ethos of the RRFSO, the legislation requiring continuing control of premises, supports a managed approach to be adopted. So a holistic view of requirement is encouraged but not often adopted. The reader is reminded that the Building Regulations are not prescriptive; they are functional. The approved document is only one way of complying. If the designer and his client feel that they can meet the functional requirements in a different way, the premise for innovation is embraced in the introduction to the ADs.

7.10 Fire alarm and fire detection systems

The following table summarises the required fire alarm and detection systems required for different building uses.

7.10.1 Fire alarms and detection in dwellings and similar residential property

Dwellinghouses

In all dwellinghouses (including bungalows), safety levels can be significantly increased by installing systems which automatically give early warning of fire. Where there is a higher fire risk to occupants, it may be appropriate to provide a higher standard of detection.

Approved Document B volume 1 gives the following range of options for dwellinghouses:

- New dwellings should be provided with mains-operated smoke and heat detectors that conform to the recommendations of BS EN 14604:2005 *Smoke alarm devices* or BS 5446-2:2003 *Fire detection and fire alarm devices for dwellinghouses,* Part 2: *Specification for heat alarms*, respectively. They should and can have either rechargeable or non-rechargeable battery or capacitor. More information is provided in BS 5839-6:2013.
  BS EN 14604 covers both ionization chamber and optical (photoelectric) smoke detectors. Either types of detector are generally suitable. Optical smoke detection tends to be less susceptible to low levels of invisible particles such as fumes from kitchens and tends to be less prone to false alarms. Ionization chamber detectors are more suitable for circulation spaces next to kitchens.
- All new dwellinghouses should be provided with a fire detection and alarm system that conforms to BS 5839-6:2013 to at least a Grade D LD3 standard.

Large dwellinghouses

A large dwellinghouse is defined in the AD as having one or more floors greater than 200 m^2 in area. Where the house has more than three storeys (including basements), the following recommendations are given in volume 1:

- Where a large house has no more than two storeys (excluding basements), it may be fitted with an automatic fire detection and alarm system of Grade B type LD3 in accordance with BS 5839-6.
- In a large dwellinghouse of three or more storeys (excluding basements), it should be fitted with a BS 5839-6 Grade A LD2 system. Detectors should be sited in accordance with recommendations of BS 5839-1 for a category L2 system.

Material alteration

If a new habitable room is created above the ground floor and there is no final exit from the room, a fire detection and alarm system should be provided. Within the common areas of the dwellinghouse, smoke alarms should be provided in the circulation spaces to comply with the standards given above.

Sheltered housing

In a warden or supervised sheltered housing scheme, a central monitoring point should be provided in an alarm-receiving centre readily accessible by the warden or supervisor. This will allow the person in charge to be aware of which dwellinghouse the alarm is raised.

When considering purpose groups, Institutional or Other Residential means of warning should be considered on a case-by-case basis following guidance given in paragraph 7.15 general guidance for buildings other than flats.

Flats

The principles for the provision of fire alarm and detection systems in flats are now given in AD B2. However provision is the same as those which apply to dwellinghouses described above, with the following additions:

- There is no need to apply the provisions to the common parts of blocks of flats.
- The systems in individual flats do not need to be interconnected.
- A flat with more than one floor entered from either the higher or lower level should be treated in the same way as a house with more than one storey.

Student residential accommodation

Traditional halls of residence consisting of individual study bedrooms and shared dining and washing facilities should be designed for general evacuation in the same way as non-residential buildings (see section 7.15).

Where the accommodation is arranged as in a block of flats, with a group of students sharing an individual flat with its own entrance door, it is appropriate for an automatic detection system to be provided in each flat. In such cases the flats will be compartmented from each other, and the automatic detection system need only give warning in the flat of fire origin.

7.10.2 Standards and guidance on smoke and heat alarms for dwellinghouses and similar properties

Guidance is provided within BS 5839-6 on the installation of fire and detection systems. The following guidance still are acceptable in most situations:

- Located in circulation areas between sleeping places and places where fires are likely to start (kitchens and living rooms) and within 7.5 m of the door to every habitable room.
- At least one smoke alarm should be provided in each storey of a flat.

- Where a kitchen is not separated from a circulation space or stairway by a door, a compatible heat detector should be provided. This should be interlinked into the detectors within the circulation spaces of the dwellinghouse.
- Fixed to the ceiling and at least 300 mm from any walls and light fittings (unless there is test evidence to prove that the detector will not be adversely affected by the proximity of a light fitting). Units specially designed for wall mounting are acceptable provided that they are mounted above the level of doorways into the space and are fixed in accordance with manufacturers' instructions.
- Sited so that the sensor, for ceiling-mounted devices, is between 25 mm and 600 mm below the ceiling (between 25 mm and 150 mm for heat detectors), assuming that the ceiling is predominantly flat and level.
- Fixed in positions that allow for routine maintenance, testing and cleaning (i.e. not over a stairwell or other floor opening).
- Sited away from areas where steam, condensation or fumes could give false alarms (this would include heaters, air conditioning outlets, bathrooms, showers, cooking areas, garages, etc.).
- Sited away from areas that get very hot (e.g. boiler rooms) or very cold (e.g. an unheated porch). They should not be fitted to surfaces which are either much hotter or much colder than the rest of the room since air currents might be created which would carry smoke away from the unit.

  The number of alarms which are installed will depend on the size and complexity of the layout of the dwelling and should be based on an analysis of the risk to life from fire. The following minimum provisions should be observed:
- At least one alarm should be installed in each storey of the dwelling.
- Where more than one smoke alarm is installed, they should be interconnected so that the detection of smoke in any unit will activate the alarm signal in all of them. Provided that the lifetime or duration of any standby power supply is not reduced, smoke alarms may be interconnected using radio links. Manufacturers' instructions should be adhered to regarding the maximum number of units that can be interconnected.
- In open plan designs where the kitchen is not separated from the stairway or circulation space by a door, the kitchen should contain a compatible interlinked heat detector. This should be in addition to the normal provision of smoke detector(s) in the circulation space(s).

It should be noted that maintenance of the system in use is of utmost importance. Since this cannot be made a condition of the passing of plans for Building Regulation purposes, it is important to ensure that developers and builders provide occupiers with full details of the use of the equipment and its maintenance (or guidance on suitable maintenance contractors). BS 5839: Parts 1 and 6 also recommend that occupiers receive manufacturers' operating and maintenance instructions.

Power supplies to smoke alarms

Power supplies for smoke alarm systems should be derived from the dwelling's mains electricity supply and connected to the smoke alarms through a separately fused circuit at the distribution board (consumer unit).

The power supply options described here are all based on using the mains supply at the normal 240 volts. Other effective (though possibly more expensive) options exist, such as reducing the mains supply to extra low voltage in a control unit incorporating a standby trickle-charged battery, before distributing the power to the smoke alarms at that voltage.

The smoke alarm system can include a standby power supply which will operate during mains failure. This can allow the system to obtain its power by connection to a regularly used local lighting circuit with the advantage that the circuit will be unlikely to be disconnected for any prolonged period. Where the system does not include a standby power supply, no other electrical equipment should be connected to the smoke alarm circuit (except for a mains failure monitoring device; see below).

The mains supply to the smoke alarm system can be monitored by a device which will give warning in the event of failure of the supply. The warning of failure may be visible or audible (in which case it should be possible to silence it) and should be sited so that it is readily apparent to occupants. The circuit for the mains failure monitor should be designed so that any significant reduction in the reliability of the mains supply is avoided.

Ideally, the smoke alarm circuit should not be protected by any residual current device (rcd) such as a miniature circuit breaker or earth leakage trip. However, sometimes it is necessary for reasons of electrical safety that such devices be used, and in these cases, either:

- the rcd should serve only the circuit supplying the smoke alarms; or
- the rcd protection of a fire alarm circuit should operate independently of any rcd protection for circuits supplying socket outlets or portable equipment.

Since it does not need any fire survival properties, the mains supply to smoke alarms, and any interconnecting wiring, may comprise any cable which is suitable for ordinary domestic mains wiring. Cables used for interconnections should be readily identifiable from those supplying power (e.g. by colour coding).

Dwellinghouses and internal spaces to dwellings

Two types of fire alarm and detection systems are specified in BS 5839-6:2013:

- Type LD – For the protection of life; and
- Type PD – For the protection of property.

Type L systems are further subdivided into:

- LD1 – Systems with detectors and alarms installed throughout the premises, with detectors in all spaces except toilets, bathrooms and shower rooms;
- LD2 – System with detectors and alarms on all circulation spaces and all high-risk rooms; and
- LD3 – System with detectors and alarms in the circulation areas forming the escape route.

Type P systems are further subdivided into:

- PD1 – Systems installed throughout the premises (excluding toilets, bathrooms and shower rooms); and
- PD2 – Systems installed only in defined parts of the building.

The standard describes the grades of circuitry required. There are six grades of system subdivided as follows:

- Grade A – A system of automatic fire detection and alarm designed to the relevant sections of BS EN 54 and sections 1–4 of BS 5839-1. Some exceptions are listed in BS 5839:6 which are slightly differently referenced;
- Grade B – An automatic system conforming to the relevant sections of BS EN 54 or to annexe C of BS 5839-6;
- Grade C – An automatic system which may be combined into a single unit of smoke alarm, which is connected to a common mains and backup supply, with central control equipment;
- Grade D – A system comprising one or more smoke or heat alarms with an integral standby supply (i.e. a battery);
- Grade E – A system of mains-powered alarms with no integral battery supply; and
- Grade F – A system of one or more battery-powered smoke alarms.

7.10.3 Fire detection and alarm in buildings other than dwellinghouses or flats

Introduction

It is extremely important to realise that there is a causal connection between the design of the means of warning and escape in a building and the eventual management of that means of warning and escape. Therefore, the escape strategy to be adopted in a particular building will be based on one of the following:

- Simultaneous evacuation – All the occupants are expected to leave the building at the same time.
- Phased evacuation – Only the storeys most affected by the fire (e.g. the floor of origin and the floor above it) are evacuated immediately. Subsequently, two floors at a time are evacuated if the need arises.
- Progressive horizontal evacuation – The concept which is usually adopted in the inpatient parts of hospitals and similar healthcare premises where total evacuation of the building is inappropriate. Inpatients are evacuated, in the event of fire, to adjoining compartments or subdivisions of compartments, the object being to provide a place of relative safety within a short distance. If necessary, further evacuation can be made from these safe places but under less pressure of time.

Therefore, in buildings other than dwellings, selection of the appropriate fire detection and alarm system will depend on the means of escape strategy adopted. For example, in residential accommodation (where the occupants sleep on the premises), the threat posed by a fire will be much greater than in premises where the occupants are fully alert. In these circumstances an escape strategy based on simultaneous evacuation will mean that all fire sounders will operate almost instantaneously once a manual call point or fire detector has been activated. If however, the escape strategy is based on phased evacuation, a staged alarm system may be more appropriate. Two or more stages of alarm may be given within a particular area corresponding to 'alert' and 'evacuate' signals.

Fire alarm systems

All buildings should have arrangements for detecting fire, and in most buildings this will be done directly by people through observation or smell. In many small buildings where there is no sleeping risk, this may be all that is needed. Similarly, the means of raising the alarm may be simple in such buildings, and where the occupants are in sight and hearing of each other, a shouted warning may be sufficient. Clearly, it is necessary to assess the risk in each set of circumstances and decide standards on a case-by-case basis.

The risk analysis will consider the likelihood of a fire occurring and the degree to which the alarm can be heard by all the occupants. Therefore any of the following may need to be incorporated in the building:

- In small buildings with a management regime that involves the person who discovers a fire, it will be acceptable to rely upon them to provide alert to the risk by shouting a warning, 'FIRE'. This must be carefully considered and in most instances will not be appropriate.
- Manually operated sounders (e.g. rotary gongs or handbells).
- Simple manual call points combined with bell, battery and charger.
- Electrically operated fire warning system with manual call points sited adjacent to exit doors, combined with sufficient sounders to ensure that the alarm can be heard throughout the building. The system should comply with BS 5839: Part 1 (see below) and the call points with Type A of BS EN 54 *Fire detection and fire alarm systems. Manual call points – Part 11: Manual call points.* BS EN 54-11 covers two types of call points:
- Type A (direct operation) – The change to the alarm condition is automatic (i.e. without the need for further manual action) when the frangible element is broken or displaced.
- Type B (indirect operation) – The change to the alarm condition requires a separate manual operation of the operating element by the user after the frangible element is broken or displaced. (Type B call points should only be used with the approval of the Building Control Body).

Three types of fire alarm and detection system are specified in BS 5839-1:2013 as follows:

- Type L – For the protection of life;
- Type M – Manual alarm systems; and
- Type P – For the protection of property.

Type L systems are further subdivided into:

- L1 – Systems installed throughout the protected building.
- L2 – Systems installed only in defined parts of the protected building (but always providing the coverage required of a Type L3 system).

- L3 – Systems installed only for the protection of escape routes other than possibly those in the room of fire origin. To achieve compliance it will normally be necessary to provide detection in rooms which open onto the escape routes.
- L4 – Systems installed within common and circulation areas such as corridors or stairways.
- L5 – System that is designed to achieve a specific fire safety objective other than a full L1 to L4 system, e.g. to provide early warning to the occupant of an inner room.

Type P systems are further subdivided into:

- P1 – Systems installed throughout the protected building; and
- P2 – Systems installed only in defined parts of the building.

In certain premises where large numbers of the public are present (e.g. large shops and places of assembly), it may be undesirable for an initial general alarm to be sounded since this may cause unnecessary confusion. Therefore it is essential in these circumstances that staff are trained to effect pre-planned procedures for safe evacuation. Usually, actuation of the fire alarm system will alert staff by means of discrete sounders or personal pagers first. This will enable them to be prepared and in position should it be necessary for a general evacuation to be initiated by means of sounders or an announcement over the public address system. In all other respects any staff system should conform to BS 5839: Part 1.

Voice alarm systems are useful in circumstances where it is considered that people might not respond quickly to a fire warning or where they are unfamiliar with fire warning arrangements. An audible fire warning signal can be given via a public address system, provided that it is distinct from other signals which are in general use and is accompanied by clear verbal instructions. Voice alarms should comply with BS 5839: *Fire detection and alarm systems for buildings,* Part 8: 2013 *Code of practice for the design, installation, commissioning and maintenance of voice alarm systems.*

It is also interesting to note that when designing a building to minimum level of alarm required in accordance with BS 9999 then unless the design involves sleeping accommodation, automatic detection is not a requirement unless the fire load is high. For instance, for a building where people are awake and familiar with their surroundings, e.g. an administrative office, then no automatic detection would be required. Or in a building in which people are awake and unfamiliar who should rely on reasonable management provision to ensure their safe escape, e.g. a lecture theatre, no automatic detection would be required. It is however, when considering detector and alarm provision to carefully consider the level of management to be provided. Further guidance is available in BS 9999.

Automatic fire detection and alarm systems

Automatic fire detection systems involve a sensor network plus associated control and indicating equipment. Sensors may detect heat, smoke or radiation, and it is usual for the control and indicating equipment to operate a fire alarm system. It may also perform other signalling or control functions, such as the operation of an automatic sprinkler system.

Automatic fire detection and alarm systems should be installed in Institutional (Purpose Group 2(a)) buildings and in Other Residential (Purpose Group 2(b)) occupancies.

Automatic fire detection systems are not normally needed in non-residential occupancies; however it may be desirable to install a fire detection system in the following circumstances:

- To compensate for the fact that it has not been possible to follow all the guidance in ADs;
- Where it is necessary as part of a fire protection operating system, such as a pressurised staircase or automatic door release mechanism; and
- Where a fire could occur unseen in an unoccupied or rarely visited part of a building and prejudice the means of escape from the occupied parts.

Where a building is designed for phased evacuation (see above), it should be fitted with an appropriate fire warning system conforming to at least the L3 standard given in BS 5839-1. Additionally, an internal speech communication system (telephone, intercom etc.) should be provided so that conversation is possible between a fire warden at every floor level and a control point at the fire service access level.

Where a building contains an atrium and is designed in accordance with BS 9999:2008, then the relevant recommendations of that code should be followed for the installation of fire alarm and/or fire detection systems.

Further guidance on the standard of automatic fire detection that may need to be provided in a building can be found in:

- home office guides that support the Regulatory Reform (Fire Safety) Order 2005; and
- the NHS Estates 'Firecode' documents for buildings in the Institutional Purpose Group 2(a).

Design, maintenance and installation of systems

Fire warning and detection systems must be properly designed, installed and maintained. Installation and commissioning certificates should be obtained wherever a fire alarm system is installed. Additionally, the United Kingdom Accreditation Service (UKAS) and independent third party certification schemes for fire protection products and related services offer an effective means for providing the fullest possible assurances that the required level of performance will be achieved and that the products actually supplied are provided to the same specification or design as those that have been tested or assessed.

7.11 Sprinkler systems

7.11.1 Introduction

Sprinkler systems when installed in buildings can:

- reduce the risk to life;
- significantly reduce the likelihood of extensive property damage; and
- be used as a compensatory feature to vary the provisions of the ADs.

Although it is normal to require the sprinkler throughout the building, where a sprinkler is being utilised as a compensatory feature to mitigate against a particular risk, it is acceptable to provide protection to part of a building.

Many other fire suppression systems also exist; it is essential when considering alternatives that they have been designed and tested for the proposed use. For examples of such installers, the reader attention is drawn to BS 5306-0:2011: *Fire protection installations and equipment on premises. Guide to selection of installed systems and other fire equipment.*

A sprinkler system should be designed and installed in accordance with the following standards.

7.11.2 For dwellings and residential buildings

- BS 9251:2014 *Fire sprinkler systems for domestic and residential occupancies – Code of practice.* Further guidance can be found in the British Automatic Fire Sprinkler Association (BAFSA) publication Technical Guidance Note 1: *Design and installation of residential and domestic sprinkler systems,* 2nd edition (2012).
- Although specific guidance is not referenced in the AD B1, it may also be possible to demonstrate compliance by the installation of a suitably designed domestic watermist system. The British Standard Institution has published a draft for development document for domestically occupied residential premise not exceeding 20 m in height. DD 8458-1:2010: *Fixed fire protection systems – Residential and domestic watermist systems. Code of Practice for design and installation.* Careful consideration needs to be given to the risk. Further guidance is provided in the BAFSA's Technical Guidance Note 3: *Watermist systems: Compliance with current fire safety guidance* (2012).

7.11.3 Non-residential buildings

For non-residential buildings or dwellings and other residential buildings outside the scope of BS 9251, the following guidance is available:

- BS EN 12845:2004: *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance* + A2:2009 (incorporating corrigendum August 2009).
- As with residential, a commonly accepted alternative when considered having regard to the instance of risk in any particular circumstance are watermist systems. When considering such alternatives, guidance can be found in DD 8489-1:2011: *Fixed fire protection systems – Industrial and commercial watermist systems. Code of practice for design and installation.*

It should be noted that any sprinkler system installed to comply with the building regulations should be designed as a life safety system.

When considering non-residential sprinklers, water supplies should consist of:

- two single water supplies complying with BS EN 12845, clause 9.6.1, where each is independent of the other; or

- two stored water supplies which comply with the applicable clauses of BS EN 12845 as follows:
  - Gravity or suction tanks – Clause 9.6.2.
  - Any pump requirements – Clause 10.2.
  - Tank capacities should be at least half the minimum required and considered appropriate to the risk; or
  - One of the tanks should be at least half the specified water volume of a single full capacity tank, and the other should not be less than the minimum volume of a reduced capacity tank (see clause 9.3.4).

Note that whichever water storage solution is used, the overall capacity including any inflow for a reduced capacity should be at least equivalent to a single full holding capacity (see Tables 9 and 10 and clause 9.3.2.3 for hazard/pipework design).

If pumps draw water from two tanks, they should be set up to draw water from either tank and arranged so that either pump may be isolated.

The sprinkler water supply should not share connections with any other service or firefighting system.

7.12 Means of escape in dwellinghouses

7.12.1 Introduction

Approved Document B1 deals with means of escape from dwellinghouses according to the height of the top storey above ground level (i.e. the ground level on the lowest side of the building).

This is probably a sensible approach since storey heights can vary, and means of rescue through upper windows become more hazardous with increasing height. Thus, the divisions chosen are:

- houses with all floors not more than 4.5 m above ground (i.e. ground and first floor only);
- houses with one floor more than 4.5 m above ground (i.e. ground floor, first floor and second floor); and
- houses with two or more floors more than 4.5 m above ground (i.e. ground floor and three or more upper floors).

Therefore, as the height of the top floor increases above ground level, the means of escape provisions become more complex, and these are dealt with under separate sections below. Certain recommendations, however, are common to all dwellings and these include:

- the provision of an automatic fire detection and alarm system (see above);
- special provisions to deal with basements and inner rooms;
- windows and external doors used for escape purposes;
- protected escape routes;
- sprinkler protection; and
- balconies and flat roofs.

The guidance contained in this section is also applicable to houses in multiple occupations (HMOs) provided that there are no more than six residents. An HMO is defined in the Housing Act 2004 as:

- an entire flat or house which is let to three or more tenants who form two or more households and who share a kitchen, bathroom or toilet.
- bedsits or other non-self-contained accommodation occupied by three or more tenants who form two or more households.
- a converted property which contains self-contained flats which did not comply with the Building Regulations 1991, where one-third of the flats are let on short term tenancies.
- used by tenants only. This includes properties let to students or migrant workers as their main residents and domestic refuges.

For HMOs containing greater numbers of occupants is required to be licensed by the Local Authority. Technical guidance is provided by the Local Authority Coordinators of Regulatory Services (LACORS) *Housing – Fire Safety – Guidance on the fire safety provisions for certain types of existing housing* 2008. Such premises are also cited as relevant premises in the RRFSO (see 'Introduction' of this chapter).

It may also be possible to treat an unsupervised group home for mentally ill or mentally impaired people with up to six residents as an ordinary dwelling, but this will depend on the nature of the occupancy and its management. Such premises have to be registered; therefore the registration authority should be consulted to establish if there are any additional fire safety measures needed by the authority.

7.12.2 General provisions

Emergency egress doors and windows

- A window or door should lead to a place of safety from a fire (see Fig. 7.11). This excludes enclosed gardens or courtyards which are not as deep as the height of the house. This aspect of design often needs an element of judgement.

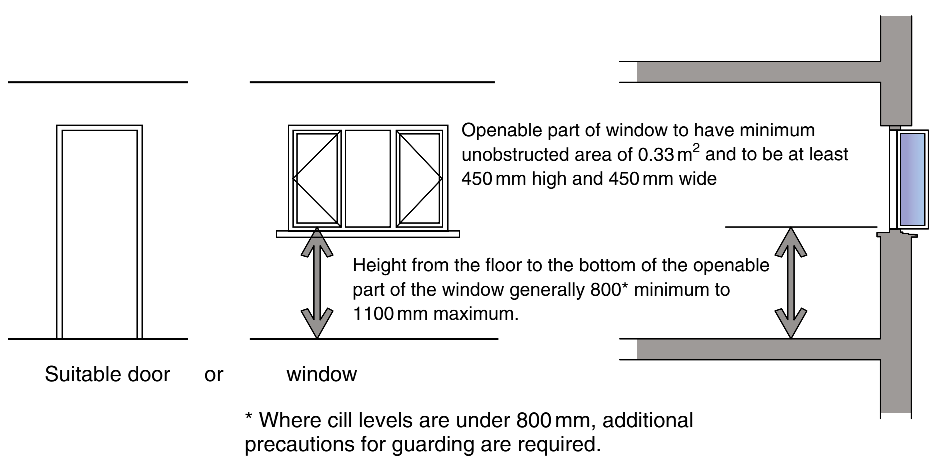


Fig. 7.11 Windows and doors for escape purposes.

- An emergency egress window should be:
  - a maximum of 0.33 m^2 unobstructed openable area;
  - at least 450 mm wide or high to allow safe passage; and
  - The bottom of the openable area should be between 600 mm and 1100 mm from the adjacent floor level. (Note: Part K does not require the provision guarding if the cill level is set at 600 mm.)

Lockable windows are allowed but are considered unwise. It is considered best practice to provide locks which will remain openable without the use of a key. If an egress window is fitted with child-resistant safety stays that limit the opening of the window, although allowable, it is considered wise to fit with a catch which will allow the window to be opened when required to the emergency egress dimensions given above. Should be designed in such a way as to avoid aided passage.

Enclosed rear gardens

Escape should be to a place of safety free from the effects of fire. Where this is to an enclosed rear garden or yard from which escape can be only by passing through other buildings, its length should be at least equivalent to the height of the dwelling (see Fig. 7.12).

Basements and inner rooms

With certain dwelling designs (such as open plan layouts and the provision of sleeping galleries), it is possible that a situation will be created whereby the innermost room (termed the inner room) will be put at risk by a fire occurring in the room that gives access to it (termed the access room), since escape is only possible by passing through that access room. Therefore, an inner room should only be used as:

- a kitchen, laundry or utility room;
- a dressing room;
- a bathroom, shower room or WC;
- any other room which has a suitable escape window or door (see next section for details), provided the room is in the basement or is on the ground or first floor; and
- a sleeping gallery (see below for details).

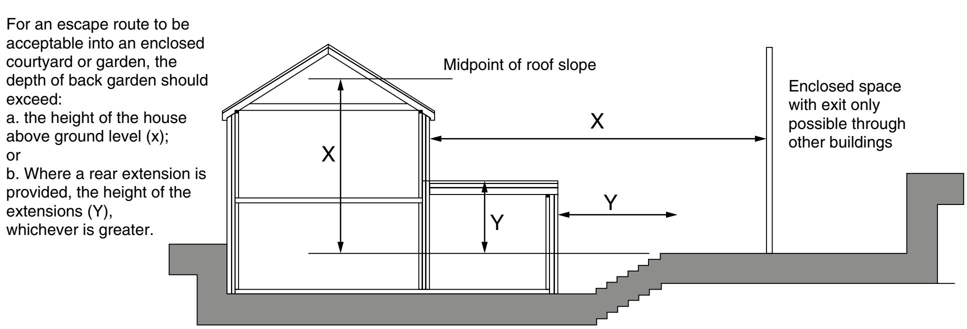


Fig. 7.12 Enclosed gardens or yards suitable for escape purposes.

Escape from a basement fire may be particularly hazardous if an internal stair has to be used, since it will be necessary to pass through a layer of smoke and hot gases. Therefore, any habitable room in a basement should have either:

- an alternative escape route via a suitable door or window; or
- a protected stairway leading from the basement to a final exit.

Balconies and flat roofs

If used as an escape route, a flat roof should:

- be part of the same building from which escape is being made;
- lead to a storey exit or external escape route;
- be provided with 30 minutes fire resistance. This applies only to the part of the flat roof forming the escape route, its supporting structure and any opening within 3 m of the escape route.

Balconies and flat roofs provided for escape purposes should be guarded in accordance with the provisions of Approved Document K.

Galleries

Where the dwelling contains a sleeping gallery (i.e. a floor which is used as a bedroom but which is open on at least one side to some other part of the dwelling) which is not more than 4.5 m above ground level:

- The distance between the foot of the access stair to the gallery and the door to the room which contains the gallery should not be more than 3 m.
- An alternative exit from the gallery complying with Fig. 7.11 should be provided, if the distance from the head of the access stair to any point in the gallery exceeds 7.5 m.
- Unless they are enclosed with fire-resisting construction, any cooking facilities within a room containing a gallery should be remote from the stair to the gallery and positioned so that they do not prejudice the escape route from the gallery.

7.12.3 Escape from ground storey

All habitable rooms (not including kitchens) in a ground storey should either:

- open directly to a hall which leads to a suitable exit, normally the entrance of the property; or
- be provided with a window or a door which meets the provisions of section 7.12.2.

7.12.4 Escape from upper floor not more than 4.5 m above ground level

All habitable rooms (not including kitchens) in an upper storey(s) which is served by one stair should:

- be provided with a window or a door which meets the provisions of section 7.12.2; or
- have direct access to a protected stairway which meets the provisions of section 7.12.5.

Provided that passage through the stair enclosure is not required and access is available by a communicating door between two rooms, escape may be by a single window within the communicating room (described below).

7.12.5 Escape from upper floor more than 4.5 m above ground level

For dwellinghouses with more than one internal stairway and then provided they are physically separated from each other, the following provisions can be ignored. The degree of physical separation can be via a number of rooms or by fire-resisting construction. Each case is normally considered on their merits of providing enhanced means of escape.

7.12.6 Dwellinghouse with one floor above 4.5 m from ground level

The following design principles apply:

- A protected stairway which should extend to a final exit or to a point on the ground floor where alternative routes to exit the building exist, which are separated by fire-resisting construction (see Fig. 7.13).
- The top storey should be separated from the lower storeys by fire-resisting construction and be provided with its own alternative final exit (see Fig. 7.14).

7.12.7 Dwellinghouses with more than one floor above 4.5 m from ground level

This applies to houses normally of four or more storeys. In addition to incorporating the measures for buildings with a storey above 4.5 m (see above), the following principles apply:

- Every storey which exceeds 7.5 m above the ground floor should be provided with an alternative escape route via:
  - the protected stairway to an upper storey or on the same floor; and
  - the protected stairway which should be housed in fire-resistant separation.
- If this difficult solution is not possible, a dwellinghouse served by a single stairway may be acceptable if a sprinkler system designed and installed in accordance with BS 9251:2014 is provided.

7.12.8 Air circulation systems in houses with any floor more than 4.5 m above ground

New houses are often fitted with air circulation systems designed for heating, energy conservation or condensation control. With such systems, there is the possibility that fire or smoke may spread (possibly by forced convection, natural convection or fire-induced convection) from the room of origin of the fire to the protected stairway. Clearly, the risk to life is greater in dwellings where there are floors at high levels, so AD B1 and BS 9991:2011 *Code of practice – Fire safety in the design and use of residential buildings* make the following recommendations for such buildings:

- The walls enclosing a protected stairway should not be fitted with transfer grilles.
- Where ductwork passes through the enclosure to a protected stairway, it should be fitted so that all joints between the ductwork and the enclosure are fire stopped.

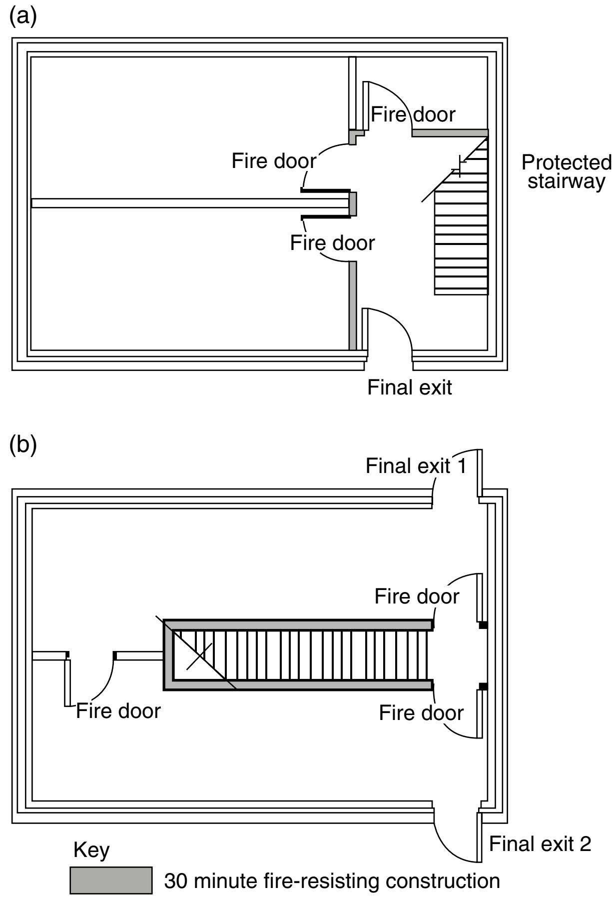


Fig. 7.13 Alternative arrangements for final exits.

- Ductwork used to convey air into the protected stairway through its enclosure should be ducted back to the plant.
- Grilles or registers which supply or return air should be positioned not more than 450 mm above floor level.
- Any room thermostat for a ducted warm air heating system should be mounted in the living room at a height between 1370 mm and 1830 mm, and its maximum setting should not be more than 27°C.
- BS 9991:2011 makes recommendations for Mechanical ventilation systems which recirculate air from ductwork.

7.12.9 Passenger lifts in dwellinghouses

If a passenger lift is installed in a dwellinghouse which serves any floor situated more than 4.5 m above ground level, it should either be contained in a fire-resisting lift shaft or be located in the enclosure to a protected stairway.

Example of alternative exit in paragraph 2.6(b)

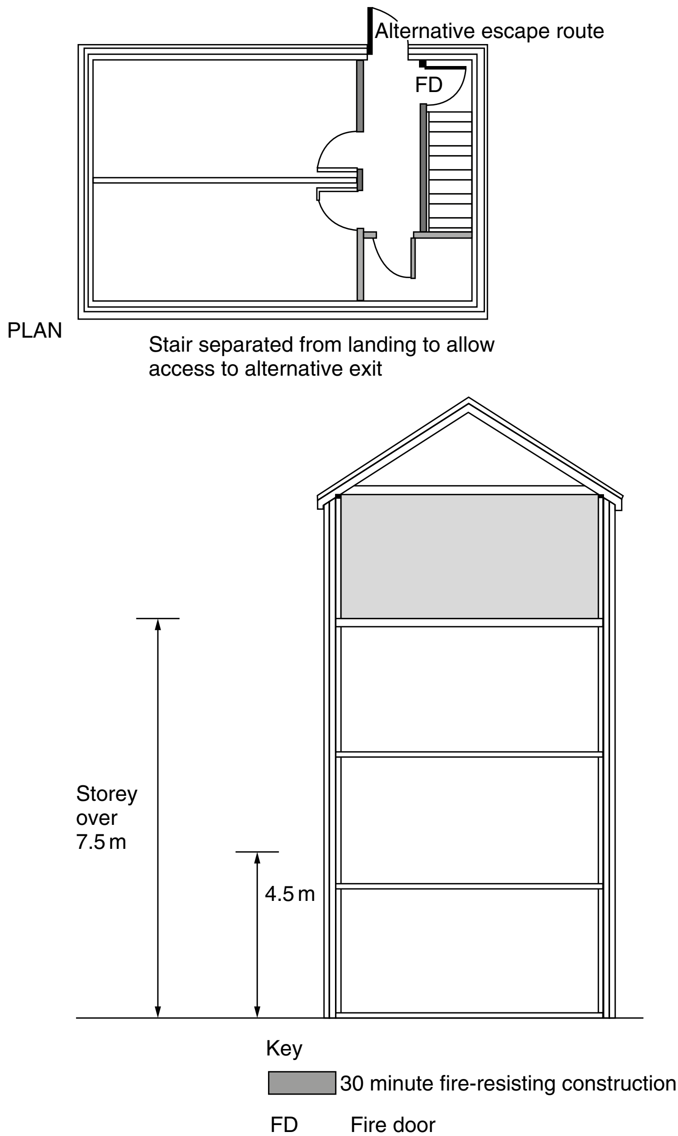


Fig. 7.14 Fire separation in houses with more than one floor over 4.5 m above ground level.

7.12.10 Work on existing houses

Replacement windows

Replacement windows are considered 'building work'. They are considered as a 'controlled service or fitting' as defined in Regulation 3(1). As such Part L and K of Schedule 1 should apply in full to replacement windows. However, they should also comply with Part B1 to the extent that after the work is complete, they should not provide a worse standard than that they provided prior to the alteration. This means that an escape window should:

- not have an openable area less than the window it replaced; or
- where a window with a very large openable area is being replaced, observe at least the minimum criteria as given in section 7.12.2.

Note that Part B3 may impose requirements for some forms of construction to ensure adequate protection is maintained.

Material alterations

The term 'material alteration' is considered in accordance with Regulation 3 and must comply with Schedule 1, Parts B1, B3, B4 and B5 to the extent that at any stage of the work, it should not result in the building being less compliant than it was before the work was carried out. In the case of 'building work' as defined by Regulation 4 in the context of material alteration, after works are carried out, the building should either be wholly compliant with Schedule 1 requirements or again no less compliant than it was before the work was carried out.

When considering the impact of the rules of material alteration, each circumstance should be considered on a case-by-case basis and have regard to the historical value of the building in question. Possible ways to satisfy the requirement includes:

- SMOKE DETECTION – Where new habitable rooms are to be provided, smoke alarms should be provided in accordance with the general provisions of section 7.10.

- LOFT CONVERSIONS – When converting an existing storey to add an additional habitable storey, the guidance of section 7.12 should be followed appropriate to the circumstances of the project.

Upgrading techniques are encouraged to ensure that the appropriate standard of fire resistance to features such as ceilings or doors can be achieved without the loss of historical features.

Where an open plan arrangement exists on the ground floor, it should be noted that it may be possible to:

- provide a suitable enclosure to provide access to an escape route similar to that in a newly built property.
- provide sprinkler protection to the open plan area. However, due to the likely varied smoke and fire load present within a dwelling, it is required that a FD20 (E20) fire door separates the open plan area from the upper storeys to prevent smoke from inhibiting rescue. On a storey not exceeding 4.5 m from external ground level, emergency egress windows complying with section 7.12.2 should be incorporated in the event of a fire occurring in the open plan area. It is required that cooking facilities are separated within fire-resisting construction.
- Other solutions are sometimes accepted by building control bodies which may involve the use of misting, smoke ventilation and detection systems. The basis for these solutions tends to be time based and almost always involves enhanced detection systems.

7.13 Flats and maisonettes

7.13.1 Introduction

It should be noted that the following topic is dealt with Approved Document B2. The reason for this is that in almost every situation, the works also need to be considered in the context of the Regulatory Reform (Fire Safety) Order 2005. Please refer to the chapter introduction for an overview of the Order.

Some additional solutions for such premises are provided within BS 9991:2011.

The means of warning and escape recommendations listed above for dwellinghouses, which consist of basement, ground and first floors only, apply equally to flats and maisonettes situated at these levels. At higher levels, escape through upper windows becomes more hazardous, and more complex provisions are necessary, especially in maisonettes where internal stairs will need protection.

In addition to the general assumptions stated in section 7.8 for all building types, the following assumptions are made when considering the means of warning and escape from flats and maisonettes.

- Fires generally originate in the dwelling.
- Rescue by ladders is not considered suitable.
- Fire spread beyond the dwelling of origin is unlikely due to the compartmentation recommendations in requirement B3; therefore simultaneous evacuation of the building should be unnecessary. Further guidance is available for high-rise properties, 'stay-put' strategies specifically. The Fire and Rescue Service may decide to evacuate the whole building. This is why heightened protection measures are recommended to staircase enclosures. These are discussed further in BS 9991:011.
- Fires which occur in common areas are unlikely to spread beyond the immediate vicinity of the outbreak due to the materials and construction used there.

The guidance contained in this section is also applicable to flats and maisonettes when they are considered to be houses in multiple occupations with an occupancy of more than six persons. These are defined in section 7.6.2 where references will be found to further guidance. Additionally, much of the following guidance will be applicable to flats used as sheltered housing although the nature of the occupancy may necessitate some additional fire protection measures.

7.13.2 Means of escape in flats and maisonettes

There are two main components to the means of escape from flats and maisonettes:

- Escape from within the dwelling itself; and
- Escape from the dwelling to the final exit from the building (usually along a common escape route).

The following sections consider these two components.

7.13.3 Means of escape from within flats and maisonettes

The provisions relating to inner rooms, basements, balconies and flat roofs in dwellings (see sections 7.12.2 and 7.12.4) also apply to the inner parts of flats and maisonettes. However, where a balcony is provided as an alternative exit to a dwelling situated more than 4.5 m above ground, it should be designed as a common balcony and should meet the conditions given in section 7.14.2 for alternative exits.

Flats and maisonettes with floors not more than 4.5 m above ground

Generally, where the floor of a flat or maisonette is not more than 4.5 m above ground, it should be planned so that any habitable room in a ground or upper storey is provided with a suitable escape window or door, as shown in Fig. 7.11.

A single door or window in an upper storey can serve two rooms provided that they each have their own access to the stair enclosure or entrance hall. A communicating door should be provided between the rooms so that it is possible to gain access to the door or window without entering the stair enclosure or entrance hall.

Alternatively, upper floors can be designed to follow the remainder of the guidance described below, in which case escape windows in upper storeys will be unnecessary.

Flats and maisonettes with floors more than 4.5 m above ground

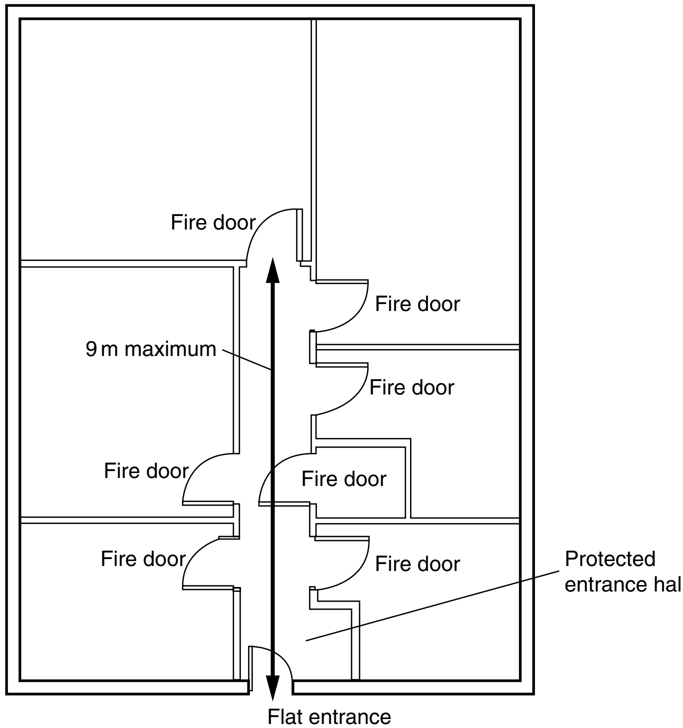
Provided that the restrictions on inner rooms are observed, three possible solutions to the internal planning of flats are given in AD B volume 2:

- All the habitable rooms in the flat are arranged to have direct access to a protected entrance hall. The maximum distance from the entrance door to the door of a habitable room should not exceed 9 m (see Fig. 7.15(a)).
- In flats where a protected entrance hall is not provided, the 9 m distance referred to in (a) should be taken as the furthest distance from any point in the flat to the entrance door. Cooking facilities should be remote from the entrance door and positioned so that they do not prejudice the escape route from any point in the flat (see Fig. 7.15(b)).
- Provide an alternative exit from the flat. In this case, the internal planning will be more flexible. An example of a typical flat plan where an alternative exit is provided, but not all the habitable rooms have direct access to the entrance hall, is shown in Fig. 7.15(c).

Where flats and maisonettes with floors more than 4.5 m above ground are fitted with air circulation systems designed for heating, energy conservation or condensation control, there is the possibility that fire or smoke may spread from the room of origin of the fire to the protected entrance hall or landing. Clearly, the risk to life is greater where there are floors at high levels, so AD B volume 2 and BS 9991:2011 make the following recommendations for such buildings:

- Any wall, door, floor or ceiling enclosing a protected entrance hall of a dwelling or protected stairway and landing of a maisonette should not be fitted with transfer grilles.

(a)



Notes:

1. This diagram does not apply where the gallery is:
   i. provided with an alternative escape route; or
   ii. provided with an emergency egress window (where the gallery floor is not more than 4.5 m above ground level)
2. Any cooking facilities within a room containing a gallery should either:
   i. be enclosed with fire resisting construction; or
   ii. be remote from the stair to the gallery and positioned such that they do not prejudice the escape from the gallery

Fig. 7.15 (a) Flat where all habitable rooms have direct access to an entrance hall.

- Where ductwork passes through the enclosure to a protected entrance hall or protected stairway and landing, it should be fitted so that all joints between the ductwork and the enclosure are fire stopped.
- Ductwork used to convey air into the protected entrance hall of a dwelling or protected stairway and landing of a maisonette through the enclosure of the protected hall or stairway should be ducted back to the plant.
- Grilles or registers which supply or return air should be positioned not more than 450 mm above floor level.
- Any room thermostat for a ducted warm air heating system should be mounted in an area from which air is drawn directly to the heating unit at a height between 1370 mm and 1830 mm, and its maximum setting should not be more than 27°C.
- Mechanical ventilation systems which recirculate air should comply with BS 9999.

(b)

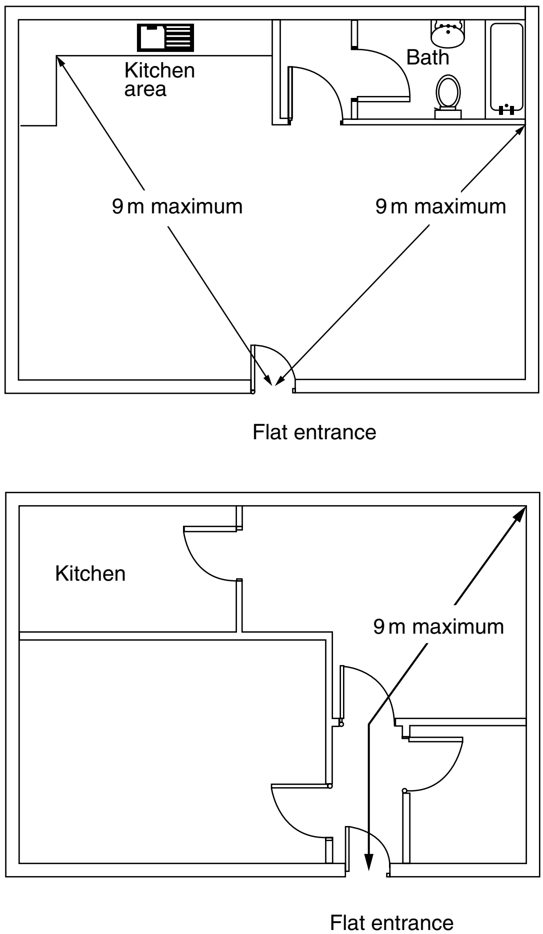


Fig. 7.15 (*Continued*) (b) Flat with restricted travel distance from furthest point from entrance.

Maisonette with independent external entrance at ground level

A maisonette of this type is similar to a dwellinghouse and should have a means of escape which complies with the recommendations for dwellings described in section 7.12, depending on the height of the top storey above ground.

Maisonette (multistorey flat) with floor more than 4.5 m above ground and no external entrance at ground level

Four internal planning arrangements are described in AD for maisonettes of this type. These are illustrated in Fig. 7.16(a) and (b), as follows:

- Provide each habitable room which is not on the entrance floor with an alternative exit.

(c)

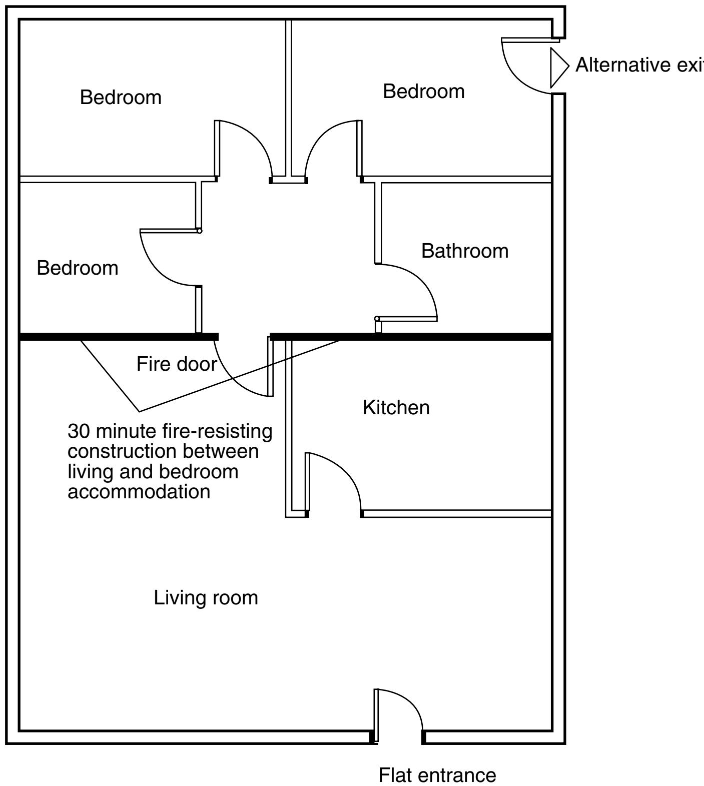


Fig. 7.15 (*Continued*) (c) Flat with alternative exit but where all habitable rooms have no direct access to an entrance hall.

- Provide a protected entrance hall and/or landing entered directly from all the habitable rooms on that floor. Additionally, one alternative exit should be provided on each floor which is not the entrance floor.
- If the vertical distance between the floor and the entrance storey and the floors above or below do not exceed 7.5 m, a protected stairway should be provided with at least an LD2 automatic fire alarm to BS 5839: Part 6, i.e. additional detectors are required to all habitable rooms and heat alarm in the kitchen.
- Provide a protected stairway and residential sprinkler system complying with section 7.11. An LD2 alarm system is still required.

7.13.4 Alternative exits from flats and maisonettes

That part of the means of escape from the entrance door of a flat or maisonette to a final exit from the building is often by way of a route which is common to all dwellings in the block. The provisions described below for means of escape in the common parts of flats and maisonettes are not applicable to such buildings where the top floor is not more than

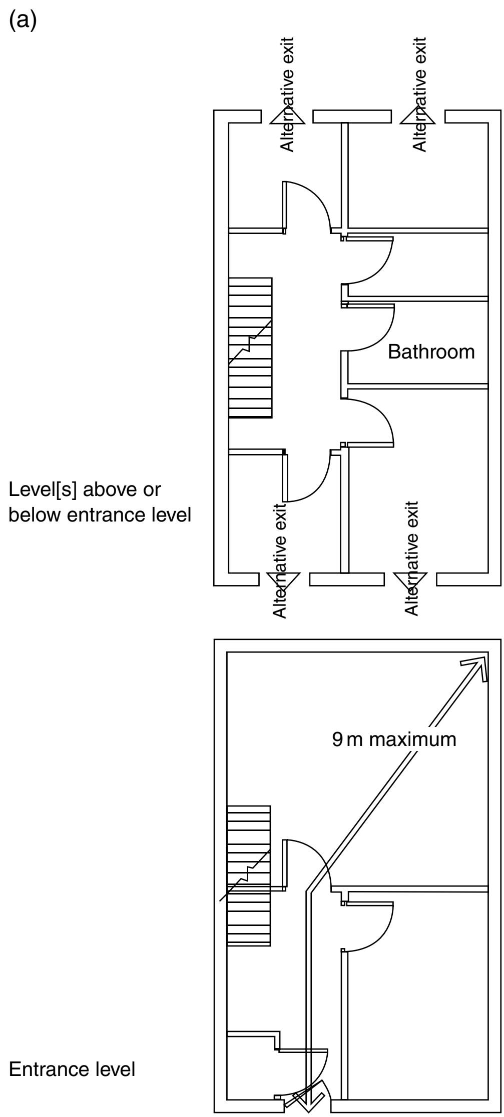


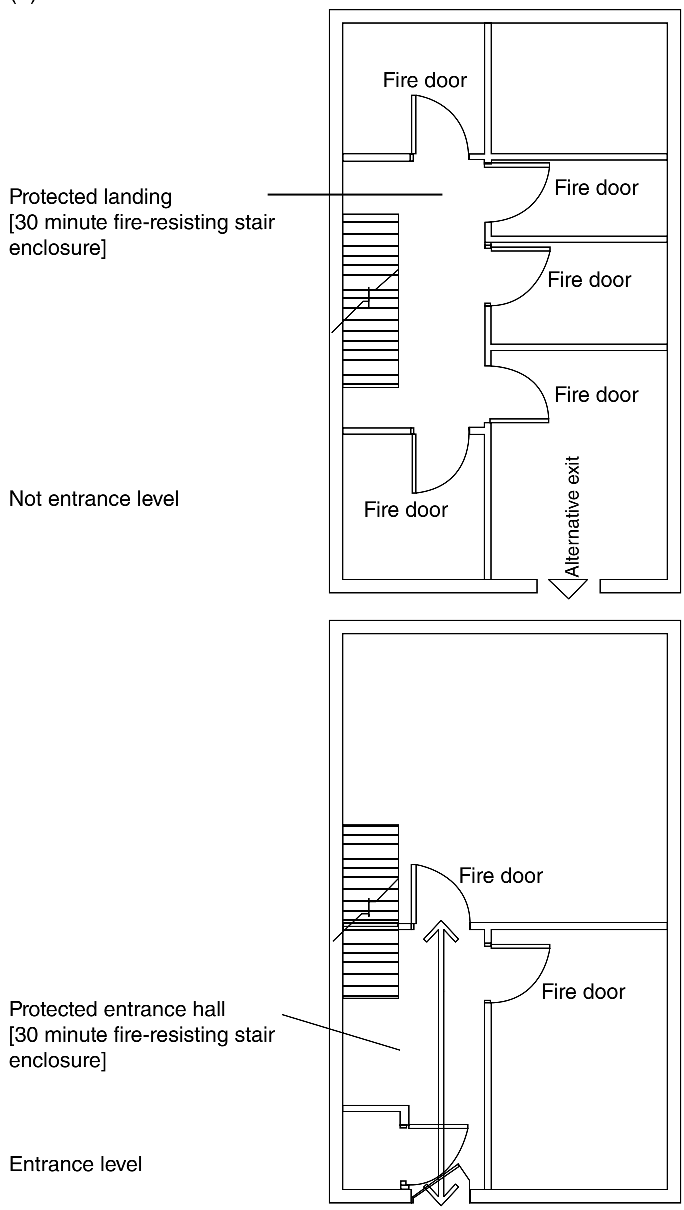
Fig. 7.16 (a) Maisonette with alternative exits from each habitable room, except the entrance hall.

4.5 m above ground level. However, they should be read in conjunction with the section on 'Provision and protection of stairs' in section 7.14.8.

Reference has been made above to the provision of alternative exits in certain planning arrangements for flats and maisonettes. Alternative exits will only be effective if they are remote from the main entrance door to the dwelling and lead to a common stair or final exit by means of:

- a door to an access corridor, access lobby or common balcony;
- an internal private stairway leading to an access corridor, access lobby or common balcony on another level;

(b)



Note: This only applies where at least one storey is more than 4.5 m above ground level.

Fig. 7.16 (*Continued*) (b) Maisonette with protected entrance hall and landing.

- a door onto a common stair;
- a door to an external stair; or
- a door to an escape route over a flat roof.

7.13.5 Means of escape in the common parts of flats and maisonettes

In general, flats and maisonettes should have access to an alternative means of escape. In this way, it will be possible to escape from a fire in a neighbouring flat by walking away from it. It is not always possible to provide alternative escape routes (which means providing two or more staircases) in all buildings containing flats and maisonettes; therefore single staircase buildings are permissible in certain circumstances. Typical examples of single and multi-stair buildings are described below.

Flats and maisonettes with single common stairs

In larger buildings, it will be necessary to separate the entrance to each dwelling from the common stair by a protected lobby or common corridor. The maximum distance from any entrance door to the common stair or protected lobby should not exceed 7.5 m (see Fig. 7.17(a) and (b)). These recommendations may be modified for smaller buildings in the following cases:

- The building consists of a ground storey and no more than three other storeys above the ground storey.
- The top floor does not exceed 11 m above ground level.
- The stair does not connect to a covered car park unless it is open sided.
- The stair does not also serve ancillary accommodation (see section 7.3), although this does not apply to ancillary accommodation:
  (a) in any storey which does not contain dwellings; and
  (b) which is separated from the stair by a ventilated protected lobby or ventilated protected corridor (i.e. provide permanent ventilation of not less than 0.4 m^2 or a mechanical smoke control system to prevent the ingress of smoke).

The modified recommendations are illustrated in Fig. 7.18(a). The maximum distance from the dwelling entrance door to the stair entrance should be reduced to 4.5 m. If the intervening lobby is provided with an automatic opening vent, this distance may be increased to 7.5 m. Where the building contains only two flats per floor, further simplifications as shown in Fig. 7.18(b) are possible. Staircase protection may also be provided by forming a protected entrance hall to the dwelling.

Flats and maisonettes with more than one common stair

Where escape is possible in two directions from the dwelling entrance door, the maximum escape distance to a storey exit may be increased to 30 m.

Furthermore, if all the dwellings on a storey have independent alternative means of escape, the maximum travel distance of 30 m does not apply. (There is still, however, the need to comply with the fire service access recommendations in Approved Document B5, where vehicle access for a pump appliance should be within 45 m of all points within a dwelling.)

In buildings of this type, it is possible to have a dead-end situation where the stairs are not located at the extremities of each storey. This is permissible provided that the dead-end

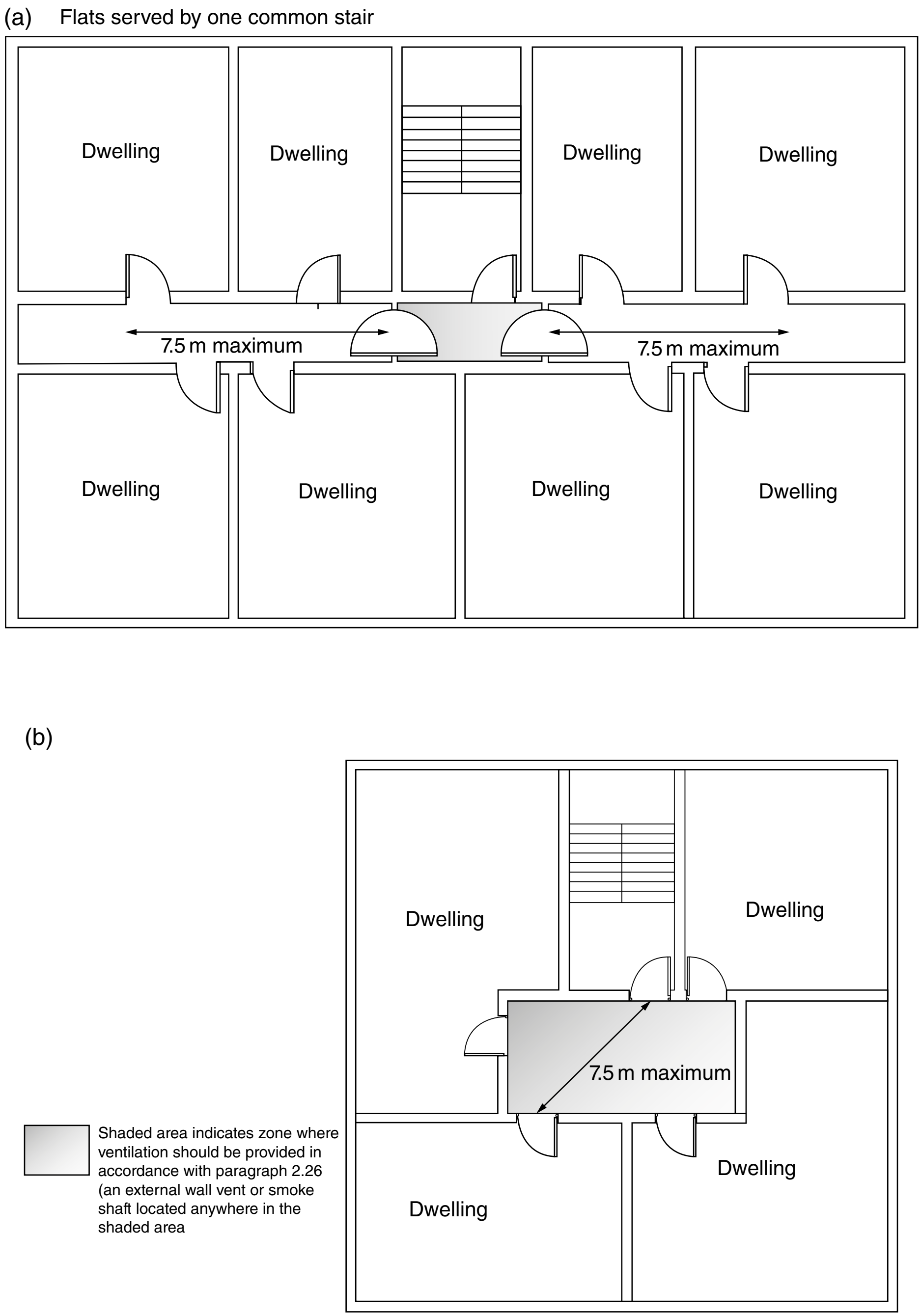
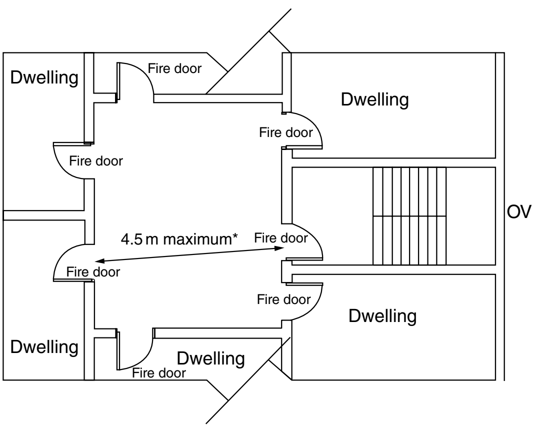
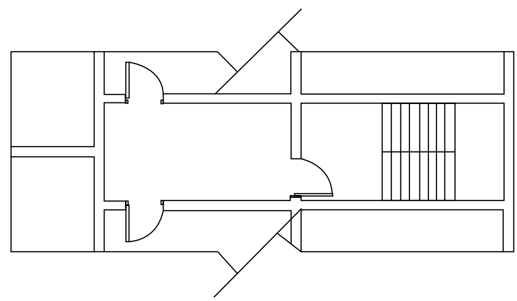


Fig. 7.17 (a) Flats served by one common stair. (b) Lobby access dwellings.

Key
Fire-resisting construction provided to all walling
OV openable vent at high level for fire service use [1 .0 m^2 minimum free area] – see paragraph 2.21e



a. Small single stair building
* If smoke control is provided in the lobby, the travel distance can be increased to 7.5 m maximum [see Diagram 7, example b]



b. Small single stair building with no more than 2 dwellings per storey
The door between the stair and lobby should be free from security fastenings

If the dwellings have protected entrance halls, the lobby between the common stair and dwelling entrance is not essential.

Notes:
1. The arrangements shown also apply to the top storey.
2. If the travel distance across the lobby in diagram 9a exceeds 4.5 m, diagram 7 applies.
3. Where, in diagram 9b, the lobby between the common stair and the dwelling is omitted in small single stair buildings, an automatic opening vent with a geometric free area of at least 1.0 m^2 is required to the top of the stair, to be operated on detection of smoke at any storey in the stair.

Fig. 7.18 Common escape route in small single-stair buildings.

portions of the corridor are fitted with automatic opening vents, and the dwelling entrance doors are within 7.5 m of the common stair entrance.

Typical details of flats and maisonettes with more than one common stair are shown in Fig. 7.19.

Flats and maisonettes with balcony or deck approach

This is a fairly common arrangement whereby all dwellings are accessed by a continuous open balcony or deck on one or both sides of the block. The reader is referred to clause 7.3 of BS 9991:2011 on which the following notes are based. The principal risk in such arrangements is smoke logging of the balconies or decks. This is less likely to occur when the balconies are relatively narrow; therefore the only considerations necessary are these:

- The vehicle access for a fire service pump appliance is within 45 m of every dwelling entrance door, and all parts of the building are within 60 m of a fire main.
- In the case of single-stair buildings, the persons wishing to escape past the dwelling on fire can do so safely. This is usually achieved by ensuring that the external part of each dwelling facing the balcony is protected by 30 minutes fire-resisting construction for a distance of 1100 mm from the balcony floor level.

Smoke logging is more likely to occur with the adoption of wider balconies or a deck approach. The provision of downstands from the soffit above a deck or balcony at right angles to the face of the building can reduce the possibility of smoke from any dwelling on fire spreading laterally along the deck. This would also reduce the chances of smoke logging on the decks above. Therefore, where the soffit above a deck or a balcony has a width of 2 m or more:

- it should be designed with downstands placed at 90° to the face of the building (on the line of separation between individual dwellings); and
- the downstand should project 300 mm to 600 mm below any other beam or downstand parallel to the face of the building.

There is a risk that occupants of dwellings with wider balconies or deck approach will use this opportunity of greater depth to erect 'external' stores or other fire risks. Therefore, no store or other fire risk should be erected externally on the balcony or deck.

Examples of common escape routes for dwellings with balcony or deck access are shown in Fig. 7.20.

Additional provisions for common escape routes

Common escape routes should be planned so that they are not put at risk by a fire in any of the dwellings or in any stores or ancillary accommodation. The following recommendations are designed to provide additional protection to these routes:

- It should not be necessary to pass through one stairway enclosure to reach another. Where this is unavoidable a protected lobby should be provided to the stairway. This lobby may be passed through in order to reach the other stair.

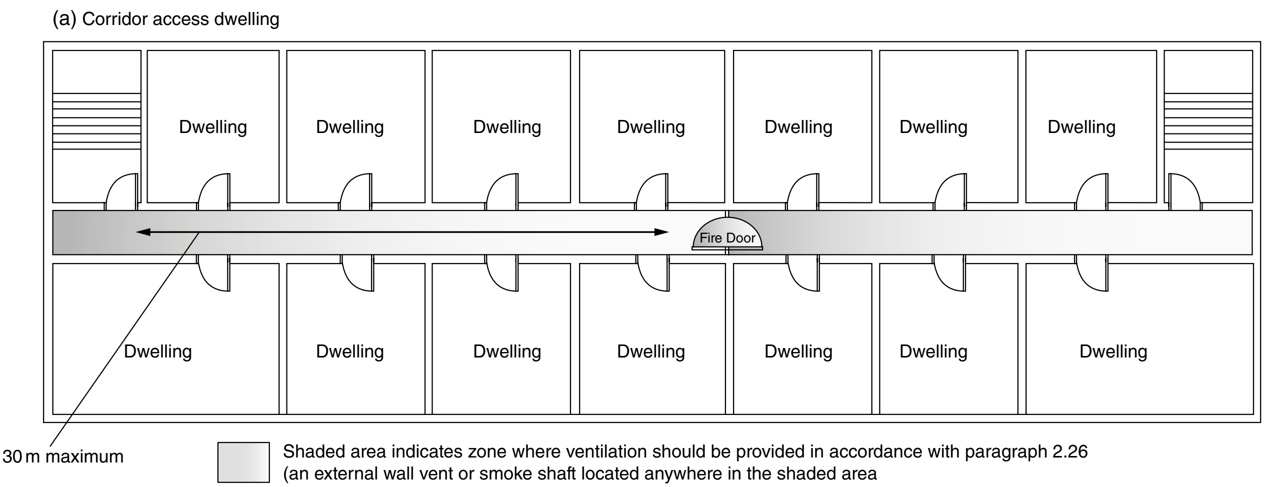


Fig. 7.19 Flats served by more than one common stair.

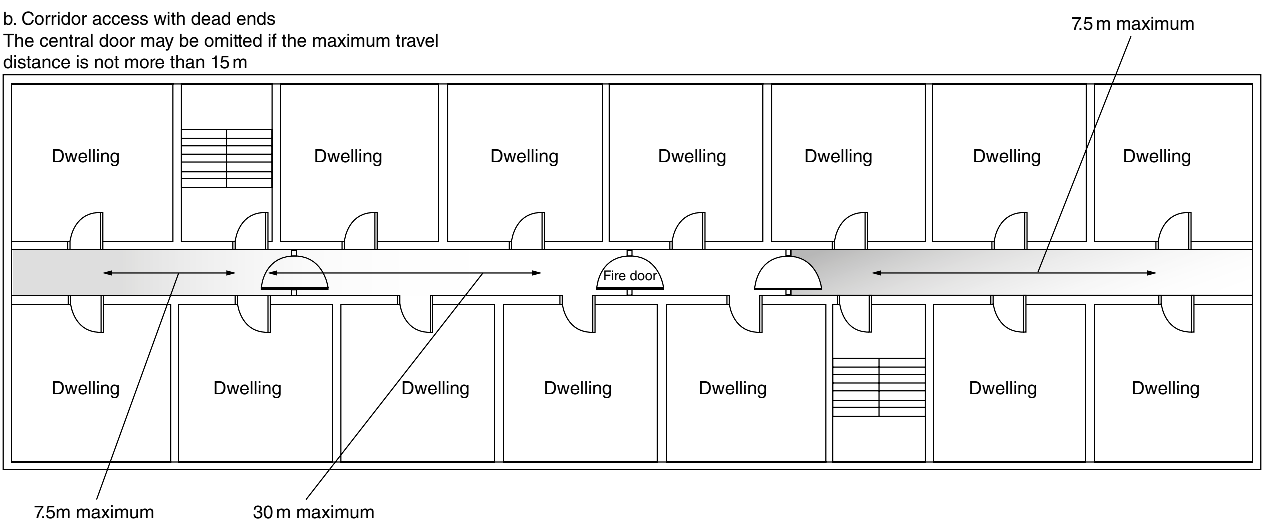


Fig. 7.19(b) (*Continued*)

(c)
'T' junction with main corridor

Note: The arrangements shown also apply to the top storey

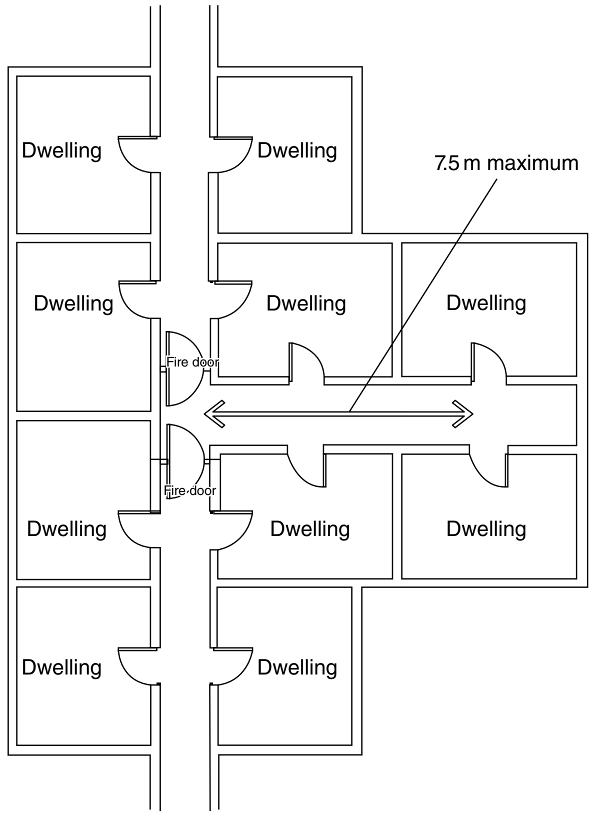


Fig. 7.19(c) (*Continued*)

- Common corridors should be designed as protected corridors and should be constructed to be fire resisting.
- The wall between each dwelling and the common corridor should be a compartment wall.
- A common corridor connecting two or more storey exits should be subdivided with a self-closing fire door and/or fire-resistant screen positioned so that smoke will not affect access to more than one storey exit.
- A dead-end section of a common corridor should be separated in a similar manner from the rest of the corridor.
- Protected lobbies and corridors should not contain any stores, refuse chutes, refuse storage areas or other ancillary accommodation. See section 7.15.10 for further details of the provision of refuse chutes and stores.

Ventilation of common escape routes

Although precautions can be taken to prevent the ingress of smoke onto common corridors and lobbies, it is almost inevitable that there will be some leakage since a flat entrance door must be opened in order that the occupants can escape. Provisions for ventilation of

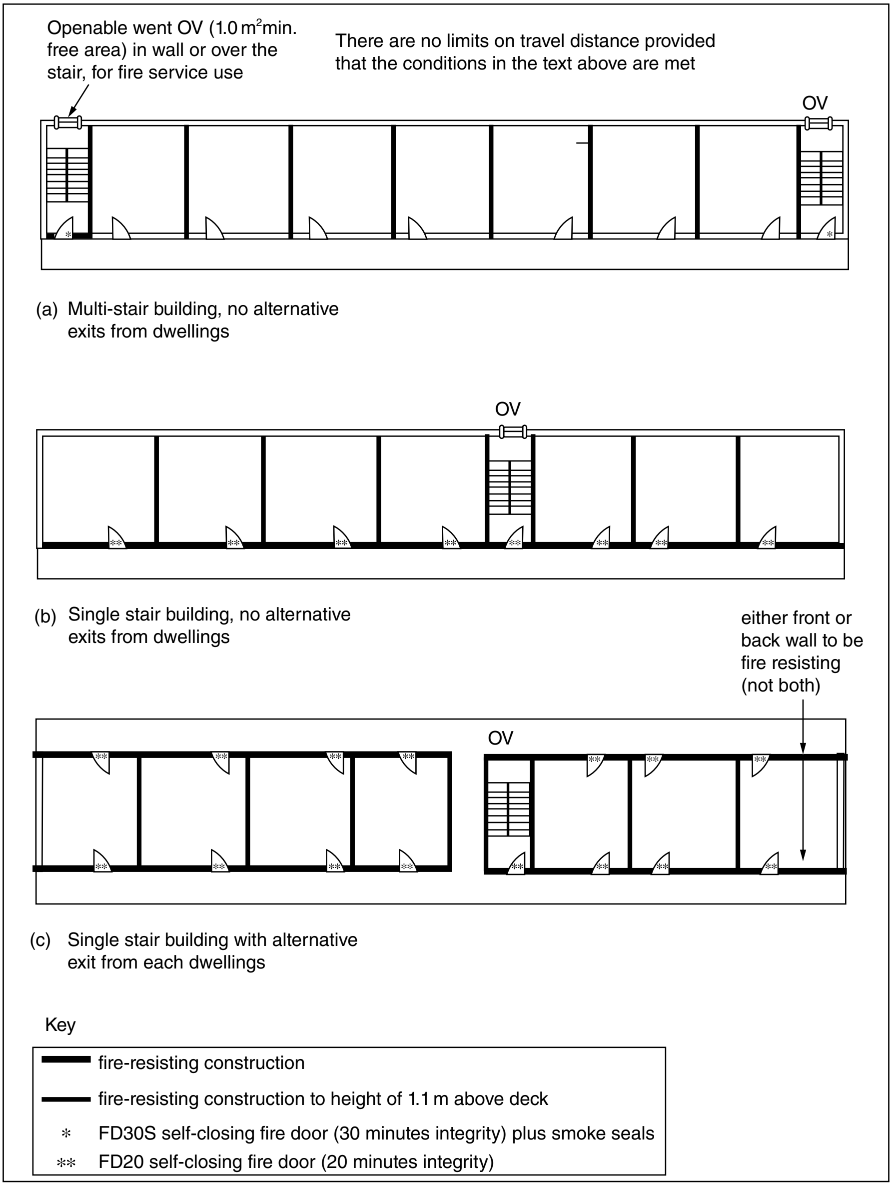


Fig. 7.20 Dwellings with balcony or deck approach.

the common areas (which also provide some protection for common stairs) are therefore vital and may be summarised as follows:

- Subject to the variations shown in Fig. 7.17(a) and (b), common corridors or lobbies in larger, single-stair buildings should be provided with automatic opening ventilators, triggered by automatic smoke detection located in the space to be ventilated. These should be positioned as shown in the figure, have a free area of at least 1.5 m^2 and be fitted with a manual override.

- Small single-stair buildings provided that the top floor level does not exceed 11 m and that there are no more than three floor above ground floor level should conform to the guidance shown in Fig. 7.18(a) and (b). Note that the stair should not connect with a covered car park unless it is open sided.
- Common corridors in multi-stair buildings should extend at both ends to the external face of the building where openable ventilators, or automatic opening ventilators, should be fitted for fire service use. They should have a free area of 1.0 m^2 at each end of the corridor (see Fig. 7.19).
- It is possible to protect escape stairways, corridors and lobbies by means of smoke control systems employing pressurisation. These systems should comply with the relevant provisions of BS 9999-1. Where these are provided the cross corridor fire doors and the openable and automatic opening ventilators referred to above should be omitted.

Escape routes across flat roofs

Where more than one escape route exists from a storey or part of a building, one of those routes may be across a flat roof if the following conditions are observed:

- The flat roof should be part of the same building.
- The escape route over the flat roof should lead to a storey exit or external escape route.
- The roof and its structure forming the escape route should be fire resisting.
- Any opening within 3 m of the route should be fire resisting.
- The route should be adequately defined and guarded in accordance with Approved Document K. (This relates to the provision of barriers at least 1100 mm high designed to prevent people falling from the escape route. The barriers should be capable of resisting at least the horizontal force given in BS EN 1991-1-7:2006).

Provision of common stairs in flats and maisonettes

Stairs which are used for escape purposes should provide a reasonable degree of safety during evacuation of a building. Since they may also form a potential route for fire spread from floor to floor, there are recommendations contained in parts B3 of the ADs which are designed to prevent this. Stairs may also be used for firefighting purposes. In this case reference should be made to the recommendations contained in Part B5 of AD B volume 2 (see section 7.28). The following recommendations are specifically for means of escape purposes:

- Each common stair should be situated in a fire-resisting enclosure with the appropriate level of fire resistance taken from Tables Al and A2 of Appendix A of the ADs.
- Each protected stair should discharge either:
  (a) direct to a final exit; or
  (b) by means of a protected exit passageway to a final exit.
- If two protected stairways or protected exit passageways leading to different final exits are adjacent, they should be separated by an imperforate enclosure.
- A protected stairway should not be used for anything else apart from a lift well or electricity meters.

- Openings in the external walls of protected stairways should be protected from fire in other parts of the building if they are situated where they might be at risk. See section 7.14.3 for additional guidance about on measures to protect common escape routes.
- A stair of acceptable width for everyday use will also be sufficient for escape purposes (BS 9999 recommends a minimum width of 1 m); however if the stair is also a firefighting stair, this should be increased to 1.1 m.
- Basement stairs will need to comply with special measures (see section 7.14.9).
- Gas service pipes and meters should only be installed in protected stairways if the installation complies with the requirements for installation and connection set out in the Pipelines Safety Regulations 1996 SI 1996/825 and the Gas Safety (Installation and Use) Regulations 1998 SI 1998/2451.
- A common stair which forms part of the only escape route from a flat or maisonette should not also serve any fire risk area such as a covered car park, boiler room, fuel storage space or other similar ancillary accommodation on the same storey as that dwelling (but see the exceptions to this in section 7.13.3 'Flats and maisonettes with single common stairs').
- Where, in addition to the common stair, an alternative escape route is provided from a dwelling, it is permitted to serve ancillary accommodation from the common stair, provided that it is separated from that accommodation by a protected lobby or protected corridor.
- Where any stair serves an enclosed car park or place of special fire hazard (see section 7.2), it should be separated from that accommodation by a ventilated lobby or ventilated corridor (i.e. provide permanent ventilation of not less than 0.4 m^2 or a mechanical smoke control system to prevent the ingress of smoke).

7.13.6 External access and escape stairs

Where the building (or any part of it) is permitted to be served by a single access stair, that stair may be placed externally if it serves a floor which is not more than 6 m above ground level and it complies with the provisions listed at (2) to (6) (see Fig. 7.21(a)).

Where there is more than one escape route available from a storey or part of a building, some of the escape routes may be by way of an external escape stair if there is at least one internal escape stair serving every part of each storey (excluding plant areas) if the following provisions can be met:

(1) The stair should not serve any floors which are more than 6 m above the ground or a roof or podium. The roof or podium should itself be served by an independent protected stair.

(2) If it is more than 6 m in vertical extent, it is sufficiently protected from adverse weather. This does not necessarily mean that full enclosure will be necessary. The stair may be located so that protection may be obtained from the building itself. In deciding on the degree of protection, it is necessary to consider the height of the stair, the familiarity of the occupants with the building and the likelihood of the stair becoming impassable as a consequence of adverse weather conditions.

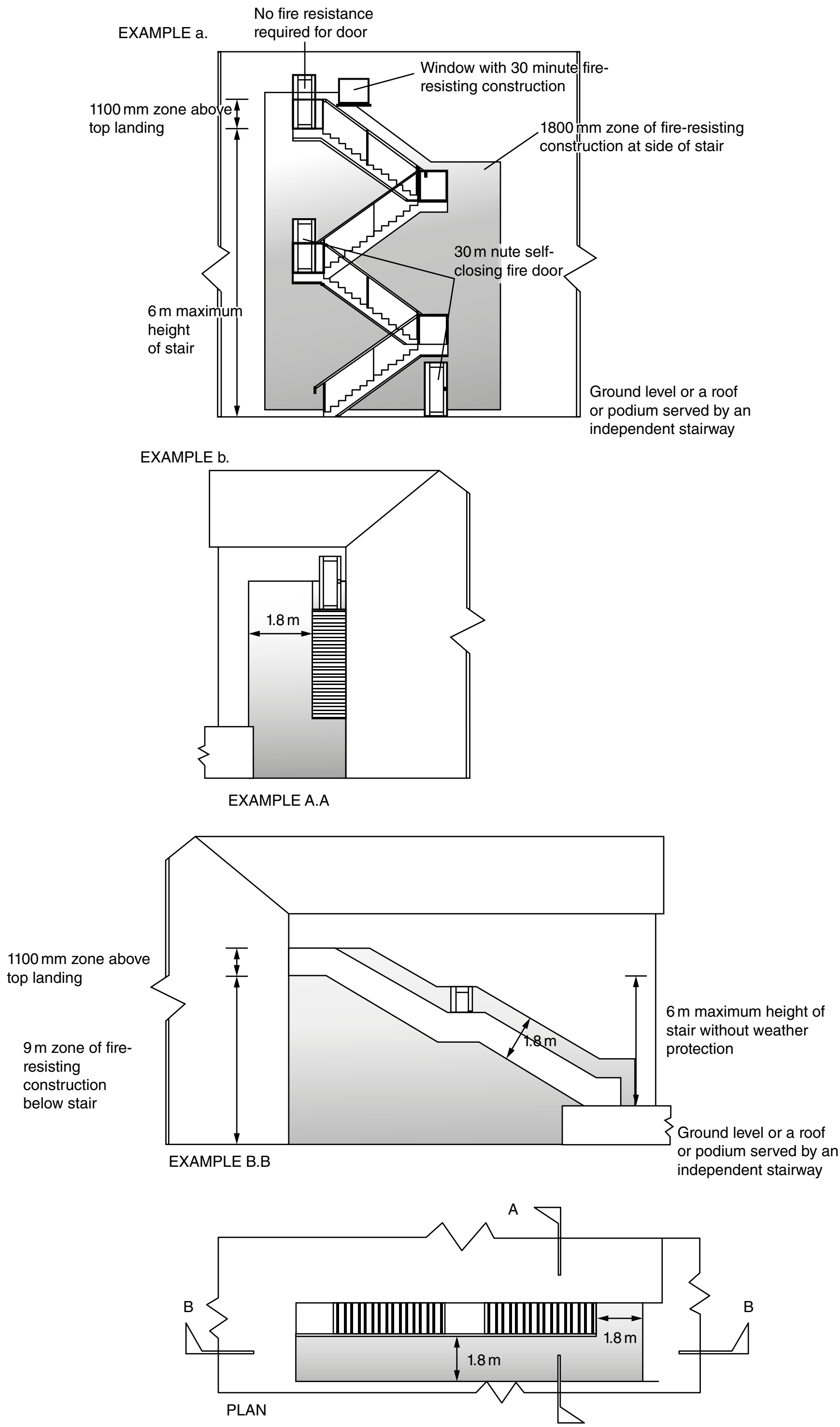


Fig. 7.21 External escape stairs to dwellings.

(3) Any part of the building (including windows and doors, etc.) which is within 1.8 m of the escape route from the stair to a place of safety should be protected with fire-resisting construction. This does not apply if there is a choice of routes from the foot of the stair thereby enabling the people escaping to avoid the effects of fire in the adjoining building. Additionally, any part of an external wall which is within 1.8 m of an external escape route (other than a stair) should be of fire-resisting construction up to a height of 1.1 m from the paving level of the route.
(4) All the doors which lead onto the stair should be fire resisting and self-closing. This does not apply to the only exit door to the landing at the head of a stair which leads downward.
(5) Any part of the external envelope of the building which is within 1.8 m of (and 9 m vertically below) the flights and landings of the stair should be of fire-resisting construction. This 1.8 m dimension may be reduced to 1.1 m above the top landing level provided that this is not the top of a stair up from basement level to ground.
(6) Any glazing which is contained within the fire-resisting areas mentioned above should also be fire resisting in terms of maintaining its integrity in a fire and be fixed shut. (For example, Georgian wired glass is adequate; it does not also have to meet the requirements for insulation.)

These provisions are illustrated in Fig. 7.21.

Stairs to dwellings in mixed use buildings

Many buildings consist of a mix of dwellings (i.e. flats and maisonettes) and other uses. Sometimes the dwellings are ancillary to the main use (such as a caretaker's flat in an office block), and sometimes they form a distinct separate use (as in the case of shops with flats over). Clearly, the degree of separation of the uses for means of escape purposes will depend on the height of the building and the extent to which the uses are interdependent.

Where a building has no more than three storeys above the ground storey, the stairs may serve both non-residential and dwelling uses, with the proviso that each occupancy is separated from the stairs by protected lobbies at all levels.

In larger buildings where there are more than three storeys above the ground storey, stairs may serve both the dwellings and the other occupancies if:

- the dwelling is ancillary to the main use of the building and is provided with an independent alternative escape route;
- the stair is separated from other occupancies in the building at lower storey levels by protected lobbies at those levels and has the same standard of fire resistance as that required by Approved Document B for the rest of the building (including any additional provisions if it is a firefighting stair);
- any automatic fire detection and alarm system fitted in the main part of the building is extended to the flat; and
- any security measures (usually installed for the benefit of the non-dwelling use) do not prevent escape at all material times.

Where fuels such as petrol and liquid petroleum gas are stored, additional measures (such as an increase in the fire resistance period for the structure between the storage area and the dwelling) may be necessary.

7.14 Means of escape from buildings other than dwellinghouses, flats and maisonettes

7.14.1 Introduction

So far we have discussed the provisions for means of escape in buildings of Purpose Groups 1(a), (b) and (c), i.e. dwellinghouses, flats and maisonettes. Although only a few of the more common arrangements for flats and maisonettes are covered in the Approved Document, the recommendations which are given are quite detailed and should form the basis for sound design guidance.

All other building types are grouped together in the remainder of AD B volume 2, and design recommendations are given for horizontal escape in section 3 and vertical escape in section 4. Of necessity, the guidance given is general in nature and is aimed at smaller, simpler types of buildings. For more complex or specialised buildings, designers may well find that it is better to use other relevant design documents (such as the BS 9999) where more comprehensive guidance may be given.

7.14.2 Horizontal escape routes in buildings other than dwellings

Section 3 of AD B volume 2 deals with the provision of means of escape from any point in the floor of a building to the storey exit of that floor. It covers all buildings apart from dwellinghouses, flats and maisonettes. Whilst most of the guidance given in section 3 is related to general issues of design, the layouts of certain institutional buildings may warrant special provisions, and some guidance on this is given in section 3.

The main decision that needs to be taken when designing the means of escape from a building is the number of escape routes and exits that are required. This will depend on:

- the maximum travel distance which is permitted to the nearest exit; and
- the number of occupants in the room, tier or storey under consideration.

Maximum travel distances and alternative escape routes in buildings other than dwellings

Ideally, there should be alternative escape routes provided from every part of the building. This is especially important in multistorey buildings and in buildings where a mixture of Purpose Groups are present. In fact, if a mixed use building also contains Residential or Assembly and Recreation purpose groups, these should be served by their own independent means of escape. (But see the exceptions to this for flats, described under section 'Stairs to dwellings in mixed use buildings'.)

Where alternative escape routes are provided, escape will be possible in more than one direction. AD B volume 2 places limits on the travel distance from any part of a room, tier or storey to a storey exit, and these are shown in Table 2 from AD B volume 2. The substance of Table 2 is summarised in Table 7.2. It should be read in conjunction with the following comments:

- The Table dimensions are actual travel distances and are measured along the shortest route taken by a person escaping in the event of a fire.
- Where there is fixed seating or there are other fixed obstructions, the travel distance is measured along the centre line of the seatways or gangways.
- Where the route of travel includes a stair, it is measured along the pitch line on the centre line of travel.
- Where the layout of a room or storey is not known at the design stage, the direct distance measured in a straight line should be taken. Direct distances should be taken as two-thirds of the travel distance.

Once it has been established that *at least one exit* is within the distance limitations given in Table 7.2, the other exits may be farther away than the distances given.

It will be observed from Table 7.2 that where escape is possible in one direction, only the travel distances are much reduced. However, where a storey exit can be reached within these one-direction travel distances, it is not necessary to provide an alternative route except in the case of a room or storey that:

- has an occupant capacity exceeding 60 in the case of places of assembly or bars;
- has an occupant capacity exceeding 30 if the building is in Purpose Group 2(a) Residential (institutional); or
- is used for inpatient care in hospitals.

Similarly, it is often the case that there will not be alternative escape routes, especially at the beginning of an escape route. A room may have only one exit onto a corridor from where it may be possible to escape in two directions. This is permissible provided that:

- the overall distance from the farthest point in the room to the storey exit complies with the multidirectional travel distance from Table 7.2; and
- the single direction part of the route (in this case, in the room) complies with the 'one-direction' travel distance specified in Table 7.2.

Although a choice of escape routes may be provided from a room or storey, it is possible that they may be so located, relative to one another, and that a fire might disable them both. In order to consider them as true alternatives, they should be positioned as shown in Fig. 7.24, i.e. the angle which is formed between the exits, and any point in the space should be at least 45°. Where this angle cannot be achieved:

- the maximum travel distance for escape in one direction will apply; or
- the alternative escape routes should be separated from each other by fire-resisting construction.

Figure 7.22 illustrates these rules covering alternative escape routes.

Table 7.2 Travel distance limitations.

Purpose group	Maximum travel distance (m) in: One direction	Multidirection	Notes
2(a) Institutional	9	18	In hospitals or other healthcare premises where the means of escape is being designed using the Department of Health's '*Firecode*' documents; the relevant travel distances recommended in those documents should be used
2(b) Other residential			
(i) In bedrooms	9	18	This is the maximum part of the travel distance within the bedroom but includes any associated dressing room, bathroom or sitting room, etc. It is measured to the door onto the protected corridor serving the bedroom or suite
(ii) In bedroom corridors	9	35	This is the distance from the door onto the protected corridor serving the bedroom or suite to the storey exit
(iii) Elsewhere	18	35	
3 Office	18	45	
4 Shop and commercial	18	34	For shopping malls see BS 9999 and BS 7974. This document applies more restrictive provisions to units with only one exit in covered shopping complexes. See also BRE Report (BR 368) *Design methodologies for smoke and heat exhaust ventilation* for guidance on associated smoke control measures
5 Assembly and recreation			
(i) Buildings mainly for disabled people (not schools)	9	18	
(ii) Schools	18	45	
(iii) Areas with seating in rows	15	32	
(iv) Elsewhere	18	45	
6 Industrial			
7 Storage and other non-residential			
(i) 'Normal' fire risk	25	45	For 'normal' fire risk as defined in Home Office *Guide to fire precautions in existing places of work that require a fire certificate: Factories, offices, shops and railway premises*

(*Continued*)

Table 7.2 (*Continued*)

Purpose group	Maximum travel distance (m) in: One direction	Multidirection	Notes
(ii) 'High' fire risk	12	25	For 'high' fire risk as defined in Home Office *Guide to fire precautions in existing places of work that require a fire certificate: Factories, offices, shops and railway premises*
2–7 Places of special fire hazard	9	18	This is the maximum part of the travel distance within the room or area. The travel distance outside such room or area should comply with the limits for the purpose group as shown above. Places of special fire hazard are oil-filled transformer and switch gear rooms, boiler rooms, storage space for fuel or other highly flammable substances and room housing fixed with internal combustion engine. Plus, in schools: laboratories, technology rooms with open heat sources, kitchens and stores for PE mats or chemicals
2–7 **Plant room or rooftop plant:**			
(i) Distance within plant room	9	35	
(ii) Escape route not in open air	18	45	Overall travel distance
(iii) Escape route in open air	60	100	Overall travel distance

Notes:
Alternative travel distance criteria is used within BS 9999. The travel distances are variable and provided a property contains no sleeping accommodation, tend to be increased from the figures shown in the table based on risk and additional fire precautions being taken.

Special rules apply where a dead-end situation exists in an open storey layout as shown in Fig. 7.23 as follows:

- XY should be within the one-direction travel distance from Table 7.2.
- Whichever is the least distance of CBA and CBD should be within the multidirectional travel distance from Table 7.2.
- Angle ABD should be at least 45° plus 2.5° for each metre travelled in a single direction from C to B.

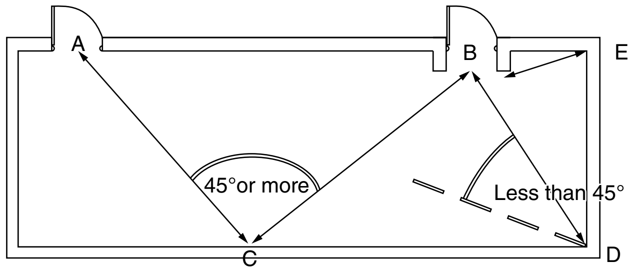


Fig. 7.22 Alternative escape routes.

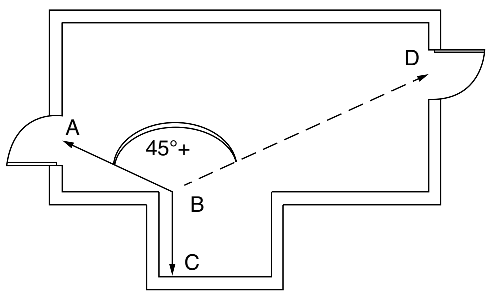


Fig. 7.23 Dead-end situations – single storey layout.

Number and widths of exits related to the number of occupants in buildings other than dwellings

The number of occupants in a room, tier or storey influences the numbers and widths of the exits and escape routes that need to be provided from that area. Table 3 of AD B volume 2 lists the minimum number(s) of escape routes or exits which should be provided relative to the maximum numbers of occupants as follows:

- Up to 60 persons – 1 exit
- 61 to 600 persons – 2 exits
- Over 600 persons – 3 exits

Realistically, the figures given above will only serve to define the absolute minimum number of exits for a means of escape. In practical terms the actual number of exits will be determined by travel distances and exit widths. The width of an escape route or exit may be determined by reference to Table 4 of AD B volume 2. The information contained in this Table is restructured in Table 7.3 to include relevant data from Approved Document M (Access and facilities for disabled people) since the minimum widths shown in Table 4 of AD B volume 2 may not be adequate for disabled access.

Usually, the narrowest part of an escape route will be at the door openings which form the room or storey exits. These are measured as shown in Fig. 7.10.

Where a storey has two or more exits, it is assumed that one of them will be disabled by a fire. Therefore the remaining exits should have sufficient width to take the occupants safely and quickly. This means that the widest exit should be discounted and the remainder should be designed to take the occupants of the storey. Since stairs need to be as wide as the exit leading onto them, this recommendation for exit width may influence the width of the stairways. (Stairways may also need to be discounted, and this is discussed in section 7.14.7.)

Final exit capacity

For example:

Three exits each 850 wide will accommodate $3 \times 110 = 330$ people.
(And **not** 510 people accommodated by a single 2250 mm wide exit).

If a ground floor exit shares a final exit with a stair via a lobby, then the designer should have regard to the following calculation procedure: Diagram 15 of AD B2 – Merging flows at Exits. This is reproduced in Fig. 7.24. The final exit width should be sufficient to enable a maximum evacuation flow equal to or greater than that from the storey exit and stair combined.

The final exit width can be calculated by the following formula.

Formula 7.1 Merging flows

$$W = \frac{\left(\frac{N}{2.5}\right) + (60S)}{80}$$

Where:
W, width of final exit (m);
N, number of people served by the ground floor storey exit; and
S, stair width (m)

Note: Where *N* is more than 60, then the distance from the foot of the stair or the storey exit to the final exit should be a minimum of 2 m. If this is unachievable then the width of the stair should be no less than the width of the stair plus the width of the storey exit.

Table 7.3 Widths of exits and escape routes.

Maximum number of persons	Minimum width of exit*	Minimum width of escape route*	Notes
Up to 60	750	750 (1)	(1) Does not apply to • Schools where minimum width in corridors is 1050 (and 1600 in dead ends) • Areas accessible to disabled people where minimum width in corridors is 1200 (or 1000 where lift access is not provided to the corridor or it is situated in an extension approached through an existing building) Gangways between fixed storage racking in Purpose Group 4 (Shop and Commercial) where minimum width may be 530 mm (but not in public areas) • Widths of escape routes and exits less than 1050 should not be interpolated
61 to 110	850	850 (2)	(2) Does not apply to: • Schools where minimum width in corridors is 1050 (and 1600 in dead ends) • Areas accessible to disabled people where minimum width in corridors is 1200 (or 1000 where lift access is not provided to the corridor or it is situated in an extension approached through an existing building) • Widths of escape routes and exits less than 1050 should not be interpolated
111 to 220	1050	1050 (3)	(3) Does not apply to: • Schools where minimum width in corridor dead ends is 1600 mm • Areas accessible to disabled people where minimum width in corridors is 1200
Over 220	5 mm/person	5 mm/person	This method of calculation should not be used for any opening serving less than 220 persons (e.g. three exits each 850 mm wide will accommodate $3 \times 110 = 330$ people, not the 510 (i.e. $2550 \div 5$) people that $3 \times 850 = 2550$ mm would accommodate)

* For method of measuring widths of escape routes and exits, see section 7.9.3.

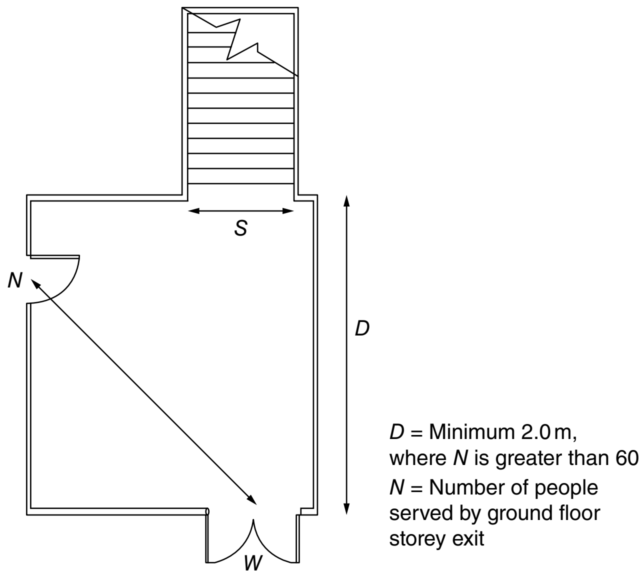


Fig. 7.24 Merging flows at exits.

For example:

A ground floor storey exit serving 250 people shares a common final exit with a 1.2 m wide stair:

$$\text{Required final exit width} = \frac{\left(\left(\frac{250}{2.5}\right) + \left(1.2 \times 60\right)\right)}{80} = 2.15\ \text{m}$$

Except in doorways, all escape routes should have clear headroom of at least 2 m.

7.14.3 Horizontal escape routes: Factors affecting internal planning

The efficacy of an escape route in a storey may be affected by a number of internal planning considerations, such as:

- the need for inner rooms;
- the relationship between circulation routes and stairways;
- the need for different occupancies in a building to use the same escape route;
- the design and layout of means of escape corridors; and
- the final exit capacity.

These are considered in more detail in the following paragraphs.

Provision of inner rooms

The rules governing the provision of inner rooms are more stringent than those for dwellings. Inner rooms are only acceptable under the following conditions:

- The occupant capacity of the inner room should not exceed 60 (or 30 for institutional buildings in Purpose Group 2(a)).
- The inner room should not be a bedroom.
- Only one access room should be passed through when escaping from the inner room.
- The maximum travel distance from the furthest point in the inner room to the exit from the access room should not exceed the appropriate limit given in Table 7.2.
- The access room should be in the control of the same occupier as the inner room.
- The access room should not be a place of special fire hazard (e.g. a boiler room).

Where these conditions are met, the inner room should be designed to conform to one of the following arrangements:

- The walls or partitions of the inner room should stop at least 500 mm from the ceiling.
- A vision panel, which need not be more than 0.1 m^2 in area, should be situated in the walls or door of the inner room (this is to enable the occupiers to see if a fire has started in the access room).
- A suitable automatic fire detection and alarm system should be fitted in the access room which will give warning of fire in that room to the occupiers of the inner room.

Horizontal escape routes and stairways

Care must be taken in the design of horizontal escape routes since they also form part of the normal circulation in a building and may jeopardise access to stairways unless the following points are considered:

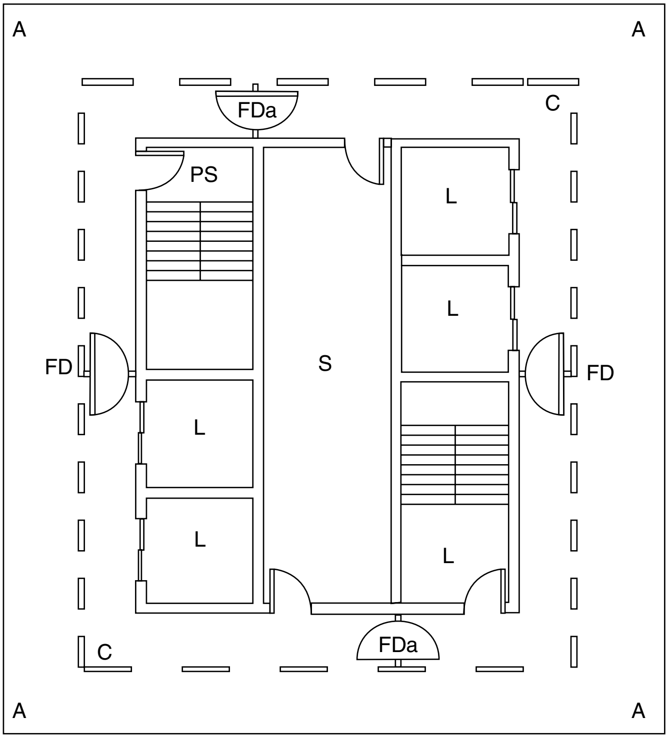
- In any storey which has more than one escape stair, it should not be necessary to pass through one stairway to reach another. Where this is unavoidable a protected lobby should be provided to the stairway. This lobby may be passed through in order to reach the other stair.
- As part of the normal circulation in a building, it should not be necessary to pass through a stairway enclosure in order to reach another part of the building on the same level. (Such circulation patterns should be avoided since familiarity breeds contempt, and fire doors may become ineffective due to excessive use or misuse.) Such an arrangement is permissible if the doors to the protected stairway and any associated exit passageway are fitted with an automatic release mechanism (see section 7.20.3).
- Where buildings are planned with more than one exit round a central core, these exits should be remote from each other, and no two exits should be approached from the same lift hall, common lobby or undivided corridor or linked together by any of these (see Fig. 7.25).

Open spatial planning

Where open connections such as escalators are planned, care must be taken not to prejudice the escape routes.

Escape routes should only be planned within 4.5 m of the opening if:

- the direction of escape is away from the opening; or,
- an alternative escape route is planned that does not pass within 4.5 m of the open connection.



Note: The doors at both ends of the area marked 'S' should be self closing fire doors unless the area is sub-divided such that any fire in that area will not be able to prejudice both sections of corridor at the same time. If that area is a lift lobby, doors should be provided as shown in BS9999.

Key
L – Lift
S – Services, toilets, etc.
FD – Fire door
FDa – Possible alternative position for fire door
C – Corridor off which accommodation opens
PS – protected stairway
A– Accommodation (e.g. office space)

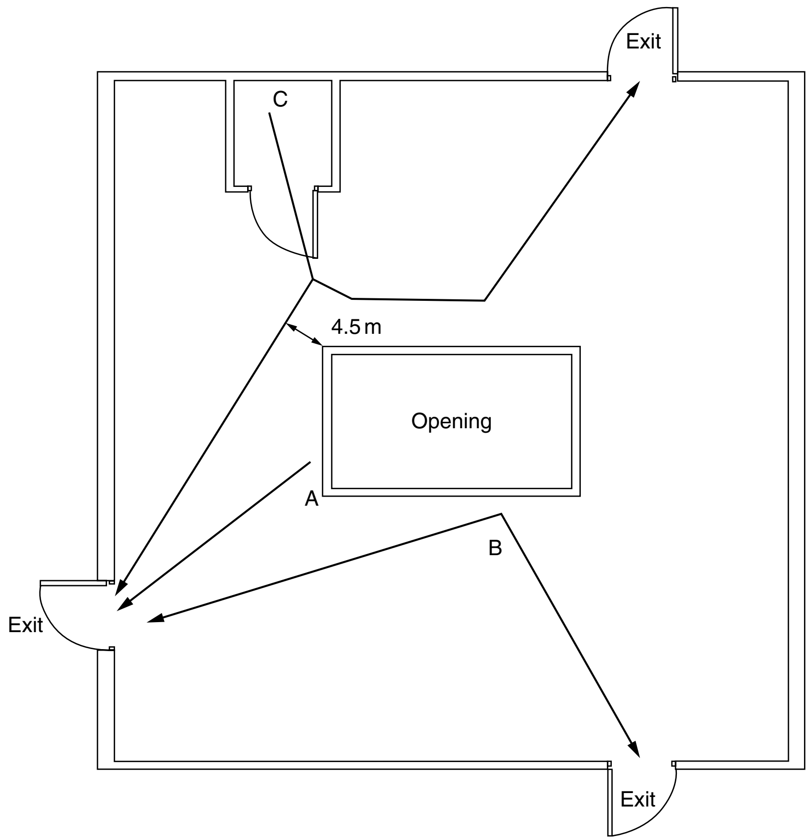
Fig. 7.25 Corridor layout; building with central core.

See Fig. 7.26 Open connections.

Use of common escape routes by different occupancies

It is common in mixed use or multi-tenanted buildings for common escape routes to be used by all the occupants. There are restrictions on this and these have been referred to in section 7.14.2. Where common escape routes are permitted, the following rules should be observed:

- The means of escape from one occupancy should not pass through another.
- Common corridors or circulation spaces should either be fire protected or fitted with an automatic fire detection and alarm system which extends throughout the storey.



From A and B at least one direction of travel is away from the opening. From C where the initial direction of travel is towards the opening, one of the escape routes is not less than 4.5 m from the opening.

Fig. 7.26 Open connections.

Storeys containing areas for consumption of food and/or drink by customers

In some buildings (such as department stores and shops), it may be desirable to provide an area for the consumption of food and/or drink by customers where this is ancillary to the main use of the building. Such an arrangement is permissible if the following conditions are met:

- At least two escape routes should be provided from each area (inner rooms which follow the guidance contained in section 7.14.3 'Provision of inner rooms' are exempt from this).
- Each escape route should lead directly to a storey exit without having to pass through a kitchen or similar area of high fire hazard.

Means of escape corridors: Design factors

The following means of escape corridors should be fire protected:

- Every dead-end corridor (although small recesses and extensions less than 2 m long and referred to in BS 9999 may be ignored).
- Every corridor serving bedrooms.
- Every corridor or circulation space common to two or more 'different occupancies' (i.e. where the premises are split into separate ownerships or tenancies of different organisations). In this case the need for fire protection may be omitted where an automatic fire detection and alarm system is installed throughout the storey. Even so, the means of escape from one occupancy should not pass through any other occupancy.

The way in which a storey layout is planned can have an effect on its means of escape characteristics. For example, whilst it is perfectly acceptable to have open plan floor areas, they offer no impediment to smoke spread but do have the advantage that occupants can become aware of a fire more quickly. On the other hand, the provision of a cellular layout, where the means of escape is enclosed by partitions, means that some defence is provided against smoke spread in the early stages of a fire even though the partitions may have no fire resistance rating.

To maintain the effectiveness of the partitions, they should be carried up to ceiling level (i.e. either the soffit of the structural floor above or to a suspended ceiling), and room openings should be fitted with doors (which do not need to be fire resisting).

Corridors which give access to alternative escape routes may become blocked by smoke before all the occupants of a building have escaped and may make both routes impassable. Additionally, the means of escape from any permitted dead-end corridors may be blocked. Therefore, corridors connecting two or more storey exits should be subdivided by means of self-closing fire doors (and screens, if necessary) if they exceed 12 m in length. The doors (and screens) should be positioned so that:

- they are approximately midway between the two-storey exits; and
- the route is protected from smoke, having regard to any adjacent fire risks and the layout of the corridor.

Unless the escape stairway and its associated corridors are protected by a pressurisation system complying with the relevant paragraphs of BS 9999, dead-end corridors exceeding 4.5 m in length giving access to a point from which alternative escape routes are available should also be provided with fire doors so positioned that the dead end is separated from any corridor which:

- provides two directions of escape; or
- continues past one storey exit to another.

These provisions for means of escape corridors are summarised in Fig. 7.27.

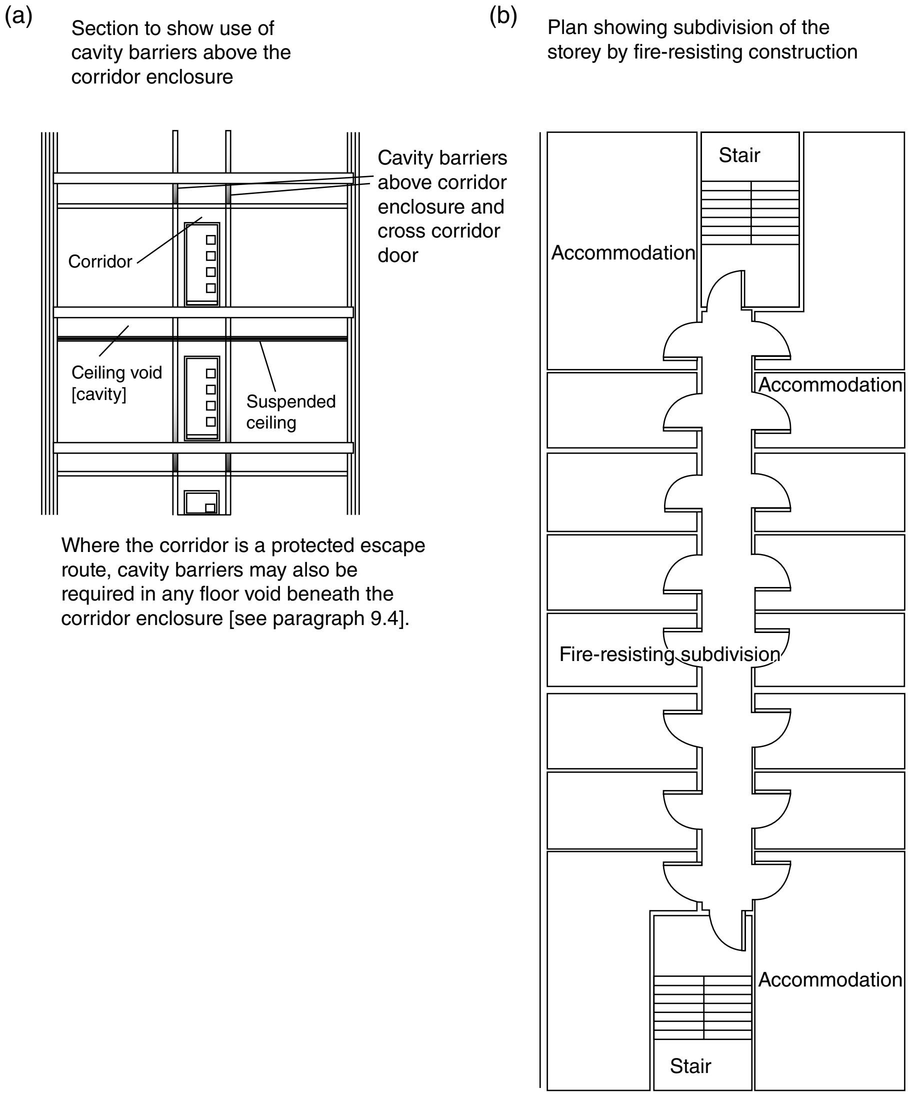


Fig. 7.27 Escape corridors.

7.14.4 Escape routes across flat roofs

The recommendations given above for escape over flat roofs from flats and maisonettes (section 7.13.3) also apply to all other building types except where the route serves an institutional building or part of a route used by members of the public.

7.14.5 Vertical escape routes in buildings other than dwellings

Section 4 of AD volume 2 deals with the provisions for vertical escape, by means of a sufficient number of adequately sized and protected escape stairs for all buildings apart from dwellinghouses, flats and maisonettes.

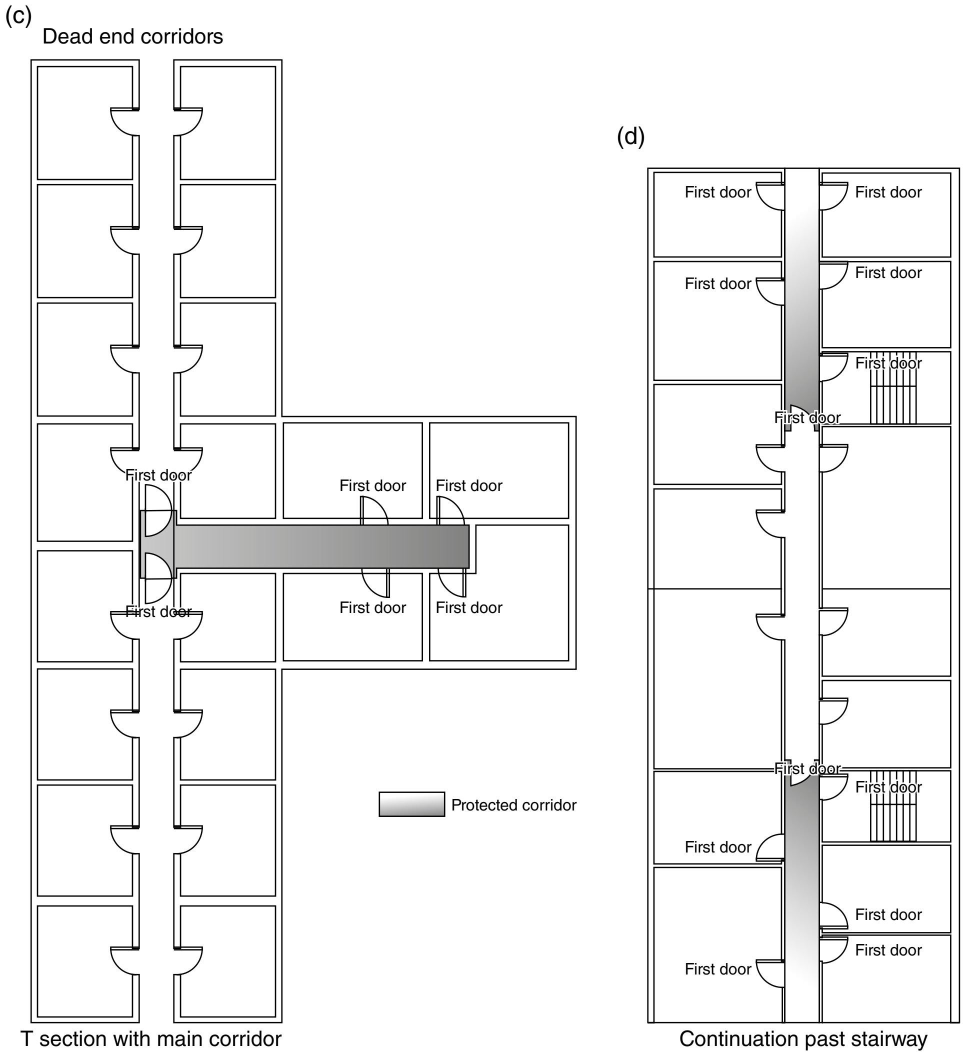


Fig. 7.27(c) (*Continued*)

The main decision to be taken when designing the vertical means of escape in a building is the number of stairways that need to be provided. It has already been shown above that alternative means of escape are required where horizontal constraints are imposed by travel distances, exit widths and numbers of occupants. Additionally, in buildings where there is a mix of different uses, it may be the case that a fire in an unattended shop or office might have serious consequences for a residential or hotel use in the same building. Therefore, it is important to analyse the risks involved and to consider whether completely separate escape routes should be provided from each different use or whether other effective means of protecting common escape routes can be provided. (See section 7.13 for examples of the use of common stairs in buildings which contain both dwellings and other uses.)

Section 4 of AD B volume 2 provides additional recommendations for assessing the number of stairways that are needed with regard to:

- the acceptability of single stairs for means of escape in a building; and
- the influence that adequate width of stairs may have on their provision whilst allowing for the fact that a stair may have to be discounted due to the effects of fire or smoke.

One further influence on the provision of stairs is the necessity to provide firefighting stairs in larger buildings. This is covered in part B5 (see section 7.28) and may mean that extra stairways are required beyond those needed merely for means of escape purposes.

7.14.6 The provision of single stairs in buildings other than dwellings

Assuming that the building is not excluded from having a single escape route by virtue of the recommendations listed above, it may be served by a single escape stair in the following circumstances:

- Where it serves a basement which is allowed to have a single horizontal escape route (i.e. storey occupancy not exceeding 60, maximum travel distance within the limits for travel in one direction).
- Section 3 of AD B volume 2 (covered in section 7.16.6) provides guidance for 'small premises' such as shops, office and other similar buildings. These premises are not as heavily occupied and tend to open plan in nature. This allows the occupant to clearly perceive risk quickly, expediting the speed of escape when compared to larger more complex buildings.
- Where it serves a building which has no floor more than 11 m above ground and in which every floor is allowed to have a single horizontal escape route.

It should be noted that in schools where single stairs are provided, the storeys above first floor level should only be occupied by adults. Additionally, where a two-storey school building (or part of a building) is provided with a single stair, the following conditions apply:

- There should be no more than 120 pupils plus supervisors on the first floor.
- The first floor should not contain a place of special fire hazard.
- Classrooms and stores should not open onto the stairway.

See Building Bulletin 100: *Design for fire safety in schools* (Dept. for Education and Schools, 2007) for additional guidance.

7.14.7 Escape stair design: Widths

Clearly, the width of escape stairs is related to the number of people that they can carry in an evacuation situation. AD B volume 2 contains a number of provisions which enable the width of stairs to be calculated by reference to:

- the number of people who will use them;
- whether or not it will be necessary to discount any of the stairs; and
- their mode of use (i.e. simultaneous or phased evacuation).

Table 7.4 Minimum widths of escape stairs.

Description of stair	Numbers of people assessed as using stair in emergency [1]	Minimum width of stair (mm) [2]
Escape stairs in any building (but see footnotes for exceptions)	Up to 50	800[3]
	51 to 150	1000
	151 to 220	1100
	Over 220	See note [4]

Notes:
[1] For methods of assessing occupancy, see section 7.9.1.
[2] BS 9999 recommends that a firefighting stair should be at least 1100 mm wide.
[3] This minimum stair width does not apply:
(a) in an Institutional buildings unless the stair will only be used by staff;
(b) in an assembly building unless the area served is less than 100 m^2 and/or is not for assembly purposes (e.g. office); and
(c) to any areas which are accessible to disabled people.
[4] See AD B volume 2 Table 7 (and Formula 7.2) for simultaneous evacuation and AD B volume 2 Table 8 (and Formula 7.3) for phased evacuation.

Escape stairs should be at least as wide as any exits giving access to them and should not reduce in width as they approach the final exit. Additionally, if the exit route from a stair also picks up occupants of the ground and basement storeys, it may need to be increased in width accordingly. Although stairs need to be sufficiently wide for escape purposes, research has shown that people prefer to stay close to a handrail when making a long descent. Therefore the centre of a very wide stairway would be little used and might, in fact, be hazardous. For this reason, AD B volume 2 puts a maximum limit of 1400 mm on the width of a stairway where its vertical extent exceeds 30 m unless it is centrally divided with a handrail. Where the design of the building calls for a stairway that is wider than 1400 mm, it should be at least 1800 mm wide and contain a central handrail. In this case, the stair width on either side of the central handrail will need to be considered separately when assessing stair capacity.

Minimum stair widths can, in the first instance, be assessed using Table 7.4. This is based on Table 6 from AD B volume 2 and is suitable for most simple building designs where the maximum number of people served by the stair(s) does not exceed 220.

Where two or more stairways are provided, it is possible that one of the stairs may be inaccessible due to fire or smoke unless special precautions are taken. Therefore, it may be necessary to discount each stair in turn in order to check that the remaining stairways are capable of coping with the demand. Discounting is unnecessary if:

- the escape stairs are approached through a protected lobby at each floor level (although a lobby is not needed for the top floor for the exception still to apply); or
- the stairs are protected by a pressurisation smoke control system designed in accordance with BS 9999.

As Table 7.4 suggests, in multistorey buildings where the number of occupants exceeds 220, it may be necessary to consider the mode of evacuation and use other methods to calculate stair widths.

Where it is assumed that all the occupants would be evacuated, this is termed 'simultaneous evacuation', and this should be the design approach for:

- all stairs which serve basements;
- all stairs which serve buildings with open spatial planning (i.e. where the building is arranged internally so that two or more floors are contained within one undivided volume); and
- all stairs which serve Assembly and Recreation buildings (PG 5) or Other Residential buildings (PG 2(b)).

Using this approach the escape stairs should be wide enough to allow all the floors to be evacuated simultaneously. The calculations take into account the number of people temporarily housed in the stairways during evacuation.

A simple way of assessing the escape stair width is to use Table 4 from AD B volume 2. This covers the capacity of stairs with widths from 1000 mm to 1800 mm for buildings up to ten storeys high (although the capacity of stairs serving more than ten storeys can be obtained from Table 4 by using linear extrapolation).

In fact, the capacities given in the table for stair widths of 1100 mm and greater are derived from the formula.

Formula 7.2 Simultaneous evacuation

$$P = 200w + 50(w - 0.3)(n - 1), \text{ or}$$
$$w = \frac{P + 15n - 15}{(150 + 50n)}$$

where:
P, the number of people that can be served by the stair;
w, the width of the stair in metres; and
n, the number of storeys in the building.

Formula 7.2 can be used for any size of building with no limit being placed on the occupant capacity or number of floors, and it is probably advisable to use it for buildings which are larger than those covered by Table 7 from AD B2. It should be noted that separate calculations should be made for stairs serving basements and for those serving upper storeys.

The formula is particularly useful where the occupants of a building are not evenly distributed – either within a storey or between storeys. However, it cannot be used for stairs which are narrower than 1100 mm, so for stairs which are allowed to be 1000 mm wide, in buildings up to ten storeys high, the values have been extracted from Table 7 and are presented in Fig. 7.28.

In certain buildings it may be more advantageous to design stairs on the basis of 'phased evacuation'. Indeed, in high buildings it may be impractical or unnecessary to evacuate the building totally, especially if the recommendations regarding fire resistance, compartmentation and installation of supporting facilities such as sprinklers and fire alarms are adhered to.

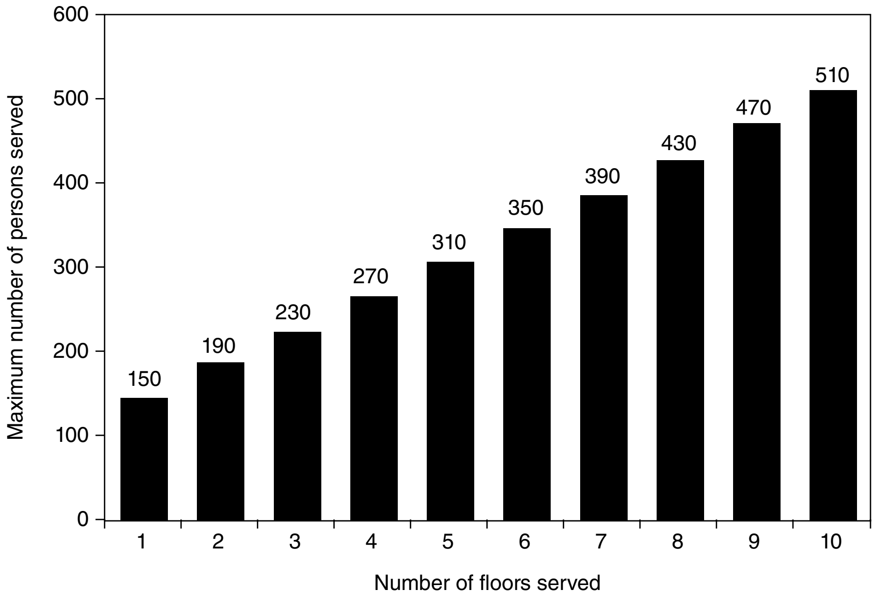


Fig. 7.28 Stair capacity for simultaneous evacuation – 1000 mm wide stair.

In phased evacuation, people with reduced mobility and those most immediately affected by the fire (i.e. those people on the floor of fire origin and the one above it) are evacuated first. After that, if the need arises, floors can be evacuated two at a time. Phased evacuation allows narrower stairs to be used and has the added advantage that it causes less disruption in large buildings than total evacuation.

Phased evacuation may be used for any buildings unless they are of the types listed above as needing simultaneous evacuation.

Where a building is designed for phased evacuation, the following conditions should be met:

- The stairs should be approached through a protected lobby or protected corridor at each floor level (this does not apply to a top storey).
- The lifts should be approached through a protected lobby at each floor level.
- Each floor should be a compartment floor.
- If the building has a floor which is more than 30 m above ground, it should be protected throughout by an automatic sprinkler system which complies with the relevant requirements of BS 12845 (i.e. the sections dealing with the relevant occupancy rating and the additional requirements for life safety). This provision does not apply to flats of PG 1(a) in a mixed use building.
- An appropriate fire warning system should be fitted which complies with BS 5839 *Fire detection and alarm systems for buildings,* Part 1: 2013 *Code of practice for system design, installation and servicing,* to at least the L3 standard.
- An internal speech communication system (such as a telephone, intercom system or similar) should be provided so that conversation is possible between a fire warden at every floor level and a control point at the fire service access level.

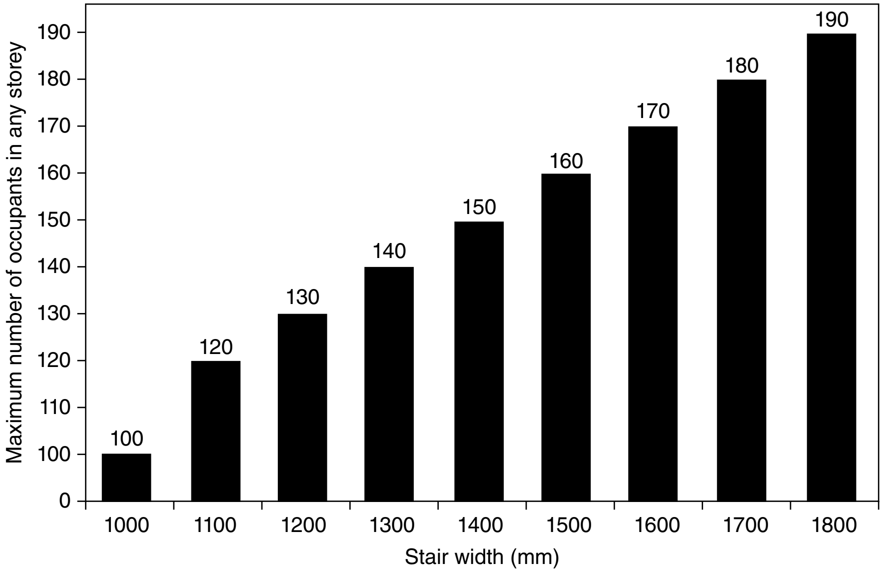


Fig. 7.29 Minimum width of stairs for phased evacuation.

- Where it is deemed appropriate to install a voice alarm, the recommendations regarding phased evacuation in BS 5839: Part 1 should be followed, and the voice alarm system itself should conform to BS 5839: Part 8: 2013 *Code of practice for the design, installation and servicing of voice alarm systems.*

When phased evacuation is used as the basis for design, the minimum stair width needed may be taken from Table 8 of AD B2 assuming phased evacuation of not more than two floors at a time. The data from Table 8, which has been reconfigured in Fig. 7.29, is derived from the formula.

Formula 7.3 Phased evacuation

$$w\left(\text{mm}\right) = \left(P \times 10\right) - 100$$

where:
w, the minimum width of stair (w must not be less than 1000 mm); and
P, the number of people on the most heavily occupied storey.

7.14.8 Provision and protection of stairs

Fire-resisting enclosures

Each internal escape stair should be a protected stair situated in a fire-resisting enclosure. Additional measures may also be necessary for a stairway which is also a protected shaft (penetrating one or more compartment floors; see AD B volume 2 section 8) or a firefighting shaft (see AD B section 17). However, this does not preclude the provision of an accommodation stair (i.e. a stair which is provided for the convenience of occupants and is additional to those required for means of escape) if the design of the building so warrants it.

Exceptionally, an unprotected stair can form part of the internal escape route to a storey or final exit in low-risk buildings if the number of people and the travel distance involved are very limited.

Please refer to section 7.16.8 which describes the requirements for the use of an unprotected stair for means of escape in what are termed 'small premises'.

Protected lobbies and corridors

Generally, protected lobbies or corridors should be provided at all levels including basements (but not at the top storey) where:

- the building has a single stair and there is more than one floor above or below the ground storey (except for small premises; see above);
- the building has a floor which is more than 18 m above ground;
- the building is designed for phased evacuation; and
- the option has been taken to not discount one stairway when calculating stair widths (see section 7.14.7).

In these cases an alternative to a protected lobby or corridor is the use of a smoke control system designed in accordance with BS 9999.

Protected lobbies are also needed where:

- the stairway is a firefighting stair (see section 17, AD B volume 2); and
- the stairway serves a place of special fire hazard (i.e. oil-filled transformer and switch gear rooms, boiler rooms, storage space for fuel or other highly flammable substances, rooms housing a fixed internal combustion engine and schools – laboratories, technology rooms with open heat sources, kitchens and stores for PE mats or chemicals). In this case, the lobby should be ventilated by permanent vents with an area of at least 0.4 m^2 or should be protected by a mechanical smoke control system.

Final exits from protected stairs

Ideally, every protected stairway should discharge directly to a final exit, i.e. it should be possible to leave the staircase enclosure and immediately reach a place of safety outside the building and away from the effects of fire.

Obviously, it is not always possible to achieve this ideal, especially where the building design calls for stairs to be remote from external walls. Therefore it is permissible for a protected stairway to discharge into a protected exit passageway, which in turn leads to a final exit from the building. Such a passageway can contain doors (e.g. to allow people on the ground floor to use the escape route), but they will need to be fire doors in order to maintain fire integrity and may need to be lobbied if the stairway needs to be served by lobbies. Therefore, if the exit route from a stair also picks up occupants of the ground and/or basement storeys, it may need to be increased in width accordingly. Thus, the width of the protected exit passageway will need to be designed in accordance with Table 7.3 for the estimated numbers of people that will use it in an emergency.

Sometimes the design of the building will call for two protected stairways or protected exit passageways to be adjacent to each other. Where this happens they should be separated by an imperforate enclosure.

Restrictions on the use of space in protected stairways

Since a protected stairway is considered to be a place of relative safety, it should be free of potential sources of fire. Therefore, the facilities that may be included in protected stairways are restricted to the following:

- Washrooms or sanitary accommodation provided that the accommodation is not used as a cloakroom. The only gas appliances that may be installed are water heaters or sanitary towel incinerators.
- A lift well, on condition that the stairway is not a firefighting stair.
- An enquiry office or reception desk area at ground or access level of not more than 10 m^2, provided that there is more than one stair serving the building.
- Fire-protected cupboards, provided that there is more than one stair serving the building.
- Gas service pipes and meters but only if the gas installation is in accordance with the requirements for installation and connection set out in the *Pipelines Safety Regulations 1996,* SI 1996/825 and the *Gas Safety (Installation and Use) Regulations 1998* SI 1998/2451.

Protection of external walls of protected stairways

If a protected stairway is situated on the external wall of a building, it is not necessary for the external part of the enclosure to be fire protected, and in many cases it may be fully glazed. This is because fires are unlikely to start in protected stairways. Therefore these areas will not contribute to the radiant heat from a building fire which might put at risk another building.

In some building designs the stairway may be situated at an internal angle in the building façade (see Fig. 7.30) and may be jeopardised by smoke and flames coming from windows in the facing walls. This may also be the case if the stair projects from the face of the building (see Fig. 7.31) or is recessed into it. In these cases any windows or other unprotected areas in the face of the building and in the stairway should be separated by at least 1800 mm of fire-resisting construction. This provision also applies to flats and maisonettes.

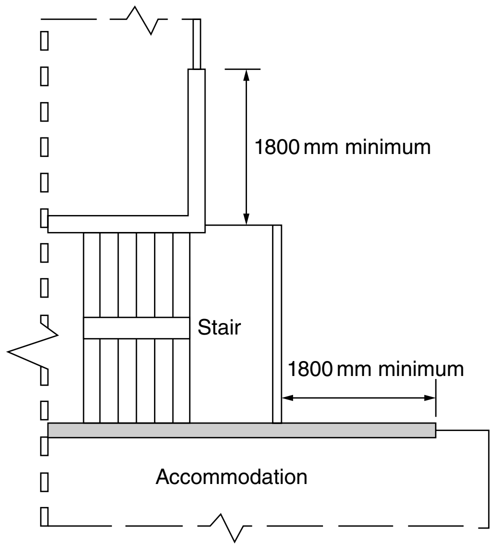


Fig. 7.30 External protection.

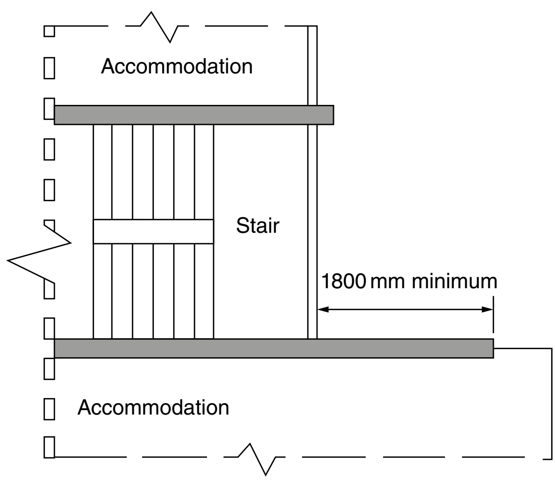


Fig. 7.31 External protection – protected stairway projecting beyond façade.

7.14.9 Basement stairs

Basement fires are particularly serious since combustion products tend to rise and find their way into stairways unless other smoke venting measures are taken (see part B5 of AD B volume 2, section 7.28.13). Therefore, it is necessary to take additional precautions to prevent a basement fire endangering upper storeys in a building as follows:

- In most buildings with only one escape stair serving the upper storeys, this stair should not continue down to the basement, i.e. the basement should be served by a separate stair.

- In buildings containing more than one escape stair, at least one of the stairs should terminate at ground level and not continue down to the basement. The other stairs may terminate at basement level on condition that the basement accommodation is separated from the stair(s) by a protected lobby or corridor at basement level.

These provisions apply to all buildings, including flats and maisonettes.

7.14.10 External escape stairs

External escape stairs have long been used to provide additional vertical means of escape where parts of the building would otherwise be contained in long dead ends or would be too distant from internal stairways. It is uncommon for such stairways to be fully protected from the elements; therefore, they are not normally used for everyday access and egress around the building. Thus it can be argued that external escape stairs are not subject to the requirements of Part K of Schedule 1 to the Building Regulations 2000 because they do not form part of a building.

In buildings other than dwellings, an external escape stair may be used as an alternative means of escape provided that there is more than one escape route available from a storey, or part of a building, and the following conditions are met. See Fig. 7.21 External escape stairs:

- There is at least one internal escape stair available from every part of each storey (plant areas excluded).
- It is not intended for use by members of the public if installed in assembly and recreation buildings (PG 5).
- It serves only office or residential staff accommodation if installed in an institutional building (PG 2(a)).
- If it is more than 6 m in vertical extent and it is sufficiently protected from adverse weather. This does not necessarily mean that full enclosure will be necessary. The stair may be located so that protection may be obtained from the building itself. In deciding on the degree of protection, it is necessary to consider the height of the stair, the familiarity of the occupants with the building, and the likelihood of the stair becoming impassable as a consequence of adverse weather conditions.
- Any part of the building (including windows and doors, etc.) which is within 1.8 m of the escape route from the stair to a place of safety should be protected with fire-resisting construction. This does not apply if there is a choice of routes from the foot of the stair thereby enabling the people escaping to avoid the effects of fire in the adjoining building. Additionally, any part of an external wall which is within 1.8 m of an external escape route (other than a stair) should be of fire-resisting construction up to a height of 1.1 m from the paving level of the route.
- All the doors which lead onto the stair should be fire resisting and self-closing. This does not apply to the only exit door to the landing at the head of a stair which leads downward.
- Any part of the external envelope of the building which is within 1.8 m of (and 9 m vertically below) the flights and landings of the stair should be of fire-resisting construction. This 1.8 m dimension may be reduced to 1.1 m above the top landing level provided that this is not the top of a stair up from basement level to ground.

- Any glazing which is contained within the fire-resisting areas mentioned above should also be fire resisting in terms of maintaining its integrity in a fire and be fixed shut. (For example, Georgian wired glass is adequate; it does not also have to meet the requirements for insulation.)

7.15 General recommendations common to all buildings except dwellinghouses

Section 5 of AD volume 2 gives general guidance on a number of features of escape routes which apply to all buildings, except dwellinghouses, concerning:

- the standard of protection necessary for the elements enclosing the means of escape;
- the provision of doors;
- the construction of escape stairs;
- the position and design of final exits;
- lighting and signing;
- mechanical services including lift installations;
- protected circuits for the operation of equipment in the event of fire;
- refuse chutes and storage; and
- the provision of fire safety signs.

These recommendations should be read in conjunction with the provisions described above for flats and maisonettes and other buildings except dwellinghouses.

7.15.1 Protection of escape routes: Standards and general constructional provisions

Those parts of a means of escape which are required by Part B1 to be fire resisting should comply with the recommendations given in part B3 (Internal fire spread – structure) or part B5 (Access and facilities for the fire service) in addition to AD B volume 2. In most cases 30 minutes fire protection is sufficient for the protection of a means of escape. The exceptions to this are when the element also performs a fire-separating function or separates areas of different fire risk, such as:

- a compartment floor;
- a compartment wall;
- an external wall;
- a protected shaft; or
- a firefighting shaft.

In these cases the element should achieve the standard of fire resistance given in Table A2 of Appendix A to the ADs (see section 7.19). This may require considerably more than 30 minutes fire resistance (the fire resistance periods in Table A2 range from 30 minutes to 120 minutes).

The following general constructional provisions should also be met:

- Fully enclosed walk-in store rooms in shops should be separated from retail areas with 30 minute fire-resisting construction (see Table A1 of Appendix A of AD B reproduced in section 7.19) if they are sited so as to prejudice the means of escape. This does not apply if the store room is fitted with an automatic fire detection and alarm system or sprinklers.
- Glazed elements in fire-resisting enclosures and doors, which are only able to meet the requirements for integrity in the event of a fire, will be limited in area to the amounts shown in Table A4 of Appendix A of AD B volume 2 (see section 7.20.3).
- There are no limitations on the use of glazed elements that can meet both the integrity and insulation performance recommendations of AD B volume 2. However, there may be some restrictions on the use of glass in firefighting stairs and lobbies in BS 9999 under the recommendations for robust construction referred to below.
- Glazed elements may also need to comply with AD K (Chapter 15).
- All escape routes should have a minimum headroom of 2 m. The only projections allowed below this are for door frames.
- The floors of escape routes, including the surfaces of steps and ramps, should be chosen so that they are not unduly slippery when wet.
- Sloping floors or tiers should not have a pitch greater than 35° to the horizontal.
- Further guidance on the provision of ramps, stairs, aisles and gangways may be found in AD K (Chapter 15) and AD M (Chapter 17).

7.15.2 The provision of doors on escape routes

The time taken to pass through a closed door can be critical when escaping from a building in a fire situation. Doors on escape routes should be readily openable if undue delay in escaping from a building is to be avoided. They should also comply with the following general provisions:

- Doors on escape routes often need to be fire resisting. This means that certain test criteria and performance standards as set out in Appendix B of Approved Document B (Table B1) will need to be met (see section 7.20.3).
- In general, escape doors should open in the direction of the means of escape where it is reasonably practicable to do so and should always do so if more than 60 people are likely to use the door in an emergency. However, for some industrial activities where there is a very high risk with potential for rapid fire growth, it may be necessary for escape doors to open in the direction of escape for lower occupant numbers than 60. The exact figure will depend on the individual circumstances of the case, and there is no specific guidance laid down in AD B volume 2.
- Ideally, doors on escape routes (whether or not they are fire doors) should not be fitted with fastenings unless these are simple to use and can be operated from the side of the door which is approached by people escaping. Any fastenings should be able to be operated without a key and without having to operate more than one mechanism: however this does not prevent doors being fitted with ironmongery which allows them to be locked when the rooms are empty. For example, this would permit a hotel

bedroom to be fitted with a lock which could be operated from the outside with a key and from the inside by a knob or lever.

- Where security of final exit doors is important, as in Assembly and Recreation (PG 5) and Shop and Commercial (PG 4) buildings, panic bolts may be used. Additionally, it is accepted that in non-residential buildings, it is appropriate for final exit doors to be locked when the building is empty. Clearly, a good deal of responsibility must be placed on management procedures for the safe use of these locks.
- Recommendations for self-closers and hold-open devices for fire doors are contained in Appendix B of AD B (see section 7.20.3).
- Doors on escape routes should swing through at least 90° to open and should not reduce the effective width of any escape route across a landing. The swing should be clear of any changes in floor level, although a single step or threshold on the line of a door opening is permitted.
- Any door that opens towards a corridor or stairway should be recessed so that it does not encroach on or reduce the effective width of the corridor or stairway.
- Doors on escape routes which subdivide corridors, or are hung to swing in two directions, should contain vision panels. (See also Approved Document M and Chapter 17 of this book for vision panels in doors across accessible corridors.)
- If revolving or automatic doors, or turnstiles, are placed across an escape route, it is possible that they might obstruct the passage of people escaping. Therefore, they should not be placed across an escape route unless:
  (a) in the case of automatic doors which are the correct width for the design of the route, they:
    (i) will fail safely to become outward opening from any position of opening,
    (ii) are provided with a monitored fail-safe system for opening the doors in the event of mains power failure, or
    (iii) fail safely in the open position in the event of mains power failure; or
  (b) they have non-automatic swing doors of the required width adjacent to them which can provide an alternative exit.

7.15.3 The construction of escape stairs: Conventional stairs

Escape stairs and their associated landings in certain high-risk situations or buildings require the extra safeguard of being constructed in materials of limited combustibility. These are composite materials (such as plasterboard) which include combustible materials in their composition so that they cannot be classed as totally non-combustible. When exposed as linings to walls or ceilings, they must achieve certain low flame spread ratings.

This recommendation applies in the following cases:

- Where a building has only one stair serving it (this does not apply to two and three-storey flats and maisonettes);
- Where a stair is located in a basement storey (except if it is a private stair in a maisonette);
- To any stair serving a storey in a building which is more than 18 m above ground or access level;

- To any external stair (except where it connects the ground floor or paving level to a floor or flat roof which is not more than 6 m above ground); and
- If the stair is a firefighting stair.

In all the above, except for the firefighting stair, it is permissible to add combustible materials to the upper surface of the stair.

Where possible, single steps should be avoided on escape routes unless prominently marked, since they can cause falls. It is permissible though to have a single step on the line of a doorway unless it is used as an unmanaged means of escape for wheelchair users or other people with disabilities.

7.15.4 The construction of escape stairs: Special stairs and ladders

Although spiral and helical stairs and fixed ladders are not as inherently safe as conventional stairs, they may be used as part of a means of escape if the following restrictions are observed:

- Spiral and helical stairs should be designed in accordance with BS 5395 *Stairs, ladders and walkways*, Part 2: 1984 *Code of practice for the design of helical and spiral stairs. (reprinted incorporated amendment No. 1 and Corrigenda Nos. 1, 2 and 3).* They are not suitable for use by pupils in schools, and if used by members of the public, they should be type E (public) stair from the above standard.
- Fixed ladders are not suitable as a means of escape for members of the public. They should only be used to access areas which are not normally occupied, such as plant rooms, where it is not practical to provide a conventional stair. They should be constructed of non-combustible materials.

7.15.5 The position and design of final exits

Final exits should not be narrower than the escape routes they serve and should be positioned to facilitate evacuation of people out of and away from the building. This means that they should be:

- positioned so that rapid dispersal of people is facilitated to a street, passageway, walkway or open space clear of the effects of fire and smoke. The route from the building should be well defined and guarded if necessary;
- clearly apparent to users. This is very important where stairs continue up or down past the final exit level in a building; and
- sited so that they are clear of the effects of fire from risk areas in buildings such as basements (e.g. outlets for basement smoke vents) and openings to transformer chambers, refuse chambers, boiler rooms and other similar risk areas.

7.15.6 Lighting and signing

All escape routes should have adequate artificial lighting. In certain cases escape lighting which illuminates the route if the mains supply fails should also be provided. These are listed in Table 7.5 which is based on Table 9 to AD B volume 2.

Table 7.5 Provision of escape lighting.

Purpose group	Description of building or part	Areas where escape lighting is required	Areas where escape lighting is *not* required
1(a)	Flat or maisonette	All common escape routes (including external routes)	Common escape routes in two-storey flats
2(a)	Institutional		Dwellinghouses in PG 1(b) and 1(c)
2(b)	Other Residential		
3	Office	(i) Underground or windowless accommodation	
4	Shop and Commercial[1]	(ii) Stairways in a central core or serving storey(s) over 18 m from ground level	
6	Industrial		
7(a)	Storage and other non-residential	(iii) Internal corridors more than 30 m long (iv) Open plan areas exceeding 60 m^2	
4	Shop and Commercial[2]	All escape routes (including external routes)	Escape routes in shops[3] of three or less storeys (with no sales floor exceeding 280 m^2)
7(b)	Car parks which admit the public		
5	Assembly and recreation	All escape routes (including external routes) and accommodation	(i) Accommodation open on one side to view sport or entertainment during normal daylight hours (ii) Parts of school buildings with natural light and used only during normal school hours
All	All	(i) Windowless toilet accommodation with floor area not exceeding 8 m^2 (ii) All toilet accommodation with floor area exceeding 8 m^2 (iii) Electricity and generator rooms (iv) Switch room/battery room for emergency lighting system (v) Emergency control room	Dwellinghouses in PG 1(b) and 1(c)

Notes:
[1] Those parts of the premises where the public are not admitted.
[2] Those parts of the premises where the public are admitted.
[3] Any 'shop' (see definition section 7.3) which is a restaurant or bar will require escape lighting as indicated in column 3.

The lighting to escape stairs will also need to be on a separate circuit from that which supplies any other part of the escape route.

Standards for installation of escape lighting systems are given in BS 5266 *Emergency lighting*, Part 1: 2011 *Code of practice for the emergency lighting of premises.*

Except in dwellinghouses, flats and maisonettes, emergency exit signs should be provided to every escape route. It is not necessary to sign exits which are in ordinary daily use. The exit should be distinctively and conspicuously marked by a sign with letters of adequate size complying with the *Health and Safety (Safety signs and signals) Regulations 1996*. In general, these regulations may be satisfied by signs containing symbols or pictograms which are in accordance with BS ISO 3864-1:2011 *Graphical symbols – Safety colours and safety signs. Design principles for safety signs and safety markings.*

In some buildings other legislation may require additional signs.

7.15.7 Lift installations

Lifts are not normally used for means of escape since there is always the danger that they may become immobilised due to power failure and may trap the occupants. It is possible to provide lifts as part of a management plan for evacuating disabled people if the lift installation is appropriately sited and protected. It should also contain sufficient safety devices to ensure that it remains usable during a fire. Further details may be found in BS 9999.

A further problem with lifts is that they connect floors and may act as a vertical conduit for smoke or flames thus prejudicing escape routes. This may be prevented if the following recommendations are observed:

- Lift wells should be enclosed throughout their height with fire-resisting construction if their siting would prejudice an escape route. Alternatively, they should be contained within the enclosure of a protected stairway.
- Any lift well which connects different compartments in a building should be constructed as a protected shaft.
- In buildings where escape is based on the principles of phased or progressive horizontal evacuation, if the lift well is not within the enclosure of a protected stairway, its entrance should be separated from the floor area on each storey by a protected lobby.
- Similarly, unless the lift is in a protected stairway enclosure, it should be approached through a protected lobby or corridor:
  (a) If it is situated in a basement or enclosed car park; or
  (b) Where the lift delivers directly into corridors serving sleeping accommodation if any of the storeys also contain high fire risk areas such as kitchens, lounges or stores.
- A lift should not continue down to serve a basement if there is only one escape stairway in the building (since smoke from a basement fire might be able to prejudice the escape routes in the upper storeys) or if it is in an enclosure to a stairway which terminates at ground level.
- Lift machine rooms should be located over the lift shaft wherever possible. Where a lift is within the only protected stairway serving a building and the machine room cannot be located over the lift shaft, then it should be sited outside the protected stairway. This is to prevent smoke from a fire in the machine room from blocking the stair.

- Wall-climber and feature lifts often figure in large volume spaces such as open malls and atria. Such lifts do not have a conventional well and may place their occupants at risk if they pass through a smoke reservoir. Care will be needed in the design in order to maintain the integrity of the reservoir and protect the occupants of the lift.

7.15.8 Mechanical ventilation and air conditioning services

Mechanical ventilation and air conditioning systems should be designed in accordance with the recommendations of CIBSE Guide B: *Heating, ventilation, air conditioning and refrigeration* (2005) to ensure that:

- ductwork does not assist in the passage of fire and smoke through the building and jeopardise the protected means of escape from accommodation areas;
- exhaust points should be positioned away from final exits, combustible cladding or roofing materials and any other openings into the building.

Ventilation ducts that either supply or extract air from escape routes should be separate to that in other areas.

If ductwork serves more than one part of a subdivided escape route, it should be fitted with an automatically actuated fire damper. It is normal to link such locations to actuate dampers via suitably positioned smoke detector heads. Fire dampers that protect escape routes should not actuate on fusible links.

If a duct passes through a protected escape route, it should be housed in fire-resisting construction.

Smoke detection should be fitted within the extract ductwork itself to any system which recirculates air. The smoke detector should cause the system to shut down immediately or switch the ventilation system from recirculatory mode to extraction only to open air, effectively ensuring that any smoke in the system is exhausted to outside air. Further guidance is contained within BS 5839-1:2013. Detectors should be positioned as follows:

- before the point of separation of recirculated air;
- before the point the air discharges to open air; and
- before any filters or other air-cleaning equipment.

Car parks, plant rooms and commercial kitchens should have separate and independent extraction systems.

Further guidance for ventilation systems in places of assembly may be found in BS 9999:2008.

Ventilation and air conditioning systems that are based on pressure differential within buildings should be compatible to not compromise operations under fire conditions.

7.15.9 Protected circuits for the operation of equipment in the event of fire

Protected power circuits are provided in situations where it is critical that the circuit should continue to function during a fire. For example, this will apply where the circuits provide power to:

- fire extinguishing systems;
- smoke control systems;
- sprinkler systems;
- firefighting shaft systems (such as firefighting lifts);
- motorised fire shutters;
- CCTV systems installed for monitoring means of escape; and
- data communications systems that link fire safety systems.

The cable used in a protected power circuit for operation of equipment in the event of fire should:

- meet the requirements for classification as CWZ in accordance with BS 6387:2013 *Test method for resistance to fire of cables required to maintain circuit integrity under fire conditions*;
- follow a route which passes through parts of the building in which there is negligible fire risk; and
- be separate from circuits which are provided for other purposes.

7.15.10 Refuse chutes and storage

Fires in refuse chute installations are extremely common, and they are required to be built of non-combustible materials. So that escape routes are not jeopardised, refuse chutes and rooms for refuse storage should:

- be separated, by fire-resisting construction, from the rest of the building; and
- not be located in protected lobbies or stairways.

Rooms which store refuse or contain refuse chutes should:

- be approached directly from the open air; or
- be approached via a protected lobby provided with at least $0.2\,m^2$ of permanent ventilation.

Refuse storage chamber access points should be sited away from escape routes, final exits and windows to dwellings.

Refuse storage chambers, chutes and hoppers should be sited and constructed in accordance with BS 5906:2005 *Waste management in buildings – Code of practice.*

7.16 Alternative approach to the provision of means of escape in selected premises

Reference has been made throughout the text above to the use of design guides, other than the ADs, in the provision of means of escape. There are certain specialised types of premises where it is recommended that this other guidance be used in preference to the more general guidance in the ADs. Additionally, whilst AD M covers access and facilities for disabled people, specific guidance is now made for disabled people within the Approved Document. This is discussed further below. It may not be necessary to provide special structural measures to aid the escape of disabled people other than suitable management arrangements to cater for emergencies. Where it is felt that special provisions for means of escape are desirable, reference should be made to BS 9999. Advice is given in the Code on refuges, evacuation lifts and the need for efficient management of escape.

7.16.1 Disabled people

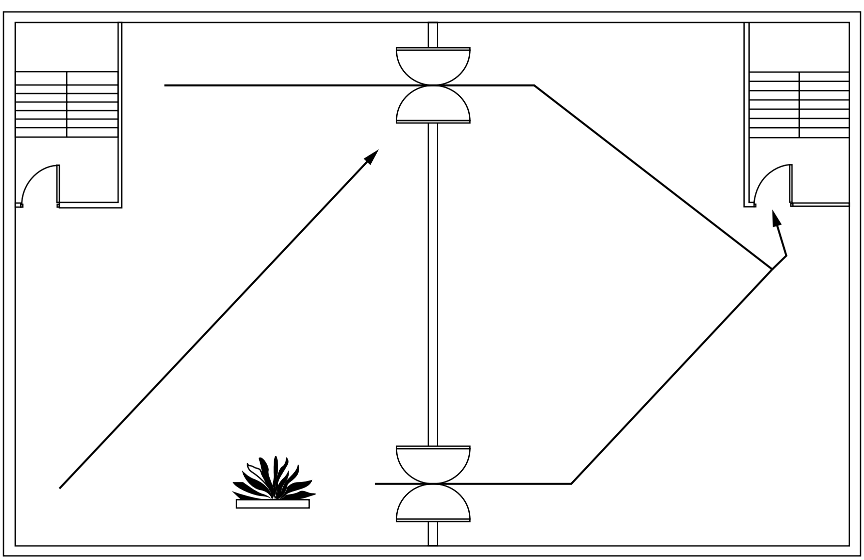
Refuge provision

A refuge is a place where disabled people can wait for short periods in relative safety. It is inappropriate for the responsible person not to have a strategy to aid their escape. A refuge is not a place where people should be stranded for long periods reliant upon fire brigade rescue.

A refuge should be provided in each storey preferably in each protected stairway. If the refuge is not provided in a stairway, it should be easily accessible from a protected stairway in order to allow ease of rescue. A refuge is not required if the storey is used solely as plant rooms.

Examples of acceptable refuges:

- Figure 7.32 shows that a refuge may be a protected lobby, corridor or separate compartment.
- Figure 7.33 shows a refuge formed in a protected stairway.
- A refuge may also be in the open air provided that the space is suitably remote or protected from an envisaged risk. The space must be provided by its own means of escape. Examples could be a flat roof, balcony, podium or similar space.



Storey divided into two refuges by compartment wall (stairways not provided with wheelchair space)

Fig. 7.32 Refuge formed by compartmentation

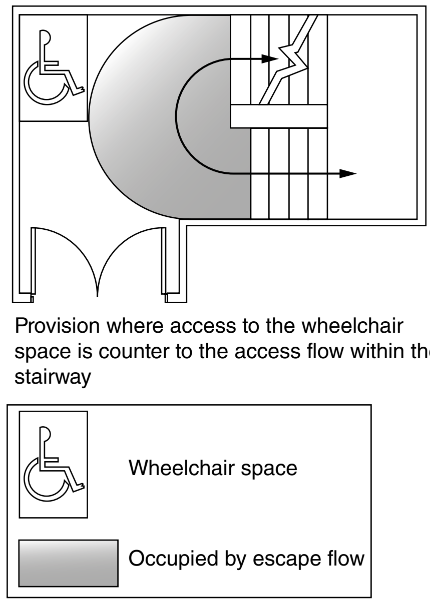


Fig. 7.33 Refuge formed within protected staircase.

A refuge must be so positioned so it does not obstruct or effectively reduce the required dimensions of the required means of escape flow. Each refuge provided must be at least 1400 × 900 mm. Multiple refuges are not required by the AD. Instead level of provision is envisaged as being part of the fire risk assessment process.

All refuges should be signed appropriately. Signage should comply with the Health and Safety (Safety Signs and Signals) Regulations. They should also be fitted with appropriate emergency voice communication (EVC) devices. This will allow an occupant of a refuge to communicate their need for assistance to the management of a property. The EVC should comply with BS 5839-9:2011: *Fire detection and fire alarm systems in buildings. Code of practice for the design, installation, commissioning and maintenance of emergency voice communication systems.* In some buildings it is possible to utilise other approaches such as wireless approaches. Careful planning of sounders associated with fire alarms should be considered. It is a relatively common mistake to have sounders next to EVCs. This is discouraged as it can stop a stranded person from being heard in the master control centre to which the EVC should be linked.

It is possible that a disabled person can use an emergency evacuation lift if considered as part of the management plan. There should be contingency arrangements for when the Fire and Rescue Service arrive.

7.16.2 Means of escape in healthcare premises and hospitals

Healthcare premises such as hospitals, nursing homes and homes for the elderly differ from other premises in that they contain people who are bedridden or who have very restricted mobility. In such buildings it is unrealistic to expect that the patients will be able to leave without assistance or that total evacuation of the building is feasible.

Hence, the approach to the design of means of escape in these premises will demand a very different approach to that embodied in much of AD B1, and NHS Estates has prepared a set of guidance documents under the general title of *Firecode* for use in healthcare buildings. These documents are also applicable to non-National Health Service premises and are as follows:

- Means of escape in new hospitals – *Firecode. Health Technical Memorandum (HTM)* 05-03, Guidance on fire risk assessments in complex healthcare premises, Dept. of Health, 2013; and
- Work that affects the means of escape in existing hospitals – *Firecode. HTM 85 Fire precautions in existing hospitals*.

If an existing house of not more than two storeys is converted for use as an unsupervised Group Home for not more than seven mentally impaired or mentally ill people, it may be regarded as a dwellinghouse (PG 1(c)) if it has means of escape designed in accordance with *Firecode. HTM 05-03:2008*. If the building is new, it might be better to regard it as being in PG 2(b) Residential (Other).

It should be noted that the *Firecode* documents contain managerial and other fire safety provisions which are outside the scope of the Building Regulations.

7.16.3 Residential care homes

Residential care can serve a diverse variety of residents, e.g. elderly people, children or people with physical and mental disabilities. The choice of fire strategy is extremely important. The responsible person and designer should have regard to level of dependency when considering the fire strategy.

A choice needs to be made, preferably early in the design, based on the occupancy as to whether simultaneous or progressive horizontal evacuation means of escape principles are to be followed. Whichever principle is adopted, the designer is best advised to discuss with the building's management and at the very least obliged by Building Regulation 38 to pass on any assumptions made in the design as to the intended evacuation management. This is essential to ensure the appropriate measures are taken to secure suitable measures are taken by the buildings management as they are considered the responsible person as cited in the Regulatory Reform (Fire Safety) Order 2005.

It is inappropriate to use the standards advocated in the AD to any premises where the NHS Firecodes guidance referred to above are cited. The following guidance is principally required for care homes for the elderly and concentrates on the principles of Progressive Horizontal Evacuation.

Progressive horizontal evacuation

The objective of PHE is to provide a place of reasonable safety without necessarily completely evacuating the building. This is particularly important in the case of the certain groups which require careful management (for instance, they may be bedbound), due to the risk that might be posed by complete simultaneous evacuation. At risk individuals or groups can then be easily managed to a place of safety. The principle relies on evacuation of a group immediately at risk of fire from one compartment to another.

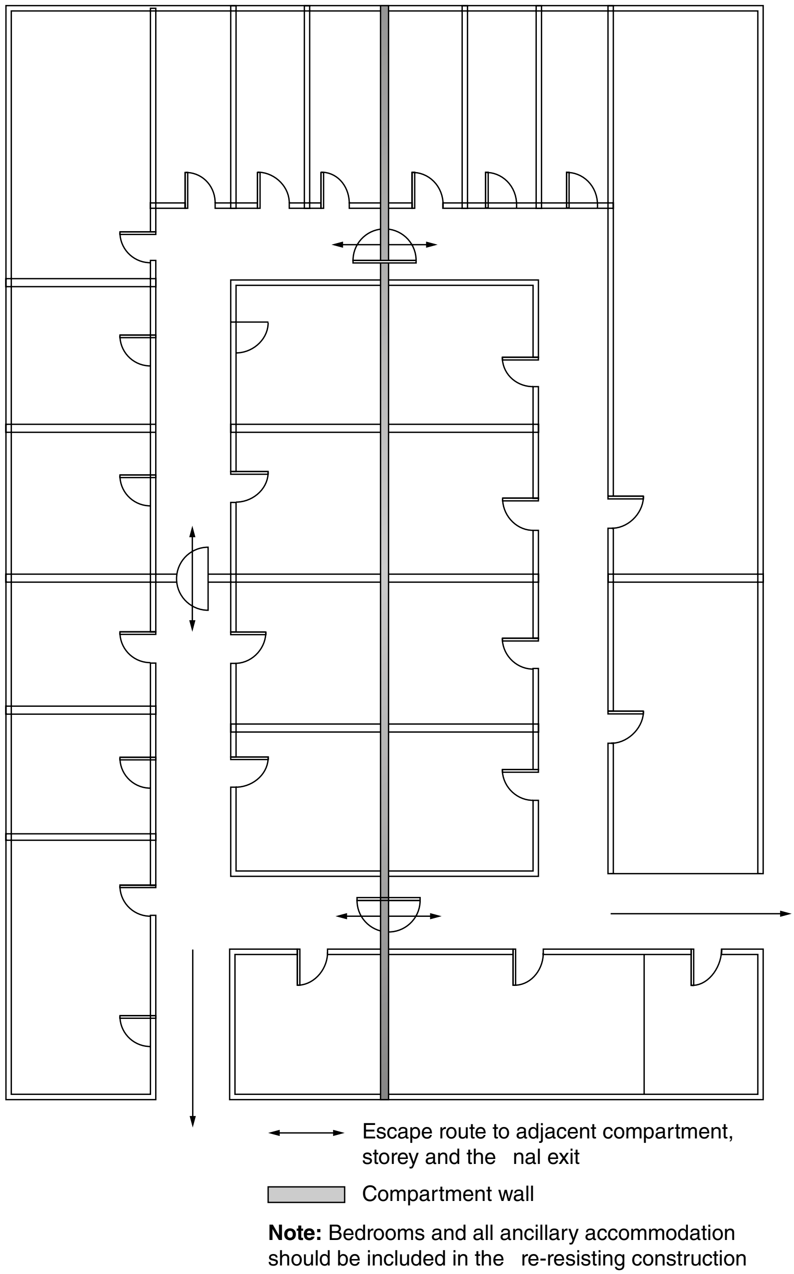


Fig. 7.34 Progressive horizontal evacuation in care homes.

Each storey should be divided into at least roughly equally sized three compartments as shown in Fig. 7.34. The corridor space within each compartment must be large enough to accommodate at least the number of people beds from the adjacent compartment. Each one must be served by at least two means of escape. The maximum travel distance from any point to a storey or final exit should not be more than 64 m.

Designers should take care to not arrange ancillary accommodation such as listed below through which escape routes will be facilitated. Ancillary accommodation should be housed within fire-resisting construction. This may include:

- chemical stores;
- cleaners' cupboards;
- day rooms;
- smoking rooms;
- disposal rooms;
- plant rooms;
- linen stores
- kitchens;
- laundry rooms;
- staff changing facilities; and
- store rooms.

It is normally acceptable to have a relatively sterile, well-managed nursing station sited within a compartment, provided that it is staffed at all times.

Early risk assessment is essential in the residential care environment to assess the number of staff available to aid means of escape during an incident.

Acceptable arrangements are as follows.

Un-sprinklered environment:

- The required automatic fire detection system is an L1 standard by reference to BS 5839-1.
- All bedrooms should be enclosed in fire-resisting construction.
- All bedroom doors should be fire doors.
- Bedrooms should not contain more than one bed.
- It is unusual for more than ten bedrooms in any one compartment. Although were staffing levels are high, this may be permissible.
- All ancillary accommodation should be behind fire-resisting construction.
- Doors separating circulation spaces and compartments may be on hold-open devices. These doors should comply with BS EN 1155:1997, *Building hardware – Electrically powered hold open devices for swing doors – Requirements and test methods (incorporating Amendment No. 1 and Corrigendum Nos 1, 2 and 3).*
- Bedroom doors should have self-closing devices. If the ability to open the door is thought to be a problem to the occupants, then free-swing devices, which actuate with the fire alarm, are acceptable. These devices also need to comply with BS EN 1155:1997.

Sprinklered environment

Where a sprinkler system is provided in accordance with section 7.11 and where the management regime has been carefully considered to account for the needs for higher numbers of compartment occupants, the following variations to the un-sprinklered environment may be acceptable:

- Self-closing devices are not required in bedrooms.
- Bedrooms may contain more than one bed.
- Protected areas may contain more than ten bedrooms.

7.16.4 Sheltered housing

Sheltered housing schemes which consist of specially adapted groups of houses, bungalows or two-storey flats with warden assistance and few communal facilities need not be treated differently from other one or two-storey houses or flats.

Sheltered accommodation in the institutional or other residential purpose groups would need to comply with the provisions for other buildings listed above. Additional guidance may be found in BS 9991:2011 Clause 8.

7.16.5 Assembly buildings

A principal problem with assembly buildings is the difficulty in escaping from fixed seating. This occurs in theatres, concert halls, conference centres and sports events. Specific recommendations for theatres, cinemas and similar venues may be found in BS 9999:2008.

Other relevant documents that can provide additional design guidance are:

- *Guide to fire precautions in existing places of entertainment and like premises*, Home Office/Scottish Home and Health Department, HMSO, 1990; and
- *Guide to safety at sports grounds*, Football Licensing Authority and Dept. of Culture, Media and Sport, 2008, for sports stadia, etc.

7.16.6 Schools and other educational buildings

Building Bulletin 100: *Design for fire safety in schools* (Dept. for Education and Schools, 2007) contains the design guidance for fire safety in schools. The document is split into clauses relevant to both life safety and property protection. Part B of the regulations will be satisfied where the life safety elements of the guidance are followed.

7.16.7 Shops and shopping complexes

The general design guidance provisions of BS 9999 may be used instead of AD volume 2.

Shopping complexes are not covered adequately by AD B volume 2 and should be designed in accordance with Annexe B and E of BS 9999:2008.

If walk-in shop store rooms are fully enclosed and positioned so that they could prejudice the means of escape, then they should be fire resistance in accordance with Table A1 of AD B volume 2, unless they are fitted with sprinklers of a suitable alarm system.

7.16.8 Small premises

In small premises, the numbers of people is generally limited. If the premises is undivided, it will be quite easy to see all parts of the building, enabling an occupant to quickly find an entrance or exit in an emergency. In these circumstances it is possible to reduce the number of stairs or exits provided.

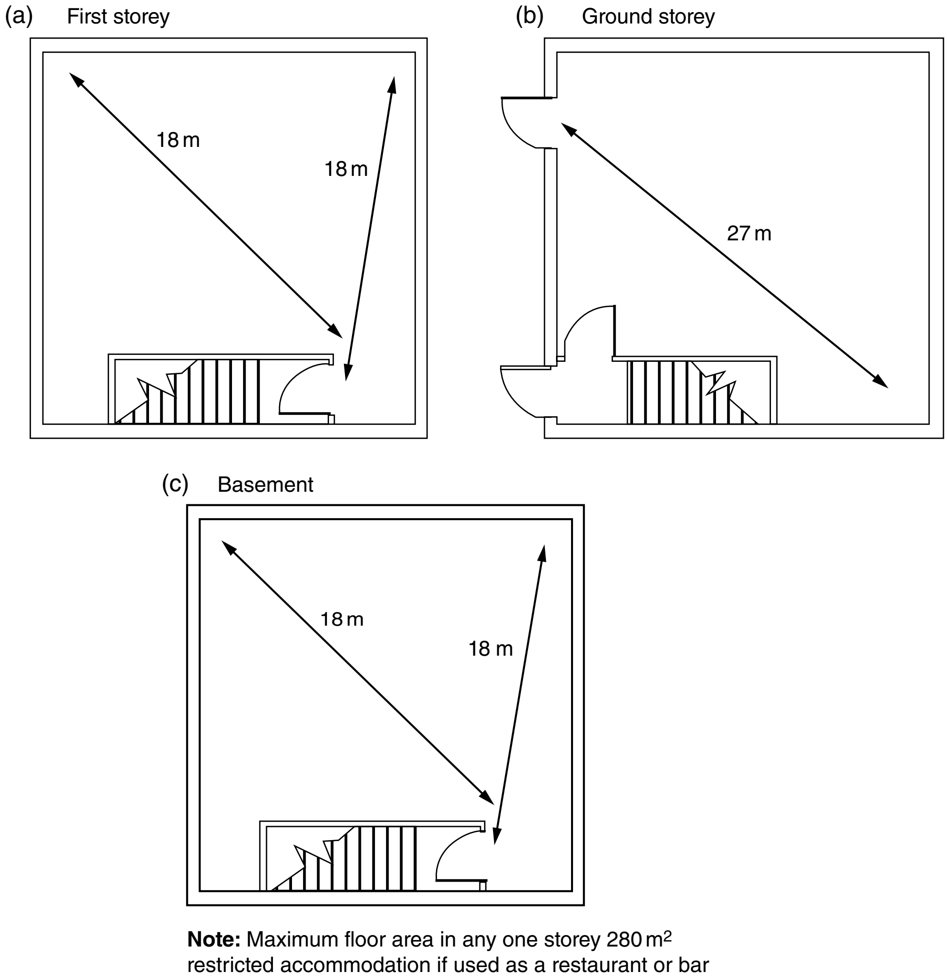


Fig. 7.35 Maximum travel distance in small two- or three-storey premises with a single stair to each unit.

The small premises guidance should not be used:

- for restaurants or bars where the occupancy exceeds 30 people per storey. It is permitted to have a ground floor occupancy of 100 people provided that the ground storey is served by an independent final exit.
- where highly flammable liquid or materials are stored or sold.

In the case of a covered shopping complex or 'mall', a small unit can be served by a single-stair exit, provided that:

- the premises is a single occupancy;
- it does not comprise more than a basement, ground and first floor;
- no storey is greater than 280 m^2 in floor area (see Fig. 7.35); and
- any kitchen or cooking area should be remote from the exit.

Layouts in such premises should be open plan so that all exits are clearly visible to occupants. Ancillary accommodation such as facilities used by staff such as kitchens, offices and stores may be separated within construction provided that:

- store rooms are housed within fire-resistant construction;
- vision panels or clear glass is provided to the separating construction that will allow staff to become aware of a fire in the open plan area; or
- automatic fire detection is placed within the open plan area to provide staff working in offices or kitchens with early warning in case of fire.

Maximum travel distances allowable

The number and siting of exits should be positioned so that the travel distance limits shown in Table 5 of AD B volume 2 (reproduced) are not exceeded.

Approved Document: Table 5 Maximum distances of travel in small premises with a protected stair.

Storey	Maximum travel distance (m)
Ground storey with single exit	27
Basement or first storey with single stair	18
Storey with more than one exit/stair	45

Note:
Figures are travel distances. Unless final layouts are known, designs will be appraised against direct distances. These are two-thirds of the travel distance shown.

The travel distance within an open stairway is measured from the foot of the stair in the basement to the head of the stair in the first storey. If more than one staircase is to be provided, they should be positioned following the general rules for means of escape.

Stairs within small premises

A stair may be open plan provided that it discharges to a fire exit on the ground floor, not more than 3 m away from the bottom of the stair.

See Figs 7.36 and 7.37 – Small Premises

In both instances:

- either the storey should be served by a protected staircase or in the case of a small premises, the storey should not exceed 90 m^2; and
- in the case of a three-storey property, either the bottom or the top storey is enclosed in fire-resisting construction at the ground floor level, which should discharge to an independent final exit (see Fig. 7.37).

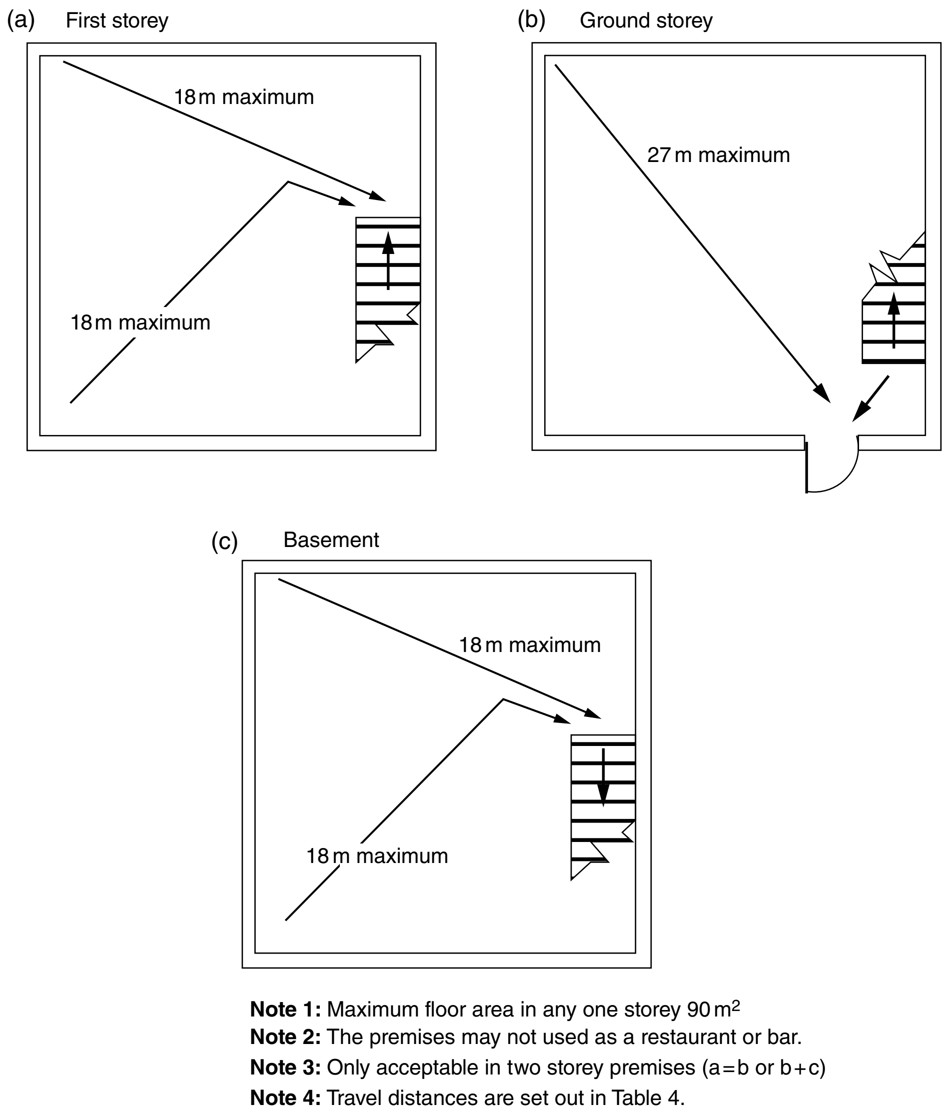


Fig. 7.36 Maximum travel distance in a small two-storey premises with a single open stair.

7.17 Internal fire spread (linings)

7.17.1 Introduction

Although the linings of walls and ceilings are unlikely to be the materials first ignited in a fire (this is more likely to occur in furniture and fittings), they can significantly affect the spread of fire and its rate of growth. This is especially true in circulation areas where rapid fire spread may prevent occupants from escaping. Part B2 of Schedule 1 to the 2010 Regulations seeks to control these surface linings.

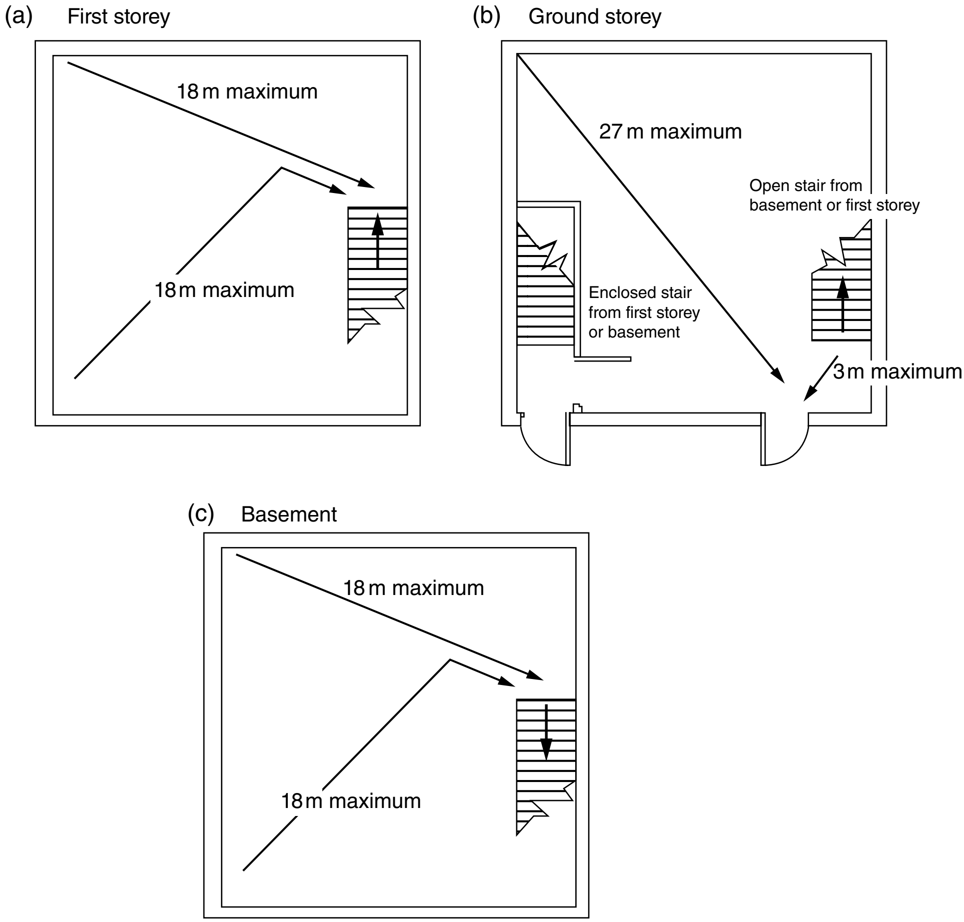


Fig. 7.37 Maximum travel distance in a small three-storey unit premises with a single stair to each storey.

7.17.2 Internal linings

Although the materials used for lining walls and ceilings are not likely to be the materials first ignited, they can significantly affect the rate of growth of fires. It is important to have regard to the types of materials specified in circulation spaces to prevent this effect being a problem to people using an escape route.

Several properties can affect the degree to which linings can influence fire growth:

- Ease of ignition; and
- The rate at which linings gives off heat when burning.

The European fire tests and classification methods have been developed that are intended to control these properties. The AD does not offer detailed guidance on other properties such as the production of smoke and fumes.

Floors and stairs

It is assumed that floors and stairs are not significantly involved in a fire until its later stages. The AD makes reference only to certain escape stairs being constructed with materials of limited combustibility in the following circumstances:

- If it is the only escape stair serving the building, or part of a building, unless the building is of two or three storeys and is in PG 1(a) Flats or PG 3 Office;
- With the exception of private stairs in flats, if a stair is situated within a basement storey;
- If it serves any storey having a floor level above 18 m above access or ground level;
- If it is external, except in the case of a stair that connects the ground floor or paving level with a floor or flat roof not more than 6 m above or below ground level; and
- All firefighting stairs.

Care should be taken when selecting any soft furnishings or carpet within a staircase enclosure, particularly within firefighting shafts.

Furniture and fittings

Furniture and fittings are not controlled within the scope of the ADs. It is recognised that they can have a major effect on the capability to spread fire throughout a building and in some cases can be controlled by various license conditions. Care should always be taken to by the responsible person when risk assessing the suitability of furniture and fittings in order that escape routes remain appropriately protected.

7.17.3 Methods of test

In order to meet the requirements of B2, it is necessary for materials or products to meet certain levels of performance in appropriate tests.

Under National classifications the surface spread of flame characteristics of a material may be determined by testing it in accordance with the method specified in BS 476 *Fire tests on building materials and structures*: Part 7:

- 1971 *Surface spread of flame tests for material;*
- 1987 *Method for classification of the surface spread of flame of product; or*
- 1997 *Method of test to determine the classification of surface spread of flame of products*.

It should also be noted that although this BS 476 standards are still cited, they have been withdrawn and superseded by BS 13823, and they remain cited in the regulations at the advice of the Fire Standards Policy Committee to ease the burden on Designers specifying a wide range of materials, which still refer to the old standard.

A strip of the material under test is placed with one end resting against a furnace, and the rate at which flames spread along the material is measured.

Materials or products are thus placed in Classes 1, 2, 3 or 4, Class 1 representing a surface of very low flame spread. Class 4 (a surface of rapid flame spread) is not acceptable under the provisions of the approved document.

Under the European classifications, lining systems are classified in accordance with BS EN 13501 *Fire classification of construction products and building elements*, Part 1: 2002 *Classification using data from reaction to fire tests*. Materials or products are classified as A1, A2, B, C, D, E or F, with A1 being the highest. When a classification includes 's3, d2', it means that there is no limit set for smoke production and/or flaming droplets/particles. The relevant European test methods are specified as follows:

- BS EN ISO 1182:2002 *Reaction to fire tests for building products – Non-combustibility test*;
- BS EN ISO 1716:2002 *Reaction to fire tests for building products – Determination of the gross calorific value*;
- BS EN 13823:2002 *Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item*;
- BS EN ISO 11925-2:2002 *Reaction to fire tests for building products*, Part: 2002 – *Ignitability when subjected to direct impingement of flame*; and
- BS EN 13238:2001 *Reaction to fire tests for building products – Conditioning procedures and general rules for selection of substrates*.

In the event of fire, some materials have a higher rate of heat release or ignite more easily than others. They are therefore more hazardous, and this may mean a reduced time to flashover. In the National test, the way in which the rate of heat release may be assessed is contained in BS 476: Part 6: 1981 or 1989 *Method of test for fire propagation of products*.

The material or product is tested for a certain period of time in a furnace and is given two numerical indices related to its performance. The sub-index (i_1) is derived from the first three minutes of the test, whilst the overall test performance is denoted by the index of performance (I).

7.17.4 Class 0 materials

In order to establish a high product performance classification for lining materials in high-risk areas (such as circulation spaces), AD B2 recommends that materials in these areas should conform to either the Class 0 (National) standard or European Class B-s3, d2 or better. Class 0 is not a classification found in any British Standard test as such; however it is evident that it draws on BS 476 test results as the following definition shows.

The Class 0 standard will be achieved by any material or the surface of a composite product which:

(a) is composed of materials of limited combustibility (see below) throughout; or
(b) is a material of Class 1 which has an index of performance (I) of not more than 12 and a sub-index (i_1) of not more than 6.

7.17.5 Interpretation

The following terms are common to both volumes of AD B.

NON-COMBUSTIBLE MATERIAL – A material which has the highest level of reaction to fire performance when tested as follows:

- (National classes) to BS 476: Part 11, the material does not flame, and there is no rise in temperature on either the centre (specimen) or furnace thermocouples; or
- (European classes) when classified as class A1 in accordance with BS EN 13501 *Fire classification of construction products and building elements*, Part 1: 2002 *Classification using data from reaction to fire tests*:
  - (a) BS EN ISO 1182:2002 *Reaction to fire tests for building products – Non-combustibility test*; and
  - (b) BS EN ISO 1716:2002 *Reaction to fire tests for building products – Determination of the gross calorific value*.

Table A6 from Appendix A of AD B (which is reproduced below) lists some examples of non-combustible materials and gives details of where they should be used.

AD B Appendix A

Table A6 Use and definitions of non-combustible materials.

References in AD B guidance to situations where such materials should be used	**Definitions of non-combustible materials**	
	National class	**European class**
1. Refuse chutes meeting the provisions in the guidance to B3 (see section 7.22.2) 2. Suspended ceilings and their supports where there is provision in the guidance to B3 (see section 7.19.2) 3. Pipes meeting the provisions in the guidance to B3 (see section 7.20.1) 4. Flue walls meeting the provisions in section 7.22.3 5. Construction forming car parks referred to in section 7.26.1	a. Any material which when tested to BS 476: Part 11 does not flame nor cause any rise in temperature on either the centre (specimen) or furnace thermocouples b. Totally inorganic materials such as concrete, fired clay, ceramics, metals, plaster and masonry containing not more than 1% by weight or volume of organic material. (Use in buildings of combustible metals such as magnesium/aluminium alloys should be assessed in each individual case.) c. Concrete bricks or blocks meeting BS 6073: Part 1 d. Products classified as non-combustible under BS 476: Part 4	a. Any material classified as class A1 in accordance with BS EN 13501-1:2002, Fire classification of construction products and building elements, Part 1 – Classification using data from reaction to fire tests b. Products made from one or more of the materials considered as Class A1 without the need for testing, as defined in Commission Decision 96/603/EC of 4 October 1996 establishing the list of products belonging to Class A1 'No contribution to fire' provided for in the Decision 94/611/EC implementing Article 20 of the Council Directive 89/106/EEC on construction products. None of the materials shall contain more than 1.0% by weight or volume (whichever is the lower) of homogeneously distributed organic material

Note:
The National classifications do not automatically equate with the equivalent classifications in the European column; therefore products cannot typically assume a European class unless they have been tested accordingly.

MATERIALS OF LIMITED COMBUSTIBILITY – Materials in this group, whilst not regarded as non-combustible, would contribute little heat energy to a fire. Therefore, they can be used in situations where control of fire spread is essential, such as stairs to basements. They are defined in AD B, Table A7 when tested as follows:

- (National classes) to BS 476: Part 11, the material does not flame, and there is no rise in temperature on either the centre (specimen) or furnace thermocouples; or
- (European classes) when classified as class A2-s3, d2 in accordance with BS EN 13501 *Fire classification of construction products and building elements*, Part 1: 2002 *Classification using data from reaction to fire* test when tested to:
  (a) BS EN ISO 1182:2002 *Reaction to fire tests for building products – Non-combustibility test*; or
  (b) BS EN ISO 1716:2002 *Reaction to fire tests for building products – Determination of the gross calorific value*, and BS EN 13823:2002 *Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item*.

AD Appendix A

Table A7 Use and definitions of materials of limited combustibility.

References in AD B guidance to situations where such materials should be used	Definitions of non-combustible materials	
	National class	**European class**
1. Stairs where there is provision in the guidance to B1 for them to be constructed of materials of limited combustibility (section 7.14.8) 2. Materials above a suspended ceiling meeting the provision in the guidance given in section 7.21.2 3. Reinforcement/support for fire stopping referred to in the guidance to B3 (see section 7.22.4) 4. Roof coverings meeting provisions: a. In the guidance to B3 (see section 7.21.2); b. In the guidance to B4, Table 16; or c. In the guidance to B4 (see section 7.25.9) 5. Roof deck meeting the provisions of the guidance to B3 (see section 7.20.1) 6. Class 0 materials meeting the provisions in Appendix A (see section 7.17.4) 7. Ceiling tiles or panels of any fire-protecting suspended ceiling (Type Z) in Table A3 (see section 7.19) 8. Compartment walls and compartment floors in hospitals referred to in section 7.20	a. Any non-combustible material listed in Table A6 b. Any material of density 300/kg/m^2 or more, which when tested to BS 476: Part 11, does not flame, and the rise in temperature on the furnace thermocouple is not more than 20°C c. Any material with a non-combustible core at least 8 mm thick having combustible facings (on one or both sides) not more than 0.5 mm thick (Where a flame spread rating is specified, these materials must also meet the appropriate test requirements).	a. Any material listed in Table A6 b. Any material/product classified as Class A2-s3, d2 or better in accordance with BS EN 13501-1:2002 *Fire classification of construction products and building elements, Part 1 – Classification using data from reaction to fire tests*

(*Continued*)

Table A7 (*Continued*)

References in AD B guidance to situations where such materials should be used	Definitions of non-combustible materials: National class	Definitions of non-combustible materials: European class
9. Insulation material in external wall construction referred to in see section 7.25 10. Insulation above any fire-protecting suspended ceiling (Type Z) in Table A3 (see section 7.21)	Any of the materials (a), (b) or (c) above or d. Any material of density less than 300 kg/m³, which when tested to BS 476: Part 11, does not flame for more than ten seconds, and the rise in temperature on the centre (specimen) thermocouple is not more than 35°C and on the furnace thermocouple is not more than 25°C	Any of the materials/ products (a) or (b) above

Notes:

1. National classifications do not automatically equate with the equivalent classifications in the European column; therefore products cannot typically assume a European class unless they have been tested accordingly.
2. A classification includes 's3, d2'; this means that there is no limit set for smoke production and/or flaming droplets/ particles.

It should be noted that certain insulating materials in group (d) of the table are of a lower standard than the group (a), (b) or (c) materials and may only be used in the situations shown in items 9 and 10 of the table. It is of course permissible to use non-combustible materials whenever a recommendation for materials of limited combustibility is specified.

7.17.6 Classification of linings

As a guide to the materials which may be used for wall and ceiling linings, AD B lists in Table A8 the typical performance ratings for some generic materials and products. Test results for proprietary materials may be obtained from manufacturers and trade associations. However, small differences in detail (e.g. thickness, substrate, colour, form, fixings, adhesives, etc.) can significantly affect the rating. Therefore, the reference used to substantiate the spread of flame rating should be carefully checked to ensure that it is suitable, adequate and applicable to the construction to be used.

Walls and ceilings should conform to the following standards. A few variations in requirement exist, which are qualified in the notes that follow Table 7.6.

Table A8 Typical performance ratings of some generic materials and products.

Rating	Material or product
Class 0 (National)	1. Any non-combustible material or material of limited combustibility (Composite products listed in Table A7 must meet test requirements given in Appendix A, paragraph 13(b))
	2. Brickwork, blockwork, concrete and ceramic tiles
	3. Plasterboard (painted or not with a PVC facing not more than 0.5 mm thick) with or without an air gap or fibrous or cellular insulating material behind
	4. Woodwool cement slabs
	5. Mineral fibre tiles or sheets with cement or resin binding
Case 3 (National)	6. Timber or plywood with a density more than 400 kg/m^3, painted or unpainted
	7. Wood particle board or hardboard, either untreated or painted
	8. Standard glass reinforced polyesters
Class A1 (European)	9. Any material that achieves this class and is defined as 'classified without further test' in a published Commission Decision
Class A2-s3, d2 (European)	10. Any material that achieves this class and is defined as 'classified without further test' in a published Commission Decision
Class B-s3, d2 (European)	11. Any material that achieves this class and is defined as 'classified without further test' in a published Commission Decision
Class C-s3, d2 (European)	12. Any material that achieves this class and is defined as 'classified without further test' in a published Commission Decision
Class D-s3, d2 (European)	13. Any material that achieves this class and is defined as 'classified without further test' in a published Commission Decision

Notes (National):

1. Materials and products listed under Class 0 also meet Class 1.
2. Timber products listed under Class 3 can be brought up to Class 1 with appropriate proprietary treatments.
3. The following materials and products may achieve the ratings listed below. However, as the properties of different products with the same generic description vary, the ratings of these materials/products should be substantiated by test evidence.
   Class 0 – Aluminium-faced fibre insulating board, flame retardant decorative laminates on a calcium silicate board, thick polycarbonate sheet, phenolic sheet and UPVC;
   Class 1 – Phenolic or melamine laminates on a calcium silicate substrate and flame retardant decorative laminates on a combustible substrate.

Notes (European):

For the purposes of the Building Regulations:

1. Materials and products listed under Class A1 also meet Classes A2-s3, d2, B-s3, d2, C-s3, d2 and D-s3, d2.
2. Materials and products listed under Class A2-s3, d2 also meet Classes B-s3, d2, C-s3, d2 and D-s3, d2.
3. Materials and products listed under Class B-s3, d2 also meet Classes C-s3, d2 and D-s3, d2.
4. Materials and products listed under Class C-s3, d2 also meet Class D-s3, d2.
5. The performance of timber products listed under Class D-s3, d2 can be improved with appropriate proprietary treatments.
6. Materials covered by the classification without further testing (CWFT) process can be found by accessing the European Commission's website via the link on the DCLG's website www.odpm.gov.uk/bregs/cpd/index.htm.
7. The National classifications do not automatically equate with the equivalent classifications in the European column; therefore products cannot typically assume a European class unless they have been tested accordingly.
8. When a classification includes 's3, d2', this means that there is no limit set for smoke production and/or flaming droplets/particles.

Definition of walls and ceilings

When referring to the performance of walls and ceilings, they are defined as follows:

Walls:

- Any glazed surface (excluding glazing in doors); and
- Any part of a ceiling which slopes at an angle of more than 70° to the horizontal.
- This definition excludes:
  - doors or door frames;
  - glazed windows and their frames;
  - architraves, picture rails, cover moulds and similar narrow members; and
  - fire place surrounds, fitted furniture and mantle pieces.

Ceilings:

- Surface of glazing;
- Any part of a wall which slopes at an angle of more than 70° to the horizontal;
- Underside of a gallery or mezzanine floor; and
- Underside of a roof exposed to the room below.
- This definition excludes:
  - trap doors;
  - glazed windows and their frames; and
  - architraves, picture rails, cover moulds and similar narrow members.

Variations and special provisions

Walls – A wall area may be of a poorer performance than that of Table 7.6. But it must still achieve a minimum standard of national Class 3 or European Class D-s3, d2; however the poorer performing elements of the wall must not exceed 50% of the total room floor area subject to the total wall areas not exceeding 20 m^2 in any residential rooms and 60 m^2 wall area in any other building.

Table 7.6 Classification of linings.

Location	National class	European class
Small rooms with an area not more than: a. 4 m^2 in residential accommodation b. 30 m^2 in non-residential accommodation c. 40 m^2 in domestic garages	3	D-s3, d2
Other rooms (including garages)	1	C-s3, d2
Circulation spaces within dwellings and dwellinghouses		
Other circulation spaces, including the common areas of blocks of flats	0	B-s3, d2

Notes:

- The National and European are not necessarily equivalent unless they have been proven by the appropriate tests.
- s3, d2 means that there is no set limit for smoke production and/or flaming droplets/particles.
- In 'other circulation spaces' wallcoverings should conform to BS EN 15102:2007 *Decorative wallcoverings – Roll and panel form products*. These achieve at least Class C-s3, d2 and bonded to a Class A2-s3, d2 substrate and are deemed acceptable.

Fire-protecting suspended ceilings – Should achieve the same performance as linings shown in Table 7.6 and should also achieve the meet the provisions of Table A3 of the ADs. This is replicated in section 7.19.

Fire-resisting ceilings – Section 7.21 describes where cavity barriers are needed within concealed floors and ceiling voids. These provisions may be reduced by use of fire-resisting ceilings below the voids. Figure 7.38 provides further guidance.

Rooflights – Need to achieve compliance with Table 7.6. However plastic rooflights with at least Class 3 rating are permitted where Table 7.7 requires a higher standard provided that the limitation of in Table 7.7 and AD B volume 2 Table 18 are observed.

Note: No guidance is offered by reference to the European fire test criteria as this has not yet been developed.

Special applications – Any flexible membrane covering all, but air-supported structures should comply with BS 7157:1989.

The reader should refer to BRE BR Report 274, 1984, *Fire safety of PTFE-based materials used in buildings* for guidance on the use of PRFE-based materials for tension membrane roofs and structures.

7.17.7 Thermoplastic materials

A thermoplastic material is a synthetic polymer which has a softening point below 200°C when tested in accordance with BS EN ISO 306:2004 method A120 *Plastics – Thermoplastic materials – Determination of Vicat softening temperature.* If the thickness of the product to be tested is less than 2.5 mm, then specimens for the test may be fabricated from the original polymer.

When used in isolation as a wall or ceiling lining, a thermoplastic material cannot be assumed to protect a substrate. The surface rating of both the substrate and the lining would need to meet the required classification. However, where the thermoplastic material is fully bonded to a non-thermoplastic substrate, then only the surface rating of the composite would need to comply.

Some thermoplastic materials can be tested under BS 476: Parts 6 and 7 and can be used in accordance with their ratings as described above. Alternatively, they may be classified as TP(a) rigid, TP(a) flexible or TP(b), as described below, but their use would

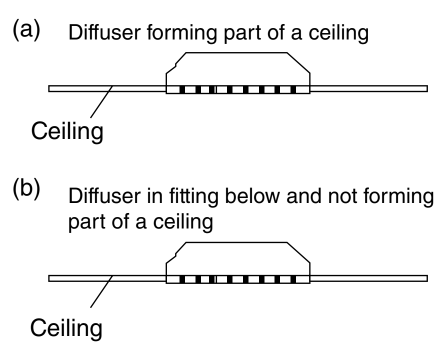


Fig. 7.38 Lighting diffuser in relation to ceiling.

Table 7.7 Limitations applied to thermoplastic rooflights and lighting diffusers in suspended ceilings and Class 3 plastic rooflights.

Minimum classification of lower surface	**Use of space below the rooflight or diffusers**	**Maximum area of each rooflight or diffuser panel** [(1)] **(m^2)**	**Maximum total area of rooflights or diffusers as a percentage of floor area of the space where ceiling is located (%)**	**Minimum separation distance between rooflights or diffuser panels** [(1)] **(m)**
TP(a)	Any except protected stairway	No limit [(2)]	No limit	No limit
D-s3, d2 Or Class 3[(3)]	Rooms	1	50 [(4, 5)]	A distance equal to the largest plan dimension of the largest rooflight of diffuser
Or TP(b)		5	50 [(4, 5)]	3 [(5)]
	Circulation spaces except protected stairways	5	15 [(4)]	3

Notes:

[(1)] Smaller panels may be grouped together provided that the overall size of the group and the space between the one group and any others satisfies the dimensions shown in Fig. 7.39(a) and (b).

[(2)] TP(a) flexible rated lighting diffusers should not be over 5 m^2 panel size overall.

[(3)] No limits on class 3 materials in small rooms.

[(4)] The minimum separation between each panel should be maintained. In some cases it may not be possible to use the maximum percentage quoted.

[(5)] Class 3/D-s3, d2 rooflights within industrial and other non-residential purpose groups may be spaced 1800 mm apart provided that the rooflights are equally distributed and do not exceed 20% of the room area.

This table is not relevant to products which meet the provisions of Table 7.6.

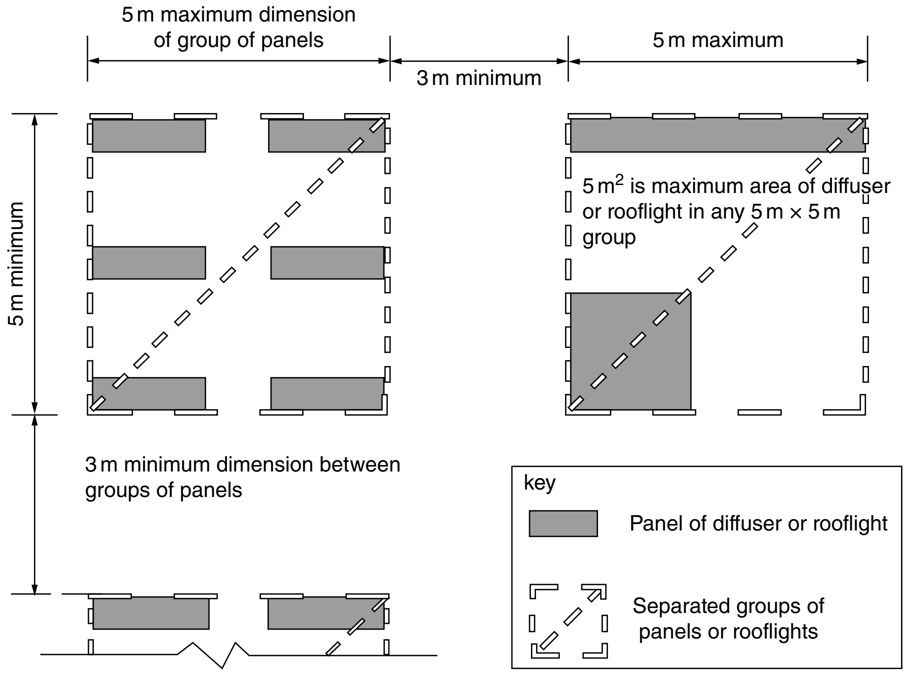
be restricted to rooflights, lighting diffusers, suspended ceiling panels and external window glazing (except in circulation areas). These uses are described more fully below. *TP(a) rigid* means:

- rigid solid PVC sheet;
- solid (i.e. not double- or multi-skin) polycarbonate sheet at least 3 mm thick;
- multi-skin rigid sheet made from uPVC or polycarbonate with a BS 476: Part 7 rating of Class 1; and
- any other rigid thermoplastic product which, when tested in accordance with BS 2782: Part 5: 1970 (1974): Method 508A, performs so that the flame extinguishes before reaching the first mark and the duration of the flame or afterglow after removal of the burner does not exceed five seconds.

TP(a) flexible means:

- flexible products not more than 1 mm thick complying with the Type C requirements of BS 5867 *Specification for fabrics for curtains and drapes*, Part 2: 1980 *Flammability requirements*, when tested to BS 5438: Test 2, 1989. In the BS 5438 test, the flame

(a)



Notes:

a. Upper and lower surface of suspended ceiling, between plastic panels, to comply with paragraph 5.1 of AD B volume 2.

b. No restriction on Class 3 rooflights in small rooms.

c. See note 5 to Table 7.7.

(b)

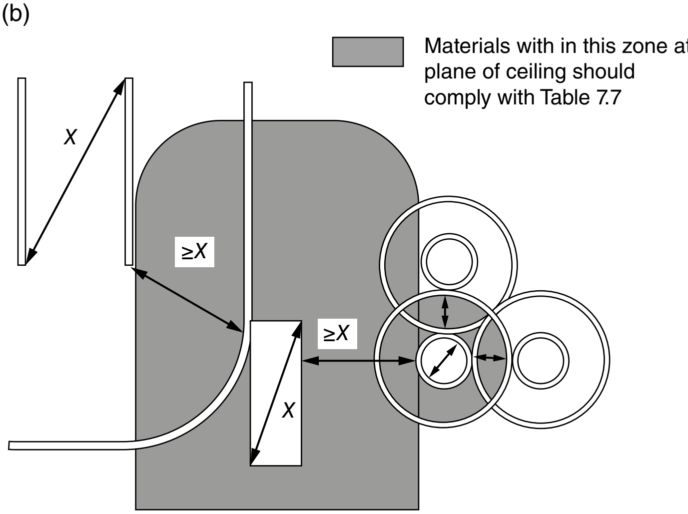


Fig. 7.39 (a) Layout restrictions for Class 3 plastic rooflights, Tb(b) rooflights and Tb(b) lighting diffusers. (b) Layout restrictions for small Class 3 plastic rooflights, Tb(b) rooflights and Tb(b) lighting diffusers.

should be applied to the specimens for 5, 15, 20 and 30 seconds, respectively, although it is not necessary to include the cleansing procedure described in the British Standard.

TP(b) means:

- rigid solid polycarbonate sheet products less than 3 mm thick or multi-skin polycarbonate sheet products which do not qualify as TP(a) by test; and
- any other product, a specimen of which between 1.5 mm and 3 mm thick, when tested in accordance with BS 2782: Part 5: 1970 (1974): Method 508A, has a rate of burning not exceeding 50 mm/minute.

If it is not possible to cut or machine a 3 mm thick test specimen from the product, then it is permissible to mould one from the original material used for the product.

Currently, no new guidance is possible on the assessment or classification of thermoplastic materials under the European system since there is no generally accepted European test procedure and supporting comparative data.

Thermoplastic materials can be used in windows, rooflights and lighting diffusers in the following circumstances:

Windows and internal glazing

- TP(a) rigid products may be for the glazing of external windows and rooms provided that the room is not considered a circulation space.
- Internal glazing should meet the standards set out in Table 7.6.

Rooflights

Unless within a protected stairway, rooflights may be permitted in rooms and circulation spaces provided that:

- the lower surface has a TP(a) Rigid or TP(b) classification; and
- the size and position of the rooflight is within the limits stated in Table 7.7 and with guidance in section 7.25.9, Table's 17 and 18 of AD B volume 2 (reproduced).

Lighting diffusers

Provided that lighting diffusers form part of a ceiling as opposed to a diffuser which does not form part of ceiling (see Fig. 7.38 for clarification), then the following provisions apply:

- Lighting diffusers which are translucent and open structured which allow light to pass through their structure may be used below rooflights.
- Unless independently tested to perform, then thermoplastic lighting diffusers should not be used in fire-resistant or protected ceilings.
- With the exception of protected stairways, thermoplastic lighting diffusers may form the ceilings associated with rooms and circulations spaces, provided that:
    - exposed wall and ceiling surfaces above the suspended ceiling comply with Table 7.6 – classification of linings;

- ○ diffusers are TP(a) rigid classification; and
- ○ if TP(b), they should be within the limits explained in Table 7.7.
- Suspended or stretched skin ceilings made from panels of thermoplastic, if made from TP(a) flexible classified materials, should not form part of a fire-resisting ceiling or exceed 5 m^2 in any unsupported area.

7.18 Internal fire spread (structure)

Paragraph B3 of Schedule 1 to the Building Regulations lists a number of factors which must be considered in order to reduce the effects of fire spread throughout the structure of a building as follows:

- The building must be so designed and constructed that its stability will be maintained for a reasonable period during a fire.
- Walls which are common to two or more buildings must be designed and constructed so that they resist the spread of fire between those buildings. Semi-detached and terraced houses are treated as separate buildings for the purposes of this requirement.
- The building must be subdivided by fire-resisting construction, depending on its size and intended use, where this is necessary to inhibit the spread of fire. (This requirement does not apply to material alterations to prisons provided under section 33 of the Prisons Act 1952.)
- Fire and smoke may spread unseen through concealed spaces in the structure and fabric of a building. The building must be designed and constructed so that this fire and smoke spread is inhibited.

7.19 Fire resistance and structural stability

If the structural elements of a building can be satisfactorily protected against the effects of fire for a reasonable period, it will be possible for the occupants to be evacuated safely, and also the spread of fire throughout the building will be kept to a minimum. The risk to fire-fighters (who may have to search for or rescue people who are trapped) will be reduced, and there will be less risk to people in the vicinity of the building from falling debris or as a result of an impact with an adjacent building from the collapsing structure.

One way to measure the standard of protection to be provided is by reference to the fire resistance of the elements under consideration. A number of factors which have a bearing on fire resistance are considered in Appendix A of AD B including the following.

- FIRE SEVERITY – Estimated from the purpose group (and therefore, the use) of the building. This assumes that the contents (which constitute the fire load) are the same for buildings of similar usage and that the contents of some building types will be more hazardous than others.

- HEIGHT OF THE TOP FLOOR ABOVE GROUND – Affects ease of escape, fire-fighting and the consequences of a large-scale collapse.

- BUILDING OCCUPANCY – Influences the speed of evacuation.

- THE PRESENCE OF BASEMENTS – Lack of venting may increase heat build-up and the duration of a fire and hinder firefighting.

- THE NUMBER OF FLOORS – Escape from single-storey buildings is easier, and a structural failure is unlikely to happen before evacuation has taken place.

It can be seen from the foregoing that an assessment of the standard of fire resistance in a building is a complicated matter. It is further complicated by the fact that there can be little control exercised over a building's future fire load unless a material change of use occurs. If a fire engineering approach is adopted for the assessment of fire severity based on fire load for a particular use, then future changes in use should also be borne in mind.

The method of assessment of fire resistance contained in AD B is based on the performance of an element of structure, door or other part of a building by reference to standard tests contained in:

- BS 476: Parts 20–24: 1987 (or to BS 476: Part 8: 1972, for items tested prior to 1 January 1988); or
- (European tests) Commission Decision 2000/367/EC of 3 May 2000 implementing Council Directive 89/106/EEC as regards the classification of the resistance to fire performance of construction products, construction works and parts thereof.

All products are classified in accordance with:

- BS EN 13501 *Fire classification of construction products and building elements,* Part 2: 2007 *Classification using data from fire resistance tests (excluding products for use in ventilation systems)*;
- BS EN 13501 *Fire classification of construction products and building elements,* Part 3: 2005 *Classification using data from fire resistance tests on components of normal building service installations (other than smoke control systems)*; and
- BS EN 13501 *Fire classification of construction products and building elements,* Part 4: 2007 *Classification using data from fire resistance tests on smoke control systems*.

Relevant European testing criteria referenced in the approved document are contained within BS EN standards 1364, 1365, 1366 and 1634.

The tests relate to the ability of the element:

- to resist a fire without collapse (load-bearing capacity), denoted R in the European classification of the resistance to fire performance;
- to resist fire penetration (integrity), denoted E in the European classification of the resistance to fire performance; and
- to resist excessive heat penetration so that fire is not spread by radiation or conduction (insulation), denoted I in the European classification of the resistance to fire performance.

Clearly the criteria of resistance to fire and heat penetration are applicable only to fire-separating elements, such as walls and floors. The criterion of resistance to collapse is applicable to all load-bearing elements, such as columns and beams, in addition to floors and load-bearing walls; however, it does not apply to external curtain walling or other claddings which transmit only self-weight and wind loads.

Table A1 to Appendix A of AD B shows the method of exposure required for the various elements of structure and other forms of construction, together with the BS 476 requirements which should be satisfied in terms of load-bearing capacity, integrity and insulation and the minimum provisions when tested to the relevant European standard. For some items the table indicates the actual period of fire resistance recommended under each heading, but for others Table A2 of Appendix A gives the detailed recommendations in respect of fire resistance periods. The performance standards for doors are contained in Table B1 of AD B which is reproduced in the section on fire doors below.

AD B Appendix A

Table A1 Specific provisions of test for fire resistance of elements of structure, etc.

Part of building	Minimum provisions when tested to the relevant part of BS 476 [1] (minutes)			Minimum provisions when tested to the relevant European standard (minutes) [3]	Method of exposure
	Load-bearing capacity [2]	**Integrity**	**Insulation**		
1. **Structural** frame, beam or column	See Table A2	Not applicable	Not applicable	R, see Table A2	Exposed faces
2. **Load-bearing wall** (which is not also a wall described in any of the following items)	See Table A2	Not applicable	Not applicable	R, see Table A2	Each side separately
3. **Floors** [4]					
a. In upper storey of two-storey dwellinghouse (but not over garage or basement)	30	15	15	REI 30 [5]	
b. Between a shop and flat above	60 or see Table A2 (whichever is greater)	60 or see Table A2 (whichever is greater)	60 or see Table A2 (whichever is greater)	REI 60 or see Table A2 (whichever is greater)	From underside [6]
c. Any other floor, including compartment floors	See Table A2	See Table A2	See Table A2	REI see Table A2	
4. **Roofs**					
a. Any part forming an escape route	30	30	30	REI 30	From underside [6]
b. Any roof that performs the function of a floor	See Table A2	See Table A2	See Table A2	REI or see Table A2	

(*Continued*)

Table A1 (*Continued*)

Part of building	Minimum provisions when tested to the relevant part of BS 476 [1] (minutes): Load-bearing capacity [2]	Integrity	Insulation	Minimum provisions when tested to the relevant European standard (minutes) [3]	Method of exposure
5. **External walls**					
a. Any part less than 1000 mm from any point on the relevant boundary	See Table A2	See Table A2	See Table A2	REI or see Table A2	Each side separately
b. Any part 1000 mm or more from the relevant boundary [7]	See Table A2	See Table A2	15	REI or see Table A2 [8]	From inside the building
c. Any part adjacent to an external escape route (see section 5, Dia. 25)	30	30	No provision [9] [10]	RE 30	From inside the building
6. **Compartment wall**					
Separating occupancies	60 or see Table A2 (whichever is less)	60 or see Table A2 (whichever is less)	60 or see Table A2 (whichever is less)	REI 60 or see Table A2 (whichever is less)	Each side separately
7. **Compartment walls** (other than in item 6)	See Table A2	See Table A2	See Table A2	REI or see Table A2	Each side separately
8. **Protected shafts**, excluding any firefighting shaft					
a. Any glazing described in section 8, Dia. 32	Not applicable	30	No provision [10]	E 30	
b. Any other part between the shaft and a protected lobby/corridor described in Diagram 32	30	30	30	REI 30	Each side separately
c. Any part not described in (a) or (b) above	See Table A2	See Table A2	See Table A2	REI or see Table A2	
9. **Enclosure** (which does not form part of a compartment wall or a protected shaft) to a					

Table A1 (*Continued*)

Part of building	Minimum provisions when tested to the relevant part of BS 476 [1] (minutes) Load-bearing capacity [2]	Integrity	Insulation	Minimum provisions when tested to the relevant European standard (minutes) [3]	Method of exposure
a. Protected stairway	30	30	30 [11]	REI 30 [11]	Each side separately
b. Lift shaft	30	30	30	REI 30	
10. **Firefighting shafts**					
a. Construction separating firefighting shaft from rest of building;	120	120	120	REI 120	From side remote from shaft
	60	60	60	REI 60	From shaft side
b. Construction separating fire-fighting stair, fire-fighting lift shaft and firefighting lobby	60	60	60	REI 60	Each side separately
11. **Enclosure** (which is not a compartment wall or described in item 8) to a					
a. Protected lobby	30	30	30 [11]	REI 30 [11]	Each side separately
b. Protected corridor	30	30	30 [11]	REI 30 [11]	
12. **Subdivision of a corridor**	30	30	30 [11]	REI 30 [11]	Each side separately
13. **Wall separating** an attached or integral garage from a dwellinghouse	30	30	30 [11]	REI 30 [11]	From garage side
14. **Enclosure** in a flat or maisonette to a protected entrance hall, or to a protected landing	30	30	30 [11]	REI 30 [11]	Each side separately

(*Continued*)

Table A1 (*Continued*)

Part of building	Minimum provisions when tested to the relevant part of BS 476 [1] (minutes)			Minimum provisions when tested to the relevant European standard (minutes) [3]	Method of exposure
	Load-bearing capacity [2]	Integrity	Insulation		
15. **Fire-resisting construction**					
a. In dwellings not described elsewhere	30	30	30 ([11])	REI 30 ([11])	Each side separately
b. Enclosing places of special fire hazard	30	30	30	REI 30	
c. Between store rooms and sales area in shops	30	30	30	REI 30	
d. Fire-resisting subdivision described in section 2, Diagram 16(b)	30	30	30	REI 30	
e. Enclosing bedrooms and ancillary accommodation in care homes	30	30	30	REI 30	
16. **Cavity barrier**	Not applicable	30	15	EI 30 [12]	Each side separately
17. **Ceiling** described Diagram 35	Not applicable	30	30	EI 30	From underside
18. **Duct** described in paragraph 10.14e	Not applicable	30	No provision	E 30	From outside
19. **Casing** around a drainage system described in section 10, Diagram 38	Not applicable	30	No provision	E 30	From outside
20. **Flue walls** described in section 10, Diagram 39	Not applicable	Half the period specified in Table A2 for the compartment wall/floor	Half the period specified in Table A2 for the compartment wall/floor	EI half the period specified in Table A2 for the compartment wall/floor	From outside

Table A1 (*Continued*)

Part of building	Minimum provisions when tested to the relevant part of BS 476 [(1)] (minutes)			Minimum provisions when tested to the relevant European standard (minutes) [(3)]	Method of exposure
	Load-bearing capacity [(2)]	Integrity	Insulation		
21. **Construction** described in Note (a) to paragraph 15.9	Not applicable	30	30	EI 30	From underside
22. **Fire doors**		See Table B1		See Table B1	

Notes:

[(1)] Part 21 for load-bearing elements, Part 22 for non-load-bearing elements, Part 23 for fire-protecting suspended ceilings and Part 24 for ventilation ducts. BS 476: Part 8 results are acceptable for items tested or assessed before 1 January 1988.

[(2)] Applies to load-bearing elements only (see B3.ii and Appendix E).

[(3)] The National classifications do not automatically equate with the equivalent classifications in the European column; therefore products cannot typically assume a European class unless they have been tested accordingly.
'R' is the European classification of the resistance to fire performance in respect of load-bearing capacity.
'E' is the European classification of the resistance to fire performance in respect of integrity.
'I' is the European classification of the resistance to fire performance in respect of insulation.

[(4)] Guidance on increasing the fire resistance of existing timber floors is given in BRE Digest 208 increasing the fire resistance of existing timber floors (BRE 1988).

[(5)] For the purposes of meeting the Building Regulations, floors under item 3a will be deemed to have satisfied the provisions above, provided that they achieve load-bearing capacity of at least 30 minutes and integrity and insulation requirements of at least 15 minutes when tested in accordance with the relevant European test.

[(6)] A suspended ceiling should only be relied on to contribute to the fire resistance of the floor if the ceiling meets the appropriate provisions given in Table A3.

[(7)] The guidance in section 14 allows such walls to contain areas which need not be fire resisting (unprotected areas).

[(8)] For the purposes of meeting the Building Regulations, external walls under item 5b will be deemed to have satisfied the provisions above, provided that they achieve the load-bearing capacity and integrity requirements as defined in Table A2 and an insulation requirement of at least 15 minutes.

[(9)] Unless needed as part of a wall in item 5a or 5b.

[(10)] Except for any limitations on glazed elements given in Table A4.

[(11)] See Table A4 for permitted extent of uninsulated glazed elements.

[(12)] For the purposes of meeting the Building Regulations, cavity barriers will be deemed to have satisfied the provisions above, provided that they achieve an integrity requirement of at least 30 minutes and an insulation requirement of at least 15 minutes.

In addition to the elements of structure defined in section 7.2 and illustrated in Fig. 7.3, there are requirements for some other elements of the building to be of fire-resisting construction. Included in this category are some doors, pipe casings and cavity barriers. These are considered later under the actual element references.

7.19.1 Minimum period of fire resistance

In order to establish the minimum period of fire resistance for the elements of structure of a building, it is necessary, first, to determine the building's use or Purpose Group. The fire resistance period will then depend on the height of the top storey of the building above ground or the depth of the lowest basement storey below ground.

It will be seen that the fire resistance recommendations for basements are generally more onerous than for ground floors in the same building. This reflects the greater difficulty experienced in dealing with a basement fire. However, it is sometimes the case that due to the slope of the ground, at least one side of a basement is accessible at ground level. This gives opportunities for smoke venting and firefighting, and in these circumstances it may be reasonable to adopt the less onerous fire resistance provisions of the upper elements of the construction for the elements of structure in the basement.

The minimum periods of fire resistance recommended for the elements of structure in the basements, ground or upper storeys of a building are given in Table A2 from Appendix A of AD B which is reproduced below.

AD B Appendix A

Table A2 Minimum periods of fire resistance.

Purpose group of building of a lowest basement	Minimum periods (minutes) for elements of structure in a:					
	Basement storey ($) including floor over		Ground or upper storey			
	Depth (m) of a lowest basement		Height (m) of top floor above ground in a building or separated part of a building			
	More than 10	Not more than 10	Not more than 5	Not more than 18	Not more than 30	More than 30
1. Residential (domestic)						
a. Flats and maisonettes	90	60	30*	60**,†	90**	120**
b. Dwellinghouses	Not relevant	30*	30*	60@	Not relevant	Not relevant
2. Residential						
a. Institutional œ	90	60	30*	60	90	120#
b. Other residential	90	60	30*	60	90	120#
3. Office						
– Not sprinklered	90	60	30*	60	90	Not permitted
– Sprinklered (2)	60	60	30*	30*	60	120#
4. Shop and commercial						
– Not sprinklered	90	60	60	60	90	Not permitted
– Sprinklered (2)	60	60	30*	60	60	120#
5. Assembly and recreation						
– Not sprinklered	90	60	60	60	90	Not permitted
– Sprinklered (2)	60	60	30*	60	60	120#

Table A2 (*Continued*)

Purpose group of building of a lowest basement	Minimum periods (minutes) for elements of structure in a: Basement storey [$] including floor over — Depth (m) of a lowest basement: More than 10	Not more than 10	Ground or upper storey — Height (m) of top floor above ground in a building or separated part of a building: Not more than 5	Not more than 18	Not more than 30	More than 30
6. Industrial						
– Not sprinklered	120	90	60	90	120	Not permitted
– Sprinklered [(2)]	90	60	30*	60	90	120#
7. Storage and other non-residential						
a. Any building or part not described elsewhere						
– Not sprinklered	120	90	60	90	120	Not permitted
– Sprinklered [(2)]	90	60	30*	60	90	120#
b. Car park for light vehicles						
i. Open-sided car park [(3)]	Not applicable	Not applicable	15*,+,(4)	15*,+,(4)	15*,+,(4)	60
ii. Any other car park	90	60	30*	60	90	120#

Single-storey buildings are subject to the periods under the heading 'not more than 5'. If they have basements, the basement storeys are subject to the period appropriate to their depth.

Modifications referred to in Table A2 (for application of the table notes in text above):

($) The floor over a basement (or if there is more than 1 basement, the floor over the topmost basement) should meet the provisions for the ground and upper storeys if that period is higher.

* Increased to a minimum of 60 minutes for compartment walls separating buildings.

** Reduced to 30 minutes for any floor within a maisonette but not if the floor contributes to the support of the building.

œ Multistorey hospitals designed in accordance with the NHS Firecode document should have a minimum 60 minutes standard.

Reduced to 90 minutes for elements not forming part of the structural frame.

+ Increased to 30 minutes for elements protecting the means of escape.

† Refer to p. 7.14.9 below regarding the acceptability of 30 minutes in flat conversions.

@ 30 minutes in the case of three-storey dwellinghouses, increased to 60 minutes minimum for compartment walls separating buildings.

Notes:

(1) Refer to Table A1 for the specific provisions of test.

(2) 'Sprinklered' means that the building is fitted throughout with an automatic sprinkler system meeting the relevant recommendations of BS 5306 Fire extinguishing installations and equipment on premises. Part 2 Specification for sprinkler systems; i.e. the relevant occupancy rating together with the additional requirements for life safety.

(3) The car park should comply with the relevant provisions in the guidance on requirement B3, section 12.

(4) For the purposes of meeting the Building Regulations, the following types of steel elements are deemed to have satisfied the minimum period of fire resistance of 15 minutes when tested to the European test method:

(i) Beams supporting concrete floors, maximum $Hp/A = 230\,m^{-1}$ operating under full design load

(ii) Free-standing columns, maximum $Hp/A = 180\,m^{-1}$ operating under full design load

(iii) Wind bracing and struts, maximum $HP/A = 210\,m^{-1}$ operating under full design load

Guidance is also available in BS 5950 Structural use of steelwork in building. Part 8 Code of practice for fire-resistant design.

AD B Appendix A

Table A3 Limitations on fire-protecting suspended ceilings (see Table A1, Note 4).

Height of building or separated part (m)	Type of floor	Provision for fire resistance or floor (minutes)	Description of suspended ceiling
Less than 18	Not compartment	60 or less	Type W, X, Y or Z
	Compartment	Less than 60	
		60	Type X, Y or Z
18 or more	Any	60 or less	Type Y or Z
No limit	Any	More than 60	Type Z

Notes:
1. Ceiling type and description (the change from Types A–D to Types W–Z is to avoid confusion with Classes A–D (European)):
   W. Surface of ceiling exposed to the cavity should be Class 0 or Class 1 (National) or Class C-s3, d2 or better (European).
   X. Surface of ceiling exposed to the cavity should be Class 0 (National) or Class B-s3, d2 or better (European).
   Y. Surface of ceiling exposed to the cavity should be Class 0 (National) or Class B-s3, d2 or better (European). Ceiling should not contain easily openable access panels.
   Z. Ceiling should be a material of limited combustibility (National) or of Class A2-s3, d2 or better (European) and not contain easily openable access panels. Any insulation above the ceiling should be of a material of limited combustibility (National) or Class A2-s3, d2 or better (European).
2. Any access panels provided in fire-protecting suspended ceilings of type Y or Z should be secured in position by releasing devices or screw fixings, and they should be shown to have been tested in the ceiling assembly in which they are incorporated.
3. European classifications.
   The National classifications do not automatically equate with the equivalent European classifications; therefore products cannot typically assume a European class unless they have been tested accordingly. When a classification includes 's3, d2', this means that there is no limit set for smoke production and/or flaming droplets/particles.

The following points should also be taken into account when using Table A2:

- Any element of structure should have fire resistance at least equal to the fire resistance of any element which it carries and supports or to which it gives stability. This principle may be varied where:
  (a) the supporting structure is in the open air and would be unlikely to be affected by a fire in the building;
  (b) where a rooftop plant room needs a higher standard of fire resistance than the structure supporting it; or
  (c) the supporting and supported structures are in different compartments (the separating element between the compartments would have to have the higher standard of fire resistance; see next item).
- If an element of structure forms part of more than one building or compartment and is thus subject to two or more different fire resistances, it is the greater of these which applies.
- A structural frame, beam, column or load-bearing wall of a *single-storey building* (or which is part of the ground storey of a building that consists of a ground storey and one or more basement storeys) is generally not required to have fire resistance. (This reflects the view that, given satisfactory means of escape and the restricted use

of combustible materials as wall and ceiling linings, fire resistance in the elements of structure in the ground storey will contribute little to the safety of the occupants.) However, the above concession will only apply if the element of structure:

(a) which is part of or supports an external wall is sufficiently far from its relevant boundary to be regarded as a totally unprotected area;
(b) is not part of and does not support a compartment wall or a wall which is common to two or more buildings;
(c) is not a wall between a house and an attached or integral garage; or
(d) does not support a gallery.

- Single-storey buildings should comply with the fire resistance periods under the heading 'not more than 5'. Where they have basements, these should, of course, comply with the recommendations for basement storeys depending on their depth below ground level.
- Further fire resistance provisions relating to the following elements may be found in the relevant sections below:
  (a) compartment walls, external walls and the wall between a dwellinghouse and a domestic garage;
  (b) walls which enclose a firefighting shaft or protect a means of escape; or
  (c) compartment floors.

7.19.2 Meeting the performance recommendations

Reference has been made above to the BS 476 tests, where the fire resistance period of a material, product, structure or system may be assessed. It should be realised that the aim of the standard fire tests is to measure or assess the response of the sample to one or more aspects of fire behaviour under standardised conditions. The tests cannot normally measure fire hazard and represent only one aspect of the total fire safety package.

In a real fire the conditions will not be standard, and there is always the possibility of premature failure of a particular component due to faulty design or workmanship. Therefore, the periods stated in Table A2 should be used for guidance and not taken as 'cast in tablets of stone', there being little correlation between the period derived from the standard test and the performance in a real fire. They do however enable different systems to be compared under similar circumstances and are useful in this sense.

Therefore, in order that a material, product or structure may be used in a building, it should:

- be in accordance with a specification or design which has been shown by test to be capable of meeting a performance standard referred to in a relevant British or European Standard or European Technical Approval (British Standards may continue to be used for products or materials where European standards or approvals are not yet available). For this purpose, laboratories accredited by the United Kingdom Accreditation Service (UKAS) for conducting the relevant tests would be expected to have the necessary expertise;

- be assessed from test evidence against appropriate standards or by using relevant design guides, as meeting the relevant performance (suitably qualified fire safety engineers and laboratories accredited by UKAS might be expected to have the necessary expertise to carry out the assessment. Additionally, anybody notified to the UK Government by the Government of another member state of the European Union as capable of assessing materials and products against the relevant British Standards may also be expected to have the necessary expertise);
- comply with an appropriate specification given in relevant tables of notional performance included in ADs. (Over the years since the 1976 Regulations, there has been a tendency to reduce the practical guidance given on forms of construction which will satisfy the fire resistance requirements. The 1992 edition of AD B contains no such examples; the reader is merely referred to the publication listed in the next point); or
- for fire-resisting elements,
  (a) conform with an appropriate specification from Part II of the BRE Report *Guidelines for the construction of fire-resisting structural elements* (BR 128, BRE, 1988); and
  (b) be designed in accordance with a relevant British Standard or Eurocode.

Where test evidence is used to substantiate a fire resistance rating of a construction, care should be taken to check that it demonstrates compliance which is adequate and applicable to the intended use. For example, small differences in detail (e.g. fixing method, joint details, dimensional variations, etc.) may significantly affect the rating.

In order to provide some assistance to readers, Table 7.7 gives notional periods of fire resistance for some common floor and wall constructions. It is based on a selection of constructions from Table A3 of DOE's 1985 Approved Document B2/3/4, which in turn is based on the BRE Report. The BRE Report mentioned above also contains much information on fire protection to structural frameworks of beams and columns. Additionally, there are available various mineral-based insulating boards, sprayed coatings and intumescent paint systems which are capable of providing differing degrees of fire protection depending on their thickness and method of fixing. Reference should be made to individual manufacturers or their trade associations for further details.

Information on tests on fire-resisting elements is also given in such publications as:

- Association for Specialist Fire Protection/Steel Construction Institute/Fire Test Study Group *Fire protection for structural steel in buildings*, 2nd edition (revised, 1992 and available from the ASFP, Association House, 99 West Street, Farnham, Surrey GU9 7EN and the Steel Construction Institute, Silwood Park, Ascot, Berks SL5 7QN);
- PD 6520 *Guide to fire test methods for building materials and elements of construction* (available from the British Standards Institution); and
- BS 6336 *Guide to development and presentation of fire tests and their use in hazard assessment*.

For the first two items in Table A3 (of DOE's 1985 Approved Document B2/3/4), it should be noted that the upper floor of a two-storey dwelling is regarded as a special case. Such a floor, when tested for fire resistance from the underside, is required only to provide:

- stability for 30 minutes;
- integrity for 15 minutes; and
- insulation for 15 minutes.

This is termed 'modified 30 minutes' fire resistance in the BRE Report (see Table A1, Appendix A, item 3, 'Floors').

Table A3 of DOE's 1985 Approved Document B2/3/4 – Notional periods of fire resistance of some common constructions.

These constructions are a selection from Table A3 of DOE's 1985 Approved Document B2/3/4.
A large number of constructions other than those shown are capable of providing the fire resistance looked for. For example, various mineral-based insulating boards can be used. Because their performance varies and is dependent on their thickness, it is not possible to give specific thicknesses in this table. However, manufacturers will normally be able to say what thickness would be needed to achieve the particular performance.

Floors: timber joist

Modified 30 minutes (stability 30 minutes) (integrity 15 minutes) (insulation 15 minutes)	**1** 	Any structurally suitable flooring: floor joists at least 37 mm wide Ceiling: (a) 12.5 mm plasterboard[a] with joints taped and filled and backed by timber; or (b) 9.5 mm plasterboard[a] with 10 mm lightweight gypsum plaster finish
	2 	At least 15 mm t&g boarding or sheets of plywood or wood chipboard, floor joists at least 37 mm wide Ceiling: (a) 12.5 mm plasterboard[a] with joints taped and filled; or (b) 9.5 mm plasterboard[a] with at least 5 mm neat gypsum plaster finish
30 minutes	**3** 	At least 15 mm t&g boarding or sheets of plywood or wood chipboard, floor joists at least 37 mm wide Ceiling: 12.5 mm plasterboard[a] with at least 5 mm neat gypsum plaster finish
	4 	At least 21 mm t&g boarding or sheets of plywood or wood chipboard, floor joists at least 37 mm wide Ceiling: 12.5 mm plasterboard[a] with joints taped and filled

(*Continued*)

Table A3 (*Continued*)

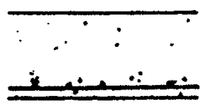
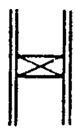
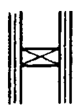
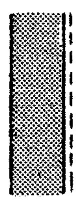
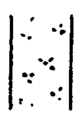
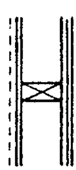
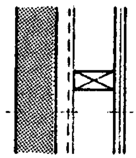
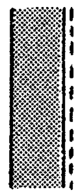
60 minutes	**5** 	At least 15 mm t&g plywood or wood chipboard, floor joists at least 50 mm wide Ceiling: Not less than 30 mm plasterboard[a] with joints staggered and exposed joints taped and filled
Floors: concrete		
60 minutes	**6** 	Reinforced concrete floor not less than 95 mm thick, with not less than 20 mm cover on the lowest reinforcement
Walls: internal		
30 minutes load bearing	**7** 	Framing members at least 44 mm wide[b] and spaced at not more than 600 mm apart, with lining (both sides) of 12.5 mm plasterboard[b] with all joints taped and filled
	8 	100 mm reinforced concrete wall[c] with minimum cover to reinforcement of 25 mm
60 minutes load bearing	**9** 	Framing members at least 44 mm wide[b] and spaced at not more than 600 mm apart, with lining (both sides) at least 25 mm plasterboard[a] in two layers with joints staggered and exposed joints taped and filled
	10 	Solid masonry wall (with or without plaster finish) at least 90 mm thick (75 mm if non-load bearing) *Note:* For masonry cavity walls, the fire resistance may be taken as that for a single wall of the same construction, whichever leaf is exposed to fire
	11 	120 mm reinforced concrete wall[c] with at least 25 mm cover to the reinforcement
Walls: external		
Modified 30 minutes (stability 30 minutes) (integrity 30 minutes) (insulation 15 minutes) Load-bearing wall 1 m or more from relevant boundary	**12** 	Any external weathering system with at least 8 mm plywood sheathing, framing members at least 37 mm wide and spaced not more than 600 mm apart Internal lining: 12.5 mm plasterboard[a] with at least 10 mm lightweight gypsum plaster finish

Table A3 (*Continued*)

30 minutes load-bearing wall less than 1 m from the relevant boundary	**13** 	100 mm brickwork or blockwork external face (with, or without, a plywood backing); framing members at least 37 mm wide and spaced not more than 600 mm apart Internal lining: 12.5 mm plasterboard[a] with at least 10 mm lightweight gypsum plaster finish
60 minutes load-bearing wall less than 1 m from the relevant boundary	**14** 	Solid masonry wall (with or without plaster finish) at least 90 mm thick (75 mm if non-load bearing) *Note:* For masonry cavity walls, the fire resistance may be taken as that for a single wall of the same construction, whichever leaf is exposed to fire

Notes:
[a] Whatever the lining material, it is important to use a method of fixing that the manufacturer says would be needed to achieve the particular performance. For example, if the lining is plasterboard, the fixings should be at 150 mm centres as follows (where two layers are being used each should be fixed separately):
9.5 mm thickness, use 30 mm galvanised nails;
12.5 mm thickness, use 40 mm galvanised nails; and
19 mm–25 mm thickness, use 60 mm galvanised nails.
[b] Thinner framing members, such as 37 mm, may be suitable depending on the loading conditions.
[c] A thinner wall may be suitable depending on the density of the concrete and the amount of reinforcement. (See *Guidelines for the construction of fire-resisting structural elements* (BRE 1988).)

7.19.3 Compartmentation

In order to prevent the rapid spread of fire within buildings (which could trap the occupants) and to restrict the size of any fires which do occur, the ADs contain provisions for subdividing a building into compartments separated from one another by fire-resisting walls and floors.

The extent of the subdivisions will depend on the same factors which were considered for fire resistance, namely:

- the severity of the fire;
- the height of the top floor above ground;
- the building occupancy;
- the presence of basements; and
- the number of floors.

These items are considered more fully in section 7.19. Additionally, the provision of a sprinkler system can affect the growth rate of a fire and may suppress it altogether.

The subdivision is achieved by means of compartment walls and compartment floors, and since these come under the definition of elements of structure, they should be fire resisting (but not, of course, the lowest floor in the building).

Most multistorey buildings should be compartmented because of the increased risk to life should a fire occur. However, in the case of a two-storey building in Purpose Group 4 – Shop and Commercial, or Purpose Group 6 – Industrial, the ground storey may be treated as a single storey building for the purposes of fire compartmentation if the use of the upper storey is ancillary to the use of the ground storey. This concession is dependent on the following conditions:

- the upper storey floor area should not exceed the lesser of 20% of the ground storey area or 500 m^2;
- the upper storey should be compartmented from the ground storey; and
- there should be an independent means of escape from the upper storey which is separated from the ground storey escape routes.

In single-storey buildings, where the risk to life is obviously less than in multistorey buildings, compartmentation is recommended only for:

- single-storey hospitals with a floor area limit of 3000 m^2;
- schools, where the floor area limit is 800 m^2; and
- un-sprinklered shops, limited to a maximum floor area of 2000 m^2.

Where atria (see section 7.7 for definition of an atrium) are incorporated into the design of a building, there are obvious implications for the integrity of any compartmentation in the building. Detailed advice on all issues relating to atria is given in BS 9999; however, the standard is only relevant where compartmentation is breached by the atria.

Generally, two main principles are adopted when deciding how to compartment a building:

(1) For non-residential buildings, the compartment sizes should be restricted to the maximum dimensions shown in Table 12 of AD B volume 2, which is reproduced below, and the following points should be noted.
   - Limits are given by reference to maximum floor areas for differing top storey heights (for multistorey buildings) for assembly and recreation, shop and commercial and industrial buildings.
   - For storage and other non-residential buildings, the limits are according to maximum compartment volumes for differing top storey heights.
   - The installation of sprinklers allows the compartment size limits to be doubled.
   - If a building has a storey which is more than 30 m above ground or a basement more than 10 m below ground, all floors should be constructed as compartment floors, including any ground floor over a basement (except for small premises described in section 7.16.8).

(2) For all buildings, the following walls and floors which separate buildings into different ownerships, uses or occupancies (or protect particular risk areas) should be constructed as compartment walls and floors:
   - Walls which are common to two or more buildings (including walls between semi-detached and terraced houses). These walls should run the full height of the building in a continuous vertical plane, the adjoining buildings being separated only by walls, not floors.
   - Walls and floors dividing parts of buildings used for different purposes. This does not apply where one use is ancillary to another (see section 7.3).
   - Walls dividing buildings into separated parts. These walls should also run the full height of the building in a continuous vertical plane, in a similar manner to

common walls above (see section 7.9), and the two separated parts can have different standards of fire resistance.

- Walls and floors bounding a protected shaft. (Protected shafts are considered in more detail below.)
- Construction enclosing places of special fire hazard (see section 7.2). Curiously, any walls or floors enclosing such places are not considered to be compartment walls and floors for the purposes of AD B volume 2.

Finally, the following walls and floors in particular Purpose Groups should be constructed as compartment walls and floors:

- Any floor or wall separating an attached or integral garage from a dwellinghouse should be constructed as shown in Fig. 7.40. It should be noted that where a door separates a dwellinghouse from the garage:
  - ○ either the floor should be laid to fall to allow fuel spills to flow away to the outside or the dwellinghouse floor level should be at least 100 mm higher than the garage floor level; and
  - ○ the door should be fitted with a self-closing device.

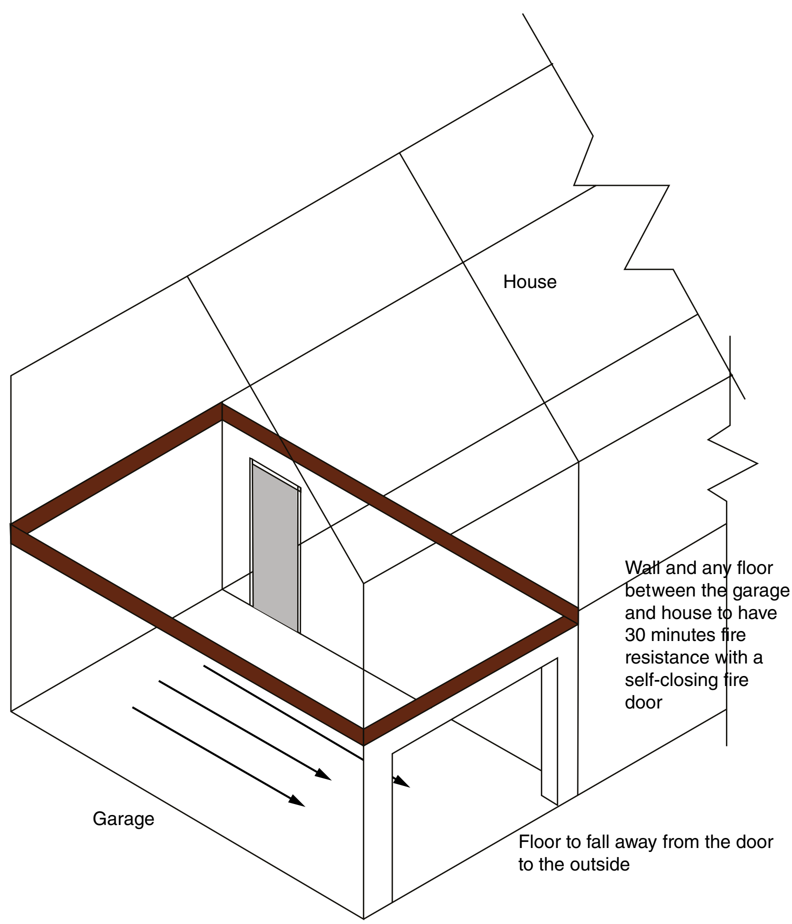


Fig. 7.40 Separation between garage and dwellinghouse.

- Any floor in an institutional or other residential building;
- Any floor in flats and maisonettes, except an internal floor in an individual dwelling;
- Any wall separating a flat or maisonette from any other part of the same building;
- Any wall enclosing a refuse storage chamber in flats and maisonettes;
- Any wall or floor in a shopping complex referred to in section 7 of BS 9999 as needing to be constructed to the compartmentation standard;
- Any wall or floor provided to divide a building into separate occupancies (i.e. parts of the building used by different organisations irrespective of whether or not they fall within the same Purpose Group) in Shop and Commercial, Industrial or Storage premises; and
- Any wall between compartments in the upper storeys of healthcare premises used for inpatients. The upper storeys of such buildings should be divided into at least two compartments (so that no compartments exceed 2000 m^2) so as to permit progressive horizontal evacuation of each compartment (see section 7.16.1).

AD B3 section 8

Table 12 Maximum dimensions of building or compartment (non-residential buildings).

		Floor area of any one storey in the building or any one storey in a compartment (m^2)	
Purpose Group of building or part	**Height of floor of top storey above ground level (m)**	**In multistorey buildings**	**In single-storey buildings**
Office	No limit	No limit	No limit
Assembly and Recreation Shop and Commercial			
a. Schools	No limit	800	800
b. Shops – not sprinklered	No limit	2000	2000
Shops – sprinklered(1)	No limit	4000	No limit
c. Elsewhere – not sprinklered	No limit	2000	No limit
Elsewhere – sprinklered(1)	No limit	4000	No limit
Industrial(2)			
Not sprinklered	Not more than 18	7000	No limit
	More than 18	2000(3)	No limit
Sprinklered(1)	Not more than 18	14,000	No limit
	More than 18	4000(3)	No limit

Table 12 (*Continued*)

	Height of floor of top storey above ground level (m)	Maximum compartment volume (m³)	
		In multistorey buildings	In single-storey buildings
Storage(2) and other non-residential			
a. Car park for light vehicles	No limit	No limit	No limit
b. Any other building or part:			
Not sprinklered	Not more than 18	20,000	18
	More than 18	4000(3)	No limit
Sprinklered(1)	Not more than 18	40,000	No limit
	More than 18	8000(3)	No limit

Notes:
(1) 'Sprinklered' means that the building is fitted throughout with an automatic sprinkler system meeting the relevant recommendations of section 7.11, i.e. the relevant occupancy rating together with the additional requirements for life safety.
(2) There may be additional limitations on floor area and/or sprinkler provisions in certain industrial and storage uses under other legislation, for example, in respect of storage of LPG and certain chemicals.
(3) This reduced limit applies only to storeys that are more than 18 m above ground level. Below this height the higher limit applies.

7.20 Compartment walls and floors: Construction details

Since the purpose of compartment walls and floors is to form a complete barrier to the passage of fire between the compartments which they separate, it follows that they should have the appropriate standards of fire resistance indicated in Tables A1 and A2 (section 7.19).

Additionally, compartment walls and floors in hospitals designed on the basis of *Firecode* (see section 7.16.1) should be constructed of materials of limited combustibility if they have a fire resistance of 60 minutes or more. This does not apply if the building is fitted throughout with a suitable sprinkler system as detailed in *Firecode*.

Any points of weakness in compartment walls and floors should be adequately protected. These points of weakness occur:

- at junctions with other compartment walls, external walls and roofs;
- where timber beams, joists, purlins and rafters are built into or pass through a compartment wall; and
- at openings for doors, pipes, ducts of various kinds, refuse chutes and protected shafts.

7.20.1 Junction details

Where a compartment wall and roof meet, the wall may be carried at least 375 mm above the roof covering surface, measured at right angles to the roof slope, or the wall may be taken up to meet the underside of the roof covering or deck and the junction fire stopped. Acceptable design solutions are illustrated in Fig. 7.41 for buildings in different purpose groups.

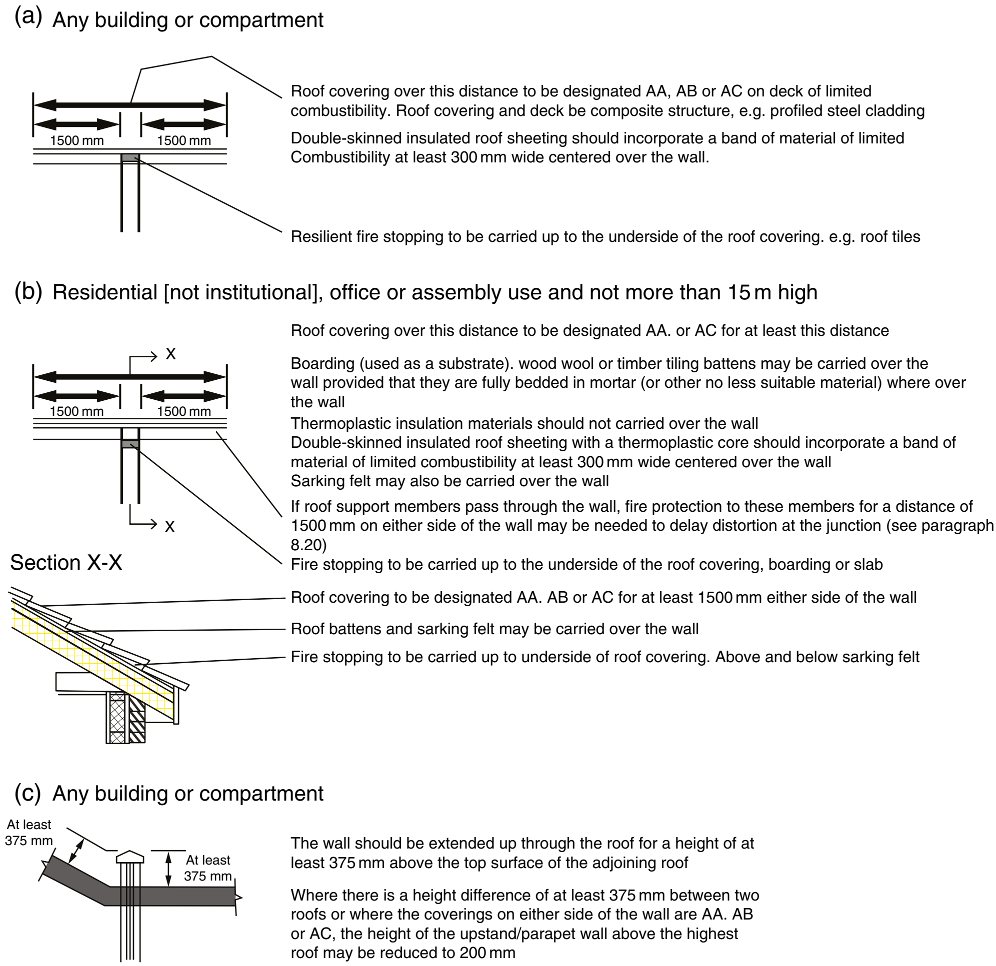


Fig. 7.41 Junction of compartment wall with roof.

Generally, the covering in a 1.5 m wide zone on either side of the wall should be designated AA, AB or AC (see below for designations), and it should be carried on a substrate or deck consisting of a material of limited combustibility. The roof covering and deck could be of a composite structure such as profiled steel cladding. Where double-skin insulated roof sheeting is specified, it should incorporate a band of material of limited combustibility at least 300 mm wide centred over the wall.

Any roof support members which pass through the wall may need to have fire protection on their undersides for at least 1.5 m on either side of the wall to delay distortion at the junction.

Some exceptions to the need for the substrate or deck to be in materials of limited combustibility are permitted in the case of certain roof constructions in buildings not more than 15 m high in dwellinghouses, offices, assembly and recreation buildings and residential buildings (but not institutional). In the roof shown at (b) in Fig. 7.41, the following combustible materials may be carried over the top of the compartment wall:

- Roof boarding serving as a base for roof covering;
- Woodwool slabs;
- Timber slating or tiling battens; or
- Sarking felt.

The materials should be fully bedded in mortar or similar material.

Where a compartment wall or floor meets another compartment wall or an external wall, the junction should maintain the fire resistance of the compartmentation. This will normally mean that the various structures should be bonded together or the junction fire stopped (see Fig. 7.41). The compartment wall should also be continued across any eaves cavity.

It is permissible for timber beams, joists, purlins and rafters to be built into or carried through a concrete or masonry compartment wall provided that the openings for them are kept as small as is practicable and are then fire stopped.

If trussed rafters bridge a compartment wall, they should be designed so that failure of any part of the truss caused by fire in one compartment does not lead to failure of any part of the truss in another compartment.

A compartment wall should be designed to take the predicted deflection of the floor above by either of the following measures. If a compartment wall is located in the middle half of the floor between its supports, the predicted deflection is assumed to be 40 mm. This figure can be reduced if structural calculations justify less of a deflection. For the areas outside this zone, the limit reduces proportionately to zero at the floor supports:

- designing a suitable detail at the junction between the head of the wall and the floor so that the integrity of the floor will be maintained when exposed to fire; or
- designing the wall to resist and additional vertical loading if the floor above sags in the fire conditions.

If steel beams do not have the required fire resistance, further guidance is available in the British Constructional Steelwork Association's publication 35/03: *Steel buildings* (2003) or SCI Publication 288: *Fire safe design: A new approach to multi-storey steel-framed buildings* (2nd editions, 2006).

7.20.2 Openings in compartment walls and floors

Generally, the only openings permitted in compartment walls and floors are one or more of the following:

- An opening fitted with a door which has the appropriate fire resistance given in Table B1 of Appendix B to the ADs and is fitted in accordance with Appendix B (see Fire doors below);
- An opening for a protected shaft (see Protected shafts in section 7.20.4);
- An opening for a refuse chute of non-combustible construction;
- An opening for a pipe, ventilation duct, chimney, appliance ventilation duct or duct encasing one or more flue pipes, provided it complies with the relevant parts of section 7.22); and

- Atria designed in accordance with BS 9999 or PD 7974-2002 *Application of fire safety engineering principles. Spread of smoke and toxic gases within and beyond the enclosure of origin* (BSI, Part 1 – 2003 and Part 2 2002).

In the case of compartment walls which are common to two or more buildings or which separate different occupancies in the same building, it would not be sensible or necessary to allow all of the above openings to exist. Therefore such walls should be imperforate except for:

- an opening for a door which is needed as a means of escape in case of fire. The door should have the same fire resistance as the wall and should be fixed in accordance with the provisions of Appendix B to the ADs (see below); or
- an opening for a pipe complying with the provisions of section 7.22.

7.20.3 Fire doors

All fire doors should be fitted with an automatic self-closing device unless they are doors **within** dwellings, and dwellinghouses are not required to be fitted with self-closing devices. Doors to cupboards and service ducts which are normally kept locked shut are not required to be self-closing. Rising butt hinges are not considered as automatic self-closing devices unless the door is in a cavity barrier

As a general rule, no device should be provided to hold a door open. However, in some cases a self-closing device may be considered a hindrance to normal use. In such cases a fire-resisting door may be held open by:

- a fusible link device, provided that the door is not fitted in an opening used as a means of escape (this does not apply where two doors are provided in the opening as mentioned below);
- a door closure delay device; or
- an automatic release mechanism, actuated by an automatic fire detection and alarm system.

In this context an automatic release mechanism is one which automatically closes a door in the event of each or any one of:

- smoke detection by appropriate apparatus suitable in nature, quality and location;
- manual operation by a suitably located switch;
- failure of the electricity supply to the device, smoke apparatus, or switch; or
- operation of a fire alarm system, if fitted.

All fire-resisting doors should have the appropriate fire performance described in Table B1 of Appendix B (see below), either:

- in accordance with a rating given in terms of their performance under test to BS 476: Part 22. This rating relates to the ability of the door to maintain its integrity for a specified period in minutes, e.g. FD30. Doors should be tested from each side separately; however, since lift doors are only at risk from one side in the event of a fire, it is only necessary to test these from the landing side. The rating for some doors has the suffix S added where restricted smoke leakage is needed at ambient temperatures. The leakage rate should not exceed 3 m^3/m/hour (head and jambs only) when tested at 25 Pa to BS 476: section 31.1, unless pressurisation techniques complying with BS 9999 are used; or

- as determined with reference to Commission Decision 2000/367/EC of 3 May 2000 implementing Council Directive 89/106/EEC as regards the classification of the resistance to fire performance of construction products, construction works and parts thereof. All such fire doors should be classified in accordance with BS EN 13501 *Fire classification of construction products and building elements*, Part 2: (+A1: 2009) 2007 *Fire Classification of construction products and building elements. Classification using data from fire resistance tests, excluding fire ventilation services*. They are tested to the relevant European method from BS EN 1634, Part 1: 2014 *Fire resistance and smoke control tests for door, shutter and openable window assemblies and elements of building hardware. Fire resistance test for doors and shutter assemblies and openable windows.*

The performance requirement is in terms of integrity (E) for a period of minutes. An additional classification of S is used for all doors where restricted smoke leakage at ambient temperatures is needed. Products tested in accordance with BS EN 1634: Part 1 (with or without prefire test mechanical conditioning) are deemed to have satisfied the provisions provided that they achieve the minimum fire resistance in terms of integrity, as detailed in Table B1.

Approved Document: Table B1 Provisions for fire doors.

Position of door	**Minimum fire resistance of door in terms of integrity (minutes) when tested to BS 476 part 22**(1)	**Minimum fire resistance of door in terms of integrity (minutes) when tested to the relevant European standard**(2)
1. In a compartment wall separating buildings	As for the wall in which the door is fitted but a minimum of 60	As for the wall in which the door is fitted but a minimum of 60
2. In a compartment wall		E30 S(2)
a. If it separates a flat or maisonette from a space in common use	FD 30S(3)	
b. Enclosing a protected shaft forming a stairway situated wholly or partly above the adjoining ground in a building used for Flats, Other Residential, Assembly and Recreation, or Office purposes	FD 30S(3)	E30 S(2)
c. Enclosing a protected shaft forming a stairway not described in (b) above	Half the period of fire resistance of the wall in which it is fitted but 30 minimum and with suffix S(3)	Half the period of fire resistance of the wall in which it is fitted but 30 minimum and with suffix S(2)

(*Continued*)

Table B1 (*Continued*)

Position of door	Minimum fire resistance of door in terms of integrity (minutes) when tested to BS 476 part 22[1]	Minimum fire resistance of door in terms of integrity (minutes) when tested to the relevant European standard[2]
d. Enclosing a protected shaft forming a lift or service shaft	Half the period of fire resistance of the wall in which it is fitted but 30 minimum	Half the period of fire resistance of the wall in which it is fitted but 30 minimum
e. Not described in (a), (b), (c) or (d) above	As for the wall it is fitted in but add S[3] if the door is used for progressive horizontal evacuation under the guidance to B1	As for the wall it is fitted in but add S[2] if the door is used for progressive horizontal evacuation under the guidance to B1
3. In a compartment floor	As for the floor in which it is fitted	As for the floor in which it is fitted
4. Forming part of the enclosures of		
a. A protected stairway (except where described in item 9)	FD 30S[3]	E20 S[3]
b. A lift shaft (see paragraph 6.42b) which does not form a protected shaft in 2(b), (c) or (d) above	FD 30	E30
5. Forming part of the enclosure of		
a. A protected lobby approach (or protected corridor) to a stairway	FD 30S[3]	E30 S[3]
b. Any other protected corridor	FD 20 (S)	E20 S[3]
c. A protected lobby approach to a lift shaft (see paragraph 6.42)	FD 30S[3]	E30 S[3]
6. Affording access to an external escape route	FD 30	E30
7. Subdividing		
a. Corridors connecting alternative exits	FD 20S[3]	E20 S[3]
b. Dead-end portions of corridors from the remainder of the corridor	FD 20S[3]	E20 S[3]
8. Any door		
a. Within a cavity barrier	FD 30	E30
b. Between a dwellinghouse and a garage	FD 30	E20

Table B1 (*Continued*)

Position of door	Minimum fire resistance of door in terms of integrity (minutes) when tested to BS 476 part 22[(1)]	Minimum fire resistance of door in terms of integrity (minutes) when tested to the relevant European standard[(2)]
9. Any door		
a. Forming part of the enclosures to a protected stairway in a single family dwellinghouse	FD 20	E20
b. Forming part of the enclosure to a protected entrance hall or protected landing in a flat or maisonette	FD 20	E20
c. Within any other fire-resisting construction in a dwelling not described elsewhere in this table	FD 20	E20

Notes:
(1) To BS 476: Part 22 (for BS 476: Part 8 subject to paragraph 5 in Appendix A).
(2) The National classifications do not automatically equate with the equivalent classifications in the European column; therefore products cannot typically assume a European class unless they have been tested accordingly.
(3) Unless pressurisation techniques complying with BS 9999 are used, these doors should also either:
(a) have a leakage rate not exceeding 3 m^3/m/h (head and jambs only) when tested at 25 Pa under BS 476 *Fire tests on building materials and structures*, section 31.1 *Methods for measuring smoke penetration through doorsets and shutter assemblies, Method of measurement under ambient temperature conditions;* or
(b) meet the additional classification requirement of S. when tested to BS EN 1634-3:xxxx, *Fire resistance tests for door and shutter assemblies, Part 3 – Smoke control doors.*

No fire door should be hung on hinges made of a material with a melting point less than 800°C, unless the hinges can be shown to be satisfactory when tested as part of a fire door assembly.

Although each fire door should have the appropriate period of fire resistance defined in Table B1, it is permissible for two fire doors to be fitted in an opening if each door is capable of closing the opening, and the required level of fire resistance can be achieved by the two doors together. However, if these two doors are fitted in an opening provided for a means of escape, both doors should be self-closing. One of them may be held open by a fusible link and be fitted with an automatic self-closing device if the other is easily openable by hand and has at least 30 minutes fire resistance.

Doors which are to be kept closed or locked when not in use, or which are held open by an automatic release mechanism, should be marked with the appropriate fire safety sign in accordance with BS ISO 3864-1: *Graphical symbols – Safety colours and safety signs. Design principles for safety signs and safety markings* (2011). The signs should be on both sides of the fire doors, except for cupboards and service ducts where it is only necessary to mark the doors on the outside. This recommendation does not apply to:

- fire doors within dwellinghouses;
- fire doors to and within flats or maisonettes;

- bedroom doors in other residential buildings (PG 2(b)); and
- lift entrance/landing doors.

Normal fire doors do not provide any significant amount of insulation. Therefore it is necessary to limit the proportion of doorway openings in compartment walls to 25% of the length of the wall, unless the doors provide both integrity and insulation (see Appendix A, Table A2).

Further sources of guidance

The following additional sources of guidance to fire doors and ironmongery are referred to in AD B and may be found useful:

- Recommendations for the specification, design, construction, installation and maintenance of fire doors constructed with non-metallic leaves may be found in BS 8214 *Code of practice for fire door assemblies with non-metallic leaves*, 1990.
- BS EN 1634-2:2008 *Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware. Fire resistance characterisation test for elements of building hardware.*
- BS EN 1634-3:2004 *Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware. Smoke control test for door and shutter assemblies.*
- European Parliament and Council Directive 95/16/EC (applies to lifts permanently serving buildings and constructions and specified safety components) of 29 June 1995 on the approximation of laws of Member States relating to lifts ('Lifts Directive') implementing the Lift Regulations 1997 (SI 1997/831) and calling upon the harmonised standard BS 81-58:2008 *Safety Rules for the construction and installation of lifts – Examination and tests. Landing doors fire resistance test.*
- Guidance for metal doors is given in *Code of practice for fire-resisting metal doorsets* published by the Door and Shutter Manufacturers' Association (DSMA) in 2009.
- Ironmongery used on fire doors can significantly affect their performance in a fire. Further guidance is available in *Hardware for timber and escape doors* published by the Builders Hardware Industry Federation, 2000.

Rolling shutters

Rolling shutters are sometimes used to protect compartments and means of escape. They are usually held open by automatic release mechanisms (see above). Where rolling shutters are provided across a means of escape, they should only be released by a heat sensor (such as a fusible link or electric heat detector) situated in the immediate vicinity of the door. Closure initiated by smoke detectors or fire alarm system should not be considered unless it is also the intention that the shutter will descend partially to form a boundary to a smoke reservoir.

All rolling shutters should be capable of manual operation for firefighting purposes.

Glazing to fire doors

It is often desirable to provide glazed vision panels in fire doors. Where the glazing can satisfy the relevant insulation criteria from Table Al of Appendix A, there are no limitations on its use in fire doors. Where this is not the case, the uninsulated glazing should comply with the recommendations of Table A4 of Appendix A, which is reproduced below. Table A4 also contains details of the use of uninsulated glazing in protected stairways, lobbies and corridors. This is described more fully under 'Protected shafts' below.

AD B Appendix A

Table A4 Limitations on the use of uninsulated glazed elements on escape routes. (These limitations do not apply to glazed elements which satisfy the relevant insulation criterion; see Table A1.) (See BS 9999 for glazing to atria and refuges.)

	Maximum total glazed area in parts of a building with access to			
	A single stairway		**More than one stairway**	
Position of glazed element	**Walls**	**Door leaf**	**Walls**	**Door leaf**
Single-family dwellinghouses				
1. a. Within the enclosures of a protected stairway or within fire-resisting separation shown in Fig. 7.42	Fixed fanlights only	Unlimited	Fixed fanlights only	Unlimited
b. Within fire-resisting separation				
i. Shown in Fig. 7.13	Unlimited above 100 mm from floor	Unlimited above 100 mm from floor	Unlimited above 100 mm from floor	Unlimited above 100 mm from floor
ii. Described in section 7.14.9				
c. Existing window between an attached/integral garage and the house	Unlimited	Not applicable	Unlimited	Not applicable
Flats and maisonettes				
2. Within the enclosures of a protected entrance hall or protected landing or within fire-resisting separation shown in Fig. 7.42	Fixed fanlights only	Unlimited above 1100 mm from floor	Fixed fanlights only	Unlimited above 1100 mm from floor
General (except dwellinghouses)				
3. Between residential/sleeping accommodation and a common escape route (corridor, lobby or stair)	Nil	Nil	Nil	Nil
4. Between a protected stairway[1] and				
a. The accommodation	Nil	25% of door area	Unlimited above 1100 mm[2]	50% of door area

(*Continued*)

Table A4 (*Continued*)

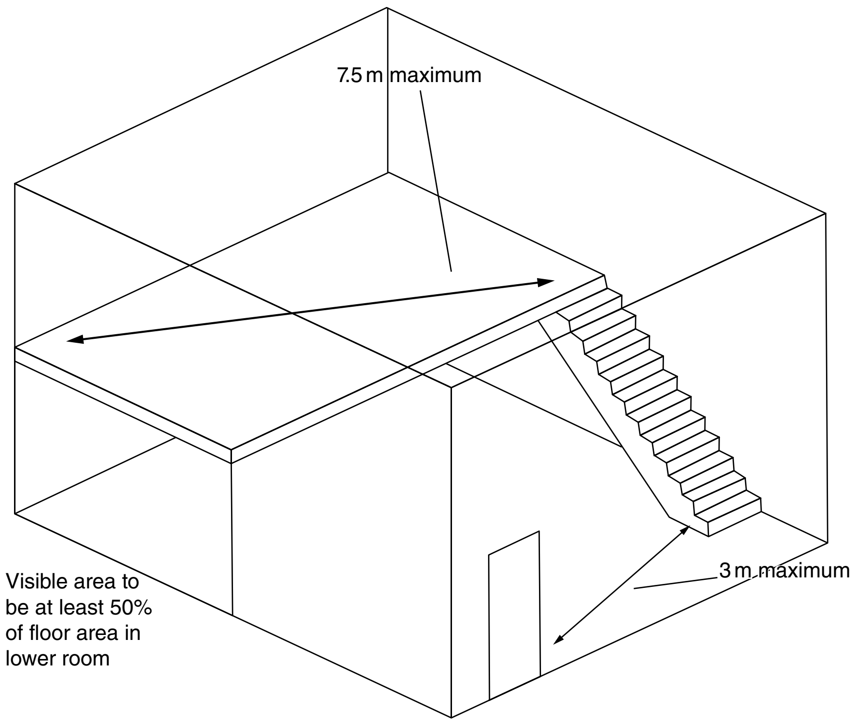
Position of glazed element	Maximum total glazed area in parts of a building with access to: A single stairway – Walls	A single stairway – Door leaf	More than one stairway – Walls	More than one stairway – Door leaf
b. A corridor which is not a protected corridor. Other than in item(3)				
5. Between				
a. A protected stairway(1) and a protected lobby or protected corridor	Unlimited above 1100 mm from floor	Unlimited above 100 mm from floor	Unlimited above 100 mm from floor	Unlimited above 100 mm from floor
b. Accommodation and a protected lobby. Other than in item(3)				
6. Between the accommodation and a protected corridor forming a dead end. Other than in item(3)	Unlimited above 1100 mm from floor	Unlimited above 100 mm from floor	Unlimited above 1100 mm from floor	Unlimited above 100 mm from floor
7. Between accommodation and any other corridor or subdividing corridors. Other than in item(3)	Not applicable	Not applicable	Unlimited above 100 mm from floor	Unlimited above 100 mm from floor
8. Adjacent to an external escape route described in section 7.13.6	Unlimited above 1100 mm from paving	Unlimited above 1100 mm from paving	Unlimited above 1100 mm from paving	Unlimited above 1100 mm from paving
9. Adjacent to an external escape stair (see section 7.13.6 and Fig. 7.21) or roof escape (see section 7.14.4)	Unlimited	Unlimited	Unlimited	Unlimited

Notes:
(1) If the protected stairway is also a protected shaft (see section 7.20.4) or a firefighting stair (see section 7.28.2), there may be further restrictions on the uses of glazed elements.
(2) Measured vertically from the landing floor level or the stair pitch line.
(3) The 100 mm limit is intended to reduce the risk of fire spread from a floor covering.
Items 1c, 3 and 6 apply also to single-storey buildings.

7.20.4 Protected shafts

Protected shafts are needed when it is necessary to pass persons, things or air between compartments. Therefore, they should only be used to accommodate:

- stairs, lifts and escalators;
- pipes, ducts or chutes; and
- sanitary accommodation and/or washrooms.



Notes:
1. This diagram does not apply where the gallery is:
   i. Provided with an alternative escape route; or
   ii. Provided with an emergency egress window (Where the gallery floor is not more than 4.5 m above ground level)
2. Any cooking facilities within a room containing a gallery should either:
   i. Be enclosed with fire resisting construction; or
   ii. Be remote from the stair to the gallery and positioned such that they do not prejudice the escape from the gallery

Fig. 7.42 Gallery floor without alternative exit.

They should form a complete barrier between the different compartments which they connect and, except for glazed screens which should meet the recommendations referred to below, should have fire resistance as specified in Table A1 of Appendix A (see above).

A protected shaft containing a stairway is often approached by way of a corridor or lobby. It is sometimes desirable to glaze the wall between the shaft and the corridor or lobby in order to allow light and visibility in both directions.

This glazing is permitted provided that it has at least 30 minutes fire resistance in terms of integrity and the following conditions are met:

- The stair enclosure is not required to have more than 60 minutes fire resistance.
- The corridor or lobby has at least 30 minutes fire separation from the rest of the floor (including doors).
- The protected shaft is not a firefighting shaft.

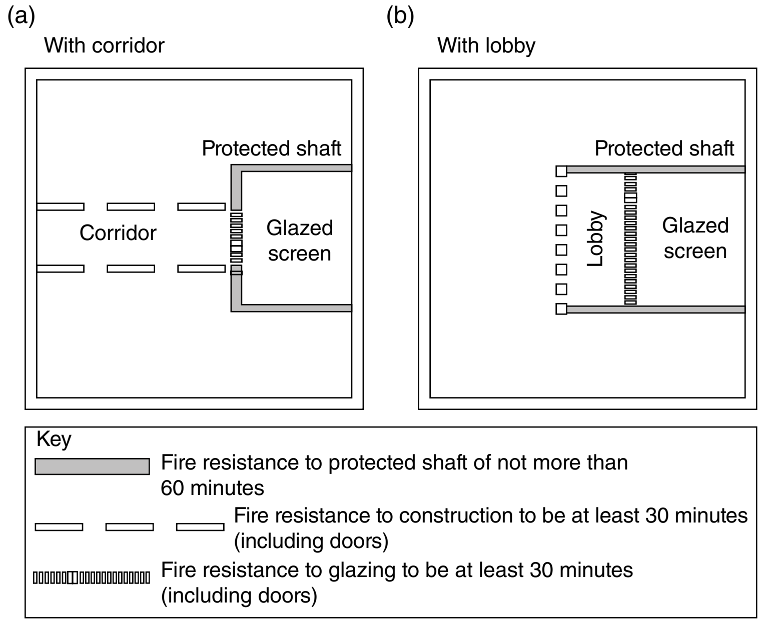


Fig. 7.43 Uninsulated glazed screen separating protected shaft from lobby or corridor.

These recommendations are illustrated in Fig. 7.43. Where these provisions cannot be met, the guidance shown in Table A4 of Appendix A relating to the limits on areas of uninsulated glazing will apply. There should be no oil pipe or ventilating duct within any protected shaft which contains any stairway and/or lift (although pipes which convey oil for hydraulic lift mechanisms and ducts used in pressurisation systems aimed at keeping stairs smoke-free are permitted).

Where a protected shaft contains a pipe carrying natural gas or LPG, the pipe should be of screwed steel or of all welded steel construction in accordance with the L 82 *Guide to the pipelines safety regulations 1996. Guidance on regulations* (HSE 2012) and L56: *Safety in the installation and use of gas systems and appliances: Gas safety (installation and use) regulations 1998. Approved code of practice and guidance* (HSE 2014). Where a pipe is completely separated from a protected shaft by fire-resisting construction, it is not considered to be contained within a protected shaft. The shaft should be adequately ventilated direct to external air by ventilation openings at high and low level in the shaft, and any extension of the floor of the storey into the shaft should not compromise the free movement of air over the entire length of the shaft. Guidance on shafts, such as those which convey piped flammable gas, may be found in BS 8313:1997 *Code of practice for accommodation of building services in ducts.*

Ideally, protected shafts should be imperforate except for certain openings mentioned below. The number of openings permitted will depend, to a great extent, on the function of the wall surrounding the protected shaft.

Generally, external walls to protected shafts do not need to be fire-resisting, and hence there are no restrictions on the number of openings in such walls. This would not be so

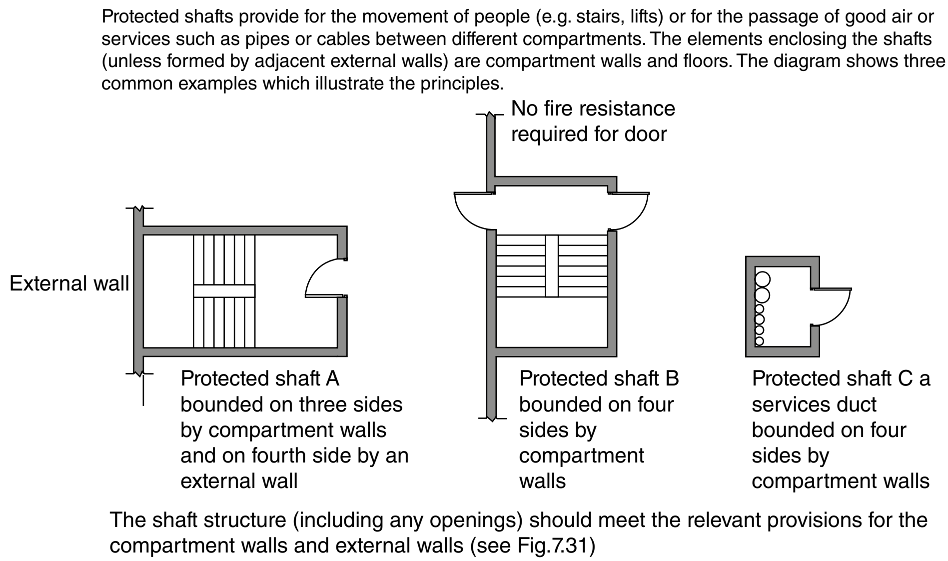


Fig. 7.44 Protected shafts.

if the external wall was part of a firefighting shaft; in this case, reference should be made to BS 9999 and section 7.15.

Where part of the enclosure to a protected shaft consists of a wall which is common to two or more buildings, the only openings permitted are those referred to in section 7.20.2.

Any other walls which make up the enclosure should have no openings other than those referred to below:

- A protected shaft containing one or more lifts may have openings to allow lift cables to pass to the lift motor room. If this is at the bottom of the shaft, the openings should be kept as small as possible.
- Where a protected shaft contains or is itself a ventilating duct, any inlets to, outlets from and openings for the duct should comply with the guidance in relation to pipes, ventilation ducts and flues in section 7.22.
- It is permissible to form an opening for pipes (other than those specifically forbidden above), provided that the pipe complies with section 9 of the ADs.
- Any opening, other than those detailed above, should be fitted with a fire door complying with Table B1 of Appendix B of AD B.

Figure 7.44 illustrates the principles of protected shafts.

7.21 Concealed spaces (cavities)

Many buildings constructed today contain large hidden void spaces within floors, walls and roofs. This is particularly true of system-built housing, schools and other local authority buildings such as old people's homes.

These buildings may also contain combustible wall panels, frames and insulation, thereby increasing the risk of unseen smoke and flame spread through these concealed spaces.

Therefore, despite compartmentation and the use of fire-resistant construction, many buildings have been destroyed as a result of fire spreading through cavities formed by, or in, constructional elements and by-passing compartment walls/ floors, etc.

Section 9 of the ADs contain provisions designed to reduce the chance of hidden fire spread by making sure that the edges of openings are closed and that cavities are:

- interrupted if there is a chance that the cavity could form a route around a barrier to fire (such as a compartment wall or floor); and
- subdivided if they are very large.

This interruption or subdivision of concealed spaces is achieved by using *cavity barriers.* These are defined in Appendix E of AD B as any form of construction (other than a smoke curtain) which is intended to close a cavity (concealed space) and prevent the penetration of smoke or flame or is fitted inside a cavity in order to restrict the movement of smoke or flame within the cavity. Therefore, provided that it meets the requirements for cavity barriers, a form of construction designed for some other use (such as a compartment wall) may be acceptable as a cavity barrier (Fig. 7.45).

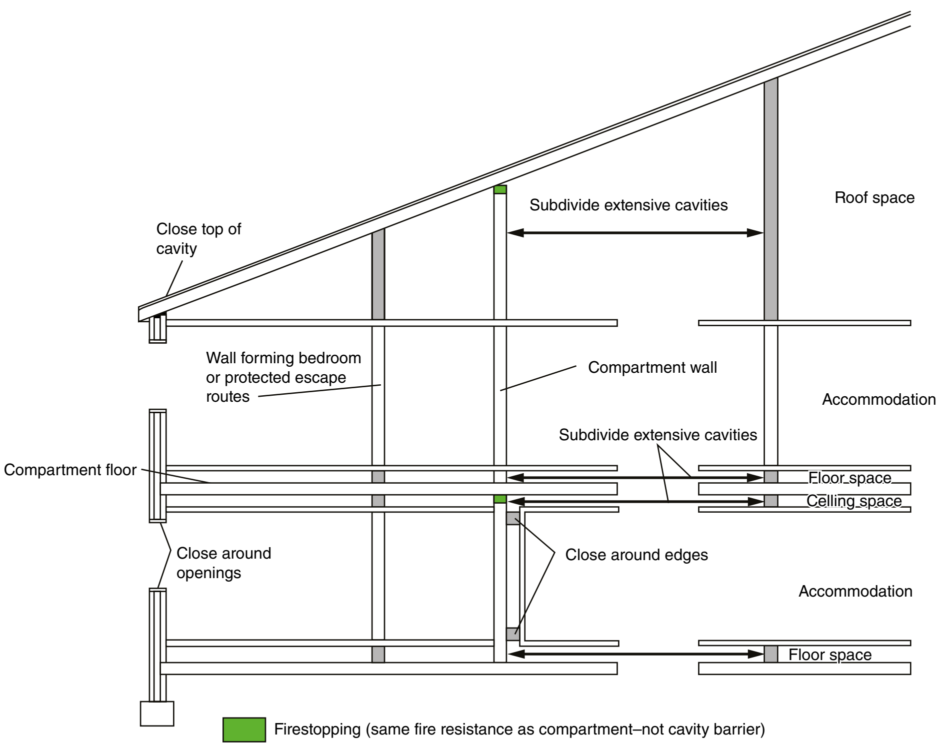


Fig. 7.45 Provision for cavity barriers.

7.21.1 Pathways around fire-separating elements

Junctions and cavity closures

Cavity barriers are required to close all edges of cavities. This includes all openings. They should also be provided:

- at the junction between every compartment floor, wall and external cavity wall (see Fig. 7.46); and
- at the junction of every compartment floor, wall or any other wall or door assembly and any internal cavity wall which does not comply with Fig. 7.46.
- Compartment walls should continue for the full height of the storey to either the roof or compartment floor. The compartment wall should be topped with a cavity barrier.

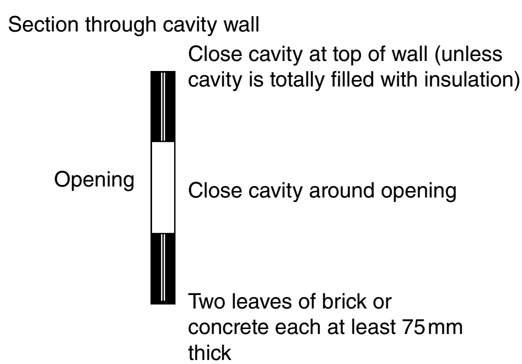
7.21.2 Protected escape routes

Where a cavity exists either below or above any fire-resisting construction, they should be provided with:

- cavity barriers throughout the junction of the escape route; or
- in the case of a compartment, separated element or fire-resistant ceiling which extends throughout the building; any fire-resisting construction should comply with Fig. 7.47.

Double-skin corrugated or profiled insulated roof sheeting

Double-skin corrugated or profiled insulated roof sheeting consists of materials of limited combustibility, provided that the sheets are separated by insulating material having surfaces of Class 0 or Class 1 (National class) or Class C-s3, d2 or better (European class) and that



Notes:

1. Domestic meter cupboards may be installed provided that:
   a) there are no more than two cupboards per dwelling
   b) the openings in the outer wall leaf is not more than 800 mm × 500 mm for each cupboard
   c) The inner leaf is not penetrated except by a sleeve not more than 80 mm × 80 mm which is fire stopped
2. Combustible materials may be laced with in the cavity.

Fig. 7.46 Cavity wall excluded from provisions for cavity barriers.

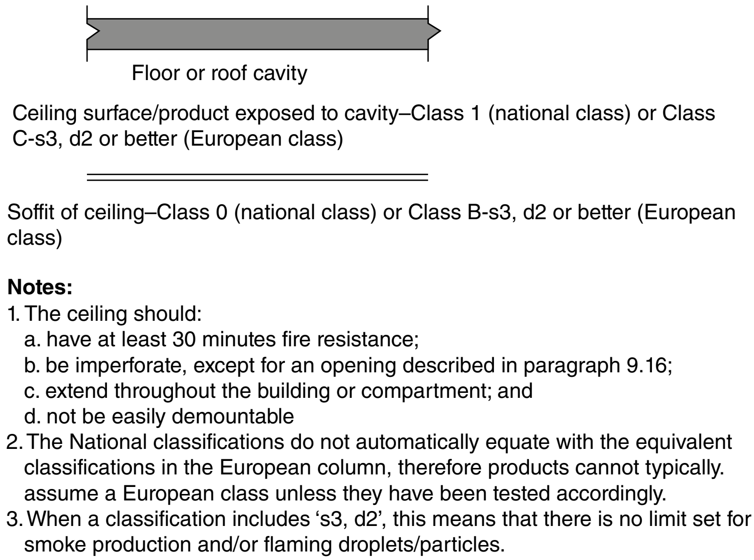


Fig. 7.47 Fire-resisting ceiling below concealed space.

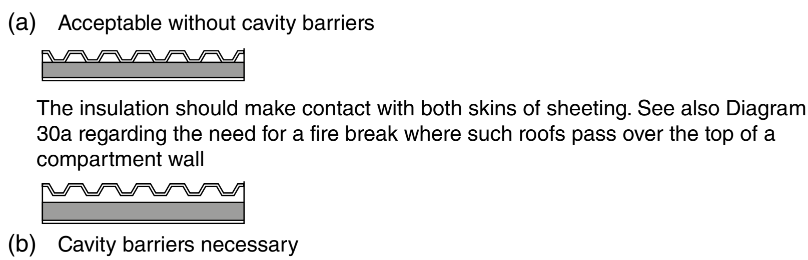


Fig. 7.48 Cavity barriers in double-skin insulated roof sheets.

insulating material is in contact with both the inner and outer liner sheets. It should be noted that when a classification includes 's3, d2', this means that there is no limit set for smoke production and/or flaming droplets/particles (see Fig. 7.48).

7.21.3 Cavities affecting alternative escape routes

If it is likely that alternative escape routes could be exposed to the risk of smoke or fire spread from an adjacent corridor, then cavity barriers should be positioned in accordance with Fig. 7.27.

Bedroom separation

Within institutional or other residential buildings, it is common for bedrooms to be designed as fire-resistant enclosures to support the means of escape strategy. In such instances cavity barriers are required to be fitted:

- in line with the partitions; or,
- in the case of cavities above partitions, that they are enclosed on the lower part of the fire-resisting ceiling which could extend throughout the compartment, separated of part or throughout the building.

7.21.4 Extensive cavities

The maximum dimensions of undivided concealed spaces are set out in Table 13. This guidance should be followed except in the following circumstances:

- In a load-bearing fire-resisting wall.
- In an external masonry or concrete cavity wall (refer to Fig. 7.45).
- Cavities above fire-resisting ceilings or floors are subject to an overall limit of 30 m in extent (see Fig. 7.46).
- Any external skin to a cladding system which is backed with an external skin of masonry or concrete inner leaf at least 75 mm thick or an existing concrete roof provided that the cavity does not contain combustible insulation and the building is not put to a residential of institutional use.
- In the case of double-skin corrugated or profiled roofing sheets. If the sheeting is a material of limited combustibility and both surfaces have an insulating layer, provided that the sheets are separated by insulating material having surfaces of Class 0 or Class 1(National class) or Class C-s3, d2 or better (European class) and that insulating material is in contact with both the inner and outer liner sheets, it should be noted that when a classification includes 's3, d2', this means that there is no limit set for smoke production and/or flaming droplets/particles.
- In any inaccessible ground floor or in a ground floor with a void less than 1 m. If opening are present in the floor where combustibles could accumulate, then cavity barriers should be provided.

Approved Document B volume 2

Table 13 Maximum dimensions of cavities in non-domestic buildings (PG 2–7).

	Class of surface/product exposed in cavity (excluding the surface of any pipe, cable or conduit or any insulation to any pipe)		
Location of cavity	**National class**	**European class**	**Maximum dimension in any direction (m)**
Between roof and ceiling	Any	Any	20
Any other cavity	Class 0 or 1	Class A1	20
		Class A2-s3, d2	
		Class B-s3, d2	
		Class C-s3, d2	
	Not Class 0 or 1	Not any of the above classes	10

Section 9 of the ADs permits certain variations to the dimensions given in Table 13 as follows:

- If a room under a ceiling cavity exceeds the dimensions given in Table 13 (which is reproduced below), then cavity barriers need only be placed on the line of the enclosing walls or partitions of that room, subject to a maximum cavity barrier spacing of 40 m, provided that the surfaces exposed in the cavity are Class 0 or Class 1 (National class) or Class C-s3, d2 or better (European class).
- Cavities over undivided areas which exceed the 40 m limit mentioned above in both directions need not be divided with cavity barriers if the following conditions can be met:
  - Both room and cavity are compartmented from the rest of the building.
  - An automatic fire detection and alarm system to BS 5839-1:2013 is fitted in the building (although detectors are not required in the cavity).
  - If the cavity is used as a plenum for ventilating and air conditioning ductwork, the recommendations about recirculating air distribution systems in BS 9999:2008 should be followed.
  - The ceiling surface exposed in the cavity is Class 0 (National class) or Class C-s3, d2 or better (European class), and any supports or fixings for the ceiling are non-combustible.
  - Any pipe insulation system should have a Class 1 flame spread rating.
  - Electrical wiring in the void should be laid in metal trays or metal conduit.
  - Any other materials in the cavity should be of limited combustibility.

AD B3 section 10

Table 13 Maximum dimensions of cavities in non-domestic buildings (Purpose Groups 2–7).

	Class of surface/product exposed in cavity (excluding the surface of any pipe, cable or conduit or any insulation to any pipe)		
Locations of cavity	**National class**	**European class**	**Maximum dimensions in any direction (m)**
Between roof and ceiling	Any	Any	20
Any other cavity	Class 0 or Class 1	Class A1 or Class A2-s3, d2 Class B-s3, d2 Class C-s3, d1	20
	Not Class 0 or Class 1	Not any of the above classes	10

Notes:
1. Exceptions to these provisions are given in paragraphs 10.11–10.13 of AD B3 and are summarised in section 7.23.2.
2. The National classifications do not automatically equate with the equivalent classifications in the European column; therefore products cannot typically assume a European class unless they have been tested accordingly.
3. When a classification includes 's3, d2', this means that there is no limit set for smoke production and/or flaming droplets/particles.

7.21.5 Construction and fixings for cavity barriers

A cavity barrier may be formed by construction provided for another purpose provided that it meets the recommendations for cavity barriers. However, where compartment walls are provided, these should be taken up the full storey height to a compartment floor or roof and not completed by cavity barriers above them. This is because the fire resistance standards for compartment walls are higher than those for cavity barriers, and compartment walls should therefore be continued through the cavity to maintain the fire resistance standard.

Table A1 of Appendix A recommends that all cavity barriers should have a minimum standard of fire resistance of 30 minutes with regard to integrity and 15 minutes with regard to insulation. The only exception to this is in the case of a cavity barrier in a stud wall or partition which is permitted to be formed of:

- steel at least 0.5 mm thick;
- timber at least 38 mm thick;
- polythene sleeved mineral wool, or mineral wool slabs, in either case under compression when installed in the cavity; and
- calcium silicate, cement-based or gypsum-based boards at least 12 m thick.

A door or a window may form the cavity barrier around its opening provided that it is constructed of steel or timber if they are at least the thicknesses given above.

Cavity barriers should be tightly fitted against rigid construction and mechanically fixed in position where possible. Where they abut against slates, tiles, corrugated sheeting and similar non-rigid construction, the junctions should be fire stopped as described below.

Cavity barriers should also be fixed in such a way that their performance is unlikely to be affected by:

- building movements due to shrinkage, subsidence, thermal change, or movement of the external envelope due to wind;
- collapse in a fire of any services which penetrate them; or
- failure of their fixings or any construction or material which they abut, due to fire. However, where cavity barriers are provided in roof spaces, the roof members to which they are fitted are not expected to have fire resistance.

7.21.6 Openings in cavity barriers

Cavity barriers should be imperforate except for one or more of the following openings:

- For a pipe which complies with section 10 the ADs;
- For a cable or for a conduit containing one or more cables;
- If fitted with a suitably mounted fire damper;
- For a duct (unless it is fire resisting) fitted with an automatic fire damper where it passes through the barrier; and
- If fitted with a door which complies with Appendix B of ADs, and having at least 30 minutes fire resistance.

The above provisions do not apply to any cavity barrier provided above any bedroom partitions which are not carried up to the full storey height (or to the underside of the roof, if they are in the top storey).

7.22 Pipes, ventilation ducts and flues

It is impossible to construct a building without passing some pipes or ducts through the walls and floors, and such penetration of the fire-separating elements of structure is a potential source of flame and smoke spread. Section 10 of ADs therefore attempts to control the specifications of such pipes and ducts and of their associated enclosing structures. The measures in section 10 are primarily designed to delay the passage of fire. They may also have the added benefit of retarding smoke spread, but the integrity test specified in Appendix A of the ADs does not cover criteria for the passage of smoke as such.

7.22.1 Pipes

For the purposes of section 11, the term 'pipe' includes a ventilating pipe for an above-ground drainage system but does not include any flue pipe or other form of ventilating pipe.

As is usual, the expression 'pipe' here may be read as 'pipeline' and should be taken to include all pipe fittings and accessories.

Requirements

Where a pipe as defined passes through an opening in:

- a compartment wall or compartment floor (unless the pipe is wholly enclosed within a protected shaft); or
- a cavity barrier,

then either a proprietary sealing system should be used which will maintain the fire resistance of the floor, wall or cavity barrier (and has been shown by test to do so), or the nominal internal diameter of the pipe should not exceed the relevant dimension listed in Table 14 of section 10. The opening should be as small as practicable and fire stopped around the pipe.

Where a pipe of specification (b) of Table 14 penetrates a structure, it is permissible to pass it through or connect it to a pipe or sleeve of specification (a) of Table 14 provided the pipe or sleeve of specification (a) extends on both sides of the structure for a minimum distance of 1 m. The sleeve should be in contact with the pipe (see Fig. 7.49).

The following above-ground drainage system pipes complying with specification (b) of Table 14 may be passed through openings in a wall which separates houses or through openings in a compartment wall or compartment floor in flats:

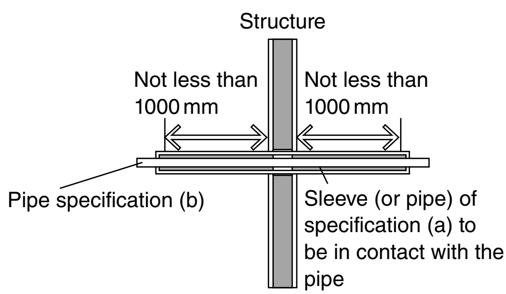
- A stack pipe of not more than 160 mm nominal internal diameter, provided it is contained within an enclosure in each storey; and
- A branch pipe of not more than 110 mm nominal internal diameter, provided it discharges into a stack pipe which is contained in an enclosure, the enclosure being partly formed by the wall penetrated by the branch pipe.

AD B volume 2 section 10

Table 14 Maximum nominal internal diameter of pipes passing through a compartment wall/floor (see paragraph 10.5 et seq.).

Situation	Pipe material and maximum nominal internal diameter (mm)		
	(a) Non-combustible material(1)	**(b) Lead, aluminium, aluminium alloy, uPVC (2) and fibre cement**	**(c) Any other material**
1. Structure (but not a wall separating buildings) enclosing a protected shaft which is not a stairway or a lift shaft	160	110	40
2. Wall separating dwellinghouses or compartment wall or compartment floor between flats	160	160 (stack pipe)(3) 110 (branch pipe)(3)	40
3. Any other situation	160	40	40

Notes:
(1) Any non-combustible material (such as cast iron, copper or steel) which if exposed to a temperature of 800°C will not soften or fracture to the extent that flame or hot gas will pass through the wall of the pipe.
(2) uPVC pipes complying with BS 5255:1989
(3) These diameters are only in relation to pipes forming part of an above-ground drainage system and enclosed as shown in Diagram 38. In other cases the maximum diameters against situation 3 apply.



Notes:
1. Make the opening in the structure as small as possible and provide firestopping between the pipe and structure.
2. See Table 14 for materials specification.

Fig. 7.49 Pipes penetrating structure.

The enclosures referred to in both cases immediately above should comply with the following requirements:

- In any storey, the enclosure should extend from floor to ceiling or from floor to floor if the ceiling is suspended.
- Each side of the enclosure should be formed by a compartment wall or floor, external wall, intermediate floor or casing.
- The internal surface of the enclosure should meet the requirements of Class 0 (National class) or Class C-s3, d2 or better (European class), except for any supporting members.

- No access panel to the enclosure should be fitted in any bedroom or circulation space.
- The enclosure should not be used for any purpose except to accommodate drainage or water supply pipes.

The 'casing' referred to in Fig. 7.46 and the second requirement immediately above should provide at least 30 minutes fire resistance, including any access panel, and it should not be formed of sheet metal. The only openings permitted in a casing are openings for the passage of a pipe or openings fitted with an access panel. The pipe opening, whether it be in the structure or the casing, should be as small as is practicable and fire stopped around the pipe (see Fig. 7.49). A casing to the drainage or water supply pipes should always be provided if a wall which separates houses is penetrated by a branch pipe in the top storey.

7.22.2 Ventilating ducts

Ventilating ducts, normally forming part of an air conditioning system, convey air to various parts of a building. It is, therefore, inevitable that they will need to pass through compartment walls and floors at some stage, and it is important that the integrity of these fire-separating elements is maintained. This can be achieved by following the guidance in section 7 of BS 9999 where alternative ways of protecting compartmentation are described when air handling ducts pass from one compartment to another.

7.22.3 Flues

Where any flue, appliance ventilation duct or duct containing one or more flues:

- passes through a compartment wall or floor; or
- is built into a compartment wall,

the flue or duct walls should be separated from the compartment wall or floor by non-combustible construction of fire resistance equal to at least half that required for the compartment wall or floor (see Fig. 7.50).

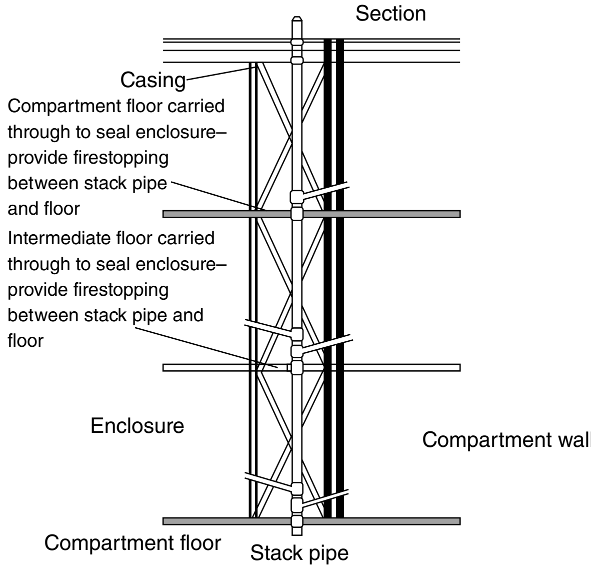
For the purposes of the above, an appliance ventilation duct is a duct provided to convey combustion air to a gas appliance.

7.22.4 Fire stops

A fire stop is defined in Appendix E of AD B as a seal provided to close an imperfection of fit or design tolerance between elements or components, to restrict the passage of fire and smoke.

Therefore, fire stops should be provided:

- at junctions or joints between elements which are required to act as a barrier to fire; and
- where pipes, ducts, conduits or cables pass through openings in cavity barriers (see section 7.21.5) or elements which serve as a barrier to fire.



Notes:

1. The enclosure should:
   a. be bounded by a compartment wall or floor, an outside wall, an intermediate floor or a casing (see specification at 2 below)
   b. have internal surface (except framing members) of class 0 (National class) or class B-s3, d2 or better (European class)
   Notes: when classification includes 's3, d2', this means that there is no limit set for smoke production and/or flaming droplets/particles
   c. not have an access panel which opens into a circulation space or bedroom
   d. be only used for drainage, or water supply or vent pipes for a drainage system
2. The casing should:
   a. be imperforate except for an opening for a pipe or an access panel
   b. not be of sheet metal
   c. have (including any access panel) not less than 30 minutes fire resistance
3. The opening for a pipe, either in the structure or the casing, should be kept as small as possible and firestopped around the pipe.

Fig. 7.50 Penetration of structure by pipes.

In the second case above, the openings should be kept as small and as few in number as possible, and the fire stopping should not restrict the thermal movement of pipes or ducts.

Fire-stopping materials should be reinforced with or supported by materials of limited combustibility to prevent displacement if:

- the unsupported span exceeds 100 mm; and
- in any other case, non-rigid materials have been used (unless these have been shown by test to be satisfactory).

Suitable fire-stopping materials include:

- cement mortar;
- gypsum-based plaster;
- cement or gypsum-based vermiculite/perlite mixes;
- glass fibre, crushed rock, blast furnace slag or ceramic-based products (with or without resin binders);
- intumescent mastics; and
- any proprietary fire-stopping or sealing systems (including those designed for penetration by services) capable of maintaining the fire resistance of the element concerned (test results would be necessary to prove acceptability).

These materials should be used in appropriate situations, i.e. they may not all be suitable in every situation.

7.23 Variations to the provisions of parts relating to B3 in the ADs

As has been mentioned in the introduction to this chapter (see section 7.1), some difficulty may be encountered when trying to apply the provisions of AD B to existing buildings. Accordingly, the AD volume B3 contains a number of specific recommendations related to raised storage areas, floors in domestic loft conversions and conversion of buildings to flats, where the 'normal' provisions are somewhat reduced.

7.23.1 Varying the provisions: Raised storage areas

Sometimes, raised free-standing floors (usually called mezzanine floors) are erected (often in single-storey industrial buildings) for the purposes of storage. They may be regarded merely as galleries or may be large enough to be considered as a floor forming an additional storey. In such cases, the normal recommendations regarding the fire resistance of elements of structure may prove to be unduly onerous if applied to raised storage areas.

It may be possible to reduce the level of fire resistance or even allow unprotected steelwork if the following precautions are taken:

(1) The structure should be used for storage purposes only and should contain only one tier.
(2) The number of people using the floor at any time should be limited. Members of the public should not be admitted.
(3) The floor is open both above and below the space in which it is located.
(4) Means of escape is provided from the floor which meets the recommendations of sections 4, 5 and 6 of AD B volume 2.
(5) The floor should comply with the following parameters regarding its size:
    - It should not be more than 10 m in length and/or width and should not be greater than half the floor area of the space in which it is located.

- The floor size may be increased to not more than 20 m in length and width where an automatic fire detection and alarm system is provided on the lower level, which complies with BS 5839-1.
- There are no limits on the size of the floor if the building is fitted throughout with an automatic sprinkler system which meets the relevant recommendations of section 7.11.

7.23.2 Varying the provisions: Dwellinghouses

Under the recommendations for means of escape in case of fire (AD B volume 1), certain provisions apply where it is proposed that a dwellinghouse is materially altered to construct one or two rooms in the roof space of a two-storey dwelling thereby creating a three-storey dwelling (see section 7.12).

Floors in an existing two-storey dwelling may only be capable of achieving a modified 30 minutes fire resistance (see section 7.21). However, AD B volume 1 recommends that floors in a dwelling of three or more storeys should have a full 30 minutes fire resistance.

It is considered reasonable to relax the recommendation for the *existing* floor (thereby allowing the modified 30 minutes standard) provided the following provisions are complied with by way of compensation:

- Only one storey is being added with a floor area not exceeding 50 m^2.
- No more than two habitable rooms are provided in the new storey.
- The existing floor should only separate rooms (not circulation spaces).
- In the case of loft conversions, the general standards contained in section 7.12 should be complied with.

The relaxed recommendation will only apply to any floor which separates rooms (i.e. not circulation spaces). Therefore, the full 30 minute standard will need to be provided where the floor forms part of the enclosures to the circulation space between the loft conversion and the final exit.

It is sometimes the case that a floor is only capable of achieving a modified 30 minutes standard of fire resistance because it is constructed with plain edged boarding on the upper surface. By overlaying the floor with a 3.2 mm thickness of standard hardboard nailed to the floor, boards can usually upgrade the floor to the full 30 minutes.

Other methods of upgrading existing timber floors can be found in *BRE Digest* 208.

7.23.3 Varying the provisions: Conversion to flats

If it is proposed to convert a building into flats, Approved Document B of Schedule 1 of the 2010 Regulations will apply due to the material change of use.

It is often the case that the existing floors are of timber construction and have insufficient fire resistance for the proposed change of use.

The provision of an adequate, fully protected means of escape which complies with the recommendations of section 3 of AD B volume 2 will allow a 30 minute standard of fire resistance in the elements of structure in a building of not more than three storeys.

The full standard of fire resistance given in Table A2 of Appendix A would normally be required if the converted building contained four or more storeys.

7.24 External fire spread

The external walls of a building are required to adequately resist the spread of fire over their surfaces and from one building to another. In assessing the adequacy of resistance to fire spread, regard must be given to the height, use and position of the building.

The roof of a building must also offer adequate resistance to the spread of fire across its surface and from one building to another, having regard to the use and position of the building.

7.25 External walls

External walls serve to restrict the outward spread of fire to a building beyond the property boundary and also help resist fire from outside the building. This is achieved by ensuring that the walls have adequate fire resistance and external surfaces with restricted fire spread and low rates of heat release. Fire spread between buildings usually occurs by radiation through openings in the external walls (termed 'unprotected areas'). The risk of fire spread and its consequences are related to:

- the severity of the fire;
- the fire resistance offered by the facing external walls including the number and disposition of the unprotected areas;
- the distance between the buildings; and
- the risk presented to people in the opposite building.

In general, the severity of a fire will be related to the amount of combustible material contained in the building per unit of floor area (termed the 'fire load density'). Certain types of buildings, such as shops, industrial buildings and warehouses, may contain large quantities of combustible materials and are usually required to be sited further from their boundaries than other types of buildings.

7.25.1 External walls: General constructional recommendations

External walls are elements of structure, and therefore they should have the relevant period of fire resistance specified in Appendix A of the ADs. However, the provisions for space separation mentioned below allow increasingly large areas of the external walls of a building to be unprotected as the distance to the relevant boundary increases. A point will eventually be reached where the whole of a wall may be unprotected. In such a case only the load-bearing parts of the wall would need fire resistance. Similarly, where a wall is 1 m or more from the relevant boundary, it only needs to resist fire from the inside, and the insulation criteria of fire resistance are, in most cases, not applied.

The combustibility of the external envelope of a building is also controlled in certain circumstances. The limiting factors are the height of the building, its use and its distance

Table 7.8 Limitations on external wall surfaces (all buildings).

Maximum height of building (m)	Distance of external surface from any point on the relevant boundary		
	Less than 1 m	**1 m or more**	
Up to 18	Class 0[1]	No provision	
		Any surface less than 18 m above the ground	Timber at least 9 mm thick or any material with an index of performance (*I*) not more than 20
Over 18	Class 0[1]		
		Any surface 18 m or more above the ground	Class 0

Notes:
1. Either class 0 (National class) or class B-s3, d2 or better (European class). For meaning of class 0 and index of performance (*I*), see section 7.17.4.

from the relevant boundary. Table 7.8 sets out the recommendations for the external surfaces of walls, and it is generally the case that buildings which are less than 1 m from the relevant boundary should have external surfaces of Class 0 (National class) or class B-s3, d2 or better (European class). For buildings which are 18 m or more in height, there are restrictions on the external surface materials irrespective of the distance to the boundary.

After the disastrous fire at the Summerland Leisure complex on the Isle of Man, special recommendations were introduced to prevent other assembly and recreation buildings from suffering a similar fate. The Summerland centre was constructed largely of plastic materials which extended to ground level. A fire was deliberately started adjacent to the building which, because of its rapid surface spread of flame characteristics, quickly became engulfed in flames. Therefore, any Assembly and Recreation Purpose Group building which has more than one storey (galleries counted, but not basements) should have only those external surfaces indicated in Fig. 7.51. This also applies in mixed use buildings which include Assembly and Recreation Purpose Group accommodation.

The provisions described above for the combustibility of external wall surfaces may, of course, be affected by the recommendations for space separation and the limits on unprotected areas contained in section 13 of AD B and described below.

Mention has already been made of the risks involved with the use of combustible insulation in rain screen cladding of buildings (see section 7.21). In such a system the surface of the outer cladding which faces the cavity should comply with the provisions of Table 7.8 and Fig. 7.51. Furthermore, any insulation used in ventilated cavities in the external walls of a building over 18 m in height should be composed of materials of limited combustibility, although this restriction does not apply to insulation in masonry cavity walls which comply with Fig. 7.46. (Reference should also be made to the BRE Report *Fire performance of external thermal insulation for walls of multi-storey buildings*, 3rd edition, BR 135, 2013.)

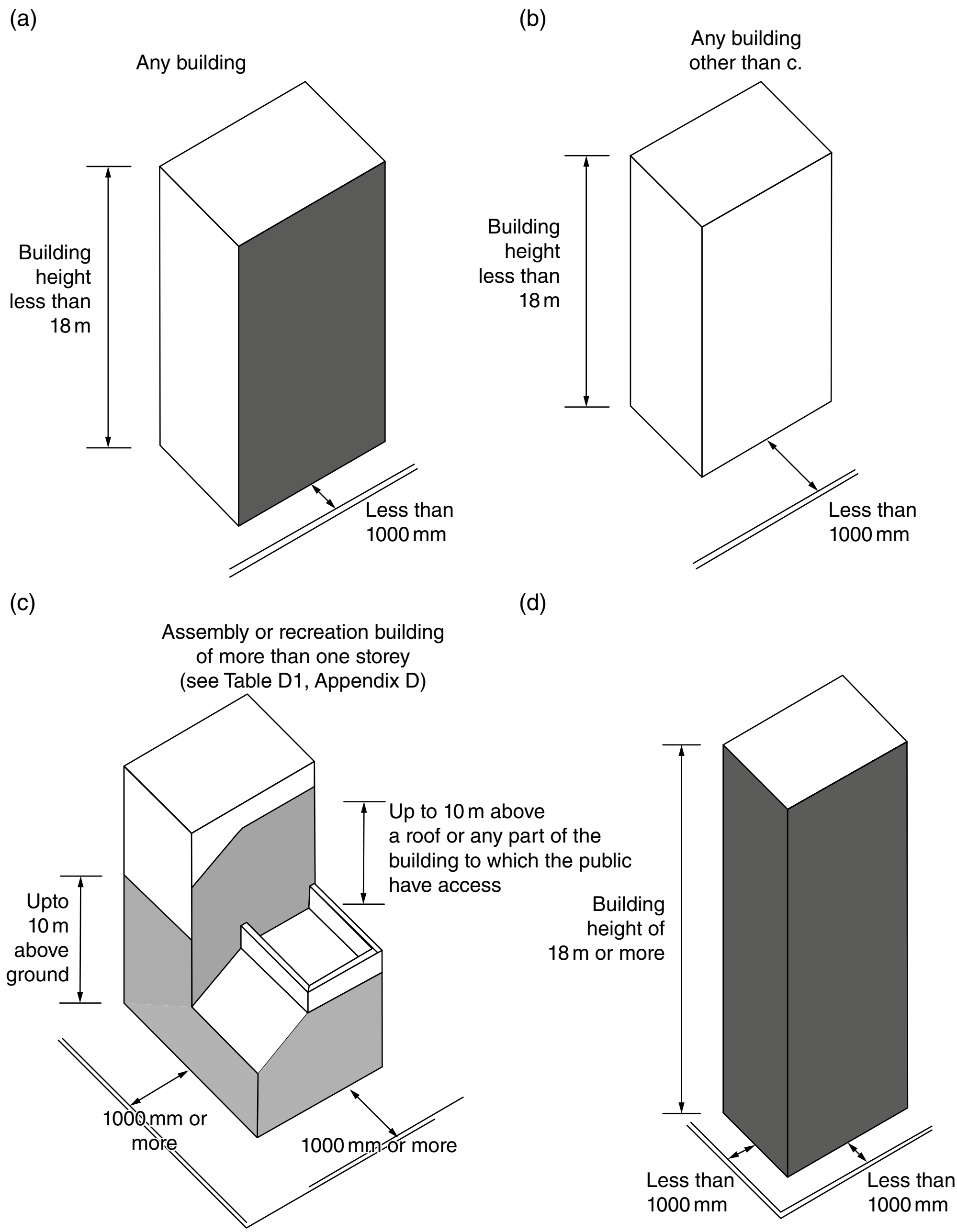
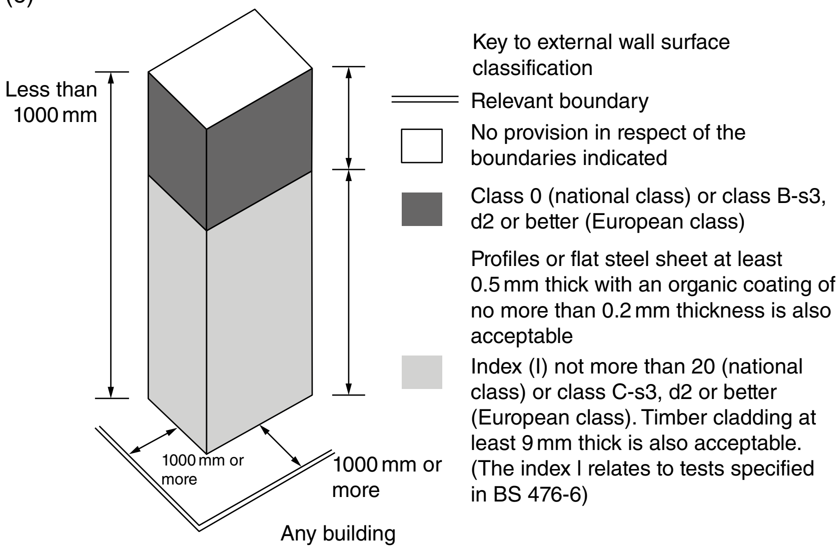


Fig. 7.51 External walls – special provisions for assembly and recreation buildings.

7.25.2 External walls and steel portal frames

Steel portal frames are commonly used in single-storey industrial and commercial buildings. Structurally, the portal frame acts as a single member. Therefore, where the column sections are built into the external walls, collapse of the roof sections may result in destruction of the walls.

(e)



Notes:
1. The national classifications do not automatically equate with the equivalent European, classifications; therefore, products cannot typically assume a European class unless they have been tested accordingly.
2. When a classification includes 's3, d2', this means that there is no limit set for smoke production and/or flaming droplets/particles.

Fig. 7.51 (*Continued*)

If the building is so situated that the external walls cannot be totally unprotected, the provisions of the ADs may recommend that both rafter and column sections be fire protected. This would result in an uneconomic building which would defeat the object of using a portal frame.

Note: The provisions described in Table 7.8 and illustrated in Fig. 7.51 might also be met by following the guidance in BRE Fire Note 9 *Assessing the fire performance of external cladding systems: a test method* (BRE 1999).

Investigations have been carried out into the behaviour of steel portal frames in fire. Provided that the connection between the frame and its foundation can be made sufficiently rigid to transfer the overturning moment caused by collapse, in a fire, of the rafters, purlins and some of the roof cladding, it may be possible to remove the fire protection to the rafters and purlins whilst still allowing the external wall to perform its structural function.

Additional measures may be necessary in certain circumstances to ensure the stability of the external walls. Full details of the design method may be found in Steel Construction Institutes publication 313: *Single storey steel framed buildings in fire boundary conditions* (2002) which is available from the Steel Construction Institute, Silwood Park, Ascot, Berks, SL5 7QN. For multistorey steel frame buildings, reference should be made to the SCI's publication 288: *Fire safe design: A new approach to multi-storey steel-framed buildings* (2nd edition, 2006). The recommendations of publication 313 that include design provision for the foundation to resist overturning need not be followed if the building is fitted with a sprinkler system that follows the recommendations of section 7.11.

Normally, reinforced concrete portal frames can support external walls without specific measures at the base to resist overturning.

The following design guidance (which some existing buildings may already comply with) is also acceptable:

- To resist overturning, the column members should be rigidly fixed to a base of suitable size and depth.
- Brick, block or concrete protection should be provided up to a protected ring beam giving lateral support.
- Some form of roof venting should be provided to give early heat release (e.g. PVC rooflights covering at least 10% of the floor area evenly spaced out).

7.25.3 Space separation: Permitted limits of unprotected areas

Unprotected areas in the external walls of a building are those areas which have less fire resistance than that recommended by Table A2 of Appendix A of the ADs. Areas such as doors, windows, ventilators or combustible cladding are permitted in the external walls, but their extent is limited depending on the use of the building and its distance from the relevant boundary. In order that a reasonable standard of space separation may be specified for buildings, the following basic assumptions are made in the ADs within section 13:

- A fire in a compartmented building will be restricted to that compartment and will not spread to adjoining compartments.
- The intensity of the fire is related to the purpose group of the building, and it can be moderated by a sprinkler system.
- Residential and Assembly and Recreation Purpose Groups represent a greater risk to life than other uses.
- Where buildings are on the same site, the spread of fire between them represents a low risk to life and can be discounted. This does not apply to buildings in the Residential and Assembly and Recreation Purpose Groups.
- There is a building on the far side of the boundary situated an equal distance away with an identical elevation to the building in question.
- The amount of thermal radiation that passes through an external wall which has fire resistance may be discounted.
- A roof which is pitched at less than 70° to the horizontal does not need to comply with the recommendations in section 14 of the ADs. (See also definition of external wall in section 7.2.)
- Vertical parts of a pitched roof (such as dormer windows) generally do not need to comply with the recommendations in section 14 of the ADs, unless they are part of a roof which is pitched at greater than 70° to the horizontal. However, a continuous run of dormer windows occupying most of a steeply pitched roof might need to be treated as a wall rather than a roof. This will be a matter of individual judgement.

It follows from the above that reduced separation distances (or increased amounts of unprotected areas) may be obtained by dividing a building into compartments.

7.25.4 Boundaries

It is clear from AD B4 that the separation distances referred to are those to the relevant boundaries of the site of the building in question. (Relevant boundary is defined in section 7.2 and is illustrated in Fig. 7.6). Where the site boundary adjoins an area which is unlikely to be developed, such as a street, canal, railway or river, then the relevant boundary is usually taken as the centreline of that area.

Where buildings share the same site, the separation distance between them is usually discounted. However, if:

- more than one building is constructed on the same site but managed or operated by different organisations; and
- either or both of the buildings are in the Residential or Assembly and Recreation Purpose Groups,

then a notional boundary is assumed to exist between them such that they both comply with the space separation recommendations of Part B4 of the ADs. (Notional boundary is defined in section 7.2 and is illustrated in Fig. 7.5.)

7.25.5 Unprotected areas that can be discounted

Certain openings, etc. such as windows and doors, in walls have little effect on fire protection. Accordingly, the ADs in section 13 provides that four areas may be discounted when calculating the permitted limits of unprotected areas in the external walls of a building:

- Any unprotected area of not more than 0.1 m^2 which is at least 1.5 m away from any other unprotected area in the same side of the building or compartment, except an area of external wall forming part of a protected shaft;
- One or more unprotected areas, with a total area of not more than 1 m^2, which is at least 4 m away from any other unprotected area in the same side of the building or compartment, except a small area of not more than 0.1 m^2 as described above;
- Any unprotected area in an external wall of a stairway in a protected shaft (But see Fig. 7.31 for further provisions affecting stairways.); and
- An unprotected area in the side of an un-compartmented building, if the area is at least 30 m above the ground adjoining the building.

Where part of an external wall is regarded as an unprotected area merely because of combustible cladding more than 1 mm thick, the unprotected area presented by that cladding is to be calculated as only half the actual cladding area (see Fig. 7.52). Any cladding with a Class 0 (National class) or class B-s3, d2 or better (European class) surface spread of flame rating need not be counted as an unprotected area.

Therefore any wall which is situated within 1 m of the relevant boundary should contain only those unprotected areas listed above and illustrated in Fig. 7.8(b). The rest of the wall will need to meet the fire resistance requirements contained in Table A2 of Appendix A of AD B.

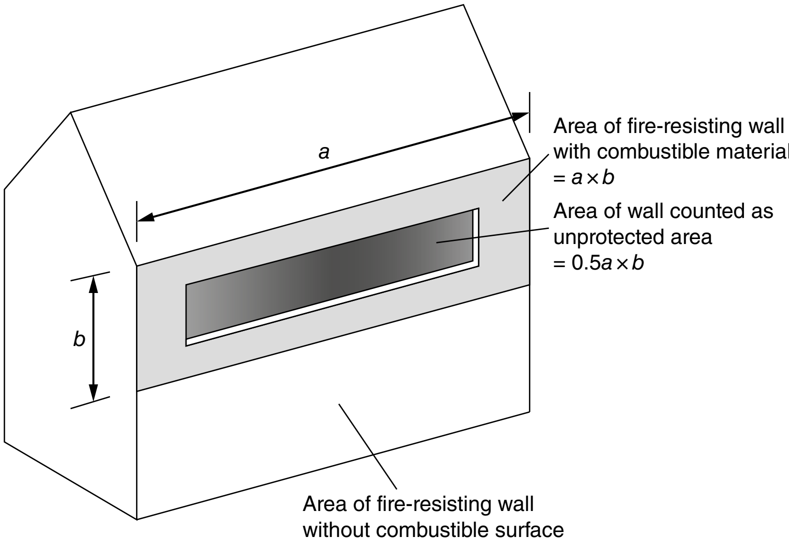


Fig. 7.52 Combustible claddings.

7.25.6 Unprotected areas: Methods of calculation

Where a wall is situated 1 m or more from the relevant boundary, the permitted limit of unprotected areas may be determined by either of two methods described in full in AD B4. The Approved Document also permits other methods, described in a BRE Report *External fire spread: Building separation and boundary distances*, BR 187, BRE, 1991. Part 1 of this report covers the 'Enclosing Rectangle' and 'Aggregate Notional Area' methods which were originally contained in the 1985 edition of AD B2/3/4 and which are also described below. An applicant may use whichever of these methods gives the most favourable result for his own building. Again, the rest of the wall should meet the fire resistance recommendations of Table 2 of Appendix A.

The basis of the two methods described in AD B4 is contained in the BRE Report mentioned above. The building should be separated from its boundary by at least half the distance at which the total thermal radiation intensity received from all unprotected areas in the wall would be 12.6 kW/m^2 in still air, assuming that the radiation intensity at each unprotected area is:

- 84 kW/m^2 for buildings in the Residential, Office or Assembly and Recreation Purpose Groups; and
- 168 kW/m^2 for buildings in the Shop and Commercial, Industrial, Storage or other non-residential Purpose Groups.

This clearly illustrates the different fire load densities assumed for the two groups of buildings.

Where a sprinkler system complying with guidance in section 7.11 is installed throughout a building, it is reasonable to assume that the extent and intensity of a fire will be reduced. In these circumstances the permitted boundary distances may be halved subject to a minimum distance of 1 m. Alternatively, if the boundary distance is kept the same, the amount of unprotected area can be doubled.

Method 1: Small residential buildings

Method 1 applies only to dwellinghouses, flats, maisonettes or other residential buildings (not institutional buildings) which:

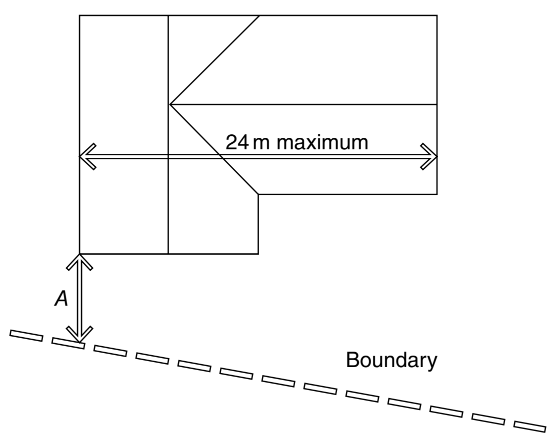
- are not less than 1 m from the relevant boundary;
- are not more than three storeys high (basements not counted); and
- have no side which exceeds 24 m in length.

The permitted limit of unprotected area in an external wall of any of these buildings is given in Fig. 7.53 which is reproduced above. It varies according to the size of the building and the distance of the side from the relevant boundary. Any parts of the side in excess of the maximum unprotected area should have the recommended fire resistance. The small areas referred to above may be discounted.

Method 2: All buildings or compartments

This method applies to buildings and compartments in any purpose group which:

- are not less than 1 m from the relevant boundary; and
- are not more than 10 m high (except open-sided car parks in Purpose Group 7(b)).



Minimum distance (*A*) between side of building and relevant boundary (m)	Minimum total area of unprotected areas (m^2)
1	5.6
2	12
3	18
4	24
5	30
6	No limit

Fig. 7.53 Permitted unprotected areas in small residential buildings.

AD B section 14

Table 15 Permitted unprotected areas in small buildings or compartments.

Minimum distance between side of building and relevant boundary (m)		Maximum total percentage of unprotected area %
Purpose groups		
Residential, Office, Assembly and Recreation	Shop and Commercial, Industrial, Storage and other non-residential	
(1)	(2)	(3)
n.a.	1	4
1	2	8
2.5	5	20
5	10	40
7.5	15	60
10	20	80
12.5	25	100

Notes:
n.a., not applicable.
a. Intermediate values may be obtained by interpolation.
b. For buildings which are fitted throughout with an automatic sprinkler system, see section 7.11.
c. In the case of open-sided car parks in Purpose Group 7(b), the distances set out in column (1) may be used instead of those in column (2).
d. The total percentage of unprotected area is found by dividing the total unprotected area by the area of the rectangle that encloses all the unprotected areas and multiplying the result by 100.

The permitted limits of unprotected areas given by this method are contained in Table 15 which is reproduced below. It should be noted that actual areas are not given. Column 3 of Table 15 expresses the permitted unprotected areas in percentage terms but fails to state what the percentage relates to. It is assumed that the percentages given refer to the total area of the side of the building in question. Thus, if a shop is at least 2 m from its relevant boundary, then it is permitted to have 8% of its external wall area on that side as unprotected. Any other areas (except the small permitted areas) would need the requisite fire resistance.

For buildings or compartments that exceed 10 m in height, the methods set out in BRE Report, BR 187 can be applied. These are explained in the following paragraphs.

Additional methods: Enclosing rectangles

This method of calculating the permitted limit of unprotected areas is based on the smallest rectangle of a height and width taken from Table 7.9 (which follows and is based on Table J2 of the 1985 edition of AD B2/3/4), which would totally enclose all the relevant unprotected areas in the side of a building or compartment. This is referred to as the *enclosing rectangle* and is usually larger than the actual rectangle that would enclose these areas (see Fig. 7.54).

The unprotected areas are projected at right angles onto a *plane of reference*, and Table 7.9 then gives the distance that the relevant boundary must be from the plane of

Table 7.9 Permitted unprotected percentages in relation to enclosing rectangles.

Width of enclosing rectangle (m)	Distance from relevant boundary for unprotected percentage not exceeding								
	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Minimum boundary distance (m); figures in brackets are for residential, office or assembly								
Enclosing rectangle 3 m high									
3	1.0 *(1.0)*	1.5 *(1.0)*	2.0 *(1.0)*	2.0 *(1.5)*	2.5 *(1.5)*	2.5 *(1.5)*	2.5 *(2.0)*	3.0 *(2.0)*	3.0 *(2.0)*
6	1.5 *(1.0)*	2.0 *(1.0)*	2.5 *(1.5)*	3.0 *(2.0)*	3.0 *(2.0)*	3.5 *(2.0)*	3.5 *(2.5)*	4.0 *(2.5)*	4.0 *(3.0)*
9	1.5 *(1.0)*	2.5 *(1.0)*	3.0 *(1.5)*	3.5 *(2.0)*	4.0 *(2.5)*	4.0 *(2.5)*	4.5 *(3.0)*	5.0 *(3.0)*	5.0 *(3.5)*
12	2.0 *(1.0)*	2.5 *(1.5)*	3.0 *(2.0)*	3.5 *(2.0)*	4.0 (2.5)	4.5 *(3.0)*	5.0 *(3.0)*	5.5 *(3.5)*	5.5 *(3.5)*
15	2.0 *(1.0)*	2.5 *(1.5)*	3.5 *(2.0)*	4.0 *(2.5)*	4.5 *(2.5)*	5.0 *(3.0)*	5.5 *(3.5)*	6.0 *(3.5)*	6.0 *(4.0)*
18	2.0 *(1.0)*	2.5 *(1.5)*	3.5 *(2.0)*	4.0 *(2.5)*	5.0 (2.5)	5.0 *(3.0)*	6.0 *(3.5)*	6.5 *(4.0)*	6.5 *(4.0)*
21	2.0 *(1.0)*	3.0 *(1.5)*	3.5 *(2.0)*	4.5 *(2.5)*	5.0 *(3.0)*	5.5 *(3.0)*	6.0 *(3.5)*	6.5 *(4.0)*	7.0 *(4.5)*
24	2.0 *(1.0)*	3.0 *(1.5)*	3.5 *(2.0)*	4.5 *(2.5)*	5.0 *(3.0)*	5.5 *(3.5)*	6.0 *(3.5)*	7.0 *(4.0)*	7.5 *(4.5)*
27	2.0 *(1.0)*	3.0 *(1.5)*	4.0 *(2.0)*	4.5 *(2.5)*	5.5 *(3.0)*	6.0 *(3.5)*	6.5 *(4.0)*	7.0 *(4.0)*	7.5 *(4.5)*
30	2.0 *(1.0)*	3.0 *(1.5)*	4.0 *(2.0)*	4.5 *(2.5)*	5.5 *(3.0)*	6.0 *(3.5)*	6.5 *(4.0)*	7.5 *(4.0)*	8.0 *(4.5)*
40	2.0 *(1.0)*	3.0 *(1.5)*	4.0 *(2.0)*	5.0 *(2.5)*	5.5 *(3.0)*	6.5 *(3.5)*	7.0 *(4.0)*	8.0 *(4.0)*	8.5 *(5.0)*
50	2.0 *(1.0)*	3.0 *(1.5)*	4.0 *(2.0)*	5.0 *(2.5)*	6.0 *(3.0)*	6.5 *(3.5)*	7.5 *(4.0)*	8.0 *(4.0)*	9.0 *(5.0)*
60	2.0 *(1.0)*	3.0 *(1.5)*	4.0 *(2.0)*	5.0 *(2.5)*	6.0 *(3.0)*	7.0 *(3.5)*	7.5 *(4.0)*	8.5 *(4.0)*	9.5 *(5.0)*
80	2.0 *(1.0)*	3.0 *(1.5)*	4.0 *(2.0)*	5.0 *(2.5)*	6.0 *(3.0)*	7.0 *(3.5)*	8.0 *(4.0)*	9.0 *(4.0)*	9.5 *(5.0)*
No limit	2.0 *(1.0)*	3.0 *(1.5)*	4.0 *(2.0)*	5.0 *(2.5)*	6.0 *(3.0)*	7.0 *(3.5)*	8.0 *(4.0)*	9.0 *(4.0)*	10.0 *(5.0)*
Enclosing rectangle 6 m high									
3	1.5 *(1.0)*	2.0 *(1.0)*	2.5 *(1.5)*	3.0 *(2.0)*	3.0 *(2.0)*	3.5 *(2.0)*	3.5 *(2.5)*	4.0 *(2.5)*	4.0 *(3.0)*
6	2.0 *(1.0)*	3.0 *(1.5)*	3.5 *(2.0)*	4.0 *(2.5)*	4.5 *(3.0)*	5.0 *(3.0)*	5.5 *(3.5)*	5.5 *(4.0)*	6.0 *(4.0)*

(*Continued*)

Table 7.9 (*Continued*)

Width of enclosing rectangle (m)	Distance from relevant boundary for unprotected percentage not exceeding								
	20%	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
	Minimum boundary distance (m); figures in brackets are for residential, office or assembly								
9	2.5 *(1.0)*	3.5 *(2.0)*	4.5 *(2.5)*	5.0 *(3.0)*	5.5 *(3.5)*	6.0 *(4.0)*	6.0 *(4.5)*	7.0 *(4.5)*	7.0 *(5.0)*
12	3.0 *(1.5)*	4.0 *(2.5)*	5.0 *(3.0)*	5.5 *(3.5)*	6.5 *(4.0)*	7.0 *(4.5)*	7.5 *(5.0)*	8.0 *(5.0)*	8.5 *(5.5)*
15	3.0 *(1.5)*	4.5 *(2.5)*	5.5 *(3.0)*	6.0 *(4.0)*	7.0 *(4.5)*	7.5 *(5.0)*	8.0 *(5.5)*	9.0 *(5.5)*	9.0 *(6.0)*
18	3.5 *(1.5)*	4.5 *(2.5)*	5.5 *(3.5)*	6.5 *(4.0)*	7.5 *(4.5)*	8.0 *(5.0)*	9.0 *(5.5)*	9.5 *(6.0)*	10.0 *(6.5)*
21	3.5 *(1.5)*	5.0 *(2.5)*	6.0 *(3.5)*	7.0 *(4.0)*	8.0 *(5.0)*	9.0 *(5.5)*	9.5 *(6.0)*	10.0 *(6.5)*	10.5 *(7.0)*
24	3.5 *(1.5)*	5.0 *(2.5)*	6.0 *(3.5)*	7.0 *(4.5)*	8.5 *(5.0)*	9.5 *(5.5)*	10.0 *(6.0)*	10.5 *(7.0)*	11.0 *(7.0)*
27	3.5 *(1.5)*	5.0 *(2.5)*	6.5 *(3.5)*	7.5 *(4.5)*	8.5 *(5.0)*	9.5 *(6.0)*	10.5 *(7.6)*	11.0 *(7.0)*	12.0 *(7.5)*
30	3.5 *(1.5)*	5.0 *(2.5)*	6.5 *(3.5)*	8.0 *(4.5)*	9.0 *(5.0)*	10.0 *(6.0)*	11.0 *(6.5)*	12.0 *(7.0)*	12.5 *(8.0)*
40	3.5 *(1.5)*	5.5 *(2.5)*	7.0 *(3.5)*	8.5 *(4.5)*	10.0 *(5.5)*	11.0 *(6.5)*	12.0 *(7.0)*	13.0 *(8.0)*	14.0 *(8.5)*
50	3.5 *(1.5)*	5.5 *(2.5)*	7.5 *(3.5)*	9.0 *(4.5)*	10.5 *(5.5)*	11.5 *(6.5)*	13.0 *(7.5)*	14.0 *(8.0)*	15.0 *(9.0)*
60	3.5 *(1.5)*	5.5 *(2.5)*	7.5 *(3.5)*	9.5 *(5.0)*	11.0 *(5.5)*	12.0 *(6.5)*	13.5 *(7.5)*	15.0 *(8.5)*	16.0 *(9.5)*
80	3.5 *(1.5)*	6.0 *(2.5)*	7.5 *(3.5)*	9.5 *(5.0)*	11.5 *(6.0)*	13.0 *(7.0)*	14.5 *(7.5)*	16.0 *(8.5)*	17.5 *(9.5)*
100	3.5 *(1.5)*	6.0 *(2.5)*	8.0 *(3.5)*	10.0 *(5.0)*	12.0 *(6.0)*	13.5 *(7.0)*	15.0 *(8.0)*	16.5 *(8.5)*	18.0 *(10.0)*
120	3.5 *(1.5)*	6.0 *(2.5)*	8.0 *(3.5)*	10.0 *(5.0)*	12.0 *(6.0)*	14.0 *(7.0)*	15.5 *(8.0)*	17.0 *(8.5)*	19.0 *(10.0)*
No limit	3.5 *(1.5)*	6.0 *(2.5)*	8.0 *(3.5)*	10.0 *(5.0)*	12.0 *(6.0)*	14.0 *(7.0)*	16.0 *(8.0)*	18.0 *(8.5)*	19.0 *(10.0)*
Enclosing rectangle 9 m high									
3	1.5 *(1.0)*	2.5 *(1.0)*	3.0 *(1.5)*	3.5 *(1.5)*	4.0 *(2.5)*	4.0 *(2.5)*	4.5 *(3.0)*	5.0 *(3.0)*	5.0 *(3.5)*
6	2.5 *(1.0)*	3.5 *(2.0)*	4.5 *(2.5)*	5.0 *(3.0)*	5.5 *(3.5)*	6.0 *(4.0)*	6.5 *(4.5)*	7.0 *(4.5)*	7.0 *(5.0)*
9	3.5 *(1.5)*	4.5 *(2.5)*	5.5 *(3.5)*	6.0 *(4.0)*	6.5 *(4.5)*	7.5 *(5.0)*	8.0 *(5.5)*	8.5 *(5.5)*	9.0 *(6.0)*

12	3.5 *(1.5)*	5.0 *(3.0)*	6.0 *(3.5)*	7.0 *(4.5)*	7.5 *(5.0)*	8.5 *(5.5)*	9.0 *(6.0)*	9.5 *(6.5)*	10.5 *(7.0)*
15	4.0 *(2.0)*	5.5 *(3.0)*	6.5 *(4.0)*	7.5 *(5.0)*	8.5 *(5.5)*	9.5 *(6.0)*	10.0 *(6.5)*	11.0 *(7.0)*	11.5 *(7.5)*
18	4.5 *(2.0)*	6.0 *(3.5)*	7.0 *(4.5)*	8.5 *(5.0)*	9.5 *(6.0)*	10.0 *(6.5)*	11.0 *(7.0)*	12.0 *(8.0)*	12.5 *(8.5)*
21	4.5 *(2.0)*	6.5 *(3.5)*	7.5 *(4.5)*	9.0 *(5.5)*	10.0 *(6.5)*	11.0 *(7.0)*	12.0 *(7.5)*	13.0 *(8.5)*	13.5 *(9.0)*
24	5.0 *(2.0)*	6.5 *(3.5)*	8.0 *(5.0)*	9.5 *(5.5)*	11.0 *(6.5)*	12.0 *(7.5)*	13.0 *(8.0)*	13.5 *(9.0)*	14.5 *(9.5)*
27	5.0 *(2.0)*	7.0 *(3.5)*	8.5 *(5.0)*	10.0 *(6.0)*	11.5 *(7.0)*	12.5 *(7.5)*	13.5 *(8.5)*	14.5 *(9.5)*	15.0 *(10.0)*
30	5.0 *(2.0)*	7.0 *(3.5)*	9.0 *(5.0)*	10.5 *(6.0)*	12.0 *(7.0)*	13.0 *(8.0)*	14.0 *(9.0)*	15.0 *(9.5)*	16.0 *(10.5)*
40	5.5 *(2.0)*	7.5 *(3.5)*	9.5 *(5.5)*	11.5 *(6.5)*	13.0 *(7.5)*	14.5 *(8.5)*	15.5 *(9.5)*	17.0 *(10.5)*	17.5 *(11.5)*
50	5.5 *(2.0)*	8.0 *(4.0)*	10.0 *(5.5)*	12.5 *(6.5)*	14.0 *(8.0)*	15.5 *(9.0)*	17.0 *(10.0)*	18.5 *(11.5)*	19.5 *(12.5)*
60	5.5 *(2.0)*	8.0 *(4.0)*	11.0 *(5.5)*	13.0 *(7.0)*	15.0 *(8.0)*	16.5 *(9.5)*	18.0 *(11.0)*	19.5 *(11.5)*	21.0 *(13.0)*
80	5.5 *(2.0)*	8.5 *(4.0)*	11.5 *(5.5)*	13.5 *(7.0)*	16.0 *(8.5)*	17.5 *(10.0)*	19.5 *(11.5)*	21.5 *(12.5)*	23.0 *(13.5)*
100	5.5 *(2.0)*	8.5 *(4.0)*	11.5 *(5.5)*	14.5 *(7.0)*	16.5 *(8.5)*	18.5 *(10.0)*	21.0 *(11.5)*	22.5 *(12.5)*	24.5 *(14.5)*
120	5.5 *(2.0)*	8.5 *(4.0)*	11.5 *(5.5)*	14.5 *(7.0)*	17.0 *(8.5)*	19.5 *(10.0)*	21.5 *(11.5)*	23.5 *(12.5)*	26.0 *(14.5)*
No limit	5.5 *(2.0)*	8.5 *(4.0)*	11.5 *(5.5)*	15.0 *(7.0)*	17.5 *(8.5)*	20.0 *(10.5)*	22.5 *(12.0)*	24.5 *(12.5)*	27.0 *(15.0)*
Enclosing rectangle 12 m high									
3	2.0 *(1.0)*	2.5 *(1.5)*	3.0 *(2.0)*	3.5 *(2.0)*	4.0 *(2.5)*	4.5 *(3.0)*	5.0 *(3.0)*	5.5 *(3.5)*	5.5 *(3.5)*
6	3.0 *(1.5)*	4.0 *(2.5)*	5.0 *(3.0)*	5.5 *(3.5)*	6.5 *(4.0)*	7.0 *(4.5)*	7.5 *(5.0)*	8.0 *(5.0)*	8.5 *(5.5)*
9	3.5 *(1.5)*	5.0 *(3.0)*	6.0 *(3.5)*	7.0 *(4.5)*	7.5 *(5.0)*	8.5 *(5.5)*	9.0 *(6.0)*	9.5 *(6.5)*	10.5 *(7.0)*
12	4.5 *(1.5)*	6.0 *(3.5)*	7.0 *(4.5)*	8.0 *(5.0)*	9.0 *(6.0)*	9.5 *(6.0)*	11.0 *(7.0)*	11.5 *(7.5)*	12.0 *(8.0)*
15	5.0 *(2.0)*	6.5 *(3.5)*	8.0 *(5.0)*	9.0 *(5.5)*	10.0 *(6.5)*	11.0 *(7.0)*	12.0 *(8.0)*	13.0 *(8.5)*	13.5 *(9.0)*
18	5.0 *(2.5)*	7.0 *(4.0)*	8.5 *(5.0)*	10.0 *(6.0)*	11.0 *(7.0)*	12.0 *(7.5)*	13.0 *(8.5)*	14.0 *(9.0)*	14.5 *(10.0)*
21	5.5 *(2.5)*	7.5 *(4.0)*	9.0 *(5.5)*	10.5 *(6.5)*	12.0 *(7.5)*	13.0 *(8.5)*	14.0 *(9.0)*	15.0 *(10.0)*	16.0 *(10.5)*

(*Continued*)

Table 7.9 (*Continued*)

Width of enclosing rectangle (m)	Distance from relevant boundary for unprotected percentage not exceeding								
	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Minimum boundary distance (m); figures in brackets are for residential, office or assembly								
24	6.0 *(2.5)*	8.0 *(4.5)*	9.5 *(6.0)*	11.5 *(7.0)*	12.5 *(8.0)*	14.0 *(8.5)*	15.0 *(9.5)*	16.0 *(10.5)*	16.5 *(11.5)*
27	6.0 *(2.5)*	8.0 *(4.5)*	10.5 *(6.0)*	12.0 *(7.0)*	13.5 *(8.0)*	14.5 *(9.0)*	16.0 *(10.5)*	17.0 *(11.0)*	17.5 *(12.0)*
30	6.5 *(2.5)*	8.5 *(4.5)*	10.5 *(6.5)*	12.5 *(7.5)*	14.0 *(8.5)*	15.0 *(9.5)*	16.5 *(10.5)*	17.5 *(11.5)*	18.5 *(12.5)*
40	6.5 *(2.5)*	9.5 *(5.0)*	12.0 *(6.5)*	14.0 *(8.0)*	15.5 *(9.5)*	17.5 *(10.5)*	18.5 *(12.0)*	20.0 *(13.0)*	21.0 *(14.0)*
50	7.0 *(2.5)*	10.0 *(5.0)*	13.0 *(7.0)*	15.0 *(8.5)*	17.0 *(10.0)*	19.0 *(11.0)*	20.5 *(13.0)*	23.0 *(14.0)*	23.0 *(15.0)*
60	7.0 *(2.5)*	10.5 *(5.0)*	13.5 *(7.0)*	16.0 *(9.0)*	18.0 *(10.5)*	20.0 *(12.0)*	21.5 *(13.5)*	23.5 *(14.5)*	25.0 *(16.0)*
80	7.0 *(2.5)*	11.0 *(5.0)*	14.5 *(7.0)*	17.0 *(9.0)*	19.5 *(11.0)*	21.5 *(13.0)*	23.5 *(14.5)*	26.0 *(16.0)*	27.5 *(17.0)*
100	7.5 *(2.5)*	11.5 *(5.0)*	15.0 *(7.5)*	18.0 *(9.5)*	21.0 *(11.5)*	23.0 *(13.5)*	25.5 *(15.0)*	28.0 *(16.5)*	30.0 *(18.0)*
120	7.5 *(2.5)*	11.5 *(5.0)*	15.0 *(7.5)*	18.5 *(9.5)*	22.0 *(11.5)*	24.0 *(13.5)*	27.0 *(15.0)*	29.5 *(17.0)*	31.5 *(18.5)*
No limit	7.5 *(2.5)*	12.0 *(5.0)*	15.5 *(7.5)*	19.0 *(9.5)*	22.5 *(12.0)*	22.5 *(14.0)*	28.0 *(15.5)*	30.5 *(17.0)*	34.0 *(19.0)*
Enclosing rectangle 15 m high									
3	2.0 *(1.0)*	2.5 *(1.5)*	3.5 *(2.0)*	4.0 *(2.5)*	4.5 *(2.5)*	5.0 *(3.0)*	5.5 *(3.5)*	6.0 *(3.5)*	6.0 *(4.0)*
6	3.0 *(1.5)*	4.5 *(2.5)*	5.5 *(3.0)*	6.0 *(4.0)*	7.0 *(4.5)*	7.5 *(5.0)*	8.0 *(5.5)*	9.0 *(5.5)*	9.0 *(6.0)*
9	4.0 *(2.0)*	5.5 *(3.0)*	6.5 *(4.0)*	7.5 *(5.0)*	8.5 *(5.5)*	9.5 *(6.0)*	10.0 *(6.5)*	11.0 *(7.0)*	11.5 *(7.5)*
12	5.0 *(2.0)*	6.5 *(3.5)*	8.0 *(5.0)*	9.0 *(5.5)*	10.0 *(6.5)*	11.0 *(7.0)*	12.0 *(8.0)*	13.0 *(8.5)*	13.5 *(9.0)*
15	5.5 *(2.0)*	7.0 *(4.0)*	9.0 *(5.5)*	10.0 *(6.5)*	11.5 *(7.0)*	12.5 *(8.0)*	13.5 *(9.0)*	14.5 *(9.5)*	15.0 *(10.0)*
18	6.0 *(2.5)*	8.0 *(4.5)*	9.5 *(6.0)*	11.0 *(7.0)*	12.5 *(8.0)*	13.5 *(8.5)*	14.5 *(9.5)*	15.5 *(10.5)*	16.5 *(11.0)*
21	6.5 *(2.5)*	8.5 *(5.0)*	10.5 *(6.5)*	12.0 *(7.5)*	13.5 *(8.5)*	14.5 *(9.5)*	16.0 *(10.5)*	16.5 *(11.0)*	17.5 *(12.0)*

24	6.5 *(3.0)*	9.0 *(5.0)*	11.0 *(6.5)*	13.0 *(8.0)*	14.5 *(9.0)*	15.5 *(10.0)*	17.0 *(11.0)*	18.0 *(12.0)*	19.0 *(13.0)*
27	7.0 *(3.0)*	9.5 *(5.5)*	11.5 *(7.0)*	13.5 *(8.5)*	15.0 *(9.5)*	16.5 *(10.5)*	18.0 *(11.5)*	19.0 *(12.5)*	20.0 *(13.5)*
30	7.5 *(3.0)*	10.0 *(5.5)*	12.0 *(7.5)*	14.0 *(8.5)*	16.0 *(10.0)*	17.0 *(11.0)*	18.5 *(12.0)*	20.0 *(13.5)*	21.0 *(14.0)*
40	8.0 *(3.0)*	11.0 *(6.0)*	13.5 *(8.0)*	16.0 *(9.5)*	18.0 *(11.0)*	19.5 *(12.5)*	21.0 *(13.5)*	22.5 *(15.0)*	23.5 *(16.0)*
50	8.5 *(3.5)*	12.0 *(6.0)*	15.0 *(8.5)*	17.5 *(10.0)*	19.5 *(12.0)*	21.5 *(13.5)*	23.0 *(15.0)*	25.0 *(16.5)*	26.0 *(17.5)*
60	8.5 *(3.5)*	12.5 *(6.5)*	15.5 *(8.5)*	18.0 *(10.5)*	21.0 *(17.5)*	23.5 *(14.0)*	25.0 *(15.5)*	27.0 *(17.0)*	28.0 *(18.0)*
80	9.0 *(3.5)*	13.5 *(6.5)*	17.0 *(9.0)*	20.0 *(11.0)*	23.0 *(13.5)*	25.5 *(15.0)*	28.0 *(17.0)*	30.0 *(18.5)*	31.5 *(20.0)*
100	9.0 *(3.5)*	14.0 *(6.5)*	18.0 *(9.0)*	21.5 *(11.5)*	24.5 *(14.0)*	27.5 *(16.0)*	30.0 *(18.0)*	32.5 *(19.5)*	34.5 *(21.5)*
120	9.0 *(3.5)*	14.0 *(6.5)*	18.5 *(9.0)*	22.5 *(11.5)*	25.5 *(14.0)*	28.5 *(16.5)*	31.5 *(18.5)*	34.5 *(20.5)*	37.0 *(22.5)*
No limit	9.0 *(3.5)*	14.5 *(6.5)*	19.0 *(9.0)*	23.0 *(12.0)*	27.0 *(14.5)*	30.0 *(17.0)*	34.0 *(19.0)*	36.0 *(21.0)*	39.0 *(23.0)*
Enclosing rectangle 18 m high									
3	2.0 *(1.0)*	2.5 *(1.5)*	3.5 *(2.0)*	4.0 *(2.5)*	5.0 *(2.5)*	5.0 *(3.0)*	6.0 *(3.5)*	6.5 *(4.0)*	6.5 *(4.0)*
6	3.5 *(1.5)*	4.5 *(2.5)*	5.5 *(3.5)*	6.5 *(4.0)*	7.5 *(4.5)*	8.0 *(5.0)*	9.0 *(5.5)*	9.5 *(6.0)*	10.0 *(6.5)*
9	4.5 *(2.0)*	6.0 *(3.5)*	7.0 *(4.5)*	8.5 *(5.0)*	9.5 *(6.0)*	10.0 *(6.5)*	11.0 *(7.0)*	12.0 *(8.0)*	12.5 *(8.5)*
12	5.0 *(2.5)*	7.0 *(4.0)*	8.5 *(5.0)*	10.0 *(6.0)*	11.0 *(7.0)*	12.0 *(7.5)*	13.0 *(8.5)*	14.0 *(9.0)*	14.5 *(10.0)*
15	6.0 *(2.5)*	8.0 *(4.5)*	9.5 *(6.0)*	11.0 *(7.0)*	12.5 *(8.0)*	13.5 *(8.5)*	14.5 *(9.5)*	15.5 *(10.5)*	16.5 *(11.0)*
18	6.5 *(2.5)*	8.5 *(5.0)*	11.0 *(6.5)*	12.0 *(7.5)*	13.5 *(8.5)*	14.5 *(9.5)*	16.0 *(11.0)*	17.0 *(11.5)*	18.0 *(13.0)*
21	7.0 *(3.0)*	9.5 *(5.5)*	11.5 *(7.0)*	13.0 *(8.0)*	14.5 *(9.5)*	16.0 *(10.5)*	17.0 *(11.5)*	18.0 *(12.5)*	19.5 *(13.0)*
24	7.5 *(3.0)*	10.0 *(5.5)*	12.0 *(7.5)*	14.0 *(8.5)*	15.5 *(10.0)*	16.5 *(11.0)*	18.5 *(12.0)*	19.5 *(13.0)*	20.5 *(14.0)*
27	8.0 *(3.5)*	10.5 *(6.0)*	12.5 *(8.0)*	14.5 *(9.0)*	16.5 *(10.5)*	17.5 *(11.5)*	19.5 *(12.5)*	20.5 *(13.5)*	21.5 *(14.5)*
30	8.0 *(3.5)*	11.0 *(6.5)*	13.5 *(8.0)*	15.5 *(9.5)*	17.0 *(11.0)*	18.5 *(12.0)*	20.5 *(13.5)*	21.5 *(14.5)*	22.5 *(15.5)*
40	9.0 *(4.0)*	12.0 *(7.0)*	15.0 *(9.0)*	17.5 *(11.0)*	19.5 *(12.0)*	21.5 *(13.5)*	23.5 *(15.0)*	25.0 *(16.5)*	26.0 *(17.5)*

(*Continued*)

Table 7.9 (*Continued*)

Width of enclosing rectangle (m)	Distance from relevant boundary for unprotected percentage not exceeding								
	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Minimum boundary distance (m); figures in brackets are for residential, office or assembly								
50	9.5 *(4.0)*	13.0 *(7.0)*	16.5 *(9.5)*	19.0 *(11.5)*	21.5 *(13.0)*	23.5 *(15.0)*	26.0 *(16.5)*	27.5 *(18.0)*	29.0 *(19.0)*
60	10.0 *(4.0)*	14.0 *(7.5)*	17.5 *(10.0)*	20.5 *(12.0)*	23.0 *(14.0)*	26.0 *(16.0)*	27.5 *(17.5)*	29.5 *(19.5)*	31.0 *(20.5)*
80	10.0 *(4.0)*	15.0 *(7.5)*	19.0 *(10.0)*	22.5 *(13.0)*	26.0 *(15.0)*	28.5 *(17.0)*	31.0 *(19.0)*	33.5 *(21.0)*	35.0 *(22.5)*
100	10.0 *(4.0)*	16.0 *(7.5)*	20.5 *(10.0)*	24.0 *(13.5)*	28.0 *(16.0)*	31.0 *(18.0)*	33.5 *(20.5)*	36.0 *(22.5)*	38.5 *(24.0)*
120	10.0 *(4.0)*	16.5 *(7.5)*	21.0 *(10.0)*	25.5 *(14.0)*	29.5 *(16.5)*	32.5 *(19.0)*	35.5 *(21.0)*	39.0 *(23.5)*	41.5 *(25.5)*
No limit	10.0 *(4.0)*	17.0 *(8.0)*	22.0 *(10.0)*	26.5 *(14.0)*	30.5 *(17.0)*	34.0 *(19.5)*	37.0 *(22.0)*	41.0 *(24.0)*	43.5 *(26.5)*
Enclosing rectangle 21 m high									
3	2.0 *(1.0)*	3.0 *(1.5)*	3.5 *(2.0)*	4.5 *(2.5)*	5.0 *(3.0)*	5.5 *(3.0)*	6.0 *(3.5)*	6.5 *(4.0)*	7.0 *(4.5)*
6	3.5 *(1.5)*	5.0 *(2.5)*	6.0 *(3.5)*	7.0 *(4.0)*	8.0 *(5.0)*	9.0 *(5.5)*	9.5 *(6.0)*	10.0 *(6.5)*	10.5 *(7.0)*
9	4.5 *(2.0)*	6.5 *(3.5)*	7.5 *(4.5)*	9.0 *(5.5)*	10.0 *(6.5)*	11.0 *(7.0)*	12.0 *(7.5)*	13.0 *(8.5)*	13.5 *(9.0)*
12	5.5 *(2.5)*	7.5 *(4.0)*	9.0 *(5.5)*	10.5 *(6.5)*	12.0 *(7.5)*	13.0 *(8.5)*	14.0 *(9.0)*	15.0 *(10.0)*	16.0 *(10.5)*
15	6.5 *(2.5)*	8.5 *(5.0)*	10.5 *(6.5)*	12.0 *(7.5)*	13.5 *(8.5)*	14.5 *(9.5)*	16.0 *(10.5)*	16.5 *(11.0)*	17.5 *(12.0)*
18	7.0 *(3.0)*	9.5 *(5.5)*	11.5 *(7.0)*	13.0 *(8.0)*	14.5 *(9.5)*	16.0 *(10.5)*	17.0 *(11.5)*	18.0 *(12.5)*	19.5 *(13.0)*
21	7.5 *(3.0)*	10.0 *(6.0)*	12.5 *(7.5)*	14.0 *(9.0)*	15.5 *(10.0)*	17.0 *(11.0)*	18.5 *(12.5)*	20.0 *(13.5)*	21.0 *(14.0)*
24	8.0 *(3.5)*	10.5 *(6.0)*	13.0 *(8.0)*	15.0 *(9.5)*	16.5 *(10.5)*	18.0 *(12.0)*	20.0 *(13.0)*	21.0 *(14.0)*	22.0 *(15.0)*
27	8.5 *(3.5)*	11.5 *(6.5)*	14.0 *(8.5)*	16.0 *(10.0)*	18.0 *(11.5)*	19.0 *(13.0)*	21.0 *(14.0)*	22.5 *(15.0)*	23.5 *(16.0)*
30	9.0 *(4.0)*	12.0 *(7.0)*	14.5 *(9.0)*	16.5 *(10.5)*	18.5 *(12.0)*	20.5 *(13.0)*	22.0 *(14.5)*	23.5 *(16.0)*	25.0 *(16.5)*
40	10.0 *(4.5)*	13.5 *(7.5)*	16.5 *(10.0)*	19.0 *(12.0)*	21.5 *(13.5)*	23.0 *(15.0)*	25.5 *(16.5)*	27.0 *(18.0)*	28.5 *(19.0)*
50	11.0 *(4.5)*	14.5 *(8.0)*	18.0 *(11.0)*	21.0 *(13.0)*	23.5 *(14.5)*	25.5 *(16.5)*	28.0 *(18.0)*	30.0 *(20.0)*	31.5 *(21.0)*

60	11.5 *(4.5)*	15.5 *(8.5)*	19.5 *(11.5)*	22.5 *(13.5)*	25.5 *(15.5)*	28.0 *(17.5)*	30.5 *(19.5)*	32.5 *(21.0)*	33.5 *(22.5)*
80	12.0 *(4.5)*	17.0 *(8.5)*	21.0 *(12.0)*	25.0 *(14.5)*	28.5 *(17.0)*	31.5 *(19.0)*	34.0 *(21.0)*	36.5 *(23.5)*	38.5 *(25.0)*
100	12.0 *(4.5)*	18.0 *(9.0)*	22.5 *(12.0)*	27.0 *(15.5)*	31.0 *(18.0)*	34.5 *(20.5)*	37.0 *(22.5)*	40.0 *(25.0)*	42.0 *(27.0)*
120	12.0 *(4.5)*	18.5 *(9.0)*	23.5 *(12.0)*	28.5 *(16.0)*	32.5 *(18.5)*	36.5 *(21.5)*	39.5 *(23.5)*	43.0 *(26.5)*	45.5 *(28.5)*
No limit	12.0 *(4.5)*	19.0 *(9.0)*	25.0 *(12.0)*	29.5 *(16.0)*	34.5 *(19.0)*	38.0 *(22.0)*	41.5 *(25.0)*	45.5 *(26.5)*	48.0 *(29.5)*
Enclosing rectangle 24 m high									
3	2.0 *(1.0)*	3.0 *(1.5)*	3.5 *(2.0)*	4.5 *(2.5)*	5.0 *(3.0)*	5.5 *(3.5)*	6.0 *(3.5)*	7.0 *(4.0)*	7.5 *(4.5)*
6	3.5 *(1.5)*	5.0 *(2.5)*	6.0 *(3.5)*	7.0 *(4.5)*	8.5 *(5.0)*	9.5 *(5.5)*	10.0 *(6.0)*	10.5 *(7.0)*	11.0 *(7.0)*
9	5.0 *(2.0)*	6.5 *(3.5)*	8.0 *(5.0)*	9.5 *(5.5)*	11.0 *(6.5)*	12.0 *(7.5)*	13.0 *(8.0)*	13.5 *(9.0)*	14.5 *(9.5)*
12	6.0 *(2.5)*	8.0 *(4.5)*	9.5 *(6.0)*	11.5 *(7.0)*	12.5 *(8.0)*	14.0 *(8.5)*	15.0 *(9.5)*	16.0 *(10.5)*	16.5 *(11.5)*
15	6.5 *(3.0)*	9.0 *(5.0)*	11.0 *(6.5)*	13.0 *(8.0)*	14.5 *(9.0)*	15.5 *(10.0)*	17.0 *(11.0)*	18.0 *(12.0)*	19.0 *(13.0)*
18	7.5 *(3.0)*	10.0 *(5.5)*	12.0 *(7.5)*	14.0 *(8.5)*	15.5 *(10.0)*	16.5 *(11.0)*	18.5 *(12.0)*	19.5 *(13.0)*	20.5 *(14.0)*
21	8.0 *(3.5)*	10.5 *(6.0)*	13.0 *(8.0)*	15.0 *(9.5)*	16.5 *(10.5)*	18.0 *(12.0)*	20.0 *(13.0)*	21.0 *(14.0)*	22.0 *(15.0)*
24	8.5 *(3.5)*	11.5 *(6.5)*	14.0 *(8.5)*	16.0 *(10.0)*	18.0 *(11.5)*	19.5 *(12.5)*	21.0 *(14.0)*	22.5 *(15.0)*	24.0 *(16.0)*
27	9.0 *(4.0)*	12.5 *(7.0)*	15.0 *(9.0)*	17.0 *(11.0)*	19.0 *(12.5)*	20.5 *(13.5)*	22.5 *(15.0)*	24.0 *(16.0)*	25.5 *(17.0)*
30	9.5 *(4.0)*	13.0 *(7.5)*	15.5 *(9.5)*	18.0 *(11.5)*	20.0 *(13.0)*	21.5 *(14.0)*	23.5 *(15.5)*	25.0 *(17.0)*	26.5 *(18.0)*
40	11.0 *(4.5)*	14.5 *(8.5)*	18.0 *(11.0)*	20.5 *(13.0)*	23.0 *(14.5)*	25.0 *(16.0)*	27.5 *(18.0)*	29.0 *(19.0)*	30.5 *(20.5)*
50	12.0 *(5.0)*	16.0 *(9.0)*	19.5 *(12.0)*	22.5 *(14.0)*	25.5 *(16.0)*	27.5 *(17.5)*	30.0 *(19.5)*	32.0 *(21.0)*	33.5 *(22.5)*
60	12.5 *(5.0)*	17.0 *(9.5)*	21.0 *(12.5)*	24.5 *(15.0)*	27.5 *(17.0)*	30.0 *(19.0)*	32.5 *(21.0)*	35.0 *(23.0)*	36.5 *(24.5)*
80	13.5 *(5.0)*	18.5 *(10.0)*	23.5 *(13.5)*	27.5 *(16.5)*	31.0 *(18.5)*	34.5 *(21.0)*	37.0 *(23.5)*	39.5 *(25.5)*	41.5 *(27.5)*
100	13.5 *(5.0)*	20.0 *(10.0)*	25.0 *(13.5)*	29.5 *(17.0)*	33.5 *(20.0)*	37.0 *(20.0)*	40.0 *(25.0)*	43.0 *(27.5)*	45.5 *(29.5)*
120	13.5 *(5.5)*	20.5 *(10.0)*	26.5 *(13.5)*	31.0 *(17.5)*	36.0 *(20.5)*	39.5 *(23.5)*	43.0 *(26.5)*	46.5 *(29.0)*	49.0 *(31.0)*
No limit	13.5 *(5.5)*	21.0 *(10.0)*	27.5 *(13.5)*	32.5 *(18.0)*	37.5 *(21.0)*	42.0 *(24.0)*	45.5 *(27.5)*	49.5 *(30.0)*	52.0 *(32.5)*

(*Continued*)

Table 7.9 (*Continued*)

Width of enclosing rectangle (m)	Distance from relevant boundary for unprotected percentage not exceeding								
	20%	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
	Minimum boundary distance (m); figures in brackets are for residential, office or assembly								
Enclosing rectangle 27 m high									
3	2.0 *(1.0)*	3.0 *(1.5)*	4.0 *(2.0)*	4.5 *(2.5)*	5.5 *(3.0)*	6.0 *(3.5)*	6.5 *(4.0)*	7.0 *(4.0)*	7.5 *(4.5)*
6	3.5 *(1.5)*	5.0 *(2.5)*	6.5 *(3.5)*	7.5 *(4.5)*	8.5 *(5.0)*	9.5 *(6.0)*	10.5 *(6.5)*	11.0 *(7.0)*	12.0 *(7.5)*
9	5.0 *(2.0)*	7.0 *(3.5)*	8.5 *(5.0)*	10.0 *(6.0)*	11.5 *(7.0)*	12.5 *(7.5)*	13.5 *(8.5)*	14.5 *(9.5)*	15.0 *(10.0)*
12	6.0 *(2.5)*	8.0 *(4.5)*	10.5 *(6.0)*	12.0 *(7.0)*	13.5 *(8.0)*	14.5 *(9.0)*	16.0 *(10.5)*	17.0 *(11.0)*	17.5 *(12.0)*
15	7.0 *(3.0)*	9.5 *(5.5)*	11.5 *(7.0)*	13.5 *(8.5)*	15.0 *(9.5)*	16.5 *(10.5)*	18.0 *(11.5)*	19.0 *(12.5)*	20.0 *(13.5)*
18	8.0 *(3.5)*	10.5 *(6.0)*	12.5 *(8.0)*	14.5 *(9.0)*	16.5 *(10.5)*	17.5 *(11.5)*	19.5 *(12.5)*	20.5 *(13.5)*	21.5 *(14.5)*
21	8.5 *(3.5)*	11.5 *(6.5)*	14.0 *(8.5)*	16.0 *(10.0)*	18.0 *(11.5)*	19.0 *(13.0)*	21.0 *(14.0)*	22.5 *(15.0)*	23.5 *(16.0)*
24	9.0 *(3.5)*	12.5 *(7.0)*	15.0 *(9.0)*	17.0 *(11.0)*	19.0 *(12.5)*	20.5 *(13.5)*	22.5 *(15.0)*	24.0 *(16.0)*	25.5 *(17.0)*
27	10.0 *(4.0)*	13.0 *(7.5)*	16.0 *(10.0)*	18.0 *(11.5)*	20.0 *(13.0)*	22.0 *(14.0)*	24.0 *(16.0)*	25.5 *(17.0)*	27.0 *(18.0)*
30	10.0 *(4.0)*	13.5 *(8.0)*	17.0 *(10.0)*	19.0 *(12.0)*	21.0 *(13.5)*	23.0 *(15.0)*	25.0 *(17.0)*	26.5 *(18.0)*	28.0 *(19.0)*
40	11.5 *(5.0)*	15.5 *(9.0)*	19.0 *(11.5)*	22.0 *(14.0)*	24.5 *(15.5)*	26.5 *(17.5)*	29.0 *(19.0)*	30.5 *(20.5)*	32.5 *(22.0)*
50	12.5 *(5.5)*	17.0 *(9.5)*	21.0 *(12.5)*	24.0 *(15.0)*	27.0 *(17.0)*	29.5 *(19.0)*	32.0 *(21.0)*	34.5 *(22.5)*	36.0 *(24.0)*
60	13.5 *(5.5)*	18.5 *(10.5)*	22.5 *(13.5)*	26.5 *(16.0)*	29.5 *(18.5)*	32.0 *(20.5)*	35.0 *(22.5)*	37.0 *(24.5)*	39.0 *(26.5)*
80	14.5 *(6.0)*	20.5 *(11.0)*	25.0 *(14.5)*	29.5 *(17.5)*	33.0 *(20.5)*	36.5 *(22.5)*	39.5 *(25.0)*	42.0 *(27.5)*	44.0 *(29.5)*
100	15.5 *(6.0)*	21.5 *(11.0)*	27.0 *(15.5)*	32.0 *(19.0)*	36.5 *(21.5)*	40.5 *(24.5)*	43.0 *(27.0)*	46.5 *(30.0)*	48.5 *(32.0)*
120	15.5 *(6.0)*	22.5 *(11.5)*	28.5 *(15.5)*	34.0 *(19.5)*	39.0 *(22.5)*	43.0 *(26.0)*	46.5 *(28.5)*	50.5 *(32.0)*	53.0 *(34.0)*
No limit	15.5 *(6.0)*	23.5 *(11.5)*	29.5 *(15.5)*	35.0 *(20.0)*	40.5 *(23.5)*	44.5 *(27.0)*	48.5 *(29.5)*	52.0 *(33.0)*	55.5 *(35.0)*

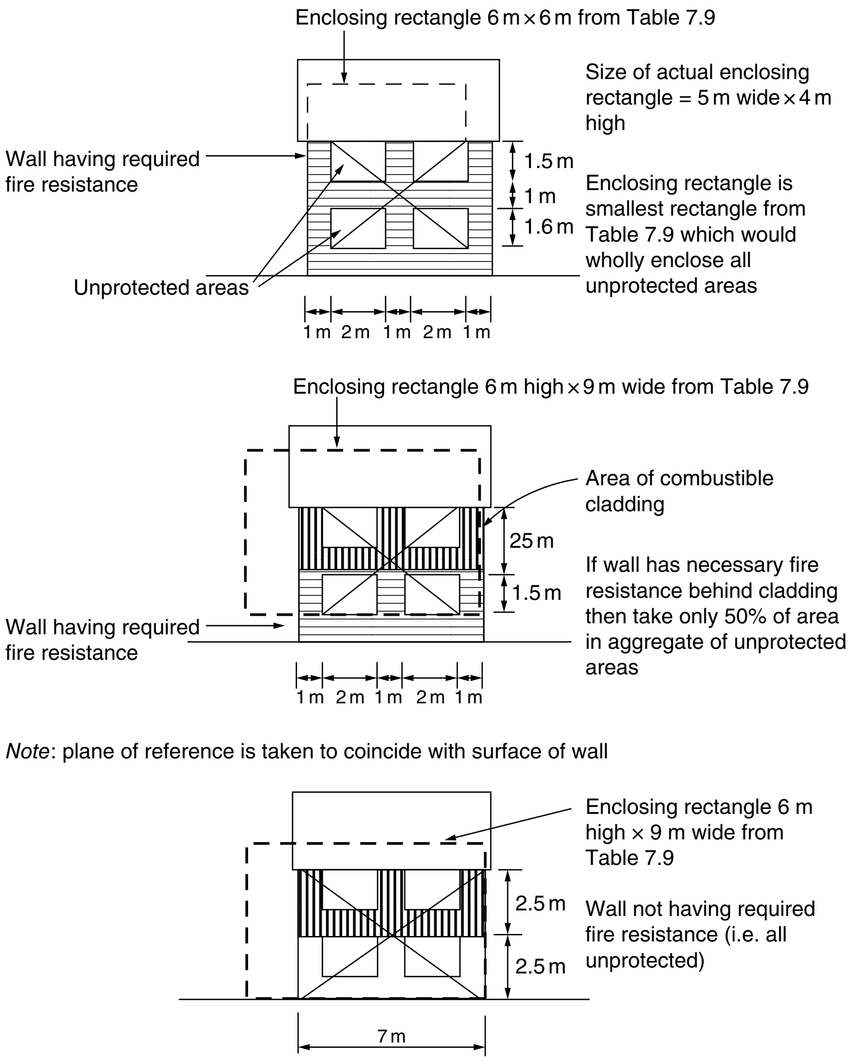


Fig. 7.54 Enclosing rectangles.

reference according to the *unprotected percentage* and the height and width of the enclosing rectangle and the Purpose Group of the building. The figures in Table 7.9 relate to Shop and Commercial, Industrial and Storage and other non-residential buildings, whilst those in brackets relate to Residential, Office or Assembly and Recreation buildings.

The plane of reference is a vertical plane which touches some part of the outer surface of a building or compartment. It should not pass through any part of the building (except projections such as balconies or copings), and it should not cross the relevant boundary. It can be at any angle to the side of the building and in any position which is most favourable to the building designer, although it is usually best if roughly parallel to the relevant boundary. This method can be used to determine the maximum permitted unprotected areas for a given boundary position (Fig. 7.55) *or* how close to the boundary a particular design of building may be (Fig. 7.56).

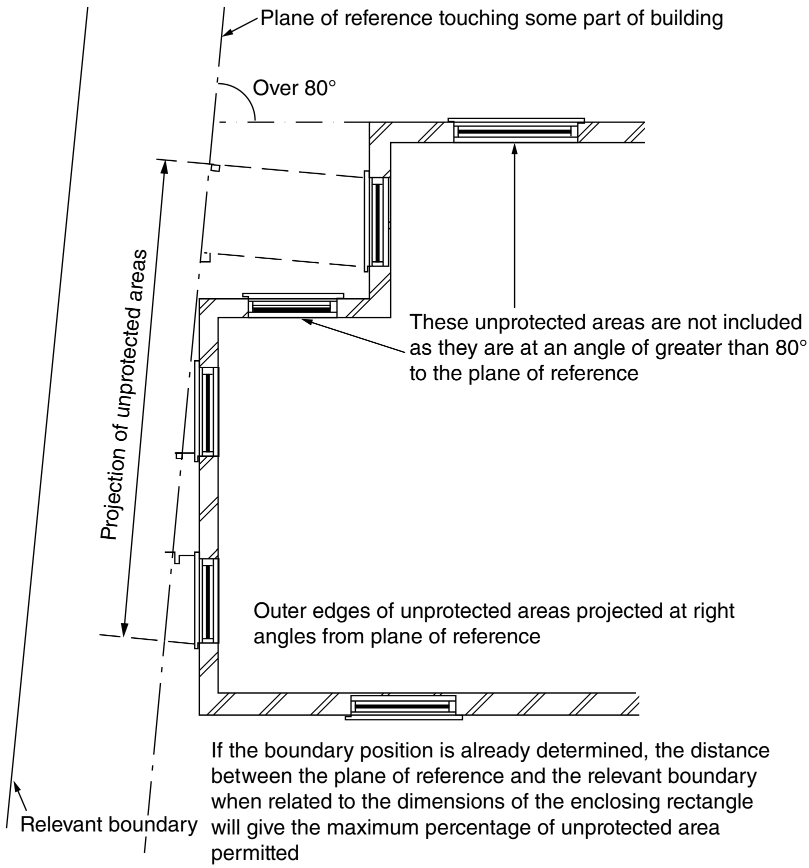


Fig. 7.55 Determination of maximum unprotected area for given boundary position.

It is permissible to calculate the enclosing rectangle separately for each compartment in a building. Therefore the provision of compartment walls and floors in a building can effectively reduce the enclosing rectangle thereby decreasing the distance to the boundary without affecting the amount of unprotected areas provided. This technique is demonstrated in Fig. 7.57 which also shows how the enclosing rectangle method is applied in practice.

This method is quick and easy to use in practice, but in certain circumstances it may give an uneconomical result with regard to the permitted distance from the boundary, and it may unduly restrict the designer's freedom in choice of openings areas, etc. It takes no account of the true distance from the boundary of unprotected areas in deeply indented buildings since all unprotected areas must be projected onto a single plane of reference. It also assumes that the effects of a fire will be equally felt at all points on the boundary from all unprotected areas despite the fact that some windows, for example, may be shielded from certain parts of the boundary by fire-resistant walls. For these reasons it may be preferable to use the following method – the *aggregate notional areas* technique – as this method is usually more accurate in practice.

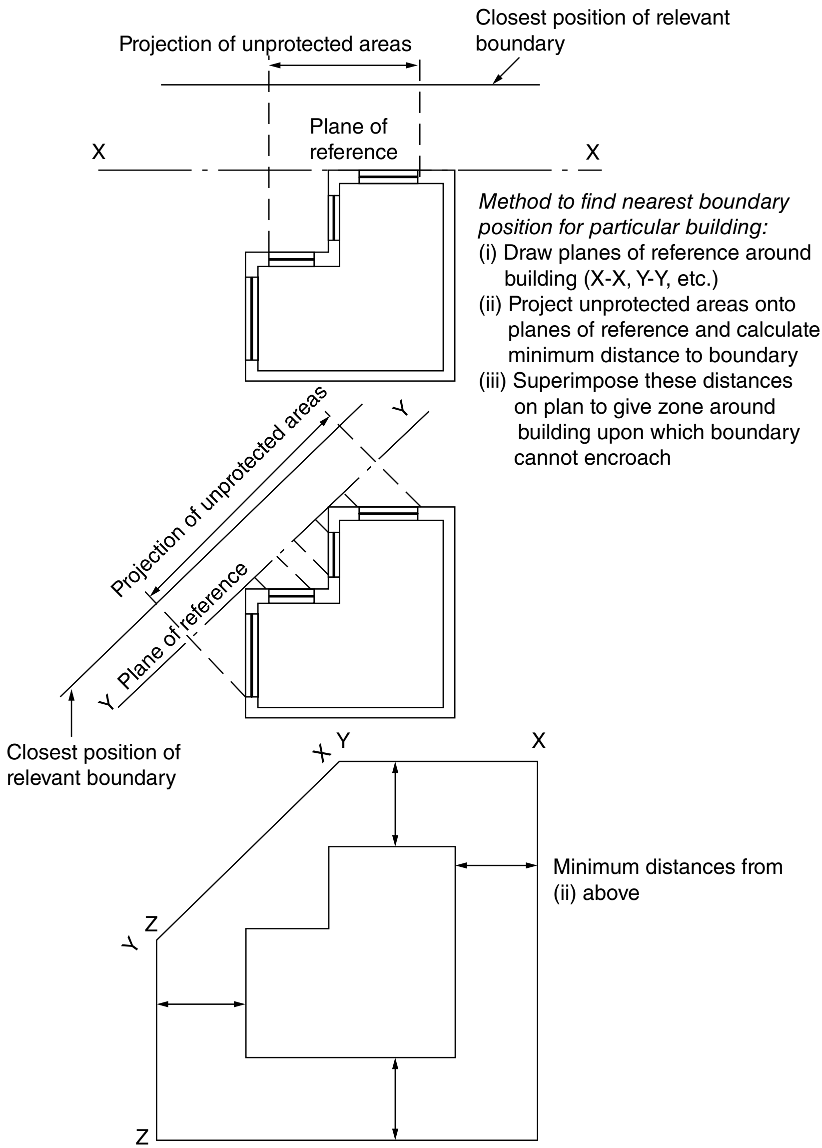
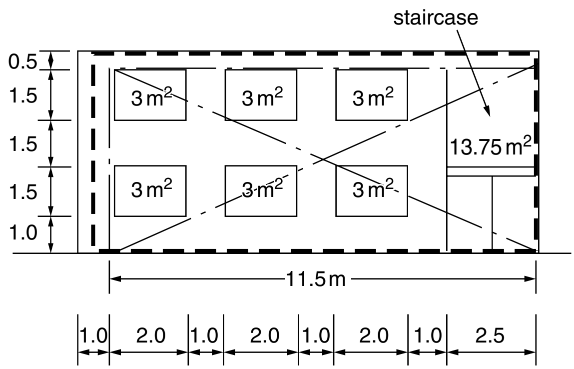


Fig. 7.56 Nearest position to boundary for a given building design.

Additional methods: Aggregate notional areas

The basis of the method of aggregate notional areas is to assess the effect of a building fire at a series of points 3 m apart on the relevant boundary.

A *vertical datum* of unlimited height is set at any position on the relevant boundary (see point P in Fig. 7.58). A *datum line* is drawn from this point to the nearest point on the building or compartment. A base line is then constructed at 90° to the datum line, and an arc of 50 m radius is drawn centred on the vertical datum to meet the base line.

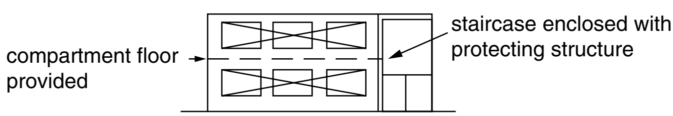


Uncompartmented building

(i) Minimum size of rectangle enclosing unprotected areas = 11.5 m wide × 5.5 m high
(ii) From Table 7.9 enclosing rectangle = 12 m wide × 6 m high (take next highest values)
(iii) Calculate aggregate of unprotected areas = 18 + 13.75 m^2 = 31.75 m^2
(iv) Calculate unprotected percentage (aggregate of unprotected areas as percentage of enclosing Rectangle) = $\frac{31.75}{12 \times 6} \times 100 = 44\%$ $\therefore$ Use 50% column tn Table 7.9
(v) Select distance from Table 7.9 (second part of table, fourth column, fourth row, figure in brackets) permitted distance to boundary = 3.5 m

Note:
(a) Minimum size of rectangle indicated by diagonal lines
(b) Enclosing rectangle indicated by dotted lines
(c) Relevant boundary is parallel with wall face; plane of reference coincides with wall face (this need not be the case).

The situation can be improved if the staircase is enclosed in a protecting structure and a compartment floor is provided:



(i) Each compartment now considered separately, the minimum rectangle being shown by diagonal lines above = 8 m × 1.5 m
(ii) Enclosing rectangle from Table 7.9 = 9 m wide × 3 m high
(iii) Aggregate of unprotected areas = 9 m^2
(iv) Unprotected percentage = $\frac{9}{9 \times 3} \times 100 = 33\frac{3}{4}\%$ i.e 40% in Table 7.9
(v) Distance from Table 7.9 = 1.5 m

Compartment has therefore reduced the permitted distance to the boundary from 3.5 m to 1.5 m.

Fig. 7.57 Enclosing rectangles – effects of compartmentation.

Using this method it is possible to exclude certain unprotected areas that would have to be considered under the enclosing rectangle method (see Fig. 7.58).

For those unprotected areas which remain (that is, those that cannot be excluded), it is necessary to measure the distance of each from the vertical datum. Table J3 from the 1985 edition of AD B2/3/4 is reproduced as Table 7.10. This contains a series of multiplication factors which are related to the distance from the vertical datum.

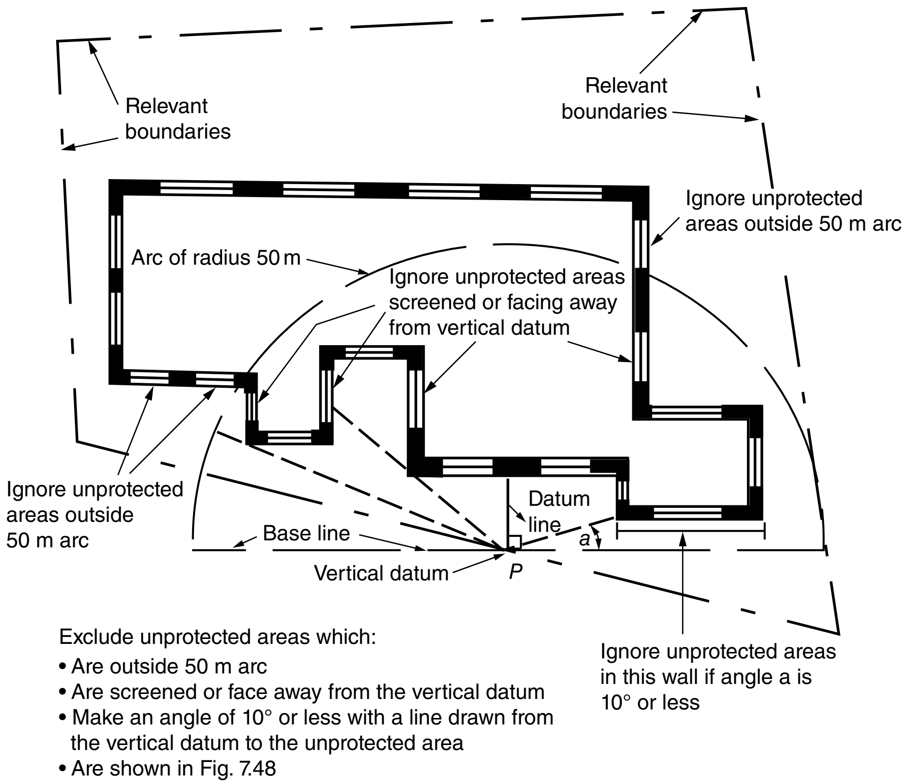


Fig. 7.58 Aggregate notional area.

Table 7.10 Multiplication factors for aggregate notional area.

Distance of unprotected area from vertical datum (m)		
Not less than	**Less than**	**Multiplication factor**
1.0	1.2	80.0
1.2	1.8	40.0
1.8	2.7	20.0
2.7	4.3	10.0
4.3	6.0	4.0
6.0	8.5	2.0
8.5	12.0	1.0
12.0	18.5	0.5
18.5	27.5	0.25
27.5	50.0	0.1
50.0	No limit	0.0

The Table is based on the fact that the amount of heat caused by a fire issuing from an unprotected area will decrease in proportion to its distance from the boundary (it does, in fact, correspond to an inverse square law of the type $y = 1/x^2$).

Therefore, each unprotected area is multiplied by its factor (which depends on its distance from the vertical datum), and these areas are then totalled to give the *aggregate notional area* for that particular vertical datum. The aggregate notional area thus achieved should not exceed:

- 210 m² for Residential, Assembly and Recreation or Office buildings; or
- 90 m² for Shop and Commercial, Industrial or Other non-residential buildings.

In order to confirm that the unprotected areas in the building comply at other points on the boundary, it is necessary to repeat the above calculations at a series of points 3 m apart starting from the original vertical datum. In practice it is usually possible, by observation, to place the first vertical datum at the worst position thereby obviating the need for further calculations.

The series of measurements and calculations mentioned above may be simplified if a number of protractors are made corresponding to different scales (i.e. 1:50, 1:100 and 1:200). A typical example is illustrated in Fig. 7.59.

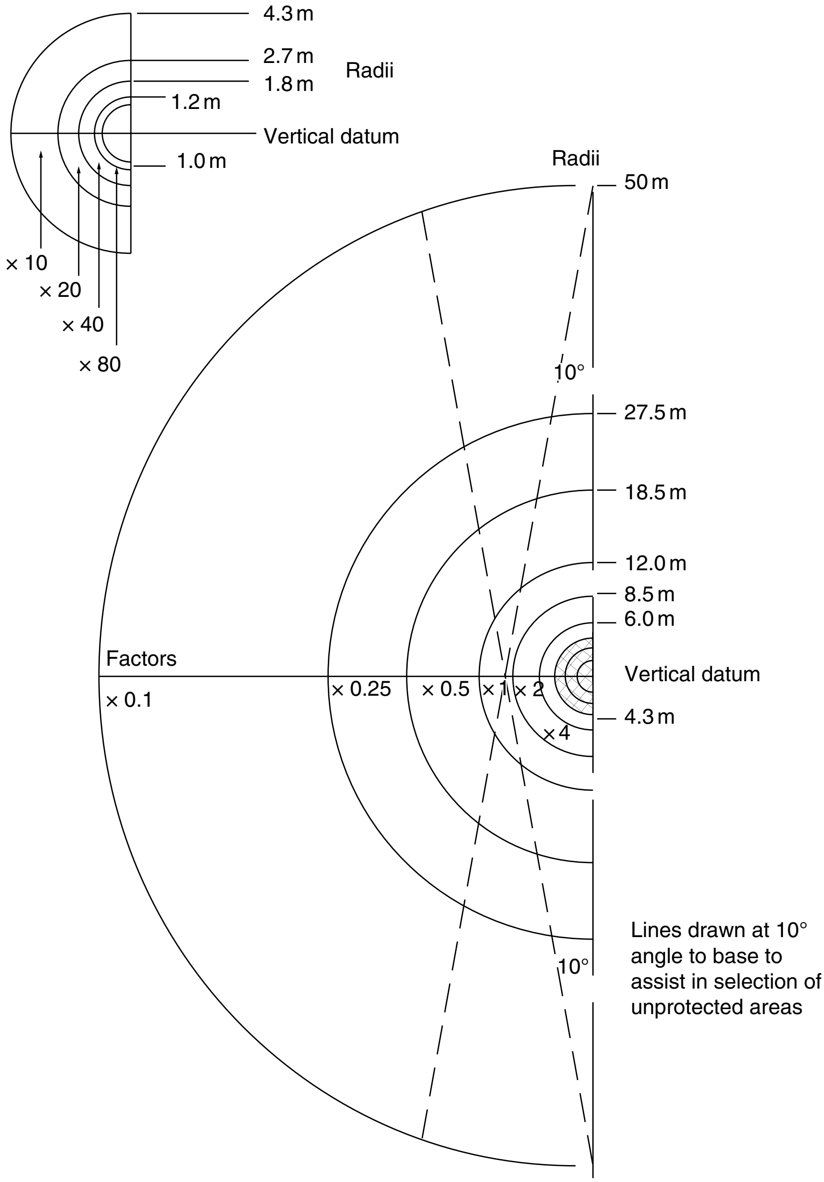
7.25.7 Canopy structures and space separation

Since Building Regulations apply to the erection of a building, a canopy would need to comply with the provisions concerning space separation (referred to above) unless it falls into one of the exempt classes (see Class VI and Class VII in section 2.5). For free-standing canopies, this might prove unduly onerous (for example, canopies over petrol pumps), since the open sides would be regarded as unprotected areas. The ADs allow space separation recommendations to be disregarded for free-standing canopies which are more than 1 m from the relevant boundary in view of the high degree of ventilation and heat dissipation achieved by the open-sided construction. For canopies attached to the side of a building, provided that the edge of the canopy is at least 2 m from the boundary, the separation distance may be judged from the side of the building rather than the edge of the canopy. This exception would not apply if the canopy had side walls (such as in an enclosed loading bay) (see Fig. 7.60).

7.25.8 Atrium buildings

An atrium is defined in section 7.7 as a space in a building (not necessarily vertically aligned) which passes through one or more structural floors. Clearly, the atrium effectively joins up all the relevant floors in the building to the extent that they can no longer be regarded as being compartmented from one another. The effect that this can have on space separation is explained above. In such buildings, if the atrium building is fitted with a sprinkler system, the area affected in a fire will be sufficiently reduced so that the potential for fire spread to adjacent buildings will be comparable to that of an equivalent non-atrium building that is compartmented at each level and protected by a sprinkler system.

Conversely, if the atrium building is un-sprinklered, space separation needs to be calculated on the basis that all storeys not separated from the atrium by fire-resisting construction may be involved in the fire.



Note: the figure shown above is an enlargement to show the radii and factors applicable near to the vertical datum (covering the portion shown hatched).

Fig. 7.59 Aggregate notional area protractor.

7.25.9 Roofs

Roofs are not required to provide fire resistance from the inside of a building but should resist fire penetration from outside and spread of flame over their surfaces. The term roof covering means constructions which may contain one or more layers of material, but it does not refer to the roof structure as a whole.

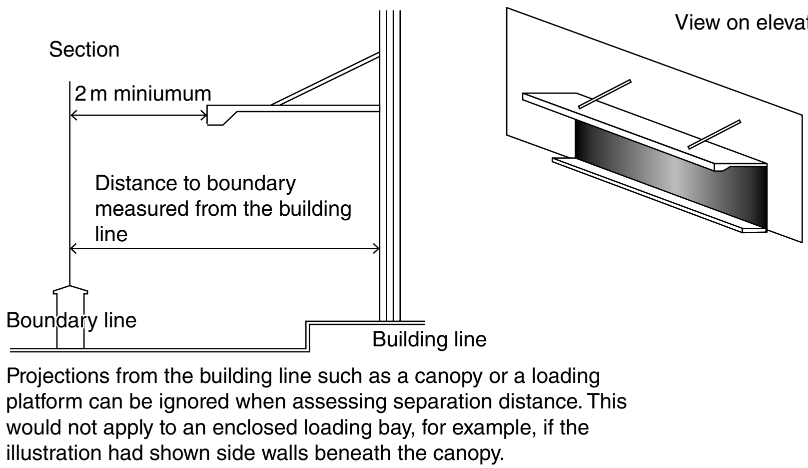


Fig. 7.60 The effect of a canopy on separation distance.

In addition to the recommendations for roof coverings contained in B4, reference should also be made to guidance related to roofs as part of a means of escape, internal surfaces of rooflights and roofs used as part of a floor and roofs passing over the top of compartment walls.

The type of construction permitted for a roof depends on the purpose group and size of the building and its distance from the boundary.

Types of construction are specified by the two-letter designations from BS 476: Part 3: 1958 *External fire exposure roof test.* (It should be noted that this is not the most recent version of the standard, but it is the one referred to in the latest edition of AD B. Performance of roof coverings is also described in BS EN 13501-1 *Fire classification of construction products and building elements. Classification using data from external fire exposure of roof tests* (+A1: 2009) (2007)).

The first letter in the BS 476 designation method refers to flame penetration:

A – Not penetrated within one hour;
B – Penetrated in not less than half an hour;
C – Penetrated in less than half an hour; and
D – Penetrated in preliminary flame test.

The second letter in the BS 476 designation method refers to the surface spread of flame test:

A – No spread of flame;
B – Not more than 21 inches (533 mm) spread;
C – More than 21 inches (533 mm) spread; and
D – Those continuing to burn for five minutes after withdrawal of the test flame or with a spread of more than 15 inches (381 mm) across the region of burning in the preliminary test.

Example

Roof surface classified AA. This means no fire penetration within one hour and no spread of flame.

Table A5 to AD B (reproduced below) gives a series of roof constructions together with their two-letter notional designations. In the example shown above, a roof constructed in accordance with Part 1 of Table A5 would satisfy the AA rating if it was of natural slates, fibre-reinforced cement slates, clay tiles or concrete tiles, and it was supported as shown in the table.

Approved Document: Table A5 Notional designations of roof coverings.

Part i: Pitched roofs covered with slates or tiles

Covering material	Supporting structure	Designation
1. Natural slates 2. Fibre-reinforced cement slates 3. Clay tiles 4. Concrete tiles	Timber rafters with or without underfelt, sarking, boarding, woodwool slabs, compressed straw slabs, plywood, wood, chipboard or fibre insulating board	AA (National Class) or B_{ROOF}(t4) European class

Note: Although the Table does not include guidance for roofs covered with bitumen felt, it should be noted that there is a wide range of materials on the market, and information on specific products is readily available from manufacturers.

Part ii: Pitched roofs covered with self-supporting sheet

Roof covered material	Construction	Supporting structure	Designation
1. Profiled sheet of galvanised steel, aluminium, fibre-reinforced cement or pre-painted (coil-coated) steel or aluminium with a PVC or pvf2 coating	Single skin without underlay or with underlay or plasterboard, fibre insulating board or woodwool slab	Structure of timber, steel or concrete	AA (National Class) or B_{ROOF}(t4) European class
2. Profiled sheet of galvanised steel, aluminium, fibre-reinforced cement or pre-painted (coil coated) steel or aluminium with a PVC or pvf2 coating	Double skin without interlayer or with interlayer of resin-bonded glass fibre, mineral wool slab, polystyrene or polyurethane	Structure of timber, steel or concrete	AA (National Class) or B_{ROOF}(t4) European class

Part iii: Flat roofs covered with bitumen felt

A flat roof comprising of bitumen felt should (irrespective of the felt specification) be deemed to be of designation AA if the felt is laid on a deck constructed of 6 mm plywood, 12.5 mm wood chipboard, 16 mm (finished) plain edged timber boarding, compressed straw, slab, screeded woodwool slab, profiled fibre-reinforced cement or steel deck (single or double skin) with or without fibre insulating board overlay, profiled aluminium deck (single or double skin) with or without fibre insulating board overlay or concrete or clay pot slab (in situ or precast) and has a surface finish of:

a. bitumen-bedded stone chippings covering the whole surface to a depth of at least 12.5 mm;
b. bitumen-bedded tiles of a non-combustible material;
c. sand and cement screed; or
d. macadam.

(*Continued*)

Table A5 (*Continued*)

Part iv. Pitched or flat roofs covered with fully supported material		
Covering material	**Supporting structure**	**Designation**
(1) Aluminium sheet (2) Copper sheet (3) Zinc sheet (4) Lead sheet (5) Mastic asphalt (6) Vitreous enamelled steel (7) Lead/tin alloy-coated steel sheet (8) Zinc/aluminium alloy-coated steel sheet (9) Pre-painted (coil-coated) steel sheet including liquid-applied PVC coatings	Timber joists and tongued and grooved boarding or plain edged boarding	AA* (National Class) or B_{ROOF}(t4) European class
	Steel or timber joists with deck of woodwool slabs, compressed straw slab, wood chipboard, fibre insulating board, or 9.5 mm Plywood	AA (National Class) or B_{ROOF}(t4) European class
	Concrete or clay pot slab (in situ or precast) or non-combustible deck of steel, aluminium or fibre cement (with or without insulation)	AA (National Class) or B_{ROOF}(t4) European class

Notes:
* Lead sheet supported by timber joists and plain edged boarding should be regarded as having a BA designation. It is deemed to be European test class C_{ROOF}(t4).
The National classifications do not automatically equate with the equivalent classifications in the European column; therefore, products cannot typically assume the European class unless they have been tested accordingly.

Table 16 of section 14 of the ADs is reproduced below and gives the notional two-letter designations for roofs in different buildings according to the distance of the roof from the relevant (or notional) boundary. Once the two-letter designation has been established, a form of construction may be chosen from Table A5. Where it has been decided to use a different form of roof construction, the manufacturer's details should be consulted to confirm that the necessary designation will be achieved. It should be noted that there are no restrictions on the use of roof coverings which are designated AA, AB or AC (National Class) or B_{ROOF}(t4) (European Class). Also, the boundary formed by the wall separating two semi-detached houses may be disregarded for the purposes of roof designations.

Where plastic rooflights form part of a roof structure, they should comply with the provisions of the ADs, section 7.17 and Tables 17 (reproduced) and Table 18 (reproduced) of B4 (see section 7.17.7) with regard to their separation, area and disposition. The following rooflight materials may be regarded as having an AA designation (National class) or B_{ROOF}(t4) classification (European class):

- Rigid thermoplastic sheet made from polycarbonate or unplasticised PVC, which achieves a Class 1 surface spread of flame rating when tested to BS 476: Part 7: 1971 or 1987 or 1997 or Class C-s3, d2 (European class); and
- Unwired glass at least 4 mm thick.

Approved Document B: Table 16 Limitations on roof coverings*.

Designation† of covering of roof or part of roof		Minimum distance from any point on relevant boundary			
National class	**European class**	**Less than 6 m**	**At least 6 m**	**At least 12 m**	**At least 20 m**
AA, AB or AC	B_{ROOF}(t4)	●	●	●	●
BA, BB or BC	C_{ROOF}(t4)	○	●	●	●
CA, CB or CC	D_{ROOF}(t4)	○	● (1)(2)	● (1)	●
AD, BD or CD (1)	E_{ROOF}(t4)	○	● (1)(2)	● (1)	● (1)
DA, DB, DC or DD (1)	F_{ROOF}(t4)	○	○	○	● (1)(2)

Notes:

* See paragraph 15.8 for limitations on glass, paragraph 15.9 for limitations on thatch and wood shingles and paragraphs 15.6 and 15.7 and Tables 18 and 19 for limitations on plastics rooflights.

† The designation of external roof surfaces is explained in Appendix A. (See Table A5 for notional designations of roof coverings.)

Separation distances do not apply to the boundary between roofs of a pair of semi-detached houses (see 15.5) and to enclosed/covered walkways. However, see Diagram 28 if the roof passes over the top of a compartment wall. Openable Polycarbonate and PVC rooflights which achieve a Class 1 rating by National test or Class C-s3, d2 (European class) test (see paragraph 15.7) may be regarded as having an AA designation (National Class) or B_{ROOF}(t4) (European class) classification.

● Acceptable

○ Not acceptable

(1) Not acceptable on any of the following buildings:
Houses in terraces of three or more houses;
Industrial, Storage or other non-residential purpose group buildings of any size; and
Any other buildings with a cubic capacity of more than 1500 m^3.

(2) Acceptable on buildings not listed in Note 1, if part of the roof is no more than 3 m^2 in area and is at least 1500 mm from any similar part, with the roof between the parts covered with a material or limited combustibility.

Approved Document: Table 17 Class 3 (National class) or Class D-s3, d2 (European class) plastic rooflights: limitations on the use and boundary distance.

Minimum classification on lower surface(1)	Space which rooflight can serve	Minimum distance from any point on the relevant boundary to rooflight with an external designation † of	
		AD BD CD (National Class) or E_{ROOF}(t4) (Euro Class) CA CB CC or D_{ROOF}(t4)	**DA DB DC DD (National Class) or F_{ROOF}(t4) (European class)**
Class 3	a. Balcony, verandah, carport, and covered loading bay, which has at least one longer side wholly or permanently open b. Detached swimming pool c. Conservatory, garage or outbuilding with a maximum floor area of 40 m^2 d. Circulation space(2) (except a protected stairway) e. Room(2)	6 m 6 m	20 m 20 m

Notes:

None of the designations are suitable for protected stairways.

Polycarbonate and PVC rooflights which achieve National class 1 and European Class C-s3, d2 by test may be regarded as having a Class AA designation or B_{ROOF}(t4) classification.

Where Diagram 30a or b shown in Fig. 7.41 applies, rooflights should be at least 1.5 m from a compartment wall.

Products may have upper and lower surfaces with different properties if they have double skins or are laminated of different materials. In which case the more onerous distance applies.

(1) Refer to guidance in B2 section 7.17.7.

(2) Single-skin rooflight only, in the case of non-thermoplastic material.

(3) The rooflight should also meet the provisions of Diagram 47.

Approved Document: Table 18 TP(a) and TP(b) plastic rooflight: limitations on use and boundary distance.

Minimum classification on lower surface	Space which rooflight can serve	Minimum distance from any point on the boundary to rooflight with an external surface class[1] of	
		TP(a)	**TP(b)**
1. TP(a) rigid	Any space except a protected stairway	6 m[2]	Not applicable
2. TP(b)	a. Balcony, verandah, carport and covered loading bay, which has at least one longer side wholly or permanently open b. Detached swimming pool c. Conservatory, garage or outbuilding with a maximum floor area of 40 m^2	Not applicable	6 m
	d. Circulation space[3] (except a protected stairway) e. Room[3]	Not applicable	6 m[4]

Notes:
Polycarbonate and PVC rooflights which achieve a Class 1 rating by test may be regarded as achieving an AA designation.
Where Diagram 30a or b shown in Fig. 7.41 applies, rooflights should be at least 1.5 m from a compartment wall.
Products may have upper and lower surfaces with different properties if they have double skins or are laminated of different materials. In which case the more onerous distance applies.
[1] Refer to guidance in B2 section 7.17.7.
[2] No limit in the case of any space described in 2a, b and c.
[3] Single-skin rooflight only, in the case of non-thermoplastic material.
[4] The rooflight should also meet the provisions of Diagram 47.

7.25.10 Thatch and wood shingles

Thatch and wood shingles that cannot achieve the performance specified in BS 476: Part 3: 1958, which should be regarded as having a designation of AD/BD/CD or European classification E_{ROOF}(t4) in Table 16. However, it may be possible to locate thatch-roofed buildings closer to the boundary than the distances permitted by Table 17 if the following precautions (taken from *Thatched buildings. New properties and extensions* (the 'Dorset Model'), obtainable on www.dorset-technical-committee.org.uk) are incorporated into the design:

- The rafters are overdrawn with construction having at least 30 minutes fire resistance.
- The guidance in Approved Document J *Combustion appliances and fuel storage systems* is followed.
- The smoke alarm system recommended in AD B volume 1 is extended to the roof space.

7.26 Special provisions relating to shopping complexes and buildings used as car parks

Additional considerations apply to the design and construction of buildings used as car parks and to shopping complexes. The recommendations are dealt with in this separate section.

7.26.1 Car parks

A considerable amount of research has been carried out into the behaviour of fire in buildings used as parking for cars and light vans, with the following results:

- The fire load is not particularly high and is well defined.
- If the car park is well ventilated, there is a low risk of fire spread from one storey to another.

Because of the above, car parks are not normally sprinklered.

The best natural ventilation is achieved in open-sided car parks. Where this cannot be attained, heat and smoke will not be as readily dissipated, and fewer concessions will apply.

Whatever standard of ventilation is achieved, certain provisions are common to all car parks as follows:

- The relevant provisions for means of escape in case of fire in the ADs will apply.
- The recommendations of Part B5 regarding access and facilities for the fire service will apply.
- All materials used in the construction of the car park building should be non-combustible except for:
  (a) any floor or roof surface finish;
  (b) any fire door;
  (c) any attendant's kiosk not greater than 15 m^2 in area; and
  (d) any shop mobility facility.
- Surface finishes in buildings, compartments or separated parts which are within the structure enclosing the car park, with the exception of open-sided car parks, do not need to be constructed from non-combustible materials.

7.26.2 Open-sided car parks

To be regarded as open-sided, the car park should comply with the following provisions:

- It should comply with the four recommendations immediately above.
- It should contain no basement storeys.
- Natural ventilation should be provided to each storey at each car parking level by permanent openings having an aggregate area of at least 5% of the floor area at that level, and at least half of the ventilation area (i.e. 2.5% of the floor area) should be equally provided in opposing walls.
- Where the building containing the car park is also used for other purposes, the part which contains the car park should be a separated part (for definition of 'separated part', see section 7.2).

If the above provisions can be met, the car park may be regarded as a small building or compartment for the purposes of space separation in Table 16 of AD B volume 2 (see section 7.25.6), and column (1) of that table may be used. Effectively, this halves the required distance to the relevant boundary (or doubles the permitted limit of unprotected areas). Additionally, the fire resistance recommendations of section 7b(i) of Table A2 of Appendix A (see section 7.19.1) will apply, reducing the fire resistance period to only 15 minutes in many cases.

7.26.3 Car parks not regarded as open sided

If the ventilation recommendations mentioned above cannot be achieved, the car park cannot be regarded as open sided, and the fire resistance recommendations of section 7b(ii) of Table A2 of Appendix A (see section 7.19.1) will apply without any concessions. All car parks require some ventilation; therefore the provisions in the following section apply whatever standard of ventilation is provided.

7.26.4 Ventilation provisions

Ventilation may be provided by natural or mechanical means as follows:

- Natural ventilation to car parks that are not open sided provide either:
  (a) permanent openings to each storey at each car parking level with an aggregate area of at least 2.5% of the floor area at that level. At least half of the ventilation should be equally provided between two opposing walls; or
  (b) smoke vents at ceiling level with an aggregate area of permanent opening of at least 2.5% of the floor area, arranged to give a through draught.

(Reference should also be made to Approved Document F *Ventilation* for additional guidance on normal ventilation of car parks.)

- Mechanical ventilation systems for basements and enclosed car parks should be:
  (a) independent of any other ventilating system (other than any system providing normal ventilation to the car park);
  (b) designed to operate at ten air changes per hour in a fire situation;
  (c) designed to run in two parts, each capable of extracting half of the amount which would be extracted at the rates set out in (b) above and designed so that each part may operate singly or simultaneously;
  (d) provided with an independent power supply for each part of the system, capable of operating in the event of failure of the main supply;
  (e) provided with extract points arranged with half the points at high level and half the points at low level;
  (f) provided with fans rated at 300°C for a minimum of 60 minutes; and
  (g) provided with ductwork and fixings constructed with materials having a melting point of at least 800°C.

(Further information on equipment for removing hot smoke may be obtained from BS EN 12101-3:2002 S*moke and heat control systems: Specification for powered smoke and heat exhaust ventilators*. For an alternative method of providing smoke ventilation from enclosed car parks, see BRE Report *Design methodologies for smoke and heat exhaust ventilation* (BR 368, 1999).)

7.27 Shopping complexes

Individual shops contained in single separate buildings should generally be capable of conforming to the recommendations of AD B volume 2. However, where a shop unit forms part of a covered shopping complex, certain difficulties may arise. Such complexes often include covered malls providing access to a number of shops and shared servicing areas. Clearly, it is not practical to compartment a shop from a mall serving it, and provisions dealing with maximum compartment sizes may be difficult to meet. Certain other problems may arise concerning fire resistance, walls separating shop units, surfaces of walls and ceilings and distances to boundaries.

In order to achieve a satisfactory standard of fire safety, certain alternative arrangements and compensatory features to those set out in AD B may be appropriate; when appropriate, reference made to Annexe E of BS 9999:2008 should be followed.

7.28 Access and facilities for the fire service

7.28.1 Introduction

Part B5 of Schedule 1 of the 1991 Regulations introduced totally new requirements for dealing with access and facilities for the fire service. It reflected guidance produced by the Home Office Fire Department for the Fire Service which had been in use for many years and replaced goodwill recommendations with statutory requirements. Many local authorities had, through the medium of local Acts of Parliament, applied means of access regulations in their own districts or boroughs for a considerable number of years. These regulations tended to vary from authority to authority, so the new requirements brought consistency to this important area of control. In order to avoid duplication of control, most provisions in local Acts of Parliament contain a statutory bar which gives precedence to Building Regulations. The guidance is fairly well established and has developed and altered only slightly over the last few years.

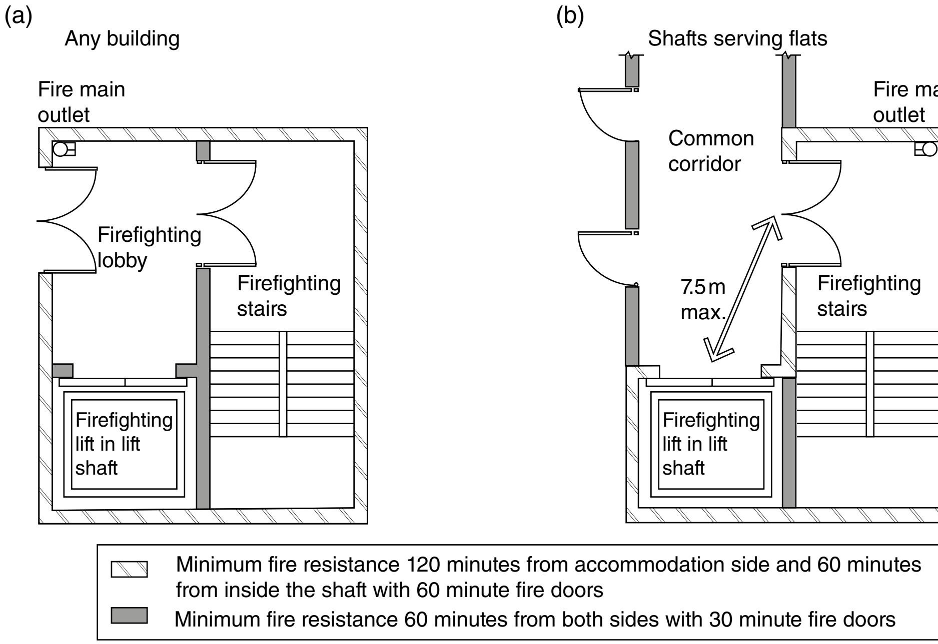
7.28.2 Interpretation

The following terms occur throughout the ADs:

FIRE SERVICE VEHICLE ACCESS LEVEL – The level at which the fire service gain access to a building. This may not always be at ground level, e.g. in a podium design, the access may be above ground level.

FIREFIGHTING LIFT – A lift which is designed to have additional fire protection in which the controls may be overridden by the fire service so that they may control it directly for use in fighting fires (see Fig. 7.61).

FIREFIGHTING LOBBY – A protected lobby usually situated between a firefighting stair and the accommodation of a building which may also give access to any associated firefighting lift (see Fig. 7.61).



Notes:

1. Outlets from a fire main should be located in the firefighting lobby, opr in the case of a shaft serving flats, and in the firefighting stairway (see Diagram b).
2. Smoke control should be provided in accordance with BS 5588–5:2004, or, where the shaft only serves flats, the provisions for smoke control given in paragraph 2.25 may be followed instead.
3. A firefighting lift is required if the building has a floor more than 18 m above or more than 10 m below fire service vehicle access level.
4. This diagram is only to illustrate the basic components and is not meant to represent the only acceptable layout. The shaft should be constructed generally in accordance with BS9999.

Fig. 7.61 Firefighting shaft and components.

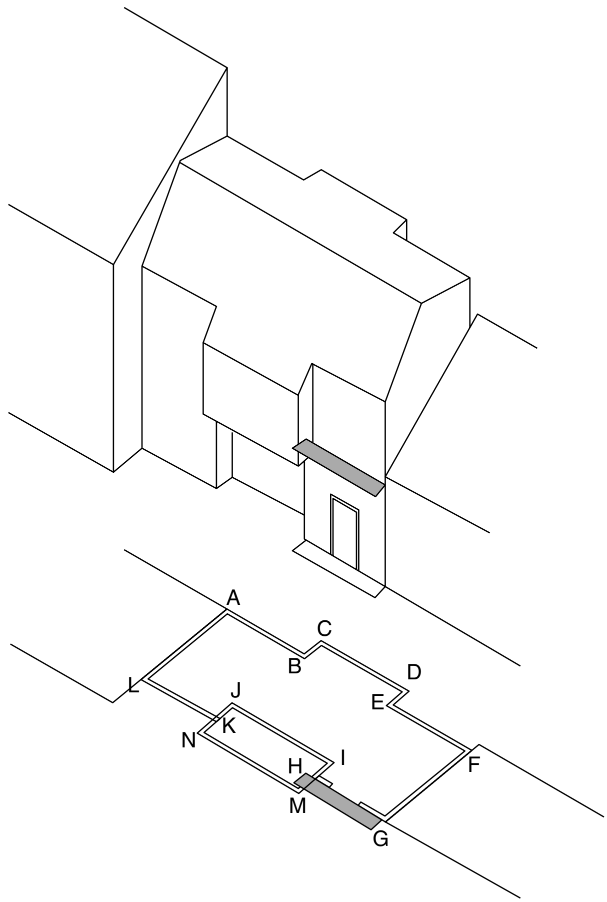
FIREFIGHTING SHAFT – A fire-protected enclosure which contains a firefighting stair and firefighting lobbies. It may also contain a firefighting lift, if this is included in the building, together with its machine room (see Fig. 7.61).

FIREFIGHTING STAIR – A fire-protected stair which is separated from the accommodation of the building by a firefighting lobby (see Fig. 7.61).

PERIMETER (of building) – The maximum aggregate plan perimeter. This is found by vertical projection of the building onto a horizontal plane and is illustrated in Fig. 7.62.

7.28.3 Access and facilities for the fire service: The statutory requirements

Buildings must be designed and constructed so as to provide reasonable facilities to assist firefighters in the protection of life. There must also be reasonable provision made within the site of the building to enable fire appliances to gain access to the building.



Plan of building AFGL where AL and FG are walls in common with other buildings
the footprint of the building is the maximum aggregate plan perimeter found by the vertical projection of any overhanging storey onto a ground storey (i.e. ABCDEFGHMNKL).

The perimeter of the building for the purposes of Table 20 is the sum of the lengths of the two external walls, taking account of the footprint i.e. (A to B to C to D to E to F) + (G to H to M to N to K to L).

If the dimensions of the building are such that Table 20 requires vehicle access, the shaded area illustrates one possible example of 15% of the perimeter. **Note**: There should be a door into the building in this length (see paragraph 16.5).

If the building does not have walls in common with other buildings, the lengths AL and FG would be included in the perimeter.

Fig. 7.62 Calculation of perimeter.

These requirements are interesting in that they apply provisions to the site of the building and not just to the building itself. This approach may be compared to that for access for disabled people in Chapter 17 of this book where site recommendations are also made. It should be noted that there is no definition of 'site' contained in the regulations or approved documents.

The main factor that determines the facilities which are needed to assist the fire service is the size of the building, since it is the philosophy of firefighting in the United Kingdom that this be carried out inside the building if it is to be effective. This philosophy ensures that the water used for firefighting actually reaches the fire and means that effective search and rescue can be carried out as close as possible to the source of the fire since it is at this point that trapped people will be in most peril.

Therefore, in order to meet these statutory requirements, it is necessary to provide:

(1) in most buildings:
- sufficient means of vehicular access across the site of the building to enable fire appliances to be brought near to the building for effective use; and
- sufficient means of access for firefighting personnel into and within the building so that they may effect rescue and fight fire;

(2) in large buildings and/or buildings with basements:
- sufficient fire mains, hydrants and other facilities, such as firefighting shafts, to assist firefighters; and
- adequate means of venting heat and smoke from basement fires.

It should be noted that these arrangements for access and firefighting facilities are required in order to secure reasonable standards of health and safety for people (including firefighters) in or about buildings and for the purposes of protecting life by assisting the fire service.

7.28.4 Access facilities for fire appliances

Vehicle access to the exterior of a building is needed:

- to enable high-reach appliances (i.e. turntable ladders and hydraulic platforms) to be used; and
- to enable pumping appliances to supply water and equipment for rescue activities and firefighting.

Clearly, the requirements for access to buildings increase with building size and height. In large buildings it may be necessary to provide firefighting shafts and fire mains. Fire mains are provided in buildings to enable firefighters to connect their hoses to a convenient water supply at the floor level of the fire. Therefore, where these are fitted, it will be necessary for pumping appliances to gain access to the perimeter of the building at points near to the mains. This is especially so in the case of dry mains since these will need to be connected by hose to the pumping appliance. The provision of fire mains and firefighting shafts is described more fully below.

7.28.5 Buildings not fitted with fire mains

Fire mains need only be provided where there is a necessity to provide a firefighting shaft (see section 7.28.9). Therefore, in buildings not fitted with fire mains, access for fire service vehicles should be provided in accordance with Table 19 of B5 which is reproduced below. It should be noted that Table 19 does not apply to buildings with fire mains, or to blocks of flats and maisonettes, because every dwelling entrance door in such buildings should be within 45 m of a pump appliance.

AD B5

Table 19 Fire service vehicle access to buildings (excluding blocks of flats) not fitted with fire mains.

Total floor area[(1)] of building m^2	Height of floor of top storey above ground[(2)]	Provide vehicle access[(3)(4)] to	Type of appliance
Up to 2,000	Up to 11	See paragraph 17.2	Pump
	Over 11	15% of perimeter[(5)]	High reach
2,000–8,000	Up to 11	15% of perimeter[(5)]	Pump
	Over 11	50% of perimeter[(5)]	High reach
8,000–16,000	Up to 11	50% of perimeter[(5)]	Pump
	Over 11	50% of perimeter[(5)]	High reach
16,000–24,000	Up to 11	75% of perimeter[(5)]	Pump
	Over 11	75% of perimeter[(5)]	High reach
Over 24,000	Up to 11	100% of perimete [(5)]	Pump
	Over 11	100% of perimete [(5)]	High reach

Notes:
[(1)] The total floor area is the aggregate of all floors in the building (excluding basements).
[(2)] In the case of Purpose Group 7(a) (storage) buildings, height should be measured to mean roof level; see Methods of Measurement in Appendix C of AD B.
[(3)] An access door is required to each such elevation (see paragraph 17.5).
[(4)] See paragraph 17.9 for meaning of access.
[(5)] Perimeter is described in Fig. 7.57.

Buildings with a total aggregate floor area of up to 2000 m^2 and a top storey less than 11 m above ground level are referred to as 'small buildings' in B5 (see the first row of Table 19). There should be vehicle access to 15% of, or to within 45 m of every point on, the maximum aggregate plan perimeter (or footprint; see Fig. 7.62) of such buildings, whichever figure is the less onerous. In the case of dwellings or blocks of flats, vehicle access for the pump appliance should be within 45 m of all points within each dwelling-house or dwelling. If this is unachievable, then it is likely that a fire main should be fitted (see section 7.28.6).

In Table 19, the key figure to remember is 11 m above ground level for the top storey of the building. Buildings above this height not fitted with fire mains will need access for high-reach appliances as well as pumping appliances. There should be a suitable door giving access to the interior of the building, at least 750 mm wide, situated in any elevations which are required to be accessed by virtue of Table 19. A typical example of this is shown in Fig. 7.62.

7.28.6 Buildings fitted with fire mains

As mentioned above, buildings provided with firefighting shafts should also have fire mains.

Where dry fire mains are fitted:

- access should be provided for a pumping appliance to within 18 m of each fire main inlet connection point; and
- the inlet should be visible from the appliance.

Where wet fire mains are fitted:

- access should be provided for a pumping appliance to within 18 m of a suitable entrance giving access to the main;
- the entrance should be visible from the appliance; and
- the inlet for the emergency replenishment of the suction tank for the main should be visible from the appliance.

Sometimes, fire mains are fitted in buildings even though there is no recommendation in the ADs that they should have firefighting shafts. In such cases the provisions for access listed above may be used instead of Table 19.

7.28.7 Provision of private hydrants

Where fire hydrants are required, their position should be clearly indicated by a plate in a conspicuous position in accordance with BS 3251:1976 *Indicator plates for fire hydrants and emergency water supplies* (AMD 6736).

The erection of a building with a compartment over 280 m^2 in area more than 100 m away from an existing fire hydrant will require additional hydrants as follows:

- A building fitted with fire mains should be provided with hydrants within 90 m of the dry fire main inlets.
- In buildings not fitted with fire mains should be provided with hydrants within 90 m of the entry point of the building and should be spaced not more than 90 m apart.

Where it is known that insufficient pressure and flow in the water main exists or when there is no available water supply, the following alternative sources of supply are acceptable:

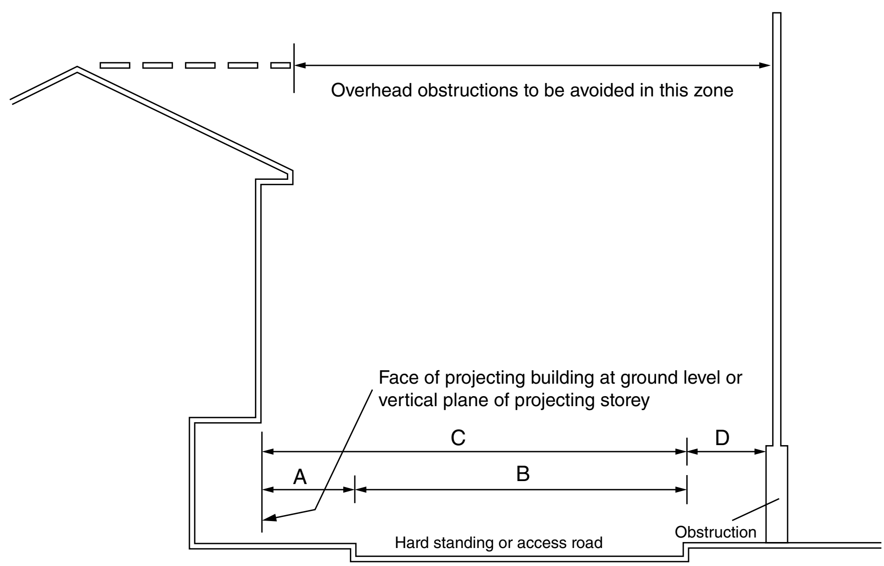
- A charged static water tank with at least 45,000 litre capacity.
- A spring, river or pond capable all year round of storing or providing at least 45,000 litres of water. To allow the Fire and Rescue Service's pumping appliance easy access to the supply, an easily accessible hard standing should be provided.
- Often it is acceptable to consider alternative water supplies in consultation with the Fire and Rescue Service, such as swimming pools.

7.28.8 Access routes and hard standings

In order to provide access for fire service vehicles across the site of a building, it is necessary to design a road or other route which is wide enough and has sufficient load-carrying capacity (including manhole covers, inspection chambers... etc.) to take the necessary vehicles. Unfortunately, fire appliances are not standardised, and so it is a wise precaution to check with the local fire service in a particular area in order to establish their weight and size requirements. Some design guidance is given in Table 20 of AD B5 (reproduced), where typical vehicle access route specifications are shown. It should be noted that the typical minimum carrying capacity for a high-reach appliance is 17 tonnes. A roadbase designed to take 12.5 tonnes should be satisfactory for high-reach vehicles since the use would be infrequent and the weight of the vehicle is distributed over a number of axles. However, structures such as bridges should still be designed to take the full 17 tonnes.

In general, where access is provided to an elevation in accordance with Table 19, the access routes and hardstandings should be designed in accordance with the following provisions:

- For buildings up to 11 m high, access should be provided for a pump appliance adjacent to the building for the percentage of the total perimeter specified in Table 19 (this does not apply where a pump appliance can get to within 45 m of every point on the perimeter of a building or to within 45 m of every dwelling entrance door in blocks of flats or maisonettes).
- For buildings over 11 m high, a zone should be established in accordance with Fig. 7.63, which should be kept clear of overhead obstructions, since it is possible that overhead



	Type of appliance: Turntable ladder dimension (m)	Hydraulic platform dimension (m)
A. Maximum distance of near edge of hardstanding from building	4.9	2.0
B. Minimum Width of hardstanding	5.0	5.5
C . Minimum distance of further edge of hardstanding from building	10.0	7.5
D. Minimum width of unobstructed space (for swing of appliance platform)	n/a	2.2

Notes:
1. Hardstanding for high reach appliances should be as level as possible and should net exceed a gradient of 1 in 12.
2. Fire appliances are not standardized. Some fire services have appliances with a greater weight or different size. In consultation with the Fire and Rescue Service, the Building Control Body should adopt the relevant dimensions and ground loading capacity.

Fig. 7.63 Overhead obstructions – access dimensions for high-reach appliances.

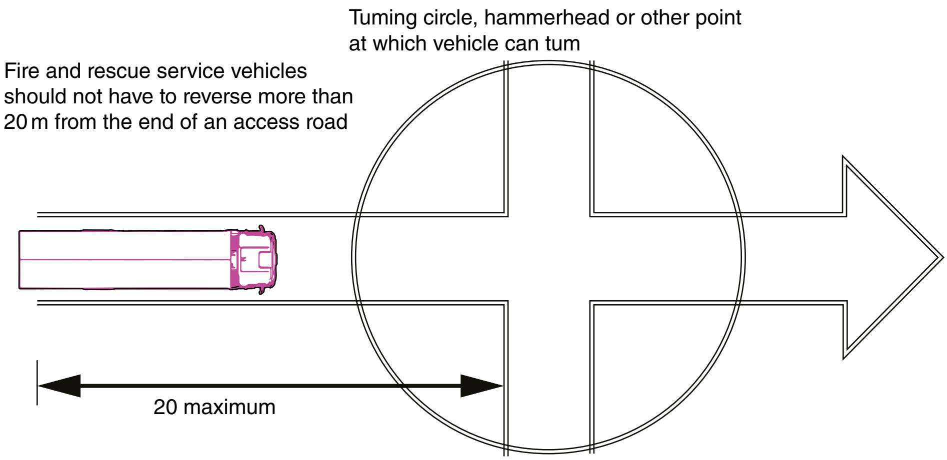


Fig. 7.64 Turning circle restrictions.

obstructions such as cables and branches might interfere with the setting of ladders or the swing of high-reach appliances.

Any dead-end access route which is more than 20 m long should be provided with a turning point, such as a hammerhead or turning circle, designed in accordance with dimensions given in Table 20 of the ADs (see Fig. 7.64). This is to ensure that fire service vehicles do not have to reverse more than 20 m from the end of an access road.

In all the above considerations for site access, it should be borne in mind that requirements cannot be made under the Building Regulations for work to be done outside the site of the works shown on the submitted plans, building notice or initial notice. Therefore, it may not always be reasonable to upgrade an existing route across a site to a small building, such as a single dwellinghouse. The reasonableness of any proposals to carry out upgrading of certain features (such as the removal of a sharp bend) should be considered by the local authority or approved inspector in consultation with the fire service.

7.28.9 Access for firefighting personnel to buildings

As has been mentioned above, it is important that fire service personnel are able to gain access to buildings in order to reach the seat of the fire and to carry out effective search and rescue.

This is especially true in tall buildings and in those with deep basements. In such buildings firefighters will need additional facilities contained within a protected firefighting shaft, such as firefighting lifts, firefighting stairs and firefighting lobbies, equipped with fire mains. Additionally, fire appliances will need access to entry points near the fire mains. These facilities are necessary in order to avoid delay in tackling the fire and to provide a safe working base from which effective action may be taken.

In other buildings, the normal means of escape will offer personnel access, and this, when combined with the ability to work from ladders and appliances on the perimeter, will generally mean that special internal arrangements are unnecessary. Vehicle access

AD B5

Table 20 Typical vehicle access route specification.

Appliance type	Minimum width of road between kerbs (m)	Minimum width of gateways (m)	Minimum turning circle between kerbs (m)	Minimum turning circle between walls (m)	Minimum clearance height (m)	Minimum carrying capacity (tonnes)
Pump	3.7	3.1	16.8	19.2	3.7	12.5
High reach	3.7	3.1	26.0	29.0	4.0	17.0

will usually be needed to some or all of the perimeters, but the extent of this will depend on the size of the building.

Dwellings and other small buildings should be sufficiently close to as point accessible to fire brigade vehicles – no other provisions are necessary.

In taller blocks of flats, the high degree of compartmentation means that the access facilities may be simpler than in other types of tall buildings; however, fire brigade personnel access facilities will still be needed within the building.

In basement fires, products of combustion tend to escape via stairways. This can make it difficult for fire service personnel to gain access to the seat of the fire. The problem can be reduced by providing smoke vents, which improve visibility, reduce temperatures and make search, rescue and firefighting less difficult.

7.28.10 Firefighting shafts

Firefighting shafts should be provided to serve the storeys indicated in the following list (also see Fig. 7.65):

(1) Buildings which contain two or more basement storeys each exceeding 900 m^2 in area;
(2) Buildings in Purpose Groups 4, 5, 6 and 7(a) (Shop and Commercial, Industrial, and Storage and other non-residential) with any storey of 900 m^2 or more in area situated more than 7.5 m above ground or fire service access level;
(3) Buildings with any floor more than 18 m above ground or fire service vehicle access level;
(4) Buildings with any floor more than 10 m below ground or fire service vehicle access level; and
(5) Shopping complexes, in accordance with the recommendations of BS 9999:2008.

Firefighting shafts should conform to the following recommendations:

- Those provided in (3) and (4) above should also contain firefighting lifts.
- Where provided to serve a basement under (1) or (4) above, there is no need to serve the upper floors also unless they qualify in their own right because of the size or height of the building.
- Similarly, where a shaft is provided to serve upper floors in (2) or (3) above, it need not also serve a basement which is not large or deep enough to qualify on its own.

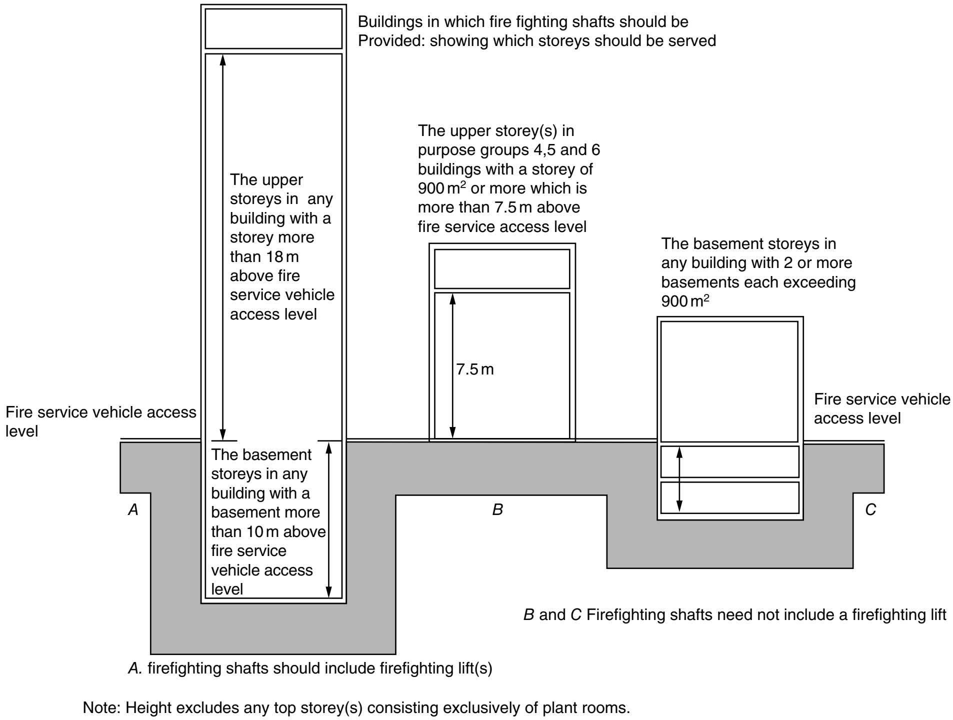


Fig. 7.65 Firefighting shaft provision.

- Where they are provided, firefighting shafts and lifts should serve all intermediate floors between the lowest and the highest in the building.

7.28.11 Standard of provision of firefighting shafts

The number of firefighting shafts which needs to be provided in a building may be obtained from Table 7.11. It can be seen that if the building is fitted with a sprinkler system meeting the relevant recommendations of section 7.11, then it is possible to reduce the number of firefighting shafts that are provided. It should be noted that if a building is not fitted with sprinklers, then every part of each storey that is more than 18 m above the access level for fire appliances should be no more than 45 m from a main outlet contained in a protected stairway. If the building is served with a fire main in the firefighting shaft, then provided that the route is suitable for a hose to be laid, this distance may be increased to 60 m from the main to each part of each storey.

Firefighting shafts should be located so that every part of each storey is within 60 m of the entrance to a firefighting lobby measured along a route which is suitable for laying fire hoses. This figure is reduced to 40 m where the internal layout of the building is not known at the design stage, the 40 m being measured in a straight line from every point in the storey to the entrance of the firefighting lobby. These distance recommendations do not apply to accommodation situated at fire service access level.

Table 7.11 Provision of firefighting shafts in buildings.

Area of largest qualifying floor (m^2)[a]	**Number of firefighting shafts to be provided**
A. With sprinklers fitted in the building (except basements)	
Under 900	1
900 to 2000	2
Over 2000	2 (plus 1 shaft for every extra 1500 m^2 or part thereof)
B. Without sprinklers and in any qualifying basement	
Up to 900	1
Over 900	2 (plus 1 shaft for every extra 900 m^2 or part thereof)

Notes:
[a] This is the largest floor area which is situated:
a. over 18 m above fire service vehicle access level;
b. over 7.5 m or more above fire service vehicle access levels and 900 m^2 in area; or
c. in any qualifying basement (see section 7.28.10).

7.28.12 Layout and construction of firefighting shafts

Firefighting shafts should be designed and constructed to encompass the following recommendations:

(1) Except in blocks of flats and maisonettes, access to the accommodation in a building from a firefighting lift or stair should be through a firefighting lobby.
(2) Every firefighting shaft should be equipped with a fire main which should have outlet connections and valves situated in firefighting lobbies.
(3) Firefighting shafts should comply with the recommendations and design recommendations contained in BS 9999:2008.

The various components of a firefighting shaft are illustrated in Fig. 7.61.

7.28.13 Provision of fire mains

Fire mains are provided to enable the fire service to fight fires inside the building. They are equipped with valves which permit direct connection of fire hoses. This assists firefighters by making it unnecessary to take hoses up stairways from the pumping appliance at ground or access level, thus saving time and avoiding blockage of the escape route.

Fire mains which serve floors above ground or access level are commonly known as rising mains, and those which serve floors below ground or access level (such as basements) are usually referred to as falling mains.

Where it is necessary to provide firefighting shafts in a building (see section 7.28.10 and Fig 7.65), each shaft should contain a fire main.

There are two types of fire main:

- Wet mains (often called 'wet risers') are usually kept full of water by header tanks and pumps in the building. Since there is the danger that the water supply may run out in a serious fire, there should be a facility to replenish the wet main from the pumping appliance in an emergency. Wet risers should be provided in any building which has a floor situated more than 60 m above ground or access level. They may, of course, serve lower floors if so desired.
- Dry mains ('dry risers') are normally kept empty and are charged with water from a fire service pumping appliance in the event of a fire. Where provided, they may serve any floor which is less than 60 m above ground or access level.

The outlets from fire mains at each floor level in the building should be situated in firefighting lobbies giving access to the accommodation from a firefighting shaft.

Further guidance on the design and construction of fire mains may be obtained from BS EN 671: Parts 1–3: *Fixed fire systems – Hose systems* (Part 1 – 2012) (Part 2 – 2012) (Part 3 – 2009).

7.28.14 Smoke and heat venting of basements

A basement fire differs from a fire in another part of a building in that it is difficult for heat and smoke to be adequately vented. Products of combustion from basement fires tend to escape via stairways making it difficult for fire service personnel to gain access to the fire. Consequently, visibility will be reduced and temperatures will tend to be higher in a basement fire making search, rescue and firefighting more difficult. If smoke outlets (or smoke vents) are installed, they can provide a route for heat and smoke, enabling it to escape direct to outside air from the basement and permitting the ingress of cooler air. Two typical designs for smoke outlet shafts are shown in Fig. 7.66.

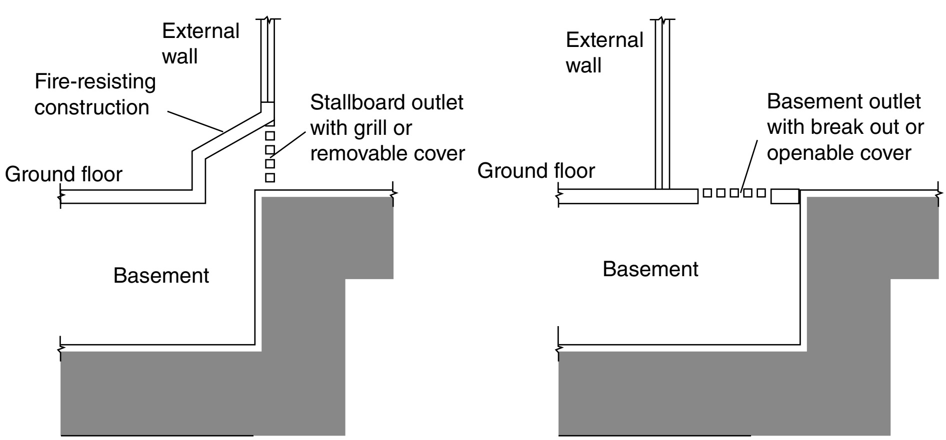


Fig. 7.66 Construction of smoke outlets.

7.28.15 Standard of provision for smoke outlets

Basement storeys which exceed 200 m^2 in area or are more than 3 m below ground level should be provided with smoke outlets connected directly to outside air. Some basements are exempted from this rule as follows:

- Any basement in a single family dwellinghouse (PG 1(b) or 1(c)); and
- Any strong room.

If possible each basement room or space should have one or more smoke outlets. In some basements the plan may be too deep, or there may be insufficient external wall areas to permit this. An acceptable solution might be to vent perimeter spaces directly and to allow internal spaces to be vented indirectly by the fire service by means of connecting doors. This solution is not acceptable if the basement is compartmented since each compartment should have direct access to venting without the use of intervening doors between compartments.

7.28.16 Means of venting

Smoke venting may be by natural or mechanical means.

Natural smoke venting may be achieved by providing smoke outlets which conform to the following recommendations:

- The total clear cross-sectional area of all the smoke outlets should be at least 2.5% of the floor area of the storey they serve.
- Places of special fire risk should be provided with separate outlets.
- Outlets should be positioned so that they do not compromise escape routes from the building.
- Outlets which terminate in readily accessible positions may be covered by pavement lights, stallboards or panels which can be broken out or opened. They should be suitably marked to indicate their position.
- Outlets which terminate in less accessible positions should be kept unobstructed and should only be covered by a louvre or grille which is non-combustible.
- Smoke outlets should be sited at high level (i.e. in the ceiling or wall of the space they serve) and should be distributed evenly around the perimeter of the building so as to discharge into open air outside the building.

Mechanical smoke extraction may be used as an alternative to natural venting if a sprinkler system conforming to section 7.11 is installed in the basement. Unless needed for other reasons, it is not necessary to install sprinklers on the other storeys in the building merely because they are provided to allow mechanical smoke extraction in the basement to be used.

Any mechanical smoke extraction system should:

- achieve at least ten air changes per hour;
- be capable of handling gas temperatures of 400°C for at least one hour; and

- come into operation automatically on activation of the sprinkler system or be activated by an automatic fire detection system conforming to BS 5839: Part 1: 2013 (at least L3 standard).

7.28.17 Construction of smoke vent outlet ducts and shafts

Outlet ducts and shafts for smoke and heat venting should be enclosed in non-combustible fire-resisting construction. This applies equally to any bulkheads over the ducts or shafts as indicated in Fig. 7.64.

Natural smoke outlets from different compartments in the same basement storey or from different basement storeys should also be separated from each other by non-combustible fire-resisting construction.

7.28.18 Ventilation of basement car parks

The provisions contained in the ADs (see section 7.26.3) regarding the ventilation of basement car parks may be regarded as satisfying the requirements for the smoke venting of any basement which is used as a car park.

7.29 Firefighting and the use of insulating core panels for internal structures

7.29.1 Introduction

Appendix F of Approved Document B provides a limited amount of guidance on the fire behaviour of insulating core panels when used for internal structures, where particular fire spread problems have been known to occur.

Internal insulating core panels are commonly used to provide chilled or sub-zero environment enclosures for the production, preservation, storage and distribution of perishable foodstuffs. They are also used where it is necessary to provide a hygienic environment.

A typical panel might consist of an inner insulating core sandwiched between, and bonded to, facing sheets of galvanised steel (sometimes bonded with a PVC facing where a hygienic finish is needed). The panels can be formed into a structure which can be free standing or can be attached to the building by lightweight fixings and hangers.

Common materials for the insulating core include:

- expanded or extruded polystyrene;
- polyurethane;
- mineral fibre;
- polyisocyanurate; and
- modified phenolic.

7.29.2 The behaviour in fire of the core materials and fixing systems

When exposed to radiated or conducted heat from a fire, polymeric materials can be expected to degrade (and will produce large quantities of smoke). Fires involving mineral fibre cores produce less potential problems than those with polymeric cores.

It is also known that panels will tend to delaminate (the core separating from the facings because of expansion of the membrane and softening of the bond line) when exposed to the high temperatures of a developed fire, irrespective of the type of core material used.

Once it is involved in a fire, the panel will lose most of its structural integrity, and the stability of the system will then depend on the residual structural strength of the non-exposed facing, the joint between panels and the fixing system. Because most panel jointing or fixing systems have an extremely limited structural integrity performance in fire conditions, there is a real chance of total and unexpected collapse of the panel system (together with any associated equipment) if the fire starts to heat up the support fixings or structure to which they are attached. Fire can also spread behind the panels, where it may be hidden from the occupants of the building, and this can prove to be a particular problem to firefighters as, due to the insulating properties of the cores, it may not be possible to track the spread of fire, even using infrared detection equipment.

7.29.3 Problems for firefighters

When encountering a fire involving insulating core panel systems, firefighters may be confronted by the following problems:

- Fire spread hidden within the panels;
- Large quantities of black toxic smoke being produced; and
- Rapid fire spread leading to flashover.

These characteristics are common to both polyurethane- and polystyrene-cored panels (although the rate of fire spread in polyurethane cores is significantly less than that of polystyrene cores) especially when any external heat source is removed.

Additionally, all systems are susceptible to the following problems, irrespective of the type of panel core used:

- Delamination of the steel facing;
- Collapse of the system; and
- Hidden fire spread behind the system.

7.29.4 Design solutions

Risk assessment techniques should be used to identify the appropriate solution. The following design strategies can be adopted once the potential fire risks within the panel system enclosures have been identified:

- Remove the risk.
- Provide an appropriate separation distance between the risk and the panels.
- Provide a fire suppression system for the risk.
- Provide a fire suppression system for the enclosure.
- Provide panels with suitable fire resistance.
- Specify appropriate materials, fixing and jointing systems.

Overall, the fire performance of the panel system should not be seen in isolation but should be considered in relation to the fire performance of the building as a whole, including the insulating envelope, the superstructure, the substructure, etc.

7.29.5 Specification of panel core materials

Panels should be specified with core materials, which are appropriate to the application under consideration. This will help to ensure an acceptable level of performance for panel systems, under fire conditions. Table 7.12 gives examples of core materials and appropriate applications.

7.29.6 Specification of materials/fixing and jointing systems

The aim of the specification should be to improve the stability of the panel system in the event of fire. Similarly, the aim of construction detailing should be to prevent the core materials from becoming exposed to the fire and contributing to the fire load. Therefore, it might be appropriate to consider the following:

- Design insulating envelopes, support systems, and supporting structure to maintain structural stability following failure of the bond line between insulant core and facing materials, by using alternative methods, such as catenary action. In a typical case this could require positive attachment of the lower faces of the insulant panels to supports.
- Where a supplementary support method is provided to support the panels, this should remain stable under fire conditions for an appropriate time. Therefore, consider fire protecting the building superstructure, together with any elements providing support to the insulating envelope, to prevent early collapse of the structure or the envelope.
- Light gauge steel members such as purlins and sheeting rails, which provide stability to building superstructures, may be compromised at an early stage of a fire. Although it is not practical to fire protect such members, it may be possible to provide supplementary fire-protected heavier gauge steelwork members at wider intervals than purlins to provide restraint in the event of a fire.

Table 7.12 Insulating core panels: specification of core materials by application.

Core material	Applications[1]
Mineral fibre cores	Cooking areas, bakeries and other hot areas
	Fire breaks in combustible panels, fire stop panels and general fire protection
All core materials	Chill stores, cold stores and blast freezers
	Food factories
	Clean rooms

Notes:
1. Core materials may be used in other circumstances where a risk assessment has been made and other appropriate fire precautions have been put in place.

- In designated high-risk areas, fire propagation through the insulant can be prevented by incorporating barriers consisting of, for example, non-combustible insulant-cored panels into wall and ceiling construction at intervals or strips of non-combustible material into specified wall and ceiling panels.
- The combustible insulant should be fully encapsulated by non-combustible facing materials that remain in place during a fire.
- Service penetration should be catered for by incorporating pre-finished and sealed areas in the panels.
- Do not allow panels or panel systems to support machinery or other permanent loads.
- Any cavity created by the arrangement of panels, their supporting structure or other building elements should be provided with suitable cavity barriers.

7.29.7 Further guidance on insulating core panels

Reference should be made to *Design, construction, specification and fire management of insulated envelopes for temperature controlled environments* published by the International Association of Cold Storage Contractors (European Division) and Scottish Executive's Building Regulation Note No. 3/99: *Fire behaviour of insulating core panels for internal structures* (1999). Both documents contain examples of possible solutions and general guidance on insulating core panel construction. Chapter 8 of the document is of particular relevance since it gives guidance on the design, construction and management of insulated structures and is considered to be appropriate for most insulating core panel applications.

7.30 Regulation 38: Provision of information

7.30.1 Provision of information

Largely unchanged from Regulation 26b of the 2000 Regulations, Regulation 38 of the 2010 Regulations requires that in the case of relevant building or buildings subjected to a relevant change of use, fire safety information should be provided to assist the responsible persons to operate, maintain and use the building in reasonable safety and to assist the eventual owner, occupier and/or employer to meet their statutory duties under the Regulatory Reform (Fire Safety) Order 2005.

7.30.2 Interpretation

FIRE SAFETY INFORMATION – This is information relating to the design or construction of the building or extension and the services, fittings and equipment provided.

RELEVANT BUILDING – A building when completed to which the Regulatory Reform (Fire Safety) Order 2005 applies.

RELEVANT CHANGE OF USE – A building subjected to works classed as a material change of use, which when complete results in a relevant building.

RESPONSIBLE PERSON – Is the person defined in article 3 of the Regulatory Reform (Fire Safety) Order 2005. The responsible person is:

- in relation to a workplace, the employer, if the workplace is to any extent under his control; or
- in relation to any relevant building:
  - the person who has control of the premises (as an occupier or otherwise) in connection with the carrying out by him of a trade, business or other undertaking (for profit or not); or
  - the owner, where the person in control of the premises does not have control in connection with the carrying on by that person of a trade, business or other undertaking.

Appendix G of the AD B volume 2 is intended to provide guidance of the kind of information that should be provided. It splits the guidance into simple and complex buildings; the level of detail required in each instance should be considered on a case-by-case basis. It is required that confirmation that this duty has been undertaken should be notified to a building control body upon the completion of works. The appendix provides the following guidance on the level of information required.

7.30.3 Simple buildings

For most buildings, basic information on the location of fire protection measures may be all that is necessary. An as-built plan of the building should be provided showing:

- escape routes;
- compartmentation and separation (that is, location of fire-separating elements including cavity barriers in walk-in spaces);
- fire doors, self-closing fire doors and other doors equipped with relevant hardware (for example, panic locks);
- locations of fire and/or smoke detector heads, alarm call points, detection/alarm control boxes;
- alarm sounders, fire safety signage, emergency lighting, fire extinguishers, dry or wet risers and other firefighting equipment, and location of hydrants outside the building;
- any sprinkler system(s), including isolating valves and control equipment;
- any smoke control system(s) (or ventilation system with a smoke control function), including mode of operation and control systems;
- any high-risk areas (for example, heating machinery);
- specifications of any fire safety equipment provided, in particular any routine maintenance schedules; and
- any assumptions in the design of the fire safety arrangements regarding the management of the building.

7.30.4 Complex buildings

For more complex buildings, a more detailed record of the fire safety strategy and procedures for operating and maintaining any fire protection measures of the building will be necessary.

Further guidance is available in Health Technical Memorandum 05-01 – 'Managing healthcare fire safety' and BS 9999:2009. Useful risk assessment guidance is also provided by the Department of Communities and Local Government, a link to which may be foundatthefollowingwebsitehttps://www.gov.uk/government/collections/fire-safety-law-and-guidance-documents-for-business.

These records should include:

- the fire safety strategy, including all assumptions in the design of the fire safety systems (such as fire load) and any risk assessments or risk analysis;
- all assumptions in the design of the fire safety arrangements regarding the management of the building;
- escape routes, escape strategy (for example, simultaneous or phased) and muster points;
- details of all passive fire safety measures, including compartmentation (that is, location of fire-separating elements), cavity barriers, fire doors, self-closing fire doors and other doors equipped with relevant hardware (for example, electronic security locks), duct dampers and fire shutters;
- fire detector heads, smoke detector heads, alarm call points, detection/alarm control boxes, alarm sounders, emergency communication systems, CCTV, fire safety signage, emergency lighting, fire extinguishers, dry or wet risers and other firefighting equipment, other interior facilities for the fire-and-rescue service, emergency control rooms, location of hydrants outside the building and other exterior facilities for the fire-and-rescue service;
- details of all active fire safety measures, including:
  - sprinkler system(s) design, including isolating valves and control equipment; and
  - smoke control system(s) (or HVAC system with a smoke control function) design, including mode of operation and control systems;
- any high-risk areas (for example, heating machinery) and particular hazards;
- as-built plans of the building showing the locations of the above;
- specifications of any fire safety equipment provided, including operational details, operator manuals, software, system zoning, routine inspection, and testing and maintenance schedules. Records of any acceptance or commissioning tests; and
- any other details appropriate for the specific building.

7.30.5 As-built fire drawings

To adequately assess the fire precautions at design stage, a set of fire drawings should normally be prepared using symbols based on BS 1635:1990 *Guidance symbols and abbreviations for fire protection drawings.*

In order to adequately assess compliance with the requirements of this guidance, the drawings should show in sufficient detail the detection and alarm systems, the means of escape, the structural fire precautions, the portable and fixed firefighting equipment, smoke control/ventilation arrangements and access and facilities for the fire-and-rescue service.

A typical set of fire drawings would comprise:

- a location plan;
- a site plan;

- a floor plan of each storey, prepared at a scale of not less than 1:200;
- a floor plan of each department, prepared at a scale of not less than 1:100 and preferably at a scale of 1:50; and
- a set of elevations.

During the construction of a project, variations to the structure and the layout frequently occur; these variations should not subvert the integrity of the agreed fire precautions. The variations should be recorded on the fire plans so that on completion, an as-built set of drawings can be prepared. In such instances the designer should be aware that it is required that a building control body is obliged if the description of work evolves to the extent that as cited on the building regulation submission, the Fire Brigade should be reconsulted in respect to the works and that an amendment notice may be required if the works are subject to an Initial Notice served by an Approved Inspector.

The as-built drawings should be held by the responsible person so that any proposed future alterations can be checked against the fire drawings to ensure that the integrity of fire safety is maintained in accordance with the recommendations in this document.

The responsible person is best advised to prepare from the Regulation 38 fire safety information to collate a fire safety manual for the building. This could contain a material listing and performance specification expected for particular elements, e.g. in the case of glazed fire-resisting systems so that individual critical components (such as glass or glazing beads or seals) can be readily sourced when necessary and record the necessity for continuity in components, e.g. that all fire-resisting glazed elements should have a permanent legible marking on the glass which is visible after glazing.

8 Materials, workmanship, site preparation and moisture exclusion (Part C)

8.1 Materials and workmanship

8.1.1 Introduction

Regulation 7 of the 2010 Regulations is concerned with the fitness and use of the materials necessary for carrying out building work. It is supported by its own Approved Document entitled *Approved Document to support Regulation 7* (AD Regulation 7). Although the regulation itself remains exactly as it was worded in the 2000 version of the Building regulations, the Approved Document was rewritten in 2013 to reflect the full implementation of European Regulation 305/2011/EU-CPR covering construction products, referred to as the Construction Products Regulations 2011.

Apart from dealing generally with the standards of workmanship needed for building work, the Approved Document to Regulation 7 is also concerned with specific issues in respect of materials.

The use of materials which are unsuitable for permanent buildings is covered by section 19 of the Building Act 1984. Local authorities are enabled to reject plans for the construction of buildings of short-lived or otherwise unsuitable materials or to impose a limit on their period of use. The Secretary of State may, by Building Regulations, prescribe materials which are considered unfit for particular purposes. Tables 1 and 2 of the 1976 Regulations listed materials which were considered unfit for the weather-resisting part of any external wall or roof. Neither the 2010 Regulations nor AD Regulation 7 prescribes any materials as unfit for particular purposes as yet; however the AD does lay down some general criteria against which materials may be judged (see sections 8.4.2 and 8.4.3). Bearing this in mind, it is unlikely that section 19 can be used by local authorities to proscribe certain materials.

8.1.2 Interpretation

A large number of terms and abbreviations appear in AD Regulation 7 as follows:

BS – British Standard, issued by the British Standards Institution (BSI). The BSI is the UK national standards body and is responsible for publication of European Standards in the UK as BS EN. Further information is available at (www.bsi.org.uk).

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

BUILDING CONTROL BODY – Includes both local authorities and approved inspectors.

CE MARKING – Materials bearing the CE mark are presumed to comply with the minimum legal requirements as set out in the Construction Products Regulations 2011.

CEN – Comité Européen de Normalisation. This is the body recognised by the European Commission (see below) to prepare harmonised standards to support the Construction Products Regulations (CPR) (see section **8.3**). The committee comprises representatives of the standards bodies of participating members of the EU and EFTA (European Free Trade Association).

EUROPEAN TECHNICAL Assessment – A technical assessment which specifies that a construction product is fit for its intended use. It is issued for the purposes of the Construction Products Regulations 2011, and it allows a manufacturer to affix CE markings on their products. Further information is available at www.eota.eu.

ISO – International Organisation for Standardisation. This is the worldwide standards organisation, and it is likely that some ISO standards may be adapted for use with the CPR. Such standards are identified by 'ISO' and a number and in the UK they may appear as BS ISO or, if they are adopted as European standards, as BS EN ISO. Unlike ENs, ISOs are published separately.

Materials – These include manufactured products such as components, fittings, items of equipment and systems. This also includes materials which are natural such as stone, timber, thatch and backfilling for excavations.

NANDO – New Approach Notified and Designated Organisations. This is an information system produced by the European Commission. It lists the harmonised European standards and the bodies notified by member states to carry out conformity assessment tasks for CE marking.

UKAS – United Kingdom Accreditation Service. The sole national accreditation body recognised by the UK government to assess against internationally agreed standards, organisations that provide certification, testing, inspection and calibration services. Accreditation by UKAS demonstrates the competence, impartiality and performance capability of these organisations. Further information is available at www.ukas.com.

8.2 The influence of European standards

In order to understand the changes which have come about with the advent of the Single European Market, the following brief summary sets out the context of these changes and their influence on the building control system in England and Wales.

A main goal of the European Community is to allow free movement amongst the Member States of goods, services, people and capital. Free movement of goods may be hampered by physical, technical or fiscal barriers.

Significant technical barriers arise from the use of different technical requirements or regulations in Member States. This results in the necessity to produce slightly different versions of the same product to satisfy different markets, and different methods of test for suitability must be used, resulting in undue expense and waste of resources by manufacturers and suppliers.

To overcome these difficulties, early directives were issued for which it was necessary to resolve technical issues with unanimous agreement by all Member States. This turned out to be a slow and cumbersome process.

8.2.1 The single European market

The Single European Act in 1986 declared an agreement to establish the Single European Market by the end of 1992. Progress to the single market was aided by a radical change in the approach to the writing of directives and European standards – the so-called New Approach. This recognised that EU legislation should only apply to areas already subject to existing national laws or regulations and also allow qualified majority voting into the decision-making process.

The New Approach Directives expressed requirements in broad terms, called the Essential Requirements. Member States presumed conformity with these requirements where a product satisfied a harmonised European technical specification or, as an interim measure, a national standard accepted by the Commission. The advent of European standards prevented Member States from using their own standards to protect their own markets.

A number of New Approach product directives were adopted which were relevant to the construction industry, the most significant being the Construction Products Directive 89/106 EEC. From 1 July 2013 this directive was replaced by the full implementation of the Construction Products Regulations 2013. These regulations build upon the CPD continuing to break down trade barriers between member states in respect of construction products.

8.3 The Construction Products Regulations 2011

Although parts of this legislation came into force in April 2011, it wasn't until 1 July 2013 that the full requirements as they related to manufacturers, importers and distributors were activated. To achieve its objective of continuing the breakdown of trade barriers, the Construction Products Regulations is divided into four main objectives:

(1) A system of harmonised technical specifications
(2) A system of conformity for each product grouping
(3) A notified bodies framework
(4) The provision of CE marking for products

The important change with the new legislation is that under the previous CPD, the affixing of CE marking to any construction product was voluntary in the UK, whereas under the new CPR this is now mandatory for any such product which is covered by a harmonised European standard.

A construction product is defined in the regulations as being 'any product or kit which is produced and placed on the market for incorporation in a permanent manner in construction works or parts thereof and the performance of which has an effect on the performance of the construction works with respect to the basic requirements for construction works'.

The basic requirements are referenced in the regulations and are similar to the 'essential requirements' referenced in the old CPD:

(1) Mechanical resistance and stability
(2) Safety in case of fire
(3) Hygiene, health and the environment
(4) Safety and accessibility in use
(5) Protection against noise
(6) Energy, economy and heat retention
(7) Sustainable use of natural resources

It is important to note that the CPR is not designed to harmonise the Building Regulations produced by member states. It harmonises testing, declaration of performance and assessment and verification.

A list of harmonised European standards can be found at the European Commission website at http://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/construction-products/index_en.htm.

The CPR identifies three types of product:

(1) Products which are covered by a harmonised European standard
(2) Products which are not fully covered by such a standard
(3) Products for which there is no harmonised standard

From 1 July 2013 the marking of a product in group 1 allows it to be sold legally on the market in any of the European member states and should also confirm that the product meets its declaration of performance issued by the manufacturer.

Enforcement of the CPR is not the responsibility of the BCB: that responsibility lies with the Trading Standards service within Local Authorities.

There is no mandatory requirement for CE marking for group 2 and 3 products.

Further information regarding CE marking and the CPR can be found in the Construction Products Association publication *Guidance note on the Construction Products Regulation*, 2012.

8.4 Materials and workmanship

8.4.1 Materials and workmanship generally

Building work must be carried out:

- with proper and adequate materials which are:
  (1) appropriate for the circumstances in which they are used,
  (2) adequately mixed and prepared, and

(3) applied, used or fixed so as adequately to perform the functions for which they are designed; and

- in a workmanlike manner.

Guidance on the choice and use of materials, and on ways of establishing the adequacy of workmanship, is given in AD Regulation 7. It should be noted, however, that materials and workmanship are controlled only to the extent of:

- securing reasonable standards of health and safety for persons in or about buildings for Parts A to D and F to K, N and P of Schedule 1 (except for paragraphs H2 and J6);
- reasonable resistance to the passage of sound in Part E;
- conserving fuel and power in Part L; and
- providing access and facilities for people in Part M.

Therefore, although it may be desirable for reasons of consumer satisfaction or protection to require higher standards, this cannot be required under building regulations.

In order to achieve a satisfactory standard of performance, **materials** should be:

- suitable in nature and quality in relation to the purposes for which, and the conditions in which, they are used.

Additionally, **workmanship** should be such that, where relevant, materials are:

- adequately mixed and prepared (for example, in concrete mixes, the correct proportions must be used, there should be an appropriate water/cement ratio, mixing should be thorough, etc.); and
- applied, used or fixed so as to adequately perform their intended functions (for example, for reinforced concrete, this would give control over the actual placing of the concrete, positioning of reinforcement, curing, etc.).

The definition of materials is quite broad and covers products, components, fittings, naturally occurring materials (such as timber, stone and thatch), items of equipment and materials used in the backfilling of excavations in connection with building work. It should be noted that building regulations do not seek to control the use of materials after completion of the building work.

In order to reduce the environmental impact of building work, careful thought should be given to the choice of materials, and where appropriate, recycled or recyclable materials should be considered. Obviously, the use of such materials must not have an adverse effect on the health and safety standards of the building work.

8.4.2 Fitness of materials

A number of ways of establishing the fitness of materials are dealt with in AD Regulation 7, and whilst this is mostly by reference to British Standards or certificates issued by European Technical Approvals issuing bodies, other materials or products may be suitable in the particular circumstances. The following aids to establishing the fitness of materials are given in the Approved Document:

- **CE marking under the Construction Products Regulations.** A CE mark will necessarily mean that the product is suitable for all end uses in all member states. The product will have a declaration of performance containing more detailed information, and it is essential to check that this declared performance is suitable for the particular building works. In the absence of anything to the contrary, the BCB must assume that the information in the declaration and CE certification is accurate and reliable.
- **CE marking under other EU directives or regulations.** Such as the Gas Appliances Directive or Pressure equipment directive. The advice above applies equally to these.
- **British Standards.** A material may conform to the relevant provisions of an appropriate British Standard.
- **Other national and international technical specification.** Where a product is not covered by a harmonised European standard, a material may conform to the national technical specifications of other Member States which are contracting parties to the European Economic Area. It should be noted that where a person intends to use a product which complies with a national technical specification of another Member State, the onus is on that person to show that the product is equivalent to the relevant British Standard (and it would be necessary to provide a translation).
- A material may be covered by a national or European certificate issued by a European Technical Approvals issuing body. The conditions of use must be in accordance with the terms of the certificate, and again, it will be up to the person intending to use the product to demonstrate equivalence and provide a translation.
- **Independent certification schemes** (e.g. the Kitemark scheme operated by the British Standards Institution). These may also serve to show that a material is suitable for its purpose. However, some materials which are not so certified may still conform to a relevant standard. In the UK, many certification bodies which approve such schemes are accredited by UKAS.
- **Tests and calculations.** A material may be shown to be capable of performing its function by the use of tests, calculations or other means. It is important to ensure that tests are carried out in accordance with recognised criteria. UKAS run an accreditation scheme for testing laboratories, and together with similar schemes run by equivalent certification bodies (including accreditation schemes operated by other Member States of the EU), this ensures that standards of testing are maintained.
- **Past experience.** In some cases past experience of a material that is in use in a building may be relied upon to ensure that it is capable of adequately performing its function.
- **Sampling.** Local authorities are entitled under regulation 46 to take and test samples of materials in order to confirm compliance. Approved inspectors have similar powers under regulation 8 of the Building (Approved Inspectors, etc.) Regulations 2010 (as amended).

8.4.3 Short-lived materials

Only general guidance is given on the use of short-lived materials. These are materials which may be considered unsuitable due to their rapid deterioration when compared to the life of the building.

The main criteria to be considered are:

- accessibility for inspection, maintenance and replacement; and
- the effects of failure on public health and safety.

Clearly, if a material or component is inaccessible and its failure would create a serious health risk, it is unlikely that the material or component would be suitable. (See also the reference to section 19 of the Building Act 1984 in section 8.1.1.)

8.4.4 Materials subject to changes in their properties

Under certain environmental conditions, some materials may undergo a change in their properties which may affect their performance over time. A notable example of this occurred during the 1970s to structures constructed using high alumina cement (HAC). The subsequent deterioration of the concrete led to the collapse of a number of long-span roof structures, and the use of HAC was banned for all work except when the material was used as a heat-resisting material. It is known that a number of other materials (such as certain stainless steels, structural silicone sealants and intumescent paints) may also be susceptible to changes in their properties under certain environmental conditions. In order to use such materials, it will be necessary to estimate their final residual properties (including their structural properties) at the time the materials are incorporated into the work. It should then be shown that these residual properties will be adequate for the building to perform its intended function for its expected life.

8.4.5 Adequacy of workmanship

It should be remembered that Building Regulations set different standards of workmanship to those imposed by, for example, a building specification. Building Regulations are not concerned with quality or value for money; they are concerned with public health and safety, the conservation of fuel and power, the waste or misuse of water and access and facilities for people in buildings.

Adequacy of workmanship, like that of materials, may be established in a number of ways:

- **CE Marking.** Workmanship requirements for a particular product may be specified in the certification for that marking.
- **Standards**. A British Standard Code of Practice or other equivalent technical specification (e.g. of Member States which are contracting parties to the European Economic Area) may be used. In this context, BS 8000 *Workmanship on building sites* may be useful since it gathers together guidance from a number of other BSI Codes and Standards.
- **Independent certification schemes.** Technical approvals, such as national or European certificates issued by European Technical Approvals issuing bodies, often contain workmanship recommendations. Additionally, it may be possible to use an equivalent technical approval (such as those of a member of EOTA) if this provides an

equivalent level of protection and performance. The onus of proof of acceptability rests with the user in this case.

- **Management systems.** Workmanship which is covered by a scheme complying with BS EN ISO 9000 *Quality management and quality assurance standards* will demonstrate an acceptable standard since these schemes relate to processes and products for which there may also be a suitable British or other technical standard. A number of such schemes have been accredited by UKAS. There are also a number of independent schemes for accreditation and registration of installers of materials, products and services, and these ensure that work has been carried out to appropriate standards by knowledgeable contractors.
- **Past experience.** In some cases past experience of a method of workmanship such as a building in use may be relied upon to ensure that the method is capable of producing the intended standard of performance.
- **Tests.** Local authorities are empowered under regulation 45 to make such tests of any building work to enable them to establish if the work complies with regulation 7 or any other applicable requirements of Schedule 1. Approved inspectors have similar powers under regulation 8 of the Building (Approved Inspectors, etc.) Regulations 2010 (as amended). There are also three specific instances where test is a statutory requirement for demonstrating compliance with the requirement, Regulation 41 (sound insulation testing), Regulation 42 (mechanical ventilation air flow rate testing) and Regulation 43 (air tightness pressure testing).

8.5 Site preparation and moisture exclusion

8.5.1 Introduction

Part C of Schedule 1 to the 2010 Regulations is concerned with site preparation and resistance to moisture. In addition to moisture exclusion, paragraph C2 contains provisions controlling sites containing dangerous or offensive substances. This replaces section 29 of the Building Act 1984.

The supporting Approved Document C now contains recommendations relating to the control of radon gas in certain areas of England and landfill gases on certain sites near waste disposal tips, etc. The guidance on the control of dampness in buildings in Approved Document C now covers damage from condensation and mould growth. This was formerly found in Approved Document F, Ventilation.

Certain provisions regarding the preparation of the site, damp proofing and weather resistance of floors and walls do not apply to buildings used solely for storage of plant or machinery in which the only persons habitually employed are store personnel, etc. Other similar types of buildings where the air is so moisture laden that any increase would not adversely affect the health of the occupants are also excluded.

Additionally, where work is carried out to historic buildings, special considerations may apply which recognise the sensitive nature of such buildings.

These normally include:

- listed buildings;
- buildings situated in conservation areas;

- buildings of architectural and historical interest and which are referred to as a material consideration in a local authority development plan; and
- buildings of architectural and historical interest within national parks, areas of outstanding natural beauty and world heritage sites.

Special considerations may apply, as any work on a historic building must balance the need to improve resistance to contaminants and moisture where it is practically possible against the following factors:

- The need to avoid prejudicing the character of the historic building;
- The danger of increasing the risk of long-term deterioration of the building fabric; and
- The danger of increasing the risk of long-term deterioration of the building's fittings.

Advice on achieving the correct balance should be sought from the conservation officer of the local authority.

Particular issues that warrant sympathetic treatment in relation to historic buildings and where advice from others could be beneficial include:

- the avoidance of excessively intrusive gas protective measures; and
- ensuring that moisture ingress to the roof is limited and the roof can breathe. Help in this area can be found in BS 7913:1998 *Guide to the principles of the conservation of historic buildings* and in SPAB Information Sheet 4 – *The need for old buildings to breathe*, 1986.

It may not always be possible to provide dedicated ventilation to pitched roofs. In such cases it is important to ensure that service penetrations in the ceiling are adequately sealed and to provide draughtproofing to trap access hatches. Additionally, roof insulation should be kept clear of the eaves so that any adventitious ventilation is not reduced.

When considering protection against radon and landfill seepage, edge-located sumps and subfloor vents are less intrusive than internal sumps or ducts that may involve taking up flagged floors. It is usual when taking up flagged floors to index and record these to facilitate relaying.

Ventilation strategies, such as positive pressurisation, can be used to disperse radon gas, and these systems can be incorporated in an unobtrusive manner. However, if this method of dispersing ground gases involves mechanical ventilation, care should be taken to ensure that the correct functioning of combustion appliances is not adversely affected since this could lead to spillage of the products of combustion into the building. Guidance on this can be found in BRE Report BR 211 *Radon: Guidance on protective measures for new buildings (including supplementary advice for extensions, conversions and refurbishment)*, 2007.

8.5.2 Preparation of site: Site investigation

In order to prepare a site for construction work, it will usually be necessary to carry out a site investigation. This will entail a study of site conditions to determine their probable influence on the design, construction and subsequent performance of a building. The following items may be encountered and are discussed in Approved Document C:

- Unsuitable material such as turf and roots;
- Mature trees which might affect services, floor slabs, oversite concrete and foundations;
- Pre-existing foundations, services and other infrastructure and buried tanks;
- Fill or made-up ground;
- Contaminants; and
- High water table, which might necessitate subsoil drainage to avoid damage to the building.

Additionally, the site investigation will identify the type and nature of the subsoil and its load-bearing capacity which will be of use in the design of foundations in accordance with Part A (see Chapter 7).

The site investigation will normally consist of the following stages:

(1) **Planning stage.** In this stage the objectives, scope and requirements of the investigation are set so as to enable it to be planned and carried out efficiently and so that the required information may be provided.
(2) **Desk study.** A desk study is a review of the historical, geological and environmental information about the site. The information can be obtained much more quickly and cheaply than information from boreholes and trial pits, and a great deal of factual information is publicly available in the UK from sources such as geological maps, Ordnance Survey sheets, aerial photographs, computer satellite databases, geological books and records, local authority building control data, mining records, reports of previous site investigations, etc.
(3) **Site reconnaissance or walkover survey.** The site reconnaissance or walkover survey aids the design of the main investigation in that it identifies actual and potential physical hazards. The object of the walkover survey is to check and make additions to the information already collected during the desk study. The site and its surrounding area are visited and covered carefully on foot. When a walkover survey is carried out, it is also possible to gather information from local authorities, local inhabitants and people working in the area, such as builders, electricity and gas workers. On completion of the survey, a structured report can be produced from the information gathered at the site and from the local enquiries.
(4) **Main investigation and reporting.** This will usually include an examination of the geotechnical properties of the ground and should be designed to verify and expand information previously collected from the desk study and site walkover survey. The investigation will usually include intrusive and non-intrusive sampling and testing by means of trial pits and boreholes to provide soil parameters for design and construction.

In determining the extent and level of investigation, it will be necessary to consider the type of development proposed and the previous use of the land. Typically the site investigation should include:

- susceptibility to groundwater levels and flow;
- underlying geology; and
- ground and hydrogeological properties.

A geotechnical site investigation should:

- identify physical hazards for site development;
- determine an appropriate design; and
- provide soil parameters for design and construction.

Where there is concern that the site might be affected by contaminants, a combined geotechnical and geo-environmental investigation should be considered. Section 2 of Approved Document C *Resistance to contaminants* (which is considered in section 8.5.5) contains guidance on assessing and remediating sites affected by contaminants.

8.5.3 Site investigation: Sources of guidance

Comprehensive guidance on site investigations may be found in BS EN 1997-2:2007: Eurocode 7: *Geotechnical design* with its UK National Annex supported by BS 5930:1999 *Code of practice for site investigations*.

For low-rise buildings the following documents may also be consulted:

- BRE Digest 322 *Site investigation for low-rise building: Procurement*, 1987;
- BRE Digest 318 *Site investigation for low-rise building: Desk studies*, 1987;
- BRE Digest 348 *Site investigation for low-rise building: The walk-over survey*, 1989;
- BRE Digest 381 *Site investigation for low-rise building: Trial pits*, 1993;
- BRE Digest 383 *Site investigation for low-rise building: Soil description*, 1993;
- BRE Digest 411 *Site investigation for low-rise building: Direct investigations*, 1995; and
- BS 8103: Part 1: 2011 *Structural design for low-rise buildings*.

8.5.4 Preparation of site: Clearance or treatment of unsuitable material

The ground to be covered by the building is required to be reasonably free from any material that might damage the building or affect its stability. This includes vegetable matter, topsoil and pre-existing foundations (see Requirement C1(1)).

Decaying vegetable matter, such as turf and roots, could be a danger to health, and it could also cause a building to become unstable if it occurred under foundations. Approved Document C, therefore, recommends that the site should be cleared of all turf and vegetable matter at least to a depth to prevent future growth. The effects of roots close to the building also need to be assessed. This might not apply to buildings used solely for storage of plant or machinery in which the only persons habitually employed are store personnel, etc. engaged only in taking in, caring for or taking out the goods. Other similar types of buildings where the air is so moisture laden that any increase would not adversely affect the health of the occupants are also excluded.

Below-ground services (such as foul or surface water drainage) should be designed to resist the effects of tree roots. This can be achieved by making services sufficiently robust or flexible and with joints that cannot be penetrated by roots. Consideration should be given to the removal of roots where they could pose a hazard to below-ground services.

Where a site has been previously built on, it will be necessary to consider if it contains any pre-existing foundations, services, buried tanks and any other infrastructure that could be a danger to persons in and about the building and any land associated with the building. In this context, Approved Document C defines *building and land associated with the building* as 'the building and all the land forming the site subject to building operations which includes land under the building and the land around it which may have an effect on the building or its users'. This definition is further clarified in paragraph 2.11 of Approved Document C, where it refers to the 'area of the site subject to building operations', i.e. 'those parts of the land associated with the building that include the building itself, gardens and other places on the site that are accessible to users of the building and those in and about the building'.

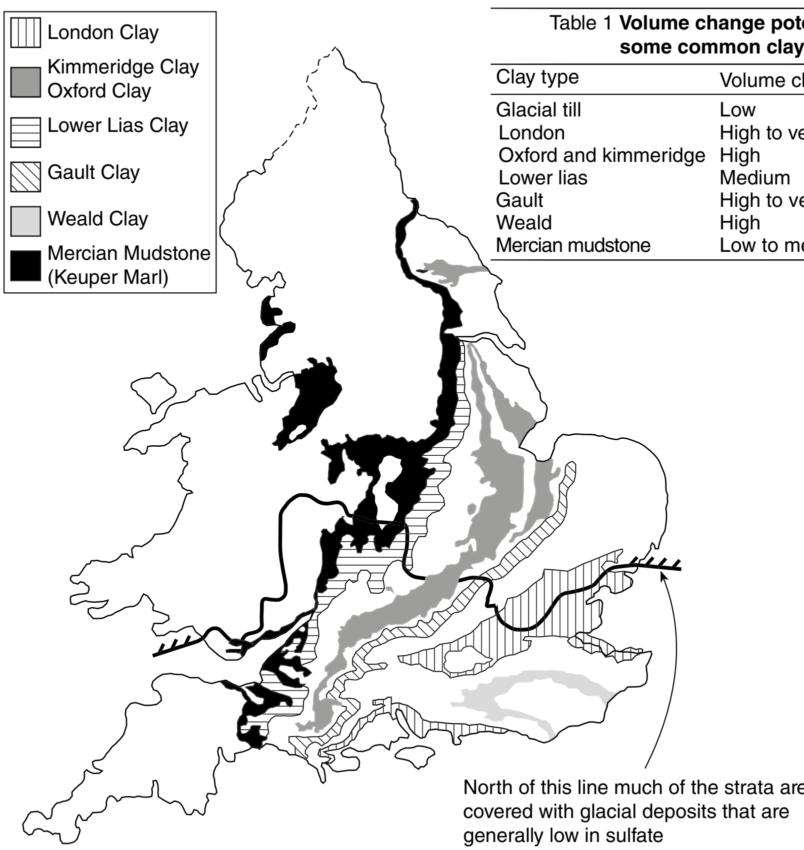
Where shrinkable clays soils are present on a site, the presence of mature trees can exacerbate the tendency of the soil to cause heave and subsidence, and this may lead to damage to services, floor slabs and oversite concrete. On such soils, the potential for damage should be assessed, and Approved Document C gives guidance, in general terms, on the likely potential for volume change for some commonly occurring clays. Reference should be made to Diagram 1 from Approved Document C (reproduced below) to ascertain the type of clay that might be occurring. When used with Table 1 from Approved Document C (shown on the same diagram), the volume change potential can be approximately assessed.

AD C

Diagram 1 Distribution of shrinkable clays and principal sulphate-/sulphide-bearing strata in England and Wales.

Table 1 **Volume change potential for some common clays**

Clay type	Volume change potential
Glacial till	Low
London	High to very high
Oxford and kimmeridge	High
Lower lias	Medium
Gault	High to very high
Weald	High
Mercian mudstone	Low to medium



For more detailed guidance, reference may also be made to BRE Digest 298 *Low-rise building foundations: The influence of trees in clay soils*, 1999.

Sometimes it becomes necessary to remove significant quantities of soil. In these cases reference may also be made to:

- BRE Digest 240 *Low-rise buildings on shrinkable clay soils*: Part 1, 1993;
- BRE Digest 241 *Low-rise buildings on shrinkable clay soils*: Part 2, 1993; and
- Foundation for the Built Environment (FBE) report – *Subsidence damage to domestic buildings: Lessons learned and questions remaining*, FBE, 2000.

The National House Building Council (NHBC) Standards Chapter 4.2 *Building near trees*, 2003, can also be consulted to assess the effects of remaining trees on services and building movements close to the building.

Sites which contain fill or made ground can present particular problems related to the compressibility of the ground and its potential for collapse when wetted. Appropriate remedial measures may need to be taken to prevent differential settlement from causing damage to the building. Guidance on these issues may be found in BRE Digest 427 *Low-rise buildings on fill* and BRE Report BR 424 *Building fill: Geotechnical aspects*, 2001.

8.5.5 Resistance to contaminants: Introduction

Reasonable precautions must be taken to prevent any contaminants found on or in the ground from causing a danger to health and safety (see requirement C1(2)). This is, of course, the ground covered (or to be covered) by the building and includes any land associated with the building (see definition in section 8.5.4).

There is a special definition of *contaminant* for the purposes of requirement C1(2) – any substance which is or could become harmful to persons or buildings including substances that are toxic, corrosive, explosive, flammable or radioactive.

Contaminants that occur on sites can be liquids, solids or gases and can arise out of a previous use of land, especially where this was related to an industrial undertaking. In recent years problems have arisen from the emission of landfill gas from waste disposal sites where it is common for biodegradable waste to be buried. Even sites which have been used for rural purposes, such as agriculture or forestry, may be contaminated by pesticides, fertiliser, fuel and oils and decaying matter of biological origin. The author remembers encountering an edge-of-town site contaminated with the carcasses of cattle slaughtered in an outbreak of foot-and-mouth disease from the 1950s.

Where a site is being redeveloped, knowledge of its previous use, from planning or other local records, may indicate a possible source of contamination. Table 2 to section 2 of AD C (reproduced below) lists a number of site uses that are likely to contain contaminants. It should not be considered to be an exhaustive list. It is derived from the *Industry Profile* guides published by the former Department of the Environment (*Department of the Environment Industry Profiles*, 1996). Each of these profiles considers a different industry which has the potential to cause contamination. The particular contaminant associated with the industry is identified together with details of where it may be found on the site and the routes it might take to migrate to other areas.

AD C

Table 2 Examples of sites likely to contain contaminants.

Animal and animal products processing works
Asbestos works
Ceramics, cement and asphalt manufacturing works
Chemical works
Dockyards and docklands
Engineering works (including aircraft manufacturing, railway engineering works, shipyards, electrical and electronic equipment manufacturing works)
Gas works, coal carbonisation plants and ancillary by-product works
Industries making or using wood preservatives
Landfill and other waste disposal sites
Metal mines, smelters, foundries, steelworks and metal finishing works
Munitions production and testing sites
Oil storage and distribution sites
Paper and printing works
Power stations
Railway land, especially the larger sidings and depots
Road vehicle fuelling, service and repair: garages and filling stations
Scrapyards
Sewage works, sewage farms and sludge disposal sites
Tanneries
Textile works and dye works

Additionally, in certain parts of the country, the following naturally occurring contaminants can arise from the underlying geology:

- Mining areas:
  - Certain heavy metals, such as cadmium and arsenic;
  - Gases such as methane and carbon dioxide (mainly from coal-mining areas); and
  - Carbon dioxide and methane gases arising from organic rich soils and sediments (such as peat and river silts) (see section 8.5.12).

Further information on these contaminants including their geographical extent, associated hazards, site investigation methods and protective measures that can be taken can be obtained from the following Environment Agency publications:

- In England – Environment Agency R&D Technical Report P291 *Information on land quality in England: Sources of information (including background contaminants)*; and
- In Wales – Environment Agency R&D Technical Report P292 *Information on land quality in Wales: Sources of information (including background contaminants).*

Other naturally occurring contaminants include:

- the radioactive gas radon; and
- sulphates.

Contamination by radon gas and its products of decay has led to concern over the long-term health of occupants of affected buildings. Measures to protect buildings and occupants against ingress of radon gas are considered in section 8.5.9. Sulphate attack affects concrete floor slabs and foundations and can cause failure and disruption. Measures can be taken (such as the use of sulphate-resisting cement) in those areas where naturally occurring sulphates are present. Diagram 1 and Table 1 from Approved Document C (illustrated above) show the principle areas of sulphate-bearing strata in England and Wales. Reference may also be made to BRE Special Digest SD1 *Concrete in aggressive ground*, 2003, where guidance will be found on investigation, concrete specification and design to mitigate the effects of sulphate attack.

8.5.6 Resistance to contaminants: Risk assessment

Introduction and general concepts

In order to develop potentially contaminated land safely, it is necessary to carry out a risk assessment.

This is normally done by adopting a tiered approach in which an increasing level of detail is required as the tiers are worked through. For a full risk assessment, it will be necessary to progress through the following three tiers:

- Preliminary risk assessment;
- Generic quantitative risk assessment (GQRA); and
- Detailed quantitative risk assessment (DQRA).

The need for a risk assessment will usually be identified during the first stages of the site investigation (desk studies and site walkover survey). Once this need has been identified, a preliminary risk assessment must always be undertaken. The extent to which it is necessary to do a more detailed risk assessment will depend on the situation and outcome of the preliminary assessment. This may indicate that it will be necessary to do only one or other (or both) of the more detailed risk assessments.

The general approach to risk assessment described above is based on the concept of the relationship between the *source* of contamination (the contaminants found on or in the ground), the *pathway* taken by the contaminants (e.g. ingestion, inhalation, direct contact, attack on building materials and services) and the *receptor* of those contaminants (i.e. buildings, building materials and services and people). This 'source–pathway–receptor' relationship, or pollutant linkage, is illustrated in Fig. 8.1.

The development of contaminated land has the inevitable consequence of introducing receptors (buildings, building services, building materials and people) onto the development site. In order to mitigate the effects of the pollutants on the receptors, the pollutant linkages must be broken. This can be achieved in a number of ways, for example, by:

- using physical, chemical, biological or other processes to treat the contaminant so as to eliminate or reduce its toxicity or harmful properties;
- removing or blocking the contaminant pathway (e.g. by installing barriers to prevent migration or protective layers to isolate the contaminant);
- removing or protecting the receptor (perhaps by the use of appropriately designed building materials or by changing the form or layout of the development); or
- removing the contaminant by excavating the contaminated material.

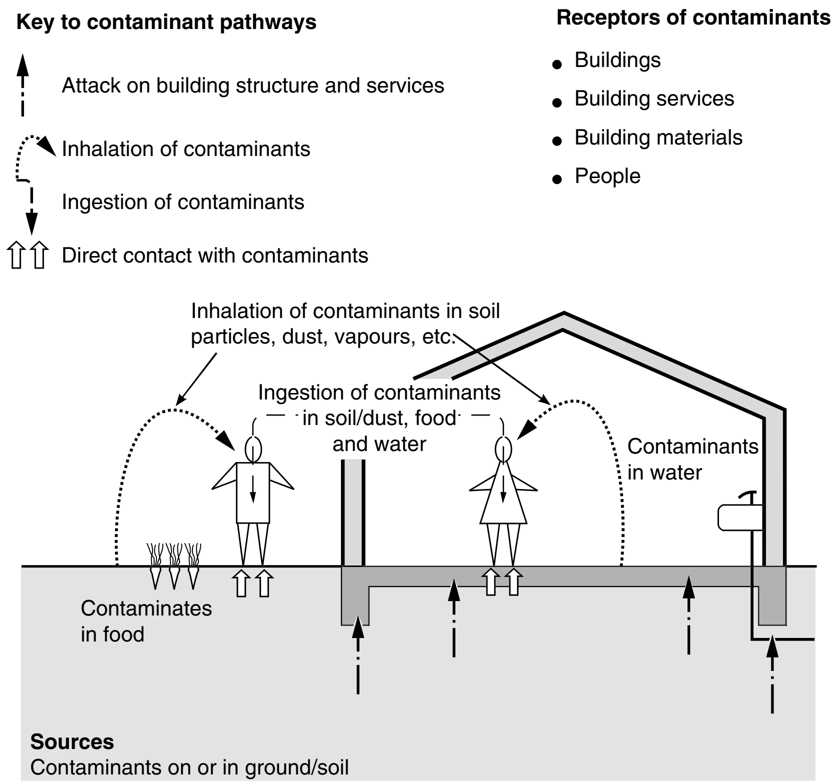


Fig. 8.1 Source–pathway–receptor – typical site conceptual model.

Risk assessment stages

For each of the tiers mentioned above (preliminary risk assessment, generic quantitative risk assessment (GQRA) and detailed quantitative risk assessment (DQRA)), AD C recommends that the Defra/Environment Agency Contaminated Land Research Report CLR 11 *Model procedures for the management of land contamination* should be consulted as it may be of considerable help when developing a site affected by contamination since it describes the stages of risk assessment that should be followed in order to identify risks and make judgements about the consequences of contamination for the affected site. These stages are summarised in Fig. 8.2 and described in more detail below.

Hazard identification and assessment

One of the needs of the preliminary site assessment is to provide information on any possible contamination of the site and surrounding area due to its past and present uses (see Table 2 from AD C in section 8.5.5 for typical uses that might give rise to site contamination). The site walkover survey may reveal signs of possible contaminants. Table 3 from AD C (which is reproduced below) gives some examples of the signs that may indicate particular contaminants; however, this is not a comprehensive list and should be used with caution since it is merely indicative.

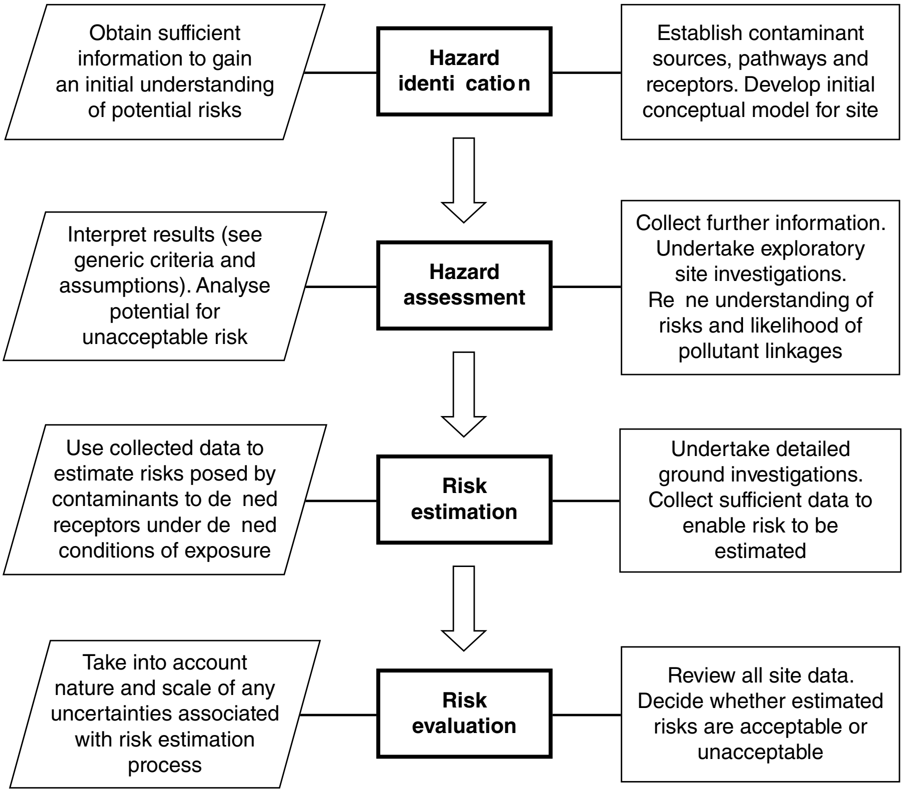


Fig. 8.2 Resistance to contaminants – risk assessment stages.

AD C
Table 3 Examples of possible contaminants.

Signs of possible contaminants	**Possible contaminant**
Vegetation (absence, poor or unnatural growth)	Metals Metal compounds
	Organic compounds Gases (landfill or natural source)
Surface materials (unusual colours and contours may indicate wastes and residues)	Metals Metal compounds
	Oily and tarry wastes
	Asbestos
	Other mineral fibres
	Organic compounds including phenols
	Combustible material including coal and coke dust
	Refuse and waste

(*Continued*)

Signs of possible contaminants	Possible contaminant
Fumes and odours (may indicate organic chemicals)	Volatile organic and/or sulphurous compounds from landfill or petrol/solvent spillage Corrosive liquids Faecal animal and vegetable matter (biologically active)
Damage to exposed foundations of existing buildings	Sulphates
Drums and containers (empty or full)	Various

Information provided by the desk study and site walkover survey will be of primary importance in the design of the exploratory and detailed ground investigation.

Clearly, the site assessment and risk evaluation should be concentrated on the area of the site subject to building operations. Therefore, the following parts of a site should be remediated to the requirements of the Building Regulations:

- Those parts of the land associated with the building itself;
- Gardens; or
- Other places on the site that are accessible to users of the building and those in and about the building.

An incremental approach to remediation of a site (perhaps including lower levels of remediation) may be acceptable where part of (or the remainder of) the land associated with the building is accessible to a lesser extent to the user or those in and about the building than the main parts of the buildings and their respective gardens. This could also apply to areas adjacent to such land. This incremental approach may also apply in the case of phased redevelopment of very large sites, where it may be possible to limit remediation to the part of the site that is actually being developed at any particular time. In all cases reliance will be placed on the risk evaluation and remediation strategy documentation in order to demonstrate that restricted remediation is acceptable. It should be noted that this will place the onus on the applicant to show why part of a site may be excluded from particular remediation measures.

The scope of the Building Regulations is limited to matters concerning health, safety, welfare and convenience. Therefore, even if the adjacent land is not subject to Building Regulations, it may still be subject to planning control legislation or to control under Part IIA of the Environmental Protection Act 1990. In fact, a substantial amount of guidance on the assessment of contaminated land has been published to support the implementation of this Act. Most of this guidance is contained in the joint Defra/Environment Agency Reports as follows:

- *Human health toxicological assessment of contaminants in soil* (Science Report: SC050021/SR2) Environment Agency

- *Updated technical background to the CLEA model* (Science Report: SC050021/SR3) Environment Agency
- CLR 11 *Model procedures for the management of land contamination* Defra/ Environment Agency, 2004
- Environment Agency R&D Technical Report P5-065 *Technical aspects of site investigation*, 2000
- Environment Agency R&D Technical Report P5-066 *Secondary model procedure for the development of appropriate soil sampling strategies for land contamination.*

Additionally, if any substance is found which is at variance with any preliminary statements made about the nature of the site, the Planning Authority should be informed before any intrusive investigations are carried out.

Risk estimation and evaluation

During the risk estimation phase, detailed ground investigations will be carried out. These must provide sufficient information for:

- confirmation of a conceptual model for the site;
- the risk assessment itself; and
- the design and specification of any remedial works.

The ground investigations are likely to involve collection and analysis, by the use of invasive and/or non-invasive techniques, of:

- soil;
- soil gas; and
- surface and groundwater samples.

Since elevated groundwater levels could bring contaminants close to the surface (both beneath the building and in any land associated with the building), an investigation of the groundwater regime, levels and flows is essential for most sites, and expert advice should be sought.

Therefore, if land affected by contaminants is to be developed, the health and safety of both the public and workers should be considered. The following references may be consulted for advice:

- HSE Report HSG 66 *Protection of workers and the general public during the development of contaminated land*, 1991; and
- CIRIA Report 132 *A guide to safe working practices for contaminated land*, 1993.

As an alternative to the generic approach, it is also possible to undertake a more site-specific quantitative risk assessment using the principles of risk assessment or a risk assessment model. For this, specialist advice should be sought.

Further guidance

For guidance on the investigation of sites potentially affected by contaminants, the following documents may also be consulted:

- Association of Geotechnical and Geoenvironmental Specialists *Guidelines for combined geoenvironmental and geotechnical investigations* (Available from: AGS, Forum Court, Office 205 Devonshire House Business Centre, 29–31 Elmfield Road, Bromley, Kent, BR1 1LT. Website: www.ags.org.uk/);
- BS 5930:1999+A2:2010 *Code of practice for site investigations*;
- BS 10175:2011 *Investigation of potentially contaminated land. Code of practice*;
- National Groundwater & Contaminated Land Centre Report NC/99/38/2 *Guide to good practice for the development of conceptual models and the selection and application of mathematical models of contaminant transport processes in the subsurface* (available from website: www.environment-agency.gov.uk/subjects/waterres/groundwater/);
- Human health toxicological assessment of contaminants in soil (Science Report: SC050021/SR2), Environment Agency;
- *Updated technical background to the CLEA model* (Science Report: SC050021/SR3), Environment Agency;
- CLR 11 *Model procedures for the management of land contamination* Defra/Environment Agency, 2004;
- Environment Agency R&D Technical Report P5-065 *Technical aspects of site investigation*, 2000; and
- Environment Agency R&D Technical Report P5-066 *Secondary model procedure for the development of appropriate soil sampling strategies for land contamination*.

These documents recommend the adoption of a risk-based approach, so that any hazards that are present can be identified and quantified and an assessment can be made of the nature of the risk they might pose. The design and execution of field investigations are described together with suitable sample distribution strategies, testing and sampling.

8.5.7 Resistance to contaminants: Remedial measures

Introduction

If the risk assessment stage results in the identification of unacceptable risks to the particular receptor (e.g. buildings, building services, building materials and people), then appropriate remedial measures will be needed in order to manage these risks. This will mean defining the risk management objectives in terms of the need to break the pollutant linkages (see section 8.5.6 and the text below in this section). Other objectives that will also need to be considered include such items as:

- timescale and cost;
- remedial works;
- planning constraints; and
- sustainability.

The remedial measures that are adopted will depend on the contaminant that has been identified. In general, three generic types of remedial measures can be considered:

- Treatment;
- Containment; and
- Removal.

It should be noted that it may be necessary to obtain a waste management licence from the Environment Agency where the containment or treatment of waste is anticipated. It is also important to consider the effects of building work on sites affected by contaminants. For example, an existing control measure which included a cover system (i.e. containment) could be breached if excavations were carried out for foundations or underground services when an extension was added.

Treatment

Contaminants can be dealt with by a wide range of treatment processes using biological, chemical and physical techniques. These can be carried out either on or off the site and are designed to decrease one or more of the contaminant's features such as mass, concentration, mobility, flux or toxicity. Since the choice of the most appropriate technique is highly site specific, specialist advice should be sought.

Containment

In general, the term containment means encapsulation of material containing contaminants. However, in the context of building development, it is usually taken to mean cover systems, sometimes incorporating vertical barriers in the ground to control lateral migration of contaminants.

In a cover system layers of materials are placed over the site in order to:

- interrupt the pollutant linkage between the contaminants and the receptors;
- sustain vegetation;
- improve geotechnical properties; and
- reduce exposure to an acceptable level.

Some parts of the structure of the building (foundations, substructure, ground floor, etc.) may assist other containment measures in providing effective protection of health from contaminants. However, the extent to which this is feasible will depend on the circumstances and form of construction.

The following issues need to be addressed when using imported fill and soil for cover systems:

- It should be assessed at source to ensure that it is not contaminated above specified concentrations.
- It should meet required standards for vegetation (see BS 3882:1994 *Specification for topsoil*).

- Where intermixing of the soil cover with the contaminants in the ground can take place, it will be necessary in the design and dimensioning of the cover system to consider its long-term performance. This may include the need for maintenance and monitoring.
- Gradual intermixing of the soil and contaminants due to natural effects and activities (e.g. by burrowing animals, gardening, etc.) should be taken into account.
- Excavations by householders for garden features, walls, ponds, etc. can penetrate the cover layer, leading to possible exposure to contaminants.

Further guidance on the design, construction and performance of cover layers can be found in the Construction Industry Research and Information Association (CIRIA) Special Publication SP124 *Barriers, liners and cover systems for containment and control of land contamination*, 1996.

Removal

Removal means the excavation and safe disposal to a licensed landfill site of the contaminants and contaminated material. This can be achieved by targeting the excavation on contaminant hot spots or by removing sufficient depth of contaminated material so that a cover system can be accommodated within the planned site levels. Removal may not always be viable since it will depend on the depth and extent of the contaminants on the site and the availability of suitably licensed landfills.

Where removal is incorporated with a subsequent cover system, any imported fill should be assessed at source to ensure that there are no materials that will pose unacceptable risks to potential receptors.

Further detailed guidance on treatment, containment and removal is given in the Environment Agency/NHBC R&D Publication 66 *Guidance for the safe development of housing on land affected by contamination*, 2008, and in the following CIRIA publications:

- CIRIA Special Publication SP102 *Decommissioning, decontamination and demolition*, 1995;
- CIRIA Special Publication SP104 *Classification and selection of remedial methods*, 1995;
- CIRIA Special Publication SP105 *Excavation and disposal*, 1995;
- CIRIA Special Publication SP106 *Containment and hydraulic measures*, 1996;
- CIRIA Special Publication SP107 *Ex-situ remedial methods for soils, sludges and sediments*, 1995; and
- CIRIA Special Publication SP109 *In-situ methods of remediation*, 1995.

8.5.8 Resistance to contaminants: Risks to buildings, building materials and services

Receptors of contaminants include not only people but also buildings, building materials and services on sites. The hazards to these receptors might include:

- **Aggressive substances** – which may affect the long-term durability of construction materials such as concrete, metals and plastics (e.g. organic and inorganic acids, alkalis, organic solvents and inorganic chemicals such as sulphates and chlorides).

- **Combustible fill** – which may lead to subterranean fires, if ignited, and consequent damage to the structural stability of buildings and the integrity or performance of services (e.g. domestic waste, colliery spoil, coal, plastics, petrol-soaked ground, etc.).
- **Expansive slags** – which may expand some time after deposition (usually when water is introduced onto the site) causing damage to buildings and services (e.g. blast furnace and steel making slag).
- **Contaminant-affected floodwater** – floodwater may be contaminated by substances in the ground, waste matter or sewage. Building elements that are close to or in the ground such as walls or ground floors may be affected by this contaminated water. Guidance on flood resilient construction may be found in the document – *Improving the flood performance of new buildings – Flood resilient construction* published by DCLG, Defra and the Environment Agency in May 2007.

Although the main receptors with these hazards are the building, the building materials and the building services, ultimately the health of the occupants may be put at risk. In particular, potable water pipes made of polyethylene may be permeated by hydrocarbons. Reference should be made to Foundation for Water Research report FR0448 *Laying potable water pipelines in contaminated ground: Guidance notes*, 1994, where guidance on reducing these risks may be found. Additionally, the Environment Agency document *Assessment and management of risks to buildings, building materials and services from land contamination*, 2001, contains further guidance.

8.5.9 Radon gas contamination: Introduction

Radon is a naturally occurring colourless and odourless gas which is radioactive. It is formed in small quantities by the radioactive decay of uranium and radium and thus travels through cracks and fissures in the subsoil until it reaches the atmosphere or enters spaces under or in buildings.

It is recognised that radon gas occurs in all buildings; however, the concentration may vary from below 20 Bq/m^3 (the national average for houses in the UK) to more than 100 times this value. The National Radiological Protection Board (NRPB) has recommended an action level of 200 Bq/m^3 for houses. The lifetime risk of contracting lung or other related cancers at the action level is about 3%.

The DCLG is constantly reviewing the areas where preventative measures should be taken as information becomes available from the Public Health England (formerly the Health Protection Agency) and the British Geological Survey (BGS). This information has been placed in the BRE guidance document *Radon: Guidance on protective measures for new dwellings (including supplementary advice for extensions, conversions and refurbishment)* (BRE Report BR 211:2007, obtainable from Building Research Establishment, Bucknalls Lane, Watford WD25 9XX, UK), which will be updated as necessary.

A common basis for radiation protection legislation in all Member States of the European Union has been established in a European Council Directive. This Directive has been put into effect in the UK by virtue of the Ionising Radiations Regulations 1999 (SI 1999/3232). These regulations set a national reference level for radon gas, and they require employers and self-employed persons responsible for a workplace to measure radon levels on being directed to do so. Reference may also be made to BRE Report FB 41

Radon in the workplace: A guide for building owners and managers (2nd edition), 2011, which provides guidance for existing non-domestic buildings.

Guidance on protection from radon in the workplace may be found on the HSE website at www.hse.gov.uk/radiation/ionising/radon.htm. Additionally, the techniques for installing radon-resistant membranes described in BR 211 may also be suitable for use in domestic-sized buildings with heating and ventilating regimes similar to those used in dwellings if caution is exercised in this approach (see also BRE Report FB 41 mentioned above for further guidance).

BR 211 provides guidance on:

- basic radon protective measures appropriate in areas where 3% to 10% of homes are predicted to have radon at or above the Radon Action Level of 200 Bq/m^3; and
- full radon protective measures in areas where more than 10% of homes are predicted to have radon at or above the Radon Action Level of 200 Bq/m^3.

BR 211 contains a number of maps showing radon-susceptible areas. These are based on an indicative atlas published by Public Health England and the British Geological Survey. Radon risk reports can be used as an alternative approach to the maps for assessing the need for protective measures, and this method will provide a more accurate assessment of whether radon protective measures are necessary and, if needed, the level of protection that is appropriate. These reports may be obtained from the following:

- UK Radon, www.UKradon.org (covers small domestic and workplace buildings and extensions that have an existing postal address);
- BGS GeoReports, www.shop.bgs.ac.uk/Georeports (covers other development sites); and
- Public Health England, radon@phe.gov.uk (covers large workplaces).

BR 211 identifies those areas where either basic or full radon protection is needed by reference to a series of maps derived from Public Health England and the BGS.

Use of the maps in accordance with directions given in BR 211 will determine whether basic, full or no protection is needed.

Areas most at risk include parts of:

- Devon
- Cornwall
- Somerset
- Gloucestershire
- Oxfordshire
- Northamptonshire
- Leicestershire and Rutland
- Lincolnshire
- Staffordshire
- Derbyshire
- West Yorkshire
- Northumberland and parts of southern Cumbria
- most of Wales.

As more information becomes available, it is likely that further areas will be covered by the need for radon precautions. Current information on the areas delineated by DCLG for the purposes of Building Regulations can be obtained from local authority building control officers or from approved inspectors. When it is necessary to make changes to areas delineated as requiring radon protection, these will be notified to Building Control Bodies and will be posted on the DCLG website. The results will be published in due course.

8.5.10 Basic protection against radon

Basic protection may be provided by an airtight, and therefore radon-proof, barrier across the whole of the building including the floor and walls. This could consist of:

- polyethylene (polythene) sheet membrane of at least 300 μm (1200 gauge) thickness;
- flexible sheet roofing materials;
- prefabricated welded barriers;
- liquid coatings;
- self-adhesive bituminous-coated sheet products; and
- asphalt tanking.

It is important to have adequately sealed joints and the membrane must not be damaged during construction. Where possible, penetration of the membrane by service entries should be avoided. With careful design it may be possible for the barrier to serve the dual purpose of damp proofing and radon protection although the damp-proof course to a cavity wall should be in the form of a cavity tray to prevent radon entering the building through the cavity.

Some typical details are shown in Fig. 8.3.

8.5.11 Full protection against radon

In practical terms, a totally radon-proof barrier may be difficult to achieve.

Therefore, in high-risk areas it is necessary to provide additional secondary protection. This might consist of:

- natural ventilation of an underfloor space by airbricks or ventilators on at least two sides;
- the addition of an electrically operated fan in place of one of the airbricks to provide enhanced subfloor ventilation; and
- a subfloor depressurisation system comprising a sump located beneath the floor slab, joined by pipework to a fan. It may only be necessary to provide the sump and underfloor pipework during construction, thus giving the owner the option of connecting a fan at a later stage if necessary.

Examples of these methods are shown in Figs 8.3 and 8.4.

It should be noted that the above brief notes on BR 211 are intended to give an idea of the content of that document. Designers of buildings in the delimited areas should consult the full report.

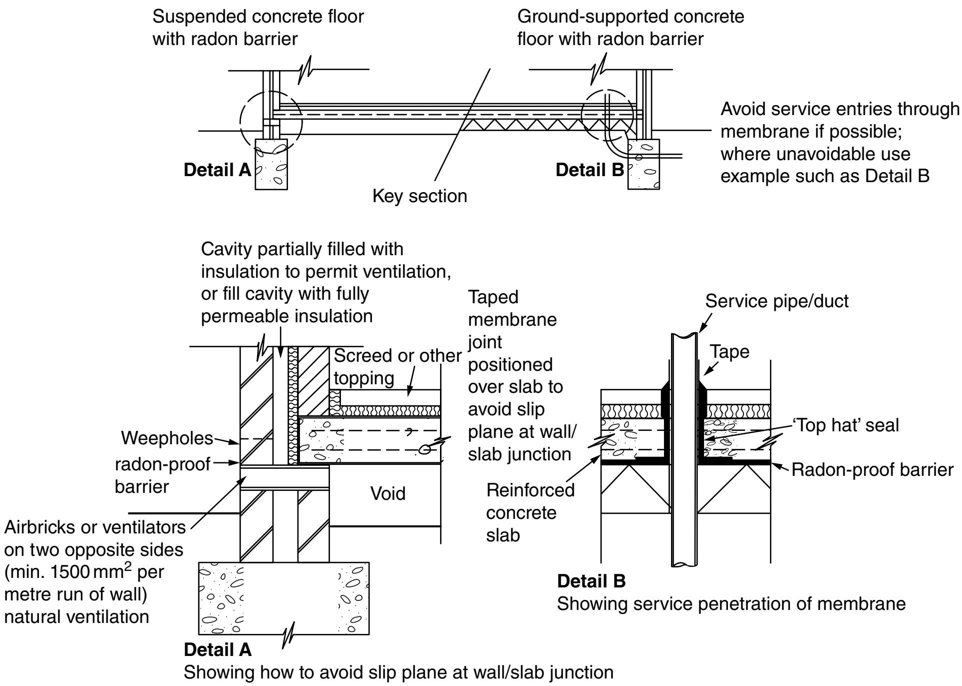


Fig. 8.3 Basic protection against radon.

8.5.12 Contamination of landfill gas

Landfill gas is typically made up of 60% methane and 40% carbon dioxide, although small quantities of other gases such as hydrogen, hydrogen sulphide and a wide range of trace organic vapours (called volatile organic compounds or VOCs in Approved Document C) may also be present. The gas is produced by the breakdown of organic material by microorganisms under oxygen-free (anaerobic) conditions on biodegradable waste materials in landfill sites. Gases similar to landfill gas can also arise naturally from coal strata, river silt, sewage and peat. Additionally, atmospheres that are deficient in methane and oxygen (usually referred to as stythe or blackdamp by miners) and that are rich in carbon dioxide and nitrogen can be produced naturally in coal-mining areas. VOCs can also arise as a result of spillages of petrol, oil and solvents.

8.5.13 Properties of landfill gases

The largest component of landfill gas, methane, is a flammable, asphyxiating gas with a flammable range between 5% and 15% by volume in air. If such a concentration occurs within a building and the gas is ignited, it will explode. Methane is lighter than air.

The other major component, carbon dioxide, is a non-flammable, toxic gas which has a long-term exposure limit of 0.5% by volume and a short-term exposure limit of 1.5%. It is heavier than air. VOCs are both inflammable and toxic and can also have strong unpleasant odours. A build-up to hazardous levels of any of these gases within buildings will result in harm to health and will compromise safety.

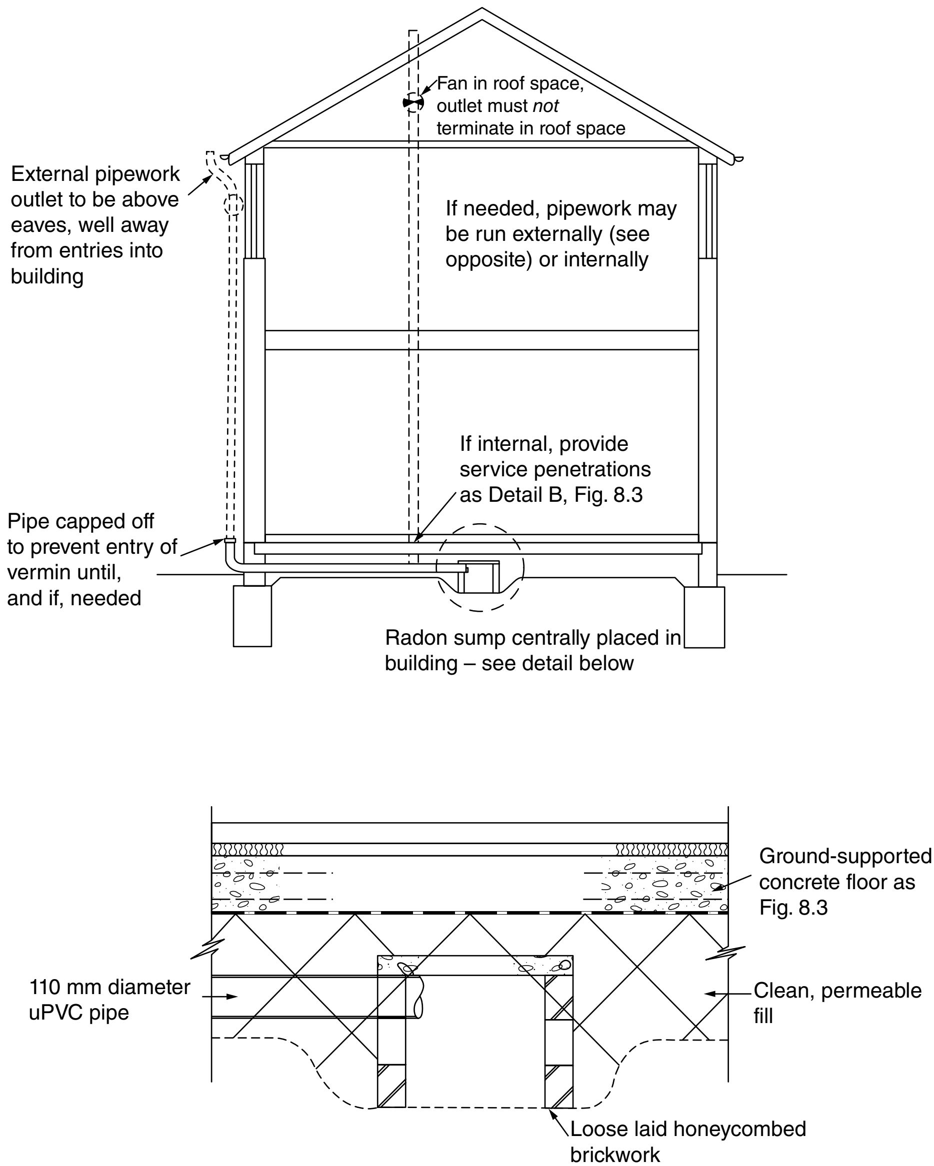


Fig. 8.4 Additional protection against radon.

8.5.14 Movement of landfill gases

The proportions of the two main landfill gases and the amount of air mixed with them will largely determine the properties of the landfill gas since they remain mixed and do not separate, although the mixture can remain separate from surrounding air. These landfill gases will migrate from a landfill site as a result of diffusion through the ground, and this migration may be increased by rainfall or freezing temperatures as these conditions tend to seal the ground surface. The gases will also follow cracks, cavities, pipelines, tunnels, etc., as these form ideal pathways. Landfill gas emissions can be increased by rapid falls in atmospheric pressure and by a rising water table. Thus, landfill gas may enter buildings and may collect in underfloor voids, drains and soakaways.

8.5.15 Building near landfill sites and on gas-contaminated land: Risk assessment

The risk assessment stages referred to in section 8.5.6 should be followed for methane and other landfill gases. Further investigations for hazardous soil gases may also be required if the ground to be covered by a building and/or any land associated with the building is:

(a) on or within 250 m of a landfill site or within the likely sphere of influence of a landfill; in these cases the policy of the Environment Agency regarding building on or near landfill sites should be followed;
(b) on a site where biodegradable substances (including made ground and fill) have been deposited on a large scale;
(c) on a site where the previous use has meant that spillages of petrol, oil and solvents could have taken place (such as vehicle scrapyards); or
(d) in an area where naturally occurring gases (e.g. methane, carbon dioxide, hydrogen sulphide and VOCs) may be present (such as old mining areas and spoil heaps).

In these specific instances, Approved Document C recommends use of the following guidance documents covering hazardous soil gases in the contexts referred to in (a) to (d) above:

- Guidance on the generation and movement of landfill gas as well as techniques for its investigation are given in HMIP Waste Management Paper No. 27 *The control of landfill gas*, TSO, 2nd edition, 1991. Complementary guidance is given in a publication by the Chartered Institution of Wastes Management (CIWM) entitled *Monitoring of landfill gas*, 2nd edition, 1998.
- Guidance covering petroleum retail sites may be found in TP 95 *Guidelines for investigation and remediation of petroleum retail sites*, Institute of Petroleum, 1998.
- Guidance on the geographical extent, associated hazards and methods of site investigation of methane, carbon dioxide and oil seeps from natural sources and mining areas can be found in BGS Technical Report WP/95/1 *Methane, carbon dioxide and oil seeps from natural sources and mining areas: Characteristics, extent and relevance to planning and development in Great Britain*, 1995. This should be read in conjunction with a report sponsored by the former Department of the Environment entitled *Methane and other gases from disused coal mines: The planning response*, 1996.
- Additionally, the following three documents published by CIRIA contain relevant information on methane and other gases including means of generation and movement within the ground, detection and monitoring methods and investigation strategies:
  - CIRIA Report 130 *Methane: Its occurrence and hazards in construction*, 1993;
  - CIRIA Report 131 *The measurement of methane and other gases from the ground*, 1993; and
  - CIRIA Report 150 *Methane investigation strategies*, 1995.

When a site investigation is carried out for methane and other hazardous gases, consideration should be given to the following matters:

- In order to characterise gas emissions fully, measurements should be taken over a sufficiently long period of time (including periods when gas emissions are likely to be higher, e.g. during periods of falling atmospheric pressure).
- It is also important to establish:
  - the concentration of methane and other gases in the ground;
  - the quantity of gas-generating materials and their rate of gas generation;
  - gas movement in the ground; and
  - gas emissions from the ground surface.

Measurements taken of the surface emission rates and borehole flow rates will give an indication of the gas regime in the ground. For further guidance on this, reference should be made to:

- CIRIA Report 151 *Interpreting measurements of gas in the ground*, 1995; and
- CIRIA Report 152 *Risk assessment for methane and other gases from the ground*, 1995.

Additionally, the gas regime on the site can be altered by construction activities undertaken as part of building development. For example, surface gas emissions can be increased by the site strip, by piling and by excavations for foundations and below-ground services; and dry biodegradable waste can be pushed into moist, gas-active zones by dynamic compaction.

In the context of traditional housing, the assessment of gas risks needs to take into account two possible contaminant pathways for human receptors:

- Direct entry of gas into the dwelling through the substructure (where it will ultimately build up to hazardous levels); and
- Later exposure of the householder in garden areas by:
  - the construction of outbuildings (e.g. garden sheds and greenhouses) and extensions to the dwelling, and
  - the carrying out of excavations for garden features (e.g. ponds).

Guidance on the carrying out of risk assessments for methane and other ground gases can be found in CIRIA Report 152 referred to above in Contaminated Land Research Report CLR 11 (see section 8.5.6) and in Environment Agency GasSIM – *Landfill gas assessment tool* (this document also includes the assessment of gas emissions from landfill sites).

The following documents describe a range of ground gas regimes (defined in terms of soil gas concentrations of methane and carbon dioxide as well as borehole flow rate measurements), which can also be helpful in assessing gas risks:

- CIRIA Report 149 *Protecting development from methane*, 1995; and
- DETR/Arup Environmental PIT Research Report: *Passive venting of soil gases beneath buildings*, 1997.

The above discussion has mainly been in the context of housing development. In the context of non-domestic development, the focus might be on the building only, but the general approach is the same.

8.5.16 Building near landfill sites and on gas-contaminated land: Gas control measures

The investigations into gas risks carried out in accordance with the advice given above may conclude that the risks posed by the gases which are present are unacceptable. If this is the case, then appropriate remedial measures may be required to manage the risks. These can be applied to the building alone, or, where the risks on any land associated with the building are deemed unacceptable, this could even mean adopting site-wide gas control measures which could include:

- removal of the material generating the gas; or
- covering together with systems for gas extraction.

CIRIA Report 149 (referred to above) contains further guidance on this. In general, where site-wide gas control measures are thought to be needed, then expert advice should be sought.

Gas control measures: Dwellings

Practical guidance on construction methods to prevent the ingress of landfill gas in buildings is not given in Approved Document C. Instead, the reader is referred to BRE/Environment Agency Report BR 414 *Protective measures for housing on gas-contaminated land*, 2001, where detailed practical guidance on the construction of protective measures may be found.

Gas control measures for dwellings are normally passive (i.e. the gas flow is driven by temperature differences (stack effect) and the effects of wind) and consist of a barrier which is gas resistant across the entire walls and floor of the dwelling. Below this will be an extraction (or ventilation) layer from which gases can be dispersed and vented into the atmosphere. In order to maximise the driving forces of natural ventilation, it will be necessary to consider the design and layout of buildings.

Figure 8.5 gives typical examples of some of the constructional details contained in the BR 414. The DETR/Arup Environmental PIT Research Report *Passive venting of soil gases beneath buildings*, referred to above, can also be used as a guide to the design of a range of commonly used gas control measures.

Gas control measures: Non-domestic buildings

In non-domestic buildings gas control measures are based on the same principles as those used for housing. Therefore, the DETR/Arup Environmental report referred to in the previous paragraph can also be used as a design guide. Since the floor areas of non-domestic buildings can be considerably larger than those of dwellings and the adequate dispersal of gas from beneath the floor must be ensured, it is usually necessary to seek

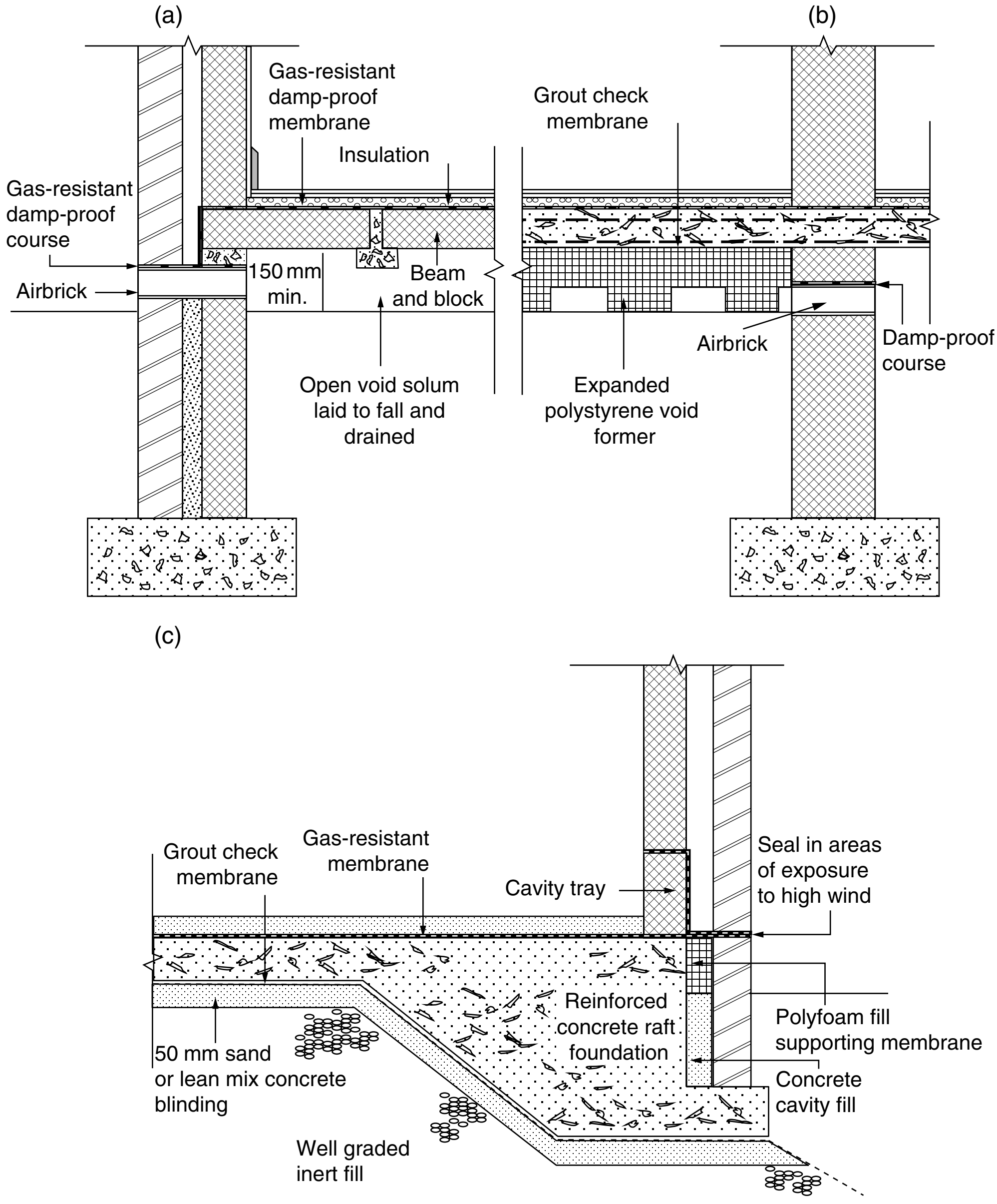


Fig. 8.5 Landfill gas protection details. (a) Beam and block floor with open void. (b) In situ slab with EPS void former. (c) Raft foundation with membrane on top of slab.

expert advice. With larger floor areas, passive systems may not be efficient at ensuring removal of gases; therefore, mechanical systems (which may include monitoring and alarm systems) may be necessary. Such systems also need to be calibrated and continually maintained, so they are more appropriate for non-domestic buildings where there is scope for this. Since special subfloor ventilation systems are carefully designed to ensure adequate performance, they should not be modified unless a specialist review of the design is undertaken. It should be noted that the use of continuous mechanical ventilation for the removal of landfill gases in dwellings is not recommended since there is a risk of interference by users and maintenance of the system cannot be guaranteed. Consequently, a failure might result in a sharp increase in indoor methane concentration with the possibility of an explosion occurring.

It should be noted that the above brief notes on BR 414 are intended to give an idea of the content of that document. Designers of buildings which are likely to be affected by landfill gas should consult the full report and any of the references mentioned in sections 8.5.12 to 8.5.16.

8.5.17 Subsoil drainage

Subsoil drainage must be provided *if* it is necessary to avoid:

- the passage of moisture from the ground to the inside of the building; or
- damage to the fabric of the building. This includes damage to the foundations of the building caused by the transport of waterborne contaminants.

The provisions in AD C assume either that the site of the building will not be subject to general flooding or, *if it is*, then suitable steps are being taken. Interestingly, although flood resistance is not covered by the Building Regulations 2010 at present, there is a presumption in planning guidance (see Planning Policy Guidance Note PPG 25 *Development and flood risk*, DTLR, 2002) that development should not take place in areas that are at risk of flooding.

However, where local considerations might necessitate building in areas that are prone to flooding, the following guidance is offered to mitigate some of its effects:

- The existence of elevated groundwater levels or the flow of subsoil water across a site may be alleviated by the provision of adequate subsoil drainage (see below).
- The creation of blockages in drains and sewers caused by flooding can lead to backflow of sewage into buildings through low-seated toilets, gullies, etc. This can be mitigated by the use of anti-flooding devices and non-return valves (see section 13.3.26 of this book or the CIRIA publication C506 *Low-cost options for prevention of flooding from sewers*, 1998).
- In areas where the design of the below-ground drainage system is such that foul water drainage also receives rainwater, these systems may surcharge in periods of heavy rainfall. This could lead to increased risks of localised flooding within properties in low-lying areas or in those that contain basements unless preventative measures are taken. Some guidance on protection is given in Approved Document H *Drainage and waste disposal* (see section 13.3.26 of this book).
- The passage of groundwater through a floor can be dealt with using water-resistant construction (see section 8.5.19).
- The entry of water into underfloor voids can be addressed by making provision for the inspection and clearing out of such locations beneath suspended floors.

The following publications may also be consulted for further guidance on flooding and flood resilient construction:

- *Improving the flood performance of new buildings – Flood resilient construction* published by DCLG, Defra and the Environment Agency in May 2007.
- *Products. Using flood protection products – A guide for home owners*, CIRIA/Environment Agency Flood, 2003.

Subsoil water may cause problems where:

- there is a high water table (i.e. within 0.25 m of the lowest floor in the building);
- surface water may enter or adversely affect the building;
- an active subsoil drain is severed during excavations;
- the stability and properties of the ground are adversely affected by groundwater beneath or around the building; or
- groundwater flows are altered by general excavation work for foundations and services.

Where problems are anticipated, it will usually be necessary either to drain the site of the building or to design and construct it to resist moisture penetration. Subsoil drainage should also be considered where contaminants are present in the ground in order to prevent the transportation of waterborne contaminants to the foundations or into the building or its services.

Severed subsoil drains that pass under the building should be intercepted and continued in such a way that moisture is not directed into the building. Figure 8.6 illustrates a number of possible solutions.

8.5.18 Resistance to moisture

Requirement C2 of Schedule 1 to the Building Regulations 2010 deals with resistance to moisture. It requires the floors, walls and roof of a building to adequately protect it and the people who use it from harmful effects caused by:

- moisture from the ground;
- precipitation and wind-driven spray;
- surface and interstitial condensation; and
- water spilt from or associated with sanitary fittings and fixed appliances.

Guidance on the application of Requirement C2 is given in Approved Document C in the following sections:

- Section 4: Floors and covering:
  - (a) ground-supported floors, suspended timber ground floors and suspended concrete ground floors when these are exposed to ground moisture;
  - (b) interstitial condensation risk in ground floors and upper floors exposed from below; and
  - (c) surface condensation risk and mould growth on any floor type;

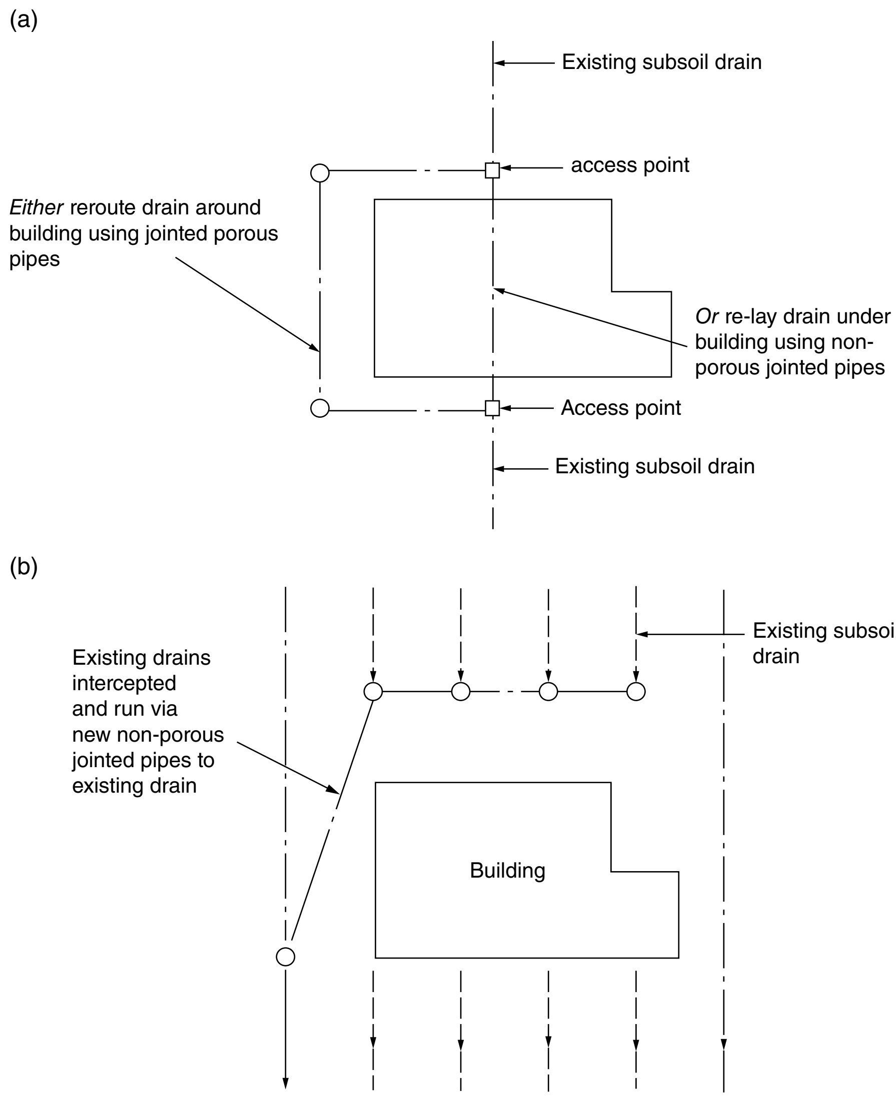


Fig. 8.6 Subsoil drainage. (a) Single subsoil drain. (b) Interception of multiple subsoil drains.

- Section 5: Walls; and
- Section 6: Roofs.

In Approved Document C, the following definitions apply with regard to Requirement C2:

FLOOR – The lower horizontal surface of any space in a building including any surface finish which is laid as part of the permanent construction. This would, presumably, exclude carpets, linoleum, tiles, etc. but would include screeds and granolithic finishes.

GROUNDWATER – Liquid water (i.e. not water vapour, ice, snow, etc.), either flowing through the ground or as a static water table.

INTERSTITIAL CONDENSATION – Water vapour being deposited as liquid water within or between the layers of the envelope of the building.

MOISTURE – Water present as a liquid, gas (e.g. water vapour) or solid (e.g. ice or snow).

PRECIPITATION – Moisture in any form falling from the atmosphere, such as rain, sleet, snow or hail, etc.

ROOF – Any part of the external envelope of a building that makes an angle of less than 70° to the horizontal.

SPRAY – Wind-driven droplets of water blown from the surface of the sea or other bodies of water close to buildings. The salt content of sea spray makes it especially hazardous to many building materials.

SURFACE CONDENSATION – Water vapour being deposited as liquid water on visible surfaces within the building.

VAPOUR CONTROL LAYER – Typically, this is a membrane material which is used in the construction, with the purpose of substantially reducing the transfer of water vapour through any building in which it is incorporated.

WALL – Any opaque part of the external envelope of a building that makes an angle of 70° or more to the horizontal.

8.5.19 Protection of floors next to the ground

Ground floors should be designed and constructed so that:

- the passage of moisture to the upper surface of the floor is resisted (this might not apply to buildings used solely for storage of goods in which the only persons habitually employed were storemen, etc. engaged only in taking in, caring for or taking out the goods; other similar types of buildings where the air is so moisture laden that any increase would not adversely affect the health and safety of the occupants might also be excluded).
- they will not be adversely affected by moisture from the ground.
- they will not be adversely affected by groundwater.
- the passage of ground gases is resisted. This relates back to Requirement C1 (2) (see section 8.5.5) where floors in certain localities may need to be constructed to resist the passage of hazardous gases such as methane or radon. The remedial measures shown in sections 8.5.10 to 8.5.16 can function as both a gas-resistant barrier and damp-proof membrane if properly detailed.
- The structural and thermal performance of the floor is not adversely affected by interstitial condensation. This also applies to floors exposed from below.

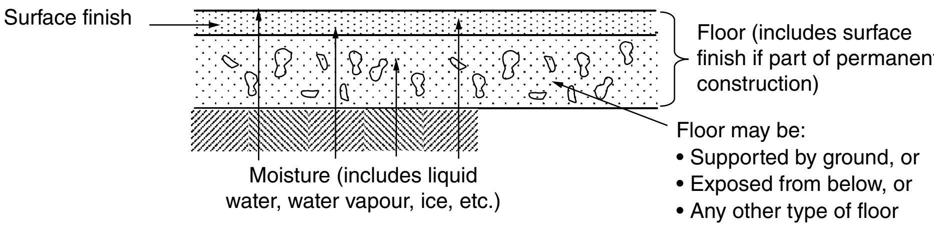


Fig. 8.7 Floors – general guidance.

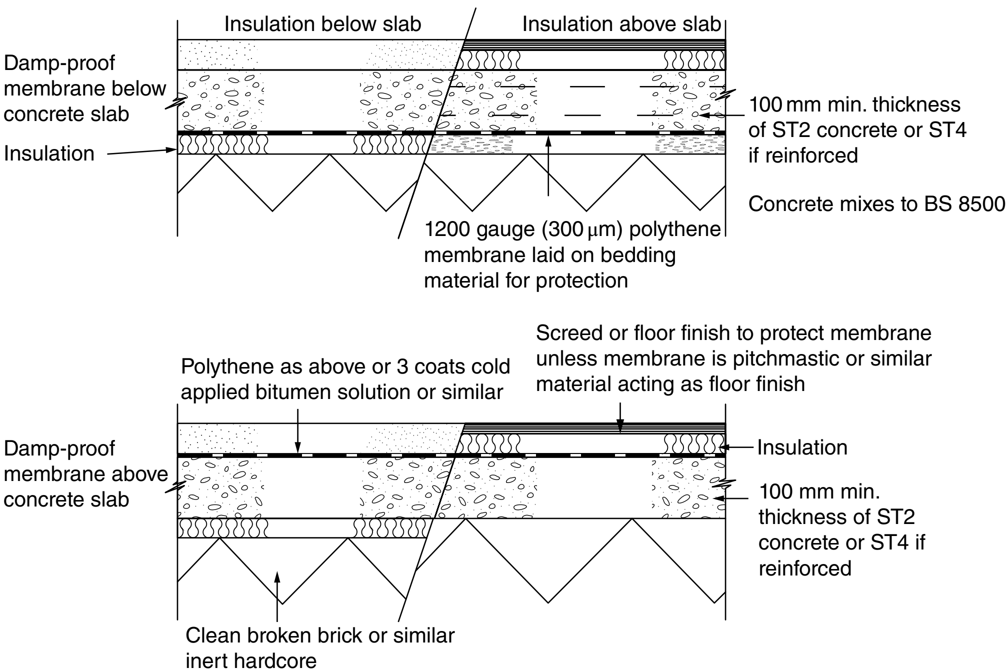


Fig. 8.8 Ground-supported floor.

- Surface condensation and mould growth are not promoted under reasonable occupancy conditions. This applies to all floors (not just those next to the ground).

This guidance is illustrated in Fig. 8.7.

8.5.20 Floors supported directly by the ground

The requirements mentioned above can be met, for ground-supported floors, by covering the ground with dense concrete incorporating a damp-proof membrane, laid on a hardcore bed. If required, insulation may also be incorporated in the floor construction.

This form of construction is illustrated in Fig. 8.8, and, unless the floor is subjected to water pressure, such as occurs with buildings on very permeable strata like chalk, gravel or limestone (see note on the use of BS 8102 below), the construction of the floor should take into account the following points:

- Well-compacted hardcore less than 600 mm thick laid under the floor next to the ground should not contain water-soluble sulphates or deleterious matter in such quantities as might cause damage to the concrete. Broken brick or stone is the best hardcore materials. Clinker is dangerous unless it can be shown that the actual material proposed is free from sulphates, etc., and colliery shales should likewise be avoided (see BRE Digest 276 *Hardcore*, *1992*, for more information). In any event, the builder might well be liable for breach of an implied common law warranty of fitness of materials; see *Hancock* v *B. W. Brazier (Anerley) Ltd* [1966] 2 All ER 901, where builders were held liable for subsequent damage caused by the use of hardcore containing sulphates.
- A damp-proof membrane (DPM) may be provided above or below the concrete floor slab and should be laid continuously with the damp-proof courses in walls, piers, etc. If laid below the concrete, the DPM should be at least equivalent to 300 μm (1200 gauge) polyethylene (e.g. polythene). It should have sealed joints and should be supported by a layer of material that will not cause damage to the polythene. If a polyethylene sheet membrane is laid above the concrete, there is no need to provide the bedding material. It is also possible to use a three-coat layer of cold-applied bitumen emulsion (or equivalent material with similar moisture and water vapour resistance) in this position. These materials should be protected by a suitable floor finish or screed. Surface protection does not need to be provided where the membrane consists of pitchmastic or similar material which also serves as a floor finish. There is one particular case where the membrane should be placed below the concrete slab, and that is where the ground contains water-soluble sulphates or other deleterious material that could contaminate the hardcore.
- The minimum thickness for the concrete slab is 100 mm (although the structural design for the slab may require it to be thicker) designed to mix ST2 in BS 8500. Reinforced concrete should be to mix ST4 in BS 8500.
- Insulants located below floor slabs should:
  - have sufficient strength to resist the weight of the slab;
  - be able to carry the anticipated floor loading;
  - be able to support any overloading during construction; and
  - if placed below the damp-proof membrane have low water absorption (in order to resist degradation) and, if necessary, be resistant to contaminants in the ground.
- AD C section 4 gives no guidance on the position of the floor relative to outside ground level. Since this type of floor is unsuitable if subjected to water pressure, it is reasonable to assume that the top surface of the slab should not be below outside ground level unless special precautions are taken.

If it is proposed to lay a timber floor finish directly on the concrete slab, it is permissible to bed the timber in a material that would also serve as a damp-proof membrane.

No guidance is given regarding suitable DPM materials. However 12.5 mm of asphalt or pitchmastic will usually be satisfactory for most timber finishes, and it may be possible to lay wood blocks in a suitable adhesive DPM. If a timber floor finish is fixed to wooden fillets embedded in the concrete, the fillets should be treated with a suitable preservative unless they are above the DPM (see BS 1282:1999 *Wood preservatives guidance on choice, use and application*).

Clause 11 of CP 102:1973 *Protection of buildings against water from the ground* may be used as an alternative to the above. Where groundwater pressure is evident, recommendations may be found in BS 8102:1990 *Code of practice for protection of structures against water from the ground.*

8.5.21 Suspended timber ground floors

The performance requirements mentioned above may be met for suspended timber ground floors by:

- covering the ground with suitable material to resist moisture and deter plant growth;
- providing a ventilated space between the top surface of the ground covering and the timber; and
- isolating timber from moisture-carrying materials by means of damp-proof courses.

A suitable form of construction is shown in Fig. 8.9 and is summarised as follows:

- The ground surface should be covered with at least 100 mm of concrete to BS 8500 mix ST1, if unreinforced. It should be laid on clean broken brick or similar inert hardcore not containing harmful quantities of water-soluble sulphates or other materials that might damage the concrete. (The Building Research Establishment suggests that over 0.5% of water-soluble sulphates would be a harmful quantity.)
  Alternatively, the ground surface may be covered with at least 50 mm of concrete, as described above, or inert fine aggregate, laid on a polythene DPM as described for ground-supported floors above. The joints should be sealed and the membrane should be laid on a protective bed such as sand blinding.
- Since it undesirable for water to collect on top of the ground-covering material under a timber floor, the ground-covering material should be laid so that *either* its top surface is not below the highest level of the ground adjoining the building *or*, where the site slopes, it may be necessary to install land drainage on the outside at the highest level of the ground adjoining the building and/or fall the ground-covering material to a drainage outlet above the lowest level of the adjoining ground.
- There should be a space above the top of the concrete of at least 75 mm to any wall plate and 150 mm to any suspended timber (or insulation where provided). This depth may need to be increased where the building is constructed on shrinkable clays in order to allow for heave.
- There should be ventilation openings in two opposing external walls allowing free ventilation to all parts of the subfloor. An actual ventilation area equivalent to 1500 mm^2 per metre run of external wall or 500 mm^2/m^2 of floor area (whichever area is greater) should be provided, and any ducts needed to convey ventilating air should

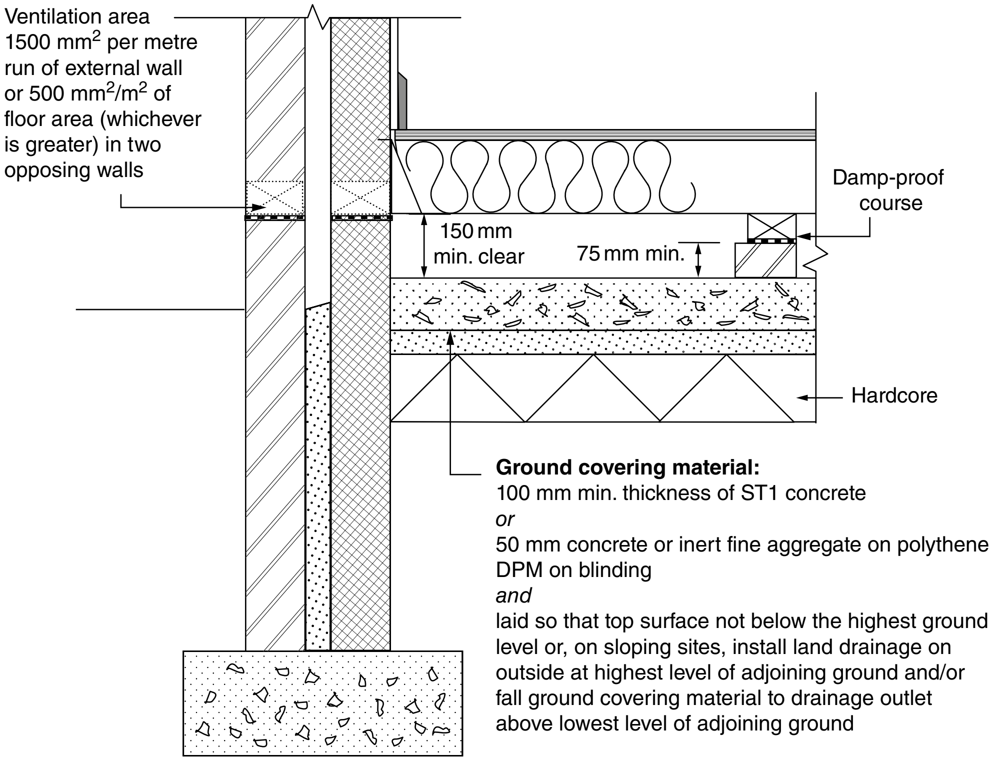


Fig. 8.9 Suspended timber floor.

be at least 100 mm in diameter. Ventilation openings should be fitted with grilles so as to prevent vermin entry, but these grilles should not unduly resist the flow of air. It may be difficult, where there is a requirement for level access to the floor, to provide the ventilators in the position shown in Fig. 8.8 since the top surface of the floor may well be nearer to the ground. The problem can usually be solved using offset (periscope) ventilators.

- Damp-proof courses of impervious sheet materials, slates or engineering bricks bedded in cement mortar should be provided between timber members and supporting structures to prevent transmission of moisture from the ground. BS 5628: Part 3: 2001 gives guidance on the choice of suitable materials.
- In areas where water may be spilled (such as bathrooms, utility rooms and kitchens), boards used for flooring should be moisture resistant, irrespective of the storey in which they are located.

Softwood boarding should be:

- a minimum of 20 mm thick; and
- either from a durable species; or
- treated with a suitable preservative.

Chipboard is particularly susceptible to moisture damage, so where this is used as a flooring material it should be:

- of one of the grades specified in BS 7331:1990 or BS EN 312 Part 5: 1997 as having improved moisture resistance; and
- laid, fixed and jointed in the manner recommended by the manufacturer with the identification marks facing upwards in order to demonstrate compliance.

Again, the recommendations of clause 11 of CP 102:1973 may be used instead of the above, especially if the floor has a highly vapour-resistant finish.

8.5.22 Suspended concrete ground floors

Moisture should be prevented from reaching the upper surface of the floor, and the reinforcement should be protected against moisture if the construction is to be considered satisfactory.

Suitable suspended concrete ground floors may be of precast construction with or without infilling slabs or they may be cast in situ.

Normally, for in situ construction, the concrete should be at least 100 mm thick (unless required to be thicker by the structural design), and it should contain a minimum of 300 kg of cement per m^3 of concrete. The reinforcement should be protected by at least 40 mm cover.

Precast concrete construction offers another solution, and this can be built with or without infilling slabs or blocks. The reinforcement in this case should have at least the thickness of cover required for moderate exposure.

A damp-proof membrane should be provided if the ground below the floor has been excavated so that it is lower than the outside ground level and it is not effectively drained. The space between the underside of the floor and the ground should be ventilated. The space should be at least 150 mm in depth (measured from the ground surface to the underside of the floor or insulation, if provided), and the ventilation recommendations should be as for suspended timber floors (see section 8.5.21).

If the building is located in an area where flooding might be a problem, it may be necessary to include a means of inspecting and clearing out the subfloor voids beneath suspended floors. The DCLG/Defra/Environment Agency publication *Improving the flood performance of new buildings – Flood resilient construction* offers guidance on preparing for floods.

These recommendations are summarised in Fig. 8.10.

8.5.23 Resistance to damage from interstitial condensation for ground floors and floors exposed from below

Ground floors and floors exposed from below (such as those above an open parking bay under a building or an open passageway) should be designed and constructed so that their structural and thermal performance is not adversely affected by interstitial condensation. No actual guidance is given in Approved Document C, the reader merely being referred to other sources of guidance such as:

- Clause 8.5 and Appendix D of BS 5250:2002 *Code of practice for the control of condensation in buildings*;

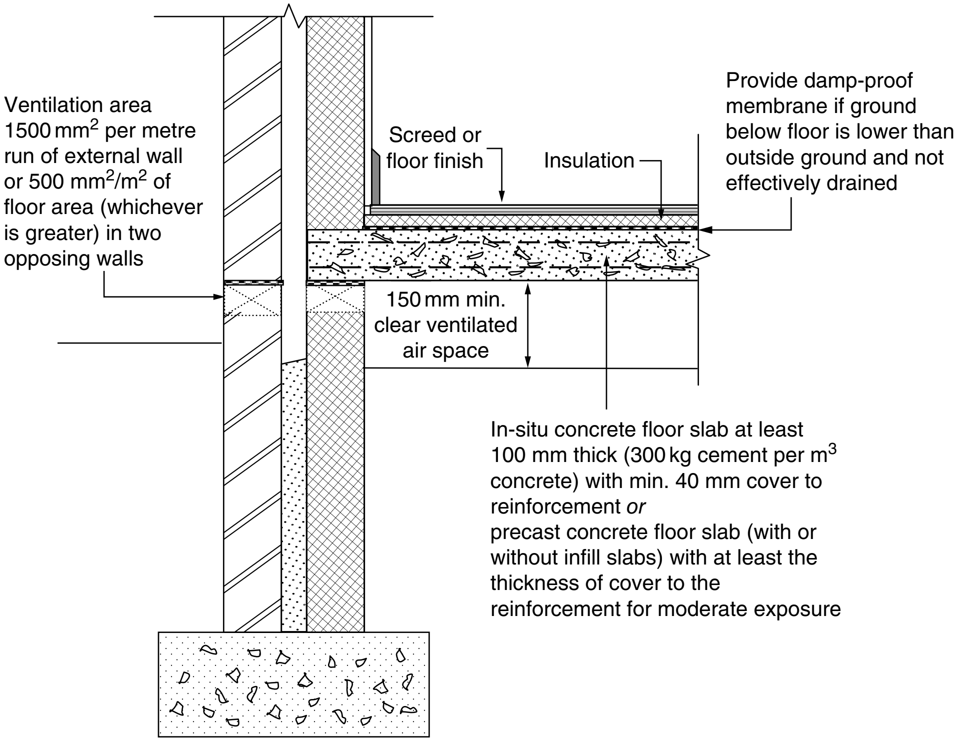


Fig. 8.10 Suspended concrete ground floors.

- BS EN ISO 13788:2001 *Hygrothermal performance of building components and building elements. Internal surface temperature to avoid critical surface humidity and interstitial condensation. Calculation methods*; and
- BRE Report BR 262 *Thermal insulation: Avoiding risks*, 2002.

8.5.24 Resistance to surface condensation and mould growth in floors

In order to resist surface condensation and mould growth in floors, it is necessary to ensure that the surface is maintained above the dewpoint temperature. This will depend on the outside temperature, the temperature of the room in which the floor surface is situated and the relative humidity of the room. It can be affected by ventilation, by thermal bridging of construction elements at junctions and by the degree of thermal insulation provided in the flooring elements.

Therefore, in all floors, care should be taken to design the junctions between the elements so that thermal bridging is avoided. This can be done by following the Accredited Construction Details for Part L published by DCLG and available from the Planning Portal website or by following the guidance of BRE Information Paper IP17/01 *Assessing the effects of thermal bridging at junctions and around openings*.

Additionally, ground floors should be designed and constructed so that the thermal transmittance (U-value) does not exceed 0.7 W/m^2K at any point.

8.5.25 Protection of walls against moisture from the ground

The term *wall* means vertical construction, which includes piers, columns and parapets and may include chimneys if they are attached to the building. Windows, doors and other openings are not included, but the joint between the wall and the opening is included.

Walls should be constructed so that:

- the passage of moisture from the ground to the inside of the building is resisted (this might not apply to buildings used solely for storage of goods in which the only persons habitually employed were storemen, etc. engaged only in taking in, caring for or taking out the goods. Other similar types of buildings where the air is so moisture laden that any increase would not adversely affect the health and safety of the occupants might also be excluded.)
- they will not be adversely affected by moisture from the ground.
- they will not transmit moisture from the ground to another part of the building that might be damaged.

The requirements mentioned above can be met for internal and external walls by providing a damp-proof course of suitable materials in the required position.

Figure 8.11 illustrates the main provisions, which can be summarised as follows:

- The damp-proof course may be of any material that will prevent moisture movement. This would include bituminous sheet materials, engineering bricks or slates laid in cement mortar, polyethylene or pitch polymer materials.
- The damp-proof course and any damp-proof membrane in the floor should be continuous.
- Unless an external wall is suitably protected by another part of the building, the damp-proof course should be at least 150 mm above outside ground level.
- Where a damp-proof course is inserted in an external cavity wall, the cavity should extend at least 225 mm below the level of the lowest damp-proof course. Alternatively, precipitation (see definition in section 8.5.18) can be prevented from reaching the inner leaf of the wall by the use of a damp-proof tray. This may be particularly useful where a cavity wall is built directly off a raft foundation, ground beam or similar supporting structure, and it is impractical to continue the cavity down 225 mm. Where a cavity tray is inserted, weep holes should be provided every 900 mm in the outer leaf in order to allow moisture collecting on the tray to pass out of the wall. In some circumstances, such as above a window or door opening, the cavity tray will not extend the full length of the exposed wall. Here stop ends should be provided to the tray and at least two weep holes should be provided.

For walls subject to groundwater pressure, reference should be made to the relevant recommendations of clauses 4 and 5 of BS 8215:1991 *Code of practice for design and installation of damp-proof courses in masonry construction*. Additionally, BS 8102:1990 *Code of practice for protection of structures against water from the ground* includes recommendations for walls subject to groundwater pressure including basement walls.

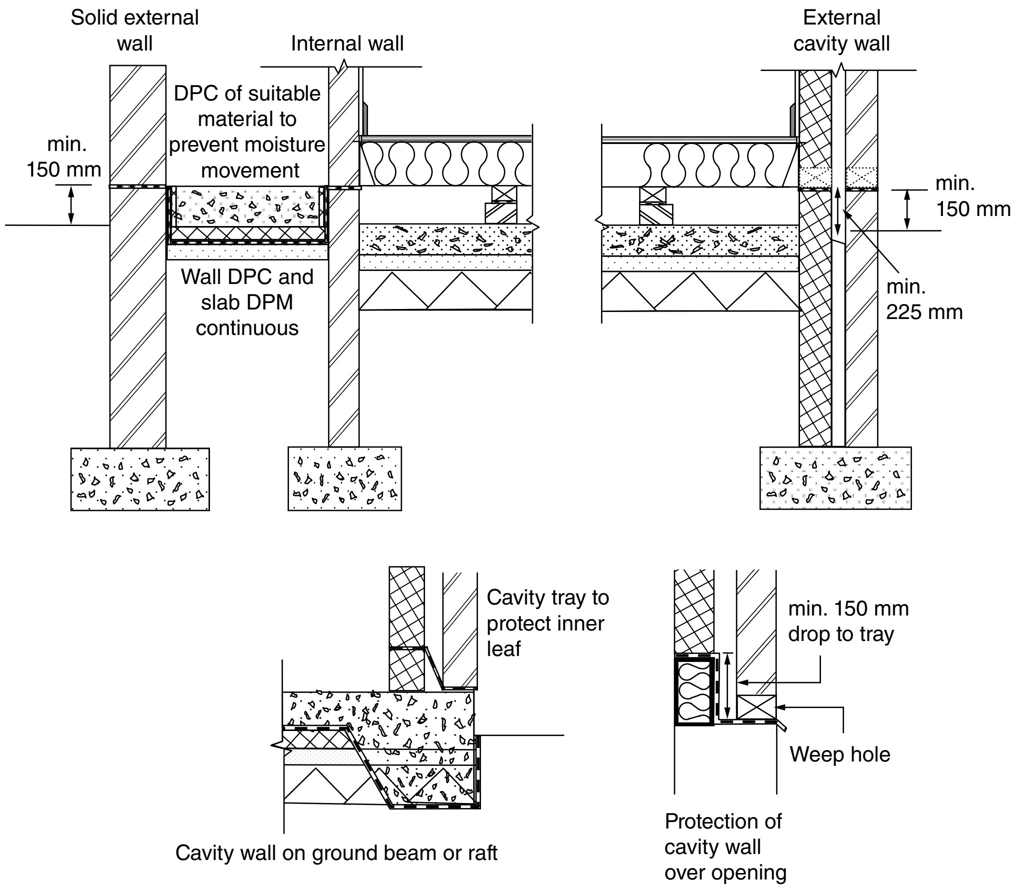


Fig. 8.11 Protection of walls against moisture from the ground.

8.5.26 Weather resistance of external walls

In addition to resisting ground moisture, external walls should:

- resist the passage of precipitation to the inside of the building (this might not apply to buildings used solely for storage of goods in which the only persons habitually employed were store personnel, etc. engaged only in taking in, caring for or taking out the goods; other similar types of buildings where the air is so moisture laden that any increase would not adversely affect the health and safety of the occupants might also be excluded);
- not transmit moisture due to precipitation to other components of the building that might be damaged;
- be designed and constructed so as not to allow interstitial condensation to adversely affect their structural and thermal performance; and
- not promote surface condensation and mould growth under reasonable occupancy conditions.

There are a number of forms of wall construction that will satisfy the above requirements:

- A solid wall of sufficient thickness holds moisture during bad weather until it can be released in the next dry spell.
- An impervious or weatherproof cladding prevents moisture from penetrating the outside face of the wall.
- The outside leaf of a cavity wall holds moisture in a similar manner to a solid wall, the cavity preventing any penetration to the inside leaf.

These principles are illustrated in Fig. 8.12.

8.5.27 Solid external walls

The thickness of a solid external wall will depend on the type of brick or block used and the severity of exposure to wind-driven rain. This may be assessed for a building in a given area by using BS 8104:1992 *Code of practice for assessing exposure of walls to wind-driven rain.* Reference may also be made to BS 5628 *Code of practice for use of masonry*, Part 3: 2001 *Materials and components, design and workmanship* and the publication by the BRE entitled *Thermal insulation – Avoiding the risks.*

In conditions of *very* severe exposure, it may be necessary to use an external cladding. However, in conditions of severe exposure, a solid wall may be constructed as shown in Fig. 8.13. The following points should also be considered:

- For brickwork or stonework, the wall should be at least 328 mm thick.
- For dense aggregate blockwork, the wall should be at least 250 mm thick.
- For lightweight aggregate or aerated autoclaved concrete, the wall should be at least 215 mm thick.
- The brickwork or blockwork should be rendered or given an equivalent form of protection.
- Rendering should have a scraped or textured finish and be at least 20 mm thick in two coats. This permits easier evaporation of moisture from the wall.
- The bricks or blocks and mortar should be matched for strength to prevent cracking of joints or bricks, and joints should be raked out to a depth of at least 10 mm in order to provide a key for the render.
  Further guidance on mortar mixes is given in BS EN 998: Part 2: 2003 *Specification of mortar for masonry*.
- The render mix should not be too strong or cracking may occur. A mix of 1:1:6 cement/lime/well-graded sharp sand is recommended for all walls except those constructed of dense concrete blocks where 1:½:4 should prove satisfactory.
  Further details of a wide range of render mixes according to the severity of exposure, and the type of brick or block may be obtained from BS 5262:1991 *Code of practice for external renderings*.
- It is, of course, possible to obtain a wide range of premixed and proprietary mortars and renders. These should be used in accordance with the manufacturer's instructions.
- Where the top of a wall is unprotected by the building structure, it should be protected to resist moisture from rain or snow. Unless the protection and joints form a complete barrier to moisture, a damp-proof course should also be provided.

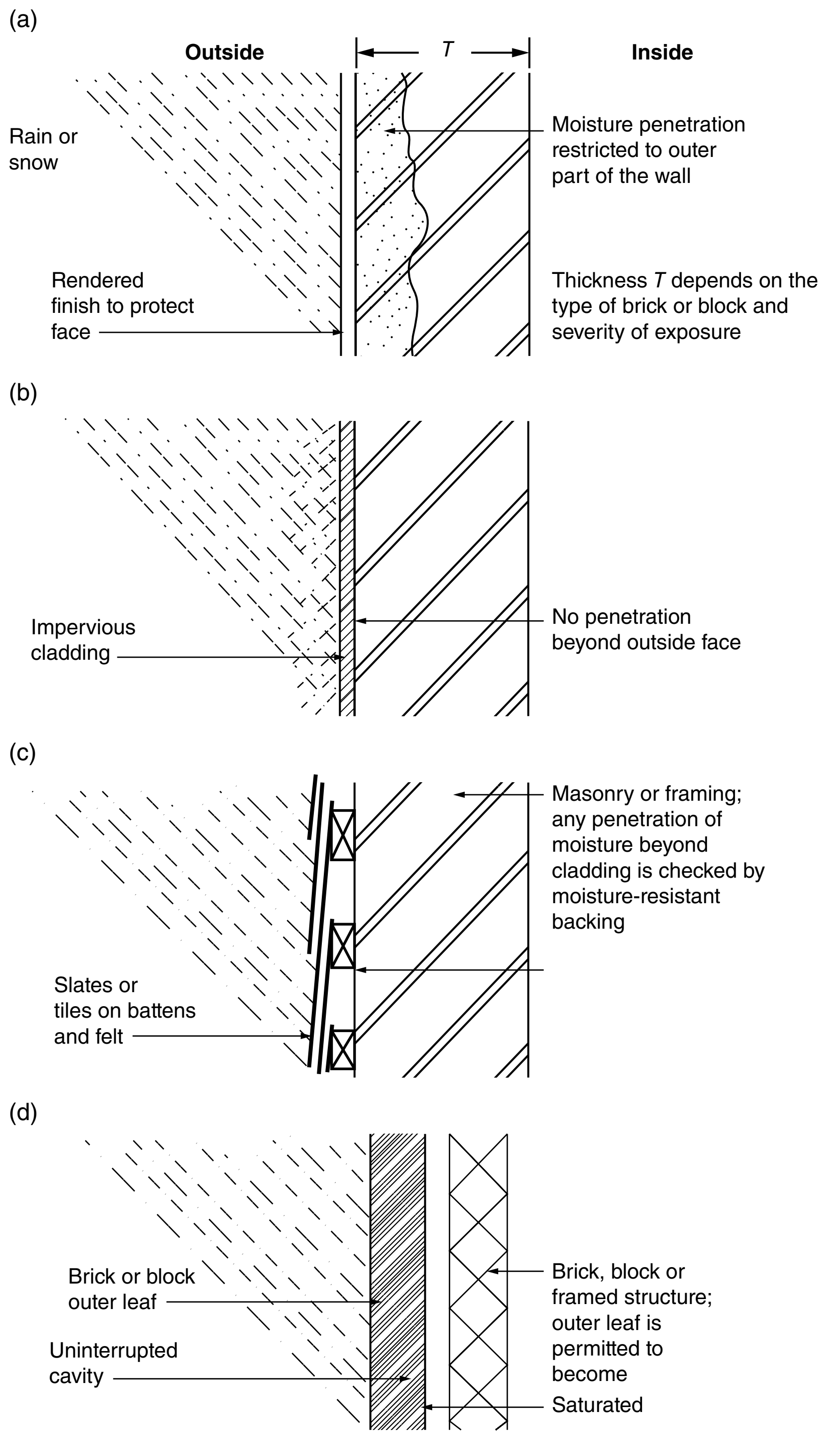


Fig. 8.12 Weather resistance of external walls – principles. (a) Solid external wall. (b) Impervious cladding. (c) Weather-resistant cladding. (d) Cavity wall.

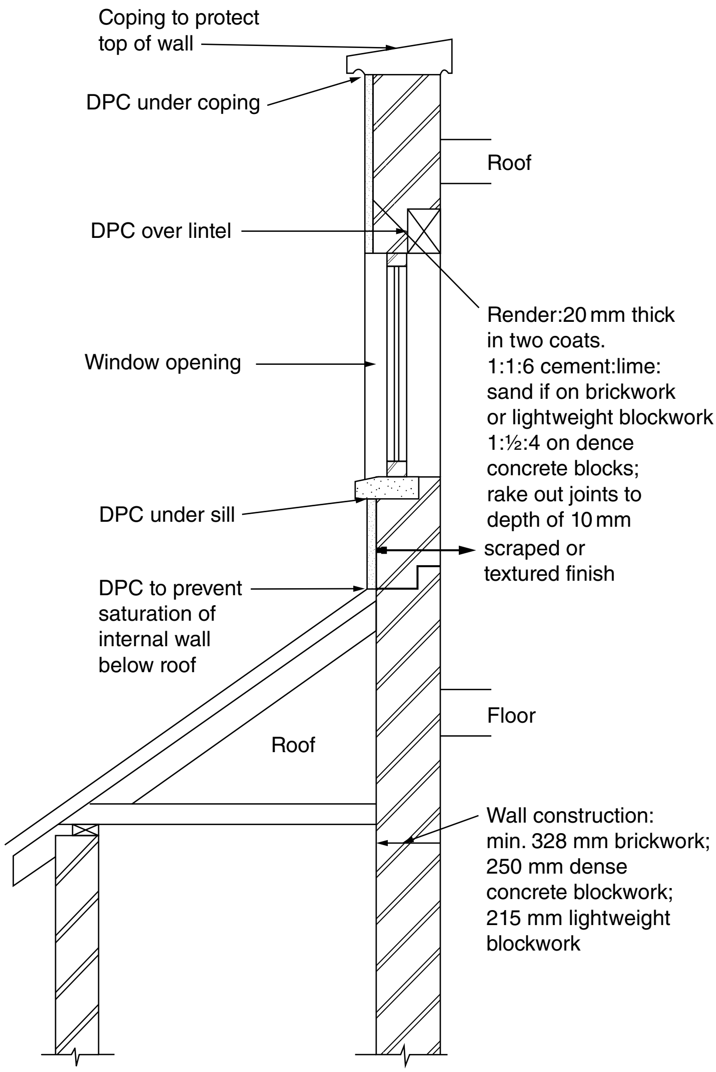


Fig. 8.13 Solid external walls – moisture exclusion.

- Damp-proof courses, trays and closers should be provided to direct moisture towards the outside face of the wall in the positions shown in Fig. 8.13.
- Insulation to solid external walls may be provided on the inside or outside of the wall. Externally placed insulation should be protected unless it is able to offer resistance to moisture ingress so that the wall may remain reasonably dry (and the insulation value may not be reduced). Internal insulation should be separated from the wall construction by a cavity to give a break in the path for moisture. (Some examples of external wall insulation are given in Fig. 8.14.)

The performance requirements for solid and cavity external walls can also be met by complying with BS 5628 *Code of practice for use of masonry*: Part 3: 2001 *Materials and components, design and workmanship*.

8.5.28 External cavity walls

In order to meet the performance requirements, an external cavity wall should consist of an internal leaf which is separated from the external leaf by:

- a drained airspace; or
- some other method of preventing precipitation from reaching the inner leaf.

An external cavity wall may consist of the following:

- An outside leaf of masonry (brick, block, natural or reconstructed stone).
- Minimum of 50 mm uninterrupted cavity. Where a cavity is bridged (by a lintel, etc.), a damp-proof course or tray should be inserted in the wall so that the passage of moisture from the outer to the inner leaf is prevented. This is not necessary where the cavity is bridged by a wall tie or where the bridging occurs, presumably at the top of a wall and is then protected by the roof. Cavity walls may also be bridged by cavity barriers and fire stops where other parts of the building regulations require this (such as Part B or Part E). Where an opening is formed in a cavity wall, the jambs should have a suitable vertical damp-proof course, or the cavity should be provided with a suitable cavity closure so as to prevent the passage of moisture.
- An inside leaf of masonry or framing with suitable lining.
- In order to ensure structural robustness and weather resistance in the wall, masonry units should be laid on a full bed of mortar, and the cross joints should be continuously and substantially filled.
- Where a cavity is only partially filled with insulation, the remaining cavity should be at least 50 mm wide (see Fig. 8.14).

Alternatively, the relevant recommendations of BS 5628 *Code of practice for use of masonry*: Part 3: 2001 *Materials and components, design and workmanship* may be followed. Factors affecting rain penetration of cavity walls are indicated in the Code.

8.5.29 Weather resistance and cavity insulation

Since the installation of cavity insulation effectively bridges the cavity of a cavity wall and could give rise to moisture penetration to the inner leaf, it is most important that it be carried out correctly and efficiently. Approved Document C lists a number of British Standards, Codes of Practice and other documents that cover the various materials that may be incorporated into a cavity wall. It also sets out a simple method for determining the minimum width of cavity whether filled or clear for various exposure conditions, various insulating methods and various forms of wall construction. Diagram 12 from Approved Document C is reproduced below. When used with Table 4 (also reproduced), the suitability of a wall for installing insulation may be determined as follows:

(1) From Diagram 12 determine the national exposure (e.g. zone 1, 2, 3 or 4).
(2) Modify this result by either adding one to the exposure zone if local conditions accentuate wind effects (e.g. open hillsides or valleys where the wind is funnelled onto the wall) or subtract one from the exposure zone where the walls do not face into the prevailing wind.

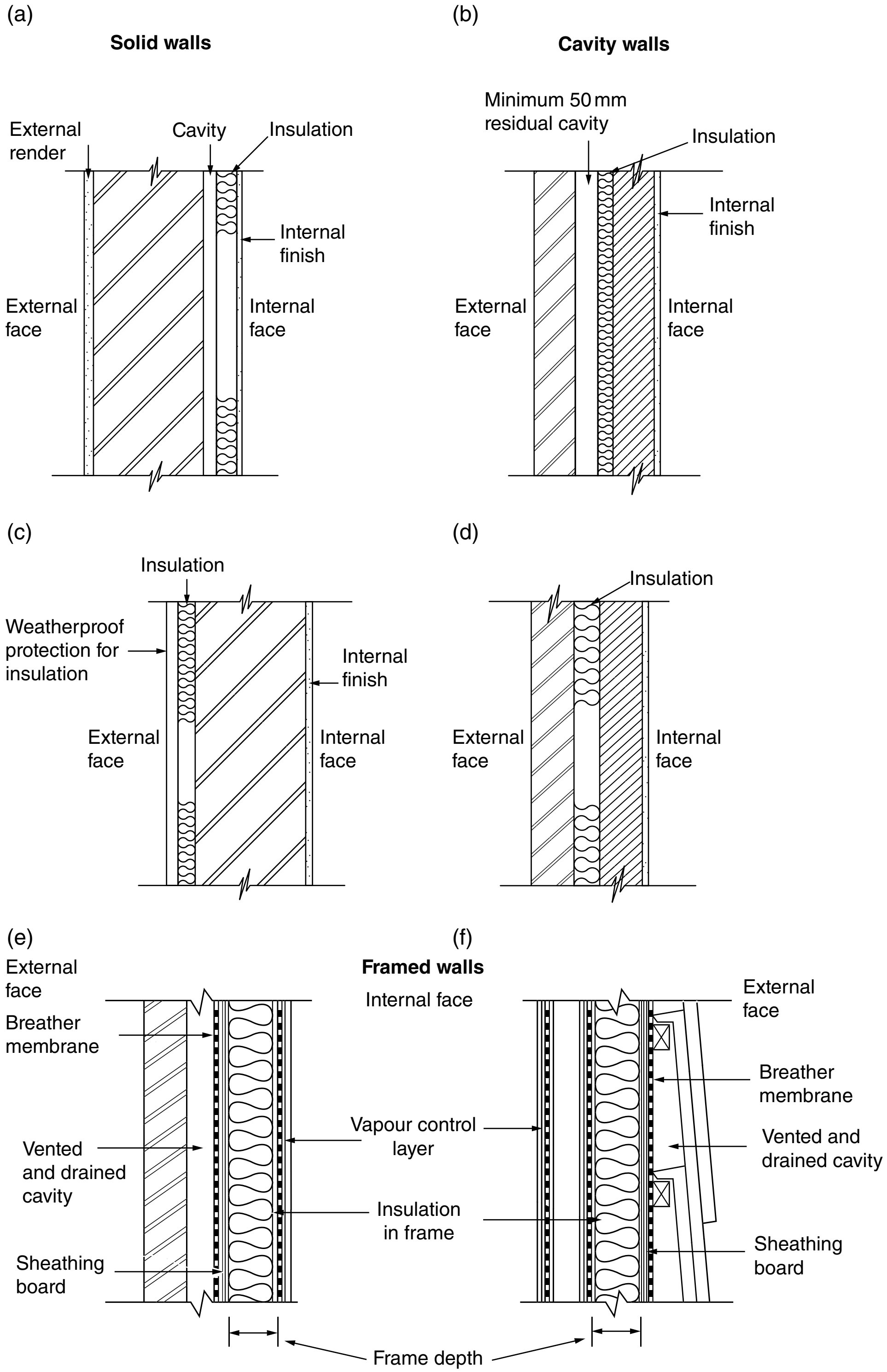


Fig. 8.14 Weather resistance and insulation of external walls. (a) Internal insulation. (b) Partially filled cavity. (c) External insulation. (d) Fully filled cavity. (e) Brick-clad timber-framed wall. (f) Tile-clad timber-framed wall.

(3) Select a form of wall construction from impervious cladding, rendered finish or facing masonry.
(4) Choose an insulation method from built-in full fill, injected fill (UF foam or other material), partial fill, internal insulation or fully filled cavity.
(5) Select the appropriate cavity width by reference to the exposure zone figure.

AD C
Diagram 12 UK zones for exposure to driving rain.

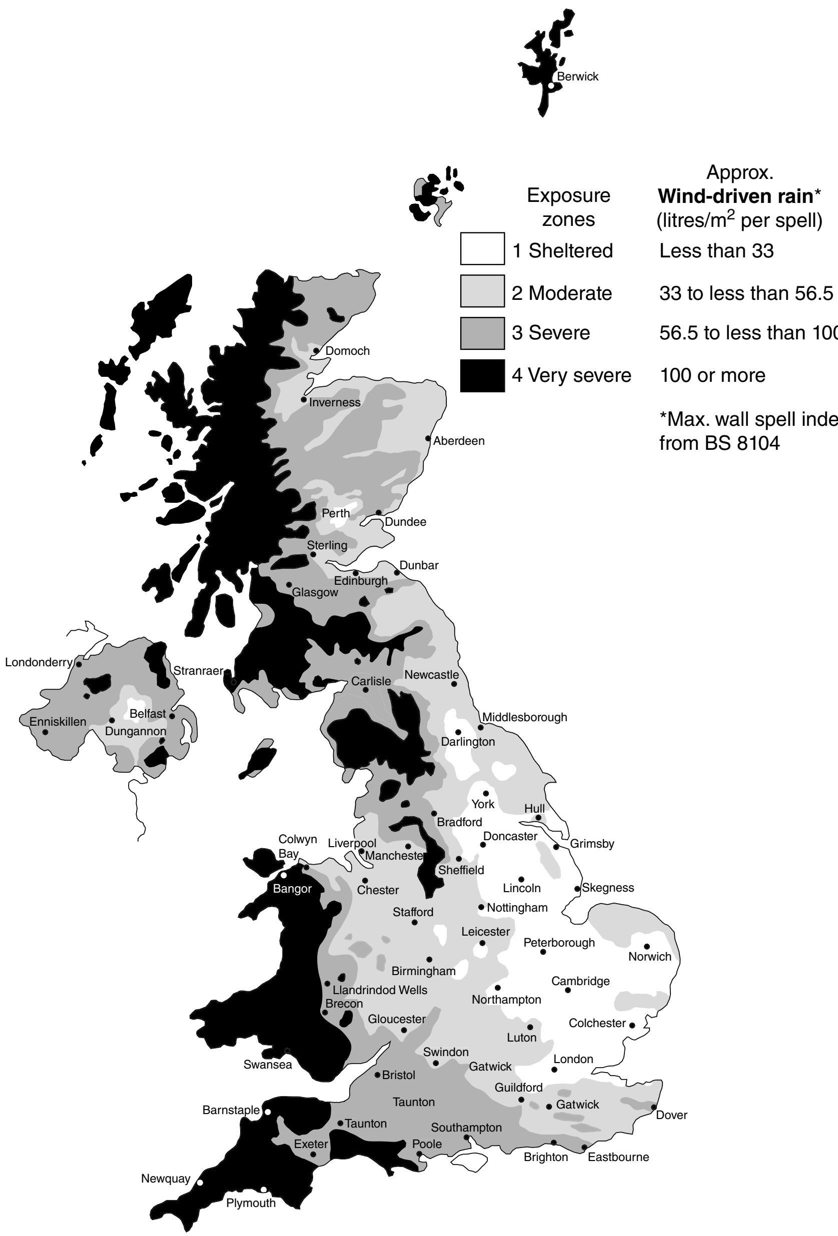


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Table 4 Maximum recommended exposure zones for insulated masonry walls.

Wail construction		Maximum recommended exposure zone for each construction						
		Impervious cladding		Rendered finish		Facing masonry		
Insulation method	Min. width of mod or clear cavity (mm)	Full height of wall	Above facing masonry	Full height of wall	Above facing masonry	Tooled flush Joint	Recessed mortar Joints	Flush slits and copings
Bun-in full fill	50	4	3	3	3	2	1	1
	75	4	3	4	3	3	1	1
	100	4	4	4	3	3	1	2
	125	4	4	4	3	3	1	2
	150	4	4	4	4	4		2
Injected fill not UF foam	60	4	2	4	2	2	1	1
	75	4	3	4	3	3	1	1
	100	4	3	4	3	3	1	1
	125	4	4	4	3	3	1	2
	150	4	4	4	4	4	1	2
Injected fill UF foam	50	4	2	3	2	1	1	1
	75	4	2	3	2	21	1	1
	100	4	2	3	2	2	1	1
Partial fill								
Residual 50 mm cavity	50	4	4	4	4	3	1	1
Residual 76 mm cavity	76	4	4	4	4	4	1	1
Residual 100 mm cavity	100	4	4	4	4	4	2	1
Internal Insulation								
Clear cavity 50 mm	50	4	3	4	3	3	1	1
Clear cavity 100 mm	100	4	4	4	4	4	2	2
Fully filled cavity 50 mm	50	4	3	3	3	2	1	1
Fully filled cavity 100 mm	100	4	4	4	3	3	1	2

BRE Report 262 *Thermal insulation: Avoiding risks* contains further information regarding the use of Table 4.

It is also possible to determine the suitability of a wall for installing insulation into the cavity by following the calculation or assessment procedure in current British or CEN standards. When partial fill materials are to be used, the residual cavity should not be less than 50 mm nominal.

The following points should also be taken into account:

- Rigid materials (boards or batts) which are built in as the wall is constructed should be the subject of current certification from an appropriate body or a European Technical Approval, and the work should be carried out to meet the requirements of that document.
- Urea-formaldehyde foam inserted after the wall has been constructed should comply with BS 5617:1985 *Specification for urea-formaldehyde (UF) foam systems suitable for thermal insulation of cavity walls with masonry or concrete inner and outer leaves* and should be installed in accordance with BS 5618:1985 *Code of practice for thermal insulation of cavity walls (with masonry or concrete inner and outer leaves) by filling with urea-formaldehyde (UF) foam systems*. Before work is commenced, the wall should be assessed for suitability, and the work should be carried out by a person operating under an Approved Installer Scheme that includes an assessment of capability (see also Chapter 9 *Toxic substances*).
- Other insulating materials inserted after the wall has been constructed should have certification from an appropriate body and be installed in accordance with the appropriate installations code. Before work is commenced, the wall should be assessed for suitability, and the work should be carried out by a person operating under an Approved Installer Scheme that includes an assessment of capability. Alternatively, the insulating material should be the subject of current certification from an appropriate body or a European Technical Approval. The work should be carried out to meet the requirements of the relevant document by operatives directly employed by the document holder. Alternatively, they may be employed by an installer approved to operate under the document. Where materials are being inserted into a cavity wall of an existing house, the suitability of the wall for filling should be assessed, before installation, in accordance with BS 8208: Part 1: 1985 *Guide to assessment of suitability of external cavity walls for filling with thermal insulation*. Special attention should be given to the condition of the external leaf of the wall (e.g. its state of repair and type of pointing). Some materials that are used to fill existing cavity walls may have a low risk of moisture being carried over to the internal leaf of the wall. In cases where a third-party assessment of such a cavity fill material contains a method of assessing the construction of the walls and exposure risk, the procedure set out above may be replaced by that method.

(See Fig. 8.14 for further information regarding the insulation of external walls.)

8.5.30 Impervious claddings for external walls

The principles of external claddings are illustrated in Fig. 8.12(b) and (c) where it is shown that they should:

- resist the passage of precipitation to the inside of the building;
- not be damaged by precipitation; and
- not transmit moisture due to precipitation to any part of the building that might be damaged.

It is possible to design cladding so that it can either hold precipitation (even if wind driven) at the face of the building (impervious cladding) or allow precipitation to penetrate beyond the face but stop it from getting beyond the back of the cladding.

Therefore the cladding should be either:

- jointless (or have sealed joints) and be impervious to moisture (such as sheets of metal, glass, plastic or bituminous materials); or
- have overlapping dry joints and consist of impervious or weather-resisting materials (such as natural stone or slate, cement-based products, fired clay or wood).

Dry-jointed claddings should be backed by a material (such as sarking felt), which will direct any penetrating moisture to the outside surface of the structure.

Moisture-resisting materials consisting of bituminous or plastic products lapped at the joints are permitted, but they should be permeable to water vapour unless there is a ventilated space behind the cladding.

Materials that are jointless or have sealed joints should be designed to accommodate structural and thermal movement.

Dry joints between cladding units should be designed either to resist precipitation or to direct any moisture entering them to the outside face of the structure. The suitability of dry joints will depend on the design of the joint and cladding and the severity of exposure of the building to wind and rain.

All external claddings should be securely fixed, and particular care should be taken with detailing and workmanship at the junctions between window and door openings and the cladding since these junctions are particularly susceptible to the ingress of moisture. BS 8000: Part 6: 1990 *Workmanship on building sites – Code of practice for slating and tiling of roofs and claddings* may be of some assistance for claddings containing these materials.

Some materials, such as timber claddings, are subject to rapid deterioration unless properly treated. These materials should only be used as the weather-resisting part of a roof or wall if they can meet the conditions specified in AD Regulation 7 described earlier in this chapter. It should be noted that the weather-resisting part of a roof or wall does not include paint or any surface rendering or coating which does not of itself provide all the weather resistance. Where the cladding is on the façade of a timber-framed building or is itself supported by timber components, the construction should be ventilated so that rapid drying out of any penetrating moisture is ensured. Furthermore, the cladding to framed external walls (see Fig. 8.14(e) and (f)) should be separated from the insulation or sheathing by a vented and drained cavity with a membrane that allows water vapour to pass through it but resists the passage of liquid water on the inside of the cavity.

Insulation may be incorporated into the roof or wall cladding provided that it is protected from moisture (or is unaffected by it). Possible problems may arise due to interstitial condensation and cold bridges in the construction. Further guidance on this may be found in BRE Report BR 262 *Thermal insulation – Avoiding risks*.

8.5.31 Impervious claddings for external walls: Alternative approach

Relevant recommendations of the following alternative guidance sources can be used instead of the detailed guidance given in Approved Document C:

- British Standard Code of Practice 143 *Code of practice for sheet roof and wall coverings* (this includes recommendations for aluminium, zinc, galvanised corrugated steel, copper and semi-rigid asbestos bitumen sheet);
- BS 6915:2001 *Specification for design and construction of fully supported lead sheet roof and wall coverings*;
- BS 8219 *Profiled fibre cement. Code of practice*;
- BS 8200:1985 *Code of practice for design of non-load-bearing external vertical enclosures of buildings*;
- BS 8297:2000 *Code of practice for design and installation of non-load-bearing precast concrete cladding*;
- BS 8298:1994 *Code of practice for design and installation of natural stone cladding and lining*;
- MCRMA Technical Paper 6 *Profiled metal roofing design guide*, revised edition 1996; and
- MCRMA Technical Paper 9 *Composite roof and wall cladding panel design guide*, 1995.

The above documents describe the materials to be used and contain design guidance including fixing recommendations.

8.5.32 Cracking of external walls

This very brief section, which was added into the 2004 edition of Approved Document C, is curious in that it rather states the obvious: that severe rain penetration may occur through cracks in masonry external walls! It goes on to give the reasons for the cracking as being thermal movement in hot weather or subsidence after prolonged droughts and advises that this should be taken into account when designing the building. There are, of course, many causes of cracking in external walls including moisture movement in clay brickwork, cavity wall tie failure, sulphate attack, frost action, swelling and shrinking of clay soils, mining subsidence, faulty drains, etc. In order to assist the reader, the following reference sources are given in the Approved Document:

- BRE Building Elements. *Walls, windows and doors*;
- BRE Report BR 292 *Cracking in buildings*; and
- BS 5628: Part 3: 2001 *Code of practice for use of masonry. Materials and components, design and workmanship*.

The first two references are both excellent information sources. The author has also found the publication *Common defects in buildings* published by The Stationery Office to be invaluable, especially in the diagnosis of defects with particular reference to cracking in external walls. BS 5628 is more relevant to choice of materials.

8.5.33 Detailing of joints between walls and door and window frames

In many cases, the most vulnerable part of the construction regarding moisture penetration due to precipitation is at the junction between the wall and any door, window or other openings into the building. The joint formed at such junctions should:

- resist the passage of precipitation to the inside of the building;
- not transmit moisture due to precipitation to other parts of the building that might be damaged; and
- not be damaged by precipitation.

The usual way of satisfying these performance criteria is by the use of suitably placed damp-proof courses to direct moisture to the outside. These should be provided:

- where moisture flowing downward would be interrupted by an obstruction, such as a lintel;
- where a sill under a door, window or other opening (including any associated joint) might not form a complete barrier to the transfer of precipitation; and
- where the construction of a reveal at a door, window or other opening (including any associated joint) might not form a complete barrier to the passage of rain or snow.

Modern methods of construction often lead to rather wide cavities due to the additional thicknesses of insulation now required by Part L (see Chapter 16) and the need in some cases for a drained 50 mm wide cavity in addition to the insulation where the cavity is only partially filled (see section 8.5.29). In such cases most window and door frames will not fully cover the cavity closer. This will necessitate lining the reveal with plasterboard, dry lining, a thermal backing board or even a support system. The internal reveal may also be wet plastered, provided that the plaster is applied to a suitable backing such as expanded metal lathing or similar support system.

In areas of the country where the exposure to driving rain is in zone 4 (see section 8.5.29), additional precautions should be taken to prevent the penetration of precipitation. Approved Document C recommends the use of checked rebates at all window and door frames. In this form of construction (Fig. 8.15), the frame is set back behind the outer leaf of masonry. An alternative to this might be by the use of a proprietary finned cavity closer.

8.5.34 Door thresholds

Approved Document M, *Access to and use of buildings* (2004 edition, see Chapter 17), specifies that in certain circumstances buildings should be provided with accessible thresholds. Clearly, this has implications for the weatherproofing of the building since there is a danger that precipitation and groundwater could enter the building at door openings. In order to prevent this, Approved Document C recommends that the external landing should slope away from the doorway at a fall of between 1 in 40 and 1 in 60.

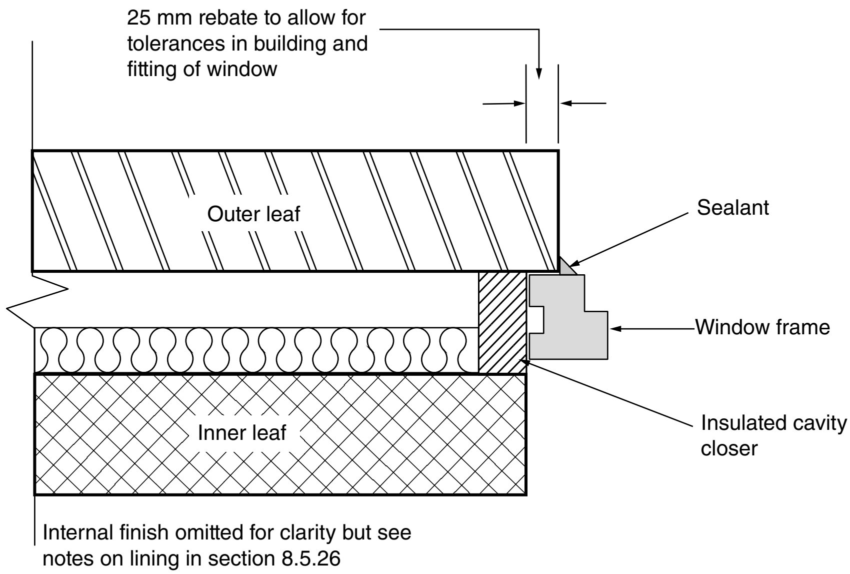


Fig. 8.15 Example of checked rebate window reveal detail – areas of severe or very severe exposure to driving rain.

In order to encourage run-off, the door sill should have a maximum slope of 15°. Some additional recommendations are illustrated in Fig. 8.16. Additional advice may be obtained from the following publications:

- BRE Good Building Guide 47 *Level external thresholds: Reducing moisture penetration and thermal bridging*, 2001;
- *Accessible thresholds in new buildings: Guidance for house builders and designers*, TSO, 1999.

8.5.35 Resistance to damage from interstitial condensation for external walls

In general, external walls will satisfy the requirements of the Building Regulations regarding resistance to damage from interstitial condensation if they are designed and constructed in accordance with Clause 8.3 of BS 5250:2002 *Code of practice for the control of condensation in buildings* and BS EN ISO 13788:2002 *Hygrothermal performance of building components and building elements – Internal surface temperature to avoid critical surface humidity and interstitial condensation – Calculation methods*.

In swimming pools and other buildings where high levels of moisture are generated, there is a particular risk of interstitial condensation in walls and also roofs (see section 8.5.38) because of the high internal temperatures and humidities that exist. In these cases specialist advice should be sought when these are being designed.

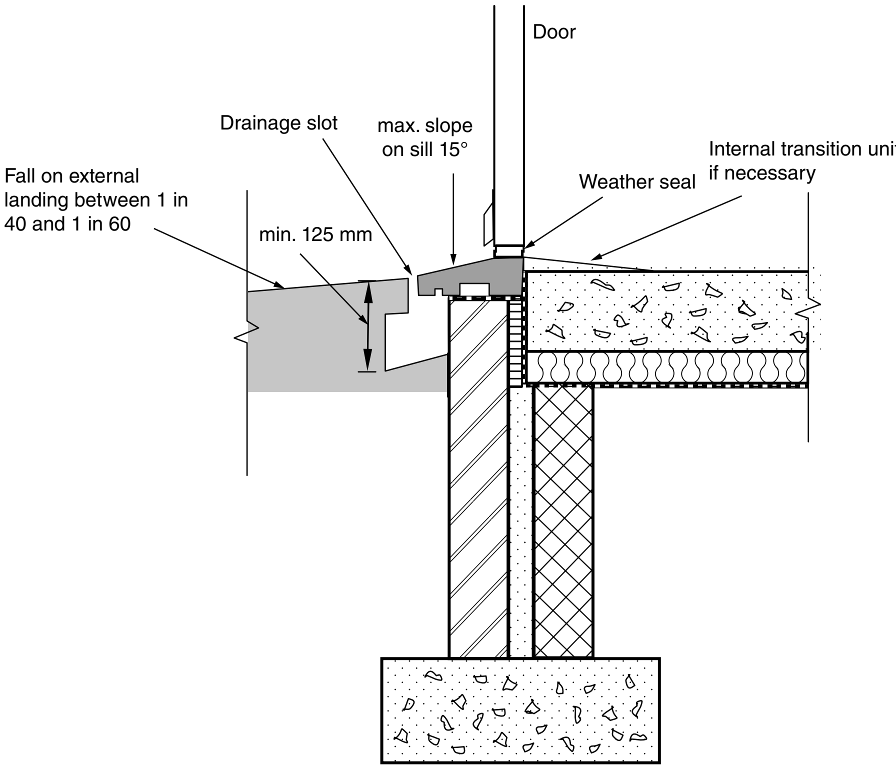


Fig. 8.16 Accessible threshold – exposed areas.

8.5.36 Resistance to surface condensation and mould growth in external walls

In order to resist surface condensation and mould growth in external walls, it is necessary to ensure that the surface is maintained above the dewpoint temperature. This will depend on the outside temperature, the temperature of the room in which the wall surface is situated and the relative humidity of the room. It can be affected by ventilation, by thermal bridging of construction elements at junctions and by the degree of thermal insulation provided in the wall elements. Therefore, in external walls, care should be taken to design the junctions between the elements so that thermal bridging is avoided. This can be done by following the Accredited Construction Details for Part L published by DCLG and available from the Planning Portal website or by following the guidance of BRE Information Paper IP17/01 *Assessing the effects of thermal bridging at junctions and around openings*.

Additionally, externals walls should be designed and constructed so that the thermal transmittance (U-value) does not exceed 0.7 W/m^{2}K at any point.

8.5.37 Weather resistance of roofs

The roof of a building should:

- resist the penetration of precipitation to the inside of the building;
- not be damaged by precipitation;

- not transmit precipitation to another part of the building that might be damaged;
- be designed and constructed so as not to allow interstitial condensation to adversely affect its structural and thermal performance; and
- not promote surface condensation and mould growth under reasonable occupancy conditions.

The recommendations for impervious external wall claddings mentioned in section 8.5.30 apply equally to roof-covering materials.

The performance requirements for external wall and roof claddings can also be met if they comply with:

- British Standard Code of Practice 143 *Code of practice sheet roof and wall coverings* (this includes recommendations for aluminium, zinc, galvanised corrugated steel, copper and semi-rigid asbestos bitumen sheet);
- BS 6915:2001 *Specification for design and construction of fully supported lead sheet roof and wall coverings*;
- BS 8219:2001 *Profiled fibre cement. Code of practice*;
- BS 8200:1985 *Code of practice for design of non-loadbearing external vertical enclosures of buildings*;
- MCRMA Technical Paper 6 *Profiled metal roofing design guide*, revised edition 1996; and
- MCRMA Technical Paper 9 *Composite roof and wall cladding panel design guide*, 1995.

The above documents describe the materials to be used and contain design guidance including fixing recommendations.

8.5.38 Resistance to damage from interstitial condensation in roofs

This section was originally contained in Part F *Ventilation* of Schedule 1 to the Building Regulations 2000 – requirement F2. With the extension of Part C to cover condensation risk in the 2004 amendment, it was logical to transfer these provisions to Part C, and they have been omitted from the 2006 edition of Part F.

The guidance given in the current Approved Document C is much less detailed than that originally contained in Approved Document F and is now stated in performance terms and by reference to other sources of guidance where particular design details are illustrated. The current trend of continually referring to additional sources of guidance is making the Approved Documents much less useful to the practitioner as, in many cases, they can only be regarded as a directory and not as a direct source of technical guidance in their own right.

When condensation occurs in roof spaces, it can have two main effects:

- The thermal performance of the insulant materials may be reduced by the presence of the water; and
- The structural performance of the roof may be affected due to increased risk of fungal attack.

Approved Document C recommends that interstitial condensation in roofs should be limited such that the thermal and structural performance of the roof will not be adversely affected.

It should be noted that the provisions of AD C apply to roofs of any pitch even though a roof that exceeds 70° in pitch is required to be insulated as if it were a wall. Additionally, small roofs over porches or bay windows may sometimes be excluded from the requirements of requirement C2(c) if there is no risk to health or safety.

In swimming pools and other buildings where high levels of moisture are generated, there is a particular risk of interstitial condensation in walls and roofs because of the high internal temperatures and humidities that exist. In these cases specialist advice should be sought when these are being designed.

For cold deck roofs (where the insulation is placed at ceiling level and can be permeated by moisture from the building), requirement C2(c) can be met by the provision of adequate ventilation in the roof space. In such roofs it is obviously essential that moist air is prevented from reaching the roof space where it might condense within or on the insulation layer, and this is particularly important above areas of high humidity such as bathrooms and kitchens. Weak points in the construction where this might occur include:

- gaps and penetrations for pipes and electrical wiring (these should be filled and sealed); and
- loft access hatches (where an effective draught seal should be provided to reduce the inflow of warm moist air).

The requirements can be met for both flat and pitched roofs by following the relevant recommendations of clause 8.4 of BS 5250:2002 *Code of practice: The control of condensation in buildings* and BS EN ISO 13788:2002 *Hygrothermal performance of building components and building elements – Internal surface temperature to avoid critical surface humidity and interstitial condensation – Calculation methods*. Further guidance may also be found in the 2002 edition of BRE Report BR 262 *Thermal insulation: Avoiding risks*.

The following guidance is based on that which was originally contained in Approved Document F which was in turn based on the guidance provided in BS 5250. It covers only a few typical examples of commonly found forms of construction where the insulation is placed at ceiling level (cold deck roofs). For full details and for other forms of construction, reference should be made to BS 5250, clause 8.4.

Roofs with a pitch of 15° or more

Pitched roofs should be cross-ventilated by permanent vents at eaves level on the two opposite sides of the roof, the vent areas being equivalent in area to a continuous gap along each side of 10 mm width. Ridge ventilation equivalent to a continuous gap of 5 mm should also be provided where the pitch exceeds 35° and/or the spans are in excess of 10 m.

Monopitch or lean-to roofs should have ventilation at eaves level as above and also at high level either at the point of junction or through the roof covering at the highest practicable point. The high-level ventilation should be equivalent in area to a continuous gap 5 mm wide (see Fig. 8.17).

In recent years vapour-permeable underlays have come onto the market. If these are used without continuous boarding below the tiling battens, it is not necessary to ventilate the roof space below the underlay. However, BS 5250 recommends that, in these

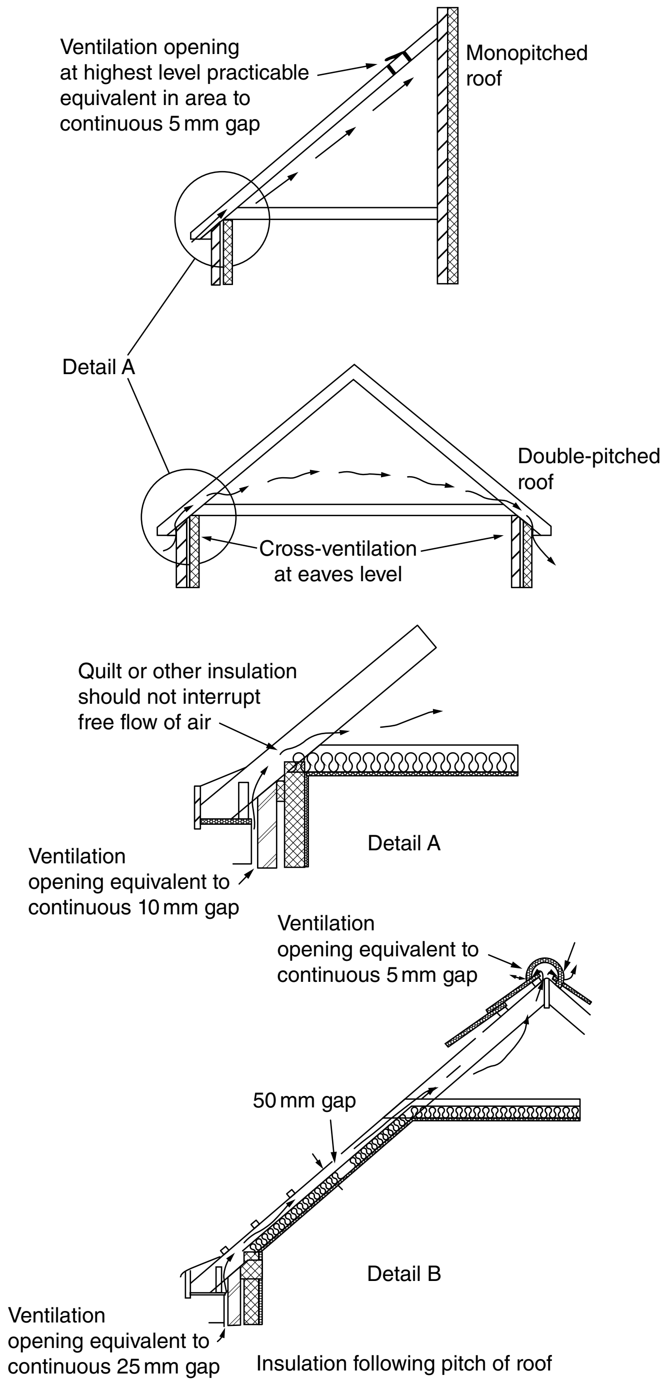


Fig. 8.17 Roof void ventilation – roofs pitched at 15° or more.

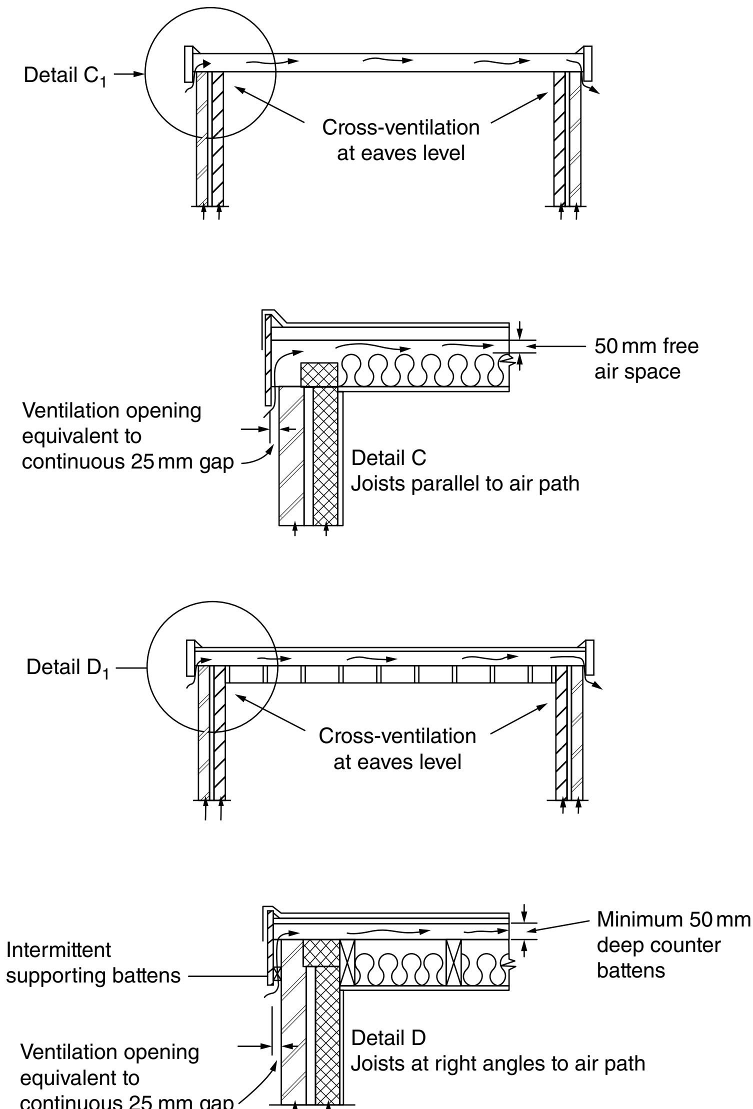


Fig. 8.18 Roof void ventilation – roofs pitched at less than 15°. A free airspace of at least 50 mm should be provided between the roof deck and the insulation. This may need to be formed using counter-battens if the joists run at right angles to the flow of air (see Fig. 8.18). Where it is not possible to provide proper cross-ventilation, an alternative form of roof construction should be considered. It is possible to install vapour checks (called vapour control layers in BS 5250) at ceiling level using polythene or foil-backed plasterboard to reduce the amount of moisture reaching the roof void. This is not acceptable as an alternative to ventilation unless a complete vapour barrier is installed.

circumstances, a ventilated space should be formed above the underlay by using 25 mm battens and counter-battens and provision of ventilation at low level equivalent to a 25 mm continuous gap and at high level equivalent to a 5 mm continuous gap. Simply relying on fortuitous ventilation through the tile/slate joints should not be relied on to ventilate this space adequately.

Roofs with a pitch of less than 15°

In low-pitched roofs the volume of air contained in the void is less, and therefore the risk of saturation is greater.

This also applies to roofs with pitch greater than 15° where the ceiling follows the pitch of the roof. The high-level ventilation should be equivalent in area to a continuous gap 5 mm wide (see Fig. 8.18).

Cross-ventilation should again be provided at eaves level, but the ventilation gap should be increased to 25 mm width.

8.5.39 Resistance to surface condensation and mould growth in roofs

In order to resist surface condensation and mould growth in roofs and roof spaces, care should be taken to design the junctions between the elements and the details of openings, such as windows, so that thermal bridging and air leakage are avoided. This can be done by following the Accredited Construction Details for Part L published by DCLG and available from the Planning Portal website or by following the guidance of BRE Information Paper IP17/01 *Assessing the effects of thermal bridging at junctions and around openings* and/or MCRMA Technical Paper 14 *Guidance for the design of metal roofing and cladding to comply with approved document L2:2001*, 2002.

Additionally, roofs should be designed and constructed so that the thermal transmittance (U-value) does not exceed 0.35 W/m^2K at any point.

9 Toxic substances (Part D)

9.1 Introduction

Urea-formaldehyde (UF) foam cavity wall insulation was used extensively in the 1970s. Its use was discontinued when certain adverse health effects started to be noticed. Health effects occur when UF-based materials and products release formaldehyde into the air. Generally there are no observable health effects from formaldehyde when air concentrations are below 1.0 ppm. The onset of respiratory irritation and other health effects, and even increased cancer risk, begins when air concentrations exceed 3.0–5.0 ppm. This triggers watery eyes, nose irritations, wheezing and coughing, fatigue, skin rash, severe allergic reactions, burning sensations in the eyes and throat, nausea and difficulty in breathing in some humans (usually >1.0 ppm). Occupants of UF foam-insulated homes with elevated formaldehyde levels experienced systemic symptoms such as headache, malaise, insomnia, anorexia and loss of libido. Irritation of the mucus membrane (specifically eyes, nose and throat) was a common upper respiratory tract symptom related to formaldehyde exposure. However when compared to control groups, the frequency of symptoms did not exceed the controls except when it came to wheezing, difficult breathing and a burning skin sensation. Controlled studies have suggested that tolerance to formaldehyde's odour and irritating effects can occur over a prolonged exposure. Its use has long since been discontinued; however, regulations made earlier are still in existence and are described below.

9.2 Cavity insulation

Part D1 of Schedule 1 to the Building Regulations 2010 requires that where insulating material is inserted into a cavity in a cavity wall, reasonable precautions must be taken to prevent the subsequent permeation of any toxic fumes from that material into any occupied parts of the building.

It should be noted that Approved Document D1 does not require total exclusion of formaldehyde fumes from buildings but merely that these should not increase to an irritant concentration.

The inner leaf of the cavity wall should provide a continuous barrier to the passage of fumes, and for this purpose it should be of brick or block construction.

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

Before work is commenced, the wall should be assessed for suitability in accordance with BS 8208 *Guide to assessment of suitability of external cavity walls for filling with thermal insulation:* Part 1: 1985 *Existing traditional cavity construction*.

The work should be carried out by a person holding a current Certificate of Registration of Assessed Capability for this particular type of work.

The UF foam should comply with the requirements of BS 5617:1985 *Specification for urea-formaldehyde (UF) foam systems suitable for thermal insulation of cavity walls with masonry or concrete inner and outer leaves* and the installation with BS 5618:1985 *Code of practice for thermal insulation of cavity walls (with masonry or concrete inner and outer leaves) by filling with urea-formaldehyde (UF) foam systems.*

10 Sound insulation (Part E)

10.1 Introduction

Over recent years, living standards have improved, lifestyles have altered and as a consequence, sources of the noise which people commonly encounter have changed. Building occupants are now subjected to higher levels of noise from both external and internal sources, both of which pose a potential risk to health. This, coupled with higher expectations of indoor environmental quality and reduced tolerance to unwanted noise, has led to increasing dissatisfaction with the standard of sound insulation provided, in particular in dwellings. Part E of Schedule 1 to the Building Regulations has sought to tackle this issue since its first inclusion in the 1985 Building Regulations. The current version of Part E together with regulatory requirements for on-site testing is the result of substantial improvement of those original requirements, and the standards set by this current requirement are aimed at dealing with the widespread dissatisfaction of occupants living in properties constructed under the preceding legislation that derived from studies undertaken prior to the 1965 Building Regulations.

The proposals for amending Requirement E prior to 2003 included the insulation of the envelope of the building against noise from external sources, but this was not included in the 2003 version, issued under the then Building Regulations 2000. Although the current version of the schedule 1 technical requirement has remained the same since coming into force on 1 July 2003, there have been alterations to the Approved Document in 2004 and 2010 to reflect changes in the application of the requirement, supporting secondary legislation and European legislation.

The 2003 version of the Requirements E1 and E2 relates to resistance to the passage of sound between dwellings constructed as part of the same building and within dwellings, and E3 is aimed at limiting reverberation of noise in the common parts of multi-occupancy buildings. The only requirement which does not relate to buildings providing living accommodation is E4, the subject of which is acoustic conditions in schools. The means of satisfying requirement E4 are found not in Approved Document E, but in Building Bulletin 93 *The acoustic design of schools* (the Stationary Office 2004).

In the previous Approved Document E, 1992, it was stated that one way of satisfying the requirements of Part E of Schedule 1 to the 1991 Building Regulations was to build components for which sound insulation was required in accordance with specific 'deemed to satisfy' constructions referred to in the document. Whilst elements constructed to a

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

standard equal to the prescribed constructions may well have provided adequate sound insulation, a fundamental shortcoming of such a procedure is that it makes no allowance for the consequences of bad workmanship other than inspection by building control authorities. Unfortunately, sound insulation is seriously affected by localised construction imperfections, and details which on completion may be hidden from view may render a construction unsatisfactory. For this reason, in 2003 it was decided that specific performance standards would be stipulated in Approved Document E and that a requirement for pre-completion testing and reporting of a sample of completed units was essential to ensure compliance with the standards. This is a very important aspect of the current control procedure, and it places a requirement on the contractor to maintain quality control.

In addition to the on-site pre-completion testing, the Building Regulations have extended the requirement to provide sound insulation in dwellings beyond the circumstances stipulated in the 1991 Regulations. Prior to the current legislation, the requirement to provide sound insulation was restricted to walls separating houses together with walls and floors separating flats. In 2003 this was extended to include similar levels of insulation between 'rooms for residential purposes' which include hotel rooms, rooms in residential homes and student halls of residence accommodation. There was also a new requirement to restrict the passage of sound between certain walls and between floors within dwelling houses and other types of accommodation.

An additional source of annoyance in multi-occupancy buildings containing dwelling units is noise generated in the common parts of such buildings which tend to be constructed using hard durable noise-reflecting surfaces. As a consequence, the 2003 changes also included a requirement to restrict the level of reverberant sound in such areas.

The current edition of the Approved Document E, *Resistance to the passage of sound*, was published in 2003 and came into effect on 1 July 2003. Amendments to this document, entitled *Amendments 2004 to Approved Document E (Resistance to the passage of sound)*, were published in June 2004 and came into effect on 1 July 2004. These two documents were consolidated into a single document, published in April 2006.

Amendments were made in 2010 to reflect the changes in the Building Regulations 2010, in particular relating to the renumbering of the regulations covering sound insulation pre-completion testing, and the revised definition of rooms for residential purpose.

Further minor amendments were made to the Approved Document in 2013 to reflect the coming into force of the Construction Products Regulations 2011 on the 1 July 2013. These changes are very minor and relate only to the reference to 'materials and workmanship' in the introduction of the document.

The main features of the 2004, 2010 and 2013 amendments were:

- clarification of some essential definitions;
- consequential changes to other parts of the regulations;
- the correction of minor errors in the 2003 document;
- the inclusion, in 2004, of Robust Details as an alternative to pre-completion testing for demonstrating compliance;
- revisions to the definition of 'room for residential purposes' issued in both 2004 and 2010; and

- reference to material and workmanship changed to reflect the coming into force of the Construction products Regulations 2011.

The definition of room for residential purposes in the 2004 amendments included the clarification, stated formally in regulation 2, of the definition of a room for residential purposes as follows:

> A 'room for residential purposes' means a room, or a suite of rooms, which is not a dwelling-house, or a flat and which is used by one or more persons to live and sleep and includes a room in a hostel, a hotel, a boarding house, a hall of residence or a residential home, whether or not the room is separated from or arranged in a cluster group with other rooms, but does not include a room in a hospital, or other similar establishment, used for patient accommodation, and, for the purposes of this definition, a 'cluster' is a group of rooms for residential purposes which is:
>
> (a) separated from the rest of the building in which it is situated by a door which is designed to be locked; and
> (b) not designed to be occupied by a single household.

In 2010 the definition was revised to provide simplification. However the new definition is almost identical to that which was published in the Building Regulations 2000 and criticised for its lack of clarity:

> Room for residential purposes means a room, or a suite of rooms, which is not a dwelling-house, or a flat and which is used by one or more persons to live and sleep and includes a room in a hostel, an hotel, a boarding house, a hall of residence or a residential home, but does not include a room in a hospital, or other similar establishment, used for patient accommodation.

With regard to Materials and Workmanship, the text in the original approved document has been substantially revised removing the sections referencing independent certification schemes and technical specifications and replacing these with a shortened text referring to the revised version of the approved document published to support Regulation 7 (materials and workmanship).

The consequential changes to other parts of the regulations, concerned regulation 20A, subsequently renumbered in the 2010 regulations as regulation 41 (Sound insulation testing), which has been modified to allow forms of construction approved by Robust Details Limited to be used as an alternative to pre-completion testing. This is discussed in section **10.9**.

For convenience, dwelling houses, flats and rooms for residential purposes will, for the remainder of this chapter, be referred to collectively as 'dwelling places'. Also, each section heading is followed by a list of the relevant paragraphs in Approved Document E 2003, modified, as appropriate, by the amendments from 2004, 2010 and 2013. However, since material relating to a specific subject may occur in a number of places within the AD, these reference lists may not be totally complete or comprehensive.

10.2 Performance standards

(Approved Document E section 0: Performance)

10.2.1 Sound insulation between dwelling places AD E: 0.1–0.8

Requirement E1 of Schedule 1 to the Building Regulations 2010 (as amended) states the following:

> 'Dwelling houses, flats and rooms for residential purposes shall be designed and constructed in such a way that they provide reasonable resistance to sound from other parts of the same building and from adjoining buildings'.

It should be noted that this requirement applies not only to purpose-built units but also to those resulting from the material change of use from some other type of building. Rooms for residential purposes include (see definitions in Chapter 2) rooms in residential homes, student halls of residence and hotels in which people may be expected to sleep.

In circumstances where Requirement E1 applies, Regulation 41 of the Building Regulations 2010 (as amended) also applies. This regulation imposes a requirement to pursue one or other of two courses of action by way of demonstrating that the necessary elements in the constructed building will achieve the required sound attenuation:

(1) To undertake an approved programme of pre-completion sound insulation testing and provide the appropriate building control body with a copy of the test results. There are specific time limits within which the results must be presented to the building control body. It is stated in Approved Document E that the normal way of satisfying regulation 41 will be to undertake this programme of testing (known as pre-completion testing) in accordance with section 1 of the approved document.

(2) Only in the case of a dwelling house or a building containing flats to use one or more of the design details approved by Robust Details Limited. This is an alternative to undertaking a programme of testing and is subject to observing specified procedures.

The requirements for pre-completion testing are considered in section **10.3**, and the experimental procedure is discussed in section **10.12**. The use of Robust Details is described in section **10.9**.

Requirement E1 will be satisfied for separating walls and floors together with stairs which separate dwelling units if they are constructed such that they satisfy the sound insulation values given in Tables 1a and 1b in the Approved Document and also in Table 10.1. Separating floors are defined as floors which separate flats or rooms for residential purposes, and separating walls are those which separate adjoining dwelling houses, flats or rooms for residential purposes. It is important to note that sound will not only be transmitted directly through the element in question but also through adjacent, or flanking, elements and that when assessing compliance with Table 10.1, flanking as well as direct transmission must be taken into account. See section **10.14** for explanations of these terms.

Table 10.1 Performance standards for separating walls, separating floors and stairs that have a separating function.

	Minimum value of airborne sound insulation $D_{nT,w} + C_{tr}$ dB	Maximum value of impact sound insulation $L'_{nT,w}$ dB
Purpose-built dwelling houses and flats		
Walls (inc. walls that separate houses and flats from rooms for residential purposes)	45	—
Floors and stairs	45	62
Dwelling houses, flats and rooms for residential purposes formed by material change of use		
Walls	43	—
Floors and stairs	43	64
Purpose-built rooms for residential purposes		
Walls	43	—
Floors and stairs	45	62

Requirement E1 does not relate only to walls and floors which separate dwelling units. If a wall or floor separates a dwelling unit from a space used for communal or non-domestic purposes, e.g. a refuse chute or common lobby/corridor in a block of flats, the level of sound insulation required may be greater than that given in Table 10.1 for separating walls and floors. In such circumstances, the required value of sound insulation will depend on the level of noise generated in the non-domestic space, and expert advice should be sought to assess the anticipated level and, if necessary, recommend higher levels of sound insulation. Figure 10.1 summarises the obligations of E1 in terms of elements requiring insulation and the nature of insulation required.

It will be seen from Table 10.1 that the criterion applied to assess airborne sound insulation is a single figure index, $D_{nT,w} + C_{tr}$, which is obtained from a frequency band analysis of the noise. The term 'airborne sound insulation' is explained in section **10.14**, and the procedure required for measurement of $D_{nT,w} + C_{tr}$ is described in section **10.12**. This index replaces $D_{nT,w}$ which is applied in the 1992 Approved Document, by the addition of the C_{tr} term. C_{tr} modifies the index by increasing the significance of low-frequency noise. The addition of C_{tr} was considered important since the powerful low frequency output of certain types of home entertainment systems is such that sound transmission at low frequencies is now a frequent source of considerable annoyance as demonstrated by noise nuisance complaints to local authorities.

The value of 45 dB for airborne sound insulation between purpose-built dwellings that appears in Table 10.1 appears at first sight to represent a reduction in the required standard when compared with the equivalent value of 49 dB which it replaced. However, the old figure of 49 dB can be reduced by 2 dB to 47 dB to allow for the permitted margin of error in the field measurement procedure. Furthermore, the computational effect of including the C_{tr} term is to reduce results calculated from measured values by approximately 5 dB, so that the old figure of 49 dB would, under the current system, be reduced by a further 5 dB to 42 dB. Thus the new requirement

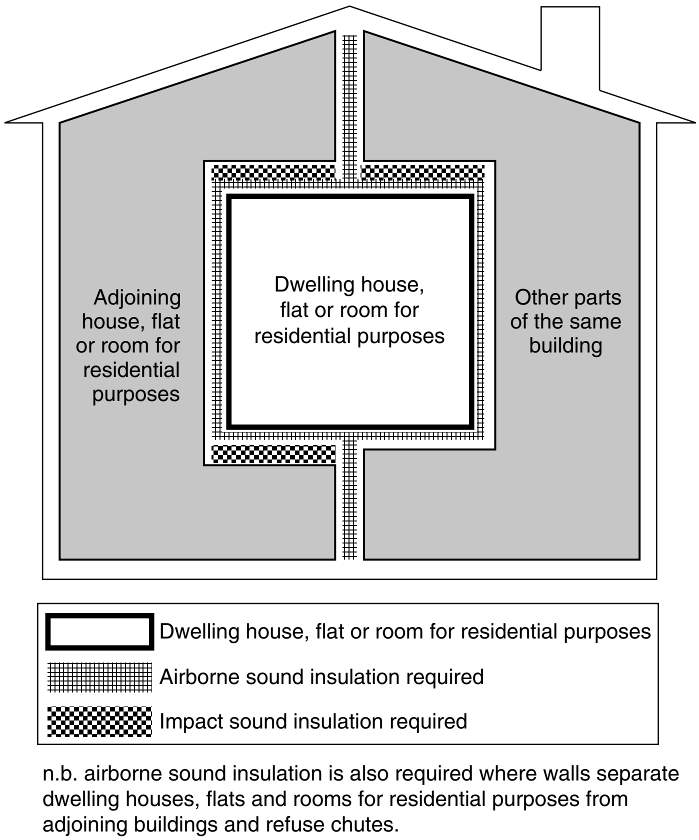


Fig. 10.1 Requirements for protection against sound between dwelling places.

of 45 dB should be considered as an increase in the standard of 3 dB on the pre-2003 requirement, i.e

$$45\text{dB} = \left(49\text{dB} - 2\text{dB} - 5\text{dB}\right) + 3\text{dB}$$

It is worth noting that in the case of a construction with a particularly poor low-frequency performance, the overall improvement in performance would need to be greater than 3 dB in order to compensate for the effect of C_{tr} at low frequencies.

Required values of the index used to assess the standard of impact sound insulation, $L'_{nT,w}$, are also shown in Table 10.1. See section **10.14** for an explanation of the term 'impact sound insulation' and section **10.12** for an explanation of the index $L'_{nT,w}$ and a description of the associated measurement procedure.

As is generally the case with building regulation requirements, there are instances where the application of the requirement would be prohibitive, and there are three circumstances in which it may not be necessary to comply fully with Requirement E1. These are:

- dwelling houses, flats, rooms for residential purpose or school buildings, constructed from prefabricated assemblies; and
- historic buildings when subject to a material change of use.

Buildings constructed from prefabricated assemblies that are newly made or delivered from stock are subject to the full requirements of Schedule 1 of the building regulations. However, in some cases, e.g. temporary dwelling places, the requirement to provide reasonable sound insulation may vary. Examples referred to in the Approved Document are buildings:

- formed by dismantling, transporting and reassembling sub-assemblies on the same premises; and
- constructed from sub-assemblies, from other premises or stock manufactured before 1 July 2003 where compliance with the 1992 Part E requirements can be demonstrated.

For school buildings, the relevant sections of Building Bulletins 87 providing guidance on acoustics should be consulted, and it would normally be acceptable to implement the recommendations.

In the case of the material change of use of some historic buildings, it may not be viable to fully comply with E1 whilst still conserving their special historical features. In such cases the aim should be to improve sound insulation as much as is practically possible without adversely affecting the character of the building or its long-term rate of deterioration. When this approach is adopted, and E1 is not fully complied with, a prominent notice should be displayed in the building indicating the level of insulation obtained by tests carried out using the appropriate procedure. For the purposes of Approved Document E, 'historic buildings' can be regarded as including:

- listed buildings;
- buildings in conservation areas;
- buildings of architectural or historic interest and referred to as a material consideration in local authority development plans or in national parks, areas of outstanding national beauty or world heritage sites; and
- vernacular buildings of traditional form and construction.

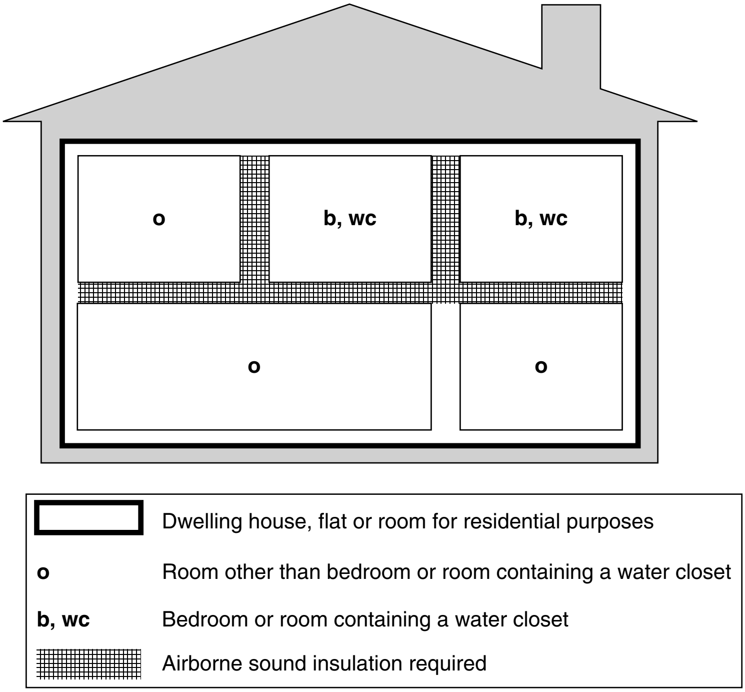
It is suggested in the AD that when assessing the relative merits of reduced sound transmission and conservation, advice should be obtained from the local planning authority's conservation officer.

10.2.2 Sound insulation within dwelling places AD E: 0.9–0.10

Requirement E2 of Schedule 1 to the Building Regulations 2010 (as amended) states that the design and construction of houses, flats and rooms for residential purposes (including extensions) should be such that:

- internal walls between bedrooms and any other rooms;
- internal walls between rooms containing water closets and any other rooms; and
- all internal floors

provide reasonable resistance to the transmission of sound. These requirements are shown diagrammatically in Fig. 10.2.



All internal floors in dwelling places must provide airborne sound insulation.

Fig. 10.2 Requirements for protection against sound within dwelling places.

Requirement E2 will be satisfied if the above elements meet the insulation values quoted in Table 0.2 of the AD. This simply states that new internal walls and floors in dwelling houses, flats and rooms for residential purposes, whether purpose built or formed by material change of use, must have a value of airborne sound insulation, $R_w = 40$ dB or above. R_w, the weighted sound reduction index, is a single figure index which results from a frequency band analysis carried out in a laboratory of a sample of the element of construction. It follows therefore that pre-completion testing of internal elements is not necessary but that builders will need to show that the elements used satisfy the above criterion. The laboratory measurement of sound insulation is discussed later in section **10.12**. There is no requirement to provide impact sound insulation in order to satisfy E2.

As with E1, Requirement E2 extends to dwelling places resulting from the material change of use of a building, but unlike E1 the same value applies to both categories of accommodation. Figure 10.2 summarises the obligations of E2 in terms of elements requiring insulation and the nature of insulation required.

10.2.3 Reverberation in common spaces and acoustic conditions in schools AD E: 0.11–0.12

Requirement E3 of the Building Regulations 2010 (as amended) states that the construction of the common internal spaces in buildings which contain flats or rooms for residential purposes shall be such as to prevent more reverberation than is reasonable.

This requirement will be satisfied if sound absorptive measures described in section 7 of the Approved Document are applied. The provision of absorption in common spaces is considered in section **10.10**.

Requirement E4 states that the design and construction of all rooms and other places in school buildings shall be such that their acoustic conditions and insulation against disturbance by noise are appropriate to their intended use. It is stated in AD E that the normal way of satisfying these conditions will be to meet the requirements given in section 1 of Building Bulletin 93, *The acoustic design of schools*. See section **10.11**.

10.3 Pre-completion testing

(Approved Document E section 1: Pre-completion testing)

10.3.1 Requirements AD E: 1.1–1.10

Approved Document E provides guidance on the nature and extent of the pre-completion testing that should be carried out in order to comply with regulation 41. This states that where Requirement E1 applies and where Robust Details are not used, sound insulation testing must be carried out in accordance with an approved procedure.

The Approved Document states that sound insulation testing should be considered as part of the construction process, the work being carried out at the cost of the builder. Regulation 41 states that it is the responsibility of the builder to ensure that:

- the work is carried out in an approved manner;
- the results are recorded in an approved manner; and
- the results are given to the approved authority or inspector within five days of the completion of the work.

However, it is expected that the building control body will actually select which properties to test and the nature of the tests in each case. Whilst regulation 41 states that the testing is the responsibility of the person carrying out the building work, it is recognised that the testing will be carried out by an appropriate testing body. Indeed, for field measurements of sound insulation to be acceptable, it will be necessary to demonstrate that the organisation undertaking the work has appropriate accreditation for field measurements, preferably by the United Kingdom Accreditation Service (UKAS) or a European equivalent. Members of the Association of Noise Consultants who are approved under their association's AD E Registration Scheme are also regarded as being suitably qualified.

Testing must be carried out on:

- purpose-built dwelling houses, flats and rooms for residential purposes; or
- dwelling houses, flats and rooms for residential purposes formed by material change of use

with the standard to be achieved being that given in Table 10.1. Guidance on appropriate construction details is given in Approved Document E, and developers are recommended in the AD that this, or other suitable guidance, is closely followed in order to ensure that the standards set in Table 10.1 are achieved. This is very important since there is no tolerance for measurement uncertainty, which has been built into the values given in the table, and if a test does not reach the prescribed value, by even a very small margin, it will be deemed to be a failure. Where there is doubt as to the required form of construction, specialist advice should be obtained at design stage. The exception to the standards defined in Table 10.1 is when historic buildings are undergoing a material change of use, and it is not practicable to achieve the prescribed standard. In this case, appropriate testing is still required with, as mentioned earlier, a notice of the standard achieved posted in a prominent position in the building.

The tests are designed to be carried out on the common wall which separates specific types of rooms and to be undertaken as soon as the dwelling place is, with the exception of decoration, complete. In the case of impact tests, with certain exceptions which are referred to in section 10.12.3, it is important that these are carried out before soft coverings are installed.

10.3.2 Grouping for tests AD E: 1.11–1.18

Not all constructions have to be tested, but those that are must allow inferences of the performance of all constructions in the particular development to be drawn. It is therefore necessary to classify the units into a number of notional groups which are representative of the whole. Houses, flats and rooms for residential purposes must form three different groups.

If there are any significant differences in the method of construction used within each of these groups, then each must be classified as a subgroup. The AD provides guidance, as follows, as to how subgroups should be determined:

- Dwelling houses (including bungalows) by type of separating wall and flats and rooms for residential purposes by type of separating wall and separating floor;
- Where there are significant differences in flanking elements, e.g. walls, floors and cavities;
- Units with specific features which are acoustically unfavourable.

It should be noted that subgrouping is not necessary if houses, flats and rooms for residential purposes are built with the same separating and flanking constructions and have similar room layouts and dimensions. However, whilst the same principles apply in the case of material change of use as for new buildings, in this case it is probable that significant differences between separating walls, separating floors and flanking constructions will occur more frequently. It follows that more subgroups will be necessary than in the case of new build work.

10.3.3 Sets of tests AD E: 1.19–1.28

The nature of the tests required between dwelling places depends on the type of accommodation they offer, i.e. there are different requirements for houses and flats. The tests required on a specific type of dwelling place are referred to collectively as a 'set of tests',

Table 10.2 Requirements for a 'set of tests' between different types of dwelling places.

	Dwelling houses (including bungalows)	Flats with separating floors but without separating walls	Flats with separating floors and separating walls
Airborne test of walls			
Where possible between rooms suitable for use as living rooms	✓		✓
Airborne test of walls			
Where possible between rooms suitable for use as bedrooms	✓		✓
Airborne test of floors			
Where possible between rooms suitable for use as living rooms		✓	✓
Airborne test of floors			
Where possible between rooms suitable for use as bedrooms		✓	✓
Impact test of floors			
Where possible between rooms suitable for use as living rooms		✓	✓
Impact test of floors			
Where possible between rooms suitable for use as bedrooms		✓	✓
Total number of tests in a set	2	4	6

and the specific requirements for sets of tests between different types of dwelling place are shown in Table 10.2. Note that:

- it is not appropriate to undertake impact tests between houses and bungalows;
- tests are only required in the circumstances identified in the table; and
- the tests referred to in Table 10.2 should each be carried out between a pair of adjacent rooms on opposite sides of the separating wall or floor between them.

Each set of tests should preferably contain individual tests between bedrooms and between living rooms. However, although it is recognised that this may not always be possible when, for example, room types are not mirrored on each side of a separating wall or floor, at least one of the rooms in one pair should be a bedroom and at least one in the other pair should be a living room. Tests should not be carried out between a living space and an adjoining corridor, stairwell or hallway even though the walls between them may need to be constructed to separating wall standard. When the layout of a property is such that there is only one pair of rooms opposite to each other over the complete area of a separating wall or floor, the number of sound insulation tests may be reduced accordingly.

In the case of rooms for residential purposes, whether in new buildings or constructed by material change of use, the sound insulation of their walls and floors should be tested by application of the measurement principles applicable to dwelling houses and flats but adapted to suit the individual circumstances. It is sometimes the case that dwelling places are sold before fitting out with internal walls and internal fitments, the example of loft apartments being quoted in the Approved Document. In these situations the dimensions and locations of the principal room are not available, but tests should still be undertaken, again applying the principles outlined for dwelling houses and flats. It is stated in the Approved Document that it is necessary in such cases to make sure that the subsequent work will not be detrimental to sound insulation by application of guidance provided on relevant construction details (see following sections).

10.3.4 Testing programmes AD E: 1.29–1.31

It is expected that the building control authority will determine the nature and extent of the testing programme which is required. However, the Approved Document lays down the overall strategy that should be adopted.

Tests should be carried out between the first pair of properties scheduled for completion/sale in each group or subgroup irrespective of the size of the development, thus providing all parties with an early indication as to the likelihood of any problems. To this end, the frequency of testing should be higher in the early stages of completion than towards its end although in the case of large developments testing should continue for a substantial part of the time that construction is taking place. Notwithstanding the fact that the rate of testing may change during the construction period, the Approved Document states that, assuming that there are no failures, the building control body should require at least one set of tests for every ten dwelling units completed in each group or subgroup. It should be recognised that each set of tests relates to the sound insulation between at least two properties, three in the case of flats with separating walls and floors.

10.3.5 Failure of tests AD E: 1.32–1.39

A set of tests is deemed to have failed if one or more of its individual tests do not satisfy the requirements of Table 10.1. In the event of a failure, remedial action must be taken to rectify the failure between the actual rooms which have failed, and also, since the separating element between those rooms may be defective, the developer must demonstrate that other rooms which share the element in question satisfy the performance criteria by:

- further testing between the other rooms;
- application of remedial measures to the other rooms; and/or
- showing that the failure is limited to the rooms initially tested.

If a test between two rooms fails, careful consideration must be given to other properties which incorporate similar elements and forms of flanking construction, and developers will be expected to take the action necessary to satisfy building control authorities that the required standards are being achieved in those properties. Clearly, this will present problems if, by then, some of the properties are occupied. In any event, it is stated in the Approved Document that following the failure of a set of tests, the rate of testing should be increased from what had previously been agreed until the building control body is satisfied that the problems have been overcome.

The AD recommends reference to BRE Information Paper IP 14/02 for guidance relating to the failure of sound insulation tests. It should be recognised that failure may be due not to the construction of the separating wall but rather to excessive flanking transmission, the two causes requiring totally different types of remedial action. The reason for the failure will also indicate which of the other rooms that have not been tested are likely to fail to meet the standard. Such rooms will require remedial treatment. Whenever remedial treatment is applied, the building control body will normally call for further sound insulation testing in order that they can be satisfied with its effectiveness.

10.3.6 Recording of pre-completion test results AD E: 1.41

Regulations 20A and 12A state that the results of sound insulation testing shall be recorded in a manner approved of by the Secretary of State. In order to comply with this requirement, the report on a set of tests must contain at least the following information in the order in which it is listed. The following list is quoted directly from the AD:

(1) Address of Building.
(2) Type(s) of property. Use the definitions in Regulation 2: dwelling house, flat, room for residential purposes. State if the building is a historic building (see definition in the section on Requirements of this Approved Document).
(3) Date(s) of testing.
(4) Organisation carrying out testing, including:
    (a) name and address;
    (b) third party accreditation number (e.g. UKAS or European equivalent);
    (c) name(s) of person(s) in charge of test;
    (d) name(s) of client(s).
(5) A statement (preferably in a table) giving the following information:
    (a) the rooms used for each test within the set of tests;
    (b) the measured single-number quantity ($D_{nT,w} + C_{tr}$ for airborne sound insulation and $L'_{nT,w}$ for impact sound insulation) for each test within the set of tests;

(c) the sound insulation values that should be achieved according to the values set out in section 0: Performance – Table 1a or 1b (Table 10.1);
(d) an entry stating 'Pass' or 'Fail' for each test within the set of tests according to the sound insulation values set out in section 0 Performance – Table 1a or 1b (Table 10.1).

(6) Brief details of the test, including:
(a) equipment;
(b) a statement that the test procedures in Annex B have been followed. If the procedure could not be followed exactly, then the exceptions should be described and reasons given;
(c) source and receiver room volumes (including a statement on which rooms were used as source rooms);
(d) results of tests shown in tabular and graphical form for third octave bands according to the relevant part of the BS EN ISO 140 series and BS EN ISO 717 series, including:
(i) single-number quantities and the spectrum adaptation terms;
(ii) D_{nT} and L'_{nT} data from which the single-number quantities are calculated'.

10.4 Separating walls and their flanking constructions: New buildings

(Approved Document E section 2: Separating walls and associated flanking constructions for new buildings)

10.4.1 Construction forms AD E: 2.1–2.17

Section 2 of the Approved Document E gives examples of walls which should achieve the performance standards, for houses and flats, tabulated in section 0: Performance – Table 1a of the AD and in Table 10.1. However, as is stated in the document, the actual performance of a wall will depend on the quality of its construction. The information in this section of the AD is provided only for guidance; it is not intended to be exhaustive, and alternative constructions may achieve the required standard. Designers are also advised to seek advice from other sources, such as manufacturers, regarding alternative designs, materials or products. The details in no way override the requirement to undergo pre-completion testing. For the provision of walls in 'rooms for residential purposes', see section **10.8**.

The separating wall constructions described in the AD are divided into four types.

(1) Type 1 Solid masonry
Walls consisting of one leaf of brick or concrete block, plastered on both sides.
(2) Type 2 Cavity masonry
Walls consisting of two leaves of brick or concrete block separated by a cavity and usually plastered on both sides.
(3) Type 3 Masonry between independent panels
Walls consisting of a layer of brick or block with independent panels on each side.

(4) Type 4 Framed walls with absorbent material
Walls consisting of independent frames of, for example, timber with panels, typically of plasterboard, fixed to the outside of each.

Within each wall type, alternatives are presented in rank order such that, as far as possible, the one which should offer the best sound insulation is described first.

It is very important that the junctions between a separating wall and the elements to which it is attached are carefully designed because this will have a significant influence on its overall acoustic effectiveness. Since the level of insulation achieved will be strongly dependent on the extent to which flanking transmission exists, considerable advice is given in the AD on this issue. Guidance is provided on the junctions between separating walls and the following other elements:

- External cavity walls with masonry inner leaf;
- External cavity wall with timber-framed inner leaf;
- Solid masonry external walls;
- Internal walls – masonry;
- Internal walls – timber;
- Internal floors – timber;
- Internal floors – concrete;
- Ground floors – timber;
- Ground floors – concrete;
- Ceiling and roof spaces; and
- Separating floors Types 1, 2 and 3 (these are considered with separating floors).

However, not all wall/junction combinations are considered. It is stated in the AD that if any element has a separating function, e.g. a ground floor which is also a separating floor for a basement flat, then the separating element requirements take priority.

The following notes should be borne in mind when considering the alternatives which are presented.

(1) The mass per unit area of walls is quoted in kilogrammes per square metre (kg/m^2), and procedures for calculating it, as described in Annex A of the AD, are outlined in section **10.13**. Densities are quoted in kilogrammes per cubic metre (kg/m^3), and when used for calculating the mass per unit area of brick and blockwork, they should take into account moisture content by using data available in the current edition of the CIBSE Part A. Alternatively, manufacturers data relating to mass per unit area may be used where this is available.
(2) The guidance assumes solid blocks which do not have voids within them. The presence of voids may affect sound transmission, and relevant information should be sought from manufacturers.
(3) Some of the constructions are described with only wet finishes. If a dry finish is used instead, advice should be sought from the manufacturer.
(4) Dry-lining laminates of plasterboard with mineral wool may be used whenever plasterboard is recommended. Manufacturer's advice should be obtained for all other dry-lining laminates. Plasterboard lining should always be fixed in accordance with manufacturer's instructions.

Table 10.3 Types and examples of solid masonry separating wall constructions.

	Wall type		
	Type 1.1	**Type 1.2**	**Type 1.3**
Form			
Description	Dense aggregate concrete block, plastered on both faces	Dense aggregate cast in situ concrete, plastered on both faces	Brickwork, plastered on both faces
Minimum mass per unit area	415 kg/m^2 including plaster	415 kg/m^2 including plaster	375 kg/m^2 including plaster
Surface finish	13 mm plaster on both room faces	Plaster on both room faces	13 mm plaster on both room faces
Other factors	Blocks laid flat to full thickness of the wall		Bricks laid 'frog up', coursed with headers
Example constructions that provide the required mass per unit area			
Thickness	215 mm block	190 mm of concrete	215 mm brick
Detail of structure	Dense aggregate concrete block, density 1840 kg/m^3	Density of concrete 2200 kg/m^3	Density of brick 1610 kg/m^3
Coursing	110 mm	n.a.	75 mm
Surface finish	13 mm lightweight plaster with a minimum mass per unit area of 10 kg/m^2, on both room faces	13 mm lightweight plaster with a minimum mass per unit area of 10 kg/m^2, on both room faces	13 mm lightweight plaster with a minimum mass per unit area of 10 kg/m^2, on both room faces
Further information	215 mm blocks laid flat		

(5) The cavity widths recommended in the guidance are minimum values.
(6) The requirements of Building Regulations Part C (Site preparation and resistance to moisture) and Part L (Conservation of fuel and power) must be considered when applying Part E to junctions between separating walls and ground floors.
(7) The walls described in Tables 10.3, 10.4, 10.5, 10.6 and 10.7 are only example constructions.

Wall ties in separating and external masonry walls AD E: 2.18–2.24

The sound insulating properties of cavity walls are effected by the coupling effect of wall ties, and so it is important that they are used correctly. In AD E, wall ties are defined, in accordance with BS 1243:1978, *Metal ties for cavity wall construction*, as Type A (butterfly ties) and Type B (double triangle ties), and their layout should be as described in BS 5628-3:2005, *Code of practice for use of masonry*. However, BS 5628–3 limits the above tie types and spacing to prescribed combinations of cavity widths and minimum masonry leaf thicknesses. It is stated in the AD that tie Type B should be used only in external cavity walls where tie Type A does not satisfy the requirements of Building Regulation Part A – Structure. This is because tie Type B may decrease airborne sound insulation, due to flanking transmission via the external leaf, compared with tie Type A.

Table 10.4 Types of cavity masonry separating wall constructions.

	Wall type			
	Type 2.1	**Type 2.2**	**Type 2.3**	**Type 2.4**
Description of wall	Two leaves of dense aggregate concrete block with 50 mm cavity, plaster on both room faces	Two leaves of lightweight aggregate block with 75 mm cavity, plaster on both room faces	Two leaves of lightweight aggregate block with 75 mm cavity and step/stagger. Plasterboard on both room faces	Two leaves of aircrete block with 75 mm cavity and step/stagger. Plasterboard or plaster on both room faces
Limitations			**Should only be used where there is a step and/or stagger of at least 300 mm**	**Should only be used in constructions without separating floors and where there is a step and/or stagger of at least 300 mm**
Minimum mass per unit area	415 kg/m^2 including plaster	300 kg/m^2 including plaster	290 kg/m^2 including plasterboard	150 kg/m^2 including finish
Minimum cavity width	50 mm	75 mm	75 mm	75 mm
Surface finish	13 mm plaster on both room faces	13 mm plaster on both room faces	Plasterboard on both room faces, minimum mass per unit area of each sheet 10 kg/m^2	Plasterboard on both room faces, minimum mass per unit area of each sheet 10 kg/m^2 or 13 mm plaster on both room faces
Other factors			The lightweight blocks should have a density in the range from 1350 to 1600 kg/m^3 The composition of the lightweight aggregate blocks contributes to performance of this construction with a plasterboard finish. Denser blocks may not give equivalent performance Increasing size of step or stagger in the separating wall tends to increase airborne sound insulation	Increasing size of step or stagger in the separating wall tends to increase airborne insulation

An option, which is of value in improving sound insulation, is to select wall ties with an appropriate dynamic stiffness for the cavity width as explained in AD E. The procedure for measuring the dynamic stiffness of wall ties is explained in BRE IP 3/2001, *Dynamic stiffness of wall ties used in masonry cavity walls*. It is essential to ensure that, if

Table 10.5 Examples of cavity masonry separating wall constructions which provide the required mass per unit area.

	Wall type			
	Type 2.1	**Type 2.2**	**Type 2.3**	**Type 2.4**
Description of wall	Two leaves of dense aggregate concrete block with 50 mm cavity, plaster on both room faces	Two leaves of lightweight aggregate block with 75 mm cavity, plaster on both room faces	Two leaves of lightweight aggregate block with 75 mm cavity and step/stagger. Plasterboard on both room faces	Two leaves of aircrete block with 75 mm cavity and step/stagger. Plasterboard or plaster on both room faces
Limitations			**Should only be used where there is a step and/or stagger of at least 300 mm**	**Should only be used in constructions without separating floors and where there is a step and/or stagger of at least 300 mm**
Thickness of block leaves	100 mm	100 mm	100 mm	100 mm
Description and minimum density of blocks	Dense aggregate concrete block, density 1990 kg/m^3	Lightweight aggregate block, density 1375 kg/m^3	Lightweight aggregate block, density 1375 kg/m^3	Aircrete block, density 650 kg/m^3
Coursing	225 mm	225 mm	225 mm	225 mm
Surface finish	13 mm lightweight plaster with a minimum mass per unit area of 10 kg/m^2, on both room faces	13 mm lightweight plaster with a minimum mass per unit area of 10 kg/m^2, on both room faces	Plasterboard on both room faces. Minimum mass per unit area of each sheet 10 kg/m^2	Plasterboard on both room faces. Minimum mass per unit area of each sheet 10 kg/m^2

wall ties are selected on the basis of satisfying dynamic stiffness criteria, they also comply with the requirements of Building Regulation A – Structure.

10.4.2 Design of wall Type 1: Solid masonry AD E: 2.29–2.35

The insulation offered against airborne sound transmission by solid walls is primarily determined by their mass per unit area. Three forms of construction based on solid walls, i.e. wall Type 1, are described in the AD and also in Table 10.3, and the document states that these should, if built correctly, comply with Requirement E1 (see Table 10.1). Examples of each of the three types of wall are provided in the AD, and these are also described in Table 10.3 and shown in Fig. 10.3.

In order for the performance of solid separating walls to be satisfactory, the junctions between them and their surrounding construction elements must be designed correctly. The requirements detailed in the AD are explained below (see also section 10.4.7).

Table 10.6 Types and examples of masonry with independent panels separating wall constructions.

	Wall type		
	Type 3.1	**Type 3.2**	**Type 3.3**
Form			
Description	Solid masonry core of dense aggregate concrete block, independent panels on both room faces	Solid masonry core of lightweight concrete block, independent panels on both room faces	Cavity masonry core of brickwork or blockwork, 50 mm cavity, independent panels on both room faces
Minimum mass per unit area of core	300 kg/m^2	150 kg/m^2	No minimum specified
Cavity width	n.a.	n.a.	50 mm minimum
Panels	Independent panels on both room faces	Independent panels on both room faces	Independent panels on both room faces
Minimum mass per unit area of each panel, excluding supporting framework	20 kg/m^2	20 kg/m^2	20 kg/m^2
Other factors	Structural requirements determine minimum core width. Ref: Part A Structure	Structural requirements determine minimum core width. Ref: Part A Structure	Structural requirements determine minimum core width. Ref: Part A Structure
Example construction			
Thickness of core	140 mm	140 mm	Two leaves, each one at least 100 mm thick
Cavity width	n.a.	n.a.	50 mm minimum
Detail of core	Dense aggregate concrete block, density 2200 kg/m^3	Lightweight concrete block, density 1400 kg/m^3	Concrete block, density not specified
Coursing	110 mm	225 mm	Not specified
Form of panels	Independent panels, each consisting of two sheets of plasterboard with staggered joints	Independent panels, each consisting of two sheets of plasterboard joined by a cellular core	Independent panels, each consisting of two sheets of plasterboard joined by a cellular core

Junctions with external cavity walls which have masonry inner leaves AD E: 2.36–2.39

- There are no restrictions on the outer leaf of the wall.
- Unless the cavity is fully filled with mineral wool, expanded polystyrene beads or some other suitable insulating material (the AD states that manufacturer's advice should be sought regarding alternative suitable materials), the cavity should be stopped with a flexible closer as shown in Fig. 10.4.

Table 10.7 One type of framed wall with absorbent material.

Form	Wall Type 4.1
Structure	A two leaf frame
Lining	Each lining to consist of two or more layers of plasterboard with staggered joints. Minimum mass per unit area of each lining: 10 kg/m^2
Width	Distance between inside lining faces: 200 mm minimum
Form of absorbent material	Unfaced mineral wool batts or quilt with a minimum density of 10 kg/m^3. These may be wire reinforced
Thickness of absorbent material	25 mm min. if suspended in cavity between frames
	50 mm min. if fixed to one frame
	25 mm min. per batt or quilt if one is fixed to each frame
Other information	Plywood sheathing may be used in the cavity as necessary for structural reasons

Notes:
1. See Fig. 10.13 for details associated with this type of wall.
2. A masonry core may be incorporated, if this is necessary for structural reasons, but it may only be connected to one frame.

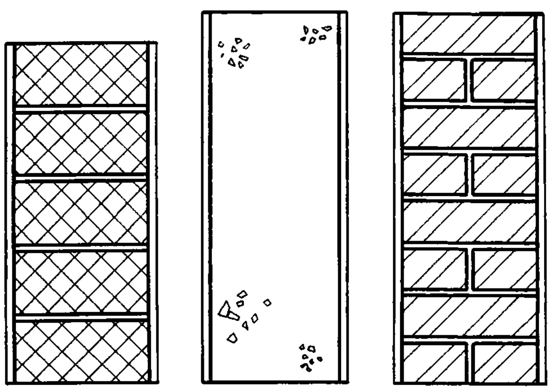


Fig. 10.3 Wall Types 1.1, 1.2 and 1.3.

- The separating wall should be joined to the inner leaf of the external wall either by bonding with at least half of the bond provided by the separating wall or by using tied construction with the inner leaf abutting the separating wall (see Fig. 10.5). See, also, Building Regulation Part A – Structure.
- The mass per unit area of the inner leaf of the external wall should be at least 120 kg/m^2 excluding its finish in order to reduce the effects of flanking transmission. This minimum mass requirement is waived only if there is no separating floor and there are openings in the external wall which are at least 1 m high, within 0.7 m of the separating wall and on both sides of the separating wall at every storey. Note, however, that if openings in the external wall are placed close to and on either side of a separating wall,

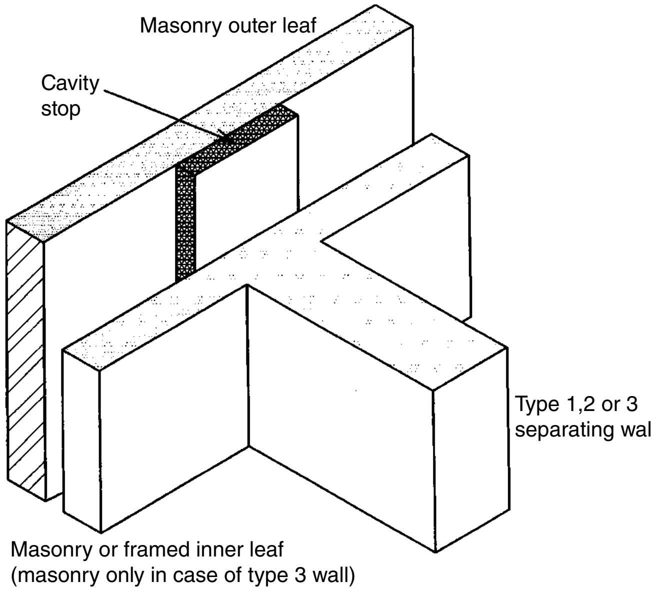


Fig. 10.4 Provision of a flexible cavity stop at the junction of a Type 1, 2 or 3 separating wall and an external cavity wall.

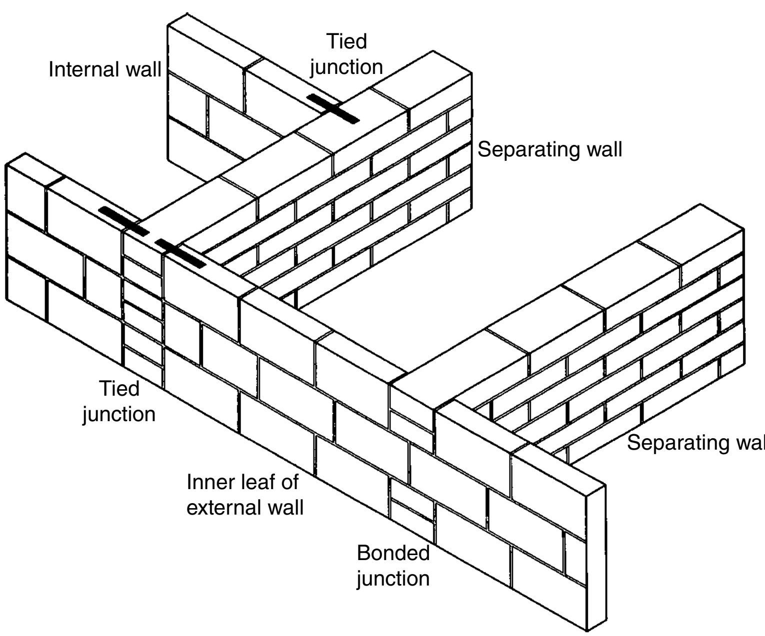


Fig. 10.5 Junctions between separating wall and other masonry walls.

some sound will be transmitted out of the opening on one side of the separating wall and back in through the opening on the other side. This may affect the result of a pre-completion test.

Junctions with external cavity walls which have timber-framed inner leaves AD E: 2.40–2.41

- There are no restrictions on the outer leaf of the wall.
- The cavity should be stopped with a flexible closer as shown in Fig. 10.4.
- The inner leaf frame of the external wall should abut the separating wall and be tied to it vertically with ties at not greater than 300 mm centres.
- The finish of the inner leaf of the external wall should be one layer of plasterboard with a mass per unit area of at least 10 kg/m^2 and having all joints sealed with tape or caulked with appropriate sealant. Two layers of plasterboard, each with a mass per unit area of at least 10 kg/m^2, are required if there is a separating floor.

Junctions with solid external masonry walls AD E: 2.42

No guidance is provided in the AD. Designers are advised to seek specialist advice.

Junctions with internal framed walls AD E: 2.43

No restrictions are imposed.

Junctions with internal masonry walls AD E: 2.44

Internal masonry walls should abut the separating wall and have a mass per unit area of at least 120 kg/m^2 excluding finish (see Fig. 10.5).

Junctions with internal timber floors AD E: 2.45

Floor joists should not be built into this type of wall. Instead, they should be supported on joist hangers.

Junctions with internal concrete floors AD E: 2.46–2.48

- The requirements for solid concrete slabs are shown in Fig. 10.6.
- Hollow core concrete plank floors and concrete beam with infill block floors should not be continuous through Type 1 separating walls.
- If concrete beam with infill block floors are built into separating walls, then the blocks in the floor must fill the space between the beams where they penetrate the wall.

Junctions with timber ground floors AD E: 2.49–2.50

Ground floor joists should not be built into this type of wall. Instead, they should be supported on joist hangers. Refer also to Approved Document C (Site preparation and resistance to moisture) and Approved Document L (Conservation of fuel and power).

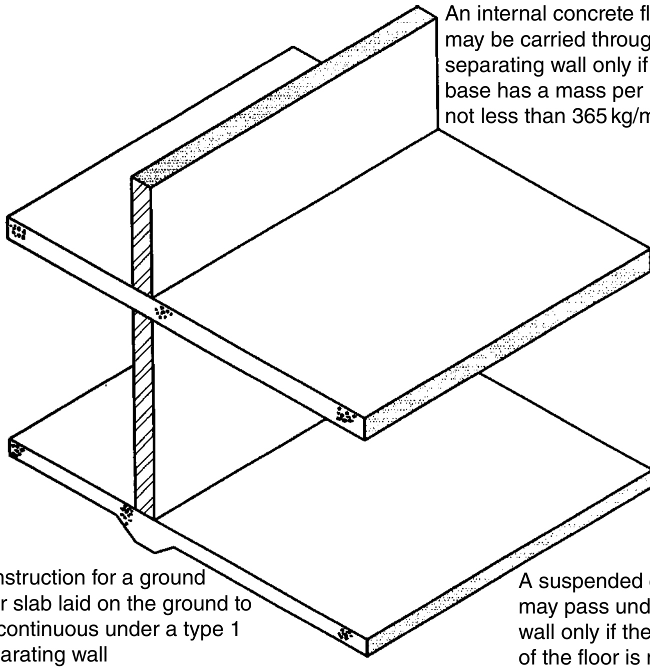


Fig. 10.6 Conditions for concrete floors to pass through Type 1 separating walls.

Junctions with concrete ground floors AD E: 2.51–2.54

- For suspended concrete ground floors and solid slabs laid directly onto the ground, see Fig. 10.6.
- Hollow core concrete plank floors and concrete beam with infill block floors should not be continuous under Type 1 separating walls.
- Refer also to Approved Document C (Site preparation and resistance to moisture) and Approved Document L (Conservation of fuel and power).

Junctions with ceilings and roofs AD E: 2.55–2.59

- The separating wall should continue to the underside of the roof with a flexible closer, which is suitable for use as a fire stop, at its junction with the roof (see Fig. 10.7).
- If the roof or loft space is not a habitable room, then the mass per unit area of the separating wall may be reduced to 150 kg/m^2 above the ceiling which separates the roof or loft space from the uppermost habitable rooms. For this reduction to apply, the mass per unit area of the ceiling must be at least 10 kg/m^2 with sealed joints around the perimeter of the ceiling (see Fig. 10.7).
- If lightweight aggregate blocks with a density of less than 1200 kg/m^3 are used above ceiling level, one side of the wall should be sealed with cement paint or plaster skim.
- Cavities in external walls should be closed at their eaves since this will have the effect of reducing any sound transmission through the cavity from the roof space. A flexible material should be used for the closure with no rigid joint between the two leaves.

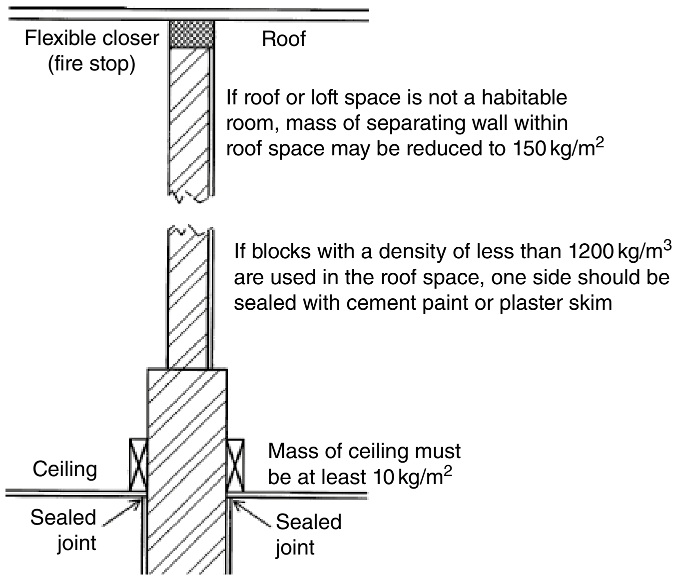


Fig. 10.7 Roof junction using wall Type 1, assuming roof space is not a habitable room.

It is important to avoid a rigid connection between the two leaves, and if a rigid material is used, it should only be rigidly attached to one leaf (see BRE BR 262, *Thermal insulation: Avoiding risks*, section 2.3).

Junctions with separating floors AD E: 2.60

See section 3 of the AD (section **10.5**) for details of junctions between separating floors and Type 1 separating walls.

10.4.3 Design of wall Type 2: Cavity masonry AD E: 2.61–2.72

The insulation offered against airborne sound transmission by cavity masonry walls depends on the mass per unit area of the masonry, the cavity width and also the nature of the connection there is between the two leaves by, for example, wall ties and foundations.

Four types of cavity masonry separating wall are described in Approved Document E, which according to the document should, if built correctly, comply with Requirement E1 (see Table 10.4). However, only two of these are appropriate for general application, the other two being restricted to situations where there is a step or stagger in the separating wall. Examples of each of the four types of wall are provided in the AD, and these are described in Table 10.5. For each of these constructions, it is important to note that:

- cavity widths are minimum values;
- Type A wall ties should be used to connect the leaves of the walls; and
- blocks without voids are used (manufacturers advice should be sought regarding the use of blocks with voids).

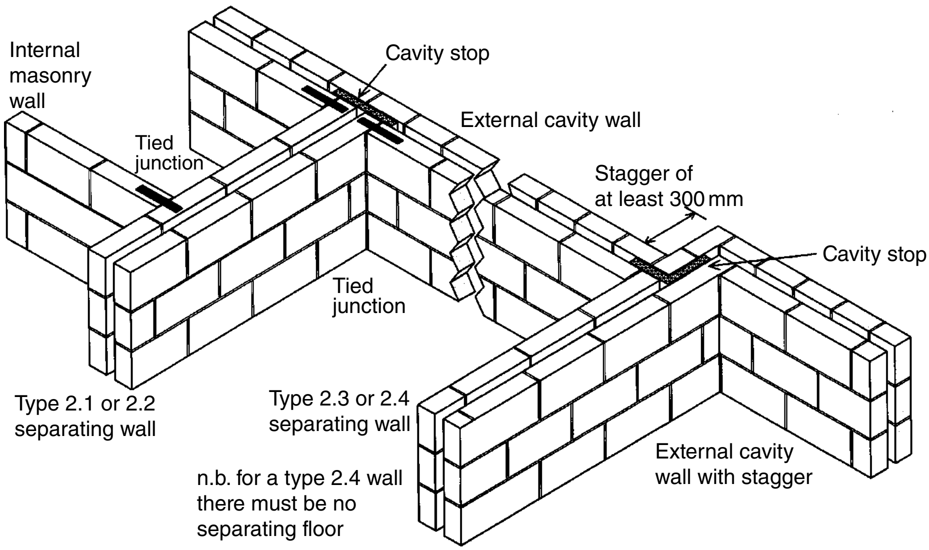


Fig. 10.8 Junctions of cavity separating walls.

In order for the performance of cavity masonry separating walls to be satisfactory, the junctions between them and their surrounding construction elements must be designed correctly. The requirements detailed in the AD are explained below (see also section 10.4.7).

Junctions with external cavity walls which have masonry inner leaves AD E: 2.73–2.76

- There are no restrictions on the outer leaf of the wall.
- Unless the cavity is fully filled with mineral wool, expanded polystyrene beads or some other suitable insulating material (the AD states that the manufacturer's advice should be sought regarding alternative suitable materials), the cavity should be stopped with a flexible closer as shown in Figs 10.4 and 10.8. Note the nature of the cavity closer for staggered wall construction in Fig. 10.8.
- The separating wall should be joined to the inner leaf of the external wall either by bonding with at least half of the bond provided by the separating wall or by using tied construction with the inner leaf of the external wall abutting the separating wall. See Building Regulation Part A – Structure.
- If there is a separating floor, the mass per unit area of the inner leaf of the external wall should be at least 120 kg/m^2, excluding its finish for all Type 2 walls in order to reduce the effects of flanking transmission. However if there is no separating floor, this requirement applies only to Type 2.2 walls and does not apply to Type 2.1, 2.3 and 2.4 walls.

Junctions with external cavity walls which have timber-framed inner leaves AD E: 2.77–2.78

- There are no restrictions on the outer leaf of the wall.
- The cavity should be stopped with a flexible closer as shown in Fig. 10.4.
- The inner leaf frame of the external wall should abut the separating wall and be tied to it vertically with ties at not greater than 300 mm centres.
- The finish of the inner leaf of the external wall should be one layer of plasterboard with a mass per unit area of at least 10 kg/m^2 with all joints sealed with tape or caulked with appropriate sealant. Two layers of plasterboard, each with a mass per unit area of at least 10 kg/m^2, are required if there is a separating floor.

Junctions with solid external masonry walls AD E: 2.79

No guidance is provided in the AD. Designers are advised to seek specialist advice.

Junctions with internal framed walls AD E: 2.80

No restrictions are imposed.

Junctions with internal masonry walls AD E: 2.81–2.83

If there is a separating floor, the mass per unit area of the internal masonry wall should be at least 120 kg/m^2, excluding finish. However, if there is no separating floor, this requirement applies only to Types 2.1 and 2.2 walls and does not apply to Types 2.3 and 2.4 walls.

Junctions with internal timber floors AD E: 2.84

Floor joists should not be built into this type of separating wall. They should be supported on joist hangers.

Junctions with internal concrete floors AD E: 2.85

Internal concrete floors should generally be built into Type 2 separating walls and continue to the face of the cavity (see Fig. 10.9). Such floors should not bridge the cavity.

Junctions with timber ground floors AD E: 2.86

Ground floor joists should not be built into this type of separating wall. They should be supported on joist hangers.

Junctions with concrete ground floors AD E: 2.88–2.90

- Concrete floor slabs laid directly onto the ground should not be continuous beneath Type 2 separating walls but should abut them as shown in Fig. 10.9.

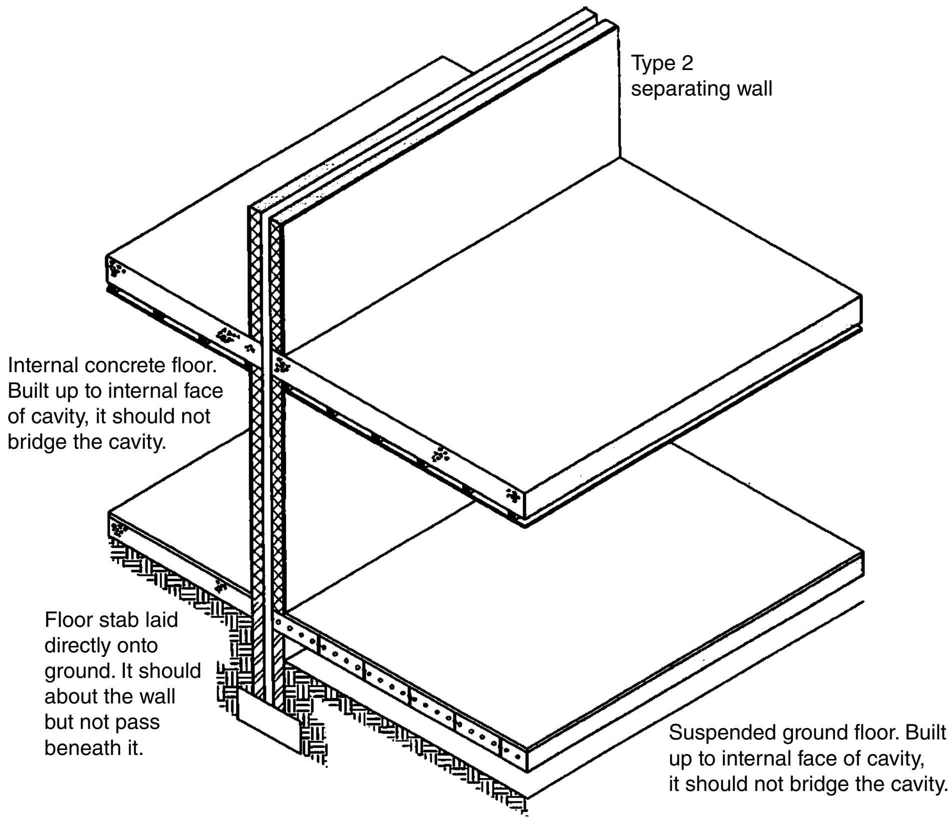


Fig. 10.9 Conditions for concrete floors and Type 2 separating walls.

- Suspended concrete ground floors should not be continuous beneath Type 2 separating walls but should be built in and continue to the face of the cavity (see Fig. 10.9). Floors should not bridge the cavity.
- Refer also to Approved Document C (Site preparation and resistance to moisture) and Approved Document L (Conservation of fuel and power).

Junctions with ceilings and roofs AD E: 2.91–2.95

- The separating wall should continue to the underside of the roof with a flexible closer, which is suitable for use as a fire stop, at its junction with the roof (see Fig. 10.10).
- If the roof or loft space is not a habitable room, then the mass per unit area of the separating wall may be reduced to 150 kg/m^2 above the ceiling which separates the roof or loft space from the uppermost habitable rooms. For this reduction to apply, the mass per unit area of the ceiling must be at least 10 kg/m^2, all joints within the ceiling and around its perimeter must be sealed and the wall above the ceiling must remain a cavity wall, as shown in Fig. 10.10.
- If lightweight aggregate blocks with a density of less than 1200 kg/m^3 are used above ceiling level, one side of the wall should be sealed with cement paint or plaster skim.

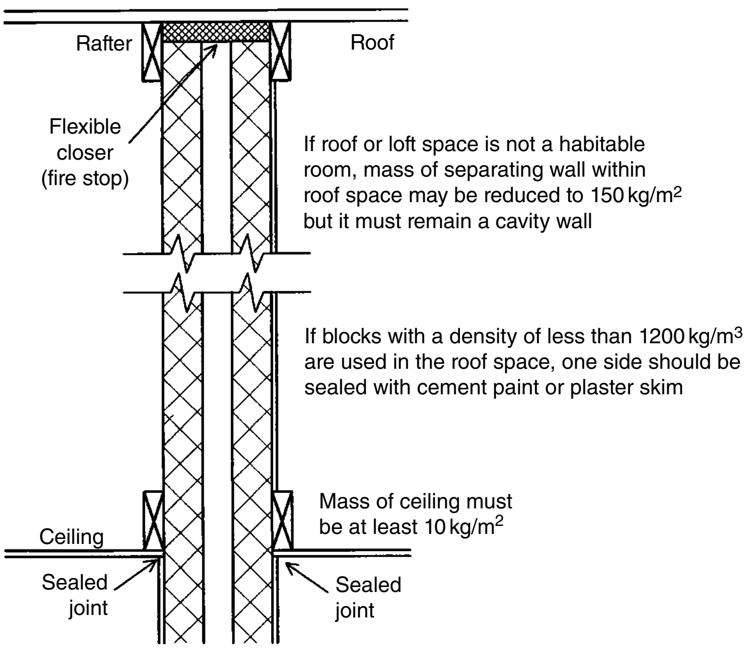


Fig. 10.10 Roof junction using wall Type 2, assuming roof space is not a habitable room.

- Cavities in external walls should be closed at their eaves since this will have the effect of reducing any sound transmission through the cavity from the roof space. A flexible material should be used for the closure with no rigid joint between the two leaves. It is important to avoid a rigid connection between the two leaves, and if a rigid material is used, it should only be rigidly attached to one leaf (see BRE BR 262, *Thermal insulation: Avoiding risks*, section 2.3).

Junctions with separating floors AD E: 2.96

See section 3 of the AD (section **10.5**) for details of junctions between separating floors and Type 2 separating walls.

10.4.4 Design of wall Type 3: Masonry walls between independent panels AD E: 2.97–2.107

The independent panels used in this type of construction are typically of plasterboard fixed to timber studs, and the insulation such walls offer to airborne sound transmission depends on the mass per unit area of the masonry and the independent panels. It is also influenced by the degree of isolation between the masonry core and the panels. Separating walls of this type are capable of providing very good airborne and impact sound insulation.

Three types of masonry/independent panel walls are described in Approved Document E, which according to the document should, if built correctly, comply with Requirement

E1 (see Table 10.6). Examples of each of the three types of wall are provided in the AD, and these are also described in Table 10.6. The essential components of this form of construction are a masonry core of either solid or cavity construction with independent panels on each side of it. The panels, and any framing which is associated with them, must not be in contact with the masonry core.

For each of these constructions:

- cavity widths in masonry cores are minimum values;
- Type A wall ties should be used to connect the leaves of cavity masonry cores; and
- a stringent specification for the construction of the independent panels should be adhered to as follows:
  (a) The independent panels must each have a mass per unit area of at least 20 kg/m^2 excluding the mass of any supporting framework;
  (b) Panels to consist of two or more layers of plasterboard with staggered joints or composite panels formed by two sheets of plasterboard separated by a cellular core; and
  (c) A gap of at least 35 mm between panels and masonry core if the panels are not supported on a frame, or a gap of at least 10 mm between the frame and the masonry core if the panels are supported on a frame.

In order for the performance of masonry with independent panel separating walls to be satisfactory, the junctions between them and their surrounding construction elements must be designed correctly. The requirements detailed in the AD are explained below. See also Table 10.8 and section 10.4.7 regarding correct and incorrect construction procedures.

Junctions with external cavity walls which have masonry inner leaves AD E: 2.108–2.112

- There are no restrictions on the outer leaf of the wall.
- Unless the cavity is fully filled with mineral wool, expanded polystyrene beads or some other suitable insulating material (the AD states that manufacturers' advice should be sought regarding alternative suitable materials), the cavity should be stopped with a flexible closer as shown in Figs 10.4 and 10.11.
- There should be a bonded or tied connection between the core of the separating wall and the inner leaf of the external wall. See Fig. 10.11 for detail of tied connection.
- The inner leaf of the external wall should be lined in the same way as the separating wall (see Fig. 10.11).
- The mass per unit area of the inner leaf of the external wall should be at least 120 kg/m^2 excluding its finish, but if there is no separating floor and the inner leaf of the external wall is lined with independent panels in the same way as the separating wall, there is no minimum mass requirement for the inner leaf.
- Where the mass per unit area of the inner leaf of the external wall is at least 120 kg/m^2 excluding its finish, there is no separating floor and wall Type 3.1 or 3.3 is used; the inner leaf of the external wall may be finished with plaster or plasterboard with a mass per unit area of not less than 10 kg/m^2.

Table 10.8 Construction procedures relating to the sound insulation of separating walls.

Separating wall type	Correct procedure	Procedures which must be avoided
1, 2, 3, 4	Control flanking transmission between separating walls and connected walls and floors as described in the text	
	Ensure external cavity walls are stopped with flexible closers at junctions with separating wall. See text	
1, 2, 3	Fill and seal all masonry joints with mortar	
	Ensure flue blocks will not adversely affect sound insulation. Ensure that a suitable finish is used over flue blocks (see BS 1289–1:1986 and obtain manufacturer's advice)	
1, 2, 4	Stagger the positions of sockets on opposite sides of separating walls. In the case of Type 4 walls, use a similar thickness of cladding material behind socket boxes	In the case of Type 1 and 2 walls, do not use deep sockets and chases in the wall and do not locate them back to back
		In the case of Type 4 walls, do not locate sockets back to back or chase plasterboard, and a minimum of 150 mm edge to edge stagger is recommended between sockets
1, 2		Do not create a junction between Type 1 and 2 walls in which the cavity is bridged by the solid wall
		Do not attempt to convert a Type 2 separating wall into a Type 1 wall by inserting mortar or concrete into the cavity
1	Lay bricks 'frog up'	
	Use bricks and blocks which extend to the full thickness of the wall	
2	Keep cavity leaves separate below ground floor level	Do not change to a solid wall in the roof space. A rigid connection between the leaves will adversely affect performance
		Do not build a cavity wall off a continuous concrete floor slab
3	Fix panels or supporting frames to ceiling and floor only	Do not fix, tie or otherwise connect the free standing panels to the masonry core wall
	Tape and seal all joints	
4	Ensure that fire stops in the cavity between frames are either flexible or fixed to one frame only	If the two leaves have to be connected for structural purposes, do not use ties of greater cross section than 40 mm by 3 mm. Fix them to the studwork at or just below ceiling level
	Ensure that each layer of plasterboard is independently fixed to the frame	Do not set the ties at closer than 1.2 m centres

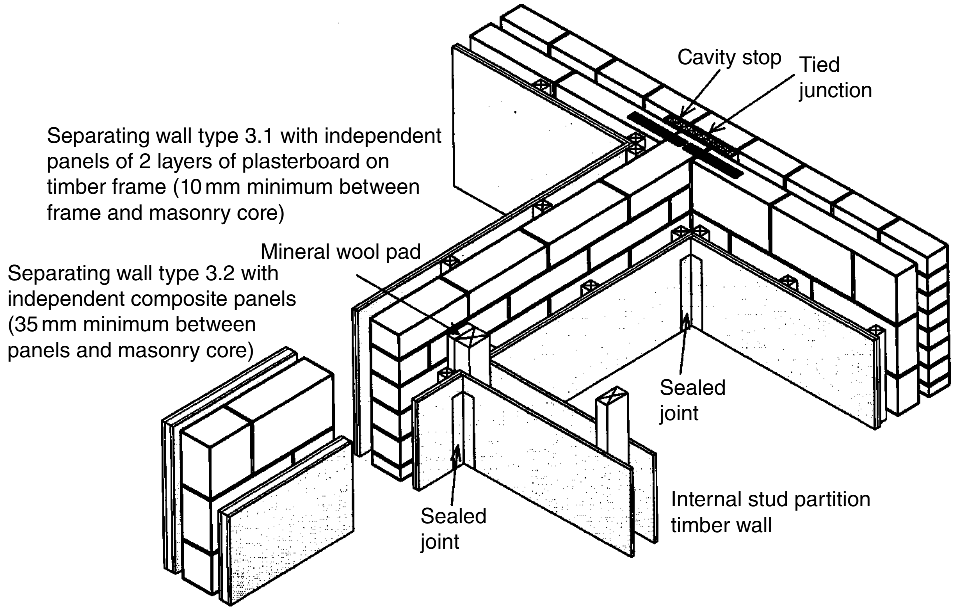


Fig. 10.11 Junctions using Type 3 separating walls.

Junctions with external cavity walls which have timber-framed inner leaves AD E: 2.113

No guidance is provided in the AD. Designers are advised to seek specialist advice.

Junctions with solid external masonry walls AD E: 2.114

No guidance is provided in the AD. Designers are advised to seek specialist advice.

Junctions with internal framed walls AD E: 2.115–2.117

Load-bearing internal framed walls should be fixed to the masonry core through a continuous pad of mineral wool as shown in Fig. 10.11, whereas non-load-bearing internal walls should be butted to the independent panels. The joints between all internal wall panels should be either sealed with tape or caulked with appropriate sealant.

Junctions with internal masonry walls AD E: 2.118

Internal walls of masonry construction should not abut Type 3 separating walls.

Junctions with internal timber floors AD E: 2.119–2.120

Floor joists should not be built into this type of wall. They should be supported on joist hangers, and the spaces at the wall surface between the joists should be sealed to the full depth of the joists with timber blocking.

Junctions with internal concrete floors AD E: 2.121–2.122

For separating wall Types 3.1 and 3.2 (solid), internal concrete floor slabs may only be carried through the solid masonry core if the floor base has a mass per unit area of 365 kg/m^2 or more. For separating wall Type 3.3 (cavity), internal concrete floors should normally be built into the wall and continue to the face of the cavity. Such floors should not bridge the cavity.

Junctions with timber ground floors AD E: 2.123–2.125

Floor joists should not be built into this type of wall. They should be supported on joist hangers, and the spaces at the wall surface between the joists should be sealed to the full depth of the joists with timber blocking. Refer also to Approved Document C (Site preparation and resistance to moisture) and Approved Document L (Conservation of fuel and power).

Junctions with concrete ground floors AD E: 2.126–2.132

- A concrete floor slab laid on the ground may be continuous under the solid core of a Type 3.1 or 3.2 (solid core) separating wall.
- A suspended concrete floor may pass under the masonry core of a Type 3.1 or 3.2 (solid core) separating wall only if the mass per unit area of the floor is 365 kg/m^2 or more.
- Hollow core concrete plank floors and concrete beam with infill block floors should not be continuous under the masonry core of a Type 3.1 or 3.2 (solid core) separating wall.
- Concrete floor slabs laid directly onto the ground should not be continuous beneath Type 3.3 (cavity core) separating walls but should abut them in a manner similar to that shown in Fig. 10.9 for cavity walls.
- Suspended concrete ground floors should not be continuous beneath Type 3.3 (cavity core) separating walls but should be built in and continue to the face of the cavity in a manner similar to that shown in Fig. 10.9 for cavity walls. The floor should not bridge the cavity.
- Refer also to Approved Document C (Site preparation and resistance to moisture) and Approved Document L (Conservation of fuel and power).

Junctions with ceilings and roofs AD E: 2.133–2.139

- The masonry core should continue to the underside of the roof with a flexible closer, which is also suitable for use as a fire stop, at its junction with the roof. Also, the independent panels should be either sealed with tape or caulked with appropriate sealant at their junction with the ceiling (see Fig. 10.12).
- Cavities in external walls should be closed at their eaves since this will have the effect of reducing any sound transmission through the cavity from the roof space. A flexible material should be used for the closure with no rigid joint between the two leaves. It is important to avoid a rigid connection between the two leaves, and if a rigid material is used, it should only be rigidly attached to one leaf (see BRE BR 262, *Thermal insulation: Avoiding risks*, section 2.3).

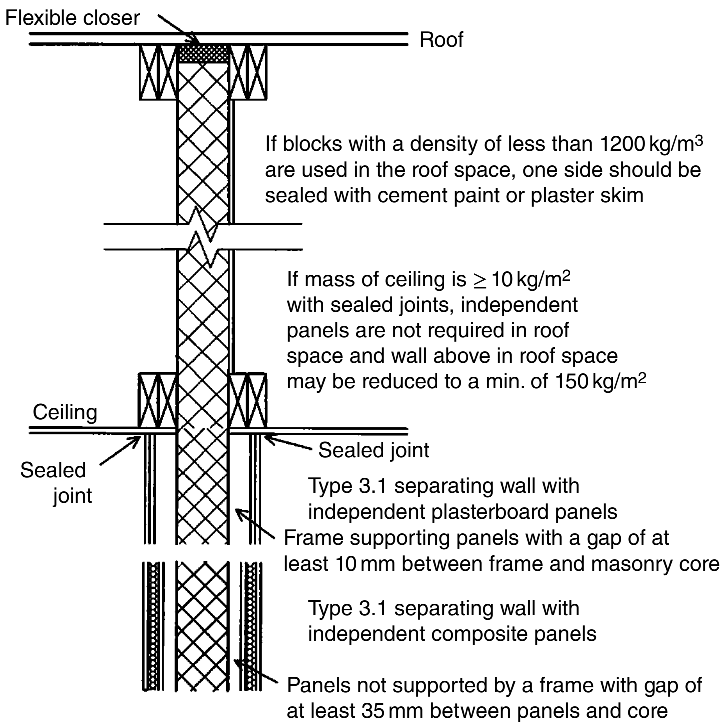


Fig. 10.12 Roof junction using wall Type 3.1 or 3.2, assuming roof space is not a habitable room.

- If the roof or loft space is not a habitable room and the mass per unit area of the ceiling is at least 10 kg/m^2 and it has sealed joints, then the independent panels may be omitted in the roof space. Also, in the case of wall Types 3.1 and 3.2, the mass per unit area of the separating wall may be reduced to 150 kg/m^2 above the ceiling (see Fig. 10.12). However, in the case of wall Type 3.3, the cavity masonry core must continue to the underside of the roof.
- If lightweight aggregate blocks with a density of less than 1200 kg/m^3 are used above ceiling level, one side of the wall should be sealed with cement paint or plaster skim.

Junctions with separating floors AD E: 2.140

See section 3 of the AD (section **10.5**) for details of junctions between separating floors and Type 3 separating walls.

10.4.5 Design of wall Type 4: Framed walls with absorbent material AD E: 2.141–2.147

Walls of this type consist of two independent frames of timber or steel with panels fixed to the outside of each and sound absorbent material such as mineral wool placed in the void between the two panels. The insulation they offer to airborne sound transmission depends on the mass per unit area of the panels, the extent to which the frames are isolated from each other and on the absorption properties of the void between them.

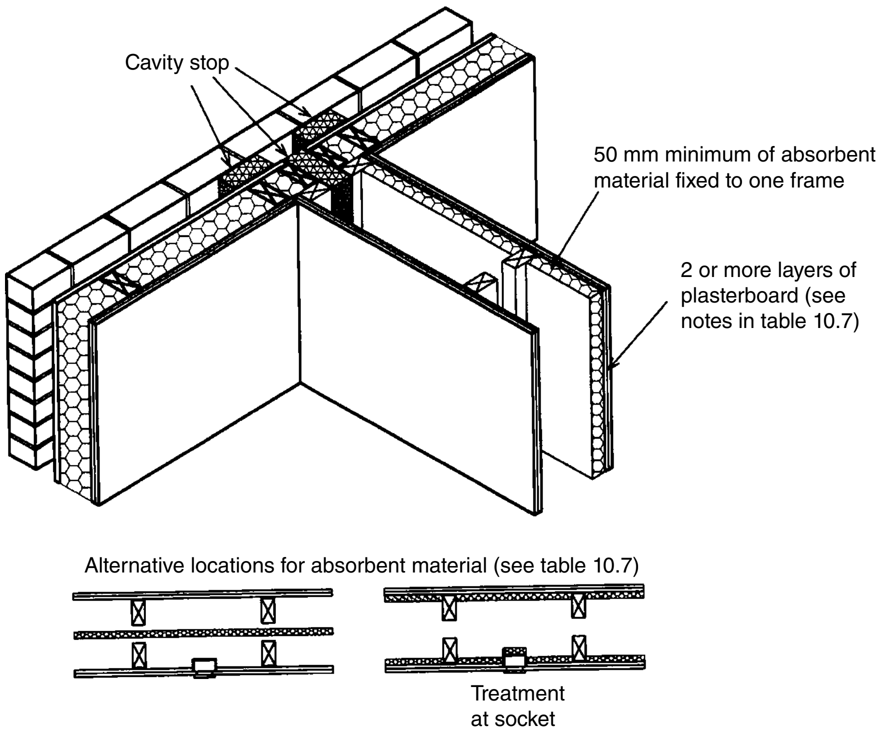


Fig. 10.13 Details of timber-framed separating wall with absorbent infill.

One type of framed wall consisting of timber frames and plasterboard lining is described in Approved Document E (see Table 10.7), and its construction form is shown in Fig. 10.13. According to the document this wall should, if built correctly, comply with Requirement E1. Designers are advised in the AD to seek advice from manufacturers for steel framed alternatives.

In order for the performance of frame and absorbent infill separating walls to be satisfactory, the junctions between them and their surrounding construction elements must be designed correctly. The requirements detailed in the AD are explained below. See also Table 10.8 and section 10.4.7 regarding correct and incorrect construction procedures.

Junctions with external cavity walls which have masonry inner leaves AD E: 2.148

No guidance is provided in the AD. Designers are advised to seek specialist advice.

Junctions with external cavity walls which have timber-framed inner leaves AD E: 2.149–2.150

- No restrictions are imposed on the form of the outer leaf.
- The cavities in the external wall and the separating wall should be stopped with flexible closers as shown in Fig. 10.13.

- The finish of the inner leaf of the external wall, assuming there is no separating floor, should consist of one layer of plasterboard with a mass per unit area of at least 10 kg/m^2, all joints being sealed with tape or caulked with appropriate sealant. If there is a separating floor, two layers of plasterboard, each with a mass per unit area of at least 10 kg/m^2, should be provided.

Junctions with solid external masonry walls AD E: 2.151

No guidance is provided in the AD. Designers are advised to seek specialist advice.

Junctions with internal framed walls AD E: 2.152

No restrictions are imposed on internal framed walls meeting a Type 4 separating wall.

Junctions with internal masonry walls AD E: 2.153

No restrictions are imposed on internal masonry walls meeting a Type 4 separating wall.

Junctions with internal timber floors AD E: 2.154

In order to prevent flanking transmission, air paths into the cavity from floor voids must be blocked by solid timber blockings, continuous ring beams or joists.

Junctions with internal concrete floors AD E: 2.155

No guidance is provided in the AD. Designers are advised to seek specialist advice.

Junctions with timber ground floors AD E: 2.156–2.157

In order to prevent flanking transmission, air paths into the cavity from floor voids must be blocked by solid timber blockings, continuous ring beams or joists. Also refer to Approved Documents C and L.

Junctions with concrete ground floors AD E: 2.158

A concrete ground floor slab laid directly on the ground may be of continuous construction under a Type 4 separating wall, whereas a suspended concrete ground floor may only pass beneath a Type 4 wall if the floor has a mass per unit area of not less than 365 kg/m^2.

Junctions with ceilings and roofs AD E: 2.160–2.163

- The separating wall should preferably continue to the underside of the roof, a flexible closer should be provided at its junction with the roof and the separating wall linings should be sealed with tape or caulked with appropriate sealant at their junction with the ceiling.

- If the roof or loft space is not a habitable room and the ceiling has sealed joints and a mass per unit area of at least 10 kg/m^2, then within the roof space, either:
  - (a) the lining on each of the two frames may be reduced to two layers of plasterboard, each sheet with a mass per unit area of at least 10 kg/m^2; or
  - (b) the wall may be reduced to one frame with two layers of plasterboard, each sheet with a mass per unit area of at least 10 kg/m^2, on both sides of the frame. In this case, the cavity must be closed at ceiling level in such a way that the two frames are not rigidly connected together.
- Cavities in external walls should be closed at their eaves. A flexible material should be used for the closure with no rigid joint between the two leaves. It is important to avoid a rigid connection between the two leaves, and if a rigid material is used, it should only be rigidly attached to one leaf (see BRE BR 262, *Thermal insulation: Avoiding risks*, section 2.3).

Junctions with separating floors AD E: 2.164

See section 3 of the AD (section **10.5**) for details of junctions between separating floors and Type 4 separating walls.

10.4.6 Walls separating habitable rooms from other parts of a building AD E: 2.25–2.28

Buildings containing flats and rooms for residential purposes often contain non-habitable spaces juxtaposed to those which are occupied. The AD stipulates the sound insulation provided by the walls of refuse chutes in terms of mass, including finishes, per unit area. If the refuse chute is separated from a habitable room or kitchen, its mass per unit area should be 1320 kg/m^2 or more, whereas if it is a non-habitable room, the mass per unit area may be reduced to 220 kg/m^2.

Another common source of noise in multi-occupancy buildings is that transmitted from corridors. The AD states that in order to control noise from this source, walls between corridors and flats should be constructed to the standard used for separating walls (see sections 10.4.2 to 10.4.5). A weak point in the sound insulation provided from corridor noise is that transmitted through doors. For this reason, the document states that doors to corridors should have good sealing around their perimeters (including, if practical, their thresholds), and a mass per unit area of at least 25 kg/m^2, or a weighted sound reduction index, R_w, of at least 29 dB. The term sound reduction index is described in section **10.14**, and the relevant measurement standards are listed in section 10.12.4 (AD E B3.9). In 'noisy' parts of a building, noise should be contained by a lobby, two doors in series (i.e. such that each door is passed through in turn) or a high performance doorset, and if this is impossible, flats in the vicinity should be provided with this type of protection at their entrances. It is very important when considering the sound insulation of doors to bear in mind also the requirements of Building Regulations Part B – Fire safety and Part M – Access and facilities for disabled people.

10.4.7 Construction procedures

The AD provides information regarding correct and incorrect construction procedures which will influence the sound insulation offered by separating walls. This is summarised in Table 10.8.

10.5 Separating floors and their flanking constructions: New buildings

(Approved Document E section 3: Separating floors and associated flanking constructions for new buildings)

10.5.1 Construction forms AD E: 3.1–3.7 & 3.9

Section 3 of the Approved Document E gives examples of floors which should achieve the performance standards for houses and flats tabulated in section 0: Performance – Table 1a of the AD and in section 10.2. However, as is stated in the document, the actual performance of a floor will depend on the quality of its construction. The information in this section of the AD is provided only for guidance; it is not intended to be exhaustive, and alternative constructions may achieve the required standard. Designers are also advised to seek advice from other sources such as manufacturers regarding alternative designs, materials or products. The details in no way override the requirement to undergo pre-completion testing. For the provision of floors in 'rooms for residential purposes', see section **10.8**.

The separating floor constructions described in the AD are divided into three types:

- **Type 1 Concrete base with ceiling and soft floor covering.**
- **Type 2 Concrete base with ceiling and floating floor.**
  Floors of this type require one of three types of floating floor. These are defined by the terms (a), (b) and (c).
- **Type 3 Timber frame base with ceiling and platform floor.**

The three floor types are shown in Fig. 10.14, and within each floor type, alternatives are presented in a ranking order such that the one which should offer the best sound insulation is described first.

The following notes should be borne in mind when considering the alternatives which are presented.

- The mass per unit area of floors is quoted in kilogrammes per square metre (kg/m^2), and this may be obtained from the manufacturers' data. Alternatively it may be obtained using a procedure described in Annex A of the AD and outlined in section **10.12**. Densities of materials are quoted in kilogrammes per cubic metre (kg/m^3).
- Acoustically, the mass of a bonded screed acts with the slab on to which it is laid and therefore, where appropriate, may be taken into account when calculating the mass

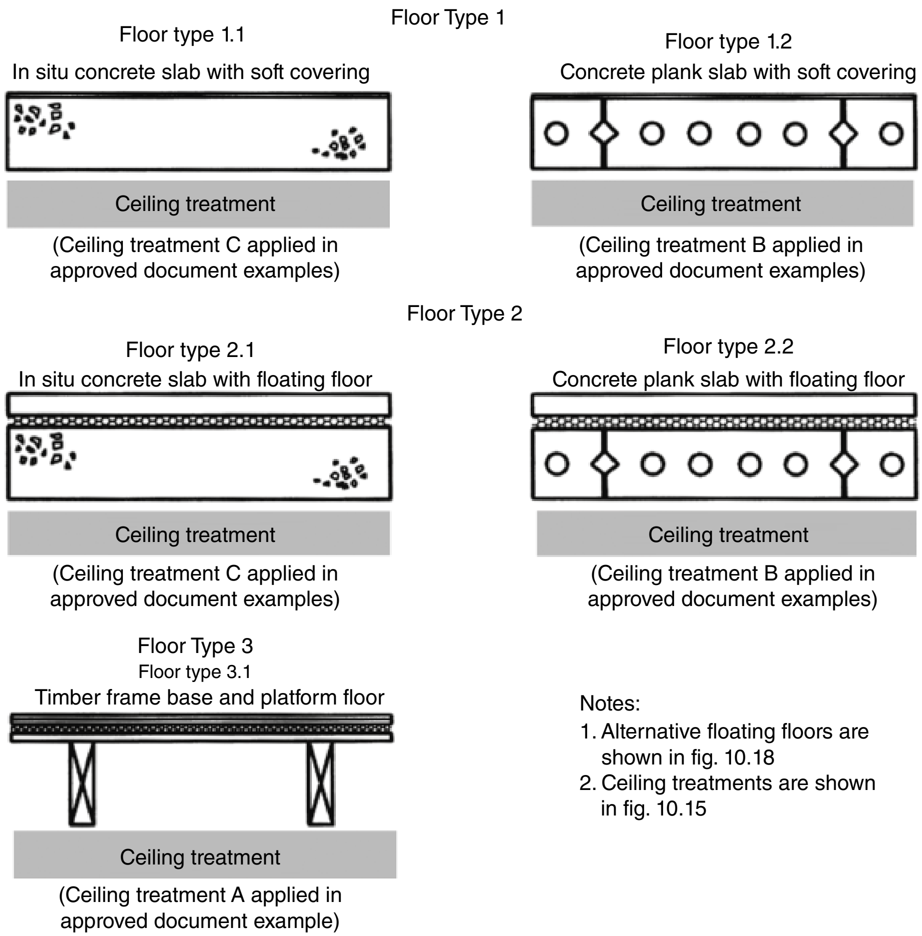


Fig. 10.14 Alternative types of floor construction.

per square metre of a floor, but the mass of a floating screed does not and therefore must not be taken into account.

- Solid in situ concrete and hollow plank floors are considered in the guidance notes, but beam and block floors are not. It is suggested that designers take advice from manufacturers regarding the sound insulation properties of this latter type of floor.

Floor penetrations AD E: 3.41–3.43 & 3.79–3.82 & 3.117–3.120

Particular attention must be given to pipes or ducts which pass through separating floors. The points in the AD are summarised as follows:

- Pipes and ducts penetrating a floor separating habitable rooms in different dwelling places should be enclosed for their full height, i.e. for the full height of the room if they pass from floor to ceiling, with material which has a mass per unit area of at least 15 kg/m^2. Not less than 25 mm of unfaced wool or mineral fibre should be used either to wrap the pipe or duct or to line the inside of the enclosure.

- If the floor incorporates a floating layer, a gap of approximately 5 mm should be left between this and the enclosure with the gap filled with sealant or neoprene. The enclosure may extend down to the floor base, but if so it must be isolated from the floating layer.
- There are fire safety implications where separating floors are penetrated and fire protection to satisfy the requirements of Building Regulation Part B must be provided. Flexible fire stopping should be used, and, in order to prevent structure-borne transmission, it is important that there is no rigid contact between pipes and floor.
- Ducts containing gas pipes must be ventilated at each floor. Gas pipes may be housed in separate ventilated ducts, or, alternatively, gas pipes need not be enclosed. It is essential that relevant codes and standards are complied with to ensure gas safety (reference: *The Gas Safety (Installation and Use) Regulations 1998* (SI 1998 2451)).

Ceiling construction AD E: 3.17–3.22

The type of ceiling provided has a significant bearing on the acoustic performance of a floor, and so, since alternative ceiling treatments may be combined with each type of floor, the three ceiling treatments described in the AD are defined by the letter A, B or C, and each floor type is qualified by the letter A, B or C depending on its ceiling treatment. The AD states that the ceiling treatments, as described in Table 10.9 and shown in Fig. 10.15, are ranked such that A should provide the highest level of sound insulation and, further, that if a ceiling treatment of a higher ranking than one applied in a guidance example is used, then providing that there is no significant flanking transmission, the result should be improved sound insulation from the complete floor.

Junctions and flanking transmission AD E: 3.10

It is very important that the junctions between a separating floor and the elements to which it is attached are carefully designed because this will have a significant influence on its overall effectiveness. Since the level of sound insulation achieved will be strongly dependent on the extent to which flanking transmission exists, considerable advice is given in the AD on this issue. Guidance is provided on the junctions between separating floors and the following other elements:

- External cavity walls with masonry inner leaf;
- External cavity wall with timber-framed inner leaf;
- Solid masonry external walls;
- Internal walls – masonry;
- Internal walls – timber;
- Floor penetrations (see above);
- Separating walls Type 1, 2, 3 and 4 (these being relevant to the design of flats).

However, not all floor/junction combinations are considered. It is stated in the AD that if any element has a separating function, e.g. a ground floor which is also a separating floor for a basement flat, then the separating element requirements should take precedence.

Table 10.9 Ceiling treatments for separating wall constructions.

Ceiling treatment	Form	Specification
A	Independent ceiling with absorbent material	At least two layers of plasterboard with staggered joints and total mass per unit area of at least 20 kg/m^2 Mineral wool laid in cavity above ceiling to provide sound absorption. Minimum thickness 100 mm, minimum density 10 kg/m^3 See note below regarding fixings
B	Plasterboard on proprietary resilient bars with absorbent material to fill ceiling void	Single layer of plasterboard with mass per unit area of at least 10 kg/m^2 Plasterboard fixed using proprietary resilient bar. For concrete floor, fix bar to timber battens. Bar should be fixed in accordance with manufacturer's instructions Fill ceiling void with mineral wool with density of at least 10 kg/m^3
C	Plasterboard on timber or plasterboard on resilient channels with absorbent material to fill ceiling void	Single layer of plasterboard with mass per unit area of at least 10 kg/m^2 Plasterboard should be fixed using proprietary resilient channels or timber battens Fill ceiling void with mineral wool with density of at least 10 kg/m^3 if resilient channels are used

Notes:

(a) If using ceiling treatment A with floor Types 1 or 2, the ceiling should be attached to independent joists supported only by surrounding walls with a clearance of a minimum of 100 mm between top of ceiling plasterboard and underside of base floor. If using floor Type 3, the ceiling should be attached to independent joists supported by surrounding walls with extra support from resilient hangers attached directly to the floor. In this case there should be a clearance of a minimum of 100 mm between the top of the ceiling joists and underside of base floor.

(b) Light fittings recessed into ceilings may reduce sound insulation.

(c) See BRE BR 262, *Thermal insulation: Avoiding risks*, section 2.4, regarding heat emission from electrical cables which may be covered by absorbent material.

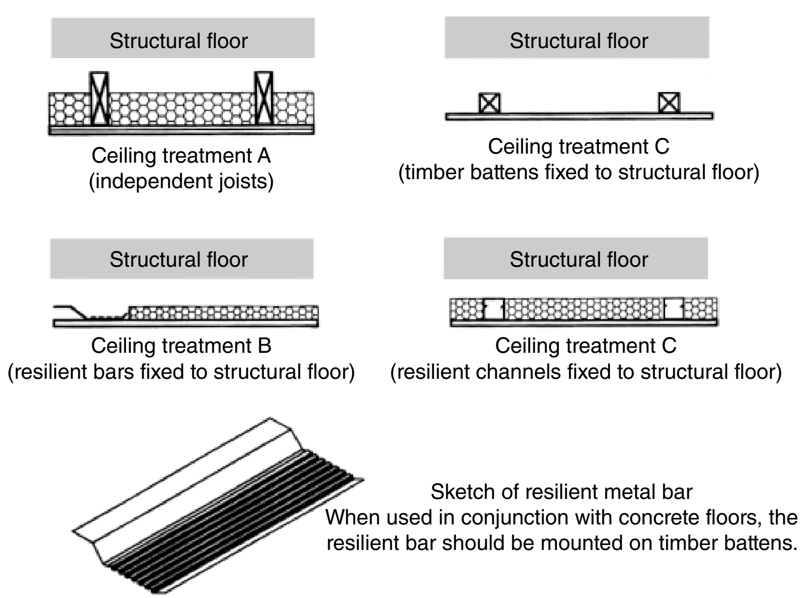


Fig. 10.15 Alternative ceiling treatments.

Table 10.10 Examples of concrete base with ceiling and soft covering floor constructions.

	Floor type	
	1.1C	**1.2B**
Description	Solid concrete slab, cast in situ with or without permanent shuttering. Soft floor covering and ceiling treatment C	Hollow or solid concrete planks. Soft floor covering and ceiling treatment B
Minimum mass per unit area of concrete base	365 kg/m² including any bonded screed. Permanent shuttering of solid concrete or metal may also be included	365 kg/m² including any bonded screed
Floor covering	Soft floor covering. This is essential	Soft floor covering. This is essential
Ceiling treatment	C or better is essential	B or better is essential
Other requirements		Use regulating floor screed
		All joints between and around planks to be fully grouted to ensure complete air tightness

10.5.2 Design of floor Type 1: Concrete base with ceiling and soft floor covering AD E: 3.23–3.30

It is the large mass of the concrete slab together with that of the ceiling which provides airborne sound insulation from this type of floor. For impact sound insulation, it relies on the soft covering preventing the contact of hard surfaces.

To be acceptable, a soft covering should be a resilient material or have a resilient base with a thickness, when uncompressed, of 4.5 mm or more. An alternative approach is to measure the 'weighted reduction of impact sound pressure level', ΔL_w, of the floor covering in accordance with the procedure described in Appendix B3 of the AD (see section 10.12.4 (Floor coverings and floating floors)). To be acceptable the measured value of ΔL_w should be 17 dB or more.

Two variations of floor Type 1 are described in Approved Document E, which according to the document should, if built correctly, comply with Requirement E1 (see Table 10.10). The first floor has ceiling treatment C and hence is referenced 1.1C, whereas the second has ceiling treatment B and hence is referenced 1.2B. In the case of floor Type 1.1C, a precast floor slab may be acceptable if it is fully sealed and bonded around the perimeter.

In order for the performance of Type 1 floors to be satisfactory, the junctions between them and their surrounding elements of constructions must be designed correctly. The requirements detailed in the AD are explained below. See also Table 10.14 and section 10.5.5 regarding correct and incorrect construction procedures.

Junctions with external cavity walls which have masonry inner leaves AD E: 3.31–3.35

- There are no restrictions on the outer leaf of the wall.
- Unless the cavity is fully filled with mineral wool, expanded polystyrene beads or some other suitable insulating material (the AD states that the manufacturers' advice

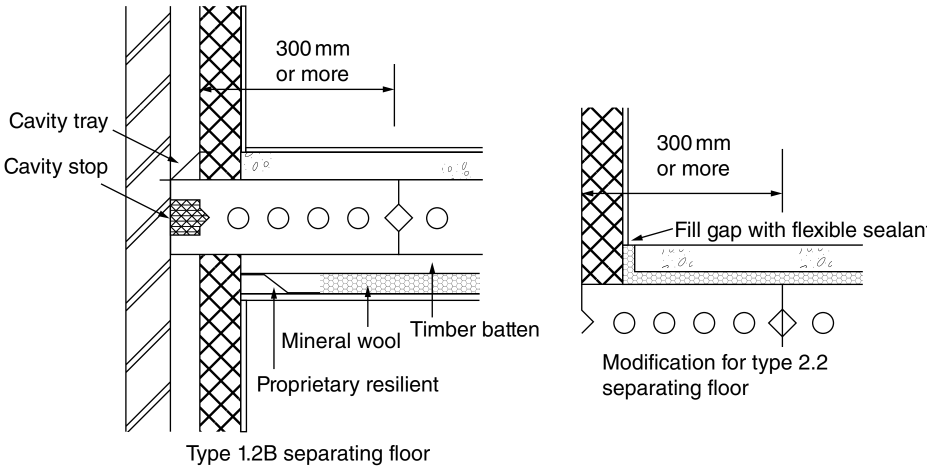


Fig. 10.16 Details of junctions between Type 1 and 2 separating floors and external cavity walls.

should be sought regarding alternative suitable materials), the cavity should be stopped with a flexible closer as shown in Fig. 10.16. The flexible closer must be protected from the effects of moisture, and it is essential that adequate drainage is provided (note the provision of a flexible cavity tray, or an equivalent, as shown in Fig. 10.16).

- The mass per unit area of the inner leaf of the external wall should be at least 120 kg/m^2 excluding its finish in order to reduce the effects of flanking transmission.
- The floor base, but not its screed, should continue to the face of the cavity without bridging the cavity, and if floor Type 1.2B is used, with the planks laid parallel to the wall, the first joint between planks should be 300 mm or more from the cavity face, as shown in Fig. 10.16.
- The use of wall ties in external masonry walls is considered in section 2 of the AD (see section 10.4.1 (wall ties)).

Junctions with external cavity walls which have timber-framed inner leaves AD E: 3.36

- There are no restrictions on the outer leaf of the wall.
- It is assumed that the cavity will not be filled, and so the cavity should be stopped with a flexible closer.
- The finish of the inner leaf should consist of two layers of plasterboard each with a mass per unit area of at least 10 kg/m^2 with all joints sealed with tape or caulked with appropriate sealant.

Junctions with solid external masonry walls AD E: 3.37

No guidance is provided in the AD. Designers are advised to seek specialist advice.

Junctions with internal framed walls AD E: 3.38

No restrictions are imposed.

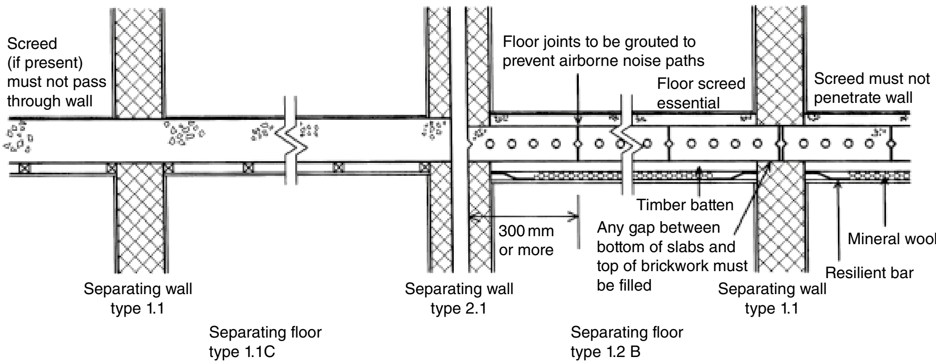


Fig. 10.17 Details of junctions between Type 1 separating floors and Type 1 and 2 separating walls.

Junctions with internal masonry walls AD E: 3.39–3.40

The floor base should be continuous through or above such walls, and any internal load-bearing wall or any other internal wall rigidly connected to a separating floor should have a mass per unit area of at least 120 kg/m^2 excluding finish.

Junctions with solid masonry (Type 1) separating walls AD E: 3.44–3.45

Floors bases of Type 1.1C should pass through Type 1 separating walls. Floor bases of Type 1.2B should not be continuous through Type 1 separating walls. In neither case should any screed penetrate the separating wall. See Fig. 10.17 for examples and requirements of both types of construction.

Junctions with cavity masonry (Type 2) separating walls AD E: 3.46–3.48

- The mass per unit area of any leaf, excluding finish, that supports or adjoins the floor should be 120 kg/m^2 or more.
- The floor base, but not its screed, should continue to the face of the cavity without bridging the cavity, and if floor Type 1.2B is used, with the planks laid parallel to the wall, the first joint between planks should be 300 mm or more from the cavity face as shown in Fig. 10.17.

Junctions with masonry between independent panels (Type 3) separating walls AD E: 3.49–3.54

Assuming the separating wall has a solid core, i.e. wall Types 3.1 and 3.2:

- Floor bases of Type 1.1C should pass through the wall. Floor bases of Type 1.2B should not be continuous through this type of separating wall. In neither case should any screed penetrate the separating wall. Construction should be similar to that shown in Fig. 10.17 for solid masonry separating walls.

- If floor Type 1.2B is used in conjunction with wall Type 3.2, with the planks laid parallel to the wall, the first joint between planks should be 300 mm or more from the centreline of the masonry core.

Assuming the separating wall has a cavity core, i.e. wall Type 3.3:

- The mass per unit area of any leaf that is supporting or adjoining the floor, excluding finish, should be 120 kg/m^2 or more.
- The floor base, but not its screed should continue to the face of the cavity without bridging the cavity, and if floor Type 1.2B is used, with the planks laid parallel to the wall, the first joint between planks should be 300 mm or more from the cavity face of the adjacent leaf of the masonry core. Construction should be similar to that shown in Fig. 10.17 for cavity masonry separating walls.

Junctions with framed with absorbent material (Type 4) separating walls AD E: 3.55

No guidance is provided in the AD. Designers are advised to seek specialist advice.

10.5.3 Design of floor Type 2: Concrete base with ceiling and floating floor AD E: 3.56–3.60

The complete floor construction consists of a concrete floor base on top of which is a resilient layer. On top of the resilient layer, there is a solid 'floating' layer, and below the concrete floor base is a ceiling which, as has previously been defined, may be classified as Type A, B or C. The floating floor consists of the floating layer and the resilient layer.

The sound insulation offered by floors of this type depends on the mass of the concrete base, the floating layer and the ceiling. It is also improved by the isolation of the floating layer and the ceiling. Impact sound is reduced at source by the floating layer. However, even if resistance to airborne sound only is required, the full construction should still be used.

Floating floors AD E: 3.62–3.66

Examples of three types of floating floors are presented in the AD. These are described in Table 10.11 and shown in Fig. 10.18.

Floor, floating floor and ceiling combinations AD E: 3.67–3.68

Two variations of floor Type 2 are described in Approved Document E, which according to the document should, if built correctly, comply with Requirement E1 (see Table 10.12). The first floor has ceiling treatment C and hence is referenced 2.1C, whereas the second has ceiling treatment B and hence is referenced 2.2B. In the case of floor Type 2.1C, a precast floor slab may be acceptable if it is fully sealed and bonded around the perimeter.

Table 10.11 Alternative types of floating floors as described in the Approved Document.

	Floating floor type		
	(a)	**(b)**	**(c)**
Description	Timber raft floating layer supported on a resilient layer	Sand and cement screed floating layer supported on a resilient layer	A floating floor designed to satisfy a performance criterion
Floating layer	Raft of board material with bonded edges, such as t&g timber with mass per unit area of not less than 12 kg/m², fixed to 45 mm × 45 mm battens	65 mm of sand and cement or suitable proprietary screed product	The floating floor should consist of a rigid board above a resilient and/or damping layer which provides a weighted reduction in impact sound pressure level, ΔL_w, of 29 dB or more. ΔL_w is the improvement in impact sound insulation obtained in a laboratory by installing a floating floor over a test floor
	Raft laid on resilient layer without any fixings. Do not lay battens along joints in resilient layer	Screed to have mass per unit area of 80 kg/m² or more Resilient layer must be protected whilst screed is laid, e.g. by using a 20–50 mm wire mesh	Laboratory measurement should be in accordance with the procedure described in section 10.12.4
Resilient layer	Mineral wool with density of 36 kg/m³ and thickness of at least 25 mm. The layer of mineral wool may have a paper faced under side	Mineral wool with density of 36 kg/m³ and thickness of at least 25 mm. The layer of mineral wool to be paper faced on upper side to prevent wet screed entering the resilient layer or, a layer which, when measured according to BS 29052-1:1992, has a dynamic stiffness of not more than 15 MN/m³ and a thickness of at least 5 mm under the load specified in the measurement procedure	

Note:
Designers are advised to take advice from the manufacturers on proprietary screed products and the performance and installation of proprietary floating floors.

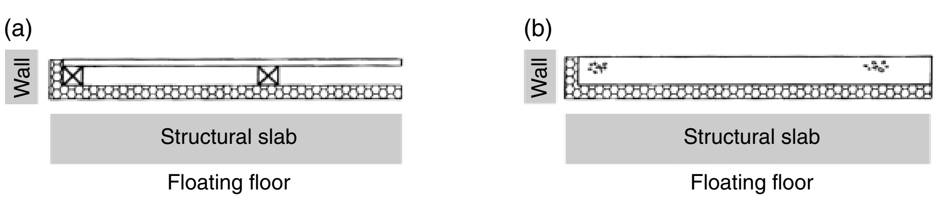


Fig. 10.18 Alternative floating floor constructions.

Table 10.12 Examples of concrete base with ceiling and floating floor constructions.

	Floor type	
	2.1C	**2.2B**
Description	Floating floor	Floating floor
	Solid concrete slab, cast in situ with or without permanent shuttering	Hollow or solid concrete planks
	Ceiling treatment C	Ceiling treatment B
Minimum mass per unit area of concrete base	300 kg/m^2 including any bonded screed. Permanent shuttering of solid concrete or metal may also be included	300 kg/m^2 including any bonded screed
Floor covering	Floating floor (a), (b) or (c) is essential	Floating floor (a), (b) or (c) is essential
Ceiling treatment	C or better is essential	B or better is essential
Other requirements	Regulating floor screed is optional	Use regulating floor screed
		All joints between and around planks to be fully grouted to ensure complete air tightness

When considering the alternatives in Table 10.12, it should be borne in mind that in the AD, alternatives are ranked such that, as far as possible, the one placed first should give the best performance. Also, the ceiling treatment specified is that which is required to meet the requirements of the AD. Since, as already stated, the ceilings are ranked in descending order of performance from A to C, substitution of Type A or B ceilings in Floor 2.1 or a Type A ceiling in Floor 2.2 should give improved sound insulation.

In order for the performance of Type 2 floors to be satisfactory, the junctions between them and their surrounding elements of constructions must be designed correctly. The requirements detailed in the AD are explained below. See also Table 10.14 and section 10.5.5 regarding correct and incorrect construction procedures.

Junctions with external cavity walls which have masonry inner leaves AD E: 3.69–3.73

- There are no restrictions on the outer leaf of the wall.
- Unless the cavity is fully filled with mineral wool, expanded polystyrene beads or some other suitable insulating material (the AD states that manufacturers' advice should be sought regarding alternative suitable materials), the cavity should be stopped with a flexible closer as shown in Fig. 10.16. The flexible closer must be protected from the effects of moisture, and it is essential that adequate drainage is provided (note the provision of a flexible cavity tray, or an equivalent, as shown in Fig. 10.16).
- The mass per unit area of the inner leaf of the external wall should be at least 120 kg/m^2 excluding its finish in order to reduce the effects of flanking transmission.

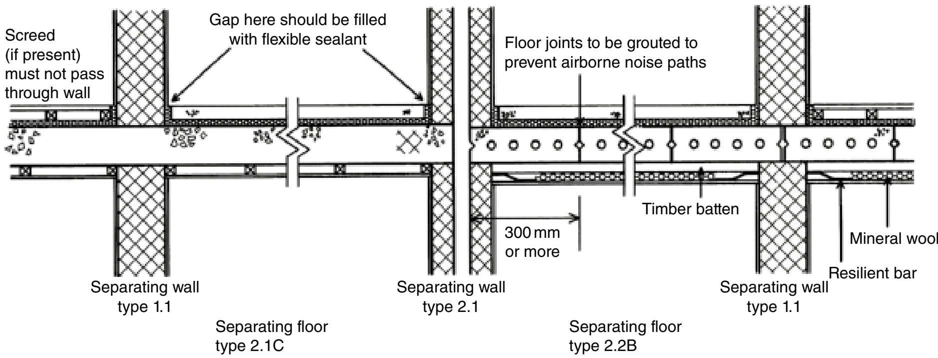


Fig. 10.19 Details of functions between Type 2 separating floors and Type 1 and 2 separating walls.

- The floor base, but not its screed, should continue to the face of the cavity without bridging the cavity, and if floor Type 2.2B is used, with the planks laid parallel to the wall, the first joint between planks should be 300 mm or more from the cavity face, as shown in Fig. 10.16.
- Treatment of the intersection of the floating layer and the wall should be as shown in Figs 10.16 and 10.19.
- The use of wall ties in external masonry walls is considered in section 2 of the AD (see section 10.4.1).

Junctions with external cavity walls which have timber-framed inner leaves AD E: 3.74

- There are no restrictions on the outer leaf of the wall.
- It is assumed that the cavity will not be filled and so the cavity should be stopped with a flexible closer.
- The finish of the inner leaf should consist of two layers of plasterboard each with a mass per unit area of at least 10 kg/m^2 with all joints sealed with tape or caulked with appropriate sealant.

Junctions with solid external masonry walls AD E: 3.75

No guidance is provided in the AD. Designers are advised to seek specialist advice.

Junctions with internal framed walls AD E: 3.76

No restrictions are imposed.

Junctions with internal masonry walls AD E: 3.77–3.78

The floor base should be continuous through or above such walls and any internal load-bearing wall or any other internal wall rigidly connected to a separating floor should have a mass per unit area of at least 120 kg/m^2 excluding finish.

Junctions with solid masonry (Type 1) separating walls AD E: 3.83–3.84

Floors bases of Type 2.1C should pass through Type 1 separating walls. Floor bases of Type 2.2B should not be continuous through Type 1 separating walls. In neither case should any screed penetrate the separating wall. See Fig. 10.19 for examples and requirements of both types of construction.

Junctions with cavity masonry (Type 2) separating walls AD E: 3.85–3.86

The floor base, but not its screed, should continue to the face of the cavity without bridging the cavity, and if floor Type 2.2B is used, with the planks laid parallel to the wall, the first joint between planks should be 300 mm or more from the cavity face as shown in Fig. 10.19.

Junctions with masonry between independent panels (Type 3) separating walls AD E: 3.87–3.92

Assuming the separating wall has a solid core, i.e. wall Types 3.1 and 3.2:

- Floor bases of Type 2.1C should pass through the wall. Floor bases of Type 2.2B should not be continuous through this type of separating wall. In neither case should any screed penetrate the separating wall. Construction should be as shown in Fig. 10.20.
- If floor Type 2.2B is used in conjunction with wall Type 3.2, with the planks laid parallel to the wall, the first joint between planks should be 300 mm or more from the centreline of the masonry core.

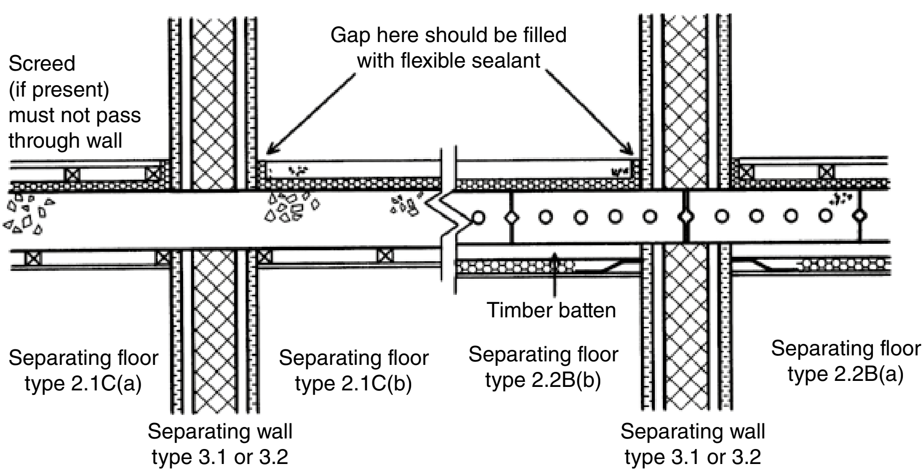


Fig. 10.20 Details of junctions between Type 2 separating floors and Type 3 separating walls.

Assuming the separating wall has a cavity core, i.e. wall Type 3.3:

- The mass per unit area of any leaf that is supporting or adjoining the floor, excluding finish, should be 120 kg/m^2 or more.
- The floor base, but not its screed, should continue to the face of the cavity without bridging the cavity, and if floor Type 2.2B is used, with the planks laid parallel to the wall, the first joint between planks should be 300 mm or more from the cavity face of the adjacent leaf of the masonry core.

Junctions framed with absorbent material (Type 4) separating walls AD E: 3.93

No guidance is provided in the AD. Designers are advised to seek specialist advice.

10.5.4 Design of floor Type 3: Timber frame base and platform floor with ceiling treatment AD E: 3.94–3.102

Floors of this type consist of a structural timber base comprising of boarding supported on timber joists upon which is a floating layer resting on a resilient layer. The platform floor consists of the floating layer and the resilient layer. Beneath the structural floor is a Type A ceiling treatment. The construction form is shown in Fig. 10.21. In order to obtain good insulation against both airborne and impact sound transmission, it is essential that there is good acoustic isolation between the platform floor and the structural base and between the structural base and the ceiling. The platform floor is important because it reduces the effects of impact noise at source. However, even if resistance to airborne sound only is required, the full construction should still be used.

There are fewer variations of this floor than there are of floor Types 1 and 2, and only one construction form is described in the AD. According to the document this should, if built correctly, comply with Requirement E1. Since this example, which is described in Table 10.13 and shown in Fig. 10.21, utilises ceiling treatment A, it is referred to as separating floor Type 3.1A.

In order for the performance of Type 3 floors to be satisfactory, the junctions between them and their surrounding elements of constructions must be designed correctly. The requirements detailed in the AD are explained below. See also Table 10.14 and section 10.5.5 regarding correct and incorrect construction procedures.

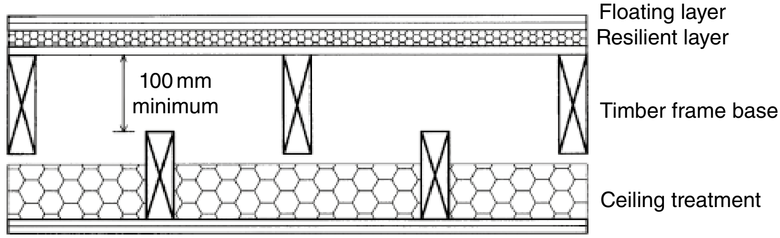


Fig. 10.21 Construction form of floor Type 3.1A.

Table 10.13 Example of timber frame base with ceiling and platform floor.

	Floor Type 3.1A
Description	Timber joists supporting a deck and platform floor (consisting of a floating layer and a resilient layer) together with ceiling treatment A beneath the structural floor
Structural floor	Timber joists selected to satisfy structural requirements together with a deck which has a minimum mass per unit area of 20 kg/m^2
Floating layer	A minimum of two layers of board each with a minimum thickness of 8 mm to provide a total mass per unit area of at least 25 kg/m^2. The layers should be fixed together ensuring staggered joints and laid loose on the resilient layer Two example floating layer constructions are provided in Approved Document E. These are as follows: (1) 18 mm of timber or wood-based board with tongued and grooved edges and glued joints. These should be spot bonded to a substrate of 19 mm thick plasterboard with staggered joints to give a total mass per unit area of at least 25 kg/m^2 (2) Two layers of cement-bonded particle board glued and screwed together with staggered joints. The resulting platform must have a total thickness of 24 mm and a mass per unit area of at least 25 kg/m^2
Resilient layer	Mineral wool, which may be paper faced on its underside, with a thickness of at least 25 mm and density in the range 60 to 100 kg/m^3 If the material chosen is towards the lower end of the above range, impact sound insulation is improved, but it may result in what is described in the document as a ‘soft’ floor, i.e. one which may be considered to respond excessively to fluctuating loads. It is suggested in the document that this may be overcome by providing additional support via a timber batten which is fixed to the walls and has a foam strip along its top
Ceiling treatment	Ceiling treatment A must be used in conjunction with this floor

Junctions with external cavity walls which have masonry inner leaves AD E: 3.103–3.108

- There are no restrictions on the outer leaf of the wall.
- Unless the cavity is fully filled with mineral wool, expanded polystyrene beads or some other suitable insulating material (the AD states that the manufacturers’ advice should be sought regarding alternative suitable materials), the cavity should be stopped with a flexible closer.
- The AD states that it is necessary to line the internal face of the masonry inner leaf of a cavity wall with independent panels as is described for Type 3 separating walls. However, if the mass per unit area of the inner leaf is greater than 375 kg/m^2, the independent panels need not be provided.
- The ceiling, which consists of independent joists supporting plasterboard, must continue to the masonry of the inner leaf. However, where the ceiling passes above the independent panels, it should be sealed with tape or caulked with appropriate sealant.
- The method of connecting the floor base, i.e. the floor joists, to the external wall is not prescribed, but it is emphasised that there must be no air paths connecting the floor to

Table 10.14 Construction procedures relating to the sound insulation of separating floors.

Element	Correct procedure	Procedures which must be avoided
Floor Types 1, 2 and 3	Seal the perimeter of independent ceilings with tape or sealant Give extra attention to workmanship and detailing at perimeter and where there are floor penetrations, to reduce flanking transmission and prevent air paths Ensure notes on junction construction are complied with to reduce flanking effects	Do not create a rigid or direct connection between an independent ceiling and its floor base
Floor Types 1 and 2	Fill all joints between floor components to avoid air paths between floors Build concrete separating floors (or floor bases) into all of their masonry perimeter walls Ensure that all gaps between heads of masonry walls and undersides of concrete floors are filled with mortar	Do not allow a floor base to bridge across a cavity in a masonry cavity wall
Floor Type 1	Fix or glue the soft covering to the floor	A soft floor covering must be used. Do not use ceramic floor tiles, wood blocks or any other non-resilient floor finish rigidly connected to the floor base
Floor Type 2	Leave small gap of size recommended by manufacturers between floating layer and wall at room edge and fill with flexible sealant	Do not bridge between the floating layer and the base or surrounding walls, e.g. with services or fixings which penetrate the resilient layer between floating layer and floor base or walls
	Leave gap of about 5 mm between skirting and floating layer and fill with flexible sealant	Do not allow the floating layer to bridge to the floor base or walls, e.g. through a void in the resilient layer
	Lay rolls or sheets of resilient materials with lapped joints or tightly butted and taped joints Prevent screed entering resilient layers by laying fibrous materials with paper facing uppermost	
Floor Type 3	With respect to the platform floor: (a) Ensure that the resilient layer has the correct density and that it is adequate to carry the applied load (b) Use a resilient material, e.g. expanded or extruded polystyrene strip around the perimeter to ensure that a gap is maintained between wall and floating layer during construction. The strip should be about 4 mm higher than the top surface of the floating layer. The gap may be filled with a flexible sealant (c) Lay sheets of resilient materials with tightly butted and taped joints	Do not bridge between the floating layer and the timber frame base or surrounding walls, e.g. with services or fixings which penetrate the resilient layer between the floating layer and the timber base or walls

the wall cavity. This would pose a source of flanking transmission which it would be difficult to remedy at a later date.

- The use of wall ties in external masonry walls is considered in section 2 of the AD. See section 10.4.1.

Junctions with external cavity walls which have timber-framed inner leaves AD E: 3.109–3.112

- There are no restrictions on the outer leaf of the wall.
- It is assumed that the cavity will not be filled, and so the cavity should be stopped with a flexible closer.
- The finish of the inner leaf should consist of two layers of plasterboard each with a mass per unit area of at least 10 kg/m^2 with all joints sealed with tape or caulked with appropriate sealant.
- The method of connecting the floor base, i.e. the floor joists, to the external wall is not prescribed, but where floor joists are perpendicular to the wall, the spaces between the floor joists should be sealed to the full depth of the floor with timber blocking.
- The junction between the ceiling and wall lining should be sealed with tape or caulked with appropriate sealant.

Junctions with solid external masonry walls AD E: 3.113

No guidance is provided in the AD. Designers are advised to seek specialist advice.

Junctions with internal framed walls AD E: 3.114–3.115

- Where floor joists are perpendicular to the internal framed wall, the spaces between the floor joists should be sealed to the full depth of the floor with timber blocking.
- The junction between the ceiling and the wall should be sealed with tape or caulked with appropriate sealant.

Junctions with internal masonry walls AD E: 3.116

No guidance is provided in the AD. Designers are advised to seek specialist advice.

Junctions with solid masonry (Type 1) separating walls AD E: 3.121–3.122

- When floor joists are to be supported on this type of wall, they should not be built into the wall but must be supported on joist hangers.
- The junction between the ceiling and the wall should be sealed with tape or caulked with appropriate sealant.

Junctions with cavity masonry (Type 2) separating walls AD E: 3.123–3.126

- When floor joists are to be supported on this type of wall, they should not be built into the wall but must be supported on joist hangers.

- The AD states that it is necessary to line the adjacent leaf of the cavity wall (i.e. the leaf which is nearest to the room with the Type 3 floor) with independent panels as is described for Type 3 separating walls. However, if the mass per unit area of the adjacent leaf is greater than 375 kg/m^2, the independent panels need not be provided.
- The ceiling, which consists of independent joists supporting plasterboard, should continue to the masonry of the wall. However, where the ceiling passes above the independent panels, it should be sealed with tape or caulked with appropriate sealant.

Junctions with masonry between independent panels (Type 3) separating walls AD E: 3.127–3.128

- When floor joists are to be supported on this type of wall, they should not be built into the wall but must be supported on joist hangers.
- The ceiling, which is supported on independent joists, should pass through the independent panels to the masonry core. The junction where the ceiling passes over the independent panels should be sealed with tape or caulked with appropriate sealant.

Junctions with timber frames with absorbent material (Type 4) separating walls AD E: 3.129–3.130

- Where the floor joists are perpendicular to the separating wall, the spaces between the floor joists should be sealed to the full depth of the floor with timber blocking.
- The junction between the ceiling and the wall lining should be sealed with tape or caulked with appropriate sealant.

10.5.5 Construction procedures

The AD provides information regarding correct and incorrect construction procedures which will influence the sound insulation offered by separating floors. This is summarised in Table 10.14.

10.6 Dwelling houses and flats formed by material change of use

(Approved Document E section 4: Dwelling houses and flats formed by material change of use)

10.6.1 General requirements AD E: 4.1–4.21

When a building is converted to dwelling places, consideration must be given to satisfying the requirements of Part E. The complexities of sound transmission in a building that is subject to conversion are considerable, and a superficial or incomplete approach to possible solutions is fraught with danger. High-quality acoustic advice is almost always essential at an early stage of the design.

Section 4 of Approved Document E describes forms of treatment to walls, floors, stairs and their associated junctions which it may be appropriate to apply when converting existing buildings by material change of use to provide dwelling houses and flats. Rooms for residential purposes are considered in section 6 of the AD (see section **10.8**). The point is made in the AD that existing components may already satisfy the requirements of Table 1a of the document, which are outlined in section **10.2**, and it is suggested that this would be so if the construction of a component, its junction detailing and flanking construction was sufficiently similar to that of one of the example walls or floors presented for new buildings. It is also stated that in some circumstances, the example of separating walls and floors (including their flanking constructions), described in sections 2 and 3 of the AD for new buildings, can be used as guidance for the work that may be necessary to bring existing components up to the required standard. The importance of the control of flanking transmission (see section 10.6.6), in instances of change of use is also emphasised in the AD.

The construction of an existing component may be such that a designer has little idea as to whether it will comply with the requirements of Table 1a of the AD. To help in this case, treatments to existing components are provided in the AD as follows:

- Walls, one form of treatment;
- Floors, two forms of treatments; and
- Stairs, one form of treatment.

The nature of each of these is explained below. It is important to note that the AD states that the example treatments 'can be used to increase sound insulation', but not that if constructed correctly, treated components will achieve the required standard. This is because the level of insulation reached will depend heavily on the existing construction. It is also stated in the AD that the information provided is only guidance and that other designs, materials or products may be used to achieve the required performance standard. Designers are recommended to seek advice from manufacturers and/or other expert sources.

It is suggested in the AD that, with respect to requirements for mass, for example, an existing component may be sufficiently similar to comply with the required performance requirements if its mass was within 15% of that of an equivalent component recommended for the construction of new buildings. This may be the case, but due to uncertainty about the workmanship and density of material used throughout the component, additional treatment may still be advisable.

In view of the complex nature of the construction forms resulting from conversion work, it may be necessary to seek specialist acoustic advice. The AD cites, as an example of a construction which will require special attention, the consequences of constructing a wall or floor across an existing continuous floor or wall such that the original floor or wall becomes a flanking element. The nature of the building may make the simple isolation of such flanking components technically difficult and in such circumstances, and when significant additional loads are imposed on the building as a result of floor and wall treatment, structural advice should be sought.

The AD recommends that the following work should be undertaken to existing floors before the recommended treatments to improve sound insulation are applied:

- Since gaps in existing floorboards are a potential source of airborne sound transmission, they should be covered with hardboard or filled with sealant.

- Replacement of floorboards. If required, these should be at least 12 mm thick, and mineral wool with a density of not less than 10 kg/m^2 should be laid between joists to a depth of not less than 100 mm.
- The mass per unit area of concrete floors should be increased to at least 300 kg/m^2, air gaps within them should be sealed and a regulating screed provided if required.
- Existing lath and plaster ceilings should be retained as long as they comply with Building Regulation B – Fire Safety, whereas other ceilings should be modified such that they consist of at least two layers of plasterboard with staggered joints and a total mass per unit area of 20 kg/m^2.

Sound transmission from corridors and, particularly, through doors in corridors is often a serious source of annoyance in dwellings formed by material change of use. It is suggested in the AD that the separating walls described in this section, i.e. section 4 of the AD, should be used to control sound insulation and flanking transmission between houses or flats formed by material change of use and corridors. The AD states that corridor doors and doors to noisy parts of a building should be constructed in the same way as the equivalent doors in a new building, as described in section 10.4.6.

10.6.2 Wall Treatment 1: Independent panel(s) with absorbent material AD E: 4.22–4.24

This treatment consists of adding a panel, or panels, to an existing wall which has poor sound insulating properties, and the result may be similar to the 'masonry wall with independent panels' as described for new constructions but with insulation in the void between the two. The existing wall will offer some sound insulation, and this will be enhanced by the provision of an independent panel, the isolation of that panel and the provision of absorbent material between the two.

The guidance suggests that if the original wall is of masonry construction, is 100 mm or more thick and is plastered on both sides, one independent panel will suffice, but in the case of different types of existing wall, a panel should be built on each side of the wall.

The specification of Wall Treatment 1 is as described in Table 10.15 and shown in Fig. 10.22. See also Table 10.19 and section 10.6.7 regarding correct and incorrect construction procedures.

10.6.3 Floor Treatment 1: Independent ceiling with absorbent material AD E: 4.26–4.29

This treatment consists of adding an additional independent ceiling comprising plasterboard, joists and absorbent infill to an existing conventional floor comprising joists, boarding and plasterboard. The mass of the new ceiling and its absorbent infill together with its acoustic isolation will add significantly to the airborne and impact sound insulation offered by the original ceiling. Further, for good insulation, the construction should be made as airtight as possible.

The specification of Floor Treatment 1 is as described in Table 10.16. See also Table 10.19 and section 10.6.7 regarding correct and incorrect construction procedures.

Table 10.15 Construction form of Wall Treatment 1.

	Description
Construction form	Plasterboard supported on a timber frame or freestanding panels consisting of plasterboard sandwiching a cellular core
Panels	The mass per unit area of each panel should be at least 20 kg/m^2 excluding the mass of any framework
	If supported on a frame, panels should consist of at least two layers of plasterboard with staggered joints. Alternatively, freestanding panels, e.g. two sheets of plasterboard separated by a cellular core, may be used
Spacing	There must be a gap of at least 35 mm between the inside face of the panels and the surface of the existing wall. The panels may be free standing, but if they are supported on a frame, there must also be a gap of at least 10 mm between the frame and the wall
Mineral wool	Mineral wool with a minimum density of 10 kg/m^2 and minimum thickness of 35 mm to be located in the cavity formed between the panel and the existing wall

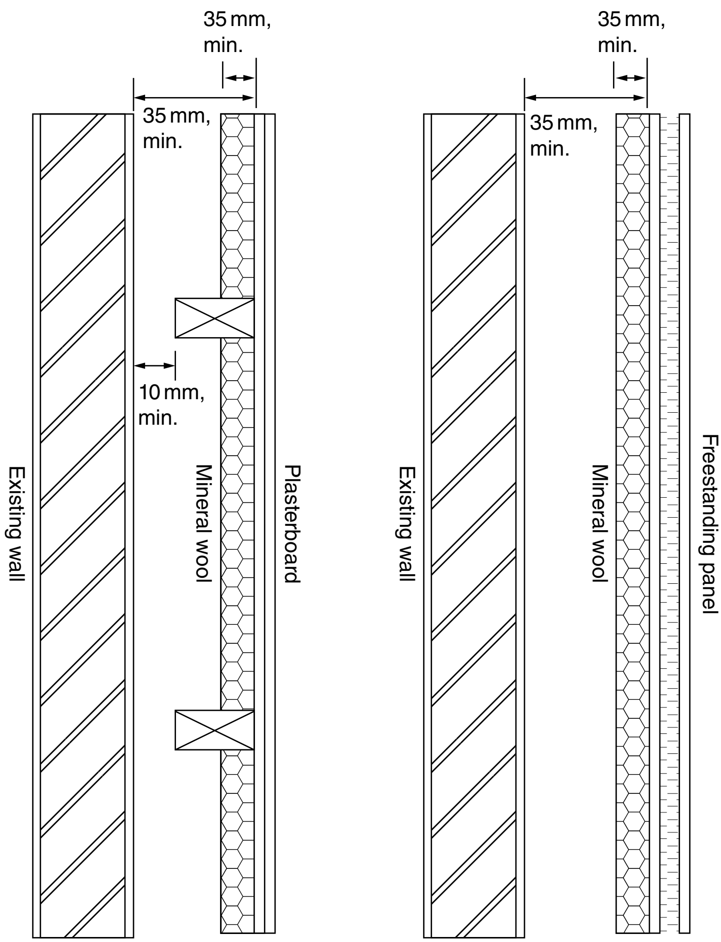


Fig. 10.22 Construction form of Wall Treatment 1.

Table 10.16 Construction form of Floor Treatment 1.

	Description
Construction form	Independent joist and plasterboard ceiling with absorbent mineral wool infill constructed below a conventional timber joist floor
Independent ceiling	Two or more layers of plasterboard having staggered joints and a mass per unit area of at least 20 kg/m²
Mineral wool	Mineral wool with a minimum density of 10 kg/m³ and minimum thickness of 100 mm to be located between the joists in the void between the new and old ceilings
Ceiling support	Independent joists fixed to surrounding walls There should be either: (a) no further support between top of the joists and underside of the existing floor; or (b) additional support by resilient hangers fixed directly to the underside of the existing floor
Existing ceiling	Upgrade as necessary to provide two or more layers of plasterboard having staggered joints and a mass per unit area of at least 20 kg/m²

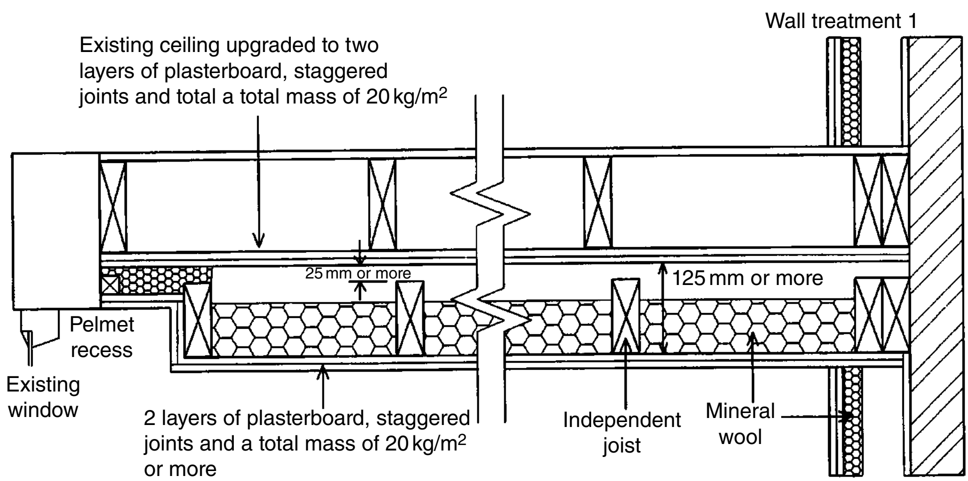


Fig. 10.23 Construction details of Floor Treatment 1 showing junction with Wall Treatment 1.

The point is made in the AD that adoption of this procedure significantly reduces the floor to ceiling height in the converted building and that this should be borne in mind at design stage, i.e. the reduction will be a minimum of 125 mm plus the thickness of the plasterboard and even more if the joists need to be deeper than 100 mm. This can present a problem if window heads are close to the height of the original ceiling and a method of solution is proposed. This, together with the wall junction treatment that should be used when this procedure is employed, is shown in Fig. 10.23. See also Table 10.19 and section 10.6.7 regarding correct and incorrect construction procedures.

Table 10.17 Construction form of Floor Treatment 2.

	Description
Construction form	A floating layer laid on a resilient layer which has first been laid onto the boarding of a conventional timber joist floor
Floating layer	A minimum of two layers of board each with a minimum thickness of 8 mm to provide a total mass per unit area of at least 25 kg/m^2. The layers should be fixed together, for example, by spot bonding or glueing and screwing, ensuring staggered joints and then laid loose on the resilient layer
	Two examples of how a platform floor/floating layer of this type could be constructed are provided in the Approved Document (see new floor Type 3.1A)
Resilient layer	Mineral wool, which may be paper faced on its underside, with a thickness of at least 25 mm and density in the range 60 to 100 kg/m^3
	If the material chosen is towards the lower end of the above range, sound insulation is improved, but it may result in what is described in the document as a 'soft' floor, i.e. one which may be considered to respond excessively to fluctuating loads. It is suggested in the document that this may be overcome by providing additional support via a timber batten which is fixed to the walls and has a foam strip along its top
Mineral wool	Mineral wool with a minimum density of 10 kg/m^3 and minimum thickness of 100 mm to be located between the joists in the floor cavity
Existing ceiling	Upgrade as necessary to provide two or more layers of plasterboard having staggered joints and a mass per unit area of at least 20 kg/m^2

10.6.4 Floor Treatment 2: Platform floor with absorbent material AD E: 4.31–4.33

This treatment consists of adding a platform floor, i.e. a floating layer supported on a resilient layer, to an existing conventional floor comprising timber joists, boarding and plasterboard ceiling. The increase in the total mass of the floor, the action of the resilient layer and the absorbent material should all serve to increase the airborne and impact sound resistance of the floor.

The specification of Floor Treatment 2 should be as described in Table 10.17 and the construction form together with a junction treatment recommended in the AD is shown in Fig. 10.24. See also Table 10.19 and section 10.6.7 regarding correct and incorrect construction procedures.

10.6.5 Stair treatment: Stair covering and independent ceiling with absorbent material AD E: 4.35–4.38

This treatment consists of adding a soft layer over the treads, which reduces impact noise at source, and constructing an independent ceiling lined with absorbent material beneath the stairs. It is the mass of the stair and independent ceiling, the isolation of the independent ceiling and the presence of the absorbent material which provides sound insulation. This is improved by constructing a cupboard enclosure beneath the stairs. It may well be necessary to consider the influence of stairs when constructing dwellings by material change of use since when stairs provide a separating function they must make the same contribution to sound insulation as separating floors.

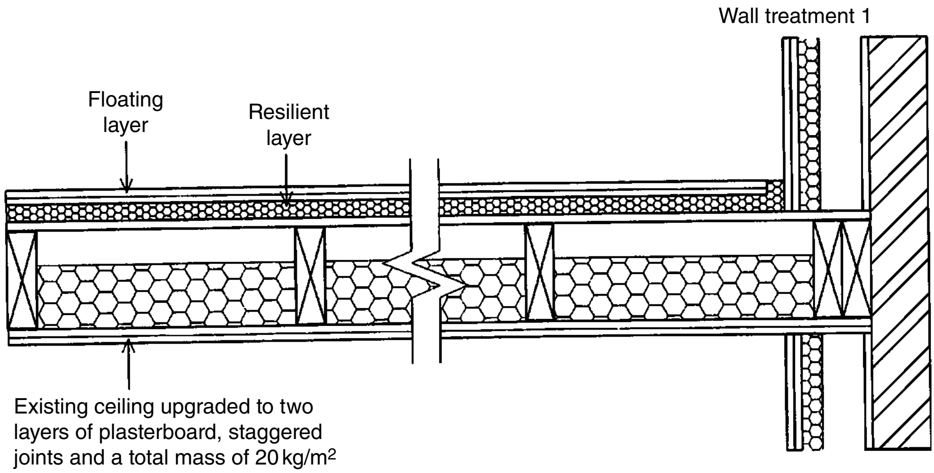


Fig. 10.24 Construction details of Floor Treatment 2 showing junction with Wall Treatment 1.

Table 10.18 Construction form of stair treatment.

	Description
Construction form	The addition of a soft layer over the existing treads and an independent ceiling lined with absorbent material beneath the stairs. A cupboard enclosure may be provided beneath the stairs
Soft covering	At least 6 mm thick, the soft covering must be securely fixed in order that it does not become a safety hazard
If there is an under stairs cupboard	The stair within the cupboard should be lined with plasterboard which has a mass per unit area of at least 10 kg/m^2. This should be mounted on battens, the space between the battens being filled with mineral wool with a density of at least 10 kg/m^3 (see Fig. 10.25)
	The cupboard should be built with a small heavy well fitted door and walls consisting of two layers of plasterboard, or its equivalent; each layer of which has a mass per unit area of 10 kg/m^2
If there is NOT an under stairs cupboard	In this case an independent ceiling as recommended in Floor Treatment 1 should be constructed beneath the stair

The specification of the stair treatment as described in Table 10.18 and its construction form, together with associated treatment of the space beneath the stair as recommended in the AD, are shown in Fig. 10.25. If a staircase performs a separating function, reference should be made to Building Regulation Part B – Fire Safety.

10.6.6 Specific junction requirements in the event of change of use AD E: 4.39–4.50

- Advice is provided in the AD for abutments of floor treatments:
  (a) In the case of floating floors, e.g. Floor Treatment 2, the resilient layer should be turned vertically upwards at room edges to ensure that there is no contact between

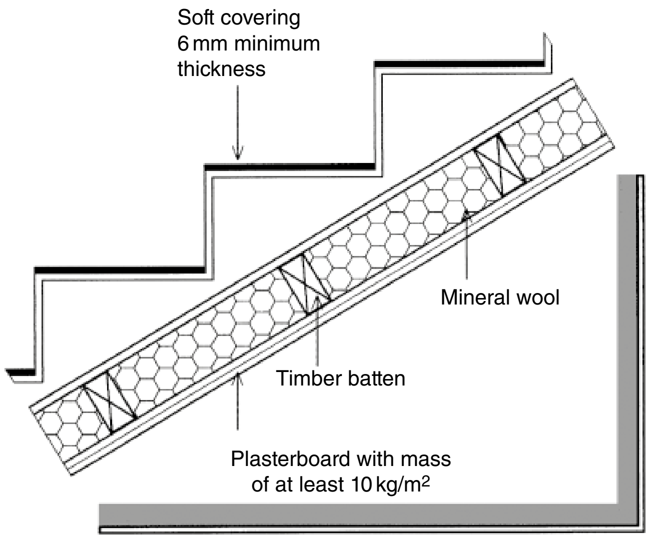


Fig. 10.25 Stair treatment assuming an under stair cupboard.

the floating layer and the wall, and a gap of about 5 mm, filled with flexible sealant, should be left between the floating layer and the skirting.

(b) The junctions between new ceilings and walls should be sealed with tape or caulked with appropriate sealant and detailed as indicated in Figs 10.23 and 10.24.

- Junctions of separating walls and floors with other elements, e.g. external or other walls or floors, are a potential source of significant flanking transmission. As stated in the AD, it may be necessary in such circumstances to seek expert advice regarding the diagnosis and control of flanking transmission. If there is significant flanking transmission via adjoining walls, this can be reduced by lining all adjoining masonry walls with:
  (a) an independent layer of plasterboard; or
  (b) a laminate of plasterboard and mineral wool.
  The AD suggests seeking manufacturers' advice for other dry-lining laminates but does not provide guidance as to the thickness of plasterboard which is appropriate since this will depend on the structure of the adjoining wall. Indeed, the document states that if the adjoining masonry wall has a mass per unit area of more than 375 kg/m^2, the lining may not significantly improve the insulation and so its use may not be appropriate.
- The requirements in the AD for penetrating services, i.e. piped services and ducts, passing through separating floors between flats in conversion buildings are essentially the same as for penetrating services in new buildings which are explained in section 10.5.1.

10.6.7 Construction procedures

The AD provides information regarding correct and incorrect construction procedures which will influence the sound insulation provided when undertaking material change of use. This is summarised in Table 10.19.

Table 10.19 Construction procedures relating to material change of use.

Element	Correct procedure	Procedures which must be avoided
Wall Treatment 1	Ensure independent panel (and frame if present) have no contact with existing wall	Do not tightly compress absorbent material as this may bridge the cavity
	Seal perimeter of independent panel with tape or sealant	
Floor Treatment 1	Apply appropriate remedial work to the existing construction	Do not create a rigid or direct connection between an independent ceiling and its floor base
	Seal perimeter of any new or independent ceiling with tape or sealant	Do not tightly compress the absorbent material – doing so may bridge the cavity
Floor Treatment 2	Apply appropriate remedial work to the existing construction	Do not bridge between the floating layer and the timber base or surrounding walls, e.g. with services or fixings which penetrate the resilient layer between the floating layer and timber base or walls
	Use correct density of resilient layer and ensure it can carry anticipated load	
	Allow for movement of materials (e.g. expansion of chipboard after laying) to maintain isolation	
	Carry resilient layer up to room edges to isolate floating layer from wall surfaces	
	Leave a gap of approximately 5 mm between skirting and floating layer and fill with flexible sealant	
	Lay resilient layers in sheets with joints tightly butted and taped	
	Seal perimeter of any new or independent ceiling with tape or sealant	
Junctions with floor penetrations	Seal joints between casings and ceilings with tape or sealant	
	Leave a gap of approximately 5 mm between casing and floating layer and fill with flexible sealant	

10.7 Internal walls and floors for new buildings

(Approved Document E section 5: Internal walls and floors for new buildings)

10.7.1 General requirements AD E: 5.1, 5.2 & 5.9–5.12

Requirement E2 of Schedule 1 to the Building Regulations 2010 (as amended) relates to protection against noise *within* dwelling places. Unlike Requirement E1 which relates to protection against noise *between* dwelling places, the performance of components within dwelling places is not assessed by pre-completion testing but simply by demonstrating that they have a laboratory measured sound insulation value of not less than $R_w = 40$ dB, as specified in Table 0.2 of the Approved Document and described in section 10.2.2. This requirement relates only to the airborne sound insulation of internal walls and floors. Occupiers wishing to improve impact sound insulation are advised to provide carpets or other soft coverings to floor surfaces. The examples in the AD are for guidance, they are not exhaustive and other designs, materials or products may be used to provide the desired performance.

The following points should be considered when designing internal walls and floors.

- If a door assembly in an internal wall offers a lower level of insulation than the wall in which it is located, this will reduce the overall insulation offered. The avoidance of air paths by good perimeter sealing is an essential way of reducing sound transmission, and in addition the AD recommends the use of doorsets.
- Stairs provide an important route of sound transmission between floors within dwellings, and if not enclosed the overall airborne sound insulation will be such that the potential of the associated floor will not be realised. However, as stated in the AD, the floor must still be constructed to comply with Requirement E2.
- The requirements for internal noise control should be borne in mind by designers who ought to ensure that noise sensitive rooms such as bedrooms are not constructed immediately adjacent to noise source rooms. The AD refers designers to BS 8233:1999 *Sound insulation and noise reduction for buildings – Code of practice*.
- The sealing of walls, floors and gaps around doors has the potential to reduce air supply, and in this context the requirements of Building Regulation Part F – Ventilation and Building Regulation Part J – Combustion appliances and fuel storage systems must be taken into account.

10.7.2 Internal walls AD E: 5.4, 5.5 & 5.8

Four examples of different types of construction which should meet the requirements for internal walls are described in the AD. These are presented in the document, as follows, as wall Types A to D in a ranking order such that, as far as possible, the ones which give the best sound insulation appear first:

- Type A Timber or metal frames with plasterboard linings on each side.
- Type B Timber or metal frames with plasterboard linings on each side and absorbent infill material.
- Type C Concrete block wall with plaster or plasterboard finish on both sides.
- Type D Aircrete block wall with plaster or plasterboard finish on both sides.

Table 10.20 Internal walls Type A and B.

Element	Wall Type A	Wall Type B
Frame	Timber or metal	Timber or metal
Linings	Linings to be provided on each side of the frame	Linings to be provided on each side of the frame
	Each lining to consist of two or more layers of plasterboard, each sheet of which has a mass per unit area of 10 kg/m² or more	Each lining to consist of a single layer of plasterboard which has a mass per unit area of 10 kg/m² or more
Distance between linings	A minimum of 75 mm if fixed to a timber frame	A minimum of 75 mm if fixed to a timber frame
	A minimum of 45 mm if fixed to a metal frame	A minimum of 45 mm if fixed to a metal frame
Absorbent layer	Not required	Unfaced wool batts or quilt with: ● thickness of 25 mm or more; and ● density of 10 kg/m³ or more suspended in the cavity
		The absorbent layer may be wire reinforced
Other requirements	All joints to be well sealed	All joints to be well sealed

Type A and B internal walls AD E: 5.17–5.18

These types of walls are similar not only in construction form but in the ways in which they insulate against airborne sound transmission. The mass of the panels and the provision of absorbent infill between them determine their resistance to airborne sound transmission which is also influenced by cavity width and material with which the frame is constructed. The construction of the examples described in the AD is outlined in Table 10.20.

Type C and D internal walls AD E: 5.19–5.20

These types are similar not only in construction form but in the ways in which they insulate against airborne sound transmission. The mass of the panels determines their resistance to airborne sound transmission. The construction of the examples described in the AD is as outlined in Table 10.21.

10.7.3 Internal floors AD E: 5.6, 5.7 & 5.8

Three examples of different types of construction which should meet the requirements for internal floors are described in the AD. These are presented in the document, as follows, as floor Types A to C in a ranking order such that, as far as possible, the ones which give the best sound insulation appear first:

- Type A Concrete planks.
- Type B Concrete beams with infilling blocks.
- Type C Timber or metal joists with board and plasterboard surfaces.

Table 10.21 Internal walls Type C and D.

Element	Wall Type C	Wall Type D
Core structure	Concrete block wall	Aircrete block wall
Required mass per unit area	A mass per unit area, excluding finish, of 120 kg/m^2 or more	A mass per unit area, including finish, of ● 90 kg/m^2 or more for plaster finish ● 75 kg/m^2 or more for plasterboard finish
Surface finish	Plaster or plasterboard on both sides	Plaster or plasterboard on both sides
Other requirements	All joints to be well sealed	All joints to be well sealed
Restrictions	No specific restrictions	This type of wall should: ● not be used as a load-bearing wall rigidly connected to a separating floor ● not be rigidly connected to the separating floors described in the AD (see guidance relating to separating floors) ● only be used with the separating walls described in the AD where there is no minimum mass requirement on the internal masonry walls (e.g. with separating wall Types 2.3 and 2.4 when there is no separating floor – see guidance relating to separating walls)

Type A and B internal floors AD E: 5.21–5.22

These types of floors are similar not only in construction form but also in the ways in which they insulate against airborne sound transmission. The mass of the planks (Type A) or beams and infilling blocks (Type B) and screed determines their resistance to airborne sound transmission. The provision of a soft covering, such as carpet, will improve impact sound insulation by reducing impact noise at its source. The construction of the examples described in the document is as outlined in Table 10.22 and shown in Fig. 10.26.

Type C internal floor AD E: 5.23

Resistance to airborne sound transmission is determined by the joist and board construction, the ceiling and the absorbent material used. The provision of a soft covering, such as carpet, will improve impact sound insulation by reducing impact noise at its source. The construction form of the example described in the document is as outlined in Table 10.23 and shown in Fig. 10.26.

10.7.4 Internal wall and floor junctions AD E: 5.13–5.16

Guidance on the form of junctions between separating walls and internal floors and separating floors and internal walls is provided in sections 2 and 3, respectively, of the AD, and this is considered in sections **10.4** and **10.5**. When separating elements

Table 10.22 Internal floors Type A and B.

Element	Floor Type A	Floor Type B
Structure	Concrete planks	Concrete beams with infilling blocks, bonded screed and ceiling
Required mass per unit area	Mass per unit area of 180 kg/m^2 or more	Mass per unit area of concrete beams and blocks to be 220 kg/m^2 or more
Screed	The provision of a regulating screed is optional	A bonded screed is required. If a sand and cement screed is used, it should have minimum thickness of 40 mm. If a proprietary product is used, manufacturers advice should be sought regarding its thickness
Ceiling finish	The provision of a ceiling finish is optional	Ceiling finish C or better, as defined in section 3, of the AD, is required. See section 10.5.1 for details
Other requirements	Although not stated in the AD, floor joints should be fully grouted to ensure air tightness	

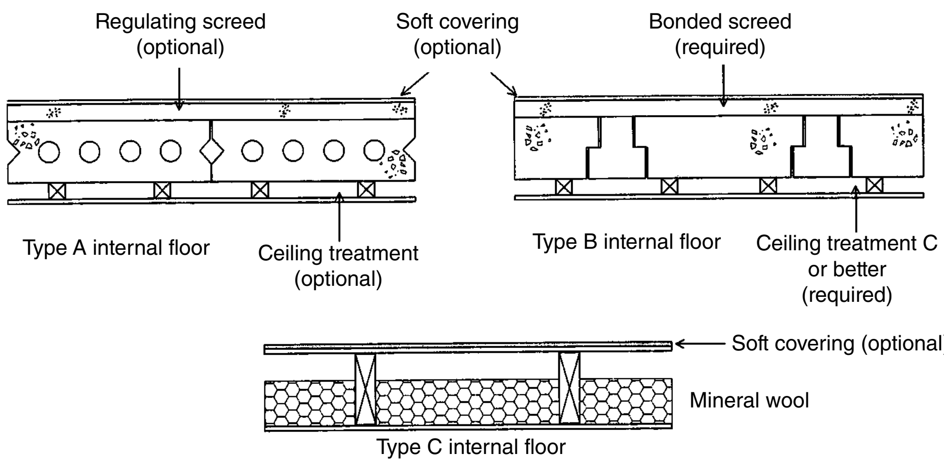


Fig. 10.26 Internal floors Type A, B and C.

Table 10.23 Internal floor Type C.

Element	Floor Type C
Structure	Timber or metal joists supporting timber or wood-based boarding, a plasterboard ceiling and absorbent material between the joists
Required mass per unit area	The timber or wood-based boarding of the floor surface should have a mass per unit area of not less than 15 kg/m^2
Ceiling finish	A ceiling consisting of a single layer of plasterboard. Mass per unit area of not less than 10 kg/m^2. Normal method of fixing
Absorbent layer	Mineral wool laid in cavity between joists. Thickness not less than 100 mm and density not less than 10 kg/m^3
Other requirements	See BRE BR 262 *Thermal insulation: Avoiding risks*, section 2.4 regarding heat emission from electrical cables which may be covered by any material, including a sound absorbing layer, which may act as thermal insulation

are present, the junctions between them and internal walls and floors should always be constructed in accordance with this guidance.

Whenever internal walls or floors are constructed, care should be taken to ensure that there are no air paths, i.e. direct or indirect routes of air passage, between rooms by filling all gaps around the wall or floor.

10.8 Rooms for residential purposes

(Approved Document E section 6: Rooms for residential purposes)

10.8.1 General requirements AD E: 6.1–6.3 & 6.16–6.18

'Rooms for residential purposes' are defined in section **10.1**. Typical examples are rooms used by one or more persons for living and sleeping in a hotel, hostel, boarding house or residential home but not in a hospital.

For walls and floors that separate rooms for residential purposes, the required performance standards are given in Table 0.1b of the AD. However, for a wall separating a room for residential purposes from an adjoining dwelling house or flat, the standard given in Table 0.1a applies. Section 6 of the AD gives examples of walls and floors which should achieve the required performance standards, assuming a sufficiently high quality of construction. The information in this section of the AD is provided only for guidance. It is not exhaustive, and designers are recommended also to seek advice from other sources, such as manufacturers, regarding alternative designs, materials or products. Note that although Robust Details may be used, they do not automatically demonstrate compliance for spaces of this type, and so pre-completion testing is always required.

It is not only sound insulation but room layout and building services which determine internal noise levels, and these factors may be particularly significant in the confined spaces of 'rooms for residential purposes'. The requirements for internal noise control should be borne in mind by designers who ought to endeavour to ensure that noise sensitive rooms such as bedrooms are not constructed immediately adjacent to noise source rooms. The AD refers designers to BS 8233:1999 *Sound insulation and noise reduction for buildings – Code of practice* and the BRE/CIRIA Report: *Sound control for homes*.

10.8.2 New buildings containing rooms for residential purposes

Separating walls AD E: 6.4

Examples of alternative types of separating walls suitable for new buildings are presented in section 2 of the AD and described in section **10.4**. It is stated in the AD that where buildings contain rooms for residential purposes, of the examples given, the most appropriate choices are:

- wall Type 1 (solid masonry), where the in situ plastered finishes associated with each of the variants 1.1, 1.2 and 1.3 may be substituted for by a single sheet of plasterboard on each face provided that the sheets each have a mass per unit area of 10 kg/m^2 or more; and

- wall Type 3 (masonry between independent panels) but only Types 3.1 and 3.2 which have solid masonry cores.

The AD states that wall Type 2 (cavity masonry) and wall Type 4 (framed wall with absorbent material) may be used, but particular care must be taken to maintain isolation between the leaves and specialist advice may be required.

Separating floors AD E: 6.8

Examples of alternative types of separating floors suitable for new buildings are presented in section 3 of the AD and described in section **10.5**. It is stated in the AD that where the buildings contain rooms for residential purposes, of the examples given, the most appropriate choice is one of the following subgroups of floor Type 1 (concrete base with soft covering):

- Floor Type 1.1C Solid concrete slab, cast in situ with or without permanent shuttering. Soft floor covering and ceiling treatment C; and
- Floor Type 1.2B Hollow or solid concrete planks. Soft floor covering and ceiling treatment B.

The AD states that floor Type 2 (concrete base with ceiling and floating floor) and floor Type 3 (timber frame base with ceiling and platform floor) may be used, but their floating floors and ceilings must not be continuous across the walls which separate rooms for residential purposes. Designers are advised that this type of construction may require specialist advice.

10.8.3 Corridor walls and doors AD E: 6.5–6.7

The walls between rooms for residential purposes and corridors should be built to the specification, as described in section 6 of the AD, of the separating walls and their junction details. However, a weak point in the sound insulation provided from corridor noise is that transmitted through doors. For this reason, the document states that doors to corridors should have good sealing around their perimeters (including, if practical, their thresholds) and a mass per unit area of at least 25 kg/m^2 or alternatively a doorset with a weighted sound reduction index of at least 29 dB. The term sound reduction index is described in section **10.13**, and the relevant measurement standards are listed in section 10.12.4.

Particular attention should be paid to potentially noisy spaces such as bars, which ideally should be separated from the rest of the building by a lobby, two doors in series or a high performance doorset. If this type of treatment cannot be applied to the noisy space, it should be applied to any nearby rooms for residential purposes.

The requirements of Building Regulation Part B – Fire safety and Building Regulation Part M – Access and facilities for disabled people must be taken into account when selecting doors for buildings of this type.

10.8.4 Material change of use: Rooms for residential purposes AD E: 6.9–6.10

Section 6 of the AD considers the treatments it may be appropriate to apply to walls, floors, stairs and their associated junctions when converting an existing building by material change of use to provide rooms for residential purposes. The point is made in the AD that existing components may already satisfy the requirements of Table 0.1b (or 0.1a for walls adjoining a dwelling house or flat) of the AD (see Table 10.1) without the need for remedial work. It is suggested that this could be so if the construction (including its flanking construction) was similar to one of the examples listed in section 10.8.2 for 'rooms for residential purposes' in a new building. For walls, this includes wall Types 1.1, 1.2, 1.3, 3.1 and 3.2 which all have a solid masonry core, and for floors it includes floor Types 1.1C and 1.2B, which are both concrete floors. If the existing wall or floor has a mass per unit area that is within 15% of the mass per unit area of the equivalent construction for a new building, then the existing structure may achieve the required performance standard. However, for an existing structure it will often be difficult to obtain the necessary details of the design, the properties of the materials and the quality of workmanship, and, even if the mass per unit area is within the 15% criterion, it may still be advisable to provide additional treatment.

If it has been decided that an existing component requires additional treatment, use may be made of the floor, wall and stair treatments recommended for houses and flats resulting from material change of use. These treatments are described in section 4 of the AD and in section **10.6**. The design of separating components and their associated junctions to provide adequate sound insulation in such circumstances may be of a complex nature, and developers are advised in the AD that specialist advice may be required when undertaking this type of work.

In order to demonstrate compliance with the relevant requirement, the finished structure will be subject to pre-completion testing. It may, therefore, be both helpful and economical for the builder or designer, before commencing building work, to obtain the results of a preliminary sound transmission test on the existing structure to ascertain the extent of the need for additional treatment.

10.8.5 Junctions AD E: 6.11–6.15

As with other forms of dwelling place, in order for separating elements to fulfil their full potential, it is essential that flanking transmission is restricted by careful junction design and selection of flanking elements. The AD states that in the case of new buildings, the guidance relating to junction design and flanking transmission provided in sections 2 and 3 of the document for separating walls and floors, respectively, of houses and flats should be adhered to when building 'rooms for residential purposes'. This guidance is described in sections **10.4** and **10.5**.

Similarly, the guidance relating to junction and flanking details for houses and flats formed by material change of use in section 4 of the AD should be applied when creating 'rooms for residential purposes' by material change of use. This guidance is explained in section **10.6**.

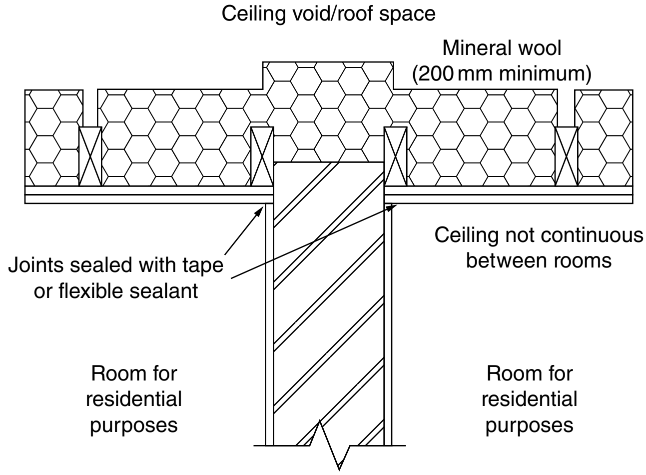


Fig. 10.27 Ceiling void/roof space detail – rooms for residential purposes only.

A relaxation to the guidance for houses and flats is that where a solid masonry Type 1 separating wall is used, the wall need not be continuous through a ceiling void or roof space to the underside of a structural floor or roof, subject to the following conditions:

- There is a ceiling consisting of two or more layers of plasterboard with a total mass per unit area of not less than 20 kg/m^2;
- There is a layer of mineral wool in the roof void which is not less than 200 mm thick and has a density of not less than 10 kg/m^3; and
- The ceiling is not perforated.

Also, the structure of the building should be such that neither the ceiling joists nor the plasterboard sheets are continuous across the wall separating 'rooms for residential purposes' with sealed joints as shown in Fig. 10.27. As stated in the AD, this construction detail may only be used if Building Regulation Part B – Fire Safety and Building Regulation Part L – Conservation of Fuel and Power are satisfied.

10.9 Robust Details: An alternative to pre-completion testing

10.9.1 Introduction

Requirement E1 of Schedule 1 to the Building Regulations 2010 (as amended) stipulates that a predefined level of acoustic performance must be provided for the walls, floors and stairs that separate adjoining dwelling places. The AD lays down the minimum acceptable performance standard in terms of specific values of airborne and impact sound insulation, as shown in Table 10.1. The forms of construction described in the AD and in sections **10.4** to **10.8** of this book are suggestions which, if followed, may be expected to provide the required performance. However, these constructions are not 'deemed to satisfy' provisions. The formal 'deemed to satisfy' provision remains the performance standard stated in Table 10.1. As this can only be guaranteed by actual measurement on-site of the finished construction, the regulations specify a programme of pre-completion testing, the details of which are described in sections **10.3** and **10.11**. However, if the construction of a separating element and its associated details were good enough to offer a potential performance well above the standards laid down in Table 10.1, then it may be argued that the need for pre-completion testing is an unnecessary expense and may be waived. This is the theory behind Robust Details, and both the Approved Document Part E and Regulation 41 allow for this possibility in certain circumstances.

10.9.2 Robust Details

The purpose of Robust Details is to provide construction designs with a sound insulation performance that is consistently greater than that required to satisfy requirement E1. To ensure that an installed separating structure will provide a performance, in terms of sound insulation, that is greater than the required standard is difficult since there are inherent variations in the composition of the materials forming the components of the structure, as well as variations in the quality of workmanship. Thus, several examples of a particular design will, when measured in a finished building, give rise to a spread of values, some of which may fail. It follows that in order to be assured that a separating component complies with the prescribed performance criteria in all but a very small number of cases, the average (i.e. design) performance will have to be significantly higher than the minimum requirement. The purpose of a Robust Detail, therefore, is to provide a design which, on average, has a measured performance that:

- has an average performance sufficiently above the minimum requirement to ensure that the lowest values in a normal distribution of its measured results will rarely, if ever, fall below the minimum requirement;
- is capable of consistently exceeding the performance requirement of AD E; and
- is practical to construct on-site and be reasonably tolerant to standards of workmanship.

In order to be accepted and approved as a Robust Detail, a particular form of construction must pass a thorough assessment and approval process. This includes an initial set of at least eight on-site sound transmission tests to demonstrate the feasibility of the construction. If this first 'Stage A' assessment is successful, then the proposal will be registered as a 'candidate robust detail'. A subsequent 'Stage B' application should be supported by a further 22 on-site tests, which if successful will qualify the construction to be accepted for publication as a 'robust detail'. Approved constructions are published in the Robust Details Part E Resistance to the Passage of Sound Handbook (see www.robustdetails.com) and include the following generic types:

- Separating walls: Masonry Timber Steel
- Separating floors: Concrete Timber Steel–concrete composite

It is important to ensure that a published Robust Detail continues to deliver the required sound insulation performance in practice. Thus, an important aspect of the Robust

Details scheme is the monitoring of the performance of constructed Robust Details in completed buildings. This is undertaken by acoustic consultants working for Robust Details Ltd on a percentage of plots registered. It includes visual inspections of work in progress and acoustic testing of completed properties.

10.9.3 Conditions relating to the utilisation of a Robust Detail

In order to avoid pre-completion testing by using a Robust Detail, four conditions must be satisfied as follows:

- The building work must consist of the erection of new attached dwelling houses or a new building containing flats.
- The person carrying out the building work must notify the building control body that design details approved by Robust Details Ltd are to be used in specified locations in the building. If building control is being carried out by the local authority, notification must be given no later than the date on which notice of commencement of construction is given under regulation 16(1) of the Building Regulations 2010. In the case of Approved Inspectors, notification must normally be given prior to commencement of the work.
- The notification must specify the unique identification numbers, issued by Robust Details Ltd, which attach to the specified use of the design details.
- The building work must be carried out in accordance with the design details specified in the notification.

Note that in the case of a 'room for residential purposes', although it is permissible to use a Robust Detail in the construction, the waiver on-site measurement does not apply, and pre-completion testing is still required.

Failure to adhere, precisely and completely, to all these conditions may invalidate the use of Robust Details. Failure could include one or more of:

- late notification;
- failure to specify the part or parts of the building where the Robust Details will be used;
- failure to provide a means to identify the Robust Detail, either by its unique reference number as included on the purchase statement or by providing a copy of the detail; and
- failure to carry out the work in accordance with the design details.

In the case of the last of these (but not the first three), it may be possible for the builder to take remedial action and then to request the building control body to accept the improved construction.

If the building control body is not satisfied that all the conditions have been met or that there has been a failure in meeting one or more parts of the required conditions, then the building control body may determine that the exemption from pre-completion testing no longer applies and that all relevant parts of the building in question should be subjected to pre-completion testing in the usual way.

Table 10.24 Example of the information given in a Plot Registration Form.

Block number (if applicable)	Plot number(s)	Quantity of plots	Plot type (H or F)	Wall RD type	Floor RD type
1	1–10	10	H	E-WM-1	n/a
3	16–19	4	F	E-WM-1	E-FC-1
5	25–28	4	F	E-WM-1	PCT

10.9.4 Procedure for using Robust Detail

The Robust Details scheme is operated by Robust Details Ltd. The procedure to be followed by a builder is as follows:

- Purchase a copy of the *Robust details handbook* and decide which detail or details are to be used.
- Obtain and complete a plot registration form, listing all plots and the codes of the proposed Robust Details (see Table 10.24 for an example).
- Submit the completed form to Robust Details Ltd together with the appropriate fee.

On receipt of the registration form, Robust Details Ltd will allocate a unique plot registration number to each plot. They will issue a purchase statement, a copy of the checklist for each Robust Detail and a compliance certificate for each plot. It is then necessary to:

- pass the purchase statement to the building control body – this must be done before starting building work, otherwise pre-completion testing will be required (if some building work has commenced, none of which affects the construction of the Robust Detail, a building control body may still accept the purchase statement and permit registration but only at its discretion).
- sign the compliance certificate for each home as soon as the Robust Detail work has been completed and make this available to the building control body for review.

10.9.5 Potential failure of Robust Details after completion

The usual method of establishing compliance with requirement E1 is by means of measurement, on site, of the finished structure. The assumption which underpins Robust Details is that their acoustic performance will exceed the standard required by the Building Regulations, as stated in Table 10.1, by a significant margin and that therefore pre-completion testing is unnecessary. However, the use of a Robust Detail is not in itself a guarantee that requirement E1 has been satisfied. What then happens in the case of a Robust Detail which, after completion and acceptance by the building control body, is subjected to a sound transmission test and found to fail? In these circumstances, the results of the pre-completion test take precedence over the use of a Robust Detail in determining whether or not requirement E1 had been satisfied, and it would be open to the owner or occupier of the building to request remedial action from the builder. It would not be a defence for the builder to show that he had correctly carried out a design detail approved by Robust Details Ltd.

10.10 Reverberation in common parts of buildings

(Approved Document E section 7: Reverberation in the common internal parts of buildings containing flats or rooms for residential purposes)

10.10.1 General requirements AD E: 7.1–7.9

The common parts of buildings containing flats and/or 'rooms for residential purpose' tend to be constructed with hard durable surface finishes, which are easily maintained. Unfortunately, such surfaces lack the soft open texture which efficiently absorbs sound, and so the level of reflected, or reverberated, sound tends to be high in such places. Requirement E3 of Part E of the Building Regulations 2010 (as amended) states that the design and construction of the common parts of such buildings shall be such as to prevent more reverberation around them than is reasonable.

Fortunately, it is relatively easy to increase sound absorption and hence reduce reverberant noise levels by surface treatment. Procedures for determining the amount of additional absorption which is required in corridors, hallways, stairwells and entrance halls providing access to flats and 'rooms for residential purposes' are described in section 7 of Approved Document E. The document differentiates between different types of common space as shown in Table 10.25.

The types of space referred to in Table 10.25 are frequently interconnected, and in such circumstance the guidance for each space should be followed individually.

The AD describes two methods, A and B, for calculating how much sound absorption is required, and the procedure for the use of each method is explained in sections 10.10.3 and 10.10.4 with an example of their application in section 10.10.5. However, whichever procedure is adopted, it is essential that any material chosen to line the internal surfaces complies with the requirements of Building Regulation Part B – Fire Safety, and it is recommended in the AD that if designers require guidance regarding the provision of additional sound absorbent material, this should be sought at an early stage of the design process.

10.10.2 Sound absorption properties of materials

When sound energy strikes a surface, some passes through it, some is absorbed by it and some is reflected. The absorption coefficient, α, of a material is defined as:

$$\alpha = \frac{\text{sound energy not reflected}}{\text{sound energy incident}}$$

Table 10.25 Limiting dimensions of common areas.

Type of space	Ratio of longest to shortest floor dimensions
Corridor, hallway	Greater than three
Entrance hall	Three or less
Stairwell	Not defined in terms of ratio of dimensions

Table 10.26 Sound absorption classes defined in EN ISO 11654:1997.

Sound absorption class	α_w
A	0.90, 0.95, 1.00
B	0.80, 0.85
C	0.60, 0.65, 0.70, 0.75
D	0.30, 0.35, 0.40, 0.45, 0.50, 0.55
E	0.25, 0.20, 0.15
Not classified	0.10, 0.05, 0.00

It follows that if no sound is reflected $\alpha = 1$ and if none is absorbed or transmitted, then $\alpha = 0$. In theory, all building materials have absorption coefficients between zero and one, values close to zero representing reflective surfaces with low absorption power and vice versa. Sound absorption is highly dependent on frequency. Some of the types of material used to line rooms have good absorption power in the mid to high frequencies of the audible spectrum whereas for others it is highest at the lower end of the spectrum. For this reason it is usual to quote one-third octave or one-octave band values of absorption coefficients measured across the audible spectrum. Octave band values of absorption coefficient for a range of materials are shown in Table 10.28.

10.10.3 Calculation of additional absorption: Method A AD E: 7.10–7.12

This method makes use of a procedure for classifying sound absorbers which is described in BS EN ISO 11654:1997. To apply this procedure, absorption coefficients are measured at one-third octave bands, and the arithmetic mean of the three one-third octave bands within each octave band is taken to obtain the 'practical sound absorption coefficient', α_{pi}, a one-octave band average value where *i* is the *i*th octave band. The one-octave band values are then compared with a reference curve which is 'shifted' in increments of 0.05 dB until the sum of the adverse deviations does not exceed 0.01 dB. The value of the reference curve at 500 Hz, α_w, is then taken as a single figure weighted average absorption coefficient of the material in question. The material is then given a classification letter according to its value of α_w as shown in Table 10.26 which is an extract from BS EN ISO 11654:1997.

Method A involves covering a prescribed area with an absorbent material of a defined classification as follows.

Entrance halls, corridors and hallways

Cover an area at least as great as the floor area with an absorber which is Class C or better. The document states that it will normally be expedient to cover the ceiling with the additional absorptive material.

Stairwells and stair enclosures

Calculate the combined area of:

- stair treads;
- upper surface of intermediate landings;

- upper surface of landings (excluding ground floor); and
- ceiling area on the top floor,

and cover an area which is equal to or larger than the calculated area with a Class D absorber, or cover an area which is at least half of the calculated area with an absorber of Class C or better. In either case the sound absorbing material should be distributed equally between floor levels. It is stated in the AD that it will normally be appropriate to cover the:

- underside of intermediate landings;
- underside of the other landings; and
- ceiling area on the top floor.

The materials used to increase sound absorption tend to be light and porous, lacking the robustness which is required to withstand day-to-day wear and tear and vandalism in common areas where they may come into contact with human beings. This is why it is recommended in the AD that they be used to cover ceilings and the undersides of landings despite the fact that they would be equally effective on other surfaces. The AD states that the use of proprietary acoustic ceilings is appropriate. These have the benefits of being available with a variety of surface finishes and are lightweight and very efficient absorbers of sound.

10.10.4 Calculation of additional absorption: Method B AD E: 7.13–7.21

This method takes into account the actual absorption power of the surfaces of the enclosure prior to the provision of additional absorbent material and allows the amount of additional material which is required to be calculated. It is stated in the AD that it is only intended for corridors, hallways and entrance halls (not stairwells) but that it offers a more flexible approach which may require less additional absorption than Method A. It is also a more efficient approach in that the additional absorption can be directed at the frequencies at which it is most needed.

For a particular surface of area S m^2 and absorption coefficient α, its absorption area A is defined as the product of S and α and it has units of m^2. This may be considered as the hypothetical area of a material which is a perfect absorber, i.e. one with $\alpha = 1$, which would provide the same sound absorption as the actual material with area S.

If an enclosure has n internal surfaces, its total absorption area, A_T, is defined as the sum of the absorption areas of its individual components, such that:

$$A_T = \alpha_1 S_1 + \alpha_2 S_2 + \alpha_3 S_3 + \cdots + \alpha_n S_n$$

It follows that A_T may be considered as the hypothetical area of a material which is a perfect absorber which would provide the same total sound absorption as the sum of the actual materials which are present.

Requirement E3 will be satisfied when the total absorption area stipulated in Table 10.27 for different types of common area has been provided at each octave band from 250 Hz to 4000 Hz.

Table 10.27 Total absorption areas for common areas using Method B.

Type of common area	Minimum total absorption area required	Location of additional absorptive material
Entrance halls	0.20 m^2 per cubic metre of volume	To be distributed over the available surfaces
Corridors, hallways	0.25 m^2 per cubic metre of volume	To be distributed over one or more of the surfaces

Table 10.28 Copy of Table 7.1 from Approved Document E providing absorption coefficients for commonly used materials.

	Sound absorption coefficient α in octave frequency bands (Hz)				
Material	**250**	**500**	**1000**	**2000**	**4000**
Fair-faced concrete or plastered masonry	0.01	0.01	0.02	0.02	0.03
Fair-faced brick	0.02	0.03	0.04	0.05	0.07
Painted concrete block	0.05	0.06	0.07	0.09	0.08
Windows, glass facade	0.08	0.05	0.04	0.03	0.02
Doors (timber)	0.10	0.08	0.08	0.08	0.08
Glazed tile/marble	0.01	0.01	0.01	0.02	0.02
Hard floor coverings (e.g. lino, parquet) on concrete floor	0.03	0.04	0.05	0.05	0.06
Soft floor coverings (e.g. carpet) on concrete floor	0.03	0.06	0.15	0.30	0.40
Suspended plaster or plasterboard ceiling (with large airspace behind)	0.15	0.10	0.05	0.05	0.05

Absorption coefficient data which should be accurate to two decimal places may be obtained from a variety of sources. For generic materials, data is provided in Table 7.1 of the AD which is reproduced as Table 10.28. It is stated in the AD that this may be supplemented by other published data. Whilst published data will be necessary and appropriate for generic surface materials not provided specifically to increase the absorption area of the enclosure, materials which are selected for their absorption properties will usually be trade products, and their absorption coefficients should be available from their manufacturers or suppliers. These should be established by measuring one-third octave band values of absorption coefficients in accordance with BS EN 20354:1993 and then converting them to one-octave band values of 'practical sound absorption coefficient', α_{pi}, using the procedure described BS EN ISO 11654:1997 (see section 10.10.3).

When calculating the area and absorption coefficient of the material necessary to satisfy the requirements of Table 10.27, calculation steps should be rounded to two decimal places.

10.10.5 Example of absorption calculation

There follows an example of the application of Methods A and B to calculate the extra absorption required for an entrance hall (see Fig. 10.28).

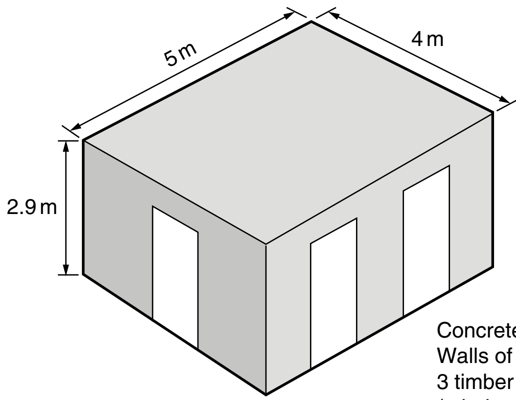


Fig. 10.28 Entrance hall relating to example question.

Application of Method A

This requires covering an area equal or greater than the floor area with a Class C, or better, absorber.

An appropriate solution would therefore be to cover $4.0 \times 5.0 = 20\,m^2$, e.g. the ceiling with an appropriate material, probably acoustic ceiling tiles, of Class C or better.

Application of Method B

Assuming that the designer has decided to cover the entire ceiling with absorptive material, the necessary calculations are as described below.

Stage 1
Calculate area of each internal surface and establish the absorption coefficient from Table 10.28 for each surface which is not being selected for its sound absorbing properties.

		Absorption coefficient for each octave band				
Surface	**Area (m^2)**	**250 (Hz)**	**500 (Hz)**	**1000 (Hz)**	**2000 (Hz)**	**4000 (Hz)**
Floor (concrete, carpet covered)	20	0.03	0.06	0.15	0.30	0.40
Doors (timber)	7.2	0.10	0.08	0.08	0.08	0.08
Walls (exc. doors) (fair-faced brick)	45	0.02	0.03	0.04	0.05	0.07
Ceiling (yet to be determined)	20					

Note that the carpeted floor provides good absorption at the higher frequency octave bands. This reduces the absorption required at these frequencies from the ceiling covering.

Stage 2
Calculate the absorption area of floor, doors and walls (the product of area and absorption coefficient) and then establish the overall absorption area of these surfaces at each octave band by summing.

	Absorption area (m²)				
Surface	**250 (Hz)**	**500 (Hz)**	**1000 (Hz)**	**2000 (Hz)**	**4000 (Hz)**
Floor	0.60	1.20	3.00	6.00	8.00
Doors	0.72	0.58	0.58	0.58	0.58
Walls (exc. doors)	0.90	1.35	1.80	2.25	3.15
Sum of absorption areas	2.22	3.13	5.38	8.83	11.73

Stage 3
Calculate the total absorption area, A_T, required at each octave band, i.e. $0.2 \times \text{volume} = 0.2 \times 5 \times 4 \times 2.9 = 11.6\,\text{m}^2$.

Stage 4
Calculate the additional absorption area required from ceiling by subtracting the values found at Stage 2 from that found at Stage 3.

	Absorption area (m²)				
	250 (Hz)	**500 (Hz)**	**1000 (Hz)**	**2000 (Hz)**	**4000 (Hz)**
Additional area required from ceiling	9.38	8.47	6.22	2.77	−0.13

The negative value at 4000 Hz indicates that sufficient absorption is provided at this octave band by the floor, doors and walls.

Stage 5
Calculate the absorption coefficient required for the ceiling by dividing the required absorption area by the area of the ceiling.

	Absorption area (m²)				
	250 (Hz)	**500 (Hz)**	**1000 (Hz)**	**2000 (Hz)**	**4000 (Hz)**
Required absorption coefficient of ceiling material	0.47	0.42	0.31	0.14	Any value

Select a patent ceiling product which has absorption coefficients greater than those in the above table.

10.10.6 Report on compliance AD E: 7.22

Demonstration of compliance with Requirement E3 may take the form of an annotated drawing or a report. The information which should be included, quoted directly from the AD, is as follows.

(1) A description of the enclosed space (entrance hall, corridor, stairwell, etc.).
(2) The approach used to satisfy Requirement E3, Method A or B:
- With Method A, state the absorber class and the area to be covered.
- With Method B, state the total absorption area of additional absorptive material used to satisfy the Requirement.

(3) The Plans indicating the assignment of the absorptive material in the enclosed space'.

10.11 School acoustics

(Approved Document E section 8: Acoustic conditions in schools)

Requirement E4 states that the design and construction of all rooms and other places in school buildings shall be such that their acoustic conditions and insulation against disturbance by noise are appropriate to their intended use. It is stated in AD E that the normal way of satisfying these conditions will be to meet the requirements given in section 1 of Building Bulletin 93, *The acoustic design of schools* with respect to sound insulation, reverberation time and internal ambient noise levels. This document is produced by DfES and published by The Stationery Office.

10.12 Calculation of sound transmission indices

(Approved Document E Annex E: Procedures for sound insulation testing)

10.12.1 Overview of procedures for establishing sound insulation values from field measurements

Field measurement of airborne sound insulation for compliance with Requirement E1 requires calculation of the 'weighted standardised level difference' $D_{nT,w}$ and the 'spectrum adaptation term' C_{tr}. Initially, a noise source is located in one of two rooms between which there is a separating element, and microphones are located in this and the room on the other side of the separating element as shown in Fig. 10.29. On the activation of the noise source, noise passes from the source room to the receiving room by the direct and indirect routes indicated on the figure, and the level difference between them, *D*, is measured in accordance with BS EN ISO 140–4:1998 and as described in section 10.12.3. The level measured at the microphone in the receiving room will be determined not only by the energy passing directly to the microphone but also by the noise energy reflected within the room which in turn will influence the calculated level difference *D*.

To take account of the reflected energy in the receiving room, a noise source is activated in the receiving room and then switched off. The sound pressure then falls, and

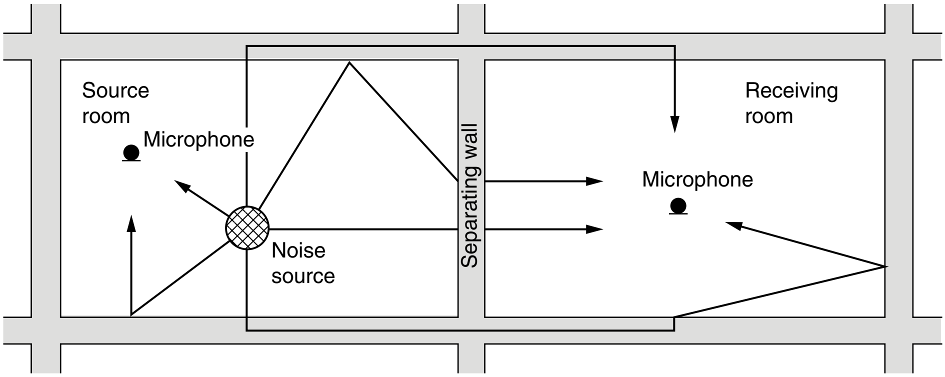


Fig. 10.29 Measurement of airborne sound insulation.

the time taken for the sound to decay by 60 dB is established. This is known as the reverberation time, and the standards relevant to reverberation time measurement are referred to in section 10.12.3. The level difference is then normalised by calculating the value D_{nT}:

$$D_{nT} = D + 10\text{Log}\left(\frac{T}{T_0}\right)\text{dB} \quad \text{with } T_0 = 0.5\,\text{s}$$

where T is the reverberation time of the receiving room and T_0 is a reference value. D_{nT} is known as the 'standardised level difference' and is the level difference which would have been measured if the receiving room had a reverberation time of 0.5 s. Hence all level differences are normalised to a receiving room reverberation time of 0.5 s. D_{nT} is measured using one-third octave bands, and these values are combined to give a single value, the weighted standardised level difference $D_{nT,w}$, using a procedure described in BS EN ISO 717-1:1997.

The spectrum adaptation term, C_{tr}, is also a single number value measured in decibels and calculated from the spectrum D_{nT} using BS EN ISO 717-1:1997. If a separating element provides poor insulation at low frequencies, C_{tr} will be large and negative, and so when added to $D_{nT,w}$ for the purposes of Requirement E1, its effect will be to reduce the overall magnitude of the insulation value.

Field measurement of impact sound insulation for compliance with Requirement E1 requires calculation of the 'weighted standardised impact sound pressure level', $L'_{nT,w}$. Initially a tapping machine is located on top of the separating floor, and a microphone(s) is located in the room beneath it (see Fig. 10.30). A tapping machine is a device with five small hammers which consecutively strike the floor producing impacts of predetermined momentum. On activation of the tapping machine, the impact sound pressure level, L_i, is measured in the room beneath the floor (the receiving room) in accordance with BS EN ISO 140-7:1998. As with airborne sound transmission, the level measured at the microphone in the receiving room will be influenced by noise energy reflected within the room, and so reverberation time is also measured when assessing impact sound insulation.

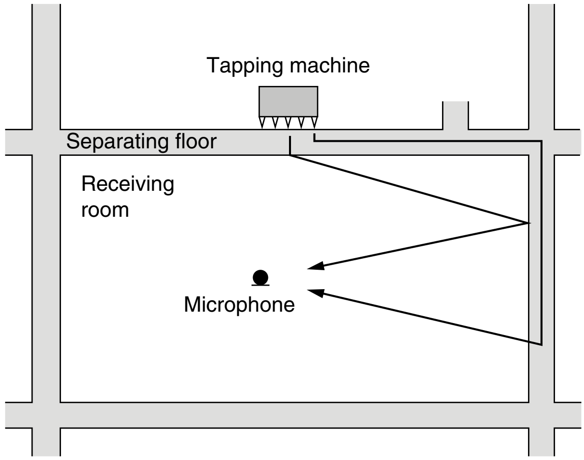


Fig. 10.30 Measurement of impact sound transmission.

In this case, the standardisation is also to the equivalent of a room with a reverberation time of 0.5 s. to give the 'standardised impact sound pressure level' L'_{nT}:

$$L'_{nT} = L_i + 10\text{Log}\left(\frac{T}{T_0}\right)\text{dB} \quad \text{with } T_0 = 0.5\,\text{s}$$

L'_{nT} is measured using one-third octave bands, and these values are combined to give a single value, the weighted standardised impact sound pressure level, $L'_{nT,w}$, using a procedure described in BS EN ISO 717-2:1997.

10.12.2 General requirements AD E: B1.4, B2.1 & B3.2

It is the responsibility of the person undertaking the building work to arrange for the necessary sound insulation testing to be carried out by a testing organisation with appropriate third party accreditation. The AD states that the organisation undertaking the testing should preferably have UKAS accreditation or a European equivalent. Members of the Association of Noise Consultants who are approved under their association's ADE Registration Scheme are also regarded as being suitably qualified. It is also a requirement that a valid traceable calibration certificate exists for the instrumentation used for the measurement and that it has been tested within the preceding two years.

Measurements are based on the BS EN ISO 140 series of standards, and rating is based on the BS EN ISO 717 series of standards, and as stated in the AD, it is important when calculating test results that rounding does not occur until required by the standard in question.

10.12.3 Field measurement of the sound insulation of separating walls and floors AD E: 0.1

Requirement E1 is satisfied if separating elements comply with Tables 0.1a and 0.1b of the AD following pre-completion testing (see section **10.2**).

Regulations 20A and 12A apply to building work to which E1 applies, and these regulations state that pre-completion testing must be carried out in accordance with an approved procedure. The approved procedure is described in Annex B2 of AD E and its content is outlined below.

Airborne insulation of separating walls or floors AD E: B2.2–B2.8

Procedure:

Measure in accordance with BS EN ISO 140-4:1998 (all measurements and calculations carried out in one-third octave bands).
Rate performance in accordance with BS EN ISO 717-1:1997 (in terms of the weighted standardised level difference $D_{nT,w}$ and spectrum adaptation term C_{tr}).

Measurements using a single sound source
The average sound pressure level (SPL) is measured in one-third octave bands in source and receiving rooms for each source position using either a series of fixed microphone positions and averaging values on an energy basis, or a single moving microphone.

The differences between average source room SPL measurements in adjacent one-third octave bands should not exceed 6 dB. If this criterion is not satisfied, the instrumentation should be adjusted and measurement repeated until it is satisfied. When it is satisfied, the average SPL in the receiving room and hence the level difference should be established.

The sound source must not be moved or its output level adjusted until measurements in the source and receiving rooms are complete.

The procedure should be repeated with the sound source moved to another position in the source room. At least two source positions should be used, and the level differences obtained at each position should be averaged to obtain the level difference *D* defined in BS EN ISO 140-4:1998.

Measurements using simultaneously operating multiple sound sources
The average SPL is measured in one-third octave bands in source and receiving rooms with the multiple sources operating simultaneously. Measurement is undertaken using either fixed microphone positions and averaging values on an energy basis or a moving microphone.

The differences between average source room SPL measurements in adjacent one-third octave bands should not exceed 6 dB. If this criterion is not satisfied, the instrumentation should be adjusted and measurement repeated until it is satisfied. When it is satisfied, the average SPL in the receiving room and hence the level difference D defined in BS EN ISO 140-4:1998 may be established.

Impact sound transmission through separating floors AD E: B2.9

Procedure:

Measure in accordance with BS EN ISO 140-7:1998 (all measurements and calculations carried out in one-third octave bands).

Rate performance in accordance with BS EN ISO 717-2:1997 (in terms of the weighted standardised impact sound pressure level, $L'_{nT,w}$).

Measurement of reverberation time AD E: B2.10

In order to calculate the weighted standardised level difference, $D_{nT,w}$, and the weighted standardised impact sound pressure level, $L'_{nT,w}$, measurements have to be corrected to take into account the degree of reverberation in the receiving room. This requires measurement of its reverberation time which is defined as the time taken for the SPL to decrease by 60 dB after a sound source is switched off. The measurement standards referenced above refer to BS EN ISO 354:2003 for the method of measuring reverberation time. Guidance in BS EN ISO 140-7:1998 with respect to positioning of equipment and number of measurements should be adhered to.

Room types and sizes AD E: B2.11

The types of rooms to be used for testing are considered in section **10.3**. They should have volumes of 25 m^3 or more, and if not, the volumes of the rooms used should be reported.

Room conditions for tests AD E: B2.12–B2.17

The following conditions should apply:

(1) Rooms (or available spaces in the case of properties sold before fitting out) used for testing should be completed but unfurnished.
(2) Floors without soft coverings should be used for impact tests. Exceptions are separating floors Type 1 and structural concrete floor bases which have integral soft coverings. If soft coverings have been laid on other types of floor, these should be removed, and if that is not possible, at least half of the floor should be exposed, with the tapping machine (this is required for impact transmission measurement) used on the exposed part of the floor.
(3) When a pair of rooms used for airborne sound insulation measurement is of different volumes, the sound source should be activated in the larger room.
(4) All doors and windows should be closed, and the doors of fitments such as kitchen units and cupboards on all walls should be empty and have open doors.

Accuracy of measurement AD E: B2.18–B2.19

SPL and reverberation time measurements should be to an accuracy of 0.1 dB and 0.01 s., respectively.

Measurement using moving microphones AD E: B2.20–B2.21

If a moving microphone is employed, measurements should be taken with it centred at two or more positions. Due to the transient nature of the reverberation time measurement process, fixed microphone positions as opposed to moving microphones should be used when measuring reverberation times.

10.12.4 Laboratory measurement procedures AD E: B1.2 & B3.1–B3.2

Laboratory testing may be required to establish the performance of building elements in order to comply with Requirement E2, components such as wall ties and floating floors to which Requirement E1 applies as well as to assess the performance of proposed novel constructions. Appropriate laboratory testing procedures are described in Annex B3 of the AD and are outlined below.

No rounding in calculations associated with sound insulation test results should take place until required by the relevant BS EN ISO 140 and BS EN ISO 717 series standards.

Floor coverings and floating floors: AD E: B3.3–B3.6

Procedure:

Test in accordance with BS EN ISO 140-8:1998 (using a test floor with a thickness of 140 mm).
Rate performance in accordance with BS EN ISO 717-2:1997.

The AD states that the text has been omitted from BS EN ISO 140-8:1998 and that for the purposes of the document, section 6.2.1 of BS EN ISO 140-8:1998 should be disregarded and section 5.3.3 of BS EN ISO 140-7:1998 be referred to instead.

BS EN ISO 140-8:1998 refers to ISO 354 for the method of measuring reverberation time. It is stated in the AD that guidance in BS EN ISO 140-8:1998 with respect to positioning of equipment and number of required decay measurements should be adhered to.

When assessing Category II specimens, defined in BS EN ISO 140-8:1998 as large specimens including rigid homogeneous surface materials (e.g. floating floors), the value ΔL_w should be measured with and without the floor carrying a defined load. ΔL_w is a measure of the improvement in impact sound insulation provided by installing a floor covering or floating floor over a laboratory test floor.

Dynamic stiffness AD E: B3.7–B3.8

Procedure for resilient layer:
Measure in accordance with BS EN 29052-1:1992 (use sinusoidal signals method with no precompression of specimens).

Procedure for wall ties:
Measure in accordance with BRE Information Paper IP 3/2001.

Airborne sound insulation of wall and floor elements AD E: B3.9

Procedure:

Measure in accordance with BS EN ISO 140-3:1995.
Rate performance in accordance with BS EN ISO 717-1:1997 (determine weighted sound reduction index R_w).

Sound reduction index and weighted sound reduction index are described in section **10.14**.

Flanking laboratory measurement AD E: B3.10–B3.14

Although tests in flanking laboratories are very useful because they include the effects of transmission through direct and flanking routes, they may not be used to indicate compliance with Requirement E1 since this relates to field performance.

Flanking laboratory measurements are a useful way of assessing the probable performance in practice of novel or alternative constructions, and it is stated in the AD that if a test construction provides airborne insulation, $D_{nT,w} + C_{tr}$, value of 49 dB or more when measured in a flanking laboratory, this may be taken as an indication that a construction which is identical in all significant details may achieve a $D_{nT,w} + C_{tr}$ value of 45 dB or more if built in the field. Note the first paragraph of this section.

It is also stated in the AD that if a test construction provides impact sound transmission, $L'_{nT,w}$, of 58 dB or less measured in a flanking laboratory, this may be taken as an indication that a construction which is identical in all significant details may achieve an $L'_{nT,w}$ value of 62 dB or less if built in the field. Note the first paragraph of this section.

A standard for laboratory measurement of flanking transmission is being developed, and construction details of a flanking laboratory are available from The Acoustics Centre, BRE, Garston, Watford WD25 9XX.

10.12.5 Test report information

Field test report information AD E: B4.1

The information to be provided in a test report relating to tests done in compliance with regulations 20A or 12A is itemised in section 1 of AD E (see section 10.3.6). It is suggested in the AD that, although not mandatory, it may be useful to also provide the following information which is quoted directly from the document:

(1) sketches showing the layout and dimensions of rooms tested;
(2) description of separating walls, external walls, separating floors, and internal walls and floors including details of materials used for their construction and finishes;
(3) mass per unit area in kg/m^2 of separating walls, external walls, separating floors, and internal walls and floors;
(4) dimensions of any step and/or stagger between rooms tested;
(5) dimensions and position of any windows or doors in external walls'.

Laboratory test report information AD E: B4.2

It is stated that the following information, which is quoted directly from the AD, should be provided in test reports:

(1) Organisation conducting test, including:
 (a) name and address;
 (b) third party accreditation number (e.g. UKAS or European equivalent); and
 (c) name(s) of person(s) in charge of test.

(2) Name(s) of client(s).
(3) Date of test.
(4) Brief details of test, including:
   (a) equipment; and
   (b) test procedures.
(5) Full details of the construction under test and the mounting conditions.
(6) Results of test shown in tabular and graphical form for third octave bands according to the relevant part of the BS EN ISO 140 series and BS EN ISO 717 series, including:
   (a) single-number quantity and the spectrum adaptation terms; and
   (b) data from which the single-number quantity is calculated'.

10.13 The calculation of mass

(Approved Document E Annex A: Method for calculating mass per unit area)

The mass per unit area, expressed in kilogrammes per square metre, may be obtained from manufacturers' data. Alternatively, it can be calculated for walls and floors by the following methods as described in Annex A of AD E.

10.13.1 Walls AD E: A2–A4

In the case of a brick or block wall, mortar beds and perpends may constitute a considerable proportion of the total volume, and, since the density of mortar may be significantly different to that of the blocks, account must be taken of this when calculating the mass per unit area. The procedure used is to define the 'co-ordinating area' as shown in Fig. 10.31 and to calculate the mass per unit area, M_A, from

$$M_A = \frac{\text{Mass of co-ordinating area}}{\text{Co-ordinating area}} = \frac{M_B + \rho_m\left(Td\left(L+H-d\right)+V\right)}{LH}\ \text{kg/m}^2$$

where, in the above equation,

M_B is the brick or block mass (kg)
ρ_m is the density of mortar (kg/m^3)
T is the brick or block thickness (m) (excluding any finish)
D is the mortar joint thickness (m)
L is the co-ordinating length (m)
H is the co-ordinating height (m)
V is the volume of any mortar filled void, e.g. a frog

In using the above equation, the following points should be noted:

- The brick or block unit must penetrate the full thickness (excluding finishes) of the wall.

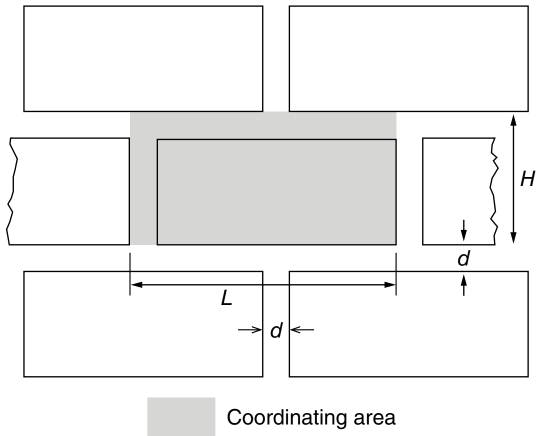


Fig. 10.31 Coordinating area used for calculation of mass per unit area.

- Since density is a function of moisture content, the mass of brick/block and density of mortar should be taken at the appropriate moisture content. The AD makes reference to CIBSE Guide A (2006) for this information.
- The above formula calculates the mass per unit area of a single leaf without surface finish. If a finish, e.g. plaster, is to be applied and/or if it is a cavity wall with another leaf, the mass per unit area of each component must be added together to obtain the total mass per unit area of the wall.
- Manufacturers' data should be used to obtain the mass per unit area of surface finishes.

Example calculation

Assume that a concrete block has the following dimensions:

Thickness = 0.120 m
Length = 0.440 m
Height = 0.290 m
Mass of block = 14 kg

and it is to be used on edge with mortar which has a density of 1800 kg/m^3 and a thickness of 0.010 m (10 mm).

In this case:

$M_B = 14$ kg
$\rho_m = 1800$ kg/m^3
$T = 0.120$ m
$d = 0.010$ m
$L = 0.450$ m
$H = 0.300$ m
$V = 0$ (it is assumed that there is no frog)

and substituting into the above equation gives a mass of 115.5 kg/m^2.

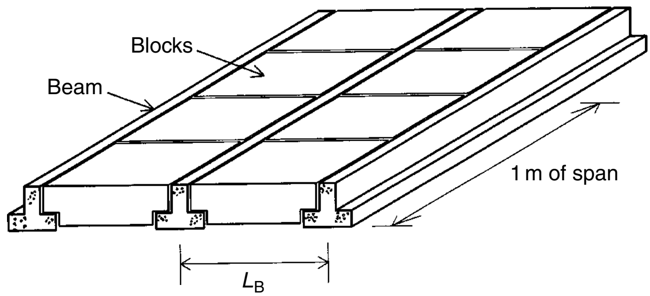


Fig. 10.32 Beam and block floor.

The AD makes reference to 'simplified equations'. These, however, are simply representations of the equation shown above with substitution for all variables for the particular case with the exception of the mass of the block. In this format the above equation would be written as

$$\text{Mass per unit area} = 7.4\,M_B + 11.8\ \text{kg/m}^2$$

Various values of M_B may now be substituted into the equation to establish the mass per unit area.

10.13.2 Floors AD E: A5

The mass per unit area of a flat solid concrete slab floor, M_F, may be obtained by multiplying its density, ρ_c, by its thickness, T:

$$M_F = \rho_c T$$

In the case of a conventional beam and block floor, as shown in Fig. 10.32, the mass per unit area, M_F, can be obtained from

$$M_F = \frac{\left(M_{\text{beam,1m}} + M_{\text{block,1m}}\right)}{L_B}$$

where, in the above equation,

$M_{\text{beam,1m}}$ is the mass of 1 m of the length of the beam
$M_{\text{block,1m}}$ is the mass of the blocks spanning between two consecutive beams for 1 m of the length of the beam
L_B is the dimension defined in Fig. 10.32

No other examples are given in the AD. Designers are advised in the AD to seek advice from manufacturers on the mass per unit area of other floor types.

10.14 Explanation of important terms

10.14.1 Absorption of sound

When sound strikes a surface, a fraction is reflected back from the surface, and the remainder is absorbed at the surface. Sound absorption, which may be thought of as the conversion of sound energy to heat, may be caused by a number of mechanisms. The absorption coefficient is the fraction of the incident energy which is not reflected from the surface and has a value between zero and one, the extreme values representing perfectly reflecting and perfectly absorbing surfaces, respectively.

10.14.2 Airborne sound insulation

Airborne sound is sound, from a source such a speech or loudspeakers, which travels through air. Elements reducing its transmission are therefore providing airborne sound insulation. Airborne sound may pass from one room to another by:

- direct transmission: sound which passes directly through the element separating two rooms; and
- flanking transmission: sound which passes indirectly between rooms, e.g. via elements which abut the separating element.

10.14.3 Dwelling places

Dwelling houses, flats and rooms for residential purposes are, for convenience, referred to collectively as 'dwelling places'.

10.14.4 Frequency

Sound results from cyclic variations in air pressure, the frequency of which is measured in the units of hertz and given the symbol Hz. The frequency in hertz refers to the number of pressure variation cycles per second. The human ear can detect sound within a range of frequencies from about 20 Hz to 20,000 Hz. An octave band contains all frequencies from a lower limiting frequency to an upper limiting frequency of twice the lower limit. One-third octave bands result from dividing an octave band into three contiguous bands in which the upper limiting frequency in each sub band is its lower limiting frequency multiplied by $2^{1/3}$.

10.14.5 Impact sound insulation

Impact sound is sound created by the impact of objects, e.g. footsteps, directly with part of the building structure. If a component is provided which reduces impact sound transmission, it is providing impact sound insulation. When sound is transmitted via the structural components of a building, it is known as structure-borne sound.

10.14.6 Impact sound pressure level

The standardised impact sound pressure level, L'_{nT}, is obtained from frequency band measurements of the impact sound generated by a standard test. The weighted standardised impact sound pressure level, $L'_{nT,w}$, is a single number expression of impact sound level measured in decibels and obtained from L'_{nT}. These indices are described in section **10.11**.

10.14.7 Level difference

The standardised level difference, D_{nT}, is obtained from frequency band measurements of the sound pressure level difference between two rooms, and the weighted standardised level difference, $D_{nT,w}$, is a single number expression of level difference obtained from D_{nT}. The spectrum adaptation term, C_{tr}, is a single number modification to $D_{nT,w}$. These indices are described in section **10.11**.

10.14.8 Separating floors and walls

These are the elements between dwelling places. Separating floors separate flats and 'rooms for residential purposes'. Separating walls separate dwelling houses, flats and 'rooms for residential purposes'.

10.14.9 Sound reduction index

The sound reduction index, R, of a building element is a laboratory measured value relating to its airborne sound insulating properties. Sound reduction index is measured in accordance with BS EN ISO 140-3:1995 in one-third octave bands across the audible frequency range and is expressed in decibels. The weighted sound reduction index, R_w, is a single number quantity which expresses the airborne sound insulation of a building element. It is derived from the sound reduction index in accordance with BS EN ISO 717-1:1997.

10.14.10 Units of measurement

The decibel, given the symbol dB, is a convenient unit for representing magnitude of sound. Sound pressure level, which is used to measure the magnitude of sound in building acoustics, is measured in decibels.

11 Ventilation (Part F)

11.1 Introduction

The requirements for Part F were substantially changed in 2006 and the substantive requirements of this part were not changed with the publication of the 2010 regulations. The current 2010 edition of Approved Document F – Ventilation has been updated and replaces the previous edition.

The approved document incorporates amendments made to reflect any changes arising as a result of the Building Regulations 2010. These changes do not relate to the specific technical requirements of this part instead mainly reflecting regulation number changes as a result of the re-ordering of regulations in the Building Regulations 2010. There have been no amendments to the substantive requirements of the schedule 1 requirement Part P in the regulations.

Ventilation is the replacement of polluted air within a building with fresh air from outside the building. It is also possible to recirculate polluted air provided it has been treated in some way, but 100% recirculation is not normally acceptable in buildings. The process of ventilation consumes energy, both because it may be necessary to heat or cool the incoming fresh air and because it may also involve the operation of energy-consuming equipment, e.g. electric fans. Because there are energy implications in providing ventilation, Part L, Conservation of Fuel and Power, imposes some limitations. The relevant ones are:

- the requirement to make buildings airtight in order to limit accidental infiltration of fresh air through the building fabric, and
- limitations on fan power in mechanically ventilated systems – see the relevant '*Building services compliance guide*', 2013 edition.

Both of these limitations tend to reduce the fresh air supply to a building. Thus the provisions of Part F become particularly important in providing a counterbalance to Part L and ensuring that there is sufficient ventilation for the purposes of health and safety. During 2008 and 2009 the government became aware of research evidence indicating that significant problems of indoor air quality were being encountered in dwellings constructed to the 2006 Part F standard. To address these issues for dwellings, the 2010 edition of Part F introduces two levels of airtightness, known as The Default Option and

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

The Alternative Option. The new default option is in effect a higher standard of ventilation applied to dwellings whose airtightness is below a certain level and represents a higher standard than that which was required under the 2006 version. The alternative option is applicable to dwellings with a more relaxed airtightness standard and the ventilation requirement is set at the 2006 level. These are described in more detail in section 11.3.2.

11.2 Definition and interpretation of terms

The principal terms used in Part F are described here, together with some other relevant terms.

AIR PERMEABILITY – Air permeability is the air leakage rate per hour per square metre of envelope area at the test reference pressure differential of 50 Pa.
The envelope area of the building (or its measured part) is the total area of all floors, walls and ceilings bordering the space being tested and includes walls and floors below external ground level. Overall internal dimensions are used to calculate this area, with no subtractions for the area of the junctions where internal elements meet the external envelope.

AIRTIGHTNESS – Airtightness is the ability of the building envelope to resist air infiltration. An airtight building has a low air permeability and therefore a low rate of infiltration.

AUTOMATIC CONTROL – This is a non-manual control that operates a ventilation device in response to a signal from a sensor which detects some property of the air or the airflow.

BACKGROUND VENTILATOR – A small ventilation opening designed to provide controllable whole building ventilation.

BASEMENT FOR DWELLINGS – A usable and habitable part of a dwelling that is wholly or partly below ground level. A cellar or other space used for purposes other than habitation (e.g. storage, heating plant, etc.) is not a basement.

BATHROOM – Any room containing a bath or shower and which may also include sanitary accommodation.

CELLAR – See the definition of basement for dwellings.

CLOSABLE OPENING – A ventilation opening which may be opened and closed either manually or automatically.

COMMON SPACE – A space where large numbers of people are expected to gather, such as a shopping mall or cinema/theatre foyer. However, for the purposes of Part F, spaces used solely or principally for circulation (e.g. corridors, lift lobbies, etc.) are *not* regarded as common spaces.

CONTINUOUS OPERATION – A mechanical ventilation device that runs all the time. The airflow rate through such a device may vary.

EQUIVALENT AREA – The area of a sharp-edged orifice through which air would pass at the same volume flow rate as an actual opening when both are subjected to the same applied pressure difference. The equivalent area of a ventilator can only be found by direct measurement of the airflow through it.

EXTRACT VENTILATION – The intermittent or continuous extraction of air, either naturally or mechanically, to the outside from an internal space (or spaces) in order to remove pollutants (e.g. odours, water vapour) and to maintain acceptable pollutant levels in the space itself and also to prevent the spread of pollutants to the rest of the building.

FREE AREA – The geometric open area of a ventilator. This is not the same as the equivalent area. Two ventilators with identical free areas may have significantly different equivalent areas.

GROSS INTERNAL VOLUME – The total internal volume of the heated space, including the volume of all contents, including furniture, internal walls and floors, etc.

HABITABLE ROOM – A room which is used for dwelling purposes but which is not solely a kitchen, utility room, bathroom, cellar or sanitary accommodation.

INFILTRATION – The uncontrolled exchange of air between the inside and outside of a building through unintentional openings in the external envelope.

INTERMITTENT OPERATION – A mechanical ventilation device that does not run all the time. The intermittent operation may be controlled manually or automatically.

MANUAL CONTROL – A ventilation device that is adjusted (e.g. on or off, opened or closed, up or down, etc.) manually by occupants.

MECHANICAL VENTILATION – A ventilation system in which the driving force is provided by fans or any other mechanical devices which require the supply of energy.

MIXED-MODE VENTILATION – A ventilation system which is designed to use both naturally driven and mechanically driven airflows.

NATURAL VENTILATION – A ventilation system in which the airflow is generated by natural forces such as the buoyancy effect or wind pressures.

OCCUPIABLE ROOM – A room in a building other than a dwelling that is occupied by people. However, this does *not* include any of the following:

- bathroom;
- sanitary accommodation;

- utility room;
- rooms or spaces used solely or principally for circulation;
- rooms or spaces used solely or principally for building services plant; and
- rooms or spaces used solely or principally for storage.

PASSIVE STACK VENTILATION (PSV) – A ventilation device consisting of ducts connecting terminals in the ceiling of a room (or at high level) to terminals on or above the roof that extract air by a combination of stack effect and wind pressure effects at roof level.

PERMANENT OPENING – A ventilation opening which is permanently fixed in the open position.

PURGE VENTILATION – Purge ventilation (also known as rapid ventilation) is ventilation of rooms or spaces at a high rate to rapidly dilute high concentrations of pollutants. Such pollutants are usually released by occasional activities (e.g. painting and decorating) or by accidental spillage. Purge ventilation is usually manually controlled and may be provided by natural or mechanical means.

PURPOSE-PROVIDED VENTILATION – That part of the ventilation of a building provided by ventilation devices designed into the building, e.g. background ventilators, PSV, extract fans, mechanical ventilation, air conditioning, etc.

SANITARY ACCOMMODATION – A space containing one or more water closets or urinals. Sanitary accommodation containing more than one cubicle counts as a single space provided there is free circulation of air throughout the space.

STACK EFFECT – The pressure differential between the inside and outside of a building due to differences in air density caused by inside/outside temperature difference.

SURFACE WATER ACTIVITY – This is a measure of the availability of water to micro-organisms. This is found from the ratio of the vapour pressure of the water in the substrate to that of pure water at the same temperature and pressure. In equilibrium conditions, this is equivalent to the relative humidity of the room air.

UTILITY ROOM – A room containing a sink or other feature that may reasonably be expected to produce water vapour in significant quantities.

VENTILATION – The supply and removal of air (naturally or mechanically) to or from a space or spaces in a building. It includes both purpose-provided ventilation and infiltration.

VENTILATION OPENING – Any means of purpose-provided ventilation, permanent or closable, which opens directly to external air, including the openable parts of a window, a louvre, a background ventilator, a door which opens directly to external air, etc.

WET ROOM – A room used for domestic activities (e.g. cooking, clothes washing, bathing) which give rise to significant production of airborne moisture. For the purposes of Part F, sanitary accommodation is regarded as a wet room.

WHOLE BUILDING VENTILATION – Nominally continuous ventilation of rooms or spaces at a relatively low rate to dilute, disperse and remove pollutants and to supply fresh outdoor air. It does not include removal of pollutants by extract ventilation, purge ventilation or infiltration. For an individual dwelling this is the whole dwelling infiltration.

11.3 General principles

The Part F requirement and its associated guidance are based on some general principles regarding ventilation. These principles can be grouped under two main headings, one concerning the purposes of ventilation and the other to do with the means of ventilation.

11.3.1 The purposes of ventilation

It is assumed throughout Part F that outdoor air is relatively uncontaminated, of reasonable quality and with low levels of pollutants. If this is not the case, then it is the responsibility of the designers to take this into account when making appropriate provision.

The main purposes of ventilation may be listed as one or more of the following:

- The removal of CO_2 and the provision of fresh air for occupants to breathe properly.
- The dilution and removal of airborne pollutants, including odours. This includes not only the pollutants generated physiologically by normal human activity but those released from the materials and products used in construction, decoration and furnishing. Activities within a building, especially non-dwellings, may also add pollutants to the indoor air (e.g. photocopiers, printers, combustion products from unflued appliances, etc.).
- Removal of excess moisture in order to control the humidity of the indoor air.
- Removal of excess heat in order to control temperature (see also Part L).
- Provision of air for fuel-burning appliances (see also Part J).

The principal requirements and provisions of Part F do not specify maximum permissible levels for pollutants, it being assumed that if the recommendations for fresh air supply rates and the sizing of ventilation openings are followed, then in normal circumstances indoor pollutant levels will be kept sufficiently low. Nor does the guidance take account of the products of tobacco smoke, it being assumed that either smoking does not occur in the ventilated areas or that separate and specific provision is made where tobacco smoke is likely to occur.

However, as an alternative, Part F does permit the evaluation of ventilation rates based on pollutant concentrations (see section 11.8). This type of approach may become necessary if circumstances are not normal or when it is known that the occupants may be exposed to unacceptable levels of specific pollutants.

11.3.2 Infiltration, purpose-provided ventilation and energy considerations

Infiltration is the ventilation that occurs due to the leakage paths in the building envelope. This leads to uncontrolled heat loss and energy wastage in winter, and so the Part L 2010 requirement sets a maximum value of $10\,m^3/h.m^2$ for the air permeability of the building envelope. In practice, many buildings, both domestic and non-domestic, are being designed and built to a much lower air permeability, typically 2 to $4\,m^3/h.m^2$ or even less. It is worth noting that the air permeability in the reference building specification for the calculation of CO_2 emissions is $5\,m^3/h.m^2$.

However, the background ventilation due to infiltration can contribute to the total ventilation requirement of a building, thus reducing the need for purpose-provided ventilation, especially in dwellings. In recognition of this, the 2010 edition of Part F provides two design options for dwellings. These are:

(1) **The Default Option**. This option applies to any dwelling regardless of its actual air permeability. The guidance assumes that the dwelling has zero air permeability (i.e. it is completely airtight) and thus has no infiltration. The whole of the ventilation requirement must be supplied by purpose-provided ventilation.
(2) **The Alternative Option**. This option applies to a dwelling that has a design air permeability not less than $5\,m^3/h.m^2$ and a measured air permeability not less than $3\,m^3/h.m^2$. It is assumed that such a dwelling will have an average infiltration rate of at least 0.15 ach. This means that the amount of fresh air supplied by purpose-provided ventilation can be less than that supplied for the default option.

Where appropriate, the detailed guidance for dwellings gives tables for both options. Care must be exercised in choosing the correct table from which to select data. However, before selecting the Alternative Option, the designer ought to consider the possibility of future occupier action to reduce infiltration, for example, by additional draught proofing.

Although the conservation of energy is controlled by Part L, there are frequent references throughout Part F to the need to consider the energy consumption implications of the design of ventilation systems. This and other relevant considerations are:

- the importance of controllable ventilation;
- the need for efficient and effective ventilation systems;
- the use of source control to reduce the emission of pollutants at source and/or to extract them close to the source;
- the need, where possible and appropriate, to include energy recovery in a ventilation system;
- the need to minimise noise generation and transmission in ventilation systems; and
- fire precautions.

11.3.3 Ventilation strategies, types and systems

Part F identifies three broad strategies for ventilation:

- extract ventilation;
- whole building ventilation; and
- purge ventilation.

These ventilation strategies may be provided by three broad types of ventilation:

- natural ventilation;
- mechanical ventilation; and
- mixed-mode (or hybrid) ventilation.

All of these terms are defined in section 11.2.

There are many systems and devices which can be used to give effect to a particular choice of ventilation strategy and type. Whichever system is chosen, it is now considered important to ensure that the ventilation is efficient and controllable so that it achieves reasonable indoor air quality without wasting energy. Where appropriate, consideration should be given not only to the energy efficiency of ventilation devices but also to heat recovery devices.

The efficiency of a ventilation system in maintaining air quality can be assessed using the concept of ventilation effectiveness. This concept is a measure of the ability of a ventilation system to deliver fresh supply air to occupants. A ventilation effectiveness of zero means that supply air moves directly to the extract point without ever reaching the occupants, i.e. the system is completely ineffective. A value of 1 means that the supply air is fully mixed with room air as soon as it enters the room and before it reaches the occupants. Ventilation effectiveness values greater than 1 imply that the occupants are receiving supply air before it is fully mixed with room air. However, there is no requirement in Part F 2010 to achieve a specific value of this parameter, and the guidance is based on the assumption that the ventilation effectiveness is 1, i.e. that supply air and room air are always fully mixed. Further details concerning ventilation effectiveness may be found in:

A guide to air change efficiency, IEA Technical Note AIVC 28, February 1990, ISBN 0 946075 43 3;

A guide to contaminant removal effectiveness, IEA Technical Note AIVC 28.2, December 1991, ISBN 0 946075 57 3;

Investigation of ventilation effectiveness, Report no. BD2523, Department for Communities and Local Government, March 2009, ISBN 978 1 4098 1028 5.

11.3.4 Installation of ventilation systems

It is recommended that the installation of ventilation systems in new and existing dwellings is carried out in accordance with a current edition of the *Domestic ventilation compliance guide*:

'*Domestic ventilation compliance guide*', 2010 edition (with 2011 amendments), Department for Communities and Local Government, ISBN 978 1 85946 378 9.

Installation guidance for buildings other than dwellings is found in a variety of publications, especially those produced by CIBSE and BSIRIA. Some specific references relevant to a particular building type or function are given in section 11.7.1.

11.4 Part F: The requirements and their applicability

Section 2 of the approved document provides a formal statement of the requirements, of which there are several. These include the requirement of Part F itself, plus additional requirements deriving from Regulations 39 (information about ventilation), 42 (mechanical ventilation airflow rate testing) and 44 (commissioning of ventilation equipment) of the Building Regulations.

11.4.1 The Part F requirement

The requirement of Part F is in two parts and concerns the **Means of Ventilation:**

F1(1)
There shall be adequate means of ventilation provided for people in the building.
F1(2)
Fixed systems for mechanical ventilation and any associated controls must be commissioned by testing and adjusting as necessary to secure that the objective referred to in F1(1) is met.

Both parts of this requirement apply to all buildings, but with some exceptions. They do not apply to a building or a space within a building:

- into which people do not normally go, or
- which is used solely for storage, or
- which is a garage used solely in connection with a single dwelling.

The additional requirements from the Building Regulations are as follows.

From 39: **Information about ventilation**
Whenever requirement F(1) applies, the person carrying out the work shall not later than five days after the work has been completed give sufficient information to the owner about the building's ventilation system and its maintenance requirements so that the ventilation system can be operated in such a manner as to provide adequate means of ventilation.
From 42: **Mechanical ventilation airflow rate testing**
Whenever requirement F(1) applies to the creation of a new dwelling by building work, the person carrying out the work shall, for the purposes of ensuring compliance with requirement F(1):

(a) ensure that testing of the mechanical ventilation airflow rate is carried out in accordance with a procedure approved by the Secretary of State; and
(b) give notice of the testing to the building control body.

The notice given to the building control body shall:

(a) record the results and the data upon which they are based in a manner approved by the Secretary of State; and
(b) be given to the building control body not later than five days after the final test is carried out.

From 44: **Commissioning**
This regulation applies to building work in relation to which F1(2) imposes a requirement, but does not apply to the provision or extension of any fixed system for mechanical ventilation or any associated controls where testing and adjustment is not possible.

This regulation does not apply to the provision or extension of any fixed building service where testing and adjustment is not possible, or would not affect the energy efficiency of that fixed building service. It is worth noting that this regulation also applies to building work in relation to which L1(b) (requirements for the energy efficiency of fixed building services) imposes a requirement.

Where this regulation applies the person carrying out the work shall, for the purposes of complying with F1(2) or L1(b), give to the building control body a notice confirming that the fixed building services have been commissioned in accordance with a procedure approved by the Secretary of State.
The notice shall be given to the building control body:

(a) not later than the date on which the notice required by regulation 16(4) is required to be given, or
(b) where regulation 16(4) does not apply, not more than 30 days after completion of the work.

11.4.2 Applicability and exemptions

Part F and the guidance given in the approved document are applicable to all new and existing buildings, both domestic and non-domestic. However, there are some exemptions. Part F does not apply to:

(a) buildings controlled under the Manufacture and Storage of Explosives Regulations 2005, the Nuclear Installations Act 1965 or included in the schedule of monuments maintained under section 1 of the Ancient Monuments and Archaeological Areas Act 1979;
(b) detached buildings into which people do not normally go, or go only intermittently for the purposes of inspecting or maintaining fixed plant or machinery, provided that the buildings are a specified distance from buildings into which people normally go;
(c) greenhouses, providing that the principal purpose of the building is not retailing, packing or exhibiting;
(d) agricultural buildings, provided that no part of the building is used as a dwelling, that the building is spaced at least one and one-half times its height from a building containing sleeping accommodation and that there is a fire exit no more than 30 m distant from any point in the building (this exemption does *not* apply to agricultural buildings used principally for retailing, packing or exhibiting);
(e) temporary buildings not intended to remain in place for more than 28 days;
(f) ancillary buildings used for the disposal of buildings or building plots on site; buildings on the site of construction or civil engineering works for use only during the course of those works and containing no sleeping accommodation; and those buildings on the site of mines and quarries which do not contain dwellings, nor are used as offices or showrooms;

(g) detached single-storey buildings of less than 30 m^2 floor area and containing no sleeping accommodation, which are either constructed substantially of non-combustible material or are sited at least 1 m from the boundary of their curtilage;
(h) detached buildings of less than 30 m^2 floor area, designed and intended to be used as shelters from nuclear, chemical or conventional weapons and used for no other purpose, provided the excavation for the building is at least 1 m plus the depth of excavation from any exposed structure;
(i) detached buildings of less than 15 m^2 floor area containing no sleeping accommodation; and
(j) extensions of buildings at ground level of less than 30 m^2 floor area formed by the addition of a conservatory, porch, covered yard, covered way or a carport open on at least two sides.

Historic and traditional buildings, although not granted full or even partial exemption, often require special consideration. Such buildings normally include:

- listed buildings;
- buildings situated in conservation areas;
- buildings of architectural and historical interest and which are referred to as a material consideration in a local authority development plan;
- buildings of architectural and historical interest within national parks, areas of outstanding natural beauty, registered historic parks and gardens, registered battlefields, the curtilage of scheduled ancient monuments and world heritage sites; and
- buildings of traditional construction with permeable fabric that both absorbs and readily allows the evaporation of moisture.

Work on a historic or traditional building should aim to provide adequate ventilation as far as is reasonable and possible. Extensions should, in general, comply with Part F. However, before embarking upon any work on these types of buildings, it is important to:

- consult with the building control body;
- obtain the views of the local authority conservation officer, particularly where there are planning permission and/or listed building issues; and
- obtain advice from recognised authorities such as English Heritage (see Chapter 16, section 16.4.5 for further details).

11.4.3 Notification of work

Notifiable ventilation work covered by the ventilation requirements should normally be notified to a building control body in advance. However, advance notification is not necessary in three circumstances:

(1) *Competent person self-certification scheme* Where work is carried out by a person registered with a competent person scheme, prior notification is not necessary, but,

within 30 days of completion of the work, the building control body must be notified of completion, and a certificate confirming that the work fully complies with all applicable building regulation requirements must be given to the building occupier. Local authority enforcement and inspection powers remain unaffected but would normally be used only in response to a complaint.

(2) *Emergency repairs* A delay in making a repair is not necessary if advance notification to the building control body is not practicable. However, any work must still comply, and the building control body be notified as soon as possible. If the work is carried out by a competent person, then notification as described above applies.

(3) *Minor works* Work of a minor nature (see the schedule of non-notifiable work, Schedule 4 to the Building Regulations 2010) must still comply but need not be notified to the building control body. Examples include:

- replacement of parts, or the addition of an output and/or control device where testing and adjustment is not possible or would not affect the system's energy efficiency, and
- provision of a self-contained mechanical ventilation or air-conditioning appliance (provided that any electrical work is exempt) where testing and adjustment is not possible or would not affect its energy efficiency and where the appliance is not installed in a room containing an open-flued combustion appliance.

Further information on the competent person schemes and schedule 3 to the Building Regulations are given in Chapter 16.

11.4.4 Other considerations

These are:

- material change of use;
- live-work units;
- mixed use developments;
- independent certification schemes;
- standards and technical specifications; and
- the Workplace (Health, Safety and Welfare) Regulations 1992.

11.5 The ventilation of new dwellings

There are four main methods of complying with the requirement. These are:

- by following the guidance set out in section 11.5.1 and by providing the minimum ventilation rates in Tables 11.1 and 11.2, or
- for dwellings without basements, by following the specifications for one of the systems described in section 11.5.2, or
- for dwellings with basements, by following the guidance set out in section 11.5.6, or
- by demonstrating that the chosen ventilation system will meet the criteria set out in sections 11.8.1 and 11.8.2 for performance-based ventilation.

Table 11.1 Minimum extract ventilation rates.

Room	Intermittent extract systems	Continuous extract systems	
	Minimum rate, l/s	Minimum high rate, l/s	Minimum low rate, l/s
Kitchen, sited adjacent to hob	30	13	The total extract rate (room plus rest of dwelling) must be at least the whole building ventilation rate as in Table 11.2
Kitchen, not sited adjacent to hob	60	13	
Utility room	30	8	
Bathroom	15	8	
Sanitary accommodation	6	6	

Table 11.2 Minimum whole building ventilation rates.

	Number of bedrooms in dwelling				
	1	2	3	4	5
Whole building ventilation rate, l/s	13	17	21	25	29

Notes:
1. In addition, the minimum ventilation should be not less than 0.3 l/s per m^2 of the total internal floor area (i.e. ground floor plus upper floors).
2. These minimum rates are based on two occupants in the main bedroom and a single occupant in all other bedrooms. If a greater occupancy level is expected, add 4 l/s per additional occupant.

11.5.1 Compliance using ventilation rates

It is necessary to provide all of the following:

- extract ventilation to outside in each kitchen, utility room, bathroom and room with sanitary accommodation, with minimum airflow rates as specified in Table 11.1;
- minimum whole building ventilation rates for the supply of air to the habitable rooms as shown in Table 11.2; and
- also in each habitable room, purge ventilation capable of extracting a minimum of 4 ach per room directly to outside, normally by means of openable windows or doors, otherwise by means of a mechanical extract system.

The airflow rates in Tables 11.1 and 11.2 are for the performance of the complete installation. The performance of ventilation devices (including associated components and ducting for fans) should be tested according to the appropriate standards, and all natural and mechanical systems should be fully commissioned (see section 11.6.5).

11.5.2 Compliance using system specification for dwellings without basements

In this method, four possible ventilation systems are described. All four systems have been sized for winter conditions. For the extra ventilation that may be necessary in warm weather, it is assumed that purge ventilation (openable windows) can be used. This method has five steps:

Step 1 – Select one out of the four ventilation systems described below, and comply with the minimum system specifications in the tables relevant to each system.
Step 2 – For all four systems, make at least minimum provision for purge ventilation, as described in section 11.5.3.
Step 3 – Choose at least the minimum areas for background ventilators appropriate to the chosen ventilation system, and select acceptable ventilator locations as described in section 11.5.4.
Step 4 – Follow the guidance on ventilation controls in section 11.5.9.
Step 5 – Follow the guidance on performance test methods, see section 11.6.5.

SYSTEM 1: Background ventilators and intermittent extract fans

This system is illustrated in Fig. 11.1. It is based on a minimum provision of background ventilators and minimum intermittent extract rates.

Background ventilators
For the rooms in the dwelling, the basic provision is for a background ventilator in every room with an external wall, with every habitable room having at least 5000 mm^2 equivalent

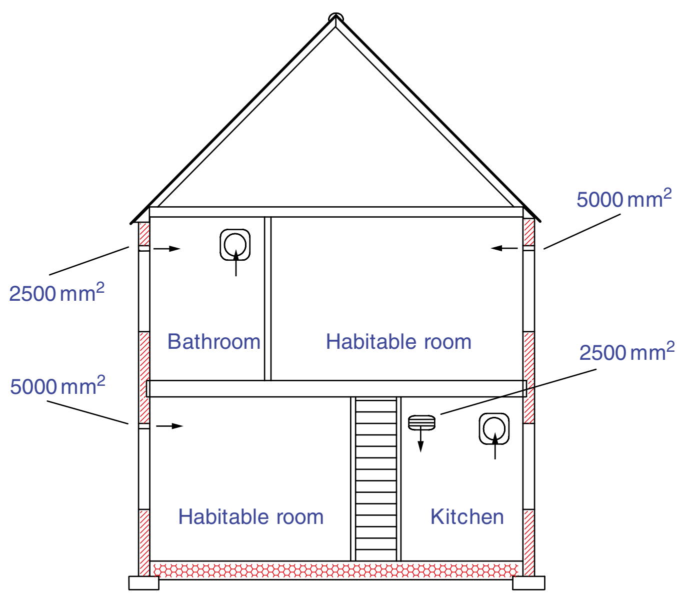


Fig. 11.1 System 1 – Background ventilators and intermittent extract fans.

area of ventilator and each wet room having at least 2500 mm^2 equivalent area of ventilator. For habitable rooms with no external wall, see section 11.5.7. For wet rooms with no external wall, see section 11.5.3 on purge ventilation and section 11.5.5 on controls.

For the whole dwelling, the minimum total equivalent area of background ventilators depends on whether the dwelling is being treated according to the default option or the alternative option, as described in section 11.3.2. The minimum is derived as follows:

- Dwellings with more than one exposed façade, and where not more than 69% of the total equivalent area is designed to be located on any one façade:
  (a) for multi-storey dwellings, and single-storey dwellings *more than* four storeys above ground level, use the ventilator areas in Table 11.3a or 11.3b unchanged, and
  (b) for single-storey dwellings *up to* four storeys above ground level, add an extra 10,000 mm^2 to the total equivalent ventilator area derived from Table 11.3a or 11.3b, and share the additional area between several rooms.
- Dwellings with only a single exposed façade, or where at least 70% of the equivalent ventilator area is designed to be on the same façade. Cross ventilation is not possible in this type of dwelling with this type of ventilation system. An alternative is required, as shown in Fig. 11.2. For all single- and multi-storey dwellings of this type, background ventilators should be located at both high and low positions in the exposed façade as follows:
  - high level ventilator at least 1.7 m above floor level;
  - low level ventilator at least 1.0 m below the high level ventilator;
  - total equivalent area at the high level as given in Table 11.3a or 11.3b;
  - in addition, the same total equivalent area at the low level; and
  - arrange the habitable rooms to be on the exposed façade, and ensure that these rooms have a maximum depth of 6 m.

Table 11.3a Default option – guidance for a dwelling with any air permeability figure.

	Minimum total equivalent ventilator area, mm^2				
	Number of bedrooms				
Total floor area, m^2	**1**	**2**	**3**	**4**	**5**
Up to 50	35,000	40,000	50,000	60,000	65,000
51–60	35,000	40,000	50,000	60,000	65,000
61–70	45,000	45,000	50,000	60,000	65,000
71–80	50,000	50,000	50,000	60,000	65,000
81–90	55,000	60,000	60,000	60,000	65,000
91–100	65,000	65,000	65,000	65,000	65,000
Greater than 100	Add 7000 mm^2 for every extra 10 m^2 floor area				

See notes attached to Table 11.3b.

Table 11.3b Alternative option – guidance for a dwelling with a design air permeability greater than 5 $m^3/h.m^2$ at 50 Pa and a measured air permeability greater than 3 $m^3/h.m^2$.

	Minimum total equivalent ventilator area, mm²				
	Number of bedrooms				
Total floor area, m²	**1**	**2**	**3**	**4**	**5**
Up to 50	25,000	35,000	45,000	45,000	55,000
51–60	25,000	30,000	40,000	45,000	55,000
61–70	30,000	30,000	30,000	45,000	55,000
71–80	35,000	35,000	35,000	45,000	55,000
81–90	40,000	40,000	40,000	45,000	55,000
91–100	45,000	45,000	45,000	45,000	55,000
Greater than 100	Add 5000 mm² for every extra 10 m² floor area				

Notes to Tables 11.3a and 11.3b

(a) The equivalent area of a background ventilator should be determined at 1 Pa pressure difference using an approved test method.

(b) The tables assume two occupants in the main bedroom and one in all other bedrooms. For each extra occupant, use the value for one extra bedroom. For more than five bedrooms, add 10,000 mm² per bedroom.

(c) The areas given in these tables are the total for the whole dwelling.

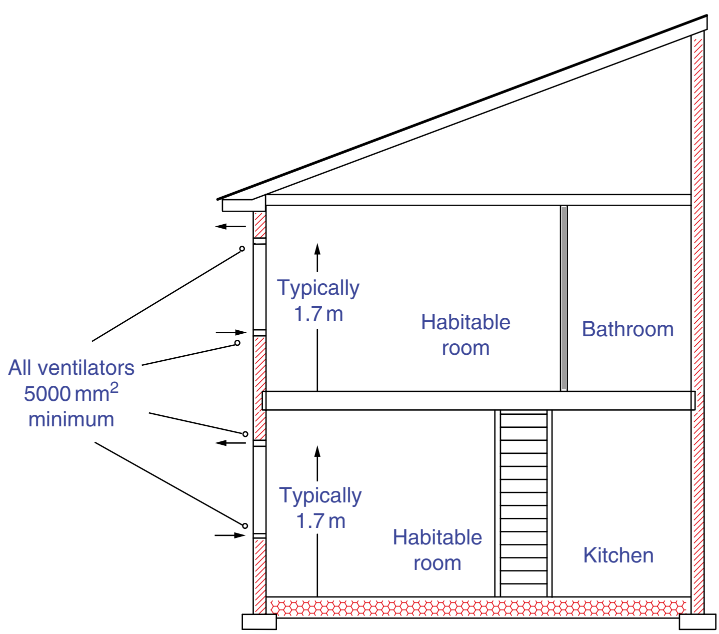


Fig. 11.2 Single-sided ventilation.

Intermittent extract

The minimum extract rates are as follows:

- Intermittent extract rates are given in Table 11.1 for sanitary accommodation only; purge ventilation provisions (windows) as given in section 11.5.3 can be used provided security is not an issue.
- Instead of a conventional intermittent fan, a continuously running single room heat recovery ventilator could be used in a wet room. It should use the minimum high rate in Table 11.1 and 50% of this rate as the minimum low rate. No background ventilator is required in the same room as a single room heat recovery ventilator. Also, the total equivalent background ventilator area can be reduced by 2500 mm^2 for each room containing a single room heat recovery ventilator. Continuously running fans should be quiet so as not to discourage their use by occupants.
- Intermittent extract fans should be installed in each wet room.
- Cooker hoods should, except where the hood has specific installation requirements to the contrary, be between 650 mm and 750 mm above the hob surface.
- Intermittent extract fans other than cooker hoods should be installed as high as possible, preferably less than 400 mm below the ceiling.
- Where fans and background ventilators are installed in the same room they should be at least 500 mm apart.

SYSTEM 2: Passive stack ventilation (PSV)

PSV may not be suitable if the proposed dwelling is near a much taller building. If the adjacent building is more than 50% taller than the dwelling, the distance between the two buildings must be at least five times the difference in their overall heights. Otherwise PSV should not be used. The PSV system is shown in Fig. 11.3. It is necessary to determine the size and location of ducts and background ventilators.

The minimum internal dimensions of the stack ducts should be taken from either column 1 or column 2 of Table 11.4.

The PSV duct design must also take account of the following:

- For a dwelling with only a single exposed façade, habitable rooms should be on the exposed façade so as to achieve their required ventilation provision.
- For sanitary accommodation only, as an alternative, the purge ventilation provisions given in section 11.5.3 can be used when security is not an issue.
- An open-flued appliance may provide sufficient extract ventilation for the room in which it is located when in operation and can be arranged to provide sufficient ventilation when not firing. For instance, the appliance could replace the PSV in that room, and the provisions would be adequate if:
  (i) the solid fuel appliance is a primary source of heating, cooking or hot water production, or
  (ii) the open-flued appliance has a flue of free area at least equivalent to a 125 mm diameter duct and the appliance's combustion air inlet and dilution inlet are permanently open, so that either there is a path with no control dampers which

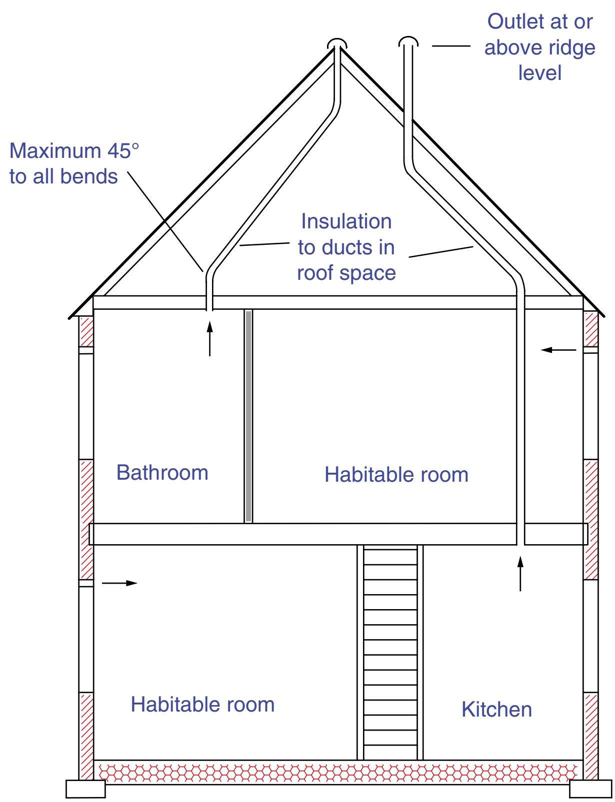


Fig. 11.3 System 2 – Passive stack ventilation.

Table 11.4 Minimum dimensions for passive stack ventilators.

Room	Internal duct diameter, mm	Internal cross-sectional area, mm^2
Kitchen	125	12,000
Utility room	125	12,000
Bathroom	125	12,000
Sanitary accommodation	125	12,000
Ceiling extract grilles	Free area not less than the duct cross-sectional area when in the fully open position	

could block the flow or the ventilation path can be left open when the appliance is not in use. Note that PSV, in common with other extract devices, depressurises the internal space and so also creates the danger of spillage into the dwelling from open flues.

If an open-flued appliance is installed in a room, refer to Approved Document J for air supply requirements.

The dwelling will require background ventilators to provide inlet air to replace the air extracted via the stacks. The required equivalent area of the background ventilators is found in three stages as follows:

Stage 1 – According to the air permeability of the dwelling, determine from Table 11.3a or Table 11.3b the equivalent ventilator area for the dwelling.
Stage 2 – Make an allowance for the total airflow through all PSV units. As an approximation under normal conditions, it may be assumed that each PSV unit provides an equivalent ventilator area of 3000 mm^2.
Stage 3 – The total equivalent area is either:
- the sum of the values found in stages 1 and 2, or
- the total cross-sectional area of all the PSV ducts

whichever is the greater.

See sections 11.5.4 and 11.9 for further details of the design and installation of PSV.

SYSTEM 3: Continuous mechanical extract (MEV)

This is illustrated in Fig. 11.4. The procedure is in three stages:

Stage 1 – Determine the whole building ventilation rate from Table 11.2. Note that no allowance is made for infiltration because the extract system lowers the pressure in the dwelling and limits the exit of air through the building fabric.

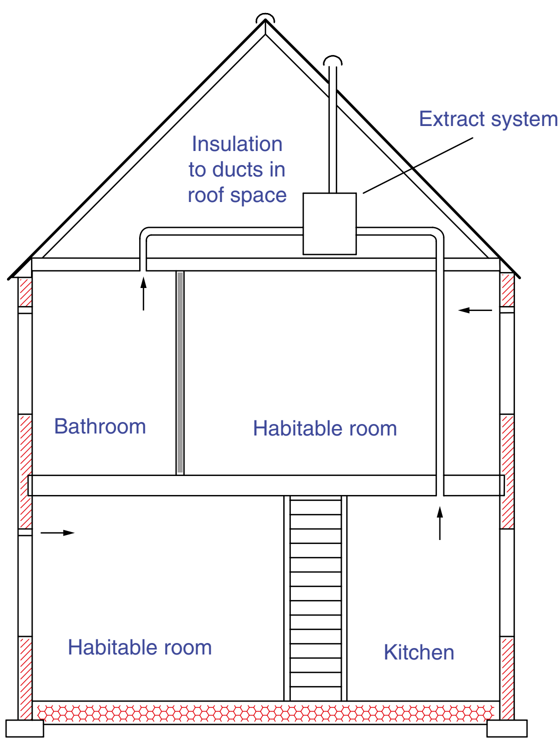


Fig. 11.4 System 3 – Continuous mechanical extract.

Stage 2 – Calculate the whole dwelling air extract rate at maximum operation by summing the individual room rates for 'minimum high rate' from Table 11.1. For sanitary accommodation only, as an alternative, the purge ventilation provisions given in section 11.5.3 can be used where security is not an issue. In this case, the 'minimum high rate' for sanitary accommodation should be omitted from this stage of the calculation.

Stage 3 – The required extract rates are as follows:

- The maximum whole dwelling extract ventilation rate (i.e. the boost rate) should be at least the greater of stage 1 and stage 2. The maximum individual room extract rates should be at least the 'minimum high rate' given in Table 11.1.
- The minimum whole dwelling extract ventilation rate should be at least the whole dwelling ventilation rate in stage 1.

This system could comprise either a central extract system or individual room fans or a combination of both. In all cases, fans should operate quietly at their minimum rate so as not to discourage their use. To ensure that the system performs to specification, extract terminals should be located to minimise wind effects, especially on the façade facing the prevailing wind. Possible solutions include ducting to a sheltered façade or installing constant volume flow rate units. Further guidance may be found at www.energysavingtrust.org.uk.

If a single room heat recovery ventilator (SRHRV) is used to ventilate a habitable room, with the rest of the dwelling provided with continuous mechanical extract, the airflow rates are determined as follows:

- Determine the whole building ventilation rate from Table 11.2.
- Calculate the room supply rate required for the SRHRV from

$$\text{SRHRV supply rate} = \frac{\text{Whole building vent rate} \times \text{Room volume}}{\text{Total volume of all habitable rooms}}$$

Then follow stages 1 to 3 for sizing the mechanical extract for the rest of the dwelling, except that in stage 1 the supply rate of the SRHRV should be subtracted from the value given in Table 11.2.

For a dwelling with both:

- a design air permeability greater than $5\,m^3/h.m^2$ at 50 Pa (i.e. the Alternative Option), and
- a measured air permeability (or that of a similar dwelling that has been measured) greater than $3\,m^3/h.m^2$ at 50 Pa,

background ventilators are not normally necessary.

For all other dwellings, including dwellings with any design air permeability (i.e. the Default Option), background ventilators to provide make-up air are needed. For this purpose, every room should have a background ventilator, manually or automatically controllable, with a minimum equivalent of $2500\,mm^2$, except for a wet room from which air is extracted. Where this approach causes difficulties (e.g. on a noisy site), specialist advice may be required.

SYSTEM 4: Continuous mechanical supply and extract with heat recovery (MVHR)

This is illustrated in Fig. 11.5. The procedure is in three stages:

Stage 1a – For a dwelling with any design air permeability (i.e. the Default Option), determine the whole building ventilation rate from Table 11.2.

Stage 1b – For a dwelling using the 'alternative option' and with a design air permeability greater than 5 $m^3/h.m^2$ at 50 Pa, determine the whole building ventilation rate from Table 11.2, and then allow for infiltration by subtracting 0.04 times the gross internal volume (in m^3) of the dwelling heated space.

Stage 2 – Calculate the whole dwelling air extract rate at maximum operation by summing the individual room rates for 'minimum high rate' from Table 11.1. For sanitary accommodation only, as an alternative, the purge ventilation provisions given in section 11.5.3 can be used where security is not an issue. In this case, the 'minimum high rate' for sanitary accommodation should be omitted from this stage of the calculation.

Stage 3 – The required airflow rates are as follows:

- The maximum whole dwelling extract ventilation rate (i.e. the boost rate) should be at least the greater of stage 1 and stage 2. The maximum individual room extract rates should be at least the 'minimum high rate' given in Table 11.1.
- The minimum air supply rate should be at least the whole dwelling ventilation rate found in stage 1.

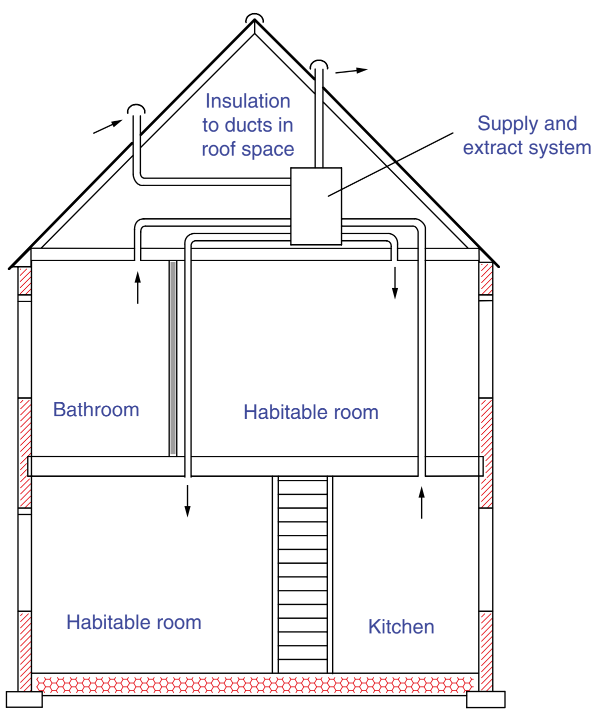


Fig. 11.5 System 4 – Continuous mechanical supply and extract with heat recovery.

11.5.3 Purge ventilation provisions for all four ventilation systems

For each habitable room with an external wall, provide windows and doors as follows:

WINDOWS:

- For a hinged or pivot window that opens 30° or more, or for sliding sash windows, the openable area should be at least 1/20 of the floor area of the room.
- For a hinged or pivot window that opens 15° or more but less than 30°, the openable area should be at least 1/10 of the floor area of the room.
- If a hinged or pivot window opens less than 15°, it cannot be included as a means of purge ventilation.
- If there is more than one openable window in a room, the required area (i.e. 1/20 or 1/10 of the floor area) is calculated according to the opening angle of the largest window. The openable area is then the sum of the areas of the openable parts of all windows in the room, whatever their opening angle.
- Refer to approved document B for the sizing of escape windows, and use the larger of the AD B or AD F provisions.
- The method of measuring the openable area of windows is illustrated in Fig. 11.6.

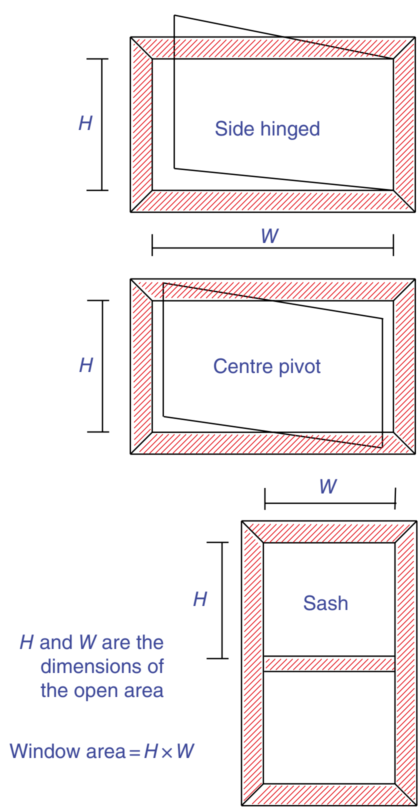


Fig. 11.6 Purge ventilation – calculation of opening area.

EXTERNAL DOORS, INCLUDING PATIO DOORS:

- For an external door, the height × width of the openable part should be at least 1/20 of the floor area of the room.
- If the room contains more than one external door, the areas of all openable areas may be added together.
- If the room contains a combination of at least one external door and at least one openable window, the areas of all the opening parts may be added to achieve at least 1/20 of the floor area of the room.

For each wet room with an external wall, install an openable window (no minimum size).

For each habitable room without an external wall, see sections 11.5.7 and 11.5.8.

For each wet room without an external wall, the extract provided by the installed ventilation system will be adequate, though purging may take longer than other rooms.

Further guidance on purging arrangements is given in:

'*Code of practice for ventilation principles and designing for natural ventilation*', BS 5925:1991 (AMD 8930, 1995).

11.5.4 Location of all ventilation devices in rooms

Background ventilators

This includes trickle ventilators. If background ventilators are located above a window, they may be mounted either in the frame above the glass or directly through the wall. An openable window with a night latch position is not recommended. The general recommendations for the location of background ventilators depend on the chosen ventilation system as follows:

- **System 1**: Locate in all rooms with an external wall and with dimensions such that they have a minimum equivalent area of:
  - 5000 mm^2 in all habitable rooms, and
  - 2500 mm^2 in all wet rooms

  and ensure that the total equivalent area is not less than that given in Table 11.3a or 11.3b.

  For habitable rooms without an external wall, follow the appropriate guidance in section 11.5.7 or 11.5.8.

  For wet rooms without an external wall, follow the guidance for mechanical intermittent extract in section 11.5.5.

  Where background ventilators and intermittent extract fans are fitted in the same room, they should be a minimum of 0.5 m apart.
- **System 2**: Locate in all rooms with an external wall, except within the same room as a passive stack extract ventilator, with dimensions such that they have a minimum equivalent area of:
  - 5000 mm^2 in all habitable rooms, and
  - 2500 mm^2 in all wet rooms

  and ensure that the required total equivalent area is achieved, as at stage 3 in section 'SYSTEM 2: Passive stack ventilation (PSV)'. Do not forget to provide an air supply to an open-flued combustion appliance.

- **System 3**: Located in each habitable room. See the description of system 3 in section 'SYSTEM 3: Continuous mechanical extract (MEV)'.
- **System 4**: No background ventilators.

In addition, the following should be observed:

- **Systems 1 and 2**: If the dwelling has more than one exposed façade, airflow should be maximised by encouraging cross ventilation. To do this, similar equivalent areas of background ventilator should be located on opposite (or if that is not possible, adjacent) façades.
- **Systems 1, 2 and 3:** Locate so as to avoid draughts, typically by placing them at least 1.7 m above floor level. For system 1, if the dwelling has a single exposed façade, the low ventilators should be at least 1.0 m below the upper ventilator (see section 'SYSTEM 1: Background ventilators and intermittent extract fans').

For systems 1 and 2 the background ventilators have been sized for the winter period. Additional ventilation may be needed during warm weather because stack driving pressures are reduced. The provisions for purge ventilation (e.g. windows) may be used. However, for dwellings designed to a high airtightness standard, additional background ventilation may be necessary, or system 3 or 4 may be more appropriate. Specialist advice may be required.

Passive stack ventilation

- PSV extract terminals should be located in the ceiling or on a wall less than 400 mm below the ceiling. There should be no background ventilators within the same room as a PSV extract terminal.
- The roof terminal design should be as specified by the manufacturer, with particular attention being paid to the height of the terminal and to the effects of wind on its performance (see also section 11.9).
- Where PSV is provided in a dwelling with a protected stairway, precautions may be necessary to avoid the possibility of the system allowing smoke or fire to spread into the stairway (see also Approved Document B).

Mechanical (intermittent and continuous) extract or supply

- Cooker hoods should be 650 mm to 750 mm above the hob surface (or follow manufacturer's instructions).
- Mechanical extract terminals and extract fans should be placed as high as practicable and preferably less than 400 mm below the ceiling.
- Mechanical supply terminals should be located and directed so as to avoid draughts.
- Where ducts or similar services are provided in a dwelling with a protected stairway, precautions may be necessary to avoid the possibility of the system allowing smoke or fire to spread into the stairway (see also Approved Document B).
- Fans or terminals should be located in the following rooms:
  - **System 1:** Extract fans should be installed in each wet room.
  - **System 3:** Extract should be from each wet room.
  - **System 4:** Extract should be from each wet room. In addition, air should normally be supplied to each habitable room. The total supply airflow should usually be distributed in proportion to the habitable room volumes. Recirculation by the system of moist air from wet rooms to habitable rooms should be avoided.

Purge ventilation
The location of ventilation devices is not critical.

Air transfer between rooms
To ensure good transfer of air throughout the dwelling, there should be an undercut of minimum area 7600 mm^2 in all internal doors above floor finish. This corresponds to an undercut of 10 mm above the floor finish on a 760 mm wide door. If the floor finish has not been fitted, the undercut should be 20 mm on a 760 mm wide door.

11.5.5 Controls for ventilation devices

Background ventilator controls
These can be controlled manually or automatically. If trickle ventilators are fitted, then:

- they should have a flap to shut off the ventilation in adverse weather conditions;
- if provided with automatic control, they should have a flap with manual override to allow the occupant to fully close or fully open the ventilator; and
- if provided with an automatic control which is pressure difference regulated, they should only be provided with a manual close option.

Openable windows with a night latch position are not recommended as a means of providing background ventilation.

Passive stack ventilation
This system should be able to operate without occupant intervention. All devices should normally be manually controlled, including extract fans for purge ventilation if they have been installed.

Mechanical intermittent extract
Intermittent extract can be controlled:

- manually, or
- automatically, or
- by a combination of manual and automatic control.

Any automatic control should have a manual override to allow the occupant to turn it on. In kitchens, any automatic control must provide sufficient flow during cooking with fossil fuel to avoid build-up of combustion products. In any room without an openable window, the extract fan must have at least a 15 minute overrun. In a room with no natural light, the extract fan could be controlled from the main room light switch. Sensors for operating automatic controls could be based on:

- humidity or moisture, but not in sanitary accommodation where odour is the main pollutant;
- occupancy/usage; and
- pollutant release.

Mechanical continuous supply and extract

This system should be set up to operate without occupant intervention. Nevertheless it may have manual or automatic controls to allow the occupant to select a 'boost' rate. Any manual boost control should be located in or close to the space being served (this is because a centrally located automatic control may result in the controlled device, e.g. a fan, being left in an inappropriate mode of operation). The control system must always allow at least the minimum whole building ventilation rate as given in Table 11.2. In kitchens, any automatic control must have manual override to allow the occupant to turn the extract on. For sensors, see mechanical intermittent extract above.

Purge ventilation

In dwellings, purge ventilation should be manually operated.

Accessibility of controls

Where manual controls are provided, they should be within reasonable reach of occupants. If necessary, pull cords, operating rods, etc. may be used to achieve this. Compliance with Requirement N3 'Safe opening and closing of windows etc.' which for the purposes of Part F also applies to dwellings is required. The relevant guidance in approved document N should be followed.

11.5.6 Compliance using system specification for dwellings with basements

Guidance depends on whether or not the basement is connected to the dwelling by a large permanent opening. In this context, a large permanent opening would typically be an open stairway.

A basement connected by a large permanent opening to the rest of the dwelling above ground

Follow the guidance in sections 11.5.2 to 11.5.9 for a multi-storey dwelling without a basement. If the basement has only a single exposed façade while the rest of the dwelling has more than one exposed façade, systems 3 and 4 are preferred. Systems 1 or 2 may be possible but should only be used with expert advice.

A basement that is NOT connected by a large permanent opening to the rest of the dwelling above ground

Consider the above ground dwelling and the below ground basement separately:

- For the part of the dwelling above ground, ventilate as for a dwelling without a basement, sections 11.5.3 to 11.5.9. If this part has no bedrooms, assume it has one bedroom when determining ventilation rates from Tables 11.1 and 11.2 and equivalent areas from Table 11.3a or 11.3b.
- For the basement, ventilate as for a single-storey dwelling, sections 11.5.3 to 11.5.9. If this basement has no bedrooms, assume it has one bedroom when determining ventilation rates from Tables 11.1 and 11.2 and equivalent areas from Table 11.3a or Table 11.3b. A ventilation system which depends wholly or in part on natural ventilation is unlikely to be appropriate.

For a dwelling that comprises a basement only, use the guidance for a single-storey dwelling above ground. However, a ventilation system which depends wholly or in part on natural ventilation is unlikely to be appropriate. If the dwelling is wholly below ground level and is more than one storey, the guidance given in AD F cannot be used, and the ventilation system must be specially designed.

11.5.7 Ventilation of a habitable room through another room

A habitable room not containing openable windows may be ventilated through another habitable room provided there is adequate provision for purge ventilation and background ventilation for both rooms. This requires all three of the following:

- a permanent opening (or openings) between the two rooms of minimum area 1/10 or 1/20 of the total floor area of both rooms, calculated according to the rules for purge ventilation in section 11.5.3;
- one or more ventilation openings in the outer room of minimum area 1/10 or 1/20 of the total floor area of both rooms, also calculated according to the rules for purge ventilation in section 11.5.3; and
- a background ventilator between the outer room and the outside of at least 8000 mm^2 equivalent area (see Fig. 11.7).

11.5.8 Ventilation of a habitable room through a conservatory

A habitable room not containing openable windows may be ventilated through a conservatory provided there is adequate provision for purge ventilation and background ventilation for both rooms. This requires all four of the following:

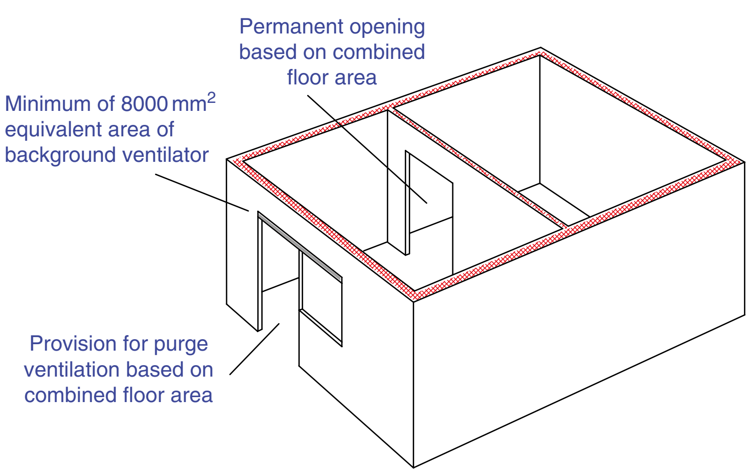


Fig. 11.7 Ventilation of an interior room through a habitable room.

- an opening (or openings), which must be closable, between the room and the conservatory of minimum area 1/10 or 1/20 of the total floor area of both spaces, calculated according to the rules for purge ventilation in section 11.5.3;
- a background ventilator between the room and the conservatory of at least 8000 mm^2 equivalent area;
- one or more ventilation openings in the conservatory of minimum area 1/10 or 1/20 of the total floor area of both rooms, also calculated according to the rules for purge ventilation in section 11.5.3; and
- a background ventilator between the conservatory and the outside of at least 8000 mm^2 equivalent area (see Fig. 11.8).

11.5.9 Performance test methods for dwellings

Test methods for dwellings are to be found in the following publications. It should be noted that most of these refer to the testing of individual components rather than the complete system in which that component is installed.

BS EN 13141-1:2004 '*Ventilation for buildings. Performance testing of components/products for residential ventilation. Externally and internally mounted air transfer devices*'.

BS EN 13141-2:2004 '*Ventilation for buildings. Performance testing of components/products for residential ventilation. Exhaust and supply air terminal devices*'.

BS EN 13141-3:2004 '*Ventilation for buildings. Performance testing of components/products for residential ventilation. Range hoods for residential use*'.

BS EN 13141-4:2004 '*Ventilation for buildings. Performance testing of components/products for residential ventilation. Fans used in residential ventilation systems*'.

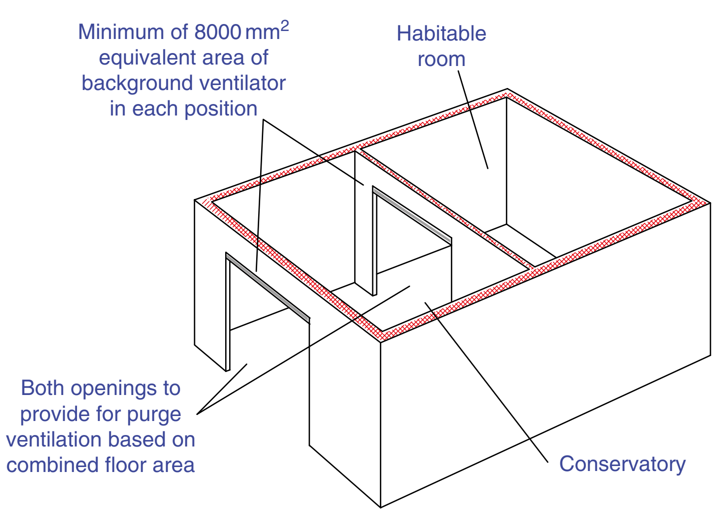


Fig. 11.8 Ventilation of an interior room through a conservatory.

BS EN 13141-5:2004 '*Ventilation for buildings. Performance testing of components/products for residential ventilation. Cowls and roof outlet terminal devices*'.

BS EN 13141-6:2004 '*Ventilation for buildings. Performance testing of components/products for residential ventilation. Exhaust ventilation system packages used in a single dwelling*'.

BS EN 13141-7:2004 '*Ventilation for buildings. Performance testing of components/products for residential ventilation. Performance testing of mechanical supply and exhaust ventilation units (including heat recovery) for mechanical ventilation systems intended for single family dwellings*'.

BS EN 13141-8:2006 '*Ventilation for buildings. Performance testing of components/products for residential ventilation. Performance testing of unducted mechanical supply and exhaust ventilation units (including heat recovery) for mechanical ventilation systems intended for a single room*'.

BS EN 13141-9:2008 '*Ventilation for buildings. Performance testing of components/products for residential ventilation. Externally mounted humidity controlled air transfer device*'.

BS EN 13141-10:2008 '*Ventilation for buildings. Performance testing of components/products for residential ventilation. Humidity controlled extract air terminal device*'.

'*Domestic ventilation compliance guide – 2010 edition*', ISBN 978 1 85946 378 9. Available at www.planningportal.gov.uk/approveddocuments.

'*Performance testing of products for residential ventilation – Central exhaust ventilation system packages used in a single dwelling – July 2007 version*', Building Research Establishment. Available at www.sap-appendixq.org.uk.

The most relevant document (or part of a document) for the testing of a specific component or system is shown in Table 11.5.

Table 11.5 Sources of performance test methods.

Component or system to be tested	Most relevant text
Intermittent extract fans	BS EN 13141-4, clause 4
Range hoods	BS EN 13141-3, clause 4
Background ventilators (non-RH controlled)	BS EN 13141-1, sub-clauses 4.1 and 4.2
Continuous mechanical extract (MEV) systems	BS EN 13141-6, clause 4, and '*Product testing of products for residential ventilation*'
Continuous supply and extract ventilation (MHVR) units	BS EN 13141-7, clause 6
Single room heat recovery ventilators (SRHRV)	BS EN 13141-8, sub-clauses 6.1, 6.2.1 and 6.2.2, and also sub-clause 3.2
Passive stack ventilators	'*Domestic ventilation compliance guide*'
Installation and testing, all systems	'*Domestic ventilation compliance guide*'

11.5.10 Example calculations

Appendix C of Approved Document F gives detailed example calculations for dwellings.

11.6 The ventilation of new buildings other than dwellings

The guidance in the approved document is grouped into:

- offices;
- car parks; and
- all other building types.

However, compared to dwellings, there is relatively little specific guidance in the approved document itself. Most of the detailed guidance is to be found in other publications to which Approved Document refers.

11.6.1 General requirements for all building types

The ventilation provision in all buildings should take account of:

- cooling;
- protection of fresh air supplies;
- the danger of *legionella* contamination;
- the health implications of recirculated air; and
- access for maintenance.

Cooling
The ventilation provisions of AD F do not include an allowance for cooling to remove excess heat. This is covered in AD L2A.

Protection of fresh air supplies
Provision should be made to protect the fresh air entering a ventilation system from harmful contaminants (see section 11.10).

Legionella
Measures for avoiding the danger of legionella contamination are given in:

'*Legionnaires' disease – The control of legionella bacteria in water systems*' (paragraphs 79 to 144), HSE Approved Code of Practice and Guidance, ISBN 9780717617722.
'*Minimising the risk of Legionnaires' disease*', CIBSE TM 13.
BSRIA Applications Guides AG19/2000, AG20/2000, and AG21/2000.

Recirculated air
Information and guidance is given in:
L24 Workplace (Health, Safety and Welfare) Regulations 1992, '*Approved code of practice and guidance*' (paragraph 32) HSE 2001, ISBN 9780717604135.

Access for maintenance

In order to allow for essential maintenance, it is necessary to provide:

- access for the purpose of replacing filters, fans and coils;
- access points for cleaning ductwork; and
- adequate space in a central plant room for the maintenance of plant.

The minimum space requirements in a central plant room are:

- for passageways, 2 m high by 0.6 m wide, and
- for crawl spaces, 1.4 m high by 1.1 m wide, with equipment requiring attention ideally not less than 0.69 m above floor level.

Dimensions greater than these minima may be necessary to allow the opening of access doors. Further guidance may be found in:

'*Space requirements for plant access operation and maintenance*', Defence Works Functional Standard, Design and Maintenance Guide G08, Ministry of Defence, 1996, ISBN 978 1 11772 785 4.

'*Hygienic maintenance of office ventilation ductwork*', CIBSE TM26, 2000, ISBN: 1903287111.

Commissioning

Although commissioning is a requirement, Approved Document F does not specify commissioning methodologies or procedures. There are many good commissioning codes published by organisations such as CIBSE and BSRIA.

11.6.2 Extract ventilation rates

The approved document gives minimum room extract rates and the minimum outdoor air supply rate, as shown in Table 11.6. These rates are applicable primarily to offices but they may also be applied to other buildings where there are similar activities or similar types and levels of contaminant release.

11.6.3 Offices

The approved document identifies four methods of complying with the Requirement:

(1) providing specified extract rates, whole building ventilation rates and purge ventilation, or
(2) following guidance on the design of the ventilation systems, or
(3) using approaches as described in other authoritative and acceptable documents, or
(4) demonstrating to the building control body that the proposed ventilation systems can satisfy the Requirement by meeting specified moisture and air quality criteria.

Although these are presented as four independent approaches, they are, to some degree, linked.

Table 11.6 Minimum ventilation extract rates.

Room	Minimum room extract rate
Rooms containing printers and photocopiers in substantial use (more than 30 minutes per hour)	20 l/s per machine during use If the operator(s) is in the room continuously, use the greater of the extract rate and the whole building ventilation rate
Office sanitary accommodation and washrooms	Intermittent air extract rate to outside of: 15 l/s per shower or bath 6 l/s per WC or urinal
Food and beverage preparation areas, but not commercial kitchens	Intermittent air extract rate to outside of: 15 l/s with microwave ovens and beverages only 30 l/s adjacent to a hob with cooker(s) 60 l/s elsewhere with cooker(s) All extract should operate while food and/or beverage preparation is in progress
Specialist buildings and spaces, including commercial kitchens and sports centres	See section 11.6.4
Whole building	**Minimum outdoor air supply rate**
Total outdoor air supply rate – no smoking or significant pollutant sources	10 l/s per person

Specification of extract rates and whole building ventilation rate

The following, which are based on the control of body odours and when no other significant pollutants are present, should be provided:

- **Extract rates**
  The minimum room extract rates are given in Table 11.6.
- **Whole building ventilation rate**
  The minimum supply rate of outdoor air is given in Table 11.6. This assumes there is no smoking.
- **Purge ventilation**
  Purge ventilation is required in each office and should be sufficient to reduce pollutants to an acceptable level before the space is occupied. Purged air must be exhausted to the outside and not recirculated.

If there are significant levels of other pollutants, these rates will have to be increased in accordance with an approved calculation method such as that given in CIBSE Guide A.

Compliance by following guidance on ventilation system design

For all systems, the minimum extract rates and the minimum whole building ventilation rate as given in Table 11.6 should be provided. The three types of ventilation system for achieving this are:

- natural ventilation;
- mixed-mode ventilation; and
- mechanical ventilation.

Natural ventilation

Approved guidance is given in the CIBSE Application manual:
'*Natural ventilation in non-domestic buildings*', AM 10:2005, ISBN 978 1 90328 756 9.

This provides guidance on:

- ventilation provisions, and
- location of ventilators in rooms.

It also provides guidance on controls for ventilators in rooms, including:

- extract;
- whole building ventilation; and
- purge ventilation.

In addition, the following should also be noted:

- Extract ventilators should be located as high as practicable and preferably less than 400 mm below ceiling level. This helps to remove pollutants from the breathing zone and improves the extraction of buoyant pollutants and water vapour.
- Passive stack ventilation (PSV) may be used instead of a mechanical extract fan to office sanitary accommodation, washrooms and food preparation areas.
- PSV extract terminals should be located in the ceiling.
- When an open-flued appliance is provided in a building with mechanical extract, spillage of flue gases must be avoided whether or not the extract fan is running. For appliances up to 70 kW input rating, see BS 5440-1 for guidance.
- Controls for extract fans may be manual or automatic. For a room with no openable window, the extract fan should have a 15 minute overrun.
- Controls for PSV may be manual and/or operated automatically by a sensor or controller.
- Readily accessible controls must be provided, particularly override controls for the occupants.

Mechanical ventilation

A mechanical system must have:

- at least the minimum ventilation extract and supply rates given in Table 11.6;
- extract ventilators located as high as practicable and preferably less than 400 mm below ceiling level (this helps to remove pollutants from the breathing zone and improves the extraction of buoyant pollutants and water vapour);
- controls for extract fans which may be manual or automatic (for a room with no openable window, the extract should have a 15 minute overrun); and
- readily accessible controls, particularly override controls for the occupants.

Alternative approaches

Acceptable alternative approaches may be found in the publications listed in section 11.6.4, especially references 1 and 6.

11.6.4 Other building types

Guidance for all other building types is to be found not in Approved Document F but in other publications. These are identified in Table 11.7, and the publications themselves are as follows:

(1) CIBSE Guide B: 2005
(2) '*The Welfare of Farm Animals (England) Regulations*', SI 2000 No. 1870
(3) '*The Welfare of Farm Animals (England) (Amendment) Regulations*', SI 2002 No. 1646 and SI 2003 No. 299
(4) '*Buildings and structures for agriculture. Guide to regulations and sources of information*', BS 5502-11:2005
(5) '*Natural ventilation in non-domestic buildings*', CIBSE AM10, 2005
(6) '*Mixed mode ventilation*', CIBSE AM13, 2000, ISBN 978 1 90328 701 9
(7) '*General ventilation in the workplace – guidance for employers*', HSE guidance note HSG 202
(8) '*Specification for safety aspects in the design, construction and installation of refrigeration appliances and systems*', BS 4434:1989
(9) '*Ventilation of kitchens in catering establishments*', HSE catering information sheet, No. 10, 2000
(10) '*The main health and safety law applicable to catering*', HSE information sheet No. 11, 2000
(11) '*Specification for kitchen ventilation systems*', HVCA DW/172
(12) For common spaces where large numbers of people gather (e.g. shopping malls, foyers, etc. but not common spaces used principally for circulation), use either:
   (a) appropriately located ventilation openings with a total area at least 1/50th of the floor area of the common space, or
   (b) mechanical ventilation to supply at least 1 l/s of fresh air per m^2 of floor area.
(13) '*Designing energy efficient multi-residential buildings*', Energy efficiency best practice in housing, BRE good practice guide GPG 192
(14) The Factories Act
(15) Health and safety at work etc. Act
(16) National Health Service Activity database
(17) Health technical memorandum (HTM) 03
(18) Health building notes (HBN), various
(19) '*Manual of recommended practice: Industrial ventilation*', 24th edition, ACGIH
(20) '*An introduction to local exhaust ventilation*', HS(G) 37
(21) '*Maintenance, examination and testing of local exhaustion ventilation*', HS(G) 54
(22) '*COSHH essentials*', HS(G) 193
(23) '*Recommendations for the storage and exhibition of archival documents*', BS 5454:2000
(24) National offender management service (NOMS), Technical services, Home Office
(25) For offices the guidance provided in Table 11.6 is suitable for most applications.
(26) '*Ventilation of school buildings*', Building Bulletin 101, version 1.4, 2006, DfES

Table 11.7 Sources of guidance for other building types.

	Source of guidance																									
Building type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
Animal husbandry	✓	✓	✓	✓																						
Assembly halls					✓	✓																				
Atria					✓	✓																				
Broadcasting studios	✓																									
Building services plant rooms							✓	✓																		
Call centres	✓				✓	✓																				
Catering including commercial kitchens	✓								✓	✓	✓															
Clean rooms	✓																									
Common spaces												✓														
Communal residential buildings													✓													
Computer rooms	✓				✓	✓																				
Darkrooms – photographic	✓																									
Dealing rooms	✓				✓	✓																				
Factories and warehouses	✓				✓	✓								✓	✓											
High-rise non-domestic buildings	✓				✓	✓																				
Horticulture	✓				✓	✓																				

Hospitals and healthcare buildings	✓			✓	✓										✓	✓	✓								
Hotels	✓			✓	✓																				
Industrial ventilation																		✓	✓	✓	✓				
Laboratories	✓																								
Museums, libraries and art galleries	✓			✓	✓																	✓			
Plant rooms	✓																								
Prison cells																							✓		
Sanitary accommodation																								✓	
Schools and educational buildings																									✓
Shops and retail premises	✓			✓	✓																				
Sports centres and swimming pools	✓																								
Standards rooms	✓																								
Transportation buildings and facilities	✓			✓	✓																				

11.6.5 Car parks

In car parks, the objective is to limit the concentration of carbon monoxide (CO) arising from vehicle exhausts. There are limits on both the long-term average and the short-term peak concentrations as follows:

- Maximum permissible long-term concentration of CO:
  30 parts per million averaged over an 8 hour period.
- Maximum permissible short-term concentration of CO:
  90 parts per million averaged over any 15 minute period.

The short-term concentrations are most likely to occur in the vicinity of ramps and exits. Ventilation systems must be designed and must operate in such a way as to keep concentrations within the permissible limits. Compliance may be demonstrated by showing by means of appropriate calculations that the limits will not be exceeded. For car parks, calculation is often impractical or inappropriate, in which case compliance may be demonstrated by following the following guidance on natural or mechanical ventilation.

Naturally ventilated car parks
Well-distributed permanent natural ventilation must be provided. At each and every car park level openings must:

- have an aggregate equivalent area of at least 1/20 of floor area at that level, and
- be distributed so that at least 25% of the opening area is on each of two opposing walls.

Mechanically ventilated car parks
Either

- provide permanent natural ventilation openings of equivalent floor area at least 1/40 of the floor area, and also a mechanical ventilation system capable of extracting not less than 3 ach (air changes per hour), or
- for basement car parks, provide a mechanical ventilation system capable of extracting not less than 6 ach.

In addition to whichever of these alternative is chosen, at ramps and exits provide local ventilation capable of extracting not less than 10 ach.
Note that Approved Document B deals with the ventilation of car parks for the purpose of fire risk management.
Further guidance is to be found in:

'*Code of practice for ground floor, multi-storey and underground car parks*', Association of petroleum and explosives administration.
CIBSE Guide B2.
Health and Safety Publication EH40.

11.7 Work on existing buildings

If a building is subject to material change of use, then Part F applies to the building or that part of the building which has been subjected to a change of use. For all other cases of work on an existing building:

- Part F applies to the building work which has been carried out, and
- the rest of the building should not be made worse in relation to the requirements of Part F than it was before the work was carried out.

If the windows are replaced as part of a material change of use, then the guidance for new buildings given in sections 11.5 and 11.7.1 applies.

11.7.1 Replacement windows and background ventilation

Windows are a controlled fitting, and so work to replace windows in an existing building must, in addition to Part F, comply with the relevant requirements of Parts L and K. Also, the completed work must not have a worse level of compliance with any other applicable requirements, especially Parts B and J.

Where the original windows were fitted with trickle ventilators, the replacement windows should also have trickle ventilators. Where the original windows were not fitted with trickle ventilators and the room is not ventilated adequately by any other provision, it is good practice to fit trickle ventilators (or an equivalent means of ventilation).

In all cases, ventilation devices should be controllable and have conveniently accessible controls.

Where trickle ventilators (or an equivalent means of ventilation) are to be fitted, the new ventilation opening should be at least the same size as that originally provided. Where the size of any existing ventilation opening is not known, or if there was no ventilation opening, the minimum equivalent area as shown in Table 11.8 should be provided. As a general rule, a night latch setting on a window is not considered acceptable as an alternative to a trickle ventilator.

Table 11.8 Minimum background ventilation provision.

Building type	Room type	Minimum equivalent area of opening
Dwellings	Habitable rooms	5000 mm^2
	Kitchen, utility room and bathroom (with or without WC)	2500 mm^2
Buildings other than dwellings	Occupiable rooms with floor area up to 10 m^2	2500 mm^2
	Occupiable rooms with floor area greater than 10 m^2	250 mm^2 per square metre of floor area
	Kitchens (domestic type)	2500 mm^2
	Bathrooms and shower rooms	2500 mm^2 per bath or shower
	Sanitary accommodation and/or washing facilities	2500 mm^2 per WC

11.7.2 Addition of a habitable room that is not a conservatory to an existing dwelling

The general ventilation rate for the additional room and if necessary adjoining rooms can be achieved by providing either:

- background ventilators, or
- a single room heat recovery ventilator in the additional room.

When background ventilators are provided, there are three possibilities:

(1) If the additional room is connected to an existing habitable room which now has no windows opening to the outside, the guidance in section 11.5.7 must be followed.
(2) If the additional room is connected to an existing habitable room which still has windows opening to the outside but has a total background ventilator equivalent area less than 5000 mm^2, the guidance in section 11.5.7 must be followed.
(3) If the additional room is connected to an existing habitable room which still has windows opening to the outside and has a total background ventilator equivalent area of at least 5000 mm^2, then there should be:
   - background ventilators of at least 8000 mm^2 equivalent area between the two rooms, and also
   - background ventilators of at least 8000 mm^2 equivalent area between the additional room and the outside.

When a single room heat recovery ventilator is provided to ventilate the additional room, the fresh air supply rate to that room is found from:

$$\text{Supply rate} = \frac{\text{Volume of additional room}}{\text{Total volume of all habitable rooms}} \times \text{Whole building vent. rate}$$

where the whole building ventilation rate is obtained from Table 11.2. The ventilation provision in the additional room must also comply with the requirements for purge ventilation, location of ventilation devices and controls as described in sections 11.5.3 to 11.5.9 inclusive.

11.7.3 Addition of a wet room to an existing dwelling

Whole building ventilation and extract ventilation can be provided by one of four alternatives:

(1) intermittent extract as described for intermittent extract in section 'SYSTEM 1: Background ventilators and intermittent extract fans' for system 1 with a background ventilator of at least 2500 mm^2 equivalent area;
(2) a single room heat recovery ventilator as described for intermittent extract in section 'SYSTEM 1: Background ventilators and intermittent extract fans' for system 1;

(3) passive stack ventilation as described for passive stack ventilation in section 'SYSTEM 2: Passive stack ventilation (PSV)' for system 2, using data from Table 11.4; and
(4) a continuous extract fan as described in section 'SYSTEM 3: Continuous mechanical extract (MEV)' for system 3.

The ventilation provision in the wet room must also comply with the requirements for purge ventilation, location of ventilation devices and controls as described in sections 11.5.3 to 11.5.9 inclusive.

11.7.4 Addition of a conservatory to an existing building

The guidance applies to conservatories with a floor area greater than $30\,m^2$. Above $30\,m^2$ floor area, the general ventilation of the conservatory and, if relevant or necessary, adjoining rooms can be achieved with background ventilators. Follow the guidance in section 11.6.4 whatever the ventilation provisions in the existing room adjoining the conservatory.

The ventilation provision in the conservatory must also comply with the requirements for purge ventilation, location of ventilation devices and controls as described in sections 11.5.3 to 11.5.9 inclusive.

11.7.5 Refurbishment of a kitchen or bathroom in an existing dwelling

If any of the work being carried out in the kitchen or bathroom of an existing dwelling is 'building work' as defined by the Building Regulations, then:

- the work must comply with all the relevant requirements of the Building Regulations, and
- compliance with any other requirements must not be made worse than it was before the building work was started, and
- before it is started, the work must be notified to the BCB, except in certain circumstances as described in section 11.4.3.

11.7.6 Historic buildings

No specific guidance is given in AD F. However, it is stated that the aim should be to improve ventilation to the extent that it is necessary without:

- prejudicing the character of the building, and
- making alterations that risk increasing the long-term deterioration of the building.

Further details and references relevant to historic buildings are given in chapter 16, section 16.4.5.

11.8 Performance-based ventilation

The guidance given in the main body of Approved Document F and its tables are derived from two sources. The first is a set of standard performance criteria which are expressed in terms of the maximum permissible concentration of certain pollutants. The second source is a set of assumptions concerning airflow and moisture movement in buildings. Whenever the performance criteria and the set of assumptions are applicable, the guidance given in section 11.5 for dwellings and in section 11.7.1 for buildings other than dwellings may be used. The standard performance criteria could become invalid if:

- the concentrations of one or more of the standard pollutants (i.e. water vapour, nitrogen dioxide, carbon monoxide, total volatile organic compounds, ozone) were to exceed its maximum permissible concentration, or
- there is pollution from flueless combustion space heaters, or
- there are products of tobacco smoke, or
- there are airborne products due to painting, or
- there are airborne products arising from cleaning agents, or
- there is the danger or spread of airborne infections, or
- there are products of industrial or commercial activities, or
- the external air contains higher than normal levels of pollutants.

In some cases, these pollutants are emitted intermittently, or even occasionally. In many cases, the best method of achieving good indoor air quality for the building occupants may be control of the pollutant at source, for example, by:

- use of low emitting products (e.g. water-based paint);
- isolation of the contaminant source (e.g. fume cupboards); and
- avoidance (e.g. by ceasing to use the source of the pollution, or to remove it to a special facility).

The set of assumptions concerning airflow and moisture movement in buildings include assumptions regarding:

- air permeability;
- surface water activity;
- relative humidity;
- ventilation effectiveness; and
- airflows derived from practical experience and/or appropriate airflow equations.

If in a particular building project there is the possibility that either the standard performance criteria or the set of assumptions are invalid, then the requirements of AD F as stated in section 11.4 will have to be met by special ventilation design, and compliance will have to be demonstrated independently of the guidance given in the approved document. It is therefore useful to know the details of the standard performance criteria.

11.8.1 Standard performance criteria for dwellings

There are three main criteria:

(1) There should be no visible mould on external walls due to excessive levels of humidity in the indoor air.

Table 11.9 Maximum concentrations of pollutants – dwellings.

Pollutant	Maximum concentration	Averaging time
Nitrogen dioxide (NO_2)	288 μg/m³ (150 ppb)	1 hour
Nitrogen dioxide (NO_2)	40 μg/m³ (20 ppb)	Long-term average
Carbon monoxide (CO)	100 mg/m³ (90 ppm)	15 minutes
Carbon monoxide (CO)	60 mg/m³ (50 ppm)	30 minutes
Carbon monoxide (CO)	30 mg/m³ (25 ppm)	1 hour
Carbon monoxide (CO)	10 mg/m³ (10 ppm)	8 hours
Total organic volatile compounds (TOVC)	300 μg/m³	8 hours

(2) Bio-effluents (i.e. body odours) will be controlled by a fresh air supply rate not less than 3.5 l/s per person.
(3) The maximum permissible concentrations of certain common indoor pollutants are not exceeded.

The maximum permissible concentrations of the most typical pollutants for dwellings are listed in Table 11.9.

11.8.2 Assumptions used in applying performance criteria to dwellings

The assumptions may be listed under the headings:

- air permeability;
- ventilation effectiveness;
- moisture, surface water and relative humidity;
- extract ventilation;
- whole dwelling ventilation;
- equivalent areas of background ventilators; and
- purge ventilation.

Details are given in Table 11.10.

11.8.3 Performance criteria for buildings other than dwellings

The data in the approved document is based on offices, but it could be applicable to other buildings if they are of sufficiently similar form function and occupancy. There are three main criteria:

(1) In the absence of tobacco smoke or other excessive pollutants, a fresh air supply rate of 10 l/s per person will be sufficient to avoid adverse health effects and to control bio-effluents (body odour).
(2) There should be no visible mould on external walls in a properly heated building with typical moisture generation.
(3) The maximum permissible concentrations of certain common indoor pollutants are not exceeded.

Table 11.10 Assumptions used in applying performance criteria to dwellings.

Air permeability (**Default Option**) – suitable for all dwellings	Ventilation systems 1 and 2	Dwelling assumed to have an infiltration of 0.05 ach	
	Ventilation systems 3 and 4	Dwelling assumed to have no infiltration	
Air permeability (**Alternative Option**) – suitable for dwellings with design air permeability >5 $m^3/h.m^2$	Ventilation systems 1, 2 and 4	Dwelling assumed to have an infiltration of 0.15 ach	
	Ventilation system 3	Dwelling assumed to have negligible infiltration	
Ventilation effectiveness		Taken as 1.0 for all dwellings	
Moisture – the criterion would be met if average surface water activity (or relative humidity) during the heating season is less than the given limit	Moving average period	Maximum permitted values	
		Surface water activity	Room air relative humidity
	1 month	0.75	65%
	1 week	0.85	75%
	1 day	0.95	85%
Intermittent extract ventilation – Main pollutant, moisture; but see note 1	Kitchens: Assumed moisture production rate, 2000 g/h	Historically, 60 l/s has been found to be satisfactory. This can be reduced to 30 l/s for cooker hoods because of greater extract effectiveness	
	Utility rooms	Assumed extract rate is 50% of that required for a kitchen	
	Bathrooms: Assumed moisture production rate, 400 g/h	Historically, 15 l/s has been found to be satisfactory	
	WCs: The principal pollutant is odour	Historically, 6 l/s has been found to be satisfactory	
Continuous extract ventilation	All situations	Extract rates provided in the 2006 edition of AD F have been found to be satisfactory and were retained in the 2010 edition	

Whole dwelling ventilation – Main pollutant, moisture; but see notes 1 and 2	Assume 100% of bathroom moisture and 50% of kitchen moisture is extracted locally	Ventilation rates given in Table 11.2 were calculated for winter conditions. At other times, rates may need to be higher, but purge ventilation may be used for this
Background ventilator equivalent areas	The ventilation rates in Table 11.2 have been used with the standard airflow equation; see note 3	Background ventilator equivalent areas for the Default Option are given in Table 11.3a, and for the Alternative Option in Table 11.3b
Purge ventilation	Calculated assuming single-sided ventilation in an urban area, a local wind speed of 2.1 m/s and a temperature difference of 3 °C	The purge rate of 4 ach is an order of magnitude greater than the whole dwelling ventilation rate

Note 1: Source production rates were taken from Code of practice for control of condensation in buildings, BS 5250:2011.

Note 2: In some dwellings moisture production may be low, and volatile organic compounds are more significant. The performance criterion of 300 μg/m^3 requires a minimum whole dwelling ventilation of 0.3 l/s per m^2 of floor area.

Note 3: The equation is $A = 1000(Q / C_d)(\rho / 2.\Delta P)^{0.5}$, where

A is the required total background ventilator area, mm^2;

Q is the whole dwelling ventilation rate, l/s;

C_d is the discharge coefficient, assumed to be 0.6 l;

ρ is the density of air, assumed to be 1.2 kg/m^3;

ΔP is the pressure difference across the ventilator, taken as 0.6 Pa for single-storey dwellings and 1.0 Pa for multi-storey dwellings.

Table 11.11 Maximum concentrations of pollutants – buildings other than dwellings.

Pollutant	Maximum concentration	Averaging time
Nitrogen dioxide (NO_2)	288 µg/m³ (150 ppb)	1 hour
Nitrogen dioxide (NO_2)	40 µg/m³ (21 ppb)	Long-term average
Carbon monoxide (CO)	100 mg/m³ (90 ppm)	15 minutes
Carbon monoxide (CO)	60 mg/m³ (50 ppm)	30 minutes
Carbon monoxide (CO)	30 mg/m³ (25 ppm)	1 hour
Carbon monoxide (CO)	10 mg/m³ (10 ppm)	8 hours
Carbon monoxide (CO) for occupational exposure	35 mg/m³ (30 ppm)	8 hours
Total organic volatile compounds (TOVC)	300 µg/m³	8 hours
Ozone (O_3)	100 µg/m³	At any time

For convenience, the maximum permissible pollutant concentrations for buildings other than dwellings are listed in Table 11.11.

11.8.4 Assumptions used in applying performance criteria to offices

The assumptions may be listed under the headings:

- air permeability;
- ventilation effectiveness;
- moisture, surface water and relative humidity;
- extract ventilation;
- whole building ventilation; and
- purge ventilation.

Details are given in Table 11.12.

11.9 Passive stack ventilation (PSV) system design

Unlike its predecessor, the 2010 edition of Approved Document F contains no specific detailed advice on the design and installation of a PSV system in a dwelling. Where it is proposed to use a PSV system, the specific requirements of the manufacturer and guidance in the approved document should be followed; however, for initial design, the guidance contained in the 2006 version of the approved document may still be of value.

Figure 11.3 shows the design layouts which should be suitable for the majority of dwellings of up to four storeys. It should be noted that:

- the preferred position for the outlet terminal is the ridge of the roof;
- a tile ventilator is acceptable if it is within 0.5 m of the ridge;
- a duct which penetrates the roof must extend to at least ridge level;

Table 11.12 Assumptions used in applying performance criteria to offices.

Air permeability: the infiltration air permeability is assumed to be no more than 3 $m^3/h.m^2$ at 50 Pa	The assumed air permeability is sufficiently low to consider infiltration to be negligible	All ventilation air is purpose provided by the installed ventilation system	
Ventilation effectiveness		Taken as 0.9	
Moisture – the criterion would be met if average surface water activity (or relative humidity) during the heating season is less than the given limit	Moving average period	Maximum permitted values	
		Surface water activity	Room air relative humidity
	1 month	0.75	65%
	1 week	0.85	75%
	1 day	0.95	85%
Extract ventilation	Equipment, e.g. laser printers and dry paper copiers, operated on average 30 minutes per hour, emit: 25 mg/h of TVOCs, and 3 mg/h of ozone	To meet the performance criteria for TVOCs and ozone, this requires a minimum extract rate of 20 l/s per machine while in use	
	Food and beverage preparation areas	The extract rates for dwellings have been applied	
	Sanitary accommodation	The extract rates for dwellings have been applied	
Whole building ventilation	The ventilation rate is based on avoidance of adverse health effects and sick building syndrome and is derived from a combination of past experience and formal office studies	A whole building ventilation rate of 10 l/s per person is considered satisfactory. Below this rate, the incidence of occupant ill health increases significantly, whereas higher rates provide little improvement. The rate may need to be higher if there are specific circumstances	
Purge ventilation	No specific criterion for purge rates is given		

- ducts from kitchens, bathrooms, utility rooms or WCs must be separate, with no branches or common outlets;
- each duct should have a maximum of two bends, each with a maximum change of direction of 45° or less, and the bends should be swept and not sharp; and
- if the dwelling is near a much taller building (i.e. more than 50% taller), PSV should *not* be installed if the distance between them is less than 5 times the difference in height.

Recommendations for the components of the PSV system are:

- Ceiling extract grilles and all outlet terminals should have a free area not less than the duct cross-sectional area.
- Rigid and flexible ducts are acceptable – flexible ducts should be fully extended but not taut.

- Duct cross-sectional areas should be maintained throughout their run, especially at junctions with terminals.
- Any part of a duct in an unheated space must be insulated with at least 25 mm of insulation with a thermal conductivity of not less than 0.04 W/m.K, or material giving an equivalent degree of insulation.
- If a duct extends above roof level, it should be either insulated or fitted with a condensation trap just below roof level.
- The outlet terminal should:
  (i) not allow ingress of birds or large insects;
  (ii) not allow rain to enter the duct and into the dwelling; and
  (iii) ensure that any condensate due to moisture in the outward airflow runs off onto the roof and not into the dwelling.
- The design of roof terminals is particularly important, and careful attention should be paid to their selection.

Other points to be noted are:

- Fire precautions – see approved document B.
- Noise – in noisy areas, sound attenuation in the duct may be necessary or at least desirable.

11.10 Ingress of external pollution

Appendix D of AD F gives guidance on strategies for minimising the intake of external air pollutants into a building. The basic principle is to locate the air intake points as far as is possible from pollutant sources. In urban areas where there are often multiple sources, including traffic and industry, the solution depends on the exact location of the building, not only in relation to the sources but in relation to other buildings. Exhaust outlets must also be carefully located to avoid pollution near pedestrians and to avoid short-circuiting to ventilation intakes. Typical urban pollutants are:

- carbon monoxide (CO);
- nitrogen dioxide (NO_2);
- sulphur dioxide (SO_2);
- ozone (O_3);
- particles (PM_{10});
- benzene (C_6H_6);
- 1,3-butadiene (C_4H_6);
- polycyclic aromatic hydrocarbons (PAHs);
- ammonia (NH_3); and
- lead (Pb).

Typical sources of pollution are:

- road traffic, including traffic junctions and underground car parks;
- combustion plant (e.g. heating appliances) burning fossil fuels, most commonly natural gas;

- other combustion processes such as waste incineration and thermal oxidation abatement systems;
- discharges from industrial processes;
- uncontrolled or partially controlled discharges of pollutants from any source;
- building ventilation system exhaust air; and
- particle and vapour discharges from construction and demolition sites.

Depending on its location, a building can be subjected simultaneously to a variety of different pollutants from multiple sources. Furthermore, conditions in the vicinity of a building may change significantly during its life. Appendix D of the approved document contains suggestions for dealing with the problem, but most of these are based simply on locating air intakes where the external pollution is likely to be at a minimum and where there is likely to be a plentiful supply of fresh air. In practice, the airflows around a building in an urban area are very complex, so that buildings which may have a high sensitivity to the ingress of pollutants (e.g. any building where the occupants are particularly susceptible) may be especially problematic.

For short periods of high external pollution levels (e.g. during rush hour), the approved document suggests several strategies for periods of up to 1 hour:

- reducing the intake of fresh air;
- closing the fresh air intakes and switching to 100% recirculation; and
- in extreme cases, switching the ventilation system off.

All three strategies rely on the volume of air within the building being sufficient to provide occupant needs while the action is being taken. However, in many modern buildings, the volume of internal air per occupant may be too low, making any such action risky. Possible exceptions occur when a building has a large atrium or unusually high ceilings.

The location of exhaust outlets is an important factor in order to prevent short-circuiting of exhaust air back into the building. The recommendations are:

- Where there is a prevailing wind direction, place exhausts downwind from the intakes.
- Do not allow exhausts to discharge into courtyards, enclosures or architectural screens.
- Where possible, pollutants from stacks should be discharged vertically upwards. If there are several stacks, they should be grouped together in order to increase upward momentum and hence the height of the plume.

Further guidance is given in:

'*Minimising pollution at air intakes*', CIBSE Technical Memorandum TM 21, 1999, ISBN 9780900953910;

Liddament, M. W., '*Ventilation strategies*', Chapter 13 in '*Indoor air quality handbook*', McGraw-Hill, 2000.

12 Sanitation, hot water safety and water efficiency (Part G)

12.1 Introduction

The Approved Document G, which came into force on 6 April 2010, contained many significant changes from its predecessor to both the legal requirements and the technical guidance. These changes were reflected in a new format, in which Part G now consists of an introduction, six parts and three appendices, as shown in Table 12.1. Like parts M and L, this requirement of the regulations stems from a specific requirement in section 1 of the Building Act 1984 where it states that the Secretary of State may make regulations for the purpose of *preventing waste, undue consumption, misuse or contamination of water.* From the 1 October 2015, as part of the 'Housing Standards Review', further changes were made to requirement G2 and Regulation 36 which apply to building work in England only resulting in a revised 2015 edition of the Approved Document.

The introduction to Part G contains reminders on matters of general relevance. These include the following.

CONSIDERATION OF TECHNICAL RISK – When carrying out work to which Part G applies, it may be necessary to consider in addition the requirements of parts A, B, C, J, L and P.

RESPONSIBILITY FOR COMPLIANCE – Responsibility lies with the person or persons carrying out the work (e.g. designer, builder and installer) or in some circumstances the building owner.

LIMITATION ON REQUIREMENTS – Part G2 is concerned with conservation rather than health and safety and therefore is not covered by the limitation on requirements set out in Regulation 8.

MATERIAL CHANGE OF USE – This refers to Regulation 5 for the definition of material change of use.

In all cases where a material change of use takes place as defined in Regulation 5, then requirements G1, G3 (1, 2 and 3), G4, G5 and G6 will apply to the work and the building

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

Table 12.1 Part G.

Introduction	General guidance including definitions of terms
G1	Cold water supply
G2	Water efficiency
G3	Hot water supply and systems
G4	Sanitary conveniences and washing facilities
G5	Bathrooms
G6	Food preparation areas
Appendix A	Water efficiency calculator for new dwellings
Appendix B	Wholesome water
Appendix C	References

must be brought up to the standards required by these parts. For changes of use involving a dwelling or flats, requirements G2 and G3 (4) also apply.

HISTORIC BUILDINGS – This states that special considerations may apply. A full discussion is given in Chapter 16, Part L.

COMPETENT PERSON SELF-CERTIFICATION SCHEMES: SCHEDULE 3 – It is not necessary to notify a BCB in advance of work covered by Part G if that work is of a type set out in column 1 of Schedule 3 and is carried out by a person registered with a relevant self-certification scheme as in column 2 of Schedule 3. The full Schedule 3 is given in Chapter 16.

WORK WHICH IS NOT NOTIFIABLE: SCHEDULE 4 – Work of a minor nature where there is no significant risk to health, safety, water efficiency or energy efficiency, as set out in Schedule 4 (reproduced in Chapter 16), needs not be notified to a BCB. Also, if *only* non-notifiable work is carried out, there is no need to provide a certificate to confirm that the work complies. Nevertheless, health, safety, water efficiency and energy efficiency requirements still apply; it is the requirement to notify a BCB that is waived in these cases.

EXEMPTIONS Schedule 2 to the Building Regulations sets out classes of building which are exempt from all Building Regulation requirements. However the exemption does not apply to some of the requirements of Part G where hot or cold water systems are shared with other buildings. Thus, despite the general exemption, Parts G1, G3 (2) and G3 (3) continue to apply to:

(i) any greenhouse which receives a hot or cold water supply from a source shared with or located inside a dwelling; and
(ii) any small detached building falling within Class VI of Schedule 2 and any extension falling within Class VII of Schedule 2 (including conservatories under 30 m^2 in area) which receive a hot or cold water supply shared with or located inside any building that is subject to the regulations.

MATERIALS AND WORKMANSHIP – The requirements of Regulation 7 to the Building Regulations 2010 apply, and it may be necessary to demonstrate compliance. This means that a product or process should conform to a national or international standard or have been certified as satisfactory by a relevant body. Examples of appropriate usage are:

(a) a product bearing the CE mark in accordance with the Construction Products Regulations 2011;
(b) a product complying with an appropriate technical specification (as defined in the above directives), a British Standard or an alternative national technical specification of any state which is a contracting party to the European Economic Area which in use is equivalent; and
(c) a product covered by a national or European certificate issued by a European Technical Approval issuing body, and the conditions of use are in accordance with the terms of the certificate.

TECHNICAL SPECIFICATIONS: WHICH VERSION APPLIES? – When a named standard is referred to in the Approved Document, the relevant version is the one listed in the current edition of the Approved Document. Revised or updated versions of a named standard may be used provided the new version is still fully relevant. If it is proposed to work with the new version, its acceptability should first be checked with the BCB. In fact, all standards and certifications must have the approval of the BCB. However, in this chapter, latest versions (current at the time of writing) of named standards are given on the grounds that they are likely to incorporate changes in product technology, practice and safety requirements.

12.2 Definition and interpretation of terms

The principal terms used in Part G are described here, together with some other relevant terms.

BCB – A BCB is a building control body, local authority or an approved inspector.

BUILDING – A building is any permanent or temporary building but not any other kind of structure or erection. It includes house, flats and public buildings, and a reference to a building includes a reference to part of a building.

BUILDING WORK – Building work includes:

- the erection or extension of a building;
- the provision or extension of a controlled service or fitting in or in connection with a building; and
- the material alteration of a building, or a controlled service or fitting.

COMBINED TEMPERATURE AND PRESSURE RELIEF VALVE – This is a mechanically operated valve that opens to discharge water when a fixed (factory set) temperature or fixed (factory set) pressure is exceeded.

CONTROLLED SERVICE OR FITTING – This includes a service or fitting subject to Schedule 1 requirements in respect of sanitation, hot water safety, water efficiency, drainage and waste disposal, combustion appliances and fuel storage, conservation of fuel or power and electrical safety.

DIRECT HEATING – This means a method of heating in which the heat source is integral with the hot water vessel. Examples include:

- an electric immersion heater;
- a gas burner with a flue arrangement that passes through the water vessel thereby heating the water; and
- the circulation of water from a vessel close to a burner with a flue arrangement that transfers heat to the circulating water.

DOMESTIC HOT WATER – This is the water that has been heated for cooking, food preparation, personal washing or cleaning purposes. Although described as domestic, the term is used for all types of building.

EARTH CLOSET – This is a closet that has a movable receptacle for the reception of faecal matter and its deodorisation by earth, ashes, chemicals, or other methods and includes chemical and composting toilets.

EXEMPT BUILDINGS AND WORK – Exemption applies to the erection of any building or extension of a kind described in Regulation 9 and Schedule 2 of the Building Regulations. Exemption also applies to the carrying out of any work to or in connection with such a building or extension provided that after the work has been completed, the building or its extension is still exempt.

EXPANSION VESSEL – An expansion vessel temporarily accommodates the expansion of water from an unvented hot water storage vessel as the water is heated.

GREYWATER – This is domestic wastewater which contains neither faecal matter nor urine. When it has been appropriately treated, greywater may be used to replace wholesome water in WC, urinals and washing machines. It may also be used for irrigation purposes.

HARVESTED RAINWATER – This is rainwater collected and stored from roofs or other suitable surfaces. When it has been appropriately treated, it may be used to replace wholesome water in WC, urinals and washing machines. It may also be used for irrigation purposes.

HEATED WHOLESOME WATER – This is water that was wholesome when cold and has been heated to a higher temperature.

HOT WATER STORAGE SYSTEM – This is a vessel, together with all its safety and operating devices, for storing:

- wholesome or softened hot water for subsequent use; or
- hot water that is used to heat other water.

HOT WATER STORAGE SYSTEM PACKAGE – This is a hot water storage system having the required safety and operating devices factory fitted by the manufacturer, together with a kit containing other applicable devices supplied by the manufacturer for fitting by the installer.

HOT WATER STORAGE SYSTEM UNIT – This is a hot water storage system having the required safety and operating devices factory fitted by the manufacturer.

INDIRECT HEATING – This is a method of heating stored water via a heat exchanger.

KITCHEN – This is a room or part of a room which contains a sink and food preparation facilities.

MATERIAL ALTERATION – This is an alteration which results in a building or a controlled service or fitting not complying with, or being more unsatisfactory then it was before, in relation to Schedule 1 requirements for:

- structure;
- means of warning and escape;
- internal and external fire spread;
- fire service access and facilities; and
- access and use.

NON-SELF-RESETTING ENERGY CUT-OUT – This means a device that will interrupt the supply of heat to a hot water storage vessel when a fixed (factory set) temperature is exceeded. Whenever this device is actuated it should only be possible to reset it manually.

PREPARATION OF FOOD – This is the handling, making and cooking of food.

PRESSURE RELIEF VALVE – This is a mechanically operated valve that opens to discharge water when a fixed (factory set) pressure is exceeded.

PRIMARY THERMAL STORE – This is a store of heat energy that can be used to heat domestic hot water by means of a heat exchanger. The thermal store may be heated by a variety of heat sources. Primary hot water thermal stores can be vented or unvented.

RISK ASSESSMENT – For the purposes of Part G, this means the identification of the hazards associated with a process or activity combined with an assessment of the probability and consequences of each hazard.

ROOM FOR RESIDENTIAL PURPOSES – A room for residential purposes means a room, or a suite of rooms, which is not a dwelling house or a flat and which is used by one or more persons to live and sleep. It includes a room in a hostel, a hotel, a boarding house, a hall of residence or a residential home but does not include a room in a hospital or other similar establishment used for patient accommodation.

SANITARY ACCOMMODATION – This is a room containing a WC or urinal, whether or not it also contains other sanitary appliances. Sanitary accommodation containing one or more cubicles counts as a single space if there is free circulation of air throughout the space.

SANITARY APPLIANCE – This includes a WC, urinal, bath, shower washbasin, sink, bidet and drinking fountain. It also includes appliances that are not connected to a water supply or drain, for example, a composting toilet or a waterless urinal.

SANITARY CONVENIENCE – This is a closet or urinal.

SINK – This is a receptacle for holding water supplied through a tap and having a waste-pipe and used for food preparation and washing.

SOFTENED WHOLESOME WATER – This is wholesome water which has been softened by a water softener or a water softening process that reduces the concentrations of calcium and magnesium. As a result of the softening process, such water may contain sodium at a raised level. Nevertheless, if the softened wholesome water still complies with the requirements for wholesome water, it is still considered to be wholesome water. However if after softening it complies with the requirements for wholesome water except for its sodium content, it is considered to be wholesome softened water (see definition below and section 12.2).

TUNDISH – This is a device installed in the discharge pipe from a valve that produces an air break allowing discharge to be conducted safely to a place of termination. The tundish also provides a visible indication of a discharge and functions as a backflow prevention device.

TEMPERATURE RELIEF VALVE – This is a mechanically operated valve that opens to discharge water when a fixed (factory set) temperature is exceeded.

UNVENTED (CLOSED) HOT WATER STORAGE SYSTEM – This is a vessel fed with cold water from a supply pipe or dedicated storage cistern (without a vent pipe) and in which water is heated directly or indirectly. Expansion of the water as it is heated is accommodated either internally or externally. The system is fitted with safety devices to prevent water temperatures exceeding 100°C and operating devices to control primary flow, prevent backflow, control working pressure and accommodate expansion.

VENTED (OPEN) HOT WATER STORAGE SYSTEM – This is a vessel fed with cold water from a dedicated storage cistern. Expansion of the water as it is heated is accommodated through the cold feed pipe. A vent pipe connecting the top of the vessel to a point above the cold water storage cistern where it is open to the atmosphere is provided as a safety device.

WATER CLOSET (WC) – This is a closet that has a separate fixed receptacle connected to a drainage system and separate provision for flushing from a supply of clean water either by the operation of a mechanism or by automatic action.

WHITE GOODS – In the context of Part G, this means household appliances which are permanently connected to the domestic water supply, specifically washing machines and dishwashers.

WHOLESOME SOFTENED WATER – This is wholesome water which has been softened by a water softener or a water softening process and which satisfies the requirements for wholesome water *except* for its high sodium content. Wholesome softened water should not be provided for drinking or food preparation.

WHOLESOME WATER – This is water complying with the requirements of regulations made under section 67 of the Water Industry Act 1991; further discussion is given in sections 12.2.

12.3 Part G1: Cold water supply

Table 12.2 states in column 1 the formal requirements for part G1 and gives in column 2 the provision that will meet those requirements. It is critical that the principal supply to a building is wholesome water – that the water supply to the building is wholesome may be assumed if:

- it is supplied by a statutory water undertaker; or
- a licensed water supplier

through an installation complying with the requirements of the Private Water Supply Regulations 2009 (SI 2009/3101) in England or the Private Water Supplies (Wales) Regulations (SI2010/66). It should be noted that these regulations make provision

Table 12.2 Requirement G1: Cold water supply.

Requirement	Provision to meet the requirement
G1 (1) There must be a suitable installation for the provision of: (a) Wholesome water to any place where drinking water is drawn off; (b) Wholesome water or softened wholesome water to any washbasin or bidet provided in or adjacent to a room containing a sanitary convenience; (c) Wholesome water or softened wholesome water to any washbasin, bidet, fixed bath or shower in a bathroom; and (d) Wholesome water to any sink provided in an area where food is prepared	This will be met if: The water supply is wholesome; The pressure and flow rate is sufficient for the operation of sanitary appliances planned in the building; and The supply is reliable and the installation conveys wholesome water or softened wholesome water to the sanitary appliances and locations specified in the Requirement without waste, misuse, undue consumption or contamination of water
G1 (2) There must be a suitable installation for the provision of water of suitable quality to any sanitary convenience fitted with a flushing device	This will be met if: The water supply is either wholesome, softened wholesome or of suitable quality having regard to the risks to health; The pressure and flow rate is sufficient for the operation of the sanitary appliances; and The supply is reliable and the installation conveys water to sanitary appliances and locations specified in the requirement without waste, misuse, undue consumption or contamination of wholesome water

for preventing contamination, waste, misuse, undue consumption and erroneous measurement of the amount of water supplied.

If a building is supplied with water from a source other than a statutory water undertaker or a licensed water supplier, then the water is considered wholesome if it meets the criteria set out in the Private Water Supplies Regulations 2009 (SI 2009/3101) for a building in England or the Private Water Supplies (Wales) Regulations 2010 (SI 2010/66) for a building in Wales.

If some or all of a wholesome water supply is softened such that after softening it still meets the criteria for wholesome water, it is called softened wholesome water and may be considered wholesome. However, if after softening it meets all the requirements for wholesomeness except for its sodium content, it is called wholesome softened water, and it should not be provided to any draw-off point where it may be used for drinking or food preparation.

12.3.1 Alternative sources of water

Alternative sources of water include:

- water abstracted from wells, springs, boreholes or water courses;
- harvested rainwater;
- reclaimed greywater; and
- reclaimed industrial process water.

Water from these sources, even after treatment, is unlikely to reach the standards required for wholesome water. Nevertheless, such water can be used in applications where wholesome water is not necessary. Possible applications include:

- flushing of toilets;
- washing machines;
- washing of exterior surfaces and cars; and
- irrigation of gardens and allotments.

Any system or unit used to supply a building (especially a dwelling) with water from an alternative source should be subjected to a risk assessment which should include consideration of:

- the appropriateness of the supply and its treatment to the purposes for which it is to be used;
- the effect on water quality of system failure or inadequate maintenance;
- the possibility of contamination of wholesome water; and
- the possibility of waste, misuse or undue consumption.

The risk assessment should be carried out by the system designer and manufacturer, and appropriate testing should be carried out to ensure the risks have been addressed.

There are several sources of guidance on the use of alternative sources of water, as shown in Table 12.3.

Table 12.3 Guidance on the use of alternative water sources.

Publication	Topic
Marking and identification of pipework for reclaimed (greywater) systems. Water Regulations Advisory Scheme, Information and guidance note 9-02-05, 2005	Marking and identification of pipework
Reclaimed water systems. Water Regulations Advisory Scheme, Information and guidance note 9-02-04, 1999	Installation, modification and maintenance
BS 8515:2009 *Rainwater harvesting systems – code of practice*	Installation, modification and maintenance and marking and identification of pipework
Rainwater and grey water: Technical and economic feasibility. Report RPWAT01/07, Market Transformation Programme (MTP), 2007	Comprehensive review
Rainwater and grey water: A guide for specifiers. Report RPWAT02/07, Market Transformation Programme (MTP), 2007	System specification
Rainwater and grey water: Review of water quality standards and recommendations for the UK. Report RPWAT03/07, Market Transformation Programme (MTP), 2007	Quality standards
Harvesting rainwater for domestic uses: An information guide. Report no: GEHO0108BNPN-E-E, Environment Agency, 2008	Design, installation and examples

12.4 Part G2 and Regulation 36: Water efficiency

Requirement G2 and Regulation 36 apply only to new dwellings when:

- a dwelling is erected; or
- when a dwelling is formed by a material change of use of a building within the meaning of Regulation 5(a) or 5(b), where the building is to be used as either as a dwelling or a flat, where previously it was not.

The requirements of G2 and Regulation 36 are given in Table 12.4.

12.4.1 Wholesome water consumption calculation

Where Regulation 36 applies, the official document which must be used for calculating the potential consumption is Appendix A, Approved Document G, DCLG, 2015.

The calculation method requires the use of water consumption figures provided from the manufacturer's product details. Before the assessment can be carried out, figures will need to be collected from the manufacturer's product information to determine the consumption of each terminal fitting, including:

- WCs;
- Bidets;
- Taps;
- Baths;

Table 12.4 Part G2 and Regulation 36.

	Requirement
Part G2	Reasonable provision must be made by the installation of fittings and fixed appliances that use water efficiently for the prevention of undue consumption of water.
Regulation 36	(1) The potential consumption of wholesome water by persons occupying a new dwelling must not exceed the requirement in paragraph (2) (2) The requirement referred to in paragraph (1) is either: (a) 125 litres per person per day; or (b) In a case to which paragraph (3) applies, the optional requirement of 110 litres per person per day As measured in either case in accordance with a methodology approved by the secretary of state (3) This paragraph applies where the planning permission under which the building work is carried out: (a) Specifies the optional requirement in paragraph (2)(b); and (b) Makes it a condition that that requirement must be complied with (4) In this part, 'new dwelling' does not include a dwelling that is formed by material change of use of a building within the meaning of 5(g)

- Dishwashers;
- Washing machines;
- Showers;
- Water softeners (where present);
- Waste disposal units (where present); and
- External taps.

It should be noted that the calculation methodology is designed to provide an assessment against the Regulation 36 requirements. It is not a design tool and is not capable of calculating the actual water consumption of a new dwelling.

If rain or greywater recycling is used as a means of reducing water consumption to achieve higher water efficiency performance levels, then full details are required to determine the savings that can be made. However, large water consuming installations such as swimming pools and Jacuzzis, where there are long intervals between replacement of the water, do not need to be included as part of the calculations for Regulation 36.

It is also useful to consult:

Water consumption in new and existing homes, Report no. BNWAT28, Market Transformation Programme, 2008.

The results of the calculation should be expressed as the number of litres of water per person per day. It should be noted that the maximum permissible consumptions of 110 or 125 litres per person per day include a fixed allowance of 5 litres per person per day for outdoor use.

12.4.2 Notification

The person carrying out the work must give the local authority a notice specifying the potential consumption of wholesome water, calculated as above, not later than five days after the work has been completed. If the work is subject to an initial notice, the result should be notified to the approved inspector not later than five days after the work has been completed or not later than the date on which the initial notice ceases to be in force if this is earlier. Provided the BCB is agreeable, the notice may be provided to them electronically.

12.4.3 Performance

Requirement G2 will be met if all of the following apply:

- The estimated total consumption of wholesome water does not exceed the require base or optional litres per person per day;
- Sanitary appliances and white goods are provided and installed in accordance with other provisions in approved document G;
- Any water from alternative sources used in the design calculation and supplied to the dwelling are provided in accordance with other provisions in approved document G;
- Building owners or occupiers are provided with a record of the installed sanitary appliances and white goods together with operating and maintenance information so that they can sustain the level of water efficiency in the building; and
- Building owners or occupiers are provided with a record of alternative sources of water together with operating and maintenance information so that they can sustain the level of water efficiency in the building.

Alternatively, requirement G2 and Regulation 36 will be met if it can be demonstrated that the water consumption of the fittings provided within the dwelling do not exceed the 'fittings approach' standard detailed in Tables 12.5 and 12.6 dependent upon which requirement the dwelling is subject to.

Where this fittings approach is used as an alternative to the water efficiency calculator, a notice must still be provided to the BCB but it should state 'Less than 110/125 (delete as applicable) litres/person/day using the fittings approach'.

If a building consists of more than one dwelling (e.g. a block of flats), the estimated consumption of wholesome water for each dwelling taken separately must not exceed the required litres per person per day.

Table 12.5 Maximum fittings consumption: 125 litres per person per day.

Water fitting	Maximum consumption
WC	6/4 l dual flush or
	4.5 l single flush
Shower	10 l/min
Bath	185 l
Basin taps	6 l/min
Sink taps	8 l/min
Dishwasher	1.25 l/place setting
Washing machine	8.17 l/kg

Table 12.6 Maximum fittings consumption: 110 litres per person per day.

Water fitting	Maximum consumption
WC	4/2.6 l dual flush
Shower	8 l/min
Bath	170 l
Basin taps	5 l/min
Sink taps	6 l/min
Dishwasher	1.25 l/place setting
Washing machine	8.17 l/kg

12.5 Part G3: Hot water supply and systems

The requirements of G3 are given in Table 12.7.

There are two limitations to the requirements:

Requirement G3 (3) does not apply to a system which heats or stores water for the purposes only of an industrial process; and

Requirement G3 (4) applies only when a dwelling is:

(a) erected, and
(b) formed by a material change of use within the meaning of regulation 5(a) or 5(b), where the building is to be used as either a dwelling or a flat where previously it was not.

Note also that G3 only requires a supply of hot water to:

- any washbasin provided in association with a sanitary convenience (see Requirement G4 (2));
- any washbasin, bidet, fixed bath or shower in a bathroom in a dwelling or provided for rooms for residential purposes, in accordance with Requirement G5; and
- any sink in a food preparation area, provided in accordance with Requirement G6.

The delivered hot water can be considered as heated wholesome water or heated softened wholesome water where:

(a) the cold water supply to the hot water system is wholesome or softened wholesome; and
(b) the installation complies with the requirements of:
'*Water supply (water fittings) regulations 1999*', SI 1999/1148 as amended.

Whichever system is in place, the pipework should be such that the transfer time between the hot water storage system and the hot water outlets is minimised.

Table 12.7 Part G3: Hot water supply and systems.

Part	Requirement	Provision to meet the requirement
G3(1)	There must be a suitable installation for the provision of heated wholesome water or heated wholesome softened water to: (a) Any washbasin or bidet provided in or adjacent to a room containing a sanitary convenience; (b) Any washbasin, bidet, fixed bath and shower in a bathroom; and (c) Any sink provided in any area where food is prepared	(a) The installation conveys hot water to the sanitary appliances and locations specified in the requirement without waste misuse or undue consumption of water (b) The water supplied is heated wholesome water or heated softened water
G3(2)	A hot water system, including any cistern or other vessel that supplies water to or receives expansion water from a hot water system, shall be designed, constructed and installed so as to resist the effects of temperature and pressure that may occur either in normal use or in the event of such malfunctions as may reasonably be anticipated and must be adequately supported	All components of the hot water system including any cistern that supplies water to or receives water from the hot water system continues to safely contain the hot water: (a) During normal operation of the hot water system; (b) Following the failure of any thermostat used to control temperature; and (c) During operation of any of the safety devices fitted in accordance with G3(3)
G3(3)	A hot water system that has a hot water storage vessel shall incorporate precautions to: (a) Prevent the temperature of the water stored in the vessel at any time exceeding 100°C; and (b) Ensure that any discharge from the safety devices is safely conveyed to where it is visible but will not cause a danger to persons in or about the building	For both vented and unvented systems: The hot water system pipework allows for the discharge of hot water from safety devices to an appropriate place open to the atmosphere without causing dangers to persons in or near the building For a vented hot water storage vessel: (a) The storage vessel has a suitable vent pipe connecting the top of the vessel to a point open to the atmosphere over the cold water storage cistern and above the level of the water in it; and (b) In addition to any thermostat, either the heat source or the storage vessel is fitted with a device to prevent the stored water exceeding 100 °C at any time For an unvented hot water storage vessel: • In addition to any thermostat, the storage vessel has at least two independent safety devices such as those that release pressure and so prevent the temperature of the stored water exceeding 100°C at any time
G3(4)	The hot water supply to any fixed bath must be so designed and installed as to incorporate measures to ensure that the temperature of the water that can be delivered to that bath does not exceed 48°C	The hot water outlet temperature is appropriate to the appliance being served, and any device to limit the maximum temperature at the outlet must not be easily altered by building users

12.5.1 Related safety considerations

A hot water system requires the consideration of several additional safety conditions, some relating to the hot water itself and some to the sources which generate and control the heating process. These requirements must be observed and are listed in Table 12.8.

12.5.2 Design and installation of hot water storage systems

All hot water storage systems should conform to all appropriate sections of the following standards:

BS 6700:2006+A1:2009 '*Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Specification*'
BS EN 12897:2006 '*Water supply. Specification for indirectly heated unvented (closed) storage water heaters*'

The hot water storage vessels themselves should conform to all appropriate sections of the following standards, or other relevant national standards:

BS 853-1:1996 '*Specification for vessels for use in heating systems. Calorifiers and storage vessels for central heating and hot water supply*'
BS 1566-1:2002+A1:2011 '*Copper indirect cylinders for domestic purposes. Open vented copper cylinders. Requirements and test methods*'

Table 12.8 Related safety requirements.

Commodity	**Safety requirement**	**Regulatory guide/instrument**
Water	Prevention of contamination, waste, misuse, undue consumption, erroneous metering	*The water supply (water fittings) regulations* *Water regulations guide*
Water (workplaces and premises controlled in connection with a trade, business, etc.)	Prevention of legionnaires disease	*Legionnaires disease: Control of legionella bacteria in water systems*, Approved code of practice and guidance L8, Health and Safety Commission 2000, ISBN 0717617726
Water (systems used solely for supplying water for industrial purposes)	Safe design and operation of pressure systems	*Pressure systems safety regulations 2000*, SI 2000/128 *Safety of pressure systems*, Approved code of practice L122, HSE Books 2000, ISBN 071781767X
Gas	Safe use of gas	*Gas safety (installation and use) regulations 1994*, SI 1994/1886
Electricity	Safe use of electricity in association with hot water systems	BS 7671:2008 *Requirements for electrical installations (IEEE wiring regulations 17th edition)*
Electricity	Electrical safety in dwellings and associated buildings	Building regulations Approved Document P

BS 3198:1981 '*Specification for copper hot water storage combination units for domestic purposes*'

Vented hot water storage systems

A vented system must have:

- a vent pipe;
- a safety device which is able to disconnect the supply of heat to the storage vessel;
- a safety device to safely discharge the water in the event of significant overheating; and
- a cold water storage cistern into which the vent pipe discharges.

The vent pipe, which must have an internal diameter of at least 19 mm, must lead from the top of the hot water storage vessel to point open to the atmosphere and above and over the level of water in the cold water storage cistern.

The safety devices must be in addition to any thermostat controlling the temperature of the stored water. In order to disconnect the supply of heat, the device:

- should, for direct heat sources, be a non-self-resetting energy cut-out which activates in the event of the storage system overheating; and
- should, for indirect sources, be an overheat cut-out which activates in the event of the stored water overheating so that the stored water does not exceed 100 C.

In order to safely discharge water, the device could be a temperature relief valve or a combined temperature and pressure relief valve.

The cold water storage cistern should conform as appropriate to either of the following:

BS 417-2:1987 '*Specification for galvanized low carbon steel cisterns, cistern lids, tanks and cylinders. Metric units*'
BS 4213:2004 '*Cisterns for domestic use. Cold water storage and combined feed and expansion (thermoplastic) cisterns up to 500 litres. Specification*'

The cistern must be supported over the whole area of its bottom by a flat level rigid platform capable of withstanding the weight of the cistern when full to the brim with water. The platform should extend at least 150 mm in any direction beyond the maximum dimensions of the cistern and should be positioned so that the cistern is accessible for maintenance and replacement. If it is replaced, the platform must, if necessary, be upgraded to satisfy all the requirements.

Unvented hot water storage systems

Unvented systems must be protected against the build-up of excessive pressure. The protection must include as a minimum:

- a thermostat to control the temperature of the stored water; and
- in addition to the thermostat, at least two independent safety devices.

A typical solution would be to provide in addition to the water temperature thermostat:

- a non-self-resetting energy cut-out which will disconnect the supply of heat in the event of system overheating; and
- a temperature relief valve (or a combined temperature and pressure relief valve) which, in the event of serious overheating, will discharge water safely.

Alternative methods of protection are acceptable provided they can be shown to give the same or better level of safety.

As well as the above, unvented systems have additional safety requirements which depend on the water capacity of the storage vessel, as shown in Table 12.9.

Any unvented hot water storage system unit or package should be indelibly marked with the following:

- The manufacturer's name and contact details;
- A model reference;
- The rated storage capacity of the storage water heater;
- The operating pressure of the system and the operating pressure of the expansion valve;
- The relevant operating data on each of the safety devices fitted; and
- For indirect units or packages, the maximum primary circuit pressure and flow temperature.

In addition, the unit or package must be indelibly marked with a warning label, clearly visible after installation, as shown in Fig. 12.1.

Table 12.9 Additional safety requirements.

Storage system capacity	**Safety requirements**
0 to 15 litres	Water heaters in this range that are fitted with appropriate safety devices for temperature and pressure will generally be considered satisfactory
15 to 500 litres and a power input up to 45 kW	(a) If the heat supply is indirect and incorporates a boiler, the energy cut-out must be on the boiler
	(b) The hot water storage system should be a propriety unit or package and should meet an appropriate standard as shown below
Over 500 litres and a power input above 45 kW	A system of this size should be in the form of a proprietary hot water storage system unit or package and should meet an appropriate standard as shown below
Standards	BS EN 12897:2006 '*Water supply. Specification for indirectly heated unvented (closed) hot water storage systems*'
	BS 6700:2006+A1:2009 '*Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Specification*'

WARNING to USER

a) DO NOT remove or adjust any component part of this unvented water heater - contact the installer.

b) If this unvented water heater develops a fault, such as a flow of hot water from the discharge pipe, switch the heater OFF and contact the installer.

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WARNING to INSTALLER

a) This installation is subject to the Building Regulations

b) Use only appropriate components for installation or maintenance

Installed by:

Name . . . .

Address . . . .

Tel. No. . . . .

Completion date . . . .

Fig. 12.1 Unvented hot water system warning label.

12.5.3 Safety devices

Non-self-resetting cut-outs

Non-self-resetting cut-outs may only be used where, on being activated, they are able to instantly disconnect the energy supply to the storage vessel. They must conform as appropriate to the following standards:

BS EN 60335-2-73:2003+A2:2009 '*Household and similar electrical appliances. Safety. Particular requirements for fixed immersion heaters*'
BS EN 60730-2-9:2010 '*Automatic electrical controls for household and similar use. Particular requirements for temperature sensing controls*'
BS EN 257:2010 '*Mechanical thermostats for gas-burning appliances*'

There are four additional considerations:

- If the cut-out disconnects the supply of energy by operating some other device (e.g. a motorised valve), i.e. it operates indirectly, the complete unit (cut-out and other device) must either satisfy as appropriate as the above standards, or the supplier or installer must be able to demonstrate that the complete unit has an equivalent performance.
- If the cut-out, with or without some other device, depends on a source of electricity, it should operate if that source of electricity is disconnected or fails.
- If the storage vessel is supplied by more than one heat source, there should be separate non-self-resetting cut-outs for each heat source.
- If there is more than one cut-out, each should be independent of the others.

Temperature and pressure relief devices

Temperature relief valves and combined temperature and pressure relief valves should *not* be used in systems which have no provision to replenish the stored water (e.g. unvented primary thermal storage vessels). In such cases there should be a second independent non-self-resetting cut-out.

In all other circumstances, if it is relevant to do so, appropriate pressure, temperature or combined temperature/pressure activated safety devices should be fitted in addition to an energy cut-out. Requirements for these devices are given in Table 12.10.

Unvented hot water systems are a potential source of danger, and so the installer must be able to demonstrate that he has the necessary knowledge and skills. The installer should therefore be registered with an appropriate competent person scheme or hold a current registered operative skills certification card for unvented hot water systems.

If the installer is registered with a competent person scheme for the installation of unvented hot water systems, it will not be necessary to notify the BCB in advance. The installer will self-certify that the work complies, and the certificate of building regulation compliance will normally be issued by the competent person scheme operator. If the installer is not so registered, the work must be notified to the BCB before commencement, and the BCB may check for compliance.

12.5.4 Electric water heating and solar water heating

Electric water heating and solar water heating must comply with the appropriate standard as shown in Table 12.11.

Solar water heating systems should also take into account:

- the need for an additional heat source to be available;
- the need to operate the additional heat source, when necessary, to maintain water temperature to restrict microbial growth; and

Table 12.10 Requirements for temperature and pressure relief devices.

Valve type	Requirement
Temperature relief valve	Should be located directly on the storage vessel so that the stored water does not exceed 100 °C
	In hot water storage system, units should be factory fitted and should not be disconnected except in order to replace
	In hot water storage system, units should not be located in any other device or fitting
	Should conform to: BS 6283-2:1991 '*Safety and control devices for use in hot water systems. Specifications for temperature relief valves for pressures from 1 bar to 10 bar*'
	Should be sized to give a discharge rating at least equal to the total power input to the hot water storage system when measured in accordance with Appendix F of BS 6283-3:1991
Combined temperature and pressure relief valve	Should be located directly on the storage vessel so that the stored water does not exceed 100°C
	Should conform to: BS EN 1490:2000 '*Building valves. Combined temperature and pressure relief valves. Tests and requirements*'

Table 12.11 Standards and guidance for electric and solar water heating.

Electric water heating	**Standards and guidance**
Fixed immersion heaters	BS EN 60335-2-73:2003+A2:2009 '*Household and similar electrical appliances. Safety. Particular requirements for fixed immersion heaters*'
Instantaneous water heaters	BS EN 60335-2-35:2002 '*Household and similar electrical appliances. Safety. Particular requirements for instantaneous water heaters*'
Storage water heaters	BS EN 60335-2-21:2003+A2:2008 '*Household and similar electrical appliances. Safety. Particular requirements for storage water heaters*'
Solar water heating	
Factory-made systems	BS EN 12976-1:2006 '*Thermal solar systems and components. Factory made systems. General requirements*'
Custom-built systems	'*Thermal solar systems and components. Custom built systems. General requirements for solar water heaters and combisystems*', DD CEN/TS 12977-1:2010, or
	BS 5918:1989 '*Code of practice for solar heating systems for domestic hot water*'
General guidance on solar systems	'*Solar heating design and installation guide*', CIBSE technical guide, 2007, ISBN: 9781903287842, or
	'*Guide G: Public health engineering*', CIBSE, 2004, ISBN: 1903287421

- the potential for elevated temperatures and pressures in solar systems and the need for all components to be rated to operate at the anticipated maximum temperature and pressure.

12.5.5 Discharge pipes from safety devices

When a temperature relief valve or a combined temperature and pressure relief valve opens, the resulting discharge will normally be dangerous due to its high temperature and/or pressure and must therefore be conveyed safely to a suitable discharge point. There are four components in the discharge system (see Fig. 12.2):

- A first discharge pipe from the valve to a tundish;
- A tundish to provide a visible indication that the relief valve is in operation and to provide an air break to the flow;
- A second discharge pipe from the tundish to the final discharge point; and
- The final discharge point.

Each of these components must meet certain minimum specifications. Table 12.12 lists the basic requirements for the most common arrangement.

In addition to the basic requirements listed in Table 12.12, there are additional considerations for the design of discharge systems. These include:

- detailed sizing of the pipework;
- alternative materials;

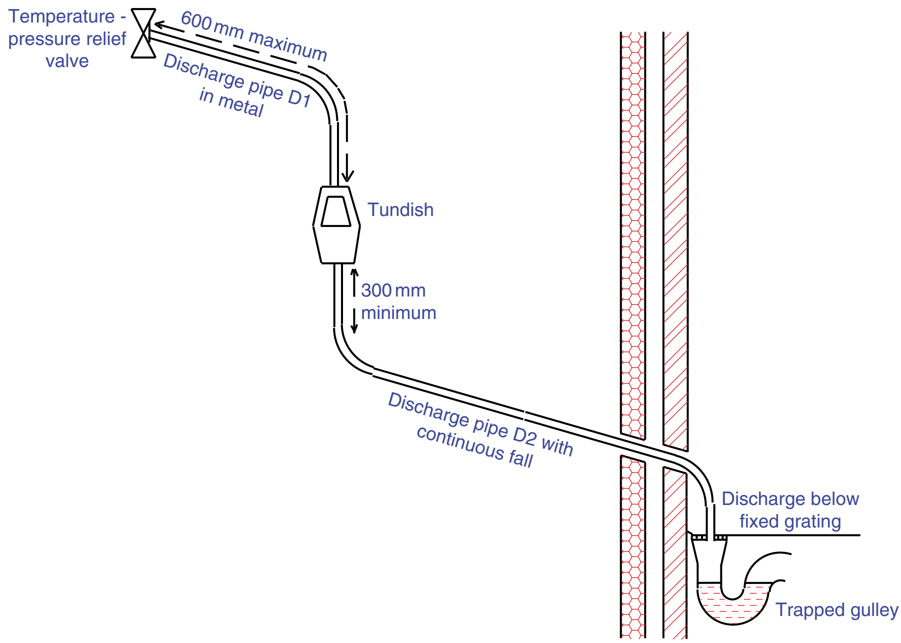


Fig. 12.2 Discharge pipe arrangement.

- more than one relief valve; and
- conditions for discharge to a soil stack.

Detailed sizing of discharge pipes

The dimensions of the first discharge pipe, D1, are as stated in Table 12.12. However the second discharge pipe, D2, must be sized so that its total flow resistance does not exceed specified limits. Table 12.13 gives details for copper pipework for typical relief valve outlet sizes.

The procedure for using Table 12.13 can be illustrated by means of an example. Assume that a temperature relief valve of size $G_{3/4}$ is connected to a tundish and then to copper discharge pipe, D2, of overall length 8 m with two bends and one elbow. From Table 12.13, we choose D1 to be 22 mm and make an initial choice of 28 mm for D2. With this choice we find:

Maximum permitted resistance of D2 = 9 m of 28 mm straight pipe

The actual equivalent resistance = 8 m plus 2 bends and 1 elbow at 1 m each

$$= 8 + 3 \times 1.0 = 11\text{m}.$$

This exceeds the permitted 9 m, and so we now choose the next size up, i.e. 35 mm:

Maximum permitted resistance of D2 = 18 m of 35 mm straight pipe

The actual equivalent resistance of our pipe = 8 m plus 2 bends and 1 elbow at 1.4 m each

$$= 8 + 3 \times 1.4 = 12.2\text{m}.$$

Table 12.12 Discharge from safety devices: component requirements.

Component	Requirement	
First discharge pipe, D1	Material:	metal pipe
	Diameter:	not less than the nominal outlet size of the relief valve
	Length:	not more than 600 mm
Tundish	Orientation:	mounted vertically and incorporating an air gap
	Location:	in the same space as the unvented hot water storage system
	Position:	as close as possible to and lower than the relief valve
Second discharge pipe, D2	Material:	metal
	Diameter:	at least one pipe size larger than the nominal outlet size of the relief valve, but see Table 12.11 for details of sizing
	Dimensions:	a vertical section, with no elbows or bends, at least 300 mm long below the tundish, followed thereafter by a continuous fall of at least 1 in 200, and total maximum flow resistance as per Table 12.11
Final discharge point	Located such that the discharge is visible and in a safe place where there is no risk to persons, examples being: (a) To a trapped gully with end of pipe below a fixed grating but above the water seal; (b) Downward discharge to a flat surface at low level (not more than 100 mm above that surface) and protected by a guard which allows visibility (e.g. a wire cage); (c) At high level, into, for example, a metal hopper and metal downpipe, or onto a roof capable of withstanding high temperature water, and at least 3 m from materials (e.g. plastic guttering) that would be damaged by the high temperature water; and (d) To a soil discharge stack but only if certain conditions are met (see text)	

Table 12.13 Sizing of discharge pipe D2 for copper.

Valve outlet size	Minimum size of D1	Minimum size of D2	Maximum permitted resistance, equivalent of straight pipe	Equivalent resistance of each elbow or bend
$G_{1/2}$	15 mm	22 mm	up to 9 m	0.8 m
		28 mm	up to 18 m	1.0 m
		35 mm	up to 27 m	1.4 m
$G_{3/4}$	22 mm	28 mm	up to 9 m	1.0 m
		35 mm	up to 18 m	1.4 m
		42 mm	up to 27 m	1.7 m
G_1	28 mm	35 mm	up to 9 m	1.4 m
		42 mm	up to 18 m	1.7 m
		54 mm	up to 27 m	2.3 m

Note:
Pipes in materials other than copper (e.g. plastic) should be sized using data appropriate to the material.

This is less than the permitted maximum of 18 m and is therefore acceptable.
An alternative method for sizing discharge pipes is given in Annex D of:

BS 6700:2006+A1:2009 '*Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Specification*'.

Alternative materials

Any material other than metal used as pipework in the discharge system must be capable of withstanding the highest water temperature it may encounter. Such pipework must be clearly and permanently marked to identify the product and a relevant performance standard, for example:

BS 7291-1:2010 '*Thermoplastics pipe and fitting systems for hot and cold water for domestic purposes and heating installations in buildings. General requirements*'.

Also, for plastic pipes in polybutylene (PB):

BS 7291-2:2010 '*Thermoplastics pipe and fitting systems for hot and cold water for domestic purposes and heating installations in buildings. Specification for polybutylene (PB) pipe and associated fittings*'

and for plastic pipes in polyethylene (PE-X):

BS 7291-3:2010 '*Thermoplastics pipe and fitting systems for hot and cold water for domestic purposes and heating installations in buildings. Specification for crosslinked polyethylene (PE-X) pipes and associated fittings*'

The assembling and jointing of plastic fittings should be in accordance with:

BS EN ISO 1043-1:2002 '*Plastics. Symbols and abbreviated terms. Basic polymers and their special characteristics*'.

More than one relief valve

Where the second discharge pipes (D2) from more than one system or relief valve feed into a single common discharge pipe, the common pipe should be at least one pipe size larger than the largest of the individual second discharge pipes to be connected.

Conditions for discharge to a soil stack

The discharge pipe (D2) should only be connected to a soil discharge stack if that stack can withstand the highest water temperature it may encounter. If this is so then:

- the discharge pipe should contain a mechanical seal, not incorporating a water trap, which allows water to pass into the branch pipe without allowing foul air to vent through the tundish;
- the branch pipe should be a separate branch pipe with no sanitary appliances connected to it;

- the branch pipe should be continuously marked with a warning that sanitary appliances should not be connected to it; and
- where pipes cannot be connected to the stack, it may be possible to route a dedicated pipe alongside or close to the discharge stack.

12.5.6 Prevention of excessive temperatures and scalding

There are several circumstances in which the domestic hot water in a storage vessel may exceed 80°C in normal operating conditions. Typically this can occur when:

- the vessel is used as a heat store; and
- the heat source is a solar collector or solid fuel boiler without intervening controls between the boiler and the hot water vessel.

In these circumstances, the outlet from the storage vessel should be controlled to limit the temperature of the water supplied to the domestic hot water system to a maximum of 60 °C. This can be done by means of an in-line tempering valve in accordance with:

BS EN 15092:2008 '*Building valves. Inline hot water supply tempering valves. Tests and requirements*'.

In order to prevent scalding, the hot water supply temperature to a bath should be limited to a maximum of 48 C. To achieve this, a temperature control device with a maximum temperature stop, and which will fail safe, should be fitted. Typically, the device can be an in-line blending valve and may be used, the relevant standards being:

BS EN 1111:1999 '*Sanitary tapware. Thermostatic mixing valves (PN 10). General technical specification*'; and
BS EN 1287:1999 '*Sanitary tapware. Low pressure thermostatic mixing valves. General technical specifications*'.

Such valves should not be easily altered by building users.

The supply pipes between in-line blending valves and final outlets should be kept short to prevent colonisation of waterborne pathogens. If the bath is used intermittently, high temperature flushing may be needed to 'pasteurise' the pipes and fittings. The pasteurisation should be managed to avoid the risk of scalding due to inadvertent use.

Additional information is given in:

'*Preventing hot water scalding in bathrooms: Using TMVs*', BRE information paper IP14/03,

and for hospitals and care homes and similar establishments:

'*Safe hot water and surface temperatures policy and procedure*', Doncaster NHS Primary Care Trusts, Policy no. G45, 2007.

Table 12.14 Part G4: Sanitary conveniences and washing facilities.

Part	Requirement	Provision to meet the requirement
G4(1)	Adequate and suitable sanitary conveniences must be provided in rooms provided to accommodate them or in bathrooms	Provide conveniences appropriate to the building and sufficient in number and type for the sex and age of those who use the building
G4(2)	Adequate handwashing facilities must be provided in: (a) Rooms containing sanitary conveniences; or (b) Rooms or spaces adjacent to rooms containing sanitary conveniences	Handwashing facilities should be sited, designed and installed so as not to be prejudicial to health. Where both hot and cold taps are provided on a sanitary appliance, the hot tap should be on the left
G4(3)	Any room containing a sanitary convenience, a bidet, or any facility for washing hands provided in accordance with paragraph G4(2)(b) must be separated from any kitchen or any area where food is prepared	

12.6 Part G4: Sanitary conveniences and washing facilities

The requirements of G4 are given in Table 12.14.

In addition to the G4 requirement, sanitary conveniences and washing facilities must adhere to several other requirements and recommendations, which should be referred to as follows:

Accessibility

Approved Document M, '*Access to and use of buildings*', volumes 1 and 2;

Water Supply (Water Fittings) Regulations 1999 (SI 1999/1148 as amended), '*Regulator's performance specification*'

Ventilation

Approved Document F, '*Ventilation*'

Workplaces (number, type and siting etc. of sanitary conveniences)

Workplace (Health, Safety and Welfare) Regulations 1992, and the associated Approved Code of Practice

For guidance on calculation of minimum numbers, consult http://www.hse.gov.uk/pubns/indg293.pdf

Food safety

Food Standards Agency Code of Practice, '*Food hygiene – A guide for businesses*'

Design, Installation and maintenance

BS 6465-1:2006+A1:2009, '*Sanitary installations. Code of practice for the design of sanitary facilities and scales of provision of sanitary and associated appliances*'

BS 6465-2:1996 '*Sanitary installations. Code of practice for space requirements for sanitary appliances*'

BS 6465-3:2006 '*Sanitary installations. Code of practice for the selection, installation and maintenance of sanitary and associated appliances*'

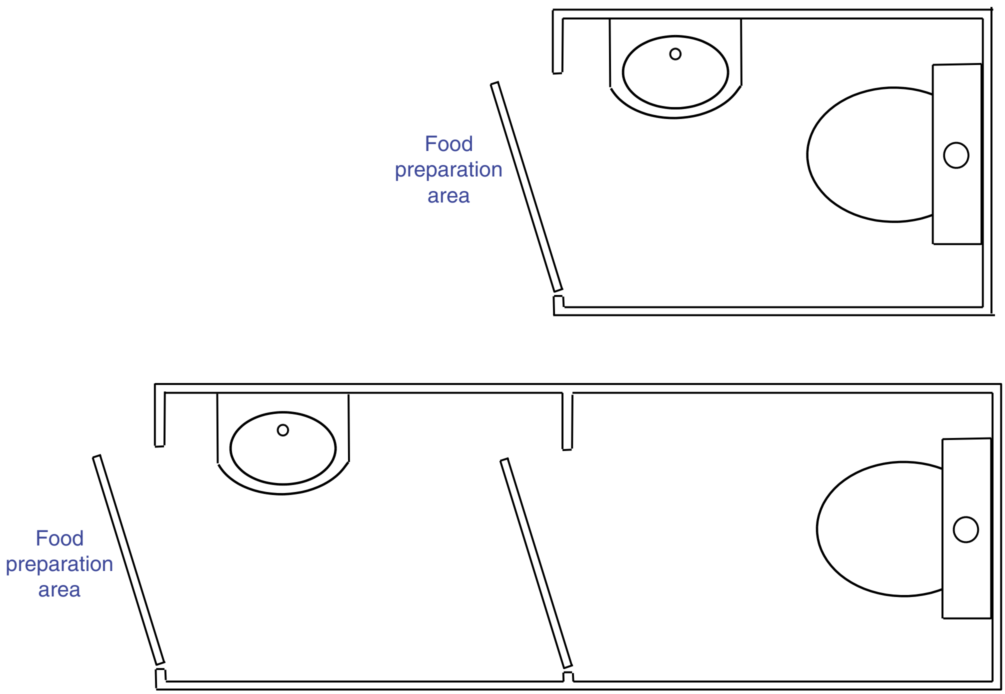


Fig. 12.3 Separation between WC and food preparation area.

12.6.1 Dwellings: Provision and layout

A dwelling must have at least one sanitary convenience and associated handwashing facility. If there is more than one, every convenience should have an associated handwashing facility. If there is only one, it should (see AD M) be located in the principal entrance storey of the dwelling.

The handwashing facility should be located either in:

- the room containing the sanitary convenience; or
- in a room (or place) that gives sole means of access to the room where the sanitary convenience is located.

Neither the room containing the sanitary convenience nor (if separate) the room containing the associated handwashing facility should be used for food preparation and should be separated from a food preparation area (including a kitchen) by a door, as shown in Fig. 12.3.

12.6.2 Buildings other than dwellings: Provision and layout

In addition to the requirements given in the various standards and recommendations for the number and type of sanitary conveniences, AD G4 states that a sanitary convenience should be provided in:

- a self-contained room which also contains a handwashing facility;
- a cubicle with shared handwashing facilities located in a room containing a number of cubicles; or
- a self-contained room with handwashing facilities provided in an adjacent room.

A place containing a sanitary convenience and/or associated handwashing facilities should be separated by a door from:

- any place used for the preparation of food;
- a kitchen; and
- a workplace.

12.6.3 Chemical and composting toilets

These may be used where:

- suitable arrangements can be made for the disposal of the waste either on or off the premises;
- the waste can be removed without carrying it through any living space or food preparation area; and
- no part of the installation is sited in any place where it might be rendered ineffective by the entry of flood water.

Composting toilets should not be connected to any energy source except for the purposes of ventilation or sustaining the composting process.

There is no British or European standard presently available for composting toilets. Guidance can be found an American standard:
'*Non-liquid saturated treatment systems*', NSF/ANSI 41:2005, Addendum 1:2007.

12.6.4 Discharge to drains

This is also covered in Approved Document H1, '*Sanitary pipework and drainage*'.

A WC fitted with a flushing mechanism should discharge to an adequate system of drainage. A urinal should discharge through a grating, a trap or mechanical seal and a branch pipe to a discharge stack or a drain.

A WC fitted with a macerator or pump may be connected to a small bore drainage system provided:

- there is also access to a WC discharging directly to a gravity system; and
- the macerator and pump meet the requirements of the following standards:

BS EN 12050-1:2001 '*Wastewater lifting plants for buildings and sites. Principles of construction and testing. Lifting plants for wastewater containing faecal matter*'; and

BS EN 12050-3:2001 '*Wastewater lifting plants for buildings and sites. Principles of construction and testing. Lifting plants for wastewater containing faecal matter for limited applications*'.

12.7 Part G5: Bathrooms

Requirement G5 applies only to dwellings and to buildings containing one or more rooms for residential purposes. The requirements of G5 are given in Table 12.15.

The standards given for Part G4 above are also applicable to bathrooms, with the addition of the following:

For backflow protection on taps, including mixer fittings and hose connections, Supply (Water Fittings) Regulations 1999 (SI 1999/1148 as amended);
For electrical safety, Approved Document P.

12.7.1 Dwellings: Provision and layout

A dwelling (including houses and flats) must have at least one bathroom with a washbasin and a fixed bath or shower.

12.7.2 Buildings with rooms for residential purposes: Provision and layout

The number of fixed baths or showers and washbasins should be in accordance with BS 6465-1:2006 and A1:2009 (see section 12.5).

12.7.3 Discharge to drains

The guidance on sanitary appliances used for personal washing (and also when the appliance fitted with a macerator and pump) is the same as that for Part G4 (see section 12.5.4).

12.8 Part G6: Food preparation areas

The G6 requirement is given in Table 12.16.

For dwellings, any area includes kitchens. Where a dishwasher is provided in a separate room that is not the principal place for food preparation, an additional sink need not be provided in that room.

Table 12.15 Part G5.

Part	Requirement
G5	A bathroom must be provided containing a wash basin and either a fixed bath or shower

Table 12.16 Part G6.

Part	Requirement
G6	A suitable sink must be provided in any area where food is prepared

Buildings other than dwellings require the same provision as dwellings. However, in buildings where the Food Hygiene Regulations apply, separate handwashing facilities may be needed, in addition to any handwashing facilities associated with WCs required by AD G4. The specific regulations are:

Food Hygiene (England) Regulations 2006 (SI 2006/14); or
Food Hygiene (Wales) Regulations 2006 (SI 2006/31 W5).

The discharge to drains follows the same guidance as is given for AD G4 (see section 12.5.4). Food Hygiene (England) Regulations 2006 (SI 2006/14).

13 Drainage and waste disposal (Part H)

13.1 Introduction

This chapter describes Part H of Schedule 1 to the Building Regulations 2010 (as amended) and the associated Approved Document H. Together, these documents cover:

- Foul water drainage (H1);
- Wastewater treatment systems and cesspools (H2);
- Rainwater drainage (H3);
- Building over existing sewers (H4);
- Separate systems of drainage (H5); and
- Solid waste storage (H6).

Part H was substantially revised in 2002, and the 2002 edition of Approved Document H draws together not only guidance on the drainage items listed above but also a certain amount of information on legislation related to drainage and waste disposal under the following headings:

- Repairs, alterations and discontinued use of drains and sewers (Appendix H1-B)
- Adoption of sewers and connection to public sewers (Appendix H1-C)
- Maintenance of wastewater treatment systems and cesspools (Appendix H2-A)
- Relevant waste collection legislation (Appendix H6-A).

The 2010 edition of Approved Document H reflects changes made as a result of the Building Regulations 2010 and the Building (Approved Inspector, etc.) Regulations 2010. The changes mainly reflect regulation number changes as a result of reordering.

13.2 Repairs, alterations and discontinued use of drains and sewers

Reconstruction and alteration to existing drains and sewers are deemed to constitute a material alteration of a controlled service under the Building Regulations and should be carried out to the same standards as new drains and sewers. Therefore,

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

where new drainage is connected to existing pipework, the following points should be considered.

- Existing pipework should not be damaged (e.g. use proper cutting equipment when breaking into existing drain runs).
- The resulting joint should be watertight (e.g. by making use of purpose made repair couplings).
- Care should be taken to avoid differential settlement between the existing and new pipework (e.g. by providing proper bedding of the pipework).

Even though the Building Regulations do not cover requirements for ongoing maintenance or repair of drains or sewers, sewerage undertakers and local authorities have a variety of powers under other legislation to make sure that drains, sewers, cesspools, septic tanks and settlement tanks do not deteriorate to the extent that they become a risk to public health and safety. This includes powers to ensure that:

- adequate maintenance is carried out
- repairs and alterations are properly carried out
- disused drains and sewers are sealed.

Requirements for inspection, maintenance, repairs and alterations

Section 48 of the Public Health Act 1936 (*power of relevant authority to examine and test drains etc. believed to be defective*) enables a local authority to examine and test any drain or sewer where it feels that it has reasonable grounds for believing that the drain is in such a condition:

- as to be prejudicial to health or a nuisance (for example it may be harbouring rats); or is so defective as to admit subsoil water (where the drain or private sewer connects indirectly with a public sewer).

Similar powers exist to enable sewerage undertakers to examine and test drains and private sewers under section 114 of the Water Industry Act 1991 (*power to investigate defective drain or sewer*).

Section 59 of the Building Act 1984 (*drainage of building*) allows a local authority to require a building owner to carry out remedial works on soil pipes, drains, cesspools or private sewers where these are deemed to be:

- insufficient for adequately draining the building
- prejudicial to health or a nuisance
- so defective as to admit subsoil water.

Section 59 also applies to disused cesspools, septic tanks or settlement tanks where these are considered to be prejudicial to health or a nuisance. The local authority can require the owner or occupier to fill or remove the tank or otherwise render it innocuous.

Under section 60 of the of the Building Act 1984, a pipe for conveying rainwater from a roof may not be used for conveying soil or drainage from a sanitary convenience or as a ventilating shaft to a foul drain. The practical effect of this provision is that all rainwater pipes must be trapped before entering a foul drain.

Section 61 of the Building Act 1984 (*Repair etc. of drain*) requires any person intending to repair, reconstruct or alter a drain to give 24 hours notice to the local authority of their intention to carry out the works. This does not apply in an emergency; however, such work must not be subsequently covered over without giving 24 hours notice. Free access must also be given to the local authority to inspect the works.

Section 17 of the Public Health Act 1961 (*power to repair drains etc. and to remedy stopped-up drains*) provides a swift procedure whereby local authorities may repair or clear blockages on drains or private sewers which have not been properly maintained. The repairs etc. must not cost more than £250 and can only be carried out after a notice has been served on the owner from whom the costs can be recovered.

Section 50 of the Public Health Act 1936 (*overflowing and leaking cesspools*) allows the local authority to take action against any person who has caused by their action, default or sufferance, a septic tank, settlement tank or cesspool to leak or overflow. The person can be required to carry out repairs or to periodically empty the tank. This does not apply to the overflow of treated effluent or flow from a septic tank into a drainage field, provided the overflow is not prejudicial to health or a nuisance. It should be noted that under this section, action can be taken against a builder who had caused the problem, as well as against the owner.

Sealing and/or removal of disused drains and sewers

Disused drains and sewers can be prejudicial to health in that they harbour rats, allow them to move between sewers and the surface, and may collapse causing possible subsidence. Therefore local authorities have a number of powers to control the sealing and removal of such drains and sewers as follows:

- Where a person carries out work which results in any part of a drain becoming permanently disused, under section 62 of the Building Act 1984 (*disconnection of drain*), a local authority may require the drain to be sealed at such points as it directs.
- Section 82 of the Building Act 1984 (*notices about demolition*) allows the local authority to require any person demolishing a building to remove or seal any sewer or drain to which the building was connected (see Chapter 1, section 1.6).
- A local authority can also use its powers under section 59 of the Building Act 1984 (see above) to require an owner of a building to remove or otherwise render innocuous any disused drain or sewer which is a health risk.

Disused drains or sewers should be disconnected from the sewer system as near as possible to the point of connection. Care should be taken not to damage any pipe which is still in use and to ensure that the sewer system remains watertight. Disconnection is usually carried out by removing the pipe from a junction and placing a stopper in the branch of the junction fitting. If the connection is to a public sewer, the sewerage undertaker should be consulted.

Shallow drains or sewers (i.e. less than 1.5 m deep) in open ground should, where possible, be removed. To ensure that rats cannot gain access, other pipes should be grout filled and sealed at both ends and at any point of connection. Larger pipes (225 mm diameter or greater) should be grout filled to prevent subsidence or damage to buildings or services in the event of collapse.

Pollution of watercourses and groundwater

Under section 85 (*offences of polluting controlled waters*) of the Water Resources Act 1991, the Environment Agency has powers to prosecute anyone causing or knowingly permitting pollution of any stream, river, lake or any groundwater. They also have powers under section 161A (*notices requiring persons to carry out antipollution works and operations*) of the Water Resources Act 1991 (as amended by the Environment Act 1995) to take action against any person causing or knowingly permitting a situation in which pollution of a stream, river, lake or groundwater is likely. Such a person can be required to carry out works to prevent the pollution.

Control over solid waste storage

With regard to solid waste storage, all dwellings are now required to have satisfactory means of storing solid waste, and the provision of sections 23(1) and (2) of the Building Act 1984 which required satisfactory means of access for removal of refuse has been replaced by paragraph H4 of Schedule 1 to the Building Regulations 2000 (as amended). This paragraph of the regulations must be read in light of other legislative provisions in respect of refuse disposal. In particular, sections 45 to 47 of the Environmental Protection Act 1990 should be referred to (see Chapter 5) since those sections deal with the removal of refuse and allied matters. Thus, under section 45 of the 1990 Act, a duty is placed on the local authority to collect all household waste in their area, whilst sections 46 and 47 make provision for the removal of trade and other refuse. Section 23(3) of the Building Act 1984 requires the local authority's consent to close or obstruct the means of access by which refuse is removed from a house.

13.3 Sanitary pipework and drainage

Paragraph H1 of Schedule 1 to the Building Regulations 2010 (as amended) requires that an adequate system of drainage must be provided to carry foul water from appliances in a building to one of the following, listed in order of priority:

- A public sewer;
- A private sewer communicating with a public sewer;
- A septic tank which has an appropriate form of secondary treatment or another wastewater treatment system; or
- A cesspool.

Movement to a lower level in the order of priority may only be on the grounds of reasonable practicability. For example, if no public or private sewer was available within a reasonable distance, then a septic tank might be a suitable alternative.

FOUL WATER is defined as waste water which comprises or includes:

- waste from a sanitary convenience, bidet or appliance used for washing receptacles for foul waste, or
- water which has been used for food preparation, cooking or washing.

Where it is proposed to divert water that has been used for personal washing or for the washing of clothes, linen or other articles to a collection system for reuse, then the provisions of requirement H1 will not apply.

Further guidance on the meaning of SANITARY CONVENIENCE is given in the general guidance to Approved Document G where it is defined as a closet or urinal.

FOUL WATER OUTFALL may be a foul or combined sewer, cesspool, septic tank or holding tank. This term is not specifically defined in AD H1; however, the term is inferred from the description of Performance on page 6 of the Approved Document.

The requirements of Paragraph H1 may be met by any foul water drainage system which:

- conveys the flow of foul water to a suitable foul water outfall;
- reduces to a minimum the risk of leakage or blockage;
- prevents the entry of foul air from the drainage system to the building, under working conditions;
- is ventilated;
- is accessible for clearing blockages; and
- does not increase the vulnerability of the building to flooding.

AD H1 sets out detailed provisions in two sections. Section 1 deals with sanitary pipework (i.e. above-ground foul drainage) and is applicable to domestic buildings and small non-domestic buildings. Section 2 deals with foul drainage (i.e. below-ground foul drainage). There is also an appendix (H1-A) which contains additional guidance for large buildings. Complex systems in larger buildings should follow the guidance in BS EN 12056 *Gravity drainage systems inside buildings*.

13.3.1 Above-ground foul drainage

A number of terms are used throughout AD H1. These are defined below and illustrated in Fig. 13.1. It should be noted that these definitions do not appear in the AD:

DISCHARGE STACK – A ventilated vertical pipe which carries soil and waste water directly to a drain.

VENTILATING STACK – A ventilated vertical pipe which ventilates a drainage system either by connection to a drain or to a discharge stack or branch ventilating pipe.

BRANCH DISCHARGE PIPE (sometimes referred to as a BRANCH PIPE) – The section of pipework which connects an appliance to another branch pipe or a discharge stack if above the ground floor or to a gully, drain or discharge stack if on the ground floor.

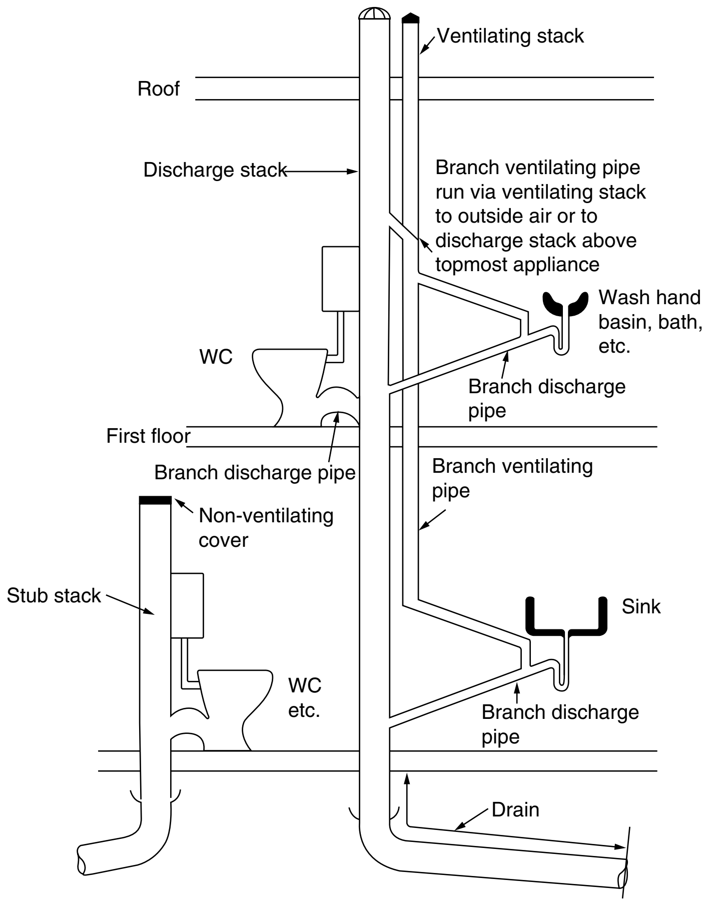


Fig. 13.1 Definitions.

BRANCH VENTILATING PIPE – The section of pipework which allows a branch discharge pipe to be separately ventilated.

STUB STACK – An unventilated discharge stack.

A drainage system, whether above or below ground, should have sufficient capacity to carry the anticipated flow at any point. The capacity of the system, therefore, will depend on the size and gradient of the pipes, whereas the flow will depend on the type, number and grouping of appliances. Table 13.1 is based on information from BS EN 12056 and Table 5 of Section 2 of AD H1 and gives the expected flow rates for a range of appliances.

Since sanitary appliances are seldom used simultaneously, the normal size of discharge stack or drain will be able to take the flow from quite a large number of appliances. Table 5 of AD H1 Section 2 is reproduced below and is derived from BS EN 12056. It shows the approximate flow rates from dwellings and is based on an appliance grouping per household of 1 WC, 1 bath, 1 or 2 washbasins and 1 sink.

Table 13.1 Appliance flow rates.

Appliance	Flow rate (l/s)
WC (9 litre washdown)	2.3
Washbasin	0.6
Sink	0.9
Bath	1.1
Shower	0.1
Washing machine	0.7
Urinal (per person unit)	0.15
Spray tap basin	0.06
Dishwashing machine	0.25

AD H1 section 2

Table 5 Flow rates from dwellings.

Number of dwellings	Flow rate (l/s)
1	2.5
5	3.5
10	4.1
15	4.6
20	5.1
25	5.4
30	5.8

The guidance given in section 1 of AD H1 is applicable for WCs with major flush volumes of 5 litres or more. WCs with flush volumes of less than 5 litres may give rise to an increased risk of blockages; however BS EN 12056 contains guidance on the design of sanitary pipework suitable for WCs with flush volumes as low as 4 litres.

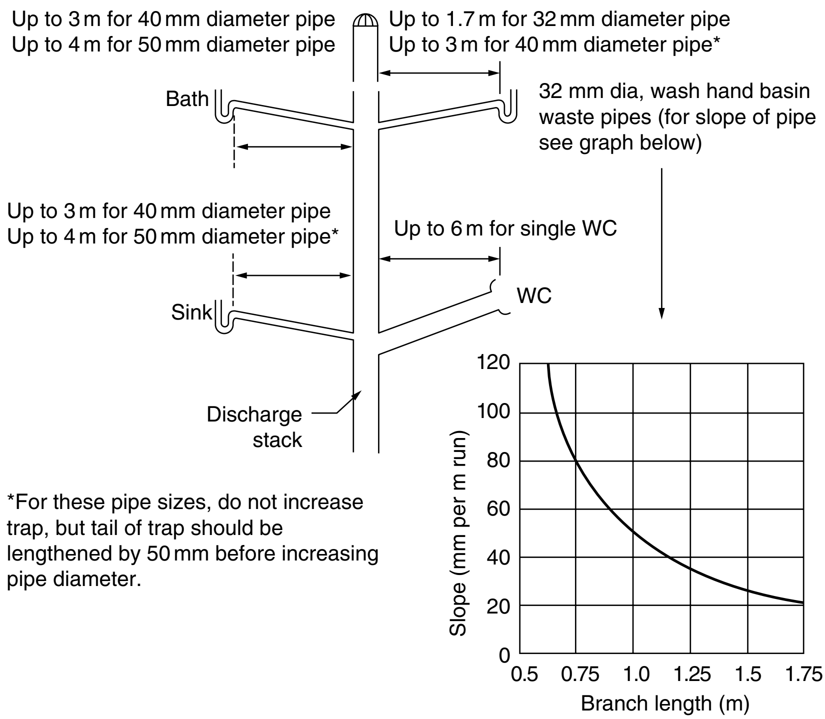
13.3.2 Pipe sizes

Since individual manufacturer's pipe sizes will vary, the sizes quoted in AD H1 are nominal and give a numerical designation in convenient round numbers. Similarly, equivalent pipe sizes for individual pipe standards are given in the standards listed in AD H Tables 4, 7 and 14 reproduced below.

13.3.3 Trap water seals

Trap water seals are provided in drainage systems to prevent foul air from the system entering the building. All discharge points into the system should be fitted with traps, and these should retain a minimum seal of 25 mm or equivalent under test and working conditions.

Traditionally the 'one pipe' and 'two pipe' systems of plumbing have required the provision of branch ventilating pipes and ventilating stacks unless special forms of trap are used. The 'single-stack' system of plumbing obviates the need for these ventilating pipes and is illustrated in Fig. 13.2. Table 13.2, which is based on Table 1 and Table A3 of AD H1, gives minimum dimensions of pipes and traps where it is proposed to use appliances other than those shown in Fig. 13.2.



Appliance	*Minimum diameter of pipe and trap (mm)*	*Depth of trap seal*	*Slope (mm/m)*
Sink	40	75	18–90
Bath	40	50	18–90
WC - outlet <80 mm	75	50	18
WC - outlet >80mm	100	50	18
Washbasin	32	75*	See graph above

* Depth of seal may be reduced to 50 mm only with ush grated wastes without plugs on spray tap basins.

Fig. 13.2 Single stack system: design limits.

It is permissible to reduce the depth of trap seal to 38 mm where washing machines, dishwashers, baths or showers discharge directly to a gully. Additionally, traps used on appliances with flat bottom (trailing waste) discharge which discharge to a gully with a grating may also have a water seal of not less than 38 mm.

It should be stressed that the minimum pipe sizes given above relate to branch pipes serving a single appliance. Where a number of appliances are served by a single branch pipe which is unventilated, the diameter of the pipe should be at least the size given in Table 2 to section 1 of AD H1, which is reproduced below.

Table 13.2 Minimum dimensions of branch pipes and traps.

Appliance	Minimum diameter of pipe and trap (mm)	Depth of trap seal (mm)
Bidet	32	75
Shower	40	75
Food waste disposal unit		
Urinal bowl		
Sanitary towel macerator		
Washing machine		
Dishwashing machine		
Industrial food waste disposal unit	50	75
Urinal stall (1 to 6 person position)	65	50

AD H1 Section 1

Table 2 Common branch discharge pipes (unventilated).

Appliance	Max no. to be connected	Max length of branch pipe (m)	Min size of pipe (mm)	Gradient limits (mm fall per metre)
WC outlet >80 mm	8	15	100	18[1] to 90
WC outlet <80 mm	1	15	75[2]	18 to 90
Urinal – bowl		3[3]	50	
Urinal – trough		3[3]	65	18 to 90
Urinal – slab[4]		3[3]		
Washbasin or bidet	3	1.7	30	18 to 22

Notes:

[1] May be reduced to 9 mm on long drain runs where space is restricted but only if more than one WC is connected.

[2] Not recommended where disposal of sanitary towels may take place via the WC, as there is an increased risk of blockages.

[3] Should be as short as possible to prevent deposition.

[4] Slab urinals longer than seven, persons should have more than one outlet.

If it is not possible to comply with the figures given in Table 13.1, Fig. 13.2 or Table 2, then the branch discharge pipe should be ventilated in order to prevent loss of trap seals. This is facilitated by means of a *branch ventilating pipe* which is connected to the discharge pipe within 750 mm of the appliance trap. The branch ventilating pipe may be run directly to outside air, where it should finish at least 900 mm above any opening into the building which is nearer than 3 m, or it may be connected to the ventilating stack or stack vent above the 'spillover' level of the highest appliance served. In this case it should have a continuous incline from the branch discharge pipe to the point of connection with the stack (see Fig. 13.3).

Where a branch ventilating pipe serves only one appliance, it should have a minimum diameter of 25 mm. This should be increased to 32 mm diameter if the branch ventilating pipe is longer than 15 m or contains more than five bends.

As appliance traps present an obstacle to the normal flow in a pipe, they may be subject to periodic blockages. It is important, therefore, that they be fitted immediately after an appliance and either be removable or be fitted with a cleaning eye. Where a trap forms an integral part of an appliance (such as in a WC pan), the appliance should be removable.

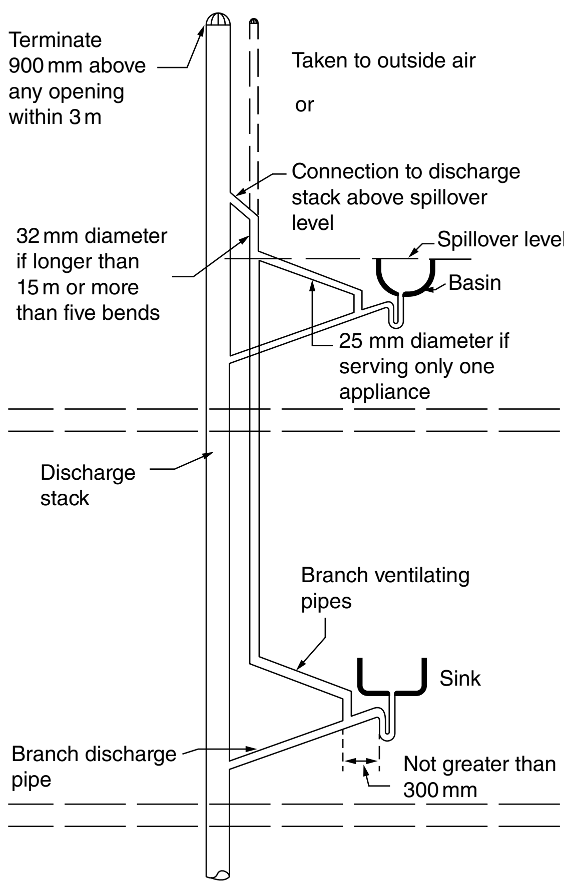


Fig. 13.3 Branch ventilating pipes.

13.3.4 Branch discharge pipes: Design recommendations

In addition to size and gradient, there are other design recommendations for branch discharge pipes that should be adhered to for efficient operation and in order to prevent loss of trap seals.

Branch pipes should only discharge into another branch pipe, a discharge stack or a gully. Gullies are usually at ground floor level but may be situated in a basement and are only permitted to take wastewater. It is not permissible to discharge a branch pipe into an open hopper. Branch pipes to ground floor appliances may also discharge into a stub stack or directly to a drain.

In high buildings especially, back pressure may build up at the foot of a discharge stack and may cause loss of trap seal in ground floor appliances. Therefore, the following recommendations should be followed:

- For multistorey buildings up to five storeys high, there should be a minimum distance of 750 mm between the point of junction of the lowest branch discharge pipe connection and the invert of the tail of the bend at the foot of the discharge stack. This is reduced to 450 mm for discharge stacks in single dwellings up to three storeys high (see Fig. 13.4).
- For appliances above ground floor level, the branch pipe should only be run to a discharge stack, to another branch pipe or to a stub stack (but see also section 13.3.8 for more information on stub stacks).
- Ground floor appliances may be run to a separate drain, gully or stub stack. (A gully connection should be restricted to pipes carrying waste water only.) They may also be run to a discharge stack in the following circumstances:
  (a) In buildings up to five storeys high – without restriction;
  (b) In buildings with 6 to 20 storeys – to their own separate discharge stack; and
  (c) In buildings over 20 storeys – ground and first floor appliances to their own separate discharge stack (see Fig. 13.5).

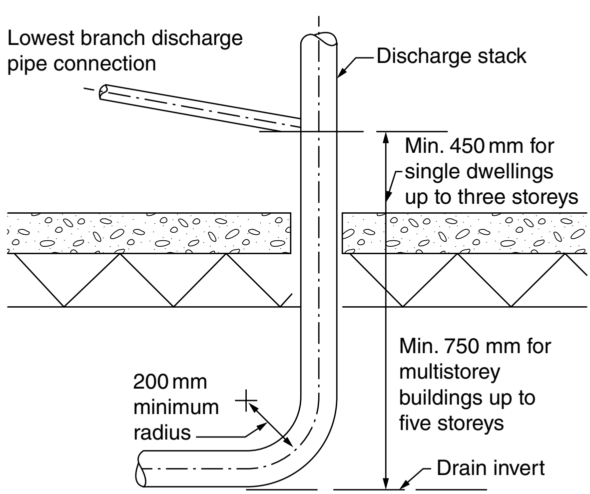


Fig. 13.4 Connection of lowest branch to discharge stack.

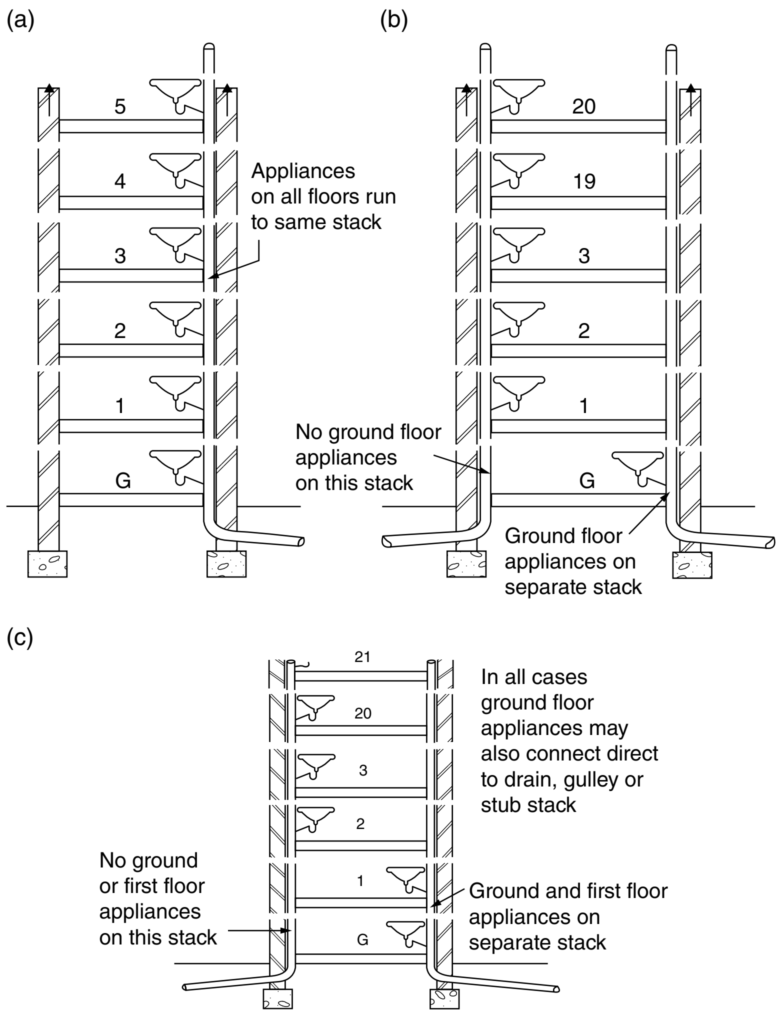


Fig. 13.5 Provision of discharge stacks to ground floor appliances. (a) Up to five storeys, (b) 6 to 20 storeys and (c) over 20 storeys.

Back pressure and blockages may occur where branches are connected so as to be almost opposite to one another. This is most likely to occur where bath and WC branch connections are at or about the same level. Figure 13.6 illustrates ways in which possible cross flows may be avoided.

Additionally, a long vertical drop from a ground floor water closet to a drain may cause self-siphonage of the WC trap. To prevent this, the drop should not exceed 1.3 m from floor level to invert of drain (see Fig. 13.7).

Similarly, there is a chance of siphonage where a branch discharge pipe connects with a gully. This can be avoided by terminating the branch pipe above the water level but below the gully grating or sealing plate (see Fig. 13.7).

Self-siphonage can also be prevented by ensuring that bends in branch discharge pipes are kept to a minimum. Where bends are unavoidable, they should be made with as large

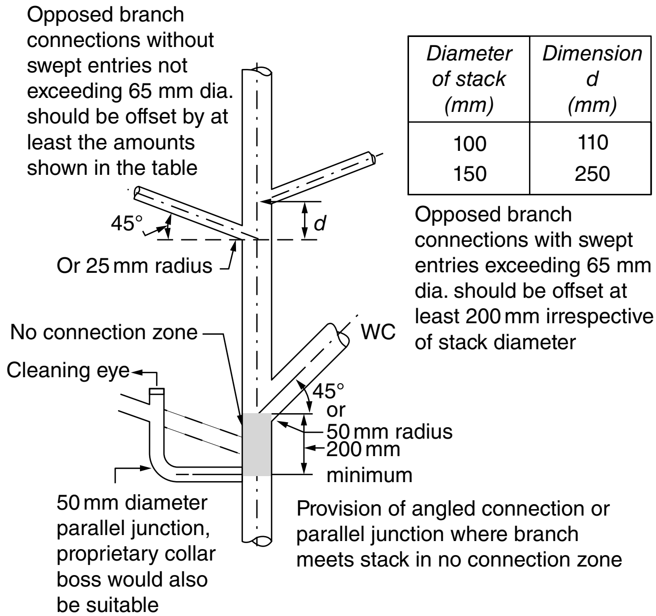


Fig. 13.6 Avoidance of cross flows in discharge stacks.

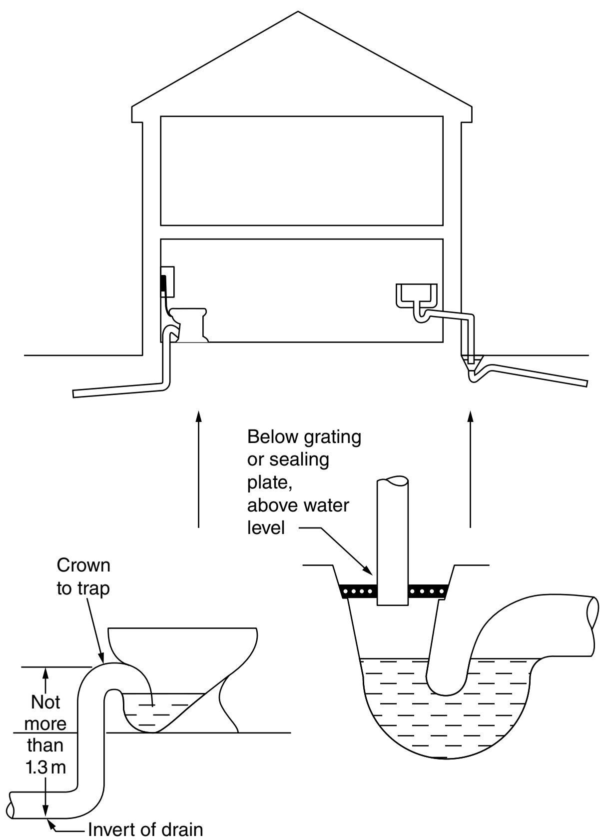


Fig. 13.7 Ground floor connections for water closets and gullies.

a radius as possible. Junctions on branches should be swept in the direction of flow with a minimum radius of 25 mm or should make an angle of 45° with the discharge stack. Where a branch diameter is 75 mm or more, the sweep radius should be increased to 50 mm (see Fig. 13.6). Branch pipes up to 40 mm diameter joining other branch pipes which are 100 mm diameter or greater should, where possible, connect to the upper part of the pipe wall of the larger branch.

Branch discharge pipes should be fully accessible for clearing blockages. Additionally rodding points should be provided so that access may be gained to any part of a branch discharge pipe which cannot be reached by removing a trap or an appliance with an integral trap.

13.3.5 Drainage of condensate from boilers

It is permissible to connect condensate drainage from boilers to sanitary pipework. The connecting pipework should have a minimum diameter of 22 mm and should pass through a 75 mm condensate trap. This can be by means of an additional trap provided externally to the boiler to achieve the 75 mm seal. If this is the case, an air gap should be provided between the boiler and the trap. The following recommendations should also be observed:

- For preference, the connection should be made to an internal stack with a 75 mm condensate trap.
- Any connection made to a branch discharge pipe should be downstream of any sink waste connection.
- All sanitary pipework receiving condensate should be made of materials which can resist a pH value of 6.5 and lower.
- The installation should follow the guidance in BS 6798:2000 *Specification for installation of gas-fired hot water boilers of rated input not exceeding 70 kW. AMD 14908 2005.*

13.3.6 Discharge stacks: Design recommendations

The satisfactory performance of a discharge stack will be ensured if it complies with the following rules:

- The foot of the stack should only connect with a drain and should have as large a radius as possible (at least 200 mm at the centreline).
- Ideally, there should be no offsets in the wet part of a stack (i.e. below the highest branch connection).
- If offsets are unavoidable then:
  (a) buildings over three storeys should have a separate ventilation stack connected above and below the offset; and
  (b) buildings up to three storeys should have no branch connection within 750 mm of the offset.
- The stack should be placed inside a building, unless the building has not more than three storeys. This rule is intended to prevent frost damage to discharge stacks and branch pipes.

AD H1 section 1

Table 3 Minimum diameters for discharge stacks.

Stack size (mm)	Max capacity (l/s)
50*	1.2
65*	2.1
75†	3.4
90	5.3
100	7.2

Note:
* No WCs.
† Not more than one siphonic WC with 75 mm outlet.

- The stack should comply with the minimum diameters given in Table 3 to section 1 of AD Hl. Additionally, the following minimum internal diameters for discharge stacks also apply:
  (a) Serving urinals – 50 mm;
  (b) Serving closets with outlets less than 80 mm – 75 mm; and
  (c) Serving closets with outlets greater than 80 mm – 100 mm.
- The diameter of a discharge stack should not reduce in the direction of flow, and the internal diameter of the stack should not be less than that of the largest trap or branch discharge pipe.
- Adequate access points for clearing blockages should be provided, and all pipes should be reasonably accessible for repairs. Rodding points in stacks should be above the spillover level of appliances.

13.3.7 Discharge stacks: Ventilation recommendations

In order to prevent the loss of trap seals, it is essential that the air pressure in a discharge stack remains reasonably constant. Therefore, the stack should be ventilated to outside air. For this purpose it should be carried up to such a height that its open end will not cause danger to health or a nuisance. AD H1 recommends that the pipe should finish at least 900 mm above the top of any opening into the building within 3 m. The open end should be fitted with a durable ventilating cover (see Fig. 13.8). In areas where rodent control is a problem, the cover should be metallic.

The dry part of a discharge stack above the topmost branch, which serves only for ventilation, may be reduced in size in one and two storey houses to 75 mm diameter.

It is permissible to terminate a discharge stack inside a building if it is fitted with an air admittance valve. This valve allows air to enter the pipe but does not allow foul air to escape. It should comply with BS EN 12380:2002 *Air admittance valves for drainage systems – Requirements, test methods and valuation of conformity* and should not adversely affect the operation of the underground drainage system which normally relies on ventilation from the open stacks to the sanitary pipework.

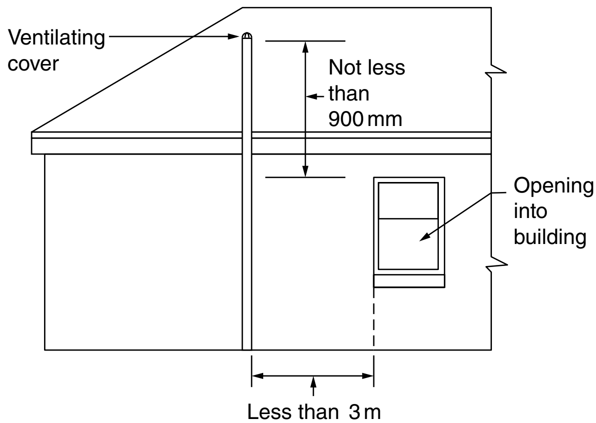


Fig. 13.8 Termination of discharge stacks.

Air admittance valves should also be:

- located in areas which have adequate ventilation
- accessible for maintenance
- removable to give access for clearing blockages.

Air admittance valves should not be used:

- in dust laden atmospheres
- outside buildings
- where there is no open ventilation on a drainage system or through connected drains – other means to relieve positive pressures should be considered.

Some underground drains are subject to surcharging. Where this is the case the discharge stack should be ventilated by a pipe of not less than 50 mm diameter connected at the base of the stack above the expected flood level. This would also apply where a discharge pipe is connected to a drain near an intercepting trap.

13.3.8 Stub stacks

There is one exception to the general rule that discharge stacks should be ventilated. This involves the use of an unvented stack (or *stub stack*). A stub stack should connect to a ventilated discharge stack or a ventilated drain which is not subject to surcharging and should comply with the dimensions given in Fig. 13.9. It is permissible for more than one ground floor appliance to connect to a stub stack.

13.3.9 Dry ventilating stacks

Where an installation requires a large number of branch ventilating pipes and the distance to a discharge stack is also large, it may be necessary to use a dry ventilating stack.

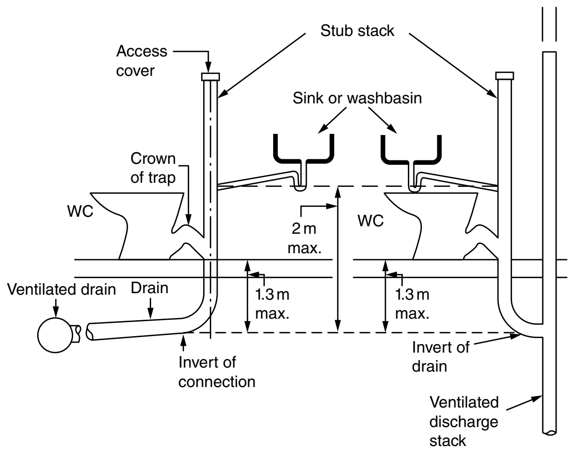


Fig. 13.9 Stub stacks.

It is normal to connect the lower end of a ventilating stack to a ventilated discharge stack below the lowest branch discharge pipe and above the bend at the foot of the stack or to the crown of the lowest branch discharge pipe connection provided that it is at least 75 mm diameter.

Ventilating stacks should be at least 32 mm in diameter if serving a building containing dwellings not more than ten storeys high. For all other buildings reference should be made to BS EN 12056 *Gravity drainage systems inside buildings.*

13.3.10 Greywater recovery systems

Greywater is defined in the Water Regulations Advisory Scheme leaflet No. 09-02-04 *Reclaimed water systems – Information about installing, modifying or maintaining reclaimed water systems* as 'water originating from the mains potable water supply that has been used for bathing or washing, washing dishes or laundering clothes'.

Such water can be used for irrigation and for other purposes such as toilet flushing or car washing; however, care must be taken to prevent contamination of potable water supplies or accidental misuse due to the greywater being mistaken for potable water.

Approved Document H1 gives very little guidance on the use of greywater other than a passing reference to the leaflet mentioned above. It is more concerned with the identification of the pipes conveying the greywater and the suitability of storage systems. Accordingly, it recommends that all sanitary pipework carrying greywater for reuse should be clearly marked with the word 'GREYWATER' in accordance with the Water Regulations Advisory Scheme leaflet No. 09-02-05 *Marking and identification of pipework for reclaimed greywater systems*.

Guidance on the provision of external tanks for the storage of greywater is given in section **13.5**.

13.3.11 Materials for above-ground drainage systems

Table 4 to section 1 of AD H1, which is reproduced below, gives details of the materials that may be used for pipes, fittings and joints in above-ground drainage systems.

AD H1 Section 1

Table 4 Materials for sanitary pipework.

Material	British Standard
Pipes	
Cast iron	BS 416, BS EN 877
Copper	BS EN 1254, BS EN 1057
Galvanised steel	BS 3868
PVC-U	BS EN 1329
Polypropylene (PP)	BS EN 1451
ABS	BS EN 1455
Polyethylene (PE)	BS EN 1519
Styrene copolymer blends (PVC + SAN)	BS EN 1565
PVC-C	BS EN 1566
Traps	BS EN 274, BS 3943

Note: Some of these materials may not be suitable for carrying trade effluent or condensate from boilers.

The following matters should also be addressed when considering which materials to use in a system of sanitary pipework:

- Pipes of different metals should be separated where necessary by non-metallic material to prevent electrolytic corrosion;
- Pipes should be adequately supported without restricting thermal movement;
- Care should be taken to ensure continuity of any electrical earth bonding; and
- Care should be taken where pipes pass through fire separating elements (see Part B of Schedule 1 to the Building Regulations 2010 and Approved Documents B1 and B2).

13.3.12 Workmanship

Workmanship should be in accordance with BS 8000 *Workmanship on building sites* Part 13: *Code of practice for above ground drainage*.

13.3.13 Test for airtightness

In order to ensure that a completed installation is airtight, it should be subjected to a pressure test of air or smoke of at least 38 mm water gauge for a maximum of three minutes. A satisfactory installation will maintain a 25 mm water seal in every trap. PVC-U pipes should not be smoke tested.

13.3.14 Alternative method of design

The requirements of the 2010 Regulations for above-ground drainage can also be met by following the relevant recommendations of BS EN 12056 *Gravity drainage systems inside buildings*. These are:

- in Part 1 *General and performance requirements* – clauses 3 to 6;
- in Part 2 *Sanitary pipework, layout and calculation*, clauses 3 to 6 and national annexes NA to NG (System III is traditionally in use in the UK); and
- in Part 5 *Installation and testing, instructions for operation, maintenance and use*, clauses 4 to 6, 8, 9 and 11.

For vacuum drainage systems, designers should follow the guidance in BS EN 12109 *Vacuum drainage systems inside buildings*.

13.3.15 Below-ground foul drainage

Section 2 of AD H1 gives guidance on the construction of underground drains and sewers from buildings to the point of connection to a suitable outfall. This may be an existing sewer, a wastewater treatment system or a cesspool and includes any drains or sewers outside the curtilage of the building.

Section 2 also gives guidance in Appendix H1-B on the repair, alteration and discontinued use of drains and sewers and in Appendix H1-C on the adoption of sewers and connection to public sewers.

In most modern systems of underground drainage, foul water and rainwater are carried separately. However, some public sewers are on the combined system taking foul and rainwater in the same pipe. The provisions of AD H1 will apply equally to combined systems although pipe gradients and sizes may have to be adjusted to take the increased flows. In some circumstances separate drainage should still be provided on a development even though the outfall of the drainage system is to a combined sewer (see Requirement H5 in section 13.9.2). Combined systems should never discharge to a cesspool or septic tank.

13.3.16 Foul water outfalls and connections with sewers and adoption of sewers

Ideally, foul drainage from a development should connect to a public foul or combined sewer. Section 106 of the Water Industry Act 1991 gives the owner or occupier of a building the right to connect to a public sewer subject to the following conditions:

- Where separate foul and surface water sewers are provided, the connections must match this appropriately and proof of connectivity will be needed by the Building Control Body;
- The manner of the connection must not prejudice the public sewer system; and
- 21 days notice of intention to connect must be given to the sewerage undertaker.

Section 107 of the Water Industry Act 1991 allows the sewerage undertaker to make the connection and recover reasonable costs from the developer. Alternatively, the sewerage undertaker may allow the developer to carry out the work under its supervision.

Drain connections (drains to drains, drains to public or private sewers and private sewers to public sewers) should be made obliquely or in the direction of flow. Connections should be made using prefabricated components, and where holes are cut to make the connection, these should be drilled to avoid damaging the pipe. Sometimes, in making a connection, it is preferable to remove a section of pipe and insert a junction. Repair couplings should be used for this to ensure a watertight joint. The coupling should be carefully packed to avoid differential settlement with adjacent pipes.

Where a sewer serves more than one property, it should be kept as far away as is practicable from the position where a future extension might be built.

The degree to which it is possible to connect to a public sewer may, to a certain extent, depend on the size of the development. For example, for a small development, it may be reasonable to connect to a public sewer up to 30 m from the development provided that the developer has the right to construct drainage over any intervening private land. This might necessitate the provision of a pumping installation where the levels do not permit drainage by gravity (see section 13.3.28). The economies of larger developments may make it feasible to connect to a public sewer which is some distance away.

It is also possible, for developments which comprise more than one curtilage, for the developer to requisition a sewer from the sewerage undertaker. This may be done under section 98 of the Water Industry act 1991. In constructing the sewer, the sewerage undertaker may use its rights of access to private land; however the person requisitioning the sewer may be required to contribute towards its cost over a 12-year period.

It may be possible to connect to an existing private sewer that connects with a public sewer where it is not reasonably practicable to connect directly to a public sewer. In such a case permission will need to be granted by the owner(s) of the private sewer, and it should be in a satisfactory condition and have sufficient capacity to take the increased flows.

A wastewater treatment system or cesspool should only be provided where it is not reasonably practicable to connect to a sewer as described above.

Adoption of sewers: Existing sewers

In some cases it may be possible for an existing sewer which is in good condition and is accessible to be adopted by the Sewerage Undertaker. *Section 102 (Adoption of sewers and disposal works) of the Water Industry Act 1991* contains provisions for this to be done at the request of the person using the sewer, or the sewerage undertaker may adopt the sewer of its own volition. In cases of dispute appeals may be made to the Director General of Water Services.

Adoption of proposed sewers

Section 104 (Agreement to adopt sewer or sewage disposal works at future date) of the Water Industry Act 1991 permits a developer to enter into an agreement with a sewerage undertaker to adopt a sewer at some time in the future subject to certain conditions. In cases of dispute appeals may be made to the Director General of Water Services.

Adoption of highway drainage

Sections 37 and 38 of the Highways Act 1980 allow a highway authority to adopt or agree to adopt in the future the drainage associated with a highway. Additionally, under the provisions of *section 115 (use of highway drains as sewers and vice versa) of the Water Industry Act 1991*, the highway authority may agree that a highway drain may be used to drain water from buildings.

In order for a decision to be made over whether or not a sewerage undertaker should adopt a drain or sewer, the developer should ensure that the sewers are constructed in accordance with the *Protocol on design, construction and adoption of sewers in England and Wales*, published by DEFRA, 2002. Table C1 from Appendix H1-C is reproduced below. It considers the characteristics that should be considered when designing or laying a shared drain/sewer so that it meets the basic requirements for adoption.

Table C1

Table C1 Characteristics that should be considered when designing or laying a shared drain/sewer so that it meets the basic requirements for adoption	
a. Sewers should be designed and constructed in accordance with the Protocol on Design Construction and Adoption of Sewers in England and Wales	Protocol on Design, Construction and Adoption of Sewers in England and Wales, Defra, 2002
b. Sewers should be laid at an appropriate distance from buildings so as to avoid damage to the foundations	H1-2.17, H1-2.25 and Diagram 8. The distance from foundation to any drain is set out in H1-2.25. When building over a sewer the recommended minimum distance is 3 m (H4-1.6)
c. The manholes and chambers, especially in private land, should be located so that they are, and continue to be, easily accessible manually or, if necessary, with maintenance equipment such as pipe jetters or mini-excavators. This is of particular importance where the depth would justify mechanical excavation to undertake repair work Although design codes indicate that access points may be up to 200 m apart, it is unlikely that it would be possible to rod or safely pressure jet small-diameter pipes over such a distance; 100m is more appropriate	H1-2.51. Consult sewerage undertaker about access for plant
d. The last access point on the house drain should be sized to allow man entry and should be located in an accessible position. This access point should, as far as practicable, be located adjacent to the curtilage and preferably form an interface with the connection to the lateral where it runs outside the curtilage of the property to discharge into a sewer in a highway, into public open space or into third-party land As this final manhole is likely to be in position where vehicle or plant loading is anticipated, its construction should accord with Sewers for Adoption	H1-2.51
e. House 'collector' drains serving each property should normally discharge into the sewer via a single junction or a manhole	H1-2.13 to 2.16
f. Sewers should not be laid deeper than necessary, but in all cases the structural integrity of the pipe needs to be maintained. This can normally be done by providing a cover to the top of the pipe barrel of 1.2 m or 0.9 m in highways or private land respectively. If these depths are not practicable, special protection measures such as a concrete slab should be provided	H1-2.27 and BS EN 1295-1
g. Sizing and design of manholes and chambers should depend on the depth and on whether man entry is required. Manholes on or near highways or other roads need to be of robust construction	H1-2.48
h. Sewers should be laid in straight lines in both vertical and horizontal alignments	H1-2.19
j. The first preference should be to provide separate foul and surface water sewerage systems. Where 'combined' or 'partially combined' sewerage is unavoidable, the sizing and the design of that sewer should be enhanced in accordance with the current codes and design methodologies to make additional provisions to deal with the runoff	Requirement H5, H1-2.35 and H3-3.5. See also BS EN 732 Parts 3 and 4, particularly note Annex ND in BS EN 752Part 4

13.3.17 Design and performance factors

The performance of a below-ground foul drainage system depends on the drainage layout, provision for ventilation, the pipe cover and bedding, the pipe sizes and gradients, the materials used and the provisions for clearing blockages.

DRAINAGE LAYOUT – The drainage layout should be kept as simple as possible with pipes laid in straight lines and to even gradients. The number of access points provided should be limited to those essential for clearing blockages. If possible, changes of gradient and direction should be combined with access points, inspection chambers or manholes.

A slight curve in a length of otherwise straight pipework is permissible provided the line can still be adequately rodded. Bends should only be used in or close to inspection chambers and manholes or at the foot of discharge or ventilating stacks. The radius of any bend should be as large as practicable.

In commercial hot food premises, drains serving kitchens should be fitted with a grease separator in compliance with BSEN 1825: *Installations for separation of grease*, Part 1: 2004 *Principles of design, performance and testing, marking and quality control* and Part 2: 2002 *Selection of nominal size, installation and maintenance*, unless other effective means of grease removal are provided.

VENTILATION – It is important to ventilate an underground foul drainage system with a flow of air. Ventilated discharge pipes may be used for this purpose and should be positioned at or near the head of each main run. An open ventilating pipe (without an air admittance valve) should be fitted on any drain run fitted with an intercepting trap (especially on sealed systems) and on drains subject to surcharge. Ventilating pipes should not finish near openings in buildings (see section 13.3.3).

PIPE COVER AND BEDDING – The degree of pipe cover to be provided will usually depend on:

- the invert level of the connections to the drainage system
- the slope and level of the ground
- the necessary pipe gradients
- the necessity for protection to pipes.

In order to protect pipes from damage, it is essential that they are bedded and backfilled correctly. The choice of materials for this purpose will depend mainly on the depth, size and strength of the pipes used. If the limits of cover cannot be attained, it may be possible to choose another pipe strength and bedding class (see also BS EN 1295-1:1998 (National Annex NA) *Structural design of buried pipelines under various conditions of loading*) or provide special protection (see section 13.3.20).

Pipes used for underground drainage may be classed as rigid or flexible. Flexible pipes will be subject to deformation under load and will therefore need more support than rigid pipes so that the deformation may be limited.

13.3.18 Rigid pipes

Tables 8 and 9 of AD H1 are set out below and contain details of the limits of cover that need to be provided for rigid clay and concrete pipes in any width of trench. For details of the bedding classes referred to in the Tables, see Figs 13.10 and 13.11.

The backfilling materials should comply with the following:

(1) Granular material for rigid pipes should conform to BS EN 1610 Annex B Table B.15. The granular material should be single sized or graded from 5 mm up to:
- 10 mm for 100 mm pipes
- 14 mm for 150 mm pipes

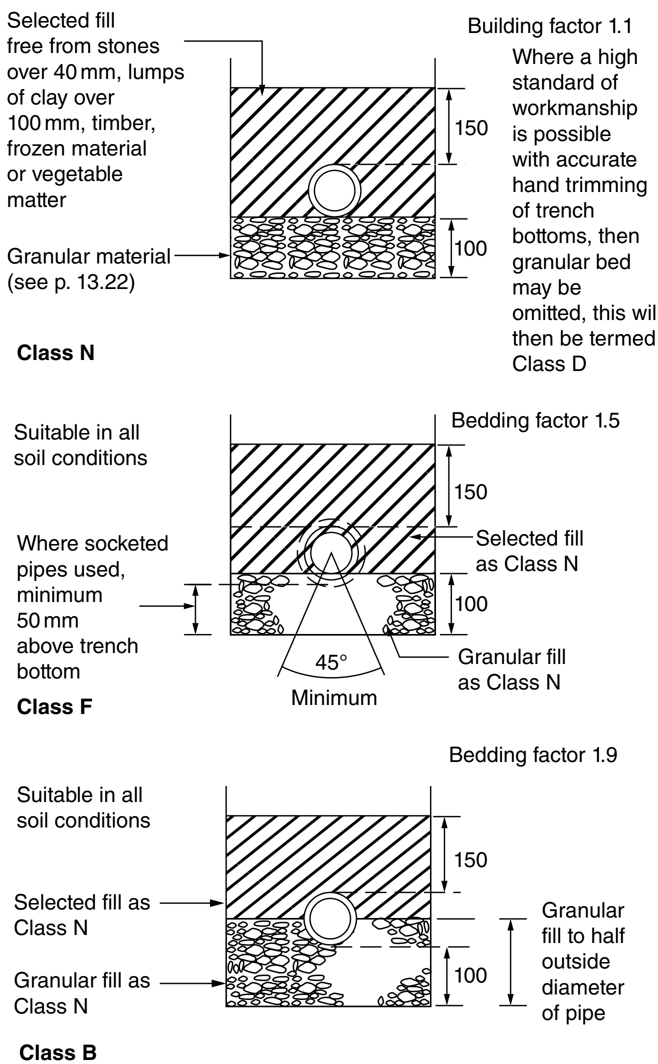


Fig. 13.10 Bedding classes for rigid pipes.

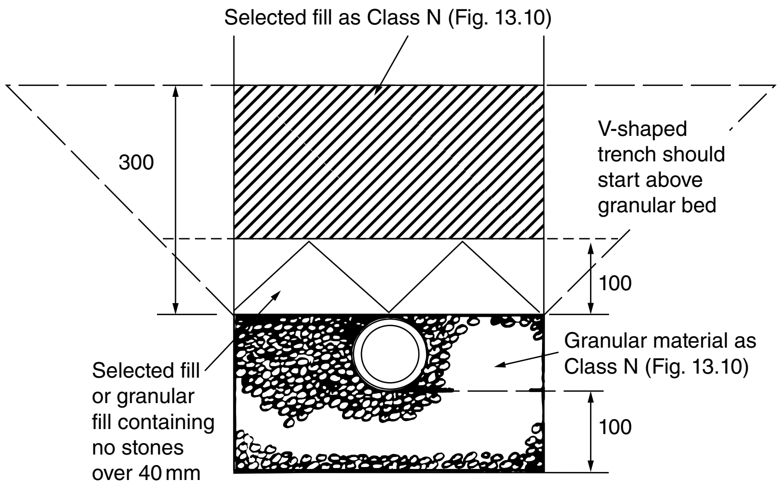


Fig. 13.11 Bedding for flexible pipes.

AD H1 section 2

Table 8 Limits of cover for class 120 clayware pipes in any width of trench.

Nominal size	Laid in fields	Laid in light roads	Laid in main roads
100 mm	0.6 m–8+ m	1.2 m–8+ m	1.2 m–8 m
225 mm	0.6 m–5 m	1.2 m–5 m	1.2 m–4.5 m
400 mm	0.6 m–4.5 m	1.2 m–4.5 m	1.2 m–4 m
600 mm	0.6 m–4.5 m	1.2 m–4.5 m	1.2 m–4 m

Notes:

1. All pipes assumed to be Class 120 to BS EN 295; other strengths and sizes of pipe are available. Consult manufacturers.
2. Bedding assumed to be Class B with bedding factor of 1.9; guidance is available on use of higher bedding factors with clayware pipes.
3. Alternative designs using different pipe strengths and/or bedding types may offer more appropriate or economic options using the procedures set out in BS EN 1295.
4. Minimum depth in roads set to 1.2 m irrespective of pipe strength.

AD H1 section 2

Table 9 Limits of cover for class M concrete pipes in any width of trench.

Nominal size	Laid in fields	Laid in light roads	Laid in main roads
300 mm	0.6 mm–3 m	1.2 m–3 m	1.2 m–2.5 m
450 mm	0.6 m–3.5 m	1.2 m–3.5 m	1.2 m–2.5m
600 mm	0.6 m–3.5 m	1.2 m–3.5 m	1.2 m–3 m

Notes:

1. All pipes assumed to be Class M to BS 5911; other strengths and sizes of pipe are available. Consult manufacturers.
2. Bedding assumed to be Class B with bedding factor of 1.9.
3. Alternative designs using different pipe strengths and/or bedding types may offer more appropriate or economic options using the procedures set out in BS EN 1295.
4. Minimum depth in roads set to 1.2 m irrespective of pipe strength.

- 20 mm for pipes from 150 mm to 600 mm diameter
- 40 mm for pipes more than 600 mm diameter.

The compaction fraction maximum should be 0.3 for class N or B and 0.15 for class F.

(2) Selected fill should be free from stones larger than 40 mm, lumps of clay over 100 mm, timber, frozen material or vegetable matter.
(3) It is possible that the groundwater may flow in trenches with granular bedding. Provisions may be required to prevent this.
(4) Socketed pipes used with class D bedding should have holes formed in the trench bottom under the sockets to give a clearance of at least 50 mm. The holes should be as short as possible.
(5) Sockets for pipes used with class F or N bedding should be at least 50 mm above the floor of the trench.

13.3.19 Flexible pipes

Flexible pipes should be provided with a minimum depth of cover of 900 mm under any road. This may be reduced to 600 mm in fields and gardens. The maximum permissible depth of cover is 7 m. Figure 13.11 shows typical bedding and backfilling details for flexible pipes. Table 10 of AD H1 gives limits of cover for thermoplastics pipes in any width of trench. Where flexible pipes have less than the minimum cover depths given in the tables, they should be protected where necessary, as shown in Fig. 13.12.

13.3.20 Special protection to pipes

Where pipes have less than the minimum cover recommended in Tables 8, 9 or 10, they should be bridged by reinforced concrete cover slabs resting on a flexible filler with at least 75 mm of granular fill between the top of the pipe and the underside of the flexible

AD H1 section 2

Table 10 Limits of cover for thermoplastics (nominal ring stiffness SN4) pipes in any width of trench.

Nominal size	Laid in fields	Laid in light roads	Laid in main roads
100 mm–300 mm	0.6 m–7 m	0.9 m–7 m	0.9 m–7 m

Notes:

1. For drains and sewers less than 1.5 m deep where there is a risk of excavation adjacent to the drain, a special calculation is necessary; see BS EN 1295, paragraph NA. 6.2.3.
2. All pipes assumed to be in accordance with the relevant standard listed in Table 7 of AD H1 section 2 with nominal ring stiffness SN4; other strengths and sizes of pipe are available. Consult manufacturers.
3. Bedding assumed to be Class S2 with 80% compaction and average soil conditions.
4. Alternative designs using different pipe strengths and/or bedding types may offer more appropriate or economic options using the procedures set out in BS EN 1295.
5. Minimum depth in roads is set to 1.5 m irrespective of pipe strength to cover loss of side support from parallel excavations.

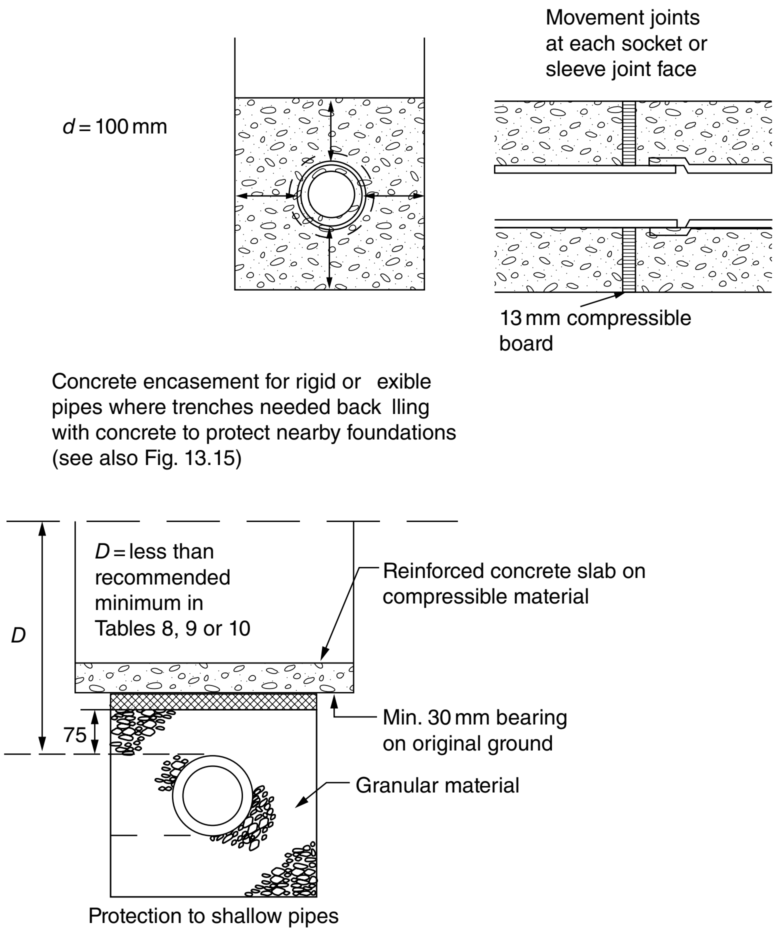


Fig. 13.12 Special protection to pipes.

filler (see Fig. 13.12). Where it is necessary to backfill a trench with concrete to protect adjacent foundations (see section 13.3.25), the pipes should be surrounded in concrete to a thickness of at least 100 mm. Expansion joints should also be provided at each socket or sleeve joint face (see Fig. 13.12).

PIPE SIZES AND GRADIENTS – Drains should be laid to falls and should be large enough to carry the expected flow. The rate of flow will depend on the type, number and grouping of appliances that are connected to the drain (see Table 5 of AD H1 Section 2 and Table 13.1, section 13.3.1). The capacity will depend on the diameter and gradient of the pipes.

Table 6 to section 2 of AD H1 gives recommended minimum gradients for different sized foul drains and shows the maximum capacities they are capable of carrying.

As a further design guide, Diagram 9 from AD H1 is reproduced below. This gives discharge capacities for foul drains running at 0.75 proportional depth.

AD H1 section 2

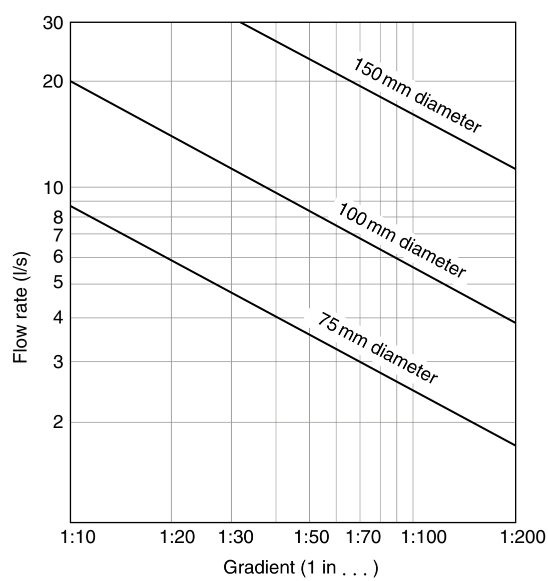
Table 6 Recommended minimum gradients for foul drains.

Peak flow (l/s)	Pipe size (mm)	Minimum gradient (l:...)	Maximum capacity (l/s)
<1	75	1:40	4.1
	100	1:40	9.2
>1	75	1:80	2.8
	100	1:80*	6.3
	150	1:150†	15.0

Notes:
* Minimum of one WC.
† Minimum of five WCs.

AD H1 section 2

Diagram 9 Discharge capacities of foul drains running 0.75 proportional depth.



A drain serving more than one property (i.e. a sewer) should normally have a minimum diameter of 100 mm if serving no more than ten dwellings. Sewers serving more than ten dwellings should normally have a diameter of at least 150 mm.

If a drain is carrying only foul water, it may have a minimum diameter of 75 mm. This is increased to a minimum of 100 mm if the drain is carrying effluent from a WC or trade effluent. Where foul and rainwater drainage systems are combined, the capacity of the system should be large enough to take the combined peak flow (see Rainwater drainage, section **13.6**).

AD H1 section 2

Table 7 Materials for below-ground gravity drainage.

Material	British Standard
Rigid pipes	
Vitrified clay	BS 65, BS EN 295
Concrete	BS 5911
Grey iron	BS 437
Ductile iron	BS EN 598
Flexible pipes	
UPVC	BS EN 1401†
PP	BS EN 1852†
Structured-wall plastic pipes	BS EN 13476

Note:
† Application area code UD should normally be specified.
Some of these materials may not be suitable for conveying trade effluent.

MATERIALS – Table 7 to section 2 of AD H1, which is reproduced below, gives details of the materials that may be used for pipes, fittings and joints in below-ground foul drainage systems. Joints should remain watertight under working and test conditions, and nothing in the joints, pipes or fittings should form an obstruction inside the pipeline. To avoid damage by differential settlement, pipes should have flexible joints appropriate to the material of the pipes.

To prevent electrolytic corrosion, pipes of different metals should be separated where necessary by non-metallic material.

PROVISIONS FOR CLEARING BLOCKAGES – Every part of a drainage system should be accessible for clearing blockages. The type of access point chosen and its siting and spacing will depend on the layout of the drainage system and the depth and size of the drain runs. A drainage system designed in accordance with the provisions of AD H1 should be capable of being rodded by normal means (i.e. not by mechanical methods).

13.3.21 Access points

Four types of access points are described in AD H1:

- Rodding eyes (or points). These are extensions of the drainage system to ground level where the open end of the pipe is capped with a sealing plate.
- Access fittings. Small chambers situated at the invert level of a pipe and without any real area of open channel.
- Inspection chambers. Chambers having working space at ground level.
- Manholes. Chambers large enough to admit persons to work at drain level.

Some typical access point details are illustrated in Fig. 13.13.

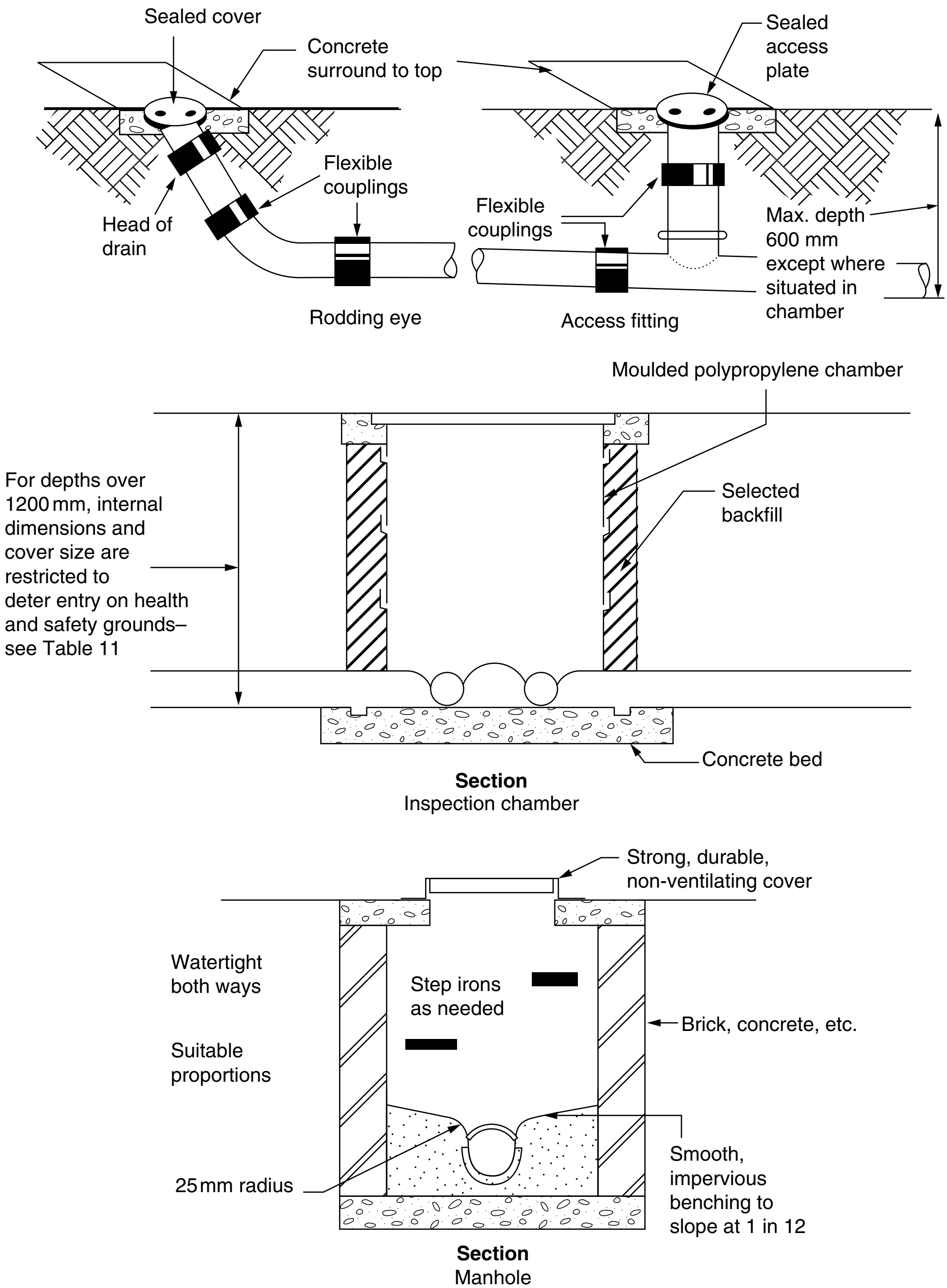


Fig. 13.13 Access points.

Whatever form of access point is used, it should be of sufficient size to enable the drain run to be adequately rodded. Tables 11 and 12 to section 2 of AD H1 set out the maximum depths and minimum internal dimensions for each type of access point. Where a large number of branches enter an inspection chamber or manhole, the sizes given in Tables 11 and 12 may need to be increased. It is usual to allow 300 mm for each branch connection (thus a 1200 mm long manhole could cater for up to four branch connections on each side).

AD H1 section 2

Table 11 Minimum dimensions for access fittings and chambers.

Type		Depth to invert from cover level (m)	Internal sizes: Length × width (mm × mm)	Internal sizes: Circular (mm)	Cover sizes: Length × width (mm × mm)	Cover sizes: Circular (mm)
Rodding eye			As drain but min 100			Same size as pipework[1]
Access fitting						
Small	150 diam	0.6 or less, except where situated in a chamber				
	150 × 100		150 × 100	150	150 × 100[1]	Same size as access fitting
Large	225 × 100		225 × 100	225	225 × 100[1]	
Inspection chamber						
	Shallow	0.6 or less	225 × 100	190[2]	–	190[1]
		1.2 or less	450 × 450	450	Min 430 × 430	430
	Deep	>1.2	450 × 450	450	Max 300 × 300[3]	Access restricted to max 350[3]

Notes:
[1] The clear opening may be reduced by 20 mm in order to provide proper support for the cover and frame.
[2] Drains up to 150 mm.
[3] A larger clear opening cover may be used in conjunction with a restricted access. The size is restricted for health and safety reasons to deter entry.

AD H1 section 2

Table 12 Minimum dimensions for manholes.

Type	Size of largest pipe (DN)	Min internal dimensions[1]: Rectangular length and width	Min internal dimensions[1]: Circular diameter	Min clear opening size[1]: Rectangular length and width	Min clear opening size[1]: Circular diameter
Manhole					
<1.5 m deep to soffit	150	750 × 675[2]	1000[2]	750 × 675[3]	na[4]
	225	1200 × 675	1200	1200 × 675[3]	
	300	1200 × 750	1200		
	>300	1800 × (DN + 450)	The larger of 1800 or (DN + 450)		

Table 12 (*Continued*)

Type	Size of largest pipe (DN)	Min internal dimensions[1]		Min clear opening size[1]	
		Rectangular length and width	Circular diameter	Rectangular length and width	Circular diameter
>1.5 m deep to soffit	225	1200 × 1000	1200	600 × 600	600
	300	1200 × 1075	1200		
	375–450	1350 × 1225	1200		
	>450	1800 × (DN + 775)	The larger of 1800 or (DN + 775)		
Manhole shaft[5]		1050 × 800	1050	600 × 600	600
>3.0 m deep to soffit of pipe	Steps[6]				
	Ladder[6]	1200 × 800	1200		
	Winch[7]	900 × 800	900	600 × 600	600

Notes:
[1] Larger sizes may be required for manholes on bends or where there are junctions.
[2] The minimum size of any manhole serving a sewer (i.e. any drain serving more than one property) should be 1200 × 675 mm rectangular or 1200 mm diameter.
[3] May be reduced to 600 by 600 where required by highway loading considerations, subject to a safe system of work being specified.
[4] Not applicable due to working space needed.
[5] Minimum height of chamber in shafted manhole 2 m from benching to underside of reducing slab.
[6] Min clear space between ladder or steps and the opposite face of the shaft should be approximately 900 mm.
[7] Winch only – no steps or ladders, permanent or removable.

13.3.22 Access points: Siting and spacing

Access points should be provided:

- at or near the head of any drain run;
- at any change of direction or gradient;
- at a junction, unless each drain run can be rodded separately from another access point;
- at a change of pipe size, unless this occurs at a junction where each drain run can be rodded separately from another access point; and
- at regular intervals on long drain runs.

The spacing of access points will depend on the type of access used. Table 13 to section 2 of AD H1 gives details of the maximum distances that should be allowed for drains up to 300 mm in diameter and is set out below.

Where an access point is provided to a sewer (i.e. serving more than one property), it should be positioned so that it is both accessible and apparent for use in emergencies. Typically, it could be positioned in a highway, public open space, unfenced front garden or shared and unfenced driveway.

AD H1 section 2

Table 13 Maximum spacing of access points in metres.

		Access fitting				
From	**To**	**Small**	**Large**	**Junction**	**Inspection chamber**	**Manhole**
Start of external drain[1]		12	12	—	22	45
Rodding eye		22	22	22	45	45
Access fitting						
Small 150 diam						
150 × 100		—	—	12	22	22
Large 225 × 100		—	—	45	22	45
Inspection chamber		22	45	22	45	45
Manhole		—	—	—	45	90[2]

Note:
[1] Stack or ground floor appliance.
[2] May be up to 200 for man-entry size drains and sewers.

AD H1 section 2

Table 14 Materials for access points.

Material	**British Standard**
1. Inspection chambers and manholes	
Clay	
Bricks and blocks	BS 3921
Vitrified clay	BS EN 295, BS 65
Concrete	
Precast	BS 5911
In situ	BS 8110
Plastics	BS 7158
2. Rodding eyes and access fittings (excluding frames and covers)	As pipes see Table 7
	ETA certificates

13.3.23 Access points: Construction

Generally, access points should:

- be constructed of suitable and durable materials;
- exclude subsoil or rainwater; and
- be watertight under working and test conditions.

Table 14 to section 2 of AD H1 lists materials which are suitable for the construction of access points.

Inspection chambers and manholes should fulfil the following:

- Have smooth impervious surface benching up to at least the top of the outgoing pipe to all channels and branches. The purpose of benching is to direct the flow into the main channel and to provide a safe foothold. For this reason the benching should fall towards the channel at a slope of 1 in 12 and should be rounded at the channel with a minimum radius of 25 mm (see Fig. 13.13).
- Be constructed so that branches up to and including 150 mm diameter discharge into the main channel at or above the horizontal diameter where half-round open channels are used. Branches greater than 150 mm diameter should be set with the soffit level with that of the main drain. Branches which make an angle of more than 45° with the channel should be formed using a three-quarter section branch bend.
- Have strong, removable, non-ventilating covers of suitable durable material (e.g. cast iron, cast or pressed steel or precast concrete or plastics).
- Be fitted with step irons, ladders, etc., if over 1.0 m deep.
- Small lightweight access covers should be secured to deter unauthorised access (e.g. by children). Commonly, such covers are screwed down.
- A manhole or inspection chamber which is situated *within* a building should have an airtight cover that is mechanically fixed (e.g. screwed down with corrosion resistant bolts). This requirement does not apply if the inspection chamber or manhole gives access to part of a drain which itself has inspection fittings, and these are provided with watertight covers.

13.3.24 Test for watertightness

After laying and backfilling, gravity below ground drains and private sewers not exceeding 300 mm in diameter should be pressure tested using air or water.

For the air test, the pipe should be pressurised up to 110 mm water gauge and held for about five minutes prior to testing. Subsequently, a head loss of up to 25 mm at 100 mm water gauge is permitted in a period of seven minutes during the test.

For the water test, the section of drain to be tested should be filled with water up to a depth of 500 mm above the lowest invert and at least 100 mm above the highest invert in the test section and left to stand for about one hour to condition the pipe. Over the next 30 minutes, the test pressure should be maintained by topping up the water level so that it is within 10 mm of the levels given above. The leakage rate per square metre of surface area should not exceed:

- 0.15 litres for pipelines only; or
- 0.20 litres for test lengths which include pipelines and manholes and 0.40 litres for tests on manholes and inspection chambers alone (i.e. no pipelines).

Using this method it is easy to check the leakage rate simply by measuring the quantity of water used to top up during the test and dividing by the surface area of the manhole or inspection chamber.

For tests on pipelines exceeding 300 mm diameter, reference should be made to BS 8000: Part 14:1989 *Workmanship on building sites. Code of practice for below ground* *drainage*, or BS EN 1610:1998 *Construction and testing of drains and sewers. Code of practice for design and construction.*

13.3.25 Special protection for drains adjacent to or under buildings

Where drains pass under buildings or through foundations and walls, there is a risk that settlement of the building may cause pipes to fracture, with consequential blockages and leakage. In the past it was a common practice to require pipes (which were rigid jointed) to be encased in concrete. Since the development of flexible pipe systems, it has become essential to maintain this flexibility in order that any slight settlement of the building will not cause pipe fracture.

Therefore, drain runs under buildings should be surrounded with at least 100 mm of granular or other flexible filling. On some sites unusual ground conditions may lead to excessive subsidence. To protect drain runs from fracture, it may be necessary to have additional flexible joints or use other solutions such as suspended drainage especially where the pipe is adjacent to structures or where there is a change in soil conditions in the length of the pipe run. Shallow drain runs under concrete floor slabs should be protected as described in section 13.3.20 and as shown in Fig. 13.12 where the crown of the pipe is less than 300 mm from the underside of the slab.

Where a drain is built into a structure (e.g. a wall, foundation, ground beam, inspection chamber, manhole, etc.), suitable measures should be taken to prevent damage or misalignment. The following solutions are possible:

- The wall may be supported on lintels over the pipe. A clearance of 50 mm should be provided round the pipe perimeter, and this gap should be masked on both sides of the wall with rigid sheet material to prevent the ingress of fill or vermin. The void should be filled with a compressible sealant to prevent ingress of gas.
- A length of pipe may be built in to the wall with its joints not more than 150 mm from each face. Rocker pipes not exceeding 600 mm in length should then be connected to each end of the pipe using flexible joints (see Fig. 13.14).

Where a drain or private sewer is laid close to a load-bearing part of a building, precautions should be taken to ensure that the drain or sewer trench does not impair the stability of the building.

Where any drain or sewer trench is within 1 m of the foundation of a wall and the bottom of the trench is lower than the wall foundation, the trench should be filled with concrete up to the level of the underside of the foundation.

Where a drain or sewer trench is 1 m or more from a wall foundation and the trench bottom is lower than the foundation, the trench should be filled with concrete to within a vertical distance below the underside of the foundation of not more than the horizontal distance from the foundation to the trench less 150 mm (see Fig. 13.15).

Where it is necessary to adopt unusual design solutions for buried pipelines due to special ground conditions (e.g. pipes are to be laid on piles or beams, ground may prove to be unstable, there may be a high water table, etc.) or where pipes are to be laid in a common trench, guidance may be found in the TRL *Guide to design loadings for buried rigid pipes.*

Additionally, local authorities may be able to provide information regarding subsoil conditions on many sites.

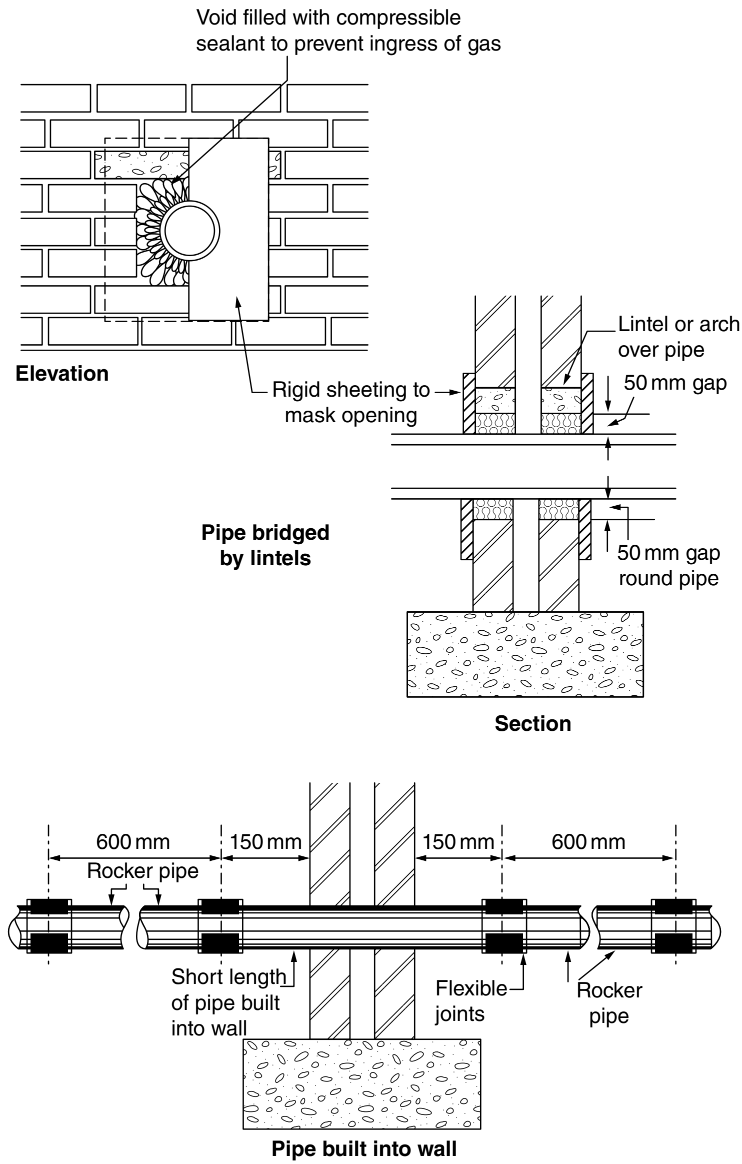


Fig. 13.14 Drains passing through foundations.

13.3.26 Special protection: Drain surcharging

Under conditions of heavy rainfall, combined and rainwater sewers are designed to surcharge, whereby the water level in the manhole rises above the top of the pipe. This may also happen to some foul sewers if they receive rainwater. Therefore, on some low-lying sites, properties may be at increased risk of flooding if the ground level of the site (or the level of a basement) is below the level at which the drainage connects to the public sewer. The sewerage undertaker should be consulted in such cases to determine the extent and frequency of the likely surcharge.

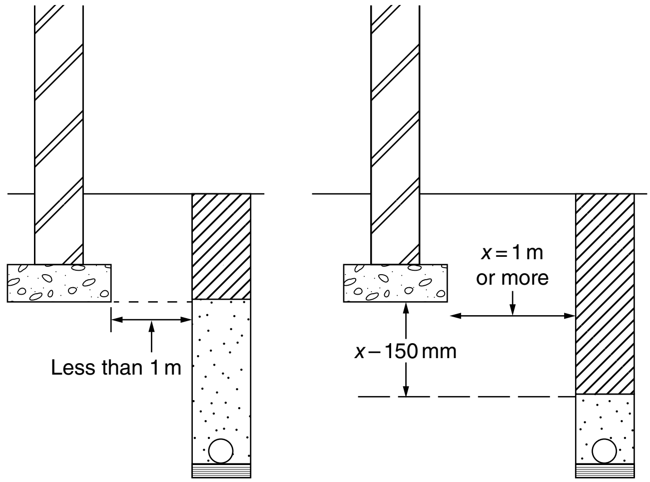


Fig. 13.15 Drain trenches.

Where a basement contains sanitary appliances and the sewerage undertaker considers that the risk of flooding due to surcharging is high, the drainage from the basement should be pumped (see section 13.3.28). For low risks, an anti-flooding valve should be installed on the drainage from the basement.

For low-lying sites (i.e. those not containing basements) where the risk is low, protection for the building may be achieved by the provision of an external gully sited at least 75 mm below floor level in a position so that any flooding from the gully will not damage any buildings. Higher risk areas should have anti-flooding valves or pumped drainage systems (see section 13.3.28).

Anti-flooding valves should:

- be of the double valve type;
- be suitable for foul water;
- have a manual closure device; and
- comply with BSEN 13564:2002 Anti-flooding devices for buildings.

Normally, a single valve should serve only one building, and information about the valve should be provided on a notice inside the building. The notice should indicate the location of any manual override and include necessary maintenance information.

Some parts of the drainage system may be unaffected by surcharging. These parts should bypass any protective measures and should discharge by gravity.

13.3.27 Special protection: Rodent control

Generally, rodent infestation (especially by rats) is on the increase. Since rats use drains and sewers as effective communication routes, on previously developed sites, the local authority should be consulted to ascertain if any special rodent control precautions are thought necessary.

Special precautions could include the following:

- By providing inspection chambers with screwed access covers on the pipework instead of open channels. These should only be used in inspection chambers where maintenance can be carried out from the surface without personnel entry.
- Intercepting traps may also be provided as in the past, although they do increase the incidence of blockages unless adequately maintained. Trap stoppers should be of the locking type and should be easy to remove and replace after clearing any blockage. They should always be replaced after maintenance operations and should only be used in inspection chambers where maintenance can be carried out from the surface without personnel entry.
- A number of different kinds of rodent barriers might be considered. These include enlarged sections of discharge stacks which prevent rats from climbing, flexible downward facing fins in discharge stacks and one way valves in underground drainage.
- The provision of metal cages on ventilator stack terminals and fixed plastic covers or metal gratings on gullies to discourage rats from leaving the drainage system.

13.3.28 Pumping installations

Reference has been made above to the use of pumping installations where gravity drainage is impracticable or where protection is required against flooding due to surcharge in downstream sewers.

AD H1 gives details of packaged pumping systems for use both inside and outside buildings as follows.

Inside buildings

Floor mounted units available for use in basements should comply with BS EN 12050 Parts 1 and 2:2001 *Wastewater lifting plants for buildings and sites – Principles of construction and testing.* The pumping installation itself should be designed in accordance with BS EN 12056:2000 *Gravity drainage systems inside buildings*: Part 4: *Effluent lifting plants, layout and calculation.*

Outside buildings

Package pumping installations for use outside buildings are also available. The pumping installation should be designed in accordance with BS EN 752 *Drain and sewer systems outside buildings:* Part 6: 1998 *Pumping installations.*

Foul water drainage pumping installations should comply with the following:

- To allow for disruption in service, the effluent receiving chamber should be sized to contain 24-hour inflow.
- For domestic use the minimum daily discharge of foul drainage should be taken as 150 litres per person per day.

- For non-domestic uses, the capacity of the receiving chamber should be based on the calculated daily demand of the water intake for the building (and should be assessed on a pro rata basis where only a proportion of the foul sewage is pumped).
- For all pumped systems the controls should be arranged to optimise pump operation.

13.3.29 Workmanship

In general, workmanship should be in accordance with BS 8000 *Workmanship on building sites* Part 14: *Code of practice for below ground drainage.*

In particular, drains and sewers which are left open during construction should be covered when work is not in progress to prevent entry by rats.

A number of measures are necessary to protect drains during construction work. For example, drains can be damaged by construction traffic and heavy machinery. Barriers should be provided where necessary to keep traffic away from the line of the sewer and heavy materials should not be stored over drains or sewers. Additionally, piling works can cause damage to drains and sewers unless certain precautions are taken. This would include carrying out a survey to establish the exact location of any drain runs and connections before piling commences. Piling should not be carried out where the distance from the outside of the sewer to the outside of the pile is less than two times the diameter of the pile.

13.3.30 Alternative method of design

Additional information on the design and construction of building drainage which meets the requirements of the 2010 Regulations may be found in the relevant parts of:

- BS EN 12056 *Gravity drainage systems inside buildings*. This standard also describes the discharge unit method of calculating flows;
- BS EN 752 *Drain and sewer systems outside buildings*: Part 3:1997 *Planning*, Part 4:1997 *Hydraulic design and environmental aspects* and Part 6:1998 *Pumping installations*;
- BS EN 1610:1998 *Construction and testing of drains and sewers*;
- BS EN 1295: Part 1:1998 *Structural design of buried pipelines under various conditions of loading*;
- BS EN 1091:1997 *Vacuum sewerage systems outside buildings*; and
- BS EN 1671:1997 *Pressure sewerage systems outside buildings.*

BS EN 752 together with BS EN 1610 and BS EN 1295 contain additional information about design and construction.

13.4 Wastewater treatment systems and cesspools

Any septic tank and its form of secondary treatment, other wastewater treatment system or cesspool must be sited and constructed so that:

- it is not prejudicial to health;
- it will not contaminate any watercourse, underground water or water supply;

- it is accessible for emptying and maintenance;
- it will continue to function in the event of a power failure to a standard sufficient for the protection of health, where this is relevant (i.e. where a power supply is needed for normal operation of the system).

Furthermore, any septic tank, holding tank which is part of a wastewater treatment system or cesspool must be:

- adequately ventilated
- of adequate capacity
- constructed to be impermeable to liquids.

Since all wastewater treatment systems and cesspools rely on adequate maintenance in order to continue to operate in a safe and healthy manner, the Regulations require that maintenance instructions be provided in the form of a durable notice which must be affixed in a suitable place in the building. Examples of typical notices are given in the text below.

It should be noted that the use of non-mains foul drainage should only be considered where connection to mains drainage is not practicable and any discharge from a wastewater treatment system is likely to require consent from the Environment Agency. Contact with the Environment Agency should be made as early as possible in the design process (usually when the planning process is being initiated and before a Building Regulation application is made for non-mains drainage). This will determine whether a consent to discharge is required and what parameters apply, which in turn can have an impact on the type of system that may be installed. Further guidance may be obtained from the Pollution Prevention Guideline No. 4 *Disposal of sewage where no mains drainage is available*, Environment Agency 1999.

13.4.1 Wastewater treatment systems

A wastewater treatment system typically includes a septic or settlement tank which provides primary treatment to the effluent from a building. This is likely to be the most economic form of treating wastewater for one to three dwellings. The discharge from the tank can, however, still be harmful; therefore, there is a need for a system of drainage which completes the treatment process after the effluent has passed through the tank, thus providing a means of secondary treatment. The term 'wastewater treatment system' can also include small sewage treatment works (see section 13.4.3).

In the past, the Regulations have tended to concentrate on the design and construction of the means of primary treatment but have failed to provide guidance on the ultimate means of disposal of the effluent. This is an area where considerable research and development have taken place in recent years, and guidance is now given on the design and construction of drainage fields and mounds and on constructed wetlands and reed beds. The performance of a wastewater treatment system will depend on the capacity, siting, design and construction of both the septic or settlement tank and the drainage field or other means of secondary treatment.

13.4.2 Primary treatment systems: Septic tanks and settlement tanks

Capacity

The primary treatment system should have sufficient capacity and should provide suitable conditions for the settlement, storage and partial decomposition of solid matter in the wastewater from the building. It should also be sited and constructed so as to prevent overloading of the receiving water.

For up to four users, a minimum capacity of 2.7 m^3 (2700 litres) below the level of the inlet is set for septic tanks and settlement tanks in order to reduce danger of overflowing and malfunctioning. This size should be increased by 0.18 m^3 (180 litres) for each additional user.

Siting and construction

Septic tanks should be designed and constructed to prevent leakage of contents and the ingress of subsoil water. They should also be provided with adequate ventilation, which should be kept away from buildings. Therefore, they should be kept at least 7 m from any habitable parts of buildings, preferably on a downslope.

Septic tanks must be periodically desludged and cleaned. This is usually carried out mechanically using a tanker. Because of the length of piping involved, it is necessary that the cesspool or tank be sited within 30 m of a vehicular access; however, where the invert level of the tank is more than 3 m below the vehicle access level, the 30 m distance will need to be reduced accordingly. Emptying and cleaning should not involve the contents being taken through a dwelling or place of work, and there should be a clear route for the hose so that the emptying and cleaning can be carried out without creating a hazard for the building's occupants. Access covers for emptying and cleaning should be sufficiently durable to resist the corrosive nature of the tank contents and should be designed to prevent unauthorised access (by being lockable or otherwise engineered to prevent personnel entry).

Tanks should also be constructed of materials which are impervious to the contents and to groundwater. This would include engineering brickwork in 1:3 cement mortar at least 220 mm thick and concrete at least 150 mm thick (C/25/P mix to BS 5328), roofed with heavy concrete slabs. Prefabricated cesspools and tanks are available and are made of glass-reinforced plastic, polyethylene or steel. These should follow the guidance in BS EN 12566 *Small wastewater treatment plants less than 50 PE*: Part 1: 2000 *Prefabricated septic tanks*. Care should be exercised over the stability of these tanks.

The inlet and outlet of the tank should be provided with access for sampling and inspection of the contents and be designed to avoid excessive disturbance of the surface scum or settled contents by incorporating at least two chambers operating in sequence. The velocity of flow into the tank can be limited by laying the last 12 m of the incoming drain at a gradient of 1 in 50 or flatter for all pipes up to 150 mm in diameter. Alternatively, a dip pipe inlet may be provided (see Fig. 13.16) where the tank width does not exceed 1200 mm.

Septic tank maintenance

It is essential that building owners are kept informed about the maintenance requirements of septic tanks. Septic tanks need to be inspected monthly to make sure that they are working properly. This involves an inspection of the inlet chamber and the outlet

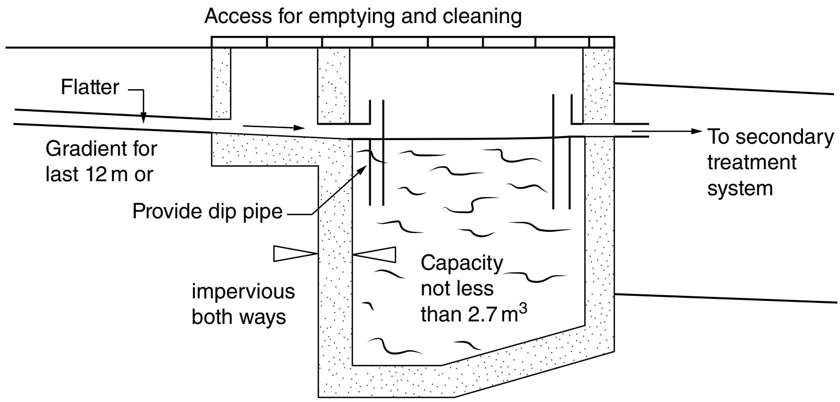


Fig. 13.16 Septic tank.

Wastewater Treatment System

Details of Necessary Maintenance

Address of Property ____

Location of treatment system ____________________________________

The foul drainage system from this property discharges to a septic tank and a [*insert type of secondary treatment*]

The tank requires monthly inspections of the outlet chamber or distribution box to observe that the effluent is free-flowing and clear.

The septic tank requires emptying at least every 12 months by a licensed contractor. The [*insert type of secondary treatment*] should be [*insert details of maintenance of secondary treatment*].

The owner is legally responsible to ensure that the system does not cause pollution, a health hazard or a nuisance.

Fig. 13.17 Septic tank: typical maintenance notice.

from the tank to ensure that the effluent is flowing freely. Additionally, the effluent at the outlet should be clear.

If these conditions are not met, the tank should be emptied by a licensed contractor who will make a charge. It may be more economical to take out an annual maintenance contract with a suitable contractor. Septic tanks should be emptied annually, and it is usual to leave a small amount of sludge to act as an anaerobic seed.

Failure to adequately maintain the tank may result in solids being carried into the drainage field or mound. The sediments deposited may block the pores in the soil necessitating early replacement of the field or mound, and in exceptional circumstances this can even render the site unsuitable for future use as a drainage field or mound.

A durable notice should be fixed within the building describing the necessary maintenance. Figure 13.17 is an example of a typical notice.

13.4.3 Primary treatment systems: Packaged treatment works

Packaged treatment works, which are engineered to treat a given hydraulic and organic load to a higher standard than septic tanks, use prefabricated components which can be installed with a minimum amount of site work. They are normally more economic than septic tanks for larger developments and can also discharge direct to a suitable watercourse. They should be considered where there are space limitations or where other options are not possible. AD H2 does not really deal with such installations in any detail since specialist knowledge is needed in their detailed design and installation. However, it does recommend that the discharge from the treatment plant should be sited at least 10 m from watercourses or any other buildings. Furthermore, since many of these systems are powered by electricity, it is important that the system should be able to adequately function for up to six hours without power or have an uninterruptible power supply.

Guidance on packaged treatment works may be obtained from BS 6297:1983 *Code of practice for design and installation of small sewage treatment works and cesspools*. Additionally, packaged treatment works should be type tested in accordance with BS 7781 or otherwise tested by a notified body.

The guidance regarding maintenance requirements mentioned above in connection with septic tanks also applies generally to packaged treatment works; however, there will be variations in maintenance needs depending on the type of plant installed. The manufacturer's instructions regarding maintenance and inspection should always be adhered to. A durable notice should be fixed within the building describing the necessary maintenance. Figure 13.18 is an example of a typical notice.

13.4.4 Secondary treatment systems: Drainage fields and drainage mounds

Drainage fields and drainage mounds are used to provide secondary treatment to the discharge from a septic tank or packaged treatment plant. Drainage fields normally consist of below-ground irrigation pipes which allow the partially treated effluent from

Wastewater Treatment System

Details of Necessary Maintenance

Address of Property ____

Location of treatment system ______________________________________

The foul drainage system from this property discharges to a packaged treatment works.

Maintenance is required [insert frequency] and should be carried out by the owner in accordance with the manufacturer's instructions.

The owner is legally responsible to ensure that the system does not cause pollution, a health hazard or a nuisance.

Fig. 13.18 Septic tank: typical maintenance notice.

the septic tank to percolate into the surrounding soil. Further biological treatment takes place naturally in the aerated soil layers. They may be used in subsoils with good percolation characteristics on sites which are not prone to flooding or waterlogging at any time of the year. Drainage mounds consist of drainage fields placed above the ground surface, thus providing an aerated soil layer to treat the discharge. On sites where there is a high water table or impervious ground where occasional waterlogging is possible, drainage mounds could be used.

It should be noted that drainage fields and mounds are not permitted by the Environment Agency in prescribed Zone 1 groundwater source protection zones.

Siting

Care has to be taken with siting in order to protect underground water sources and watercourses and to ensure that the system will operate effectively. Therefore, a drainage field or mound serving a wastewater treatment system or septic tank should be sited:

- not less than 10 m from any permeable drain or watercourse;
- not less than 50 m from the abstraction point of any groundwater supply;
- away from any Zone 1 groundwater protection zone;
- not less than 15 m from any building;
- far enough away from other drainage fields, mounds or soakaways so that the overall soakage capacity of the ground is not exceeded; and
- on the downslope side of any groundwater sources.

The disposal area should be isolated and should not contain any access roads, driveways or paved areas. Additionally, no water supply pipes or other underground services should be located within the disposal area other than those required by the disposal system itself.

Ground conditions and percolation

Some indication of the likely percolation characteristics of a site may be gained by taking a sample and observing the nature of the subsoil. Table 13.3 gives an indication of the likely percolation characteristics of the different subsoil colours and types. Percolation characteristics should be ascertained under both summer and winter conditions. This usually takes the form of a preliminary assessment followed by a percolation test.

Table 13.3 Likely percolation characteristics of different soil types.

Likely percolation characteristics	Soil colour	Likely soil type
Well drained and well aerated	Brown, yellow or reddish	Sand, gravel, chalk, sandy loam, clay loam
Poorly drained or saturated	Grey, blue	Sandy clay, silty clay, clay
Indicative of periodic saturation	Grey or brown mottling	Sandy clay, silty clay, clay

The preliminary assessment should involve:

- consultation with the Environment Agency and the local authority to determine the possible suitability of the site;
- an assessment of the on-site natural vegetation (most plants generally grow best on well-drained land, the presence of certain plants may indicate wet or boggy conditions); and
- a determination of the position of the standing groundwater table.

The standing groundwater table is determined by excavating a trial hole. This should be at least 1 m^2 in area and should be at least 2 m deep or 1.5 m below the invert of the proposed drainage field pipework. The groundwater table should be at least 1 m below the invert level of the proposed effluent distribution pipes in both summer and winter.

The preliminary assessment should be followed by a percolation test of the proposed disposal area. Figure 13.19 illustrates the three stages of the percolation test. Where deep drains are needed, the 300 mm hole should be excavated at the base of a wider excavation to allow room for working. Alternatively a modified test procedure can be adopted using

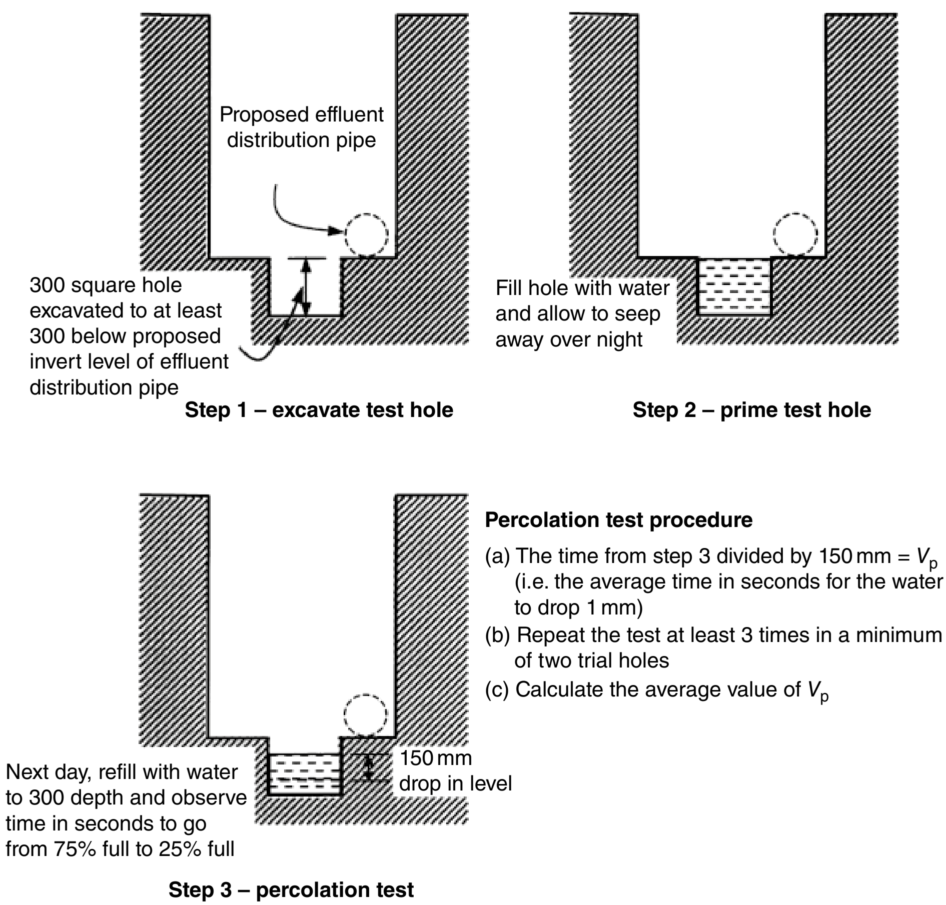


Fig. 13.19 Percolation test method.

a 300 mm earth auger bored vertically into the ground. All debris should be removed from the hole before the test is carried out.

The test should only be carried out when weather conditions are suitable (i.e. not during heavy rain, severe frost or drought).

Disposal via a drainage field should only be considered when:

- the percolation tests give values of V_p between 12 and 100 sec/mm;
- the preliminary site assessment report is favourable; and
- the trial hole tests give acceptable results.

The values of V_p given above ensure that untreated effluent cannot percolate too rapidly into the groundwater. Where V_p is outside the quoted range, treatment via a drainage field is unlikely to be successful. In these circumstances it may still be possible to use a septic tank provided that an alternative method of secondary treatment can be used to treat the effluent from the septic tank. It might then be possible to take the final discharge to a soakaway.

Design and construction

The main features of a typical drainage field are illustrated in Fig. 13.20, whilst Fig. 13.21 shows the main features of a drainage mound. Both are designed to ensure aerobic contact between the liquid effluent and the subsoil.

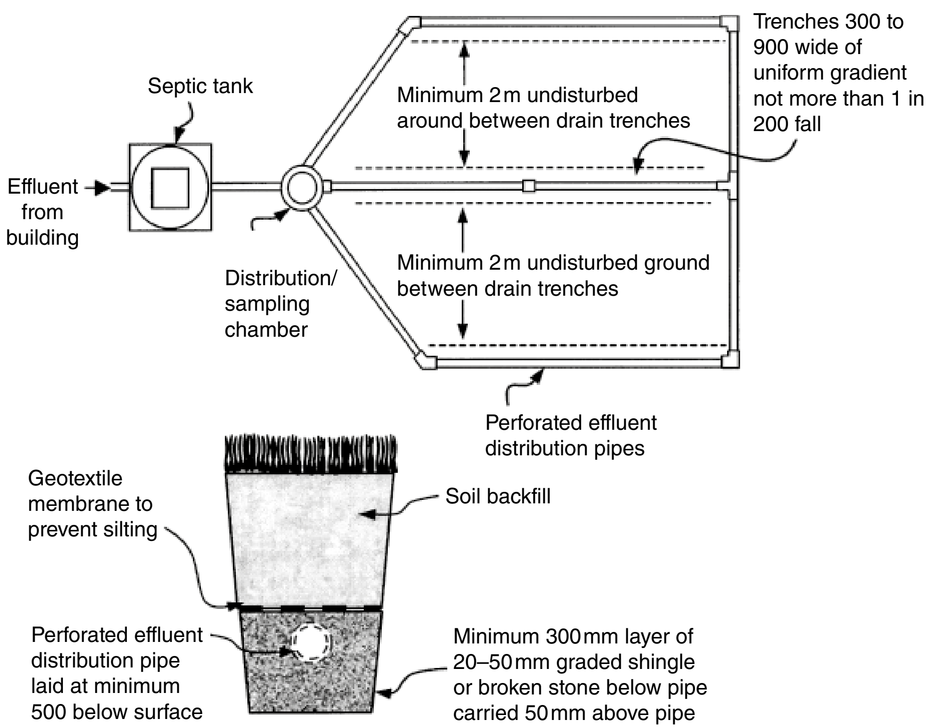


Fig. 13.20 Drainage field.

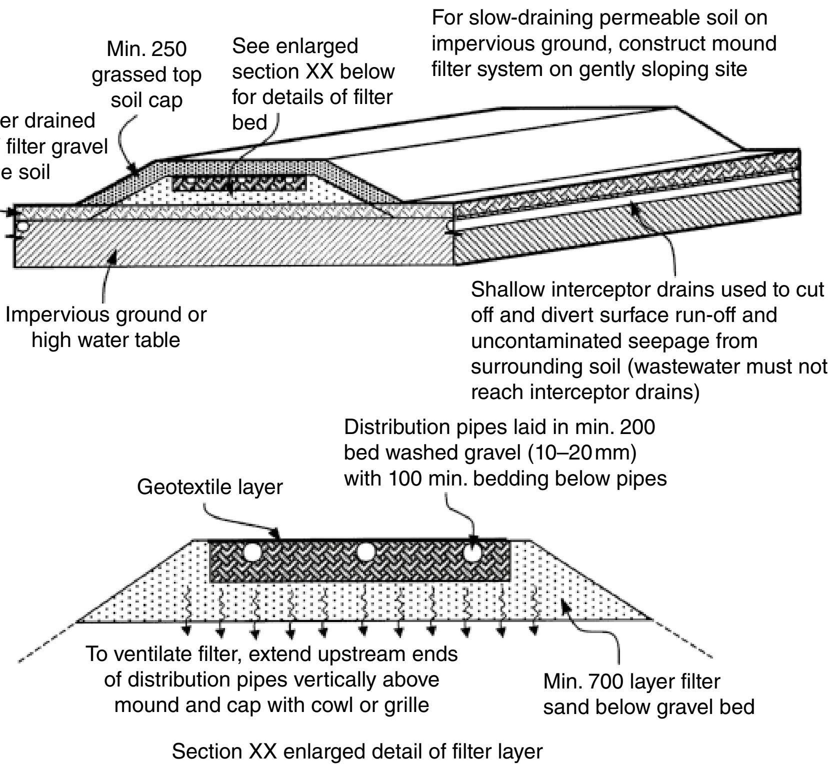


Fig. 13.21 Drainage mound details.

Pipes for drainage fields should be:

- perforated and laid in trenches of uniform gradient not exceeding 1 in 200;
- laid on a 300 mm layer of clean shingle or broken stone graded between 20 mm and 50 mm;
- laid at a minimum depth of 500 mm below the surface of the ground; and
- laid in a continuous loop fed from an inspection chamber sited between the septic tank and the drainage field.

Pipe trenches for drainage fields should be:

- filled to a level of 50 mm above the pipe with the shingle or broken stone and covered with a layer of geotextile to prevent entry of silt;
- topped up with soil to ground level;
- between 300 mm and 900 mm wide; and
- at least 2 m from other trenches in the same drainage field.

The area needed to be covered by the drainage field (the floor area, A_t m^2) can be calculated from the formula

$$A_t = p \times V_p \times 0.25$$

where *p*, number of persons served by the septic tank; and V_p, the percolation value in sec/mm obtained as described above.

Drainage mounds should contain the features shown in Fig. 13.21.

13.4.5 Secondary treatment systems: Constructed wetlands/reed beds

Where drainage fields or mounds are not a practical solution, it may be possible to treat septic tank effluent by means of constructed wetlands discharging to a suitable watercourse. Constructed wetlands (e.g. consisting of reed beds) are man-made systems which exploit the natural treatment capacity of certain wetland plants such as the common reed (*Phragmites communis*). The Environment Agency's consent may be required for this.

Constructed wetlands: General comments

Constructed wetland treatment systems purify wastewater by a combination of filtration, bacterial oxidation, sedimentation and chemical precipitation as the effluent moves through a gravel bed and around the rhizomes and roots of the wetland plants. In this way the biological oxygen demand (BOD) and suspended solids of the effluent are reduced, ammonia is oxidised, nitrates are reduced and a small amount of phosphorus is removed.

Plants used for reed beds and in constructed wetlands include:

common reed (*Phragmites communis*);
reedmaces (*Typha latifolia*);
rushes (*Juncus effusus*);
bulrush (*Schoenoplectus lacustris*);
members of the sedge family (*Carex*); and
yellow flag (*Iris pseudacorus*).

In general, shaded areas (under trees or close to buildings) should not be used as the site for a constructed wetland as this will lead to poor and patchy growth. Additionally, the likely winter performance of the wetland should be taken into account during the design stage, as the lower temperatures tend to lead to poorer removal of ammonia although the other functions mentioned above are not affected.

Constructed wetlands: Design

There are two principal designs for constructed wetland systems, horizontal flow and vertical flow. These can be used separately or can be combined to give superior treatment. The reed bed systems that produce good quality effluents with nitrification use vertical flow reed beds followed by a horizontal flow bed. Whether such a high level of treatment is appropriate depends on the quality and dilution of the receiving water body.

Vertical flow systems

In a vertical flow system, the top surface of the reed bed is intermittently flooded with wastewater. There are usually two or more beds provided side by side allowing a regime

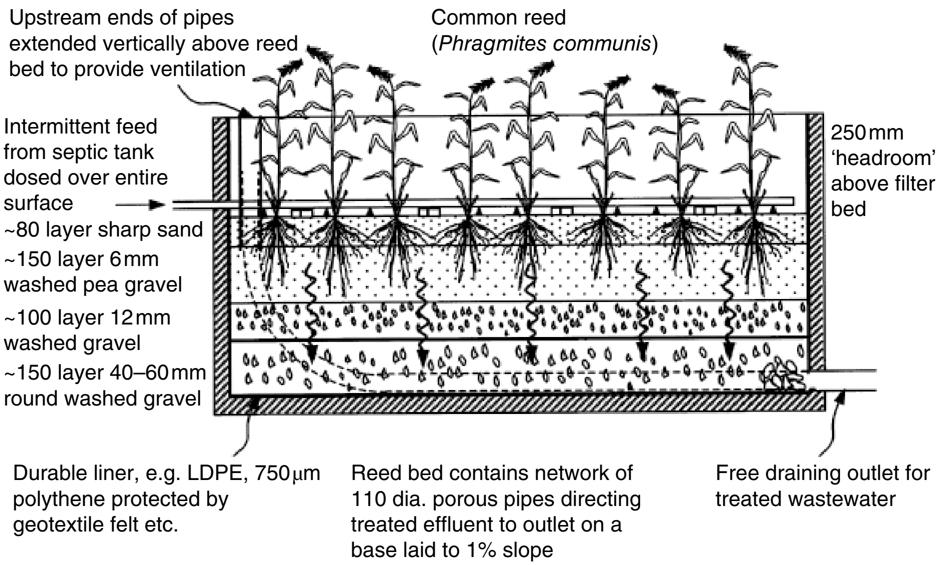


Fig. 13.22 Typical vertical flow reed bed treatment system.

of rest and loading so that the surface, which might become clogged in use, can recover its permeability. The flow of wastewater passes down through layers of free-draining sand and gravel to an outlet at the bottom where it is collected by a system of drains at the base. In practice, depth is limited by available falls and construction techniques; however, a bed depth of about 1 m is typical, and good results should be achieved with a single bed between 1 m and 2 m deep.

In general, vertical flow systems are able to achieve more complete treatment of the effluent (particularly of ammonia) than horizontal flow systems because they can deliver much better oxygen transfer. Unfortunately, they do require more maintenance.

A typical vertical flow reed bed treatment system is shown in Fig. 13.22.

Horizontal flow systems

In a horizontal flow system, wastewater is continuously fed in from the upstream end and passes over the full width of a gravel bed to an outlet at the downstream end. Horizontal flow systems have the disadvantage of being oxygen limited and therefore incapable of fully treating concentrated effluents, especially those containing high levels of ammonia. They also require a relatively level site but have lower maintenance needs than vertical flow systems since only one bed is needed. A typical horizontal flow reed bed system is illustrated in Fig. 13.23.

The guidance provided in AD H2 on vertical and horizontal flow reed bed systems is extremely limited and has been enhanced in the above notes and illustrations by reference to BRE Good Building Guide 42 (GBG 42) to which reference should be made. There are many other forms of constructed wetland treatment systems available and being developed both nationally and internationally. GBG 42 contains a number of references to such systems which will normally require specialist advice.

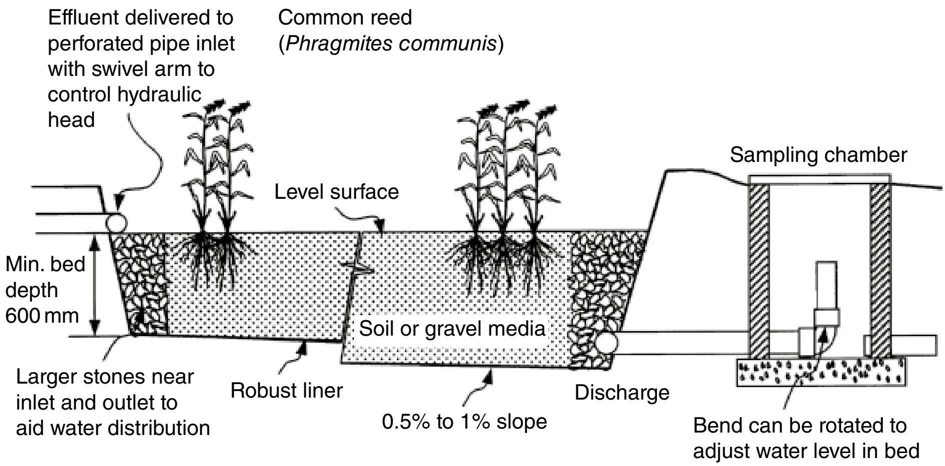


Fig. 13.23 Typical horizontal flow reed bed.

Wastewater Treatment System

Details of Necessary Maintenance

Address of Property __________________________________

Location of treatment system ______________________________

The foul drainage system from this property discharges to a [*insert type of primary treatment*] and a constructed wetland.

The [*insert type of primary treatment*] requires [*insert details of maintenance of the primary treatment*].

The constructed wetland system requires [*insert details of maintenance of the constructed wetland*].

Fig. 13.24 Constructed wetland: typical maintenance notice.

Maintenance of constructed wetlands

It is essential that building owners are kept informed about the maintenance requirements where constructed wetlands are provided. The main maintenance requirements are weeding, annual reed cutting and general grounds care around the system. There will also be the need for periodic resting where multiple beds are provided in horizontal flow systems. Horizontal flow reed beds require less routine maintenance than vertical flow beds, and where weeds are a problem, the bed can be flooded to kill off the weeds. Full details of guidance on maintenance of reed beds can be found in GBG 42 Part 2. A durable notice should be fixed within the building describing the necessary maintenance. Figure 13.24 is an example of a typical notice.

13.4.6 Cesspools

Where no other drainage disposal option is available, it may be acceptable to provide a cesspool. Quite simply, a cesspool is a watertight underground tank provided for the storage of raw sewage. No treatment is involved.

Siting

Cesspools should be sited:

- on sloping ground away from and lower than nearby buildings;
- below and at least 7 m from the habitable parts of buildings;
- within 30 m of a vehicle access; and
- at such levels that emptying and cleaning can be carried out without creating a hazard for the building's occupants and without the contents being taken through a dwelling or place of work.

Access for emptying and cleaning may be through a covered space which may be lockable.

Design and construction

The minimum capacity of the cesspool measured below the level of the inlet should be 18 m^3 (18,000 litres) based on two users. This capacity should be increased by 6.8 m^3 (6800 litres) for each additional user.

Additionally, cesspools should:

- have no openings except for the inlet from the drain, access for emptying and cleaning and ventilation;
- prevent leakage of the contents and ingress of subsoil water;
- be ventilated; and
- be provided with access for emptying, cleaning and inspection at the inlet.

Access covers for emptying and cleaning should be sufficiently durable to resist the corrosive nature of the tank contents and should be designed to prevent unauthorised access (by being lockable or otherwise engineered to prevent personnel entry).

Cesspools should also be constructed of materials which are impervious to the contents and to groundwater. This would include engineering brickwork in 1:3 cement mortar at least 220 mm thick and concrete at least 150 mm thick (C/25/P mix to BS 5328), roofed with heavy concrete slabs. Prefabricated cesspools are available and are made of glass-reinforced plastics, polyethylene or steel. These should follow the guidance in BS EN 12566 *Small wastewater treatment plants less than 50 PE:* Part 1: 2000 *Prefabricated septic tanks.* Care should be exercised over the stability of these tanks. Figure 13.25 illustrates a typical cesspool designed for two users.

Maintenance of cesspools

It is essential that building owners are kept informed about the maintenance requirements where cesspools are provided. Cesspools should be inspected every two weeks for overflow and emptied as necessary. A typical emptying frequency is once per month, and this can be estimated by assuming a filling rate of 150 litres per person per day. Cesspools which do not fill within the expected period may be leaking and should be checked out. A durable notice should be fixed within the building describing the necessary maintenance. Figure 13.26 is an example of a typical notice.

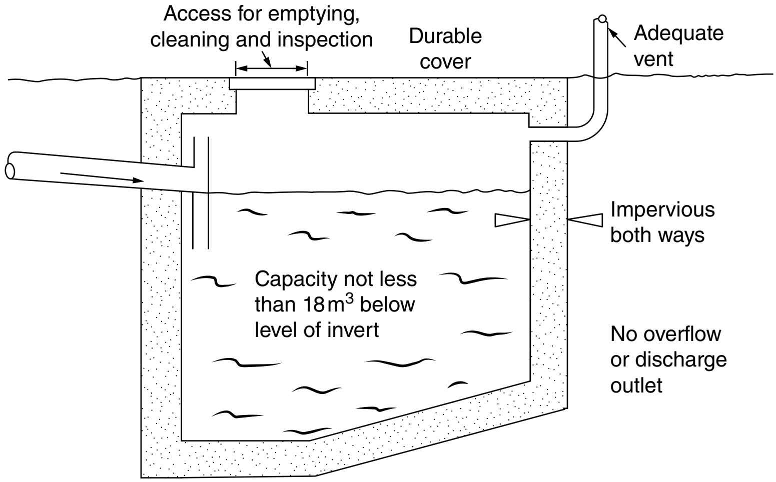


Fig. 13.25 Cesspools.

Cesspool foul drainage system
Details of Necessary Maintenance
Address of Property ___________________________________
Location of treatment system ________________________________
The foul drainage system from this property is served by a cesspool.
The system should be emptied approximately every [*insert design emptying frequency*] by a licensed contractor and inspected fortnightly for overflow.
The owner is legally responsible to ensure that the system does not cause pollution, a health hazard or a nuisance.

Fig. 13.26 Cesspool: typical maintenance notice.

13.5 Greywater and rainwater storage tanks

AD H2 concludes with limited guidance information on tanks for storage of greywater or rainwater for reuse within the building. The guidance does not apply to water butts used for storing rainwater for use in gardens.

Reclaimed water systems aid water conservation by reducing the amount of mains supply water used in houses and commercial buildings. Clearly there is a potential for reclaimed water systems to contaminate potable mains water supplies by inadvertent cross connection or backflow. Therefore, it is essential that water installations comply with the Water Supply (Water Fittings) Regulations 1999 in England and Wales, the Water Byelaws 1999 in Scotland or the Water Regulations in Northern Ireland.

Greywater should only be used for irrigation purposes, and even then, certain precautions should be taken to prevent possible health problems occurring. Section 9 of the Water Regulations Advisory Scheme leaflet 09-02-04 *Reclaimed water systems – Information* *about installing, modifying or maintaining reclaimed water systems* gives general tips on reclaimed water uses and treatment. It also includes a great deal more information than can be found in AD H2, including a definition of greywater. This means water originating from the mains potable water supply that has been used for bathing or washing, washing dishes or laundering clothes.

Therefore, greywater and rainwater tanks should be:

- ventilated and prevent ingress of subsoil water or leakage of the contents;
- fitted with an anti-backflow device on any overflow connected to a drain or sewer to prevent contamination should a surcharge occur in the drain or sewer; and
- provided with access for emptying and cleaning.

Access covers for emptying and cleaning should be sufficiently durable to resist the corrosive nature of the tank contents and should be designed to prevent unauthorised access (by being lockable or otherwise engineered to prevent personnel entry).

13.5.1 Alternative approach

Requirement H2 of Schedule 1 to the Building Regulations 2010 may also be met by complying with the relevant recommendations of BS 6297:1983 *Code of practice for the design and installation of small sewage treatment works and cesspools.* These are sections 1, 2, 4 and the appendices and clauses 6–11 of section 3.

13.6 Rainwater drainage

Paragraph H3 of Schedule 1 to the Building Regulations 2010 requires that:

- any system carrying rainwater from the roof of a building is adequate; and
- paved areas around the building are so constructed as to be adequately drained.

It should be noted that only the following paved areas are covered by the Regulations:

- Those which provide access for disabled people in accordance with requirements:
  - (i) M1 (access to and use of buildings other than dwellings) and
  - (ii) M4 (Access to and use of dwellings) – M4(1) optional requirement (Category 1 – visitable dwelling), M4(2) optional requirement (Category 2 – accessible and adaptable dwellings) and M4(3) optional requirement (Category 3 – wheelchair user dwellings) (see Chapter 17);
- Those which provide access to or from a place used for the storage of solid waste (see requirement H6(2) below); and
- Those which give access to the building where this is intended to be used in common by the occupiers of one or more other buildings.

Rainwater from the roof of the building and any relevant paved areas must be taken to one of the following, listed in order of priority:

- An adequate soakaway or some other adequate infiltration system;
- A watercourse; or
- A sewer.

Movement to a lower level in the order of priority may only be on the grounds of reasonable practicability since it is the purpose of the Regulation to encourage drainage connections to other than surface water sewers where this is technically feasible. This is an attempt to lessen the effect of flash flooding occurring in times of exceptionally heavy rainfall. This requirement does not apply to the gathering of rainwater for reuse.

The requirements of Paragraph H3 will be met if the following are fulfilled:

- Rainwater from paved areas and roofs is carried away from the relevant surface by a drainage system or some other appropriate means.
- Any rainwater drainage system:
  (a) conveys the flow of rainwater to a suitable outfall (soakaway, watercourse, surface water or combined sewer);
  (b) reduces to a minimum the risk of leakage or blockage; and
  (c) is accessible for clearing blockages.
- Rainwater soaking into the ground (for example, to a soakaway) is sufficiently distributed so as not to damage the foundations of the building or any adjacent structure.

The emphasis in H3 on infiltration systems to dispose of rainwater means that it is essential to ensure adequate distribution of rainwater where it will not harm the structure of the building. Rainwater or surface water should never be discharged to a cesspool or septic tank.

13.6.1 Gutters and rainwater pipes

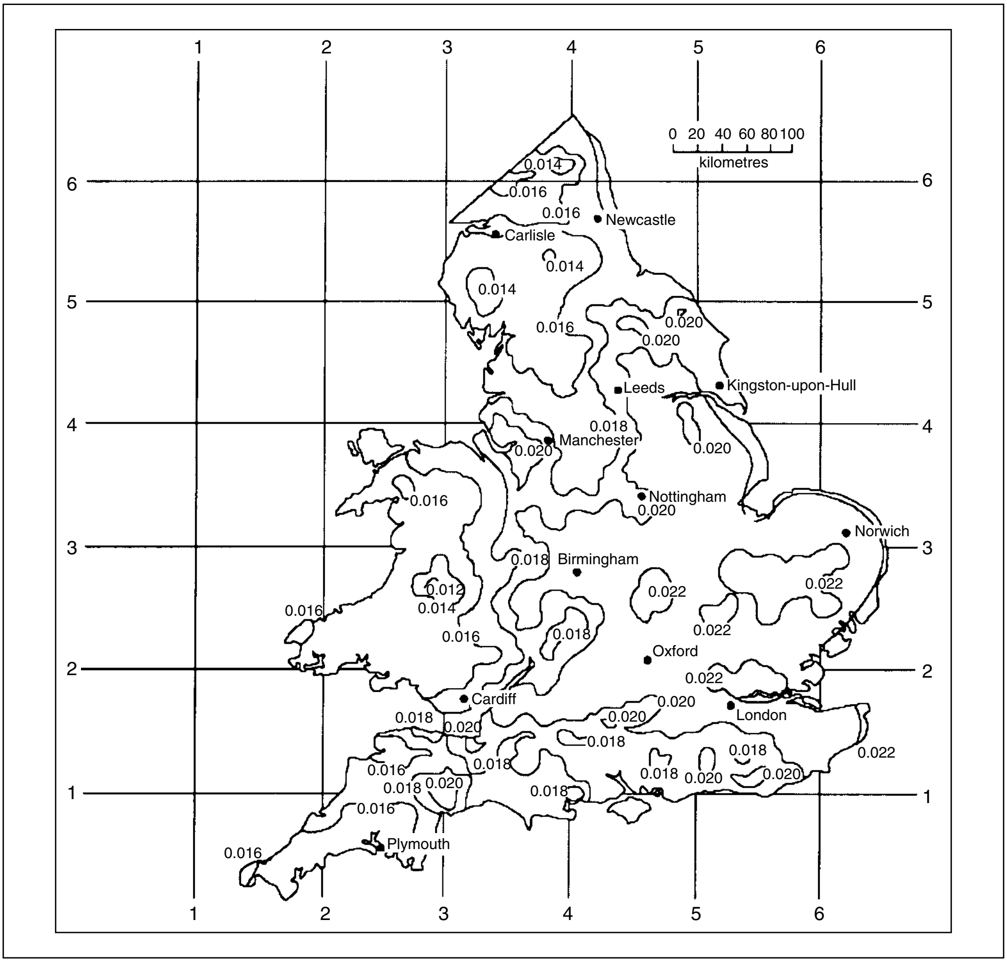
A rainwater drainage system should be capable of carrying the anticipated flow at any point in the system. The flow will depend on the area of roofs to be drained and on the intensity of the rainfall. For eaves gutters, a design rainfall intensity of 0.021 l/s/m^2 (i.e. 75 mm of rainfall in any one hour) should be assumed in design calculations. For valley gutters, parapet gutters, siphonic systems and other rain gathering systems, the rainfall intensity should be obtained from Diagram 1 of AD H3 which is reproduced below.

For some roof designs, incorporating valley gutters, parapet gutters or drainage from flat roofs, it is possible that intense rainfall could cause overtopping of the construction resulting in water entering the building causing damage, wetting of insulation, etc. The design of such systems should be carried out in accordance with BS EN 12056 *Gravity drainage systems inside buildings*.

The ultimate capacity of gutters and rainwater pipes depends on their length, shape, size and gradient and on the number, disposition and design of outlets. AD H3 contains design data for half-round gutters up to 150 mm in diameter. They are assumed to be laid level and to have a sharp-edged outlet at one end only. Table 2 to section 1 of AD H3 is reproduced below and gives gutter and outlet sizes for the drainage of different roof areas for lengths of gutter up to 50 times the water depth. The gutter capacity should be reduced for greater lengths.

AD H3 section 1

Diagram 1 Rainfall intensities for design of gutters and rainfall pipes (l/s/m²).



AD H3 section 1

Table 2 Gutter sizes and outlet sizes.

Max effective roof area (m²)	Gutter size (mm dia)	Outlet size (mm dia)	Flow capacity (l/s)
6.0	—	—	—
18.0	75	50	0.38
37.0	100	63	0.78
53.0	115	63	1.11
65.0	125	75	1.37
103.0	150	89	2.16

Note:
Refers to nominal half-round eaves gutters laid level with sharp-edged outlet at one end.
Round-edged outlets allow smaller downpipe sizes.

AD H3 section 1

Table 1 Calculation of area drained.

Type of surface		Effective design area (m^2)
1	Flat roof	Plan area of relevant portion
2	Pitched roof at 30°	Plan area of portion × 1.29
	Pitched roof at 45°	Plan area of portion × 1.50
	Pitched roof at 60°	Plan area of portion × 1.87
3	Pitched roof over 70° or any wall	Elevational area × 0.5

The maximum roof areas given in Table 2 are the largest effective areas which should be drained into the gutters given in the table. The effective area of a roof will depend on whether the surface is flat or pitched. Table 1 to section 1 of AD H3 shows how the effective area may be calculated for different roof pitches.

Gutters should also be fitted so that any overflow caused by abnormal rainfall will be discharged clear of the building. Additional outlets may be necessary on flat roofs, valley gutters and parapet gutters to avoid overtopping.

Where it is not possible to comply with the conditions assumed in Table 2, further guidance is given in AD H3:

- Where an end outlet is not practicable, the gutter should be sized to take the larger of the roof areas draining into it.
- If two end outlets are provided, they may be 100 times the depth of flow apart.
- It may be possible to reduce pipe and gutter sizes if:
  (a) the gutter is laid to fall towards the nearest outlet;
  (b) a different shaped gutter is used with a larger capacity than the half-round gutter; or
  (c) a rounded outlet is used.

In these cases reference should be made to the following parts of BS EN 12056:

- Part 3: Roof drainage layout and calculation, clauses 3 to 7
- Annex A and National Annexes
- Part 5: Installation, testing instructions for operation and maintenance and use, clauses 3, 4, 6 and 11.

Rainwater pipes should comply with the following rules:

- Discharge should be to a drain, gully, other gutter or surface which is drained.
- Any discharge into a combined system of drainage should be through a trap (e.g. into a trapped gully).
- Rainwater pipes should not be smaller than the size of the gutter outlet. Where more than one gutter serves a rainwater pipe, the pipe should have an area at least as large as the combined areas of the gutter outlets and be large enough to take the flow from the whole contributing area.

- Discharge from a rainwater pipe onto a lower roof or paved area should be via a pipe shoe to divert water away from the building.
- Where a single downpipe serves a roof with an effective area greater than 25 m^2 and discharges onto a lower roof, a distributor pipe should be fitted to the shoe to ensure that the width of flow at the receiving gutter is great enough to prevent overtopping of the gutter.

13.6.2 Siphonic roof drainage systems

Using siphonic action to accelerate the flow of water from the gutters to the below-ground drainage system enables small-diameter pipes to achieve high rates of discharge. This permits a reduction in the number of downpipes that need to be provided when compared with traditional systems of roof drainage, and this is particularly useful in large single-storey commercial buildings with restricted numbers of columns.

For the siphonic action to start, the pipework must be airtight. This requires special rainwater outlets with baffle plates, correctly dimensioned pipes and fully sealed joints. Additionally, care should be taken that other trades do not connect their internal drainage pipes into a siphonic system and thus break the vacuum.

The following considerations should also be taken into account:

- Possible surcharging in the downstream drainage system as this can cause reductions in flow rates in downpipes.
- The time taken to prime the siphonic action may be excessive where long gutters are specified. In this case, overflow arrangements to prevent gutters from overtopping should be provided.

More information on the design of siphonic systems of roof drainage may be obtained from Report SR 463 *Performance of syphonic drainage systems for roof gutters* published by Hydraulics Research Ltd. Reference should also be made to BS EN 12056: Part 3.

13.6.3 Eaves drop systems

In modern buildings it is normal for rainwater from roofs to be collected by a system of guttering and downpipes to be transmitted to a system of below-ground drainage. In fact, the requirement of H3 for adequacy or rainwater systems means that an eaves drop system (where rainwater is allowed to fall from the roof freely to the ground) can be a perfectly acceptable solution provided that the following design considerations are taken into account:

- The fabric of the building should be protected against ingress of water caused by splashing against the external walls.
- The entry of water into doorways and windows should be prevented.
- Persons should be protected from falling water in doorways or other openings into the building.
- Splashback caused by water hitting the ground should be prevented from affecting people and the fabric of the building (e.g. by providing a gravel layer or angled concrete apron to deflect water away).
- Foundations should be protected from concentrated discharges which occur at valleys, valley gutters or from excessive flows caused by large roofs (where the area of roof per unit length of eaves is high).

13.6.4 Rainwater recovery systems

In order to conserve water supplies, it is possible to collect rainwater for reuse within the building provided that the following considerations are taken into account:

- Storage tanks should follow the guidance given in section **13.5**.
- Pipework, valves and washouts used for recovered water should be clearly identified on marker plates in accordance with the recommendations the Water Regulations Advisory Scheme leaflet 09-02-04 *Reclaimed water systems – Information about installing, modifying or maintaining reclaimed water systems* where further guidance on the use of rainwater recovery systems will also be found.

13.6.5 Materials

Materials used should be adequately strong and durable. Additionally,

- Gutters should have watertight joints under working conditions.
- Downpipes placed inside a building should be capable of withstanding the test for airtightness described in section 13.3.13.
- Gutters and rainwater pipes should be adequately supported with no restraint on thermal movement.
- Pipes and gutters of different metals should be separated by non-metallic material to prevent electrolytic corrosion.
- Siphonic roof drainage pipework should be designed to resist negative pressures.

13.6.6 Alternative method of design

The requirements of the 2010 Regulations for rainwater drainage can also be met by following the relevant recommendations of BS EN 12056 *Gravity drainage systems inside buildings.* These are:

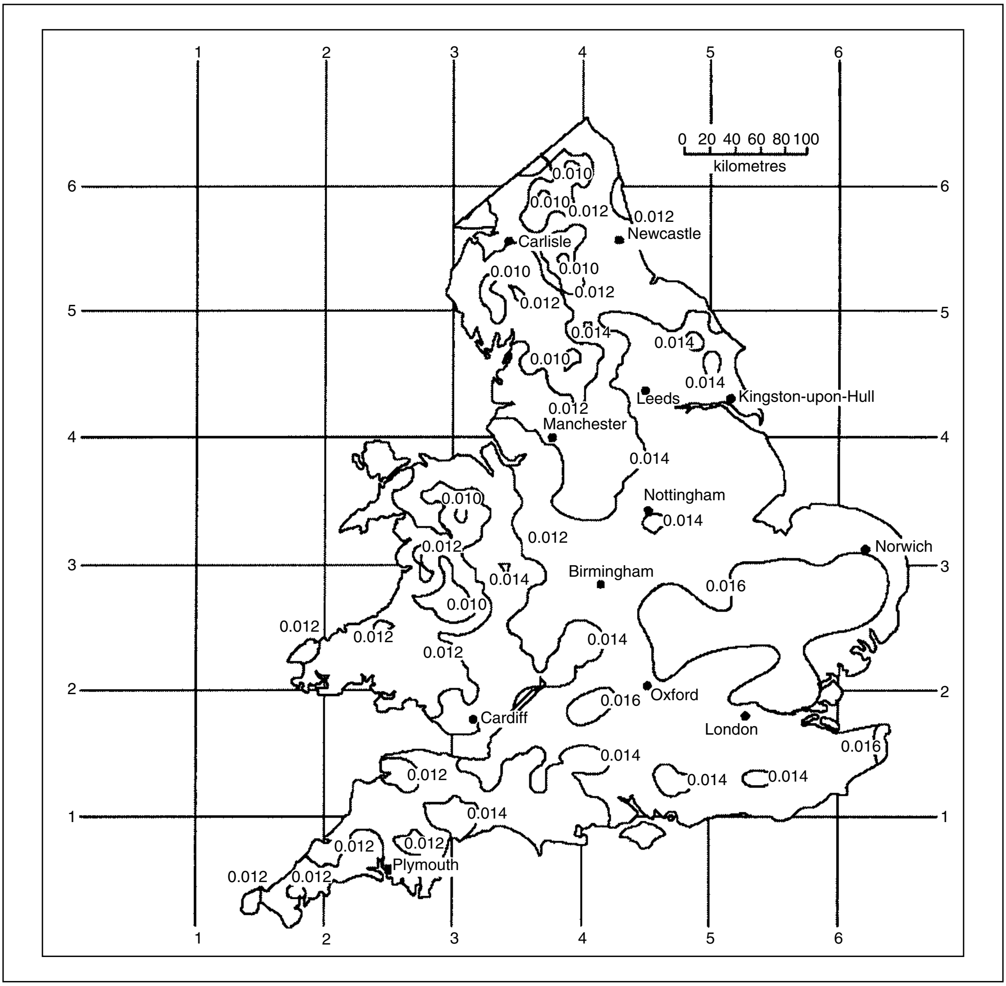
- In Part 3 *Rainwater drainage, layout and calculation*, clauses 3 to 7.
- Annex A and National Annexes.
- In Part 5 *Installation and testing, instructions for operation, maintenance and use*, clauses 3, 4, 6 and 11.

13.6.7 Drainage of paved areas

Section 2 of AD H3 contains information on the design of rainwater drainage systems for paved areas around buildings and small car parks up to 4000 m^2. For the design of systems serving larger catchment areas, the guidance in BS EN 752 *Drain and sewer systems outside buildings* Part 4: 1998 *Hydraulic design and environmental aspects* should be followed. Rainfall intensities of 0.014 $l/s/m^2$ (i.e. 50 mm of rainfall in any one hour) are assumed for normal situations. More accurate local figures can be obtained from Diagram 2 of section 2 to AD H3 which is reproduced below. In very high risk areas where ponding could lead to flooding of buildings, drainage of paved areas should be designed in accordance with BS EN 752: Part 4.

AD H3 section 2

Diagram 2 Rainfall intensities for design of drainage from paved areas and underground rainwater drainage (l/s/m²).



AD H3 describes three methods for draining paved areas:

- Allow pavings to drain freely onto adjacent pervious surfaces
- Use pervious paving
- Use impervious paving discharging to gullies or channels connected to a drainage system

13.6.8 Design of free-draining surfaces

Surface water should not be allowed to soak into ground where the conditions are not suitable; however, paved areas do not always have to be served by underground drainage systems. It is acceptable for paths, driveways and other narrow areas of paving to be free draining to pervious areas (e.g. grassland) if the following conditions are met:

- Water should be directed away from buildings where foundations could be damaged. This can be achieved by suitable surface gradients (e.g. where ground levels would cause water to collect along the wall of a building, a reverse gradient could be created at least 500 mm wide to divert water away).
- Impervious surfaces should have a cross fall of at least 1 in 60 to permit rapid draining. The fall across a path should not exceed 1 in 40.
- Where paving drains onto adjacent ground, it should be finished flush with or above the level of the surrounding ground to permit the water to run off.
- The soakage capacity of the ground should not be overloaded, and where the adjacent ground is not sufficiently permeable to take the flow, it may be necessary to provide filter drains (see section 13.7.4).

13.6.9 Pervious paving

As an alternative and where it is not possible to drain large paved areas to adjacent pervious surfaces, it may be possible to construct pervious paving to deal with surface drainage. Pervious paving is made up of a porous or permeable surface material placed onto a granular layer which acts as a storage reservoir, retaining peak water flows until soakage into the underlying subsoil takes place. The storage layer should be designed on a similar basis to the design of the storage volume in a soakaway (see section 13.7.4).

On steeply sloping surfaces, it will be necessary to check that the water level can rise sufficiently in the storage reservoir to enable its full capacity to be used. It will also be necessary to check that water is not inadvertently accumulating around the building foundations.

Pervious paving, on flat or sloping sites, may even be used where infiltration drainage is not possible (see section 13.7.4). In this case an impermeable barrier is placed below the storage layer to act as a detention tank or pond prior to discharge of the stored water to a drainage system (see section 13.6.10).

Pervious paving should not be used:

- where excessive amounts of sediment are present since these can enter the pavement and block the pores; and
- in oil contaminated areas or where run-off may be contaminated with pollutants.

More information on the design of pervious paving can be found on pages 64 to 66 of CIRIA report C522: *Sustainable urban drainage systems – Design manual for England and Wales.*

13.6.10 Paving connected to drainage system

Where it is not possible for the paving to be free draining or for pervious paving to be used, impervious paving should be used in conjunction with gullies or channels connected to a drainage system. Gullies should comply with the following guidance:

- Be provided as necessary at low points to ensure that ponding does not occur.
- Be provided at intermediate positions so that individual gullies are not overloaded and channels do not have excessive depths of flow.
- Have their gratings set about 5 mm below the surrounding paving to allow for settlement of the paving.

Since it is possible that drainage from pavings may encourage silt and grit to enter the drainage system, this should be intercepted by providing suitably sized gully pots or catchpits.

13.6.11 Alternative method of design

The requirements of the 2010 Regulations for drainage of pavings can also be met by following the relevant recommendations of BS EN 752 *Drain and sewer systems outside buildings.* These are:

- in Part 4, *Hydraulic design and environmental considerations*, clause 11; and
- National Annexes ND and NE.

13.7 Rainwater drainage below ground

13.7.1 Connections and outlets

Section 3 of AD H3 deals specifically with drainage systems carrying only rainwater. Where practicable, surface water drainage should discharge to a soakaway or other infiltration system. Discharge to a watercourse is the next best option, but the consent of the Environment Agency may be required, and they may put a limit on the rate of discharge, although this can be attenuated by the use of detention ponds or basins. Where these forms of outlet are not practicable, discharge should be made to a suitable sewer.

Combined systems (those carrying both foul and rainwater) are permitted by some drainage authorities where allowance is made for the additional capacity. Where a combined system does not have sufficient capacity, rainwater will need to be taken via a separate system to its own outfall. Even where a sewer is operated as a combined system and has sufficient capacity, it may still be necessary to provide separate systems of drainage to the building in accordance with the provisions of Requirement H5 (see section 13.9.2). Surface water drainage connected to a combined system should have traps on all inlets.

Pumped systems of surface water drainage may be needed where there is a tendency to surcharging or gravity connections are impracticable (see also section 13.3.28).

The design information contained below is suitable for the drainage of small impervious catchment areas up to 2 hectares with an assumed design rainfall intensity of 0.014 l/s/m^2 for normal situations. Rainfall intensity may also be obtained from Diagram 2 of AD H3 illustrated in section 13.6.7. Where it is intended to drain larger areas than 2 hectares or where low levels of surface flooding could cause flooding of buildings, reference should be made to BS EN 742: Part 4.

With the exception of pipe gradients and sizes, the recommendations given above for below-ground foul drainage (materials, bedding and backfilling, clearance of blockages, workmanship and testing and inspection) apply equally to rainwater drainage below ground.

13.7.2 Pipe sizes and gradients

Drains should be laid to falls and should be large enough to carry the expected flow. The rate of flow will depend on the area of the surfaces (including paved or other hard surfaces) being drained. The capacity will depend on the diameter and gradient of the pipes. The minimum permitted diameter of any rainwater drain is 75 mm. Surface water sewers (i.e. drains serving more than one building) should have a minimum diameter of 100 mm. Diagram 3 to section 3 of AD H3 is reproduced below and gives discharge capacities for rainwater drains running full where it will be seen that the capacity increases proportionately with the pipe diameter and gradient.

In general, the minimum permitted gradient of a pipe is related to its diameter as shown in Table 13.4.

AD H3 section 3

Diagram 3 Discharge capacities of rainwater drains running full.

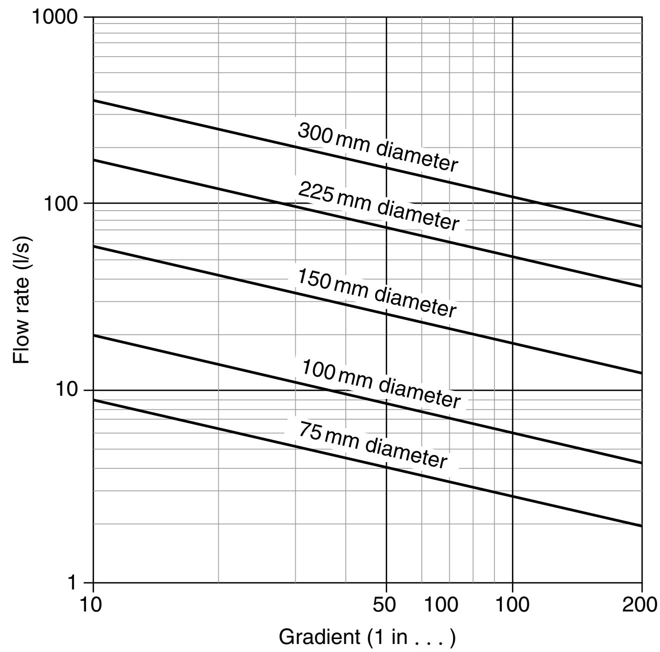


Table 13.4 Pipe sizes and minimum gradients.

Pipe diameter (mm)	Minimum gradient
75	1 in 100
100	1 in 100
150	1 in 150
225	1 in 225
Over 225	See BS EN 752: Part 4

13.7.3 Contaminated run-off

It is an offence under section 85 (*offences of polluting controlled waters*) of the Water Resources Act 1991 to discharge any polluting or noxious material into coastal or underground water or a watercourse. Since most surface water sewers discharge to watercourses, separate drainage systems should be provided where materials are stored or used which could cause pollution. The drainage system should include:

- an appropriate form of separator (see oil separators below);
- an appropriate treatment system; or
- discharge of the flow into a system suitable for receiving polluted effluent.

Certain areas, such as petrol filling stations and car parks, suffer from leakage or spillage of oil, and the surface water run-off from these areas can find its way via the drainage system to a watercourse where pollution can occur. Since it is an offence under section 111 (*restrictions on the use of public sewers*) of the Water Industry Act 1991 to discharge petrol into any drain connected to a public sewer, oil separators should be provided in risk situations.

There are, of course, other controls over the storage of petrol, due to its combustible nature. Premises used for keeping petrol must be licensed under the Petroleum (Consolidation) Act 1928. A license can be granted with or without conditions. Guidance on the storage of oil may be obtained from the Health and Safety Executive.

Oil separators

The type of oil separator that should be provided will depend on the risk of contamination represented by the site.

For comparatively low risk areas, such as paved areas around buildings and car parks, a bypass separator should be provided with a nominal size (NSB) of 0.0018 times the contributing area and a silt storage volume in litres equal to 100 × NSB. Bypass separators treat all flows generated by rainfall rates of up to 5 mm/hr, thus accounting for 99% of all rainfall events. Flows above this rate are allowed to bypass the separator.

For fuel storage and other high risk areas, full retention separators should be provided with nominal size (NS) equal to 0.018 times the contributing area and a silt storage volume in litres equal to 100 × NS. Full retention separators treat the full flow that can be delivered by the drainage system which is normally equivalent to the flow generated by a rainfall intensity of 50 mm/hr.

Separators should:

- be Class 1 when discharging to infiltration devices or surface water sewers (i.e. designed to achieve a concentration of less than 5 mg/litre of oil under standard test conditions);
- be leak tight and adequately ventilated;
- have inlet arrangements that avoid directing the inflow to the surface of the water already in the separator;
- comply with the requirements of the Environment Agency and BSEN 858:2002 A1 2004 and BS EN 858-2:2003 Separator systems for *light liquids (e.g. petrol or oil)*;

- comply with the requirements of the licensing authority where the Petroleum Act applies;
- be regularly maintained to ensure continued effectiveness. It is normal for routine inspections to be carried out every six months including the completion of a log which details the inspection date, depth of oil and any cleaning undertaken; and
- be provided with sufficient access points to allow for inspection and cleaning of all internal chambers.

More information on the provision of oil separators may be found in the Environment Agency publication – Pollution Prevention Guidelines 3 (PPG 3) *Use and design of oil separators in surface water drainage systems.*

13.7.4 Infiltration drainage systems

Infiltration drainage systems are designed to return rainwater from roofs and pavings to the ground in the vicinity of the building, without involving connection to sewers or watercourses. They include such devices as soakaways, swales, infiltration basins, filter drains and detention ponds (but see the comments on these below). AD H3 gives a very brief summary of the various infiltration devices which are available; however, the information provided is too brief to be of any real use for the designer. The notes which follow have been enhanced using the various documents referred to in the text. These reference sources are essential for anyone seriously interested in infiltration drainage systems.

It is not always possible to provide infiltration drainage to a building. For example, infiltration devices should not be provided in the following situations:

- Within 5 m of a road or building.
- In areas of unstable land. (Annex 1 of Planning Policy Guidance Note 14 warns against the use of infiltration systems in areas subject to landslip).
- In ground with a high water table (i.e. where the water table reaches the base of the device at any time of the year).
- Where groundwater source or resource might be polluted by the presence of contamination in the run-off.
- At such a distance from drainage fields, drainage mounds or other soakaways so that the overall soakage capacity of the ground would be exceeded and the effectiveness of any drainage field would be impaired.

Soakaways

Soakaways should be designed to store the immediate surface water run-off and allow for its efficient infiltration into the surrounding soil. Stored water must be discharged sufficiently quickly to provide the necessary capacity to receive run-off from a subsequent rainfall event. The time taken for discharge depends upon the soakaway shape and size and the infiltration characteristics of the surrounding soil.

Soakaways serving catchment areas of less than 100 m^2 are usually built as square or circular pits filled with rubble or lined with dry-jointed masonry or precast perforated concrete ring units surrounded by suitable granular backfill. For drained areas above 100 m^2, soakaways can be lined pits or of trench type, and usually a depth of 3 m to 4 m is adequate if ground conditions allow. Trench soakaways are cheaper to dig with readily available excavating equipment.

Although the design of soakaways should be carried out by considering storms of different durations over a ten-year period in order to determine the maximum storage volume, for small soakaways serving 25 m^2 or less, a design rainfall of 10 mm in five minutes can be taken to represent the worst case. For soakaways serving larger areas reference should be made to BRE Digest 365 *Soakaway design* or BS EN 752: Part 4. Where the percolation characteristics of the ground are marginal, it may still be possible to use soakaways in conjunction with overflow drains.

The percolation test described in AD H2 (see Fig. 13.19) may be carried out to determine the capacity of the soil to receive infiltration. The value of V_p from the percolation test may be used in the equation below to determine the soil infiltration rate:

$$f = \frac{10^{-3}}{2V_p}$$

where *f*, the soil infiltration rate.

Therefore, assuming a value of V_p of 20,

$$f = \frac{1}{1000 \times 2 \times 20} = 0.000025 \text{ m/s}$$

The storage volume of the soakaway should be able, during storm conditions, to accommodate the difference between the inflow volume and the outflow volume.

The inflow volume is simply calculated by considering the design rainfall depth during a storm multiplied by the drainage area. Therefore, if a rainfall depth of 10 mm is considered over an area of 25 m^2 in a five minute period:

$$\text{The inflow volume} = 0.01 \times 25 = 0.25 \text{ m}^3$$

The outflow volume (O) is calculated from the equation

$$O = a_{s50} \times f \times D$$

where a_{s50} is the area of the side of the storage volume when filled to 50% of its effective depth, and D is the duration of the storm in minutes.

Using the figures from the example given above and assuming a soakaway 2 m deep and 2 m × 1 m in area with the inlet 1 m below ground,

$$O = 4 \times 0.000025 \times 5 \times 60 = 0.03 \text{ m}^3$$

Therefore the difference between the inflow volume and the outflow volume equals the storage volume = 0.25 – 0.03 = 0.22 m^3.

The actual volume of soakaway below inlet = 1 × 1 × 2 = 2 m^3 which is more than adequate.

Swales

Swales are simply grass-lined channels with shallow side slopes used to carry rainwater from a site. They can also control the flow and quality of surface run-off and allow a certain amount of the flow to infiltrate into the ground. To increase the infiltration and detention capacity of swales, they can be provided with low check dams across their width. To prevent overtopping during wet spells, it is possible to provide an overflow at one end discharging into another form of infiltration device or watercourse. They can be used to treat run-off from small residential developments, parking areas and roads.

Infiltration basins

These are dry grass-lined basins for storage of surface run-off that are free from water under dry weather flow conditions. They can be designed to manage water quantity and quality and are used to encourage surface water infiltration into the ground.

Filter drains

Otherwise known as french drains, filter drains consist of geotextile-lined trenches filled with gravel, sometimes containing perforated pipes to assist drainage. They are designed so that most of the flow enters the filter drain directly from the run-off or is discharged into it through other drains from where it infiltrates into the ground.

Detention ponds

The term 'detention pond' appears to be a mistake in the AD since the reference material given for this section in AD H3 (*Sustainable urban drainage systems – A design manual for England and Wales* published by CIRIA) makes reference to 'detention basins' and 'retention ponds' but not 'detention ponds'.

According to this reference source '*detention basins are vegetated depressions. They are formed below the surrounding ground, and are dry except during and immediately following storm events. Detention basins only provide flood storage to attenuate flows. Extending the detention times improves water quality by permitting the settlement of course silts*'.

On the other hand, '*retention ponds are permanently wet ponds with rooted wetland and aquatic vegetation – mainly around the edge. The retention time of several days provides better settlement conditions than offered by extended detention ponds and provides a degree of biological treatment*'. The description given in AD H3 could apply to either or both of the above.

13.7.5 Alternative method of design

Requirement H3 can also be met by following the relevant recommendations of BS EN 752 *Drain and sewer systems outside buildings*.

These are:

- in Part 4, *Hydraulic design and environmental considerations*, clauses 3 to 12; and
- National Annexes NA, NB and ND to NI.

Additionally, detailed information about design and construction can be found in:

- BS EN 1295, *Structural design of buried pipelines under various conditions of loading:* Part 1: 1998 *General requirements*; and
- BS EN 1610:1998 *Construction and testing of drains and sewers*.

13.8 Building over existing sewers

13.8.1 Introduction

Control of building works over or near existing sewers has long been subject to control in England and Wales. Until the coming into effect of the first amendment to the 2000 Regulations on 1 April 2002, this control was exercised by local authorities through the medium of section 18 of the Building Act 1984. The first amendment introduced a new Building Regulation requirement H4, which replaced section 18 and can be administered by both local authorities and approved inspectors, although the substance of section 18 has been little altered by the change. What has altered is the substantial amount of guidance provided by Approved Document H4.

13.8.2 Interpretation

The following terms apply in AD H4:

DISPOSAL MAIN – Any pipe, tunnel or conduit used for the conveyance of effluent to or from a sewage disposal works, which is not a public sewer.

MAP OF SEWERS – Any records kept by a sewerage undertaker under section 199 of the Water Industry Act 1991.

13.8.3 Building over sewers

H4 requires that where it is intended to:

- erect a building;
- extend a building; or
- carry out works of underpinning to a building

near to or over a drain, sewer or disposal main, then the work must be carried out so that it is not detrimental to the building or extension or to the continued maintenance of the drain, sewer or disposal main.

H4 is limited to work carried out:

- near to or over a drain, sewer or disposal main which is shown on any map of sewers; or
- which will result in interference with the use of, or obstruction of any person's access to, any drain, sewer or disposal main shown on any map of sewers.

In order to meet the requirements of H4, it is necessary to ensure the following:

(1) That the work of building, extending or underpinning:
- is expedited so as not to overload or otherwise damage the drain, sewer or disposal main both during construction and after it is completed; and
- will not prevent reasonable access to any manhole or inspection chamber situated on the drain, sewer or disposal main.

(2) That where the drain, sewer or disposal main needs to be replaced:
- a satisfactory diversionary route can be provided; or
- the building or extension will not unduly obstruct the replacement work if the current alignment is maintained.

(3) That if the drain, sewer or disposal main fails, the risk of damage to the building will not be excessive. To assess the risk of damage to the building, it is necessary to consider:
- the nature of the ground;
- the location, construction and condition of the drain, sewer or disposal main;
- the nature, volume and pressure of the flow in the drain, sewer or disposal main; and
- the design and construction of the building's foundations.

13.8.4 Application

The provisions of H4 apply where it is intended to erect, extend or underpin a building that is situated over, or within 3 m of the centreline of, an existing drain, sewer or disposal main shown on the sewer records of the sewerage undertaker, even if the sewer is not a public sewer.

The public have access to copies of sewer record maps during normal office hours, these being held by both sewerage undertakers and local authorities.

13.8.5 Consultation

When it is proposed to carry out any work to which H4 applies, the developer should always consult the owner of the drain or sewer (for public sewers this would be the sewerage undertaker) unless, of course, the developer is also the owner. In the case of public sewers, the sewerage undertaker should be able to provide useful information regarding the age, location, condition and depth to invert of the sewer. They may also be able to arrange an inspection, and if a public sewer needs to be repaired or replaced, they will carry out this work. The sewerage undertaker should also be consulted where it is proposed to build or extend over a sewer that is later intended for adoption.

In order to ensure compliance with H4, it will be necessary to apply to the relevant building control body (local authority or approved inspector) so that the works can be properly controlled. This will involve the carrying out of further consultations as follows:

- If using the local authority you must deposit full plans. This enables the local authority to carry out its duties under Regulation 15 of the Building Regulations 2010 to consult the sewerage undertaker as soon as practicable after the plans have been deposited. The local authority is not permitted to pass the plans or issue a completion certificate until the consultation has taken place (the sewerage undertaker has up to 15 days to reply), and it must have regard to the views expressed by the sewerage undertaker.

- If using an approved inspector, he must consult the sewerage undertaker where an initial notice or amendment notice is to be given (or has been given). The consultation must take place at the following stages:
  - (a) Before or as soon as is practicable after giving an initial notice or an amendment notice;
  - (b) Before giving a plans certificate (whether or not this is combined with an initial notice); and
  - (c) Before giving a final certificate.

Additionally, he must allow the sewerage undertaker up to 15 working days to comment, and have regard to the views it expresses, before giving a plans certificate or final certificate to the local authority.

13.8.6 Building near drains or sewers in risk situations

Unless special measures are taken, buildings should not be constructed or extended over or within 3 m of any of the following:

- drains or sewers in poor condition (pipes which are cracked, fractured, misaligned or more than 5% deformed);
- drains or sewers constructed from brick or other masonry; and
- rising mains (except those used only to drain the building)

since failure of the drain or sewer would expose the building to a high level of risk.

Additionally, certain soil types (fine sands, fine silty sands, saturated silts and peat) are easily eroded by groundwater leaking into drains or sewers. Therefore, failure of a drain or sewer could result in erosion of soil from around the foundations, thereby exposing the building to undue risk. Where such soils are present, buildings should not be constructed or extended over or within 3 m of any drain or sewer to which H4 applies unless special measures are taken in the design and construction of the foundations to mitigate the effect of drain or sewer failure. Special measures are not needed if the invert of the drain or sewer is:

- above the level of the foundations;
- above the level of the groundwater; and
- no deeper than 1 m.

13.8.7 Access for maintenance

Figure 13.27 gives details of the precautions that should be taken to ensure that sewers remain accessible when buildings are constructed over or within 3 m of them. The following main points should be observed;

- Do not construct a building or extension over a manhole, inspection chamber or access fitting on a sewer (i.e. a drain serving more than one property).

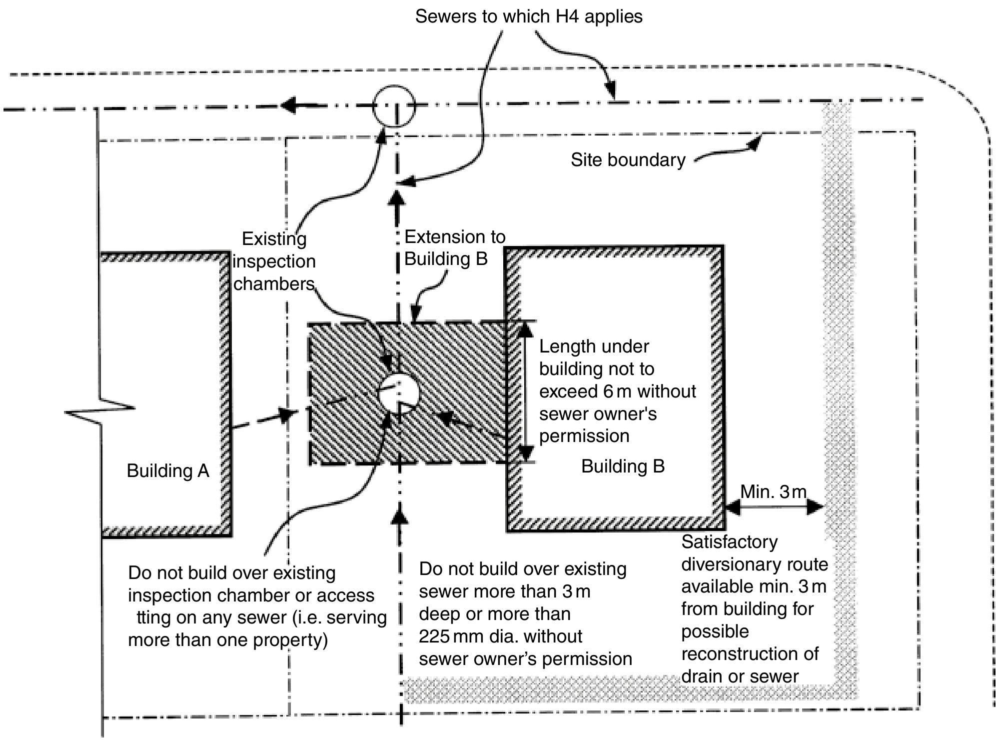


Fig. 13.27 Building over sewers.

- Locate access points to sewers where they are accessible and apparent for use in emergency. Where this provision is already met by the existing sewer, do not construct a building or extension which would remove this provision unless a satisfactory alternative on the line of the sewer can be agreed with the sewer owner.
- Ensure that a satisfactory diversionary route is available at least 3 m from the building to allow the drain or sewer to be reconstructed without affecting the building. Where existing drains or sewers more than 1.5 m deep have access for mechanical excavators, ensure that the diversionary route also has such access.
- Unless the sewer owner agrees, the length of drain or sewer under a building should not exceed 6 m in length.
- Do not build over or near an existing sewer more than 3 m deep or more than 225 mm diameter without the sewer owner's permission.

13.8.8 Protection of drains and sewers

Approved Document H4 contains details of protection which should be provided during construction of the building over the drain or sewer and subsequently to prevent damage by settlement of the building. Details of other protection measures for below-ground drainage also apply to drains or sewers covered by the following notes. They may be found in sections 13.3.20 (pipes), 13.3.25 (drains), 13.3.26 (surcharging) and 13.3.27 (rodent control).

Protection during construction

During construction activities drains and sewers should be protected from damage by:

- providing barriers to keep construction traffic and heavy machinery away from the line of the sewer; and
- not storing heavy materials over drains or sewers.

Piling works present a special risk, and care should be taken to avoid damage to drains and sewers in the vicinity of such activities. The following precautions should be taken:

- A survey should be carried out to establish the position of the drain or sewer.
- Where piling will take place within 1 m of a drain or sewer, trial holes should be excavated to establish its exact position and the location of any connections.
- Piling should not be carried out where the distance from the outside of the pile to the outside of the drain or sewer is less than twice the pile diameter.

Protection from settlement

Drains or sewers passing under buildings should comply with the following guidance:

- Provide at least 100 mm of granular or other flexible filling round the pipe.
- Where excessive subsidence is possible, provide additional flexible joints or adopt other solutions (e.g. suspended drainage).
- Provide special protection where the crown of the pipe is within 300 mm of the underside of the slab (see section 13.3.20).
- For drains or sewers less than 2 m deep, increase the depth of the foundations in the vicinity of the drain or sewer so that it may pass through the wall.
- For drains or sewers greater than 2 m deep, design the foundations as a lintel spanning the drain or sewer. The 'lintel' should extend at least 1.5 m on either side of the pipe and should be designed so that no loads are transmitted to the drain or sewer.
- Where the drain or sewer passes through a wall or foundation, follow the guidance given in section 13.3.25 and shown in Fig. 13.14.
- Trenches for drains and sewers should only be excavated below the level of the building foundations if the precautions described in section 13.3.25 and illustrated in Fig. 13.15 are taken.

13.9 Separate systems of drainage

13.9.1 Introduction

Control over the provision of separate systems of drainage was first introduced into the Building Regulations with the coming into force of the first amendment to the 2000 Regulations on 1 April 2002. These provisions were consolidated into the 2010 Regulations. The provisions are aimed at helping to minimise the volume of rainwater which enters the public foul sewer system since this can lead to overloading of the capacity of sewers and treatment works and can cause flooding.

13.9.2 Requirement H5

Any system for discharging water to a sewer which is provided to take rainwater from roofs or from paved areas around buildings covered by the requirements of H3 (see section **13.6**) must be separate from that provided for the conveyance of foul water from the building.

For H5 to apply:

- the drainage system must be provided in connection with the erection or extension of a building; and
- it must be reasonably practicable for the system to discharge directly or indirectly to a sewer for the separate conveyance of surface water.

Additionally, the sewer must be:

- shown on a map of sewers (see definition in section 13.8.2); or
- under construction either by the sewerage undertaker or by some other person (although in this case the sewerage undertaker must have agreed in advance to adopt the drain or sewer in accordance with section 104 of the Water Industry Act 1991).

13.9.3 Meeting the requirement

The requirements of H5 can be met in either of two ways:

- By connecting to separate public sewers which are already in existence; or
- By providing separate drainage systems on the site of the building which will later be connected to separate public sewers which are under construction at the time of the building works.

13.9.4 Provision where separate sewer systems already exist

Where the sewerage undertaker has provided separate sewer systems, the owner or occupier of a building has a right to connect to the public sewers (see section 106 of the Water Industry Act 1991) provided that the following restrictions are observed:

- The surface water drainage from the building must be connected to the appropriate public surface water sewer.
- The foul water drainage from the building must be connected to the appropriate public foul water sewer.
- The way in which the connection is made must not be prejudicial to the public sewer system.
- 21 days notice must be given to the sewerage undertaker of the intention to make the connection.

It is normal for the sewerage undertaker to carry out the work of making the connection and recover its reasonable costs from the developer (see section 107 of the Water Industry Act 1991). Alternatively the developer may be permitted to carry out the work under the supervision of the sewerage undertaker.

13.9.5 Provision where separate sewer systems are proposed

Separate sewer systems should still be provided to drain the building even if only a combined system exists at the time of the building works, provided that separate public sewers are under construction by the sewerage undertaker or by some other person for later adoption by the sewerage undertaker. Depending on the respective programmes for the building works and the public sewer construction, it may be necessary initially to connect the separated site drainage to the existing combined sewer. Later reconnection to the separate sewer systems can be made when these are completed, thus minimising disruption to the building occupiers.

13.9.6 Dealing with contaminated surface water

It should be noted that the necessity to connect to a separate surface water sewer would only apply if the surface water was uncontaminated. Drainage from areas where materials are stored could contaminate run-off and lead to pollution if discharged to a surface water sewer. The alternative of discharging such contaminated water to a foul sewer needs to be discussed with the sewerage undertaker (see section 106 of the Water Industry Act 1991 and notes above) whose consent is required. It will also be necessary to consult the sewerage undertaker when connecting such contaminated run-off via a new foul sewer to an existing combined sewer, if it is intended that this will eventually be reconnected to a foul sewer that is proposed or under construction.

13.10 Solid waste storage

13.10.1 Introduction

The efficacy of the refuse storage system is dependent on its capacity and ease of collection by the waste collection authority. The waste collection authority has powers to specify the type and number of receptacles which should be provided and the position where the waste should be placed for collection under the provisions of the following Acts:

- For household waste – section 46 (*Receptacles for household waste*) of the Environmental Protection Act 1990 (as amended by section 19 of the London Local Authorities Act 2007, section 76 and Schedule 5 of the Climate Change Act 2008).
- For commercial or industrial waste – section 47 (*Receptacles for commercial or industrial waste*) of the Environmental Protection Act 1990 (as amended by section 21 of the London Local Authorities Act 2007). Therefore it is important that consultations take place with the waste collection authority to establish its specific requirements regarding the storage and collection of waste.

The opportunity has been taken in AD H6 to give general recommendations regarding the separate storage of waste for recycling. This is interesting since the Building Regulations do not cover the recycling of household or other waste. However, there are moves afoot to amend sections 46 and 47 of the Environmental Protection Act 1990 to allow for separate storage, and of course, there are a number of national initiatives on recycling and waste reduction which the AD is attempting to support. From a legal standpoint it is unlikely that the recommendations can, in fact, be enforced.

13.10.2 Requirement H6

Buildings are required to have:

- adequate means of storing solid waste;
- adequate means of access for the users of the building to the place of storage; and
- adequate means of access from the place of storage to:
  - (a) a collection point where one has been specified by the waste collection authority under section 46 (as amended) (for household waste) or section 47 (as amended) (for commercial waste) of the Environmental Protection Act 1990; or
  - (b) to a street (in the case of no collection point being specified).

The requirements of paragraph H6 may be met by providing solid waste storage facilities which are:

- large enough, bearing in mind the requirements of the waste collection authority for the number and size of receptacles (this relates to the quantity of refuse generated and the frequency of removal, see sections 46 and 47 (as amended) of the Environmental Protection Act 1990);
- designed and sited so as not to present a health risk; and
- sited so as to be accessible for filling by people in the building and for removing to the access point specified by the waste collection authority.

13.10.3 Domestic buildings: Storage capacity

Assuming weekly collection, dwelling houses, flats and maisonettes up to four storeys high should have, or have access to, a location large enough to accommodate at least two movable individual or communal containers, which meet the requirements of the waste collection authority.

The location should cater for separated waste (i.e. one container taking waste for recycling and another taking all other waste). The combined capacity of the two containers should not be less than $0.25\,m^3$ per dwelling (or such other capacity as is agreed with the waste collection authority). If the waste collection authority does not provide weekly collections, then larger capacity containers or more individual containers will need to be provided.

The size of the location will depend on whether this is based on the provision of communal or individual storage. Where individual storage is provided for each dwelling, this should be an area with dimensions of at least $1.2\,m \times 1.2\,m$. The waste collection authority should be consulted regarding space requirements for communal storage areas.

Dwellings in buildings above the fourth storey may either:

- share a container fed by a chute for non-recyclable waste, plus be provided with separate storage for waste which is to be recycled; or
- be provided with storage compounds or rooms for both types of waste if suitable management arrangements can be assured for conveying the waste to the place of storage.

For large blocks, recyclable waste can also be dealt with by providing 'Residents Only' recycling centres (places where residents can bring their own recyclable waste for storage in large containers, such as bottle banks).

13.10.4 Siting of waste containers and storage areas

Waste containers should comply with the following rules with regard to siting:

- For new buildings it should be possible to take a container to a collection point without taking it through a building. (It is permissible to pass through a porch, garage, carport or other covered space.) Buildings should not be extended or converted in such a way as to remove such an access facility where it already exists.
- Waste containers and chutes should not be sited more than 25 m from the waste collection point specified by the waste collection authority.
- Householders should not be required to carry refuse more than 30 m to a storage area for a waste container or chute (excluding any vertical distance).
- For waste containers with capacities up to 250 litres:
  (a) Steps should be avoided wherever possible on the route between the container store and the waste collection point, and where unavoidable they should be restricted to three in number;
  (b) Ideally, slopes should not be greater than 1 in 12, but where this is unavoidable, they should be of restricted length and not in a series.
- For waste containers with capacities greater than 250 litres, the storage area should be located so that steps are avoided altogether.
- The waste collection authority should be consulted to ensure that the collection point can be accessed by its normal size of waste collection vehicle.
- External locations for waste containers should be sited in shade or under shelter away from windows or ventilators.
- Waste storage areas should not obstruct pedestrian or vehicle access routes to buildings.

13.10.5 Design of waste containers and storage areas

Enclosures, compounds or storage rooms

Enclosures, compounds and storage rooms should comply with the following:

- Be designed to allow room for filling and emptying.
- Have a clear space of 150 mm provided between and around containers.

- Be permanently ventilated at top and bottom.
- Have paved impervious floors.
- Be secure to prevent access by vermin (unless, in the case of compounds, the refuse is stored in secure containers with close fitting lids).
- If enclosing communal containers, they should have:
  (a) clear headroom of 2 m;
  (b) provision for washing down and draining the floor into a drainage system designed to receive polluted effluent; and
  (c) gullies incorporating traps which maintain their seals even after prolonged periods of disuse.
- If enclosing individual containers, they should be sufficiently high to allow the lid to be opened for filling.
- Where storage rooms are provided, these should contain separate rooms for recyclable and non-recyclable waste.

A waste storage facility which is located in a publicly accessible area or in an open area around a building (such as a front garden) should be provided with an enclosure or shelter.

Refuse chutes

For high rise domestic developments where refuse chutes are provided, AD H6 recommends that they should be at least 450 mm in diameter and constructed with:

- smooth, non-absorbent inner surfaces
- close fitting access doors at each storey containing a dwelling
- ventilation at top and bottom.

Alternatively, refuse chutes may be designed in accordance with the relevant clauses in BS 5906:1980 *Code of practice for storage and on-site treatment of solid waste from buildings*. Figure 13.28 is based on the recommendations of BS 5906:1980 and illustrates a typical refuse chute installation.

13.10.6 Non-domestic buildings

In the development of non-domestic buildings, special problems may arise. It is therefore essential to consult the refuse collection authority for their requirements with regard to the following:

- The storage capacity required for the volume and nature of the waste produced. (The collection authority will be able to give guidance as to the size and type of container they will accept and the frequency of collection).
- Storage method. This may include details of any proposed on-site treatment and should be related to the future layout of the development and the building density.
- Location of storage and treatment areas and collection points, including access for vehicles and operatives.
- Measures to ensure adequate hygiene in storage and treatment areas.

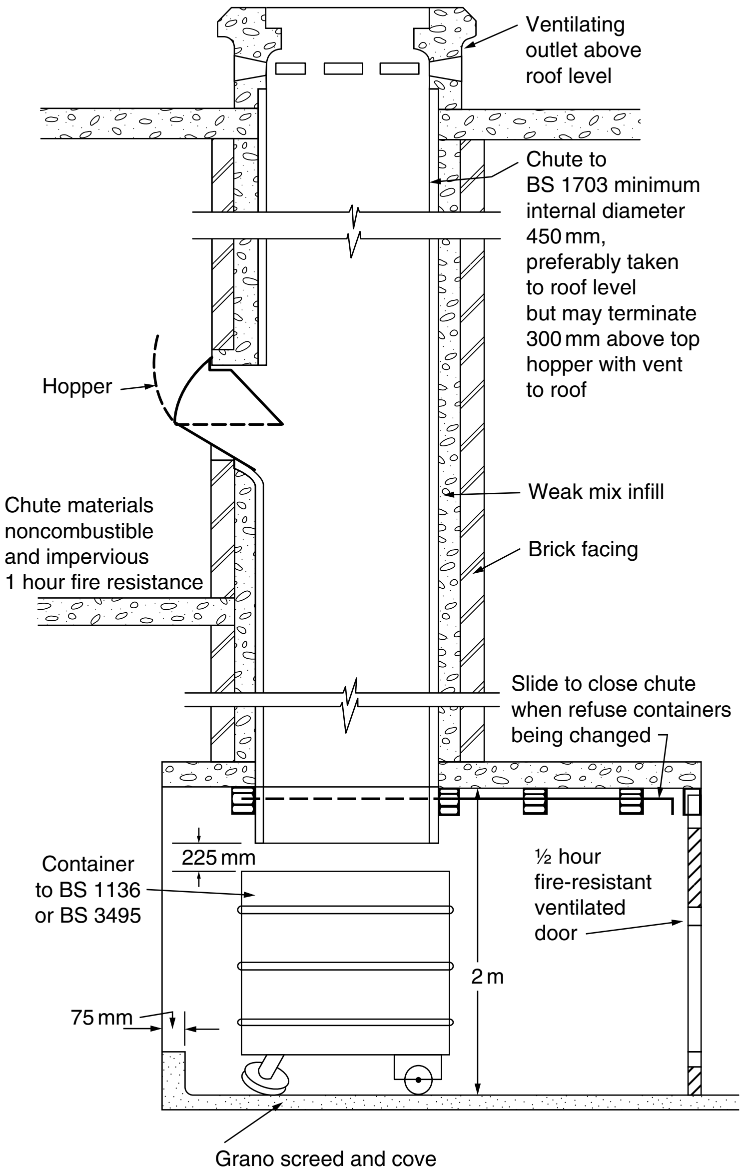


Fig. 13.28 Refuse chutes.

- Measures to prevent fire risks.
- Segregation of waste for recycling.

The following recommendations should also be considered:

- Rooms and compounds provided for the open storage of waste should be secure to prevent access by vermin (unless in the case of compounds, the refuse is stored in secure containers with close fitting lids).

- Waste storage areas should:
  - (a) have an impervious floor and provision for washing down and draining the floor into a drainage system designed to receive polluted effluent;
  - (b) have gullies incorporating traps which maintain their seals even after prolonged periods of disuse;
  - (c) be marked to show their use and signs should be provided to indicate their location.

13.10.7 Alternative approach

As an alternative to the recommendations listed above for waste disposal, it is permissible to use BS 5906:1980 especially clauses 3 to 10, 12 to 15 and Appendix A. However, BS 5906 does not contain information on recycling. It is currently being revised, and the new edition is expected to contain such information.

14 Combustion appliances and fuel storage systems (Part J)

14.1 Introduction

Part J of Schedule 1 to the Building Regulations 2010 (as amended) is concerned with the safe installation and use of combustion appliances in buildings. In 2002 Part J was extended to six parts from the original three to include the provision of information in respect of flues etc. (J4), the protection of liquid fuel storage systems from fire in neighbouring buildings (J5) and the protection against pollution resulting from spills from oil storage tanks (J6). In 2010 this was further expanded to seven parts with a new requirement covering the provision of carbon monoxide alarms in dwellings where solid fuel appliances are installed. To incorporate this requirement adjacent to the existing requirement for the discharge of products of combustion involved a reordering of the numbering in respect of the various parts. The technical requirements for Part J in schedule 1 are now as follows:

J1 – Air supply
J2 – Discharge of products of combustion
J3 – Warning of release of carbon monoxide
J4 – Protection of building
J5 – Provision of information
J6 – Protection of liquid fuel storage systems
J7 – Protection against pollution

The requirements are limited to fixed appliances burning solid fuel, oil or gas and to incinerators. (Since no further guidance is given, it can be assumed that this means incinerators that burn solid fuel, oil or gas.) It excludes all electric heating appliances and small portable heaters such as paraffin stoves.

The above requirements will be met if in the building provisions for the following are made:

(1) Enable the admission of sufficient air for the proper combustion of fuel, the operation of flues and the cooling of appliances where necessary;
(2) Enable appliances to operate normally without the products of combustion becoming a hazard;

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

(3) A suitably positioned carbon monoxide detector where a fixed solid fuel appliance is installed in a dwelling;
(4) To prevent damage to the fabric of the building through heat or fire from an appliance under normal use;
(5) Suitable inspection and testing of an appliance to demonstrate fitness for purpose;
(6) Suitable labelling of an appliance to confirm performance capabilities;
(7) Liquid fuel storage and pipework systems are located and constructed to be reasonable protected from a fire in the building or beyond the boundary; and
(8) Oil storage tanks serving dwellings are reasonably resistant to damage and corrosion, minimising the risk of oil escaping, incorporate a secondary containment provision where a significant risk of pollution exists and are suitably labelled with instructions for responding to a leak.

14.1.1 The Clean Air Acts 1956–1993

As a direct result of the great London smog of 1952 and after the Report of the Committee on Air Pollution (Cmnd. 9322, November 1954), the Clean Air Act 1956 was passed to give effect to some of the Committee's recommendations. The 1956 Act, amended in 1968, was consolidated in the Clean Air Act 1993. Its main provisions may be summarised briefly and should be borne in mind in considering the effect of Part J of Schedule 1 to the 2000 Regulations.

The Act makes it an offence to allow the emission of *dark smoke* from a chimney, but certain special defences are allowed, e.g. unavoidable failure of a furnace. DARK SMOKE is defined as smoke which appears to be as dark as, or darker than, shade 2 on the Ringelmann Chart. Regulations made under the Act amplify its provisions in relation to industrial and other buildings, and it should be noted that the prohibition on dark smoke applies to all buildings, railway engines and ships. However, its chief effect is on industrial and commercial premises.

House chimneys rarely emit dark smoke, but local authorities may, by order confirmed by the Secretary of State for the Environment, declare *smoke control areas*. In a smoke control area the emission of smoke from chimneys constitutes an offence, although it is a defence to prove that the emission of smoke was not caused by the use of any fuel other than an authorised fuel. Regulations prescribe the following authorised fuels: anthracite, briquetted fuels carbonised in the process of manufacture, coke, electricity, low-temperature carbonisation fuels, low-volatile steam coals and fluidised char binderless briquettes.

The 1956 Act, as amended, provides for the payment of grants by local authorities, and Exchequer contributions, towards the cost of any necessary adaptation or conversion of fireplaces to smokeless forms of heating in private dwellings in smoke control areas.

14.1.2 Combustion appliances and fuel storage systems

Although Part J applies to any combustion installation and liquid fuel storage system within the limits on application, the guidance in Approved Document J deals mainly with domestic installations, such as those which comprise space and water heating systems and cookers and their flues, and their attendant oil and LPG fuel storage systems.

Therefore, the guidance is concerned only with combustion installations having the following power ratings:

- Solid fuel installations of up to 50 kW rated output;
- Gas installations of up to 70 kW net (77.7 kW gross) rated input; and
- Oil installations of up to 45 kW rated heat output

and with fuel storage installations with the following capacities:

- Heating oil storage installations with capacities up to 3500 litres; and
- Liquefied petroleum gas (LPG) storage installations with capacities up to 1.1 tonne.

It should be noted, however, that no upper size limit is specified on the application of paragraph J6 of Part J of Schedule 1 to the Building Regulations 2010 (which deals with the protection of liquid fuel storage systems).

There are no specific references to incinerators or to the installation of appliances with a higher rating than those given above in AD J even though these are covered by the requirements of Part J and it is evident that specialist guidance will usually be needed (since these will almost invariably be installed under the supervision of a heating engineer). Some larger installations can be shown to comply by adopting the relevant recommendations of:

- CIBSE Design Guide Volume B; and
- Practice standards produced by the BSI (British Standards Institute) and IGEM (the Institution of Gas Engineers and Managers).

14.2 Interpretation

For the purposes of providing clarity in the guidance, the current edition of AD J contains the definition of 41 terms used within the document:

APPLIANCE COMPARTMENT means an enclosure specifically constructed or adapted to accommodate one or more gas or oil-fired appliances.

BALANCED COMPARTMENT refers to a method of installing an open-flued appliance into a compartment so that it is sealed from the remainder of the building. Its ventilation is so arranged in conjunction with the appliance flue as to achieve a balanced flue effect (see below for definitions of BALANCED FLUED APPLIANCE and OPEN FLUED APPLIANCE).

BALANCED FLUE APPLIANCE means a combustion appliance that draws its combustion air from a point immediately adjacent to the point where it discharges its combustion products. The inlet and outlet are so arranged as to substantially balance any wind effects. Balanced flues can run vertically, but they usually discharge horizontally through the external wall on which the appliance is situated.

BOUNDARY. This definition should not be confused with the definition of relevant boundary given in AD B (see Chapter 7) and applies solely for the purposes of AD J. What is referred to here is the boundary of the land or buildings belonging to and under the control of the building owner. Some sections of AD J relate to the distance that outlets from chimneys and flues can be from the boundary. In these cases the measurements may be taken up to the centre line of adjacent routes or waterways. Other sections refer to the distance that oil and LPG storage tanks must be from the boundary. In these cases the measurements may only be taken to the physical boundary of the site.

BUILDING CONTROL BODY may be either the local authority or an approved inspector. These are fully described in Chapters 3 and 4.

CAPACITY of an oil tank means its nominal volume as stated by the manufacturer. This is usually about 95% of the volume of liquid required to totally fill it.

CHIMNEY includes a wall or walls enclosing one or more flues (see Fig. 14.1). (The chimney for a gas appliance may be referred to as the flue in the gas industry.)

COMBUSTION APPLIANCE means an apparatus which burns fuel to generate energy for space heating, water heating, cooking, etc. (e.g. boilers, warm air heaters, water heaters, fires, stoves and cookers), but not including fuel delivery or heat distribution systems.

DECORATIVE FUEL EFFECT (DFE) FIRES are described in BS 5871: Part 3. These are gas-fired imitations, which can be substituted for the solid fuel appliances in open

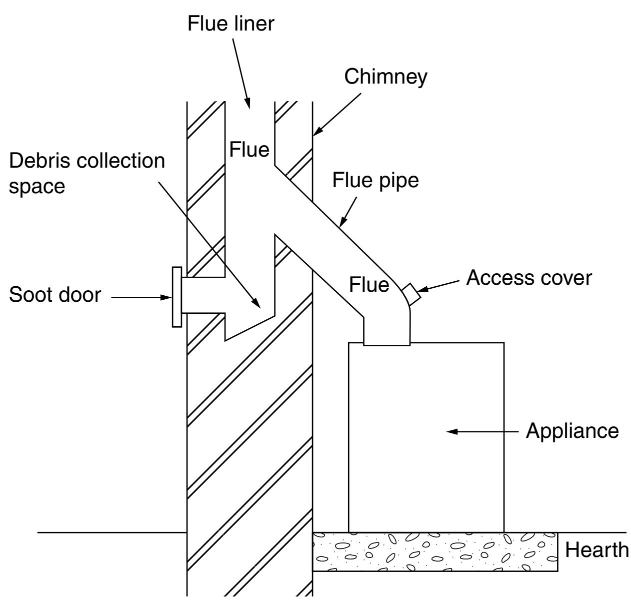


Fig. 14.1 Interpretation – chimneys and flues.

fires. Where suitable, they can also be used in flue boxes designed for gas appliances only. Common designs include beds of artificial coals shaped to fit into a fireplace recess or baskets of artificial logs for use in larger fireplaces or under canopies (see Fig. 14.2(a)).

DESIGNATION SYSTEM for the performance characteristics of a chimney or its components means designations which are referred to throughout AD J, and details of the designation system are contained in BS EN 1443:2003 and in Appendix G of Approved Document J. This allows the performance characteristics to be expressed by means of a code detailing the following characteristics:

Temperature (T), pressure (N, P or H followed by 1 or 2), condensate resistance (W or D; corrosion resistance (1, 2 or 3), soot-fire resistance and distance to combustibles (G or O followed by xx distance expressed in mm).

Example of chimney designation would be '*Chimney EN 1457 – T450 N2 D 1 G50*'.

DRAUGHT BREAK is an opening into any part of the flue serving an open-flued appliance, formed by a factory-made component. This can allow dilution air to be drawn into a flue or can be used to lessen the effects of downdraught on combustion in the appliance.

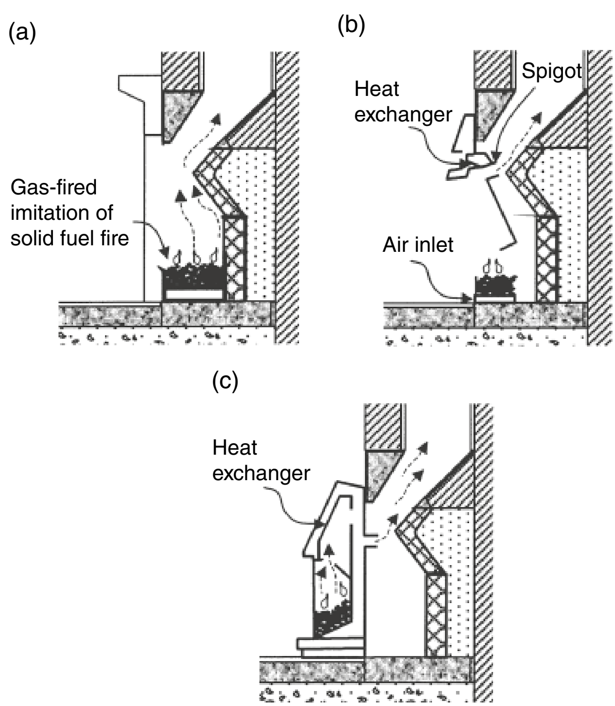


Fig. 14.2 Interpretation – gas fires. (a) Decorative fuel effect (DFE) fire, (b) inset live fuel effect (ILFE) fire and (c) radiant convector gas fire.

DRAUGHT DIVERTER is a form of draught break which allows an open-flued appliance to operate without interference from downdraughts that may occur in the main length of flue in adverse wind conditions and excessive draught.

DRAUGHT STABILISER is a factory-made counterbalanced flap device usually mounted in the flue pipe or chimney, but sometimes located on the appliance, which admits air to the flue from the same space as the combustion air. It is designed to prevent excessive variations in the draught.

EQUIVALENT AREA is the area of a sharp-edged circular orifice which would pass the same airflow rate at the same applied pressure difference as the device being tested. For a simple ventilator this will be less than the geometrical free area and may be significantly less for complex products.

FACTORY-MADE METAL CHIMNEYS are prefabricated chimneys that are usually manufactured as sets of components for assembly on-site. Commonly available types range from single-walled metal chimneys suitable for some gas appliances to chimneys with insulation sandwiched between an inner liner and an outer metal wall designed for oil or solid fuel use. They are also known as system chimneys.

FANNED DRAUGHT INSTALLATION. Sometimes known as forced draught appliances, these incorporate a fan to enable the proper discharge of the flue gases. The fan may be separately installed in the flue or may be an integral part of the combustion appliance. Fans can be installed in most oil-fired and many gas-fired boilers and may either extract flue gases from the combustion chamber or may cause the flue gases to be displaced from the combustion chamber if the fan is supplying it with air for combustion. Depending on the location of the fan, flues in fanned draught installations can run horizontally or vertically and can be at higher or lower pressures than their surroundings.

FIREPLACE RECESS means a structural opening formed in a wall or chimney breast, from which a chimney leads and including a hearth at its base. For closed appliances such as stoves, cookers or boilers, a simple structural opening may be suitable. For accommodating open fires it will usually be necessary to form a gather to reduce the recess to the size of the flue. Fireplace recesses are often lined with firebacks to accommodate inset open fires and lining components, and decorative treatments may be fitted around openings to reduce the opening area. It is this finished fireplace opening area which determines the size of flue required for an open fire in such a recess (see Fig. 14.14 in section 14.7.1).

FIREWALL is a means of shielding a fuel tank from the heat of a fire. For LPG tanks, a firewall will lengthen the path that has to be travelled by gas accidentally leaking from the tank or fittings. This will allow it more time to disperse safely, before reaching a hazard such as other potential ignition sources, an opening in a building or a boundary.

FLUE means a passage conveying the products of combustion to the external air (see Fig. 14.1).

FLUE BLOCK CHIMNEY means a chimney constructed from a set of factory-made components. Flue block chimneys may be made from precast concrete, clay or other masonry units, designed for assembly on-site to provide a complete chimney with the performance appropriate for the intended appliance. Two types of common systems are available:

- For use solely with gas burning appliances; and
- For solid fuel burning appliances (sometimes called chimney block systems).

FLUE BOX means a factory-made unit (usually of metal) which is designed to accommodate a gas burning appliance in conjunction with a factory-made chimney (see also PREFABRICATED APPLIANCE CHAMBER).

FLUELESS APPLIANCE means an appliance which is designed to be used without being connected to a flue. Its products of combustion mix with the surrounding room air and are eventually ventilated from the room to the outside. Examples include gas cookers, gas instantaneous water heaters and some types of gas space heaters.

FLUE LINER is the wall of the chimney that is in contact with the products of combustion. This could be a concrete flue liner, the inner liner of a factory-made chimney system or a flexible liner fitted into an existing chimney (see Fig. 14.1).

FLUE OUTLET is that part of the combustion installation where the products of combustion are discharged from the flue to the outside air, such as the top of a chimney pot or flue terminal.

FLUE PIPE (see Fig. 14.1) means a pipe that connects a combustion appliance to a flue in a chimney (sometimes called a CONNECTING FLUE PIPE). It may be either single walled (bare or insulated) or double walled. (The term FLUE PIPE is also used to describe the tubular components from which some factory-made chimneys for gas and oil appliances are made or from which plastic flue systems are made.)

HEARTH is a base on which a combustion appliance is placed (see Fig. 14.1). It provides safe isolation between the appliance, people, combustible parts of the building fabric and soft furnishings. The exposed surface of the hearth usually extends beyond the appliance and provides a region which can be kept clear of anything at risk of fire. The hearth may be constructed of:

- thin insulating board;
- a substantial thickness of material such as concrete; or
- some intermediate form of construction depending on the weight and downward heat emission characteristics of the appliance(s) upon it.

For solid fuel open fires the substantial thickness of material necessary may be provided by a constructional hearth (often as part of the building structure, floor slab, etc.), on which may be placed a decorative superimposed hearth to provide the clear surface.

HEAT INPUT RATE. For a gas appliance, this is the maximum rate of energy flow that could be provided by the prevailing rate of fuel flow into the appliance if the fuel were to be burnt with full oxidation. It is calculated as the rate of fuel flow to the appliance multiplied by either the fuel's gross or net calorific value. The gross calorific value takes account of the latent heat due to the condensation of water in combustion products and allows this to be included in the heat obtained from the fuel (such as in a gas condensing boiler). It is thus a larger figure than the net heat input rate. Either heat input rating can be used for any given appliance; however, it is now usual to express the rating of a gas appliance as a net heat input rate (kW (net)).

INDEPENDENTLY CERTIFIED means that the product conforms to a product certification scheme that has been approved by an independent certification body. Such schemes certify compliance with the requirements of a recognised document that is appropriate to the purpose for which the material is to be used. Materials which are not so certified may still conform to a relevant standard. Many certification bodies, which approve such schemes, are accredited by UKAS.

INSET LIVE FUEL EFFECT (ILFE) FIRES are described in BS 5871: Part 2. These gas fires stand fully or partially within a fireplace recess or suitable flue box and give the impression of an open fire. The appliance covers the full height of the fireplace opening so that air only enters through purpose-designed openings and the flue gases only discharge through the spigot (see Fig. 14.2(b)).

INSTALLATION INSTRUCTIONS means the manufacturer's instructions, to enable installers to correctly install and test appliances and flues and to commission them into service.

NATURAL DRAUGHT flue. This is the traditional concept for a flue whereby the draught which takes the flue gases up the flue to outside air relies on the difference between the temperature of the gases within the flue and the temperature of the ambient air. Draught increases with the height of the flue, and a satisfactory natural draught requires an essentially vertical run of flue. This concept can be contrasted with balanced flue appliances which are designed to discharge directly through the wall adjacent to the appliance (see above).

NON-COMBUSTIBLE means capable of being classed as non-combustible:

- when subjected to the non-combustibility test of BS 476, Part 4: 1970 (1984) *Non-combustibility test for materials*; and
- any material which when tested to BS 476, Part 11: 1982 (1988) *Method for assessing the heat emission from building materials* does not flame nor cause any rise in temperature on either the centre (specimen) or furnace thermocouples (see also Chapter 7).

NOTIFIED BODY for the purposes of the Gas Appliances (Safety) Regulations (1995) means a body that:

- is approved by the Secretary of State for Trade and Industry as being competent to carry out the required Attestation procedures for gas appliances and whose name and identification number have been notified by him/her to the Commission of the European Community and to other member states in accordance with the Gas Appliances (Safety) Regulations 1995; and
- has been similarly approved for the purposes of the Gas Appliances Directive by another member state and whose name and identification number have been notified to the Commission and to other member states pursuant to the Gas Appliances Directive.

OPEN-FLUED APPLIANCE is, for example, the traditional open fire or stove that draws its combustion air from the room or space in which it is installed and which requires a flue to discharge its products of combustion to the outside air (see Fig. 14.3).

PREFABRICATED APPLIANCE CHAMBER means a set of factory-made precast concrete components designed to provide a FIREPLACE RECESS (see above). It is normal for the chamber to be positioned against a wall and it may be designed to support a chimney. The chamber and chimney can be enclosed to create a false chimney breast (see also FLUE BOX).

RADIANT CONVECTOR GAS FIRES, CONVECTOR HEATERS AND FIRE/BACK BOILERS are described in BS 5871: Part 1. These stand in front of a closure plate which is fitted to the fireplace opening of a fireplace recess or suitable flue box. The appliance covers the full height of the fireplace opening so that air only enters through purpose-designed openings and the flue gases only discharge through the flue spigot (see Fig. 14.2(c)).

RATED HEAT INPUT (or rated input) for a gas appliance means the maximum heat input rate at which it can be operated. This will be declared on the appliance data plate, and for gas appliances it is now usual to express this rating as a net value (kW (net)) although the gross value (kW (gross)) was used until recently. (For details of net and gross values, see HEAT INPUT RATE.)

RATED HEAT OUTPUT for an oil appliance is the maximum declared energy output rate (kW) as declared on the appliance data plate. For a solid fuel appliance, this is the maximum manufacturers' declared energy output rate (kW) for the appliance. This may be different for different fuels.

ROOM-SEALED APPLIANCE means an appliance whose combustion system is sealed from the room in which the appliance is situated. The appliance obtains combustion air either from a ventilated uninhabited space within the building or directly from the open air outside the building. The products of combustion will be vented directly to open air outside the building (see Fig. 14.3).

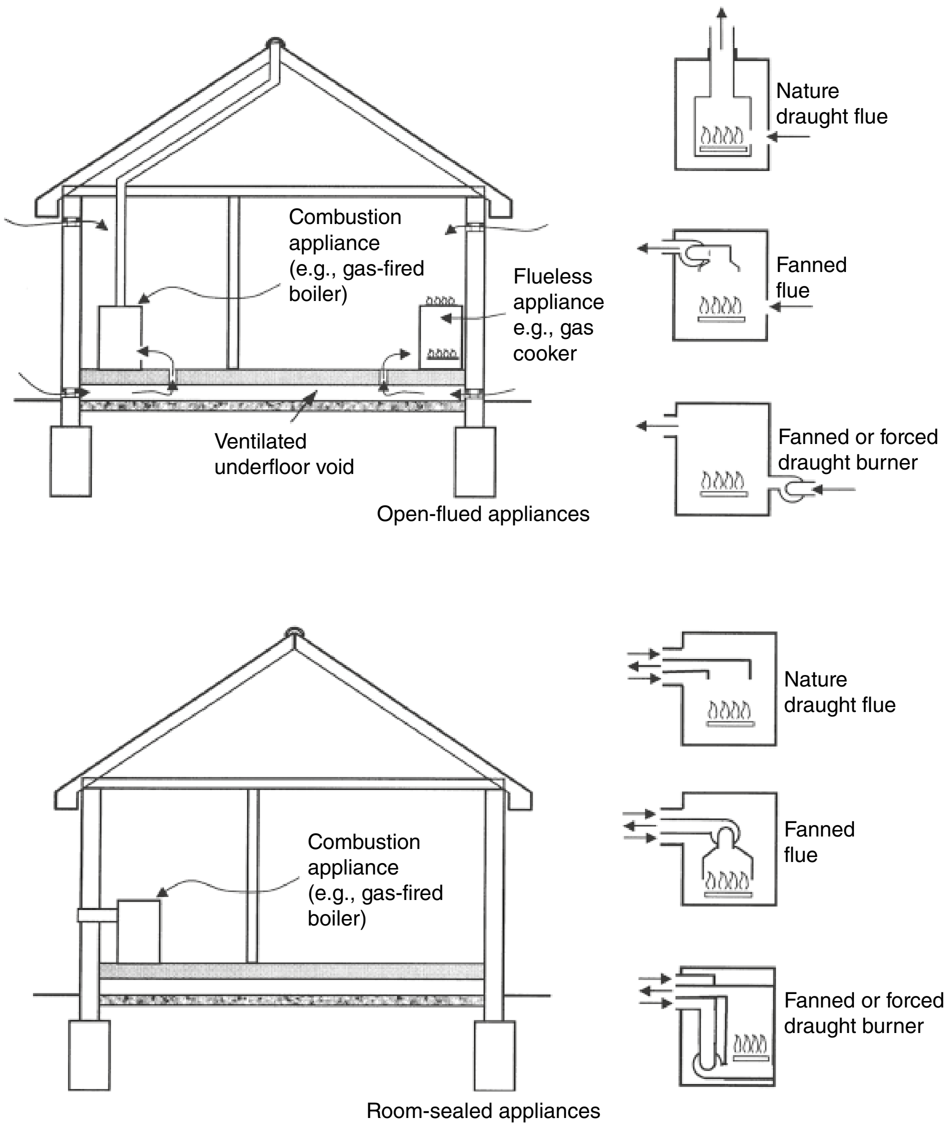


Fig. 14.3 Types of combustion installation.

SOLID BIOFUEL is a solid fuel derived from plants and trees, which can include logs, wood chips, wood pellets and other processed plant material.

THROAT means a narrowing part of the flue between a fireplace recess and its chimney. Throats can be formed from prefabricated components or can be built in brickwork by a process of corbelling.

14.3 Rules for measurement

When measuring the size of a duct or flue (to establish the area, diameter, etc. for the purposes of the approved document guidance), the dimensions should be taken at right angles to the direction of gas flow. Minimum requirements for flue sizes are given in the text below, and where offset components are used, they should not reduce the flue area to less than the quoted figures.

14.4 Checking the condition of combustion installations before use

Combustion installations must be designed and constructed in accordance with the requirements of Part J. Additionally, before being used they should be inspected and tested to prove that they are in fact in compliance. This applies not only to new build but also to repairs, refurbishment and reuse of existing flues (see section 14.8.3 for details of this). Responsibility for such proof of compliance rests with the person carrying out the work. This could be a specialist firm working directly for the client, a developer, a main contractor or even a subcontractor working for the main contractor.

Proving compliance can involve a number of steps, which should be documented in the form of a report drawn up by a 'specialist' firm for the main contractor, client or developer.

To be acceptable to the Building Control Body, the specialist firm would probably need to be a registered member of one of the following organisations although there is no clear guidance in the AD to this effect:

- For Gas appliances the Gas Registration Body (Gas Safe) contactable at www.gassaferegister.co.uk (note this replaced CORGI across the UK from t April 2010);
- For solid fuel appliances the Heating Equipment Testing and Approval Scheme (HETAS) contactable at www.hetas.co.uk;
- For oil appliances the Oil Firing Technical Association for the Petroleum Industry (OFTEC) contactable at www.oftec.org;
- The National Association of Chimney Sweeps (NACS) contactable at www.chimneyworks.co.uk; and
- The National Association of Chimney Engineers (NACE) contactable at www.nace.org.uk.

The Building Control Body can ask for this report as a way of proving compliance. An example of a completed checklist for such a report is given in Appendix A to AD J, which is reproduced below. The report will need to show that materials and components have been used which are suitable for the intended application and that flues have passed appropriate tests.

AD J, Appendix A

Hearths, fireplaces, flues and chimneys

This checklist can help you to ensure hearths, fireplaces, flues and chimneys are satisfactory. If you have been directly engaged, copies should also be offered to the client and to the Building Control Body to show what you have done to comply with the requirements of Part J. If you are a subcontractor, a copy should be offered to the main contractor.

1. **Building address, where work has been carried out**			
2. **Identification of hearth, fireplace, chimney or flue**	*Example: Fireplace in lounge*	*Example: Gas fire in rear addition bedroom*	*Example: Small boiler room*
3. **Firing capability: solid fuel/gas/oil/all**	*All*	*Gas only*	*Oil only*
4. **Intended type of appliance. State type or make. If open fire give finished fireplace opening dimensions**	*Open fire 480 W × 560 H (mm)*	*Radiant/ convector fire 6 kW input*	*Oil-fired boiler 18 kW output (pressure jet)*
5. **Ventilation provision for the appliance: state type and area of permanently open air vents**	*2 through wall ventilators each 10,000 mm² (100 cm²)*	*Not fitted*	*Vents to outside: Top 9900 mm² Bottom 19,800 mm²*
6. **Chimney or flue construction**			
(a) **State the type or make and whether new or existing**	*New. Brick with clay liners*	*Existing masonry*	*S.S. prefab to BS 4543-2*
(b) **Internal flue size (and equivalent height, where calculated – natural draught gas appliances only)**	*200 mm Ø*	*125 mm Ø (H_e = 3.3 m)*	*127 mm Ø*
(c) **If clay or concrete flue liners used, confirm they are correctly jointed with socket end uppermost and state jointing materials used**	*Sockets uppermost Jointed by fire cement*	*Not applicable*	*Not applicable*
(d) **If an existing chimney has been refurbished with a new liner, type or make of liner fitted**	*Not applicable to BS 715*	*Flexible metal liner*	*Not applicable*
(e) **Details of flue outlet terminal and diagram reference**		*125 mm Ø GC1 terminal*	*Maker's recommended terminal*
Outlet detail:	*Smith Ltd Louvred pot 200 mm Ø*	*As BS 5440-1:2000*	*As Diagram 41 AD J*
Complies with:	*As Diagram 2.2 AD J*	*Figure C.1*	*1 × 90° Tee*
(f) **Number and angle of bends**	*2 × 45°*	*2 × 45°*	*Sweep annually via base of Tee and via appliance*
(g) **Provision for cleaning and recommended frequency**	*Sweep annually via fireplace opening*	*Annual service by CORGI engineer*	
7. **Hearth. Form of construction. New or existing?**	New. *Tiles on concrete floor. 125 mm thick. As Diagram 2.9 AD J*	Existing *hearth for solid fuel fire, with fender*	New. *Solid floor Min 125 mm concrete above DPM. As Diagram 4.3 AD J*

8. **Inspection and testing after completion** **Tests carried out by:** **Tests (Appendix E in AD J 2002 ed.) and results**		*Inspected and tested by J Smith, Smith Building Co*	*Tested by J Smith, CORGI Reg no. 12345*	*Tested by J Smith, The Oil Heating Co*
Flue	**visual**	*Not possible, bends*	*Not possible, bends*	*Checked to section 10,*
Inspection	**sweeping**	*OK*	*Not applicable*	*BS 7566:Part 3:*
	coring ball	*OK*	*Not applicable*	*1992 – OK*
	smoke	*OK*	*Not applicable*	*OK*
Appliance (where included)	**spillage**	*Not included*	*OK*	*OK*

I/We the undersigned confirm that the above details are correct. In my opinion, these works comply with the relevant requirements in Part J of Schedule 1 to the Building Regulations.

Print name and title .... Profession ....

Capacity ......(e.g. 'Proprietor of Smith's Flues', Authorising Engineer for Brown plc) .... Tel no ....

Address .... Postcode ....

Signed .... Date ....

Registered membership of .... (e.g. CORGI, OFTEC, HETAS, NACE, NACS) ....

In addition to checking a combustion installation for compliance, where a material change of use takes place in a building (e.g. conversion to flats; see Chapter 2), the fire resistance of the existing chimney walls should be checked and improved as necessary. This can be done by applying additional layers of non-combustible material to the existing chimney walls.

14.5 Requirement J1: Air supply

Requirement J1 of Part J states that 'combustion appliances shall be so installed that there is an adequate supply of air to them for combustion, to prevent overheating and for the efficient working of any flue'.

14.5.1 Air supply: General provisions

Where combustion appliances are installed in a building, Paragraph J1 can be met if provisions are made to enable the admission of sufficient air for:

- proper combustion of the fuel;
- proper operation of any flues (or for flueless appliances, safe dispersal of the products of combustion to the outside air); and
- cooling control systems and/or to make sure that appliance casings do not become too hot to touch, where this is deemed necessary.

AD J gives a range of air vent sizes, which vary with the type of fuel being burnt. These are described below and should be read with the following general notes:

- The figures given are for single combustion appliances only and will need to be increased if more than one appliance is installed in a room (e.g. where a kitchen contains an open-flued boiler and a flueless appliance such as a cooker).
- Where an open-flued appliance is installed in a room, it will receive a small amount of combustion air from infiltration through the building fabric. Depending on the type of appliance installed, this will need to be supplemented by permanently open air vents.
- Where an open-flued appliance is installed in an appliance compartment:
  - (a) all the air necessary for combustion and proper operation of the flue must be supplied through adequately sized permanent vents which may be situated in an outside or internal wall;
  - (b) where cooling air is needed, the compartment should be large enough to allow air to circulate via high- and low-level vents; and
  - (c) the appliance and ventilation system manufacturer's instructions should be followed where appliances are to be installed within balanced compartments since special provisions will be necessary.
- Ventilation direct to outside air should be provided for other rooms or spaces within the building where:
  - (a) a room-sealed appliance takes its combustion air from another space (e.g. a roof void); or
  - (b) a flue has a permanent opening to another space (e.g. where it feeds a secondary flue in the roof void).

In the case of ventilation via roof voids, the ventilation provisions contained in Approved Document C (see Chapter 8) would normally be adequate, where the combustion installation serves a dwelling.

In other cases, the room or space from which the combustion air is obtained should have air vent openings direct to outside air of at least the same size as the internal openings serving the appliance, although air vents for flueless appliances should always open direct to outside air (i.e. not through an adjoining space). Figure 14.4 gives examples of locations for permanent air vent openings.

Where permanently open air vents are called for (see guidance related to specific fuels below), they should be:

- non-adjustable;
- appropriately sized to admit the correct amount of air taking into account their free area (or equivalent free area; see Fig. 14.5) and any obstructions such as grilles and anti-vermin mesh (which should have aperture dimensions no smaller than 5 mm);
- positioned so that they are unlikely to become blocked; and
- located so that occupants are not provoked to seal them against cold draughts and noise (e.g. place vents close to appliances; draw air from hallways or other intermediate spaces; place air vents next to ceilings to ensure good mixing of incoming cold air; install noise attenuated ventilators to cut down on unwanted external noise; place

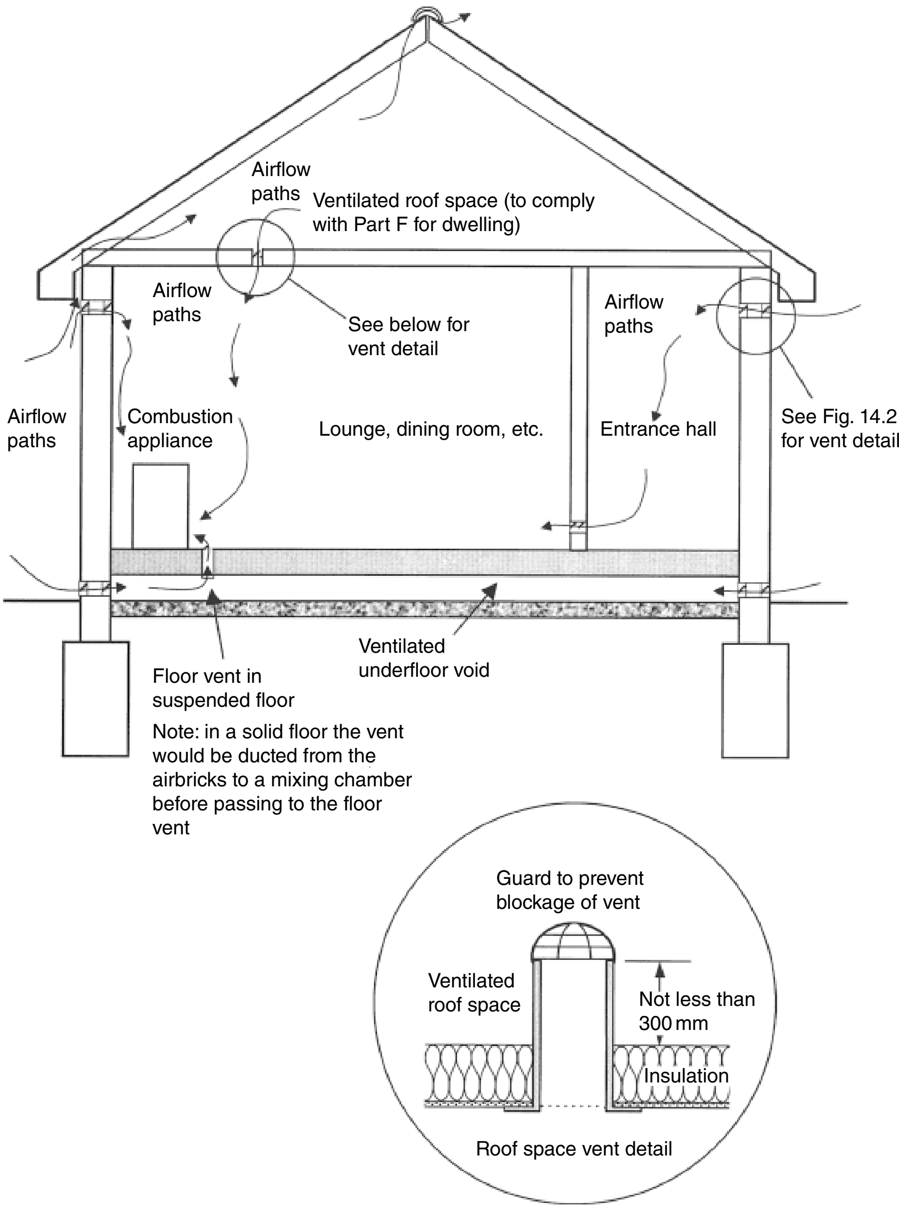


Fig. 14.4 Example locations of permanent air vent openings.

ventilators outside fireplace recesses and beyond the hearths of open fires where dust or ash might be disturbed by draughts).

Permanently open air vents should not be installed in fire-resisting walls. Although external walls are excluded from this provision, this exclusion will not apply to parts of external walls shielding LPG tanks. Additionally, vents should not be sited in fireplace recesses unless expert advice has been sought.

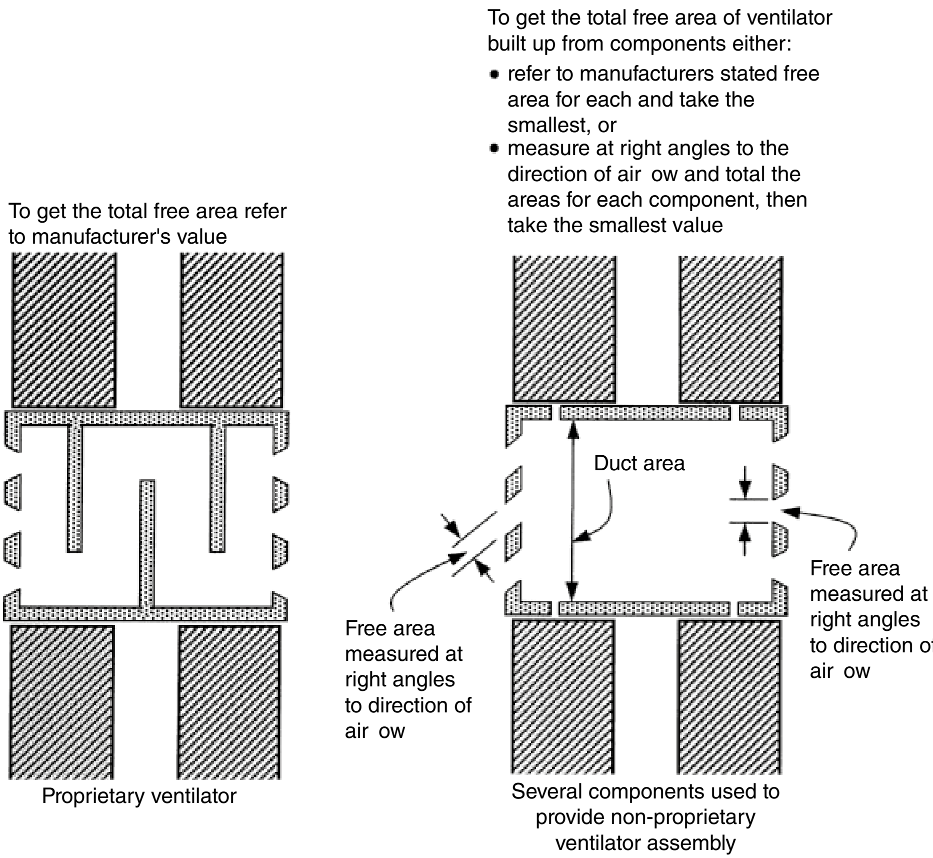


Fig. 14.5 Free area of ventilators.

Ventilation via permanently open vents can be provided in a number of ways. Where proprietary components or assemblies are used, the manufacturer will usually be able to give a value for the free area (or equivalent free area). Where this is not available (e.g. some airbricks, grilles or louvres), it will be necessary to calculate the free area as shown in Fig. 14.5 by aggregating the individual apertures and taking the smallest free area in the assembly (or the overall duct area if this is less).

Where buildings have airtight membranes in their floors (such as radon or landfill gas barriers; see Chapter 8), ventilation ducts or vents should be installed so as not to compromise the effectiveness of the membrane.

14.5.2 Air supply: Compliance with other parts of the Regulations

By referring to Chapter 11 (which deals with Part F, Ventilation of the 2010 Regulations), it will be apparent that buildings need to be ventilated not only to provide combustion air for fuel burning appliances (where these are present) but also to provide general ventilation for health reasons. A possible conflict might occur between the two forms of ventilation since the guidance in Approved Document F allows the background ventilation to be adjustable, whereas Part J ventilation must be permanently open. Previous editions of Part J have been unsuccessful in addressing this conflict; however the 2002 edition gives the following guidance:

Where rooms or spaces contain open-flued appliances:

- permanently open vents provided for combustion appliances are acceptable to replace some or all of the Part F adjustable background ventilation (depending on location and amount of opening area); and
- adjustable Part F vents can only be used for Part J combustion air ventilation if they are fixed permanently open.

Where rooms or spaces contain flueless appliances (see definition in section 14.2), it may be necessary to provide permanent, background and purge ventilation (e.g. an openable window) to comply with Parts F and J. For such appliances:

- permanent, purge and background ventilation provisions for Part J and Part F compliance can be used as described for open-flued appliances above; and
- the purge ventilation provided by opening elements for Part F compliance may also be accepted for Part J compliance, provided that the minimum opening areas are achieved.

Where mechanical extract ventilation is provided for Part F compliance, dangerous conditions can be created where open-flued appliances are also present due to the spillage of flue gases (even where the fans and appliances are in different rooms). Approved Document F contains recommendations designed to avoid flue gas spillage for different types of combustion appliances. They should be read in conjunction with the following:

- Specialist advice may be needed for commercial and industrial installations, regarding the possible need for the interlocking of gas heaters and any mechanical ventilation systems.
- Suitable spillage tests for gas appliances may be provided by appliance manufacturers in their installation instructions. Alternatively, the procedure given in BS 5440 Part 1:2008: *Installation and maintenance of flues and ventilation for gas appliances of rated input not exceeding 70 Kw net (1st, 2nd and 3rd family gases) – Specification for installation and maintenance of flues* can also be used. The object of the test is to check for spillage when appliances are subjected to the greatest possible depressurisation. To cater for this, the following should be taken into account:
  (a) All external doors, windows and other adjustable ventilators to outside should be closed.
  (b) Several tests may be necessary to demonstrate the safe operation of the appliance with reasonable certainty since various combinations of fans in operation and open internal doors will be possible, and the specific combination causing the greatest depressurisation at the appliance will depend on the circumstances in each case. One test should of course be carried out with the door leading into the room of installation closed and all fans in that room switched on.

(c) The effect of ceiling fans should be taken into account during the tests.
(d) It is important to consider all fans which might be in use and not only the obvious ones, such as those on view in kitchens. Others include fans installed in domestic appliances such as tumble dryers, fans fitted to other open-flued combustion appliances and fans installed to draw radon gas from the ground below a building (see also *BRE good building guide, GBG 25* and Chapter 8).

14.5.3 Air supply: Specific provisions relating to appliances burning solid fuel

In addition to the general recommendations given above, appliances burning solid fuel with rated outputs up to 50 kW should have permanently open air vents at least as great as the sizes shown in Table 1 to Approved Document J, which is reproduced below. It should be noted that where an appliance is installed that is capable of burning a range of different solid fuels, the ventilation requirements should suit the fuel that produces the greatest heat output.

AD J section 2

Table 1 Air supply to solid fuel appliances.

Type of appliance	Type and amount of ventilation (1)	
Open appliance, such as an open fire with no throat, e.g. a fire under a canopy	Permanently open air vent(s) with a total equivalent area of at least 50% of the cross-sectional area of the flue	
Open appliance, such as an open fire with a throat	Permanently open air vent(s) with a total equivalent area of at least 50% of the throat opening area (2)	
Other appliance, such as a stove, cooker or boiler, with a flue draught stabiliser	Permanently open air vent(s) as below (3):	
	If design air permeability is >5.0 $m^3/h.m^2$, then	
	First 5 kW of appliance rated output	300 mm^2/kW
	Balance of rated output	850 mm^2/kW
	Where permeability is <5.0	850 mm^2/kW
Other appliance, such as a stove, cooker or boiler, with no flue draught stabiliser	Permanently open air vent(s) as below (3):	
	For >5 kW of appliance rated output	550 mm^2/kW
	If design air permeability is <5.0 $m^3/h.m^2$, then 550 mm^2/kW of appliance rated output	

Notes:

1. Equivalent area is as measured according to the method in BS EN 13141-1:2004 or estimated according to paragraph 1.14 – divide the area given in mm^2 by 100 to find the corresponding area in cm^2.
2. For simple open fires (see Fig. 14.15), the requirement can be met with room ventilation areas as follows:

Nominal fire size (fireplace opening size)	500 mm	450 mm	400 mm	350 mm
Total free area of permanently open air vents	20,500 mm^2	18,500 mm^2	16,500 mm^2	14,500 mm^2

3. Example: an appliance with a flue draught stabiliser and a rated output of 7 kW would require a free area of: $[5 \times 300] + [2 \times 850] = 3200$ mm^2.

Manufacturers' installation instructions should be followed where these vary from the Table recommendations (e.g. they may specify even larger areas of permanently open air vents or, in the case of a cooker, omit to specify a rated output).

14.5.4 Air supply: Specific provisions relating to appliances burning gas

Appliances burning gas with rated inputs up to 70 kW (net) should comply with the general recommendations given above. Additionally, the amount of permanently open air vents which should be provided will vary with the type of appliance (and whether it is room sealed, open flued or flueless). The various combinations are discussed below.

Flued decorative fuel effect (DFE) fires

These are defined in section 14.2. Any room or space containing a DFE fire should have ventilation provided in accordance with Table 14.1.

Flued appliances other than DFE fires

These include inset live fuel effect fires (ILFE), radiant convector gas fires, convector heaters and fire/back boilers (all as defined in section 14.2). All these combustion appliances come in both room-sealed and open-flued variants. Table 14.2 gives the free areas of permanently open vents for these appliances.

Air supply to flueless gas appliances

Flueless appliances are designed to be used without being connected to a flue. The products of combustion mix with the surrounding room air and are eventually ventilated from the room to the outside. Examples include gas cookers, gas instantaneous water heaters and some types of gas space heaters.

It will usually be necessary to comply with Part F (see Chapter 11) regarding background, rapid and extract ventilation and subject to the size of the room may require the permanent ventilation provisions detailed in Part J. For rooms over a certain volume, it may not be necessary to provide permanent ventilation for particular types of appliance.

Table 14.1 Supply of combustion air to flued decorative fuel effect fires.

Type of appliance	Type of ventilation
1. DFE fire in a fireplace recess with a throat	Air vent free area of at least 10,000 mm^2 (100 cm^2)
2. DFE fire in a fireplace with no throat (e.g. under a canopy)	Air vent free area sized as for a solid fuel fire (see Table 2.1 to AD J section 2)
3. DFE fire with rating not exceeding 7 kW (net) in dwellings with air tightness >5 $m^3/h.m^2$	Permanently open air vents not necessary for appliances certified by a Notified Body (see section 14.2) as having a flue gas clearance rate (without spilling) not exceeding 70 m^3/h

Table 14.2 Supply of combustion air to gas appliance installations (other than DFE fires or flueless appliances).

Location/type of appliance	Amount/type of ventilation
1. Appliance in a room or space:	Ventilation direct to outside air
(a) Open flued	Permanently open vents of at least 500 mm² per kW (net) of rated input over 7 kW (net)
(b) Room sealed	No vents needed
2. Appliance in appliance compartment:	Ventilation via adjoining room or space
(a) Open flued	From adjoining room or space to outside air: permanently open vents of at least 500 mm² per kW (net) of rated input over 7 kW (net)
	Between adjoining room or space and appliance compartment, permanently open vents: at high level – 1000 mm² per kW input (net) at low level – 2000 mm² per kW input (net)
(b) Room sealed	Between adjoining space and appliance compartment, permanently open vents: both high and low levels – 1000 mm² per kW input (net)
3. Appliance in appliance compartment:	Ventilation direct to outside air:
(a) Open flued	Permanently open vents: at high level – 500 mm² per kW input (net) at low level – 1000 mm² per kW input (net)
(b) Room sealed	Permanently open vents: both high and low levels – 500 mm² per kW input (net)

Example calculation
An open-flued boiler with a rated input of 20 kW (net) is installed in a boiler room (appliance compartment, row 3) ventilated directly to the outside. The design of the boiler is such that it requires cooling air in these circumstances.
The cooling air will need to be exhausted via a high-level vent.
From above, the area of ventilation needed = 20 kW × 500 mm²/kW = 10,000 mm².
A low-level vent will need to be provided to allow cooling air to enter, as well as admitting the air needed for combustion and the safe operation of the flue.
From above, the area of ventilation needed = 20 kW × 1000 mm²/kW = 20,000 mm².
These ventilation areas can be converted to cm² by dividing the results given above in mm² by 100.
The calculated areas are the free areas of the vents (or equivalent free areas for proprietary ventilators) described in section 14.5.1.

Table 14.3 gives details of the amounts of permanent ventilation that should be provided in different circumstances. These are in addition to any openable elements or extract ventilation needed to comply with Part F. The table should be read in conjunction with the general provisions listed above. Where a gas point is installed in a room which is intended to be used with a flueless appliance, the room should have the ventilation provisions required for the intended appliance. The ventilation provision should be calculated on the basis that the largest rated appliance consistent with the Table 14.3 recommendations will be installed in the room.

A flueless instantaneous water heater should never be installed in a room or space which has a volume of less than 5 m³.

Table 14.3 Ventilation of flueless gas appliances.

Type of flueless appliance	Maximum rated heat input of appliance	Volume of room, space or internal space[1] (m^3)	Free area of permanently open air vents (mm^2)
1. Cooker, oven, hob, grill or combination of these	Not applicable	Up to 5	10,000
		5 to 10	5000[2]
		Over 10	Permanently open vent not needed
2. Instantaneous water heater	11 kW (net)	5 to 10	10,000
		10 to 20	5000
		Over 20	Permanently open vent not needed
3. Space heater[3]:			
(a) Not in an internal space[4]	0.045 kW (net) per m^3 volume of room or space	All room sizes	10,000 **plus** 5500 per kW (net) greater than 2.7 kW
(b) In an internal space[5]	0.09 kW (net) per m^3 volume of room or space	All room sizes	10,000 **plus** 2750 per kW (net) greater than 5.4 kW

Notes:

[1] In this table 'internal space' means a hallway or landing (a space which communicates with several other rooms spaces).

[2] If the room or space has a door direct to outside air, no permanently open air vent is needed.

[3] For LPG fired space heaters which conform to BS EN 449:2002+A1:2007 *Specification for dedicated liquified petroleum gas appliances – Domestic flueless space heaters (including diffusive catalytic combustion heaters)*, follow the guidance in BS 5440: Part 2: 2000.

[4] A space heater is to be installed in a lounge measuring $5 \times 4 \times 2.5 = 50\,m^3$. Its maximum rated input should not exceed $50 \times 0.045 = 2.25$ kW (net).

[5] A space heater installed in a hallway to provide background heating has a rated input of 6 kW (net). It will need to be provided with $10{,}000 + 2750 \times (6 - 5.4) = 11{,}650\,mm^2$ of permanently open ventilation.

14.5.5 Air supply: Specific provisions relating to appliances burning oil

The guidance in Approved Document J is relevant to combustion appliances burning the following oils:

Class C2 (kerosene) to BS 2869:2006;
Class D (gas oil) to BS 2869:2006;
Liquid biofuel to EN 14213:2003; and
Blends of mineral oil and liquid biofuel.

Appliances burning oil with rated outputs up to 45 kW should comply with the general recommendations given above. In rooms such as bathrooms and bedrooms, where there is an increased risk of carbon monoxide poisoning, open-flued oil-fired combustion appliances should not be installed. Instead, room-sealed appliances should be installed.

Table 14.4 gives details of the amounts of permanent ventilation that should be provided in different circumstances. Manufacturers' installation instructions should

Table 14.4 Supply of combustion air to oil-fired appliance installations.

Location/type of appliance	Amount/type of ventilation
1. Appliance in a room or space:	Ventilation direct to outside air
(a) Open flued	Permanently open vents of at least 550 mm^2 per kW of rated output over 5 kW[1]
(b) Room sealed	No vents needed
2. Appliance in appliance compartment:	Ventilation via adjoining room or space
(a) Open flued	From adjoining room or space to outside air: permanently open vents of at least 550 mm^2 per kW of rated output over 5 kW Between adjoining room or space and appliance compartment, permanently open vents: at high level – 1100 mm^2 per kW output at low level – 1650 mm^2 per kW output
(b) Room sealed	Between adjoining space and appliance compartment, permanently open vents: both high and low levels – 1100 mm^2 per kW output
3. Appliance in appliance compartment:	Ventilation direct to outside air:
(a) Open flued	Permanently open vents: at high level – 550 mm^2 per kW output at low level – 1100 mm^2 per kW output
(b) Room sealed	Permanently open vents: both high and low levels – 550 mm^2 per kW output

Notes:
[1] Increase the area of permanent ventilation by a further 550 mm^2 per kW output if appliance fitted with draught break.

Example calculation

An open-flued boiler with a rated output of 15 kW is installed in a cupboard (appliance compartment, row 2) ventilated via an adjacent room. Since the boiler output exceeds 5 kW, permanent ventilation openings will be needed in the adjacent room in addition to the vents between the cupboard and the room designed to provide combustion and cooling air.

Area of permanent vents to outside air needed in adjacent room = (15 kW – 5 kW) × 550 mm^2/kW = 5500 mm^2. The cooling air will need to be exhausted via a high-level vent.

From above, the area of ventilation needed = 15 kW × 1100 mm^2/kW = 16,500 mm^2.

A low-level vent will need to be provided to allow cooling air to enter, as well as admitting the air needed for combustion and the safe operation of the flue.

From above the area of ventilation needed = 15 kW × 1650 mm^2/kW = 24,750 mm^2.

These ventilation areas can be converted to cm^2 by dividing the results given above in mm^2 by 100.

The calculated areas are the free areas of the vents (or equivalent free areas for proprietary ventilators) described in section 14.5.1.

be followed where these require greater areas or permanent ventilation than shown in the table recommendations.

14.5.6 Air supply: Assessing the air permeability of existing dwellings

When installing fixed appliances in existing dwellings, judging whether the requirements for permanent ventilation have been achieved can be very much dependent on assessing the airtightness of the dwelling into which they are to be installed.

Following the inclusion of airtightness testing within the building regulations in 2006, many dwellings built to these standards are likely to have evidence of their airtightness either by means of an individual air permeability test certificate for the dwelling itself or alternatively by means of a representative test of a similar dwelling on the same development.

For dwellings which do not have such evidence or older houses, it may be safe to assume that they will have an air permeability greater than 5.0 $m^3/h.m^2$ unless the building has been substantially upgraded. Appendix F of Approved Document J list typical upgrade measures as follows:

- Full double or triple glazing;
- Effective closures on trickle vents and other controllable ventilation devices;
- All external doors with integral draught seals and letter box seals;

Internal and external sealing around external doors and window frames;
Filled cavity or solid walls;
Impermeable overlay and edge sealing of suspended ground floors;
Careful sealing at junctions between building elements such as between walls and floors or ceilings;
Careful sealing around loft hatch;
Careful sealing around chimney or flue penetrations;
Careful sealing around internal soil pipe;
Careful sealing around domestic water and heating pipes passing into externally ventilated spaces;
Careful sealing of all service penetrations in the building fabric;
Internal warning pipe for WC;
All cable channels for light switches and power sockets sealed; and
All cable entry for lighting and ceiling roses sealed. Recessed lighting should not penetrate ceilings separating loft spaces.

If there is any doubt with regard to the airtightness of an individual dwelling where a new appliance is to be installed, it should be assumed that the air permeability is lower than 5.00 $m^3/h.m^2$ and the appropriate permanent ventilation should be provided.

14.6 Requirement J2: Discharge of products of combustion

Requirement J2 of Part J states that 'combustion appliances shall have adequate provision for the discharge of the products of combustion to the outside air'.

In general, this means that the combustion installation must enable normal operation of the appliances without a hazard to health being created by the products of combustion.

Apart from flueless appliances, this is achieved by providing each combustion appliance with a suitable flue which discharges to the outside air.

14.6.1 Provision of flues and chimneys

The guidance in AD J is based on the provision of a separate flue for each appliance. Although every solid fuel appliance should be connected to its own flue, for oil and gas-fired installations, it is possible to connect more than one appliance to a single flue by following the alternative guidance in:

- BS 5410 Part 1:1997 *Code of practice for oil firing, Installations up to 44 kW output capacity for space heating and hot water supply purposes* for oil-fired installations; and
- BS 5440 Part 1:2008 *Installation and maintenance of flues and ventilation for gas appliances of rated input not exceeding 70 kW net (1st, 2nd and 3rd family gases) – Specification for installation and maintenance of flues* for gas-fired installations.

A chimney is defined above as a structure consisting of a wall or walls enclosing one or more flues, and the old practice of building chimneys with unlined flues became obsolete many years ago.

Interestingly, AD J now contains provisions for the repair and testing of flues in existing chimneys when these are brought back into use or reuse. In many cases this will involve relining the old flues.

14.6.2 Chimneys, flues and flue pipes: General provisions

AD J gives a range of flue sizes and a number of specific recommendations, which vary with the type of fuel being burnt. These are described below and should be read with the following general notes.

Liners to masonry chimneys

Liners to masonry chimneys should be installed in accordance with manufacturer's instructions and the following notes:

- The flue should be formed with appropriate components, keeping joints to a minimum and avoiding cutting.
- Matching factory-made components should be used for bends and offsets.
- Liners should be built into the chimney with sockets or rebate ends uppermost to keep moisture and other condensates in the flue (this also prevents condensate from running out of the joints where it might adversely affect any caulking material).
- Joints between liners should be sealed with fire cement or refractory mortar or installed in accordance with manufacturer's instructions.
- The space between the liners and the masonry should be filled with weak mortar or insulating concrete, with mixes such as:
  (a) 1:20 ordinary Portland cement : suitable lightweight expanded clay aggregate (minimally wetted);
  (b) 1:6 ordinary Portland cement : vermiculite; and
  (c) 1:10 ordinary Portland cement : perlite.

The following liners for masonry chimneys are suitable for all fuels.

- Liners as described in BS EN 1443:2003 with performance at least equal to the designation T400 N2 D 3 G (see 'designation system' definition in section 14.2), such as:
  (a) clay flue liners with rebated or socketed joints which meet the requirements for Class A1 N2 or Class A1 N1 to BS EN 1457:2009;
  (b) concrete flue liners independently certified as meeting the requirements for the classification Type A1, Type A2, Type B1 or Type B2 as described in BS EN 1857:2003; or
  (c) other products that meet the BS EN 1443 criteria.

Construction of flue block chimneys

For all fuels, flue block chimneys should:

- be constructed using factory-made components suitable for the intended application;
- be installed in accordance with manufacturer's instructions;
- have joints sealed in accordance with the flue block manufacturer's instructions;
- have bends and offsets formed only with matching factory-made components;
- be constructed using:
  (a) liners as described in BS EN 1443:2003 with performance at least equal to the designation T400 N2 D 3 G (see section 14.2), such as:
    (i) clay flue blocks meeting the requirements for the class FB1 N2 to BS EN 1806:2006 *Chimneys – Clay/ceramic flue blocks for single wall chimneys – Requirements and test methods*; or
    (ii) other products that are independently certified as meeting the BS EN 1443 criteria; and
  (b) blocks lined as for masonry chimneys above.

Condensates in flues

The products of combustion of all fuels contain considerable quantities of water vapour which can condense on the inside of the flue and cause damage if not satisfactorily controlled. Some modern condensing appliances are designed to extract the latent heat of vaporisation from the condensate to improve efficiency.

In the case of chimneys that do not serve condensing appliances, satisfactory control of condensation can be achieved by insulating flues so that flue gases do not condense under normal conditions of operation.

For chimneys serving condensing appliances, satisfactory control of condensation can be achieved by:

- using lining components that are impervious to condensates and suitably resistant to corrosion, BS EN 1443:2003 'W' designation;
- making appropriate drainage provisions and avoiding ledges, crevices, etc.; or
- providing for the disposal of condensate from condensing appliances.

Plastic flue pipe systems

Under certain circumstances it is possible to use plastic flue pipe systems. For example, with condensing boiler installations, the flue pipes should be:

- appropriately designated in accordance with BS EN 14471:2005; and
- supplied by or specified by the appliance manufacturer.

Concealed flues

When a flue is first installed or when an appliance is serviced, access to the flue will be required to check the following aspects of the installation to be checked and confirmed:

- *that the flue is continuous throughout its length;*
- *that all joints appear correctly assembled and sealed;*
- *that the flue is adequately supported throughout its length; and*
- *that the required gradient of fallback to the boiler and any drain points are provided.*

Where a flue is installed within a void, suitable means of access will need to be provided to facilitate the above. Full physical access is not required, and Diagram 14 in Approved Document J shows an acceptable approach for a typical concealed flue.

The important rules for dealing with concealed flues are as follows:

- *Although flues may pass through communal areas in buildings, they must not pass through another dwelling.*
- *The means of access must not impair the fire, thermal or acoustic requirements of the building.*
- *Inspection panels may need to be fitted with resilient seals to meet the above requirements.*
- *Access hatches must be at least 300 mm × 300 mm or larger to allow sufficient access.*

Design of flues serving natural draught open-flued appliances

Flue systems serving natural draught open-flued appliances rely on the stack effect (the natural buoyancy of hot air) to ensure that the products of combustion are successfully discharged to outside air. Therefore, the system should offer as little resistance as possible to the passage of the flue gases, and it should be possible to inspect and sweep the whole flue after the appliance (if any) has been installed. This can be done by minimising changes in direction and avoiding long horizontal sections of flue. The following design factors illustrated in Fig. 14.6 should be considered:

- Build flues so that they are as straight and vertical as possible.
- Restrict horizontal sections of flue to connections to appliances with rear outlets and do not allow these to be longer than 150 mm.
- If bends have to be included in the flue, make sure that they are angled at not greater than 45° to the vertical.

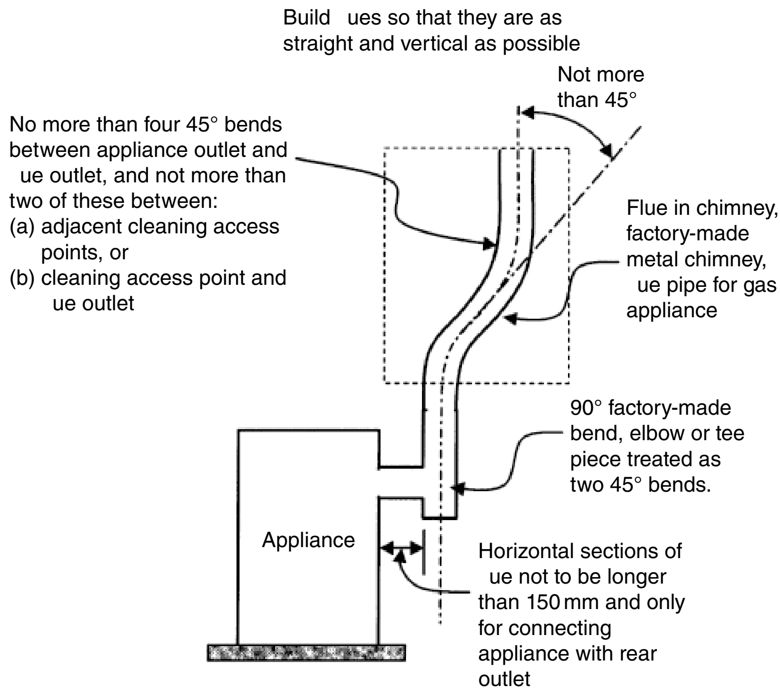


Fig. 14.6 Configuration of natural draught flues serving open-flued appliances.

- Have no more than four 45° bends between the appliance outlet and the flue outlets and not more than two of these between:
  - (a) adjacent cleaning access points; or
  - (b) a cleaning access point and the flue outlet.

It should be noted that a 90° factory-made bend, elbow or tee piece should be treated as two 45° bends.

Openings into flues for inspection and cleaning

No flue should communicate with more than one room or internal space in a building except for the purposes of:

- inspection or cleaning; or
- the fitting of a draught diverter, draught stabiliser, draught break or explosion door.

Openings for inspection and cleaning should meet the following criteria:

- Be formed using purpose factory-made components which are compatible with the flue system;
- Have an access cover with the same level of gas tightness as the flue system and an equal thermal insulation level; and
- Allow easy passage of the sweeping brush.

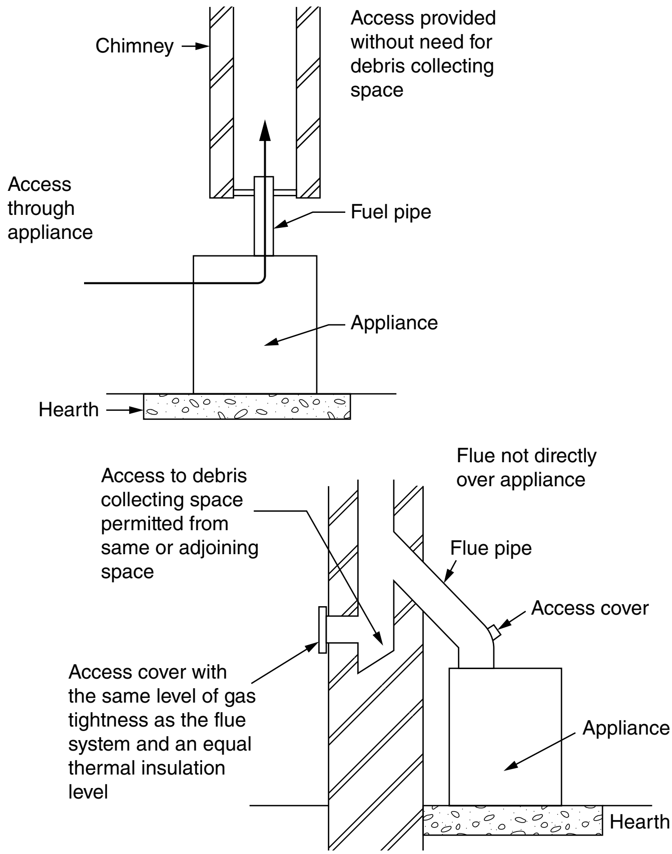


Fig. 14.7 Access for inspection and cleaning.

- Covers should be non-combustible unless fitted to a combustible flue pipe (e.g. a plastic flue pipe).
- A chimney which cannot be cleaned through an appliance should be provided with:
  (a) suitably sized openings for cleaning provided at a sufficient number of locations in the chimney (see Fig. 14.7); and
  (b) a debris collecting space with access for emptying.

For gas appliances, the debris collection space should be provided at the base of a flue unless it is a factory-made metal chimney with a flue box, is lined or is constructed of flue blocks. To achieve this, provide a space which:

- has a volume of at least 12 litres and a depth of at least 250 mm below the point where flue gases discharge into the chimney; and
- is readily accessible for clearing debris, (e.g. by removing the appliance).

For radiant convector gas fires, convector heaters, fire/back boilers and inset live fuel effect fires, provide a clearance of at least 50 mm between the end of the appliance flue outlet and any surface.

Connecting flue pipes

A connecting flue pipe is used to connect a combustion appliance to a flue in a chimney. Suitable components for constructing connecting flue pipes include:

- cast iron, in accordance with BS 41:1973 (1998) *Specification for cast iron spigot and socket flue or smoke pipes and fittings*;
- metal flue pipes appropriately designed to BS EN 1856-2:2004 to suit the types of fuel to be burnt;
- vitreous enamelled steel complying with BS 6999:1989 *Specification for vitreous enamelled low carbon steel flue pipes, other components and accessories for solid fuel burning appliances with a maximum rated output of 45 kW*; and
- other flue pipes which have been independently certified to have the necessary performance designation for suitable use with the intended appliance.

Where spigot and socket flue pipes are used, the sockets should be placed uppermost to contain moisture and other condensates in the flue. In order to achieve gas-tight joints, it is usual either to use proprietary jointing accessories or, where appropriate, to pack the joints with non-combustible rope and fire cement.

Inspection and testing of flues

As explained in section 14.4, combustion installations should be inspected and tested before use to prove that they are in compliance with the Building Regulations. For flues this entails carrying out checks to show that they are:

- free from obstructions;
- satisfactorily gas tight; and
- constructed of materials and components of the correct size to suit the intended application.

If building work also includes installation of the combustion appliance, tests can be carried out which involve firing up the appliance. These should include:

- tests for gas tightness of the flue and at joints between the flue and the combustion appliance outlet; and
- spillage tests as part of the commissioning process to check compliance with:
  (a) Part J2 and Part L (see Chapter 16); and
  (b) The Gas Safety (Installation and Use) Regulations 1998 (see Chapter 5).

It will normally be necessary for a suitably qualified person to prepare a report showing that the above considerations have been taken into account. An example checklist for such a report is given in section 14.4. For more information on methods of checking compliance with Regulation J2, see the section on *repair and reuse of existing flues* in section 14.8.3.

Dry lining around fireplace openings

It is usual to finish off around a fireplace opening with decorative treatment, such as a fireplace surround, masonry cladding or dry lining. Care must be taken to avoid the creation of any gaps that could allow flue gases to escape from the fireplace opening into the void behind the decorative treatment by applying a suitable sealant at the junction. The sealant should be able to remain in place despite any relative movement between the decorative treatment and the fireplace recess.

14.6.3 Access to combustion appliances for maintenance purposes

Combustion appliances should be provided with a permanent means of access for maintenance purposes. The means of access should suit the location of the appliance, e.g. where an appliance is installed in a roof space, it would probably be necessary to provide an access walkway.

14.6.4 Factory-made metal chimneys

These are defined in section 14.2 and consist of prefabricated chimneys that are usually manufactured as sets of components for assembly on-site.

Specification of factory-made metal chimneys

Where it is proposed to use component systems, they should be appropriately designated as complying with:

- BS EN 1856-1:2003 *Chimneys – Requirements for metal chimneys – System chimney products.*

Such component systems should be installed in accordance with the relevant recommendations of:

- BS EN 15287-1:2007 *Chimneys – Design, installation and commissioning of chimneys.*

Gas- and oil-fired appliances with flue gas temperatures not exceeding 250°C using twin-wall component systems (oil fired) or single-wall component systems (gas fired) should be appropriately designated in accordance with BS EN 1856-1:2003. They should be installed in accordance with BS 5440 Part 1:2008 *Installation and maintenance of flues and ventilation for gas appliances of rated input not exceeding 70 kW net (1st, 2nd and 3rd family gases) – Specification for installation and maintenance of flues*.

Apart from the above, any other chimney system can be used, provided that it is independently certified as being suitable for its purpose and it is installed in accordance with BS EN 15287 or BS 5440 as appropriate.

Using factory-made metal chimneys: General precautions

Where a factory-made metal chimney passes through a fire compartment wall or floor, it must comply with the requirements of Part B (see Chapter 7) regarding the integrity of the compartmentation. Additionally, it may meet the requirements if:

- it is surrounded in non-combustible material having at least half the fire resistance required for the compartment wall or floor; or
- it has an appropriate level of fire resistance and is installed in accordance with BS EN 1856-1:2003 Annex NA.

No combustible material should be placed nearer to the outer surface of the chimney than the distance 'xx' derived from the test procedures specified in BS EN 1856-1:2003. The distance 'xx' will be the flue manufacturer's declared minimum distance as derived from the test. Additionally, a chimney passing through a cupboard, storage space or roof space may be separated from that space by a guard of suitable imperforate material, provided that no combustible material is enclosed within the guard, and the distance between the inside of the guard and the outside of the chimney is not less than the distance (X) specified above.

Although it is not permissible to take a connecting flue pipe serving a solid fuel appliance (or an oil-fired appliance with flue gas temperatures which exceed 250°C) through a roof space, partition, internal wall or floor, it is permissible to do this for a factory-made metal chimney if the following precautions are taken:

- When passing through a wall, provide sleeves so that thermal movement is allowed to take place without damaging the flue or the building.
- Do not conceal joints between chimney sections within ceiling joist spaces or walls, since this might prevent the flue from being checked for gas tightness.

The chimney should be designed and constructed so that the appliance can be changed at a later date without the need for the chimney to be dismantled.

Like any other flue, factory-made metal chimneys should be guarded if they present a burn hazard which is not immediately apparent to people or they are so sited as to be at risk of damage.

14.6.5 Flues: Specific provisions relating to appliances burning solid fuel

In addition to the general recommendations given above, appliances burning solid fuel with rated outputs up to 50 kW should comply with the following specific recommendations.

Size of flues for appliances burning solid fuel

Flue pipes and flues should:

- be at least the size shown in Table 2 to Approved Document J, which is reproduced below;
- have the same diameter or equivalent cross-sectional area as that of the appliance flue outlet;

AD J section 2

Table 2 Size of flues in chimneys.

Installation (1)	Minimum flue size
Fireplace with an opening of up to 500 mm × 550 mm	200 mm diameter or rectangular/square flues having the same cross-sectional area and a minimum dimension not less than 175 mm
Fireplace with an opening in excess of 500 mm × 550 mm or a fireplace exposed on two or more sides	See Paragraph 2.7. If rectangular/square flues are used, the minimum dimension should not be less than 200 mm
Closed appliance of up to 20 kW rated output which: (a) burns smokeless or low volatiles fuel (2); or (b) is an appliance which meets the requirements of the Clean Air Act when burning an appropriate bituminous coal (3)	125 mm diameter or rectangular/square flues having the same cross-sectional area and a minimum dimension not less than 100 mm for straight flues or 125 mm for flues with bends or offsets
Other closed appliance of up to 30 kW rated output burning any fuel	150 mm diameter or rectangular/square flues having the same cross-sectional area and a minimum dimension not less than 125 mm
Closed appliance of above 30 kW and up to 50 kW rated output burning any fuel	175 mm diameter or rectangular/square flues having the same cross-sectional area and a minimum dimension not less than 150 mm

Notes:

1. Closed appliances include cookers, stoves, room heaters and boilers.
2. Fuels such as bituminous coal, untreated wood or compressed paper are not smokeless or low-volatile fuels.
3. These appliances are known as 'exempted fireplaces'.

- not be smaller than the size recommended by the appliance manufacturer; and
- where a multi-fuel appliance is installed, be sized to accommodate burning the fuel that requires the largest flue.

Table 2 should used in conjunction with the following notes:

- A fireplace with an opening larger than 500 mm × 550 mm should be provided with a flue with a cross-sectional area equal to 15% of the total face area of the fireplace opening.
- Specialist advice should be sought when proposing to construct flues having an area of:
  (a) more than 15% of the total face area of the fireplace openings; or
  (b) more than 120,000 mm^2 (0.12 m^2).
- Where a fireplace is exposed on two or more sides, the area of the opening should be calculated from the formula

$$\text{Fireplace opening area}\left(\text{mm}^2\right) = L \times H,$$

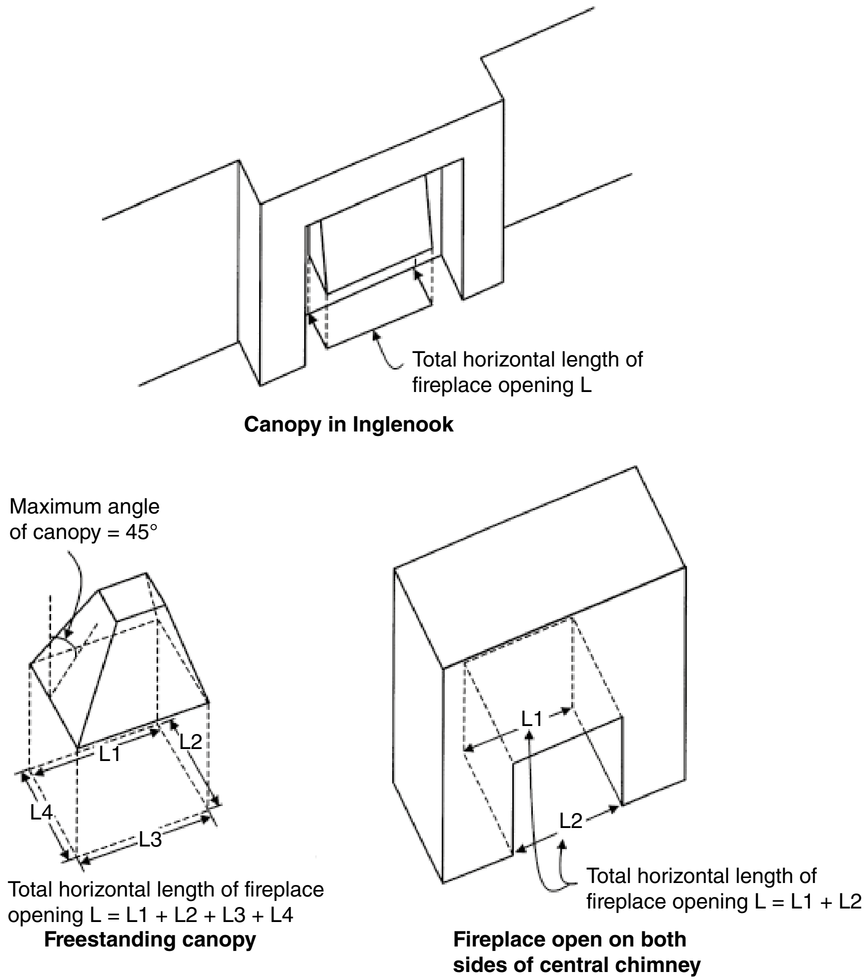


Fig. 14.8 Calculating fireplace opening.

where

L, total horizontal length of fireplace opening in mm; and
H, height of fireplace opening in mm
For examples, see Fig. 14.8.

Outlets of flues for appliances burning solid fuel

Flue outlets should be located above the roof of the building where, whatever the wind conditions, the products of combustion can discharge freely and will not present a fire hazard.

Where wind exposure, surrounding tall buildings, high trees or high ground could have adverse effects on flue draught, these chimney heights and/or separations may need to be increased.

The outlet of any flue should be at least:

- 1 m measured vertically above the highest point of contact between the flue and the roof; and
- 2.3 m measured horizontally from the roof surface; or
- At least as high as the ridge;
- 1 m above the top of any openable part of a dormer window, roof light, or similar opening which is in a roof or external wall and is not more than 2.3 m horizontally from the top of the flue; and
- 600 mm above any part of an adjoining building which is within 2.3 m horizontally of the top of the flue.

Additionally, if the flue passes through the roof within 600 mm of the ridge and both slopes are at 10° or more to the horizontal, the top of the flue should be not less than 600 mm above the ridge (see Fig. 14.9).

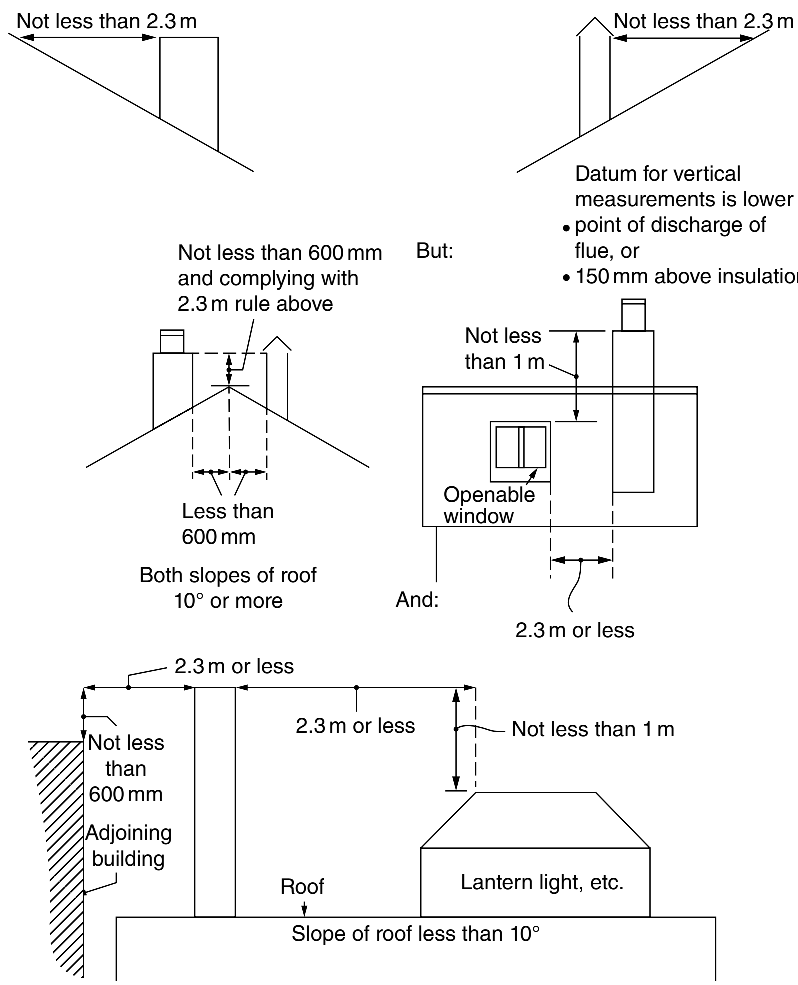


Fig. 14.9 Flue outlets – appliances burning solid fuel.

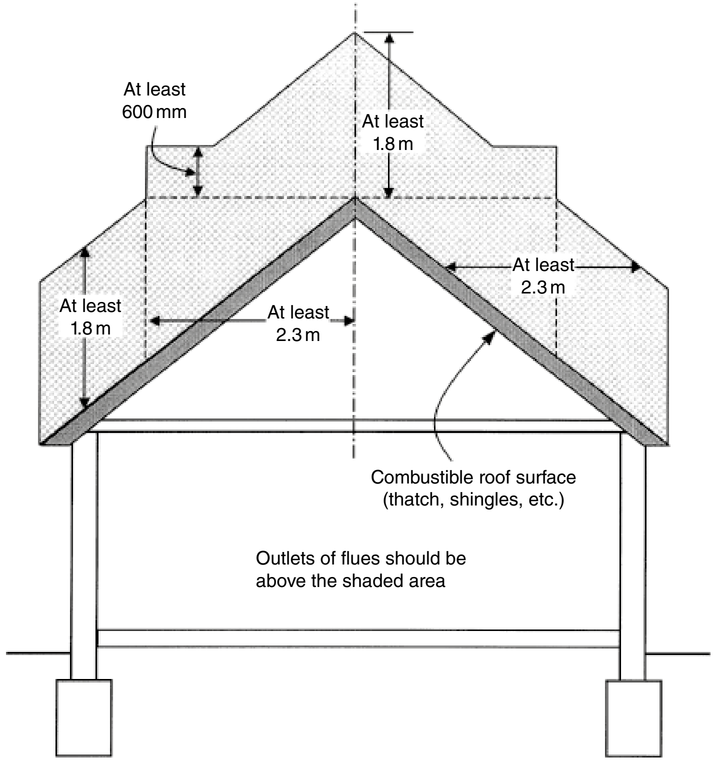


Fig. 14.10 Flue outlets from solid fuel appliances above easily ignitable roof surfaces.

Where flues discharge on or close to roofs with readily ignitable surfaces (e.g. roofs covered in thatch or shingles), the clearances shown in Fig. 14.9 might be insufficient to avoid a fire hazard. In such cases the outlet of any flue should be:

- at least 2.3 m measured horizontally from, and at least 1.8 m above, the roof surface; or
- at least 600 mm above the ridge and at least 1800 mm vertically above the roof surface.

Figure 14.10 gives details of these clearances.

Heights of flues for appliances burning solid fuel

The height of flue needed to ensure that sufficient draught is provided to clear the products of combustion will depend on:

- the type of the appliance;
- the height of the building;
- the type of flue and the number of bends in it; and
- a careful assessment of local wind patterns.

It is possible that a flue height of 4.5 m could be satisfactory if the guidance on the position of flue outlets in sections 14.6.2 and 14.6.5 is followed.

Alternatively, the calculation procedure shown in BS EN 13384-1:2005 *Chimneys – Thermal and fluid dynamic calculation methods – Chimneys serving one appliance* can be used to decide whether or not a chimney design will provide sufficient draught.

When serving an open fire, the flue height is measured vertically from the highest point at which air can enter the fireplace (e.g. the top of the fireplace opening or, for a fire under a canopy, the bottom of the canopy) to the level at which the flue discharges into the outside air.

14.6.6 Flues: Specific provisions relating to appliances burning gas

In addition to the general recommendations given above, appliances burning gas with rated inputs up to 70 kW (net) should comply with the following specific recommendations.

Additionally, for new appliances of known type, satisfactory provision for chimneys and flues will be achieved by:

- using factory-made components which have been independently certified (when tested to an appropriate BS EN European chimney standard) as complying with the performance requirements corresponding to the designations given in Table 3.2 from AD J (reproduced); and
- installing these components in accordance with the appliance and component manufacturer's installation instructions and the guidance on location and shielding of flue pipes, connecting flue pipe components, masonry and flue block chimneys and factory-made metal chimneys given in the text below.

AD J section 3

Table 6 Minimum performance designations for chimney and flue pipe components for use with new gas appliances.

Appliance type		**Minimum designation (see Notes)**
Boiler: open flued	Natural draught	T250 N2 D 1 O
	Fanned draught	T250 P2 D 1 O
	Condensing	T140 P2 W 1 O
Boiler: room sealed	Natural draught	T250 N2 D 1 O
	Fanned draught	T250 P2 D 1 O
	Condensing	T140 P2 W 1 O
Gas fire – radiant/convector, ILFE or DFE		T250 N2 D 1 O
Air heater	Natural draught	T250 N2 D 1 O
	Fanned draught	T200 P2 D 1 O
	SE – duct	T250 N2 D 1 O

Notes:

1. The designation of chimney products is described in section 14.2. The BS EN for the product will specify its full designation and marking requirements.
2. These are default designations. Where appliance manufacturer's installation instructions specify a higher designation, this should be complied with.

Connecting DFE, ILFE and other gas appliances to flues

The building provisions needed to safely accommodate each of the main categories of gas appliance will differ for each type. Provided that the safety of the installation can be assured, it is permissible to install gas fires into fireplaces with flues designed for solid fuel appliances. Certain types of gas fire may also be installed in fireplaces with flues designed specifically for gas appliances. Reference to the Gas Appliances (Safety) Regulations 1995 will show that it is a requirement for particular combinations of appliance, flue box (if required) and flue to be selected from those stated in the manufacturer's instructions as having been shown to be safe by a Notified Body (see section 14.2).

Size of natural draught flues for open-flued appliances burning gas

Flues for gas-fired appliances should:

- be at least the size shown in Table 5 to Approved Document J, where the builder is responsible for providing (or refurbishing) the flue but is not responsible for supplying the appliance;
- for a connecting flue pipe, have the same diameter or equivalent cross-sectional area as that of the appliance flue outlet (the chimney flue should also have the same cross-sectional area as the appliance flue outlet); and
- be sized in accordance with the appliance manufacturer's installation instructions for appliances that are CE marked as complying with the Gas Appliances (Safety) Regulations.

AD J section 3

Table 5 Size of flues for gas-fired appliances.

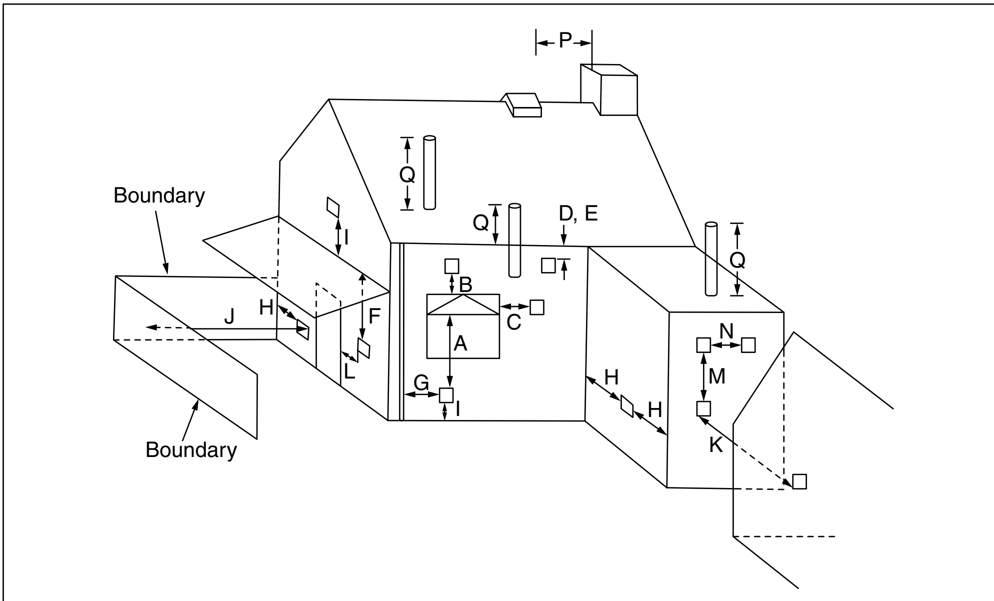
Intended installation	Minimum flue size	
Radiant/convector gas fire	New flue:	
	Circular	125 mm diameter
	Rectangular	16,500 mm² cross-sectional area with a minimum dimension of 90 mm
	Existing flue:	
	Circular	125 mm diameter
	Rectangular	12,000 mm² cross-sectional area with a minimum dimension of 63 mm
ILFE fire or DFE fire within a fireplace opening up to 500 mm × 550 mm	Circular or rectangular	Minimum flue dimension of 175 mm
DFE fire installed in a fireplace with an opening in excess of 500 mm × 550 mm	Calculate in accordance with Fig. 14.8 and the notes referring to similar-sized openings for appliances burning solid fuel in section 14.6.5	

Outlets of flues for appliances burning gas

Flue outlets should be located externally so as to permit dispersal of the products of combustion and, for balanced flues, the intake of air. Suitable positions for outlets for both balanced and open-flued appliances are shown in Diagram 34. Minimum separation distances of outlets from various elements of buildings are given in the *Table to Diagram 34*. Both Diagram 34 and its accompanying table are reproduced below. It should be noted that Diagram 34 and its table are substantially the same as Figure C.8 and Table C.1 from BS 5440 Part 1:2008 *flueing and ventilation for gas appliances of rated input not exceeding 7 kW net (1st, 2nd and 3rd family gases) – Specification for installation and maintenance of flues.*

AD J section 3

Diagram 34 Location of outlets from flues serving gas appliances.



AD J section 3

Table to Diagram 34 Location of outlets from flues serving gas appliances.

Minimum separation distances for terminals in mm						
		Balanced flue			**Open flue**	
Location		**Natural draught**		**Fanned draught**	**Natural draught**	**Fanned draught**
A	Below an opening (1)	Appliance rated heat input (net)		300	(3)	300
		0–7 kW	300			
		>7–14 kW	600			
		>14–32 kW	1500			
		>32 kW	2000			

Table to Diagram 34 (*Continued*)

Minimum separation distances for terminals in mm						
		Balanced flue			Open flue	
Location		Natural draught		Fanned draught	Natural draught	Fanned draught
B	Above an opening (1)	0–32 kW	300	300	(3)	300
		>32 kW	600			
C	Horizontally to an opening (1)	0–7 kW	300	300	(3)	300
		>7–14 kW	400			
		>14 kW	600			
D	Below gutters, soil pipes or drain pipes	300		75	(3)	75
E	Below eaves	300		200	(3)	200
F	Below balcony or car port roof	600		00	(3)	200
G	From a vertical drain pipe or soil pipe	300		150 (4)	(3)	150
H	From an internal or external corner or to a boundary alongside the terminal (2)	600		300	(3)	200
I	Above ground, roof or balcony level	300		300	(3)	300
J	From a surface or a boundary facing the terminal (2)	600		600	(3)	600
K	From a terminal facing the terminal	600		1200	(3)	1200
L	From an opening in the car port into the building	1200		1200	(3)	1200
M	Vertically from a terminal on the same wall	1200		1500	(3)	1500
N	Horizontally from a terminal on the same wall	300		300	(3)	300
P	From a structure on the roof	Not applicable		Not applicable	1500 mm if a ridge terminal. For any other terminal, as given in BS 5440-1:2000	N/A
Q	Above the highest point of intersection with the roof	Not applicable		Site in accordance with manufacturer's instructions	Site in accordance with BS 5440-1:2000	150

Notes:

1. An opening here means an openable element, such as an openable window, or a fixed opening, such as an air vent. However, in addition, the outlet should not be nearer than 150 mm (fanned draught) or 300 mm (natural draught) to an opening into the building fabric formed for the purpose of accommodating a built in element, such as a window frame.
2. Boundary as defined in section 4.2. Smaller separations to the boundary may be acceptable for appliances that have been shown to operate safely with such separations from surfaces adjacent to or opposite the flue outlet.
3. Should not be used.
4. This dimension may be reduced to 75 mm for appliances of up to 5 kW input (net).

Where a flue passes through a roof near to a roof window, the point at which the flue passes through the roof should not be nearer to the window than:

- for a flat roof – 600 mm; and
- for a pitched roof – 600 mm if sited adjacent to or above the window and 2000 mm if below the cill of the window.

Where they are at significant risk of blockage, flue outlets should be suitably protected as follows:

- For flues serving natural draught, open-flued appliances consideration should be given to the following:
  (a) Protect with a suitable outlet terminal if the flue is less than 170 mm diameter. Suitable terminals are specified in BS EN 1856-1:2003 and conforming to BS EN 13502:2002.
  (b) For flues of over 170 mm diameter, local conditions should be taken into account when assessing the risk of blockage. This could include the risk of blockage from nesting squirrels or jackdaws in areas where these creatures are prevalent. Protective cages designed for use with solid fuel appliances with mesh sizes between 6 mm and 25 mm could be used, provided that the total free area of the outlet openings in the cage is at least twice the cross-sectional area of the flue.
- Any flue outlet should also be protected with a guard to prevent it being damaged and to protect people who might otherwise come in contact with it.
- Flue outlets in vulnerable positions (e.g. in reach of a balcony, veranda or window or from the ground) should be designed so that the entry of any matter which might restrict the flue is prevented.

Heights of natural draught flues for open-flued appliances burning gas

The height of flue needed to ensure that sufficient draught is provided to clear the products of combustion will depend on:

- the type of the appliance;
- the height of the building;
- the type of flue and the number of bends in it; and
- a careful assessment of local wind patterns.

The requirement for sufficient flue height can be met:

- for appliances that are CE marked as complying with the Gas Appliances (Safety) Regulations 1995 by following the appliance manufacturer's installation instructions; and
- for older appliances that are not CE marked (but have manufacturer's installation instructions) by following:
  (a) the guidance in BS 5871 Part 3:2005: *Specification for installation of gas fires, convector heaters, fire/back boilers and decorative fuel effect gas appliances: Decorative*

fuel effect gas appliances of heat input not exceeding 20 kW (2nd and 3rd family gases) for decorative fuel effect fires; or

(b) the calculation procedure BS 5440 Part 1: 2008 for appliances other than decorative fuel effect fires.

Components for connecting flue pipes for appliances burning gas

Suitable components for constructing connecting flue pipes include:

- any components given in section 14.6.2 'Connecting flue pipes';
- sheet metal flue pipes complying with BS EN 1856-2:2004;
- fibre cement pipes as described in BS EN 1857:2003+A1:2008; or
- any other material or component that has been independently certified as suitable for this purpose.

Construction of flue block chimneys for installations burning gas

In addition to the general recommendations for flue block chimneys (see section 14.6.2 'Construction of flue block chimneys'), for gas-fired installations, flue block chimneys:

- should be supported and restrained in accordance with manufacturer's instructions where they are not intended to be bonded into surrounding masonry;
- have sealed joints in accordance with the manufacturer's instructions;
- have bends or offsets formed using factory-made components; and
- may be constructed from factory-made flue block systems (consisting of, for example, straight blocks, lintel blocks, offset blocks, transfer blocks, recess units and jointing materials) complying with:
  (a) BS EN 1858-1:2003 for concrete flue blocks of at least class D2, or
  (b) BS EN 1806:2006 for clay/ceramic flue blocks with a performance class of at least (with a performance class of at least FB4 N2).

14.6.7 Flues: Specific provisions relating to appliances burning oil

In addition to the general recommendations given above, appliances burning oil with rated outputs up to 45 kW should comply with the following specific recommendations.

Size of flues for appliances burning oil

No specific minimum flue sizes are given in the 2010 edition of AD J. This reflects the different types of oil-fired appliances that are available (and their different modes of operation, e.g. pressure jet or vaporising) since they are likely to have different discharge velocities. Therefore, in general, flues should be sized to suit the appliance being installed, so that adequate discharge velocities are achieved to prevent flow reversal problems and excessive flow resistances are avoided.

Oil-fired appliances can be connected to discharge:

- via a connecting flue pipe to a flue in a chimney or flue block chimney; or
- to a balanced flue (or a flue designed to discharge through or adjacent to a wall).

In the first case the connecting flue pipe should be the same size as the appliance flue outlet, and any flue in a chimney should have the same cross-sectional area as the appliance flue outlet. If the make and model of the appliance are known when the chimney (or flue block chimney) is being designed and built, then the flue can be made the same size as the appliance flue outlet. Otherwise, the flue can be made large enough to allow the later insertion of a suitable flexible flue liner matching the appliance to be installed.

In all cases, the flue size should always be provided to suit the appliance manufacturers' installation instructions.

Outlets of flues for appliances burning oil

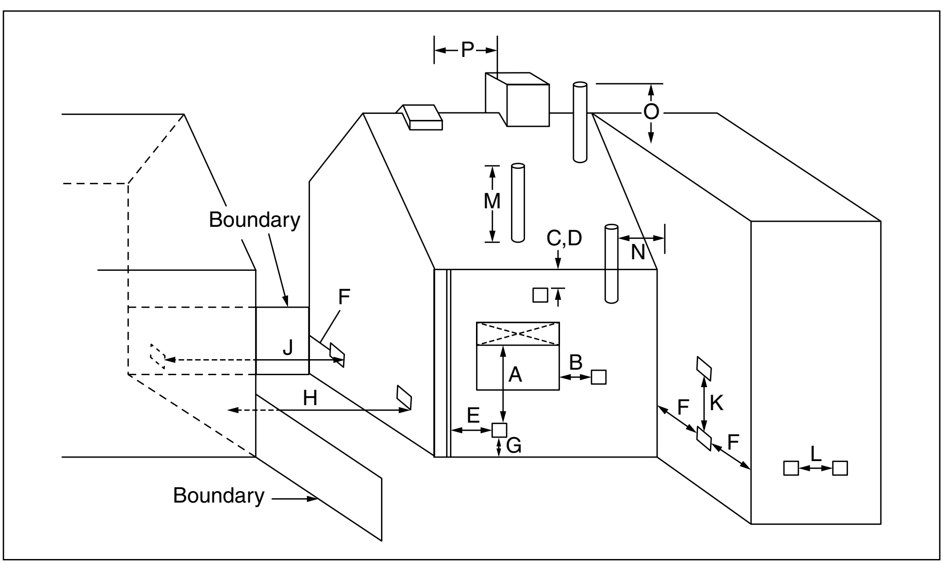
Flue outlets should be located externally so as to permit:

- dispersal of the products of combustion;
- correct operation of a natural draught flue; and
- for balanced flues, the intake of air.

Suitable positions for outlets for both balanced and open-flued appliances are shown in Diagram 41. Minimum separation distances of outlets from various elements of buildings are given in the Table to Diagram 41. Both Diagram 41 and its accompanying table are reproduced below.

AD J section 4

Diagram 41 Location of outlets from flues serving oil-fired appliances.



AD J section 4

Table to Diagram 41 Location of outlets from flues serving oil-fired appliances.

Minimum separation distances for terminals in mm			
Location of outlet (1)		**Appliance with pressure jet burner**	**Appliance with vaporising burner**
A	Below an opening (2, 3)	600	Should not be used
B	Horizontally to an opening (2, 3)	600	Should not be used
C	Below a plastic/painted gutter, drainage pipe or eaves if combustible material protected (4)	75	Should not be used
D	Below a balcony or a plastic/painted gutter, drainage pipe or eaves without protection to combustible material	600	Should not be used
E	From vertical sanitary pipework	300	Should not be used
F	From an external or internal corner or from a surface or boundary alongside the terminal	300	Should not be used
G	Above ground or balcony level	300	Should not be used
H	From a surface or boundary facing the terminal	600	Should not be used
J	From a terminal facing the terminal	1200	Should not be used
K	Vertically from a terminal on the same wall	1500	Should not be used
L	Horizontally from a terminal on the same wall	750	Should not be used
M	Above the highest point of an intersection with the roof	600 (6)	1000 (5)
N	From a vertical structure to the side of the terminal	750 (6)	2300
O	Above a vertical structure which is less than 750 mm (pressure jet burner) or 2300 mm (vaporising burner) horizontally from the side of the terminal	600 (6)	1000 (5)
P	From a ridge terminal to a vertical structure on the roof	1500	Should not be used

Notes:

1. Terminals should only be positioned on walls where appliances have been approved for such configurations when tested in accordance with BS EN 303-1:1999 or OFTEC standards OFS A100 or OFS A101.
2. An opening means an openable element, such as an openable window, or a permanent opening, such as a permanently open air vent.
3. Notwithstanding the dimensions above, a terminal should be at least 300 mm from combustible material, e.g. a window frame.
4. A way of providing protection of combustible material would be to fit a heat shield at least 750 mm wide.
5. Where a terminal is used with a vaporising burner, the terminal should be at least 2300 mm horizontally from the roof.
6. Outlets for vertical balanced flues in locations M, N and O should be in accordance with manufacturer's instructions.

The minimum separation distances given in Table to Diagram 41 may need to be increased where:

- local factors, such as wind patterns, might disrupt operation of the flue;
- the height of a natural draught flue may be insufficient to disperse the products of combustion from an open-flued appliance; or
- the plume of wet flue products discharging from a condensing boiler might constitute a 'statutory nuisance' for neighbouring properties as set out in the Environmental

Protection Act. Further guidance can be found in the *Guide to condensing boiler installation assessment procedure for dwellings* published by the ODPM April 2005 ISBN 1851127844.

Flue outlets should be protected with guards to prevent them being damaged and to protect people who might otherwise come in contact with them. Flue outlets in vulnerable positions (e.g. in reach of a balcony, veranda or window or from the ground) should be designed so that the entry of any matter which might restrict the flue is prevented.

Appliances burning oil: The effect of flue gas temperatures on the design of chimneys and flue pipes

In order to provide a satisfactory chimney or flue pipe for an oil-fired appliance, it is necessary to establish whether the flue gas temperature is above or below 250°C as measured by a suitable method (e.g. as in *OFTEC Standards A 100 or A 101*).

As a guide to establishing the likely flue gas temperatures for a particular appliance, the following notes may prove useful:

- Since flue gas temperatures depend on the appliance type and its age, older and reused appliances will probably have flue gas temperatures in excess of 250°C.
- Modern appliances bearing the CE Mark (showing compliance with the *Boiler (Efficiency) Regulations 1993*) will usually have flue gas temperatures which do not exceed 250°C.
- Manufacturers of appliances should be able to supply information on flue gas temperatures for individual appliances in their installation instructions.
- The Oil Firing Technical Association for the Petroleum Industry (OFTEC) can be contacted to obtain information on individual appliances at www.oftec.co.uk.

Where information is unobtainable, the flue gas temperature for a particular appliance should be assumed to be greater than 250°C.

Design of flues for oil-fired appliances with flue gas temperatures exceeding 250°C

Where the flue gas temperature exceeds 250°C, a satisfactory design for the flue could be achieved by discharging the appliance:

- via a connecting flue pipe, masonry or flue block chimney designed for use with solid fuel;
- to a suitable factory-made metal chimney designed for flue gas temperatures exceeding 250°C (see section 14.7.3); or
- via other products which have been independently certified as being suitable for this purpose.

Design of flues for oil-fired appliances with flue gas temperatures not exceeding 250°C

Where the flue gas temperature does not exceed 250°C, a satisfactory design for the flue could be achieved:

- for any appliances (new or existing), by following:
  - (a) the guidance for installations where the flue gas temperature exceeds 250°C listed above; and
  - (b) the provisions for location and shielding of flue pipes and connecting flue pipe components, outlined in section 14.7.3; or
- for new appliances of known type, by:
  - (a) using factory-made components which have been independently certified (when tested to an appropriate BS EN European chimney standard) as complying with the performance requirements corresponding to the designations given in Table 8 from AD J (reproduced); and
  - (b) installing these components in accordance with the appliance and component manufacturer's installation instructions and the guidance on location and shielding of flue pipes, connecting flue pipe components, flue block chimneys and factory-made metal chimneys given in section 14.7.3.

AD J section 4

Table 8 Minimum performance designations for chimneys and flue pipe components for use with new oil-fired appliances with flue gas temperature less than 250°C.

Appliance type	Minimum designation	
Condensing boiler (including combination), range cooker, range cooker/boiler with pressure jet burners	T120 N2 W1 O	Class C2 oil (kerosene) liquid biofuel conforming to EN 14213:2003
Condensing boiler (including combination), range cooker, range cooker/boiler with pressure jet burners	T160 N2 W2 O	Class D oil (heating oil)
Non-condensing boiler (including combination), range cooker, range cooker/boiler with pressure jet burners	T250 N2 D1 O	Class 2 oil (kerosene) liquid biofuel conforming to EN 14213:2003
Non-condensing boiler (including combination), range cooker, range cooker/boiler with pressure jet burners	T250 N2 D2 O	Class D oil (heating oil)
Cooker and room heater – with vaporising burner	T160 N2 D1 O	Class C2 oil (kerosene)
Cooker and room heater – with vaporising burner	T160 N2 D2 O	Class D oil (heating oil)

Notes:

1. The designation of chimney products is described in section 14.2. The BS EN for the product will specify its full designation and marking requirements.
2. These are default designations. Where appliance manufacturer's installation instructions specify a higher designation, this should be complied with.
3. Refer to the appliance manufacturer regarding the suitability of the appliance and flue system for use with oil/bio-liquid blends,

Components for connecting flue pipes for appliances burning oil

Suitable components for constructing connecting flue pipes include:

- any components given in section 14.6.2 'Connecting flue pipes';
- sheet metal flue pipes as described in BS EN 1856-2:2004;
- fibre cement pipes as described in BS EN 1857:2003+A1:2008; or
- any other material or component that has been independently certified as suitable for this purpose.

Construction of flue block chimneys for installations burning oil

In addition to the general recommendations for flue block chimneys (see section 14.6.2 'Construction of flue block chimneys'), for oil-fired installations, flue block chimneys:

- should be supported and restrained in accordance with manufacturer's instructions where they are not intended to be bonded into surrounding masonry; and
- may be constructed from factory-made flue block systems (consisting of, for example, straight blocks, lintel blocks, offset blocks, transfer blocks, recess units and jointing materials) complying with:
  (a) BS EN 1858:2003 for concrete flue blocks; or
  (b) BS EN 1806:2006 for clay/ceramic flue blocks with a performance at least equal to the Table 8 of AD J section 4, designations for oil-fired appliances.

14.6.8 Carbon monoxide alarms

Requirement J3 of Part J states that 'where a fixed combustion appliance is provided, appropriate provision having regard to the design and location of the appliance shall be made to detect and give warning of the release of carbon monoxide at levels harmful to persons, Requirement J3 applies only to fixed combustion appliances located in dwellings'.

Although the technical requirement in schedule 1 itself places no limitation on the type of appliance or fuel used, the performance guidance in the approved document limits its application to appliances using solid fuel. Having placed this limitation, it then states that the provision of a detection device can reduce the risk of poisoning from other types of appliance.

A carbon monoxide detector should be placed in the room in which a solid fuel appliance is located. The device and its installation should meet the following specifications.

The device should:

- comply with BS EN 50291:2001;
- be powered by a battery designed to operate for the working life of the alarm;
- incorporate a warning device when the working life has expired;
- as an alternative to being battery powered, be mains powered (BS EN 50291 Type A) with fixed wiring and a sensor failure warning device;
- located on a ceiling >300 mm from any wall and >150 mm from the ceiling; or
- between 1 m and 3 m horizontally from the appliance.

14.7 Requirement J4: Protection of building against fire and heat

Requirement J4 of Part J states that 'combustion appliances and fluepipes shall be so installed and fireplaces and chimneys shall be so constructed and installed as to reduce to a reasonable level the risk of people suffering burns or the building catching fire in consequence of their use'.

In general, this means that the combustion installation must enable normal operation of the appliances without danger being caused through damage to the fabric of the building by heat or fire. Additionally, the combustion installation should undergo inspection and testing to ensure that it is suitable for its intended purpose.

Therefore, there are implications for the design and construction of hearths, fireplaces, chimneys and flues to ensure that they are:

- of sufficient size;
- constructed of suitable materials; and
- suitably isolated from any adjacent combustible materials.

14.7.1 Protection of the building against fire and heat: Appliances burning solid fuel

Hearths for appliances burning solid fuel: General provisions

In most cases constructional hearths should be provided where an appliance burning solid fuel is to be installed. However, where it can be independently certified that the appliance cannot cause the temperature of the hearth to exceed 100°C (and the appliance is not designed to stand in an appliance recess), it is possible to provide a hearth made of non-combustible board/sheet material or tiles at least 12 mm thick.

Constructional hearths should be constructed of solid non-combustible material at least 125 mm thick (including the thickness of any non-combustible floor under the hearth).

Constructional hearths built in connection with a fireplace recess should:

- extend within the recess to the back and jambs of the recess;
- project at least 500 mm in front of the jamb; and
- extend outside the recess to at least 150 mm beyond each side of the opening.

If not built in connection with a fireplace recess, the plan dimensions of the hearth should be such as to accommodate a square of at least 840 mm. See Fig. 14.11 for details.

Hearths for appliances burning solid fuel: Proximity of combustible materials

Hearths are provided to prevent combustion appliances setting fire to the building fabric and furnishings and to limit the risk of people being accidentally burnt.

Therefore, they should be separated from adjacent combustible materials and should be satisfactorily delineated from surrounding floor finishes (carpets, etc.) as follows:

- Combustible material should not be placed under a constructional hearth for a solid fuel appliance within a vertical distance of 250 mm from the upper surface of the hearth, unless there is an airspace of at least 50 mm between the combustible material and the underside of the hearth (see Fig. 14.11).

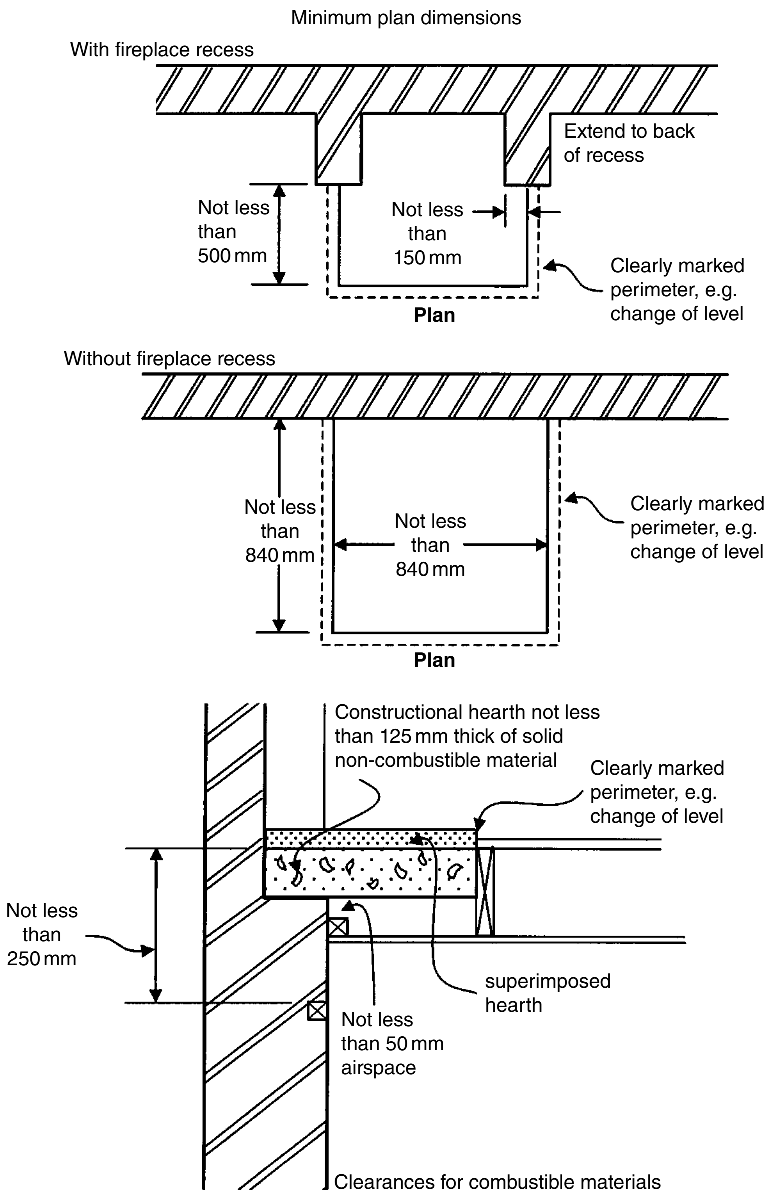


Fig. 14.11 Hearths for appliances burning solid fuel.

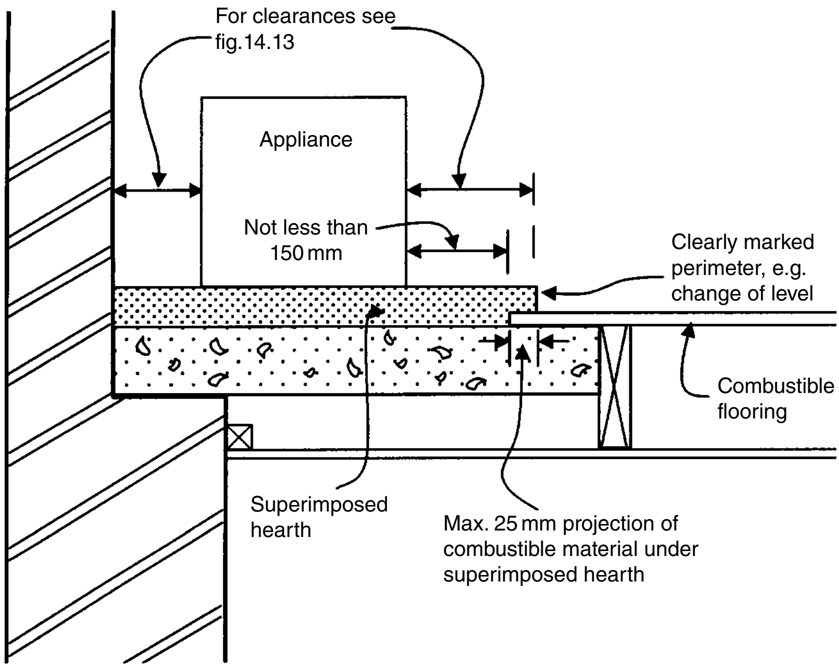


Fig. 14.12 Appliances burning solid fuel – superimposed hearths.

- Where a superimposed hearth has been placed onto a constructional hearth, combustible material placed on or beside the constructional hearth should not extend under the superimposed hearth by more than 25 mm or closer to the appliance than 150 mm (see Fig. 14.12).
- Ensure that the hearth (superimposed or constructional) is suitably delineated to discourage combustible floor finishes from being laid too close to the appliance by marking the edges or providing a change of level.
- Position the appliance on the hearth such that combustible material cannot be laid closer to the base of the appliance than:
  (a) *at the front*, 300 mm if the appliance is an open fire or stove which can, when opened, be operated as an open fire, or 225 mm in any other case; or
  (b) *at the back and sides*, 150 mm or in accordance with the recommendations below which relate to distance from hearth to walls.

If any part of the back or sides of the appliance lies within 150 mm horizontally of the wall, then the wall should be of solid non-combustible construction at least 75 mm thick from floor level to a level of 300 mm above the top of the appliance and 1200 mm above the hearth.

If, however, any part of the back or sides of the appliance lies within 50 mm of the wall, then the wall should be of solid non-combustible construction at least 200 mm thick from floor level to a level of 300 mm above the top of the appliance and 1200 mm above the hearth (see Fig. 14.13). Where the hearth itself is at least 150 mm from an adjacent wall, there is no requirement for protection of the wall. It should be noted that these

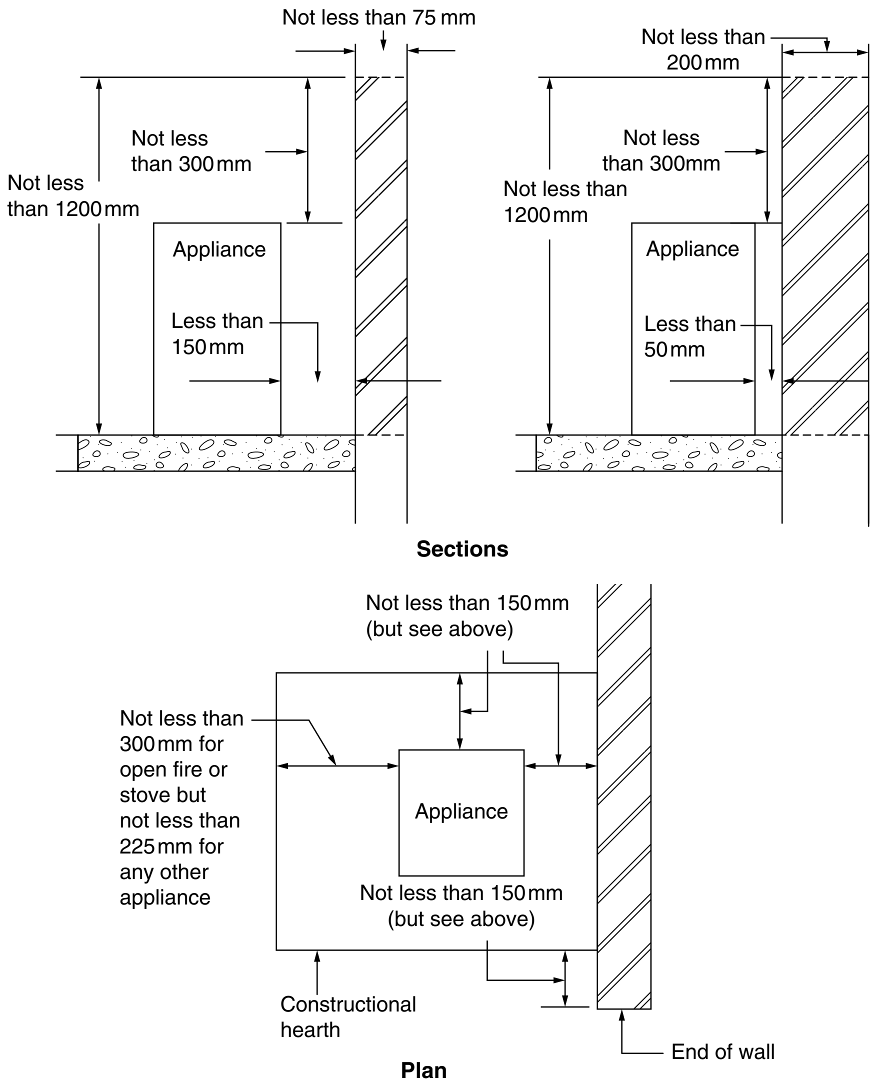


Fig. 14.13 Positioning of appliances burning solid fuel.

thicknesses of solid non-combustible material can be substituted by thinner material if the same overall level of protection can be achieved.

Fireplace recesses for appliances burning solid fuel: General provisions

Fireplace recesses need to be constructed so that they protect the building from the risk of fire. Traditionally, fireplace recesses have been constructed in masonry or concrete, and guidance on these forms is still available in AD J. It is also possible to construct prefabricated factory-made appliance chambers, and the 2010 edition of AD J contains guidance on these.

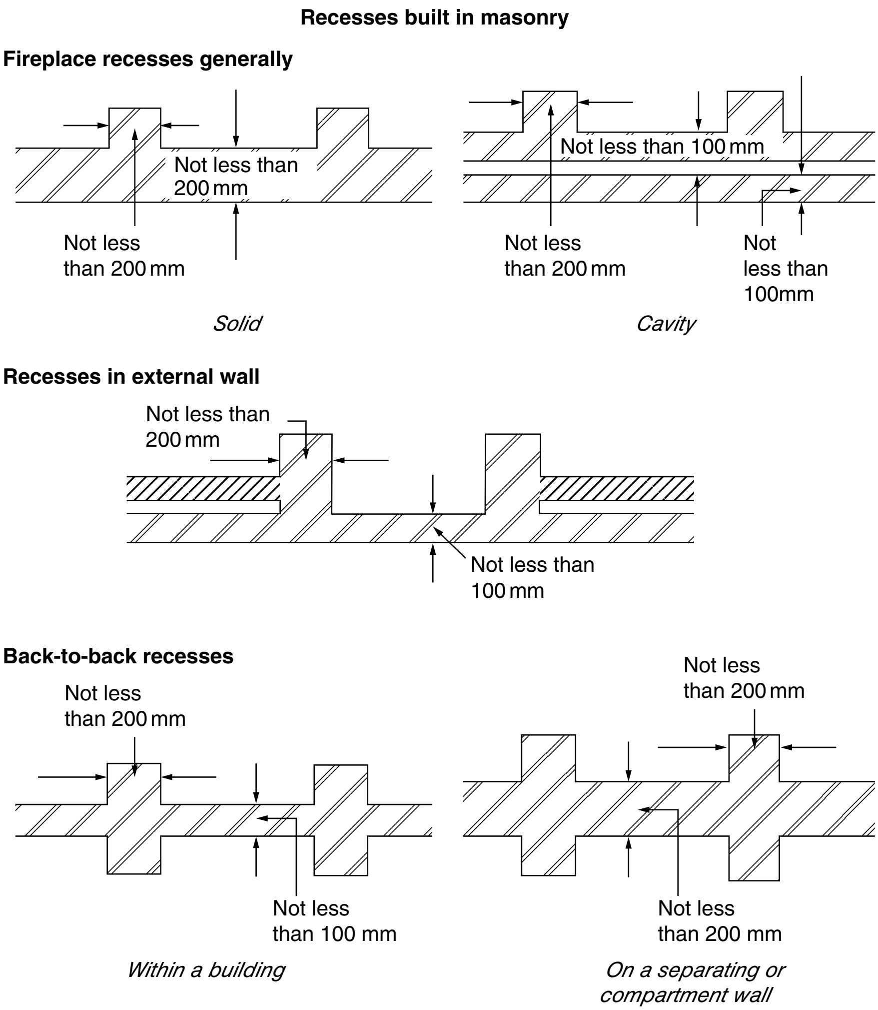


Fig. 14.14 Fireplace recesses – appliances burning solid fuel.

Fireplace recesses constructed in masonry or concrete should have a jamb on each side at least 200 mm thick, a solid back wall at least 200 mm thick or a cavity wall back with each leaf at least 100 mm thick. These thicknesses are to run the full height of the recess. However, if a fireplace recess is in an external wall, the back may be a solid wall of not less than 100 mm thickness. Similarly, if part of a wall acts as the back of two recesses on opposite sides of the wall, it may be a solid wall not less than 100 mm thick. It is assumed that this latter exemption does not apply to a wall separating buildings or dwellings within a building since the requirements for chimney walls (see below) specify a minimum thickness of 200 mm in these circumstances (see Fig. 14.14).

Fireplace recesses constructed from prefabricated factory-made appliance chambers use components made from insulating concrete with a density between 1200 kg/m^2

and 1700 kg/m^2. Table 4 in AD J sets out the minimum thicknesses for the various components of a prefabricated appliance chamber as follows:

- Base – 50 mm;
- Side sections (forming walls on each side if the chamber) – 75 mm;
- Back section (forming the rear of the chamber) – 100 mm; and
- Top slab, lintel or gather (forming the top of the chamber) – 100 mm.

These components should be supplied as a set which must be assembled and jointed in accordance with the manufacturer's instructions.

Fireplace recesses for appliances burning solid fuel: Linings

In most cases a fireplace recess will need to be lined so that it is able to provide an acceptable setting for the installation of an appliance (such as an inset open fire). There are a great many lining components on the market, and one example of a traditional fireplace lining and throat forming lintel is shown in Fig. 14.15. In the example, the tapered gather is formed by a throat forming lintel. Gathers are needed to ensure the proper working of the flue and can be formed in other ways, such as by:

- using a combined prefabricated lintel and gather unit built into the fireplace recess;
- traditional corbelling of the masonry;
- using a prefabricated appliance chamber incorporating the gather; or
- using a suitable canopy (see Fig. 14.8).

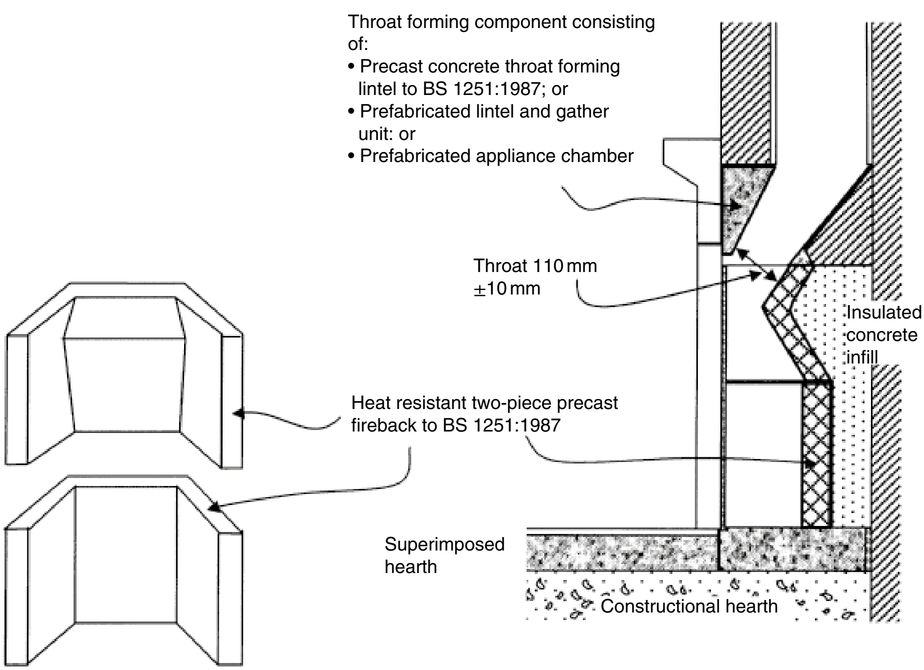


Fig. 14.15 Lining and fireplace components to open fireplace burning solid fuel.

Fireplace recesses for appliances burning solid fuel: Proximity of combustible material

Combustible materials should not be placed where they could be ignited by heat dissipating through the walls of the fireplace recess. This means that combustible material should be at least:

- 200 mm from the *inside* surface of the fireplace recess;
- At least xxmm from a flue product with designated separation distance (Gxx); or
- 40 mm from the *outside* surface (although this does not apply to floorboards, skirting boards, dado and picture rails, mantelshelves and architraves).

Masonry and flue block chimneys for appliances burning solid fuel

A masonry chimney provides structural support to suitably caulked flue liners and flue blocks, and fire protection to the building, by being constructed of bricks, medium-weight concrete blocks or stone set in suitable mortar. The thickness of the masonry will vary with the type of fuel. Therefore, for appliances burning solid fuel, if a chimney is built of masonry and is lined as described above, any flue in that chimney (including a flue composed of flue blocks) should be:

- surrounded and separated from any other flue in that chimney by at least 100 mm thickness of solid masonry material, excluding the thickness of any flue lining material;
- separated by at least 200 mm of solid masonry material from another compartment of the same building, another building or another dwelling; or
- separated by at least 100 mm of solid masonry material from the outside air (see Fig. 14.16).

The minimum chimney thickness and distance to combustibles (xxmm) should be no less than the manufacturers product declaration (Gxx).

Masonry and flue block chimneys for appliances burning solid fuel: Proximity of combustible material

Combustible materials should not be placed where they could be ignited by heat dissipating through the walls of flues. This means that combustible material should be at least:

- 200 mm from the *inside* surface of a flue;
- xxmm from a flue product with designated separation distance (Gxx); or
- 40 mm from the *outside* surface of the chimney (although this does not apply to floorboards, skirting boards, dado and picture rails, mantelshelves and architraves).

No metal fastening in contact with combustible material should be placed within 50 mm of the inside of the flue (see Fig. 14.17).

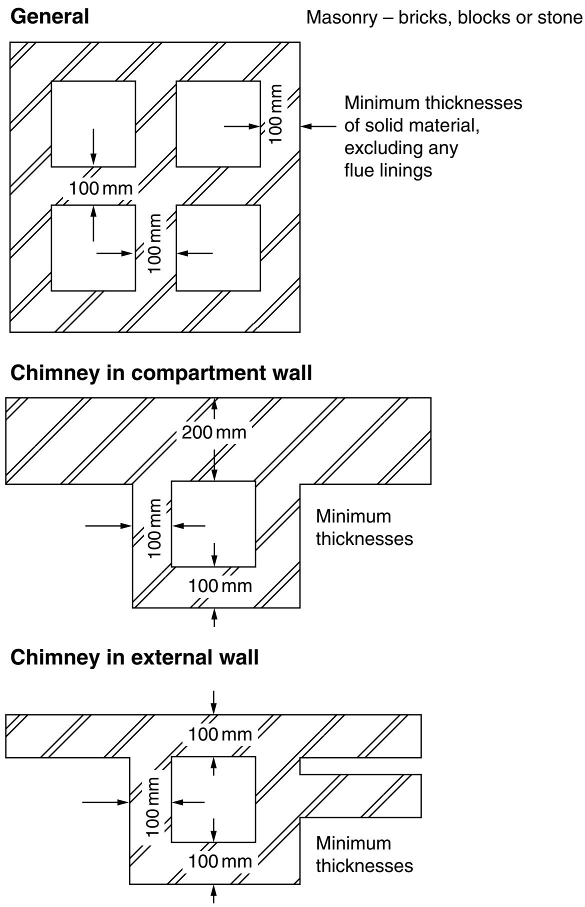


Fig. 14.16 Masonry and flue block chimneys – wall thicknesses.

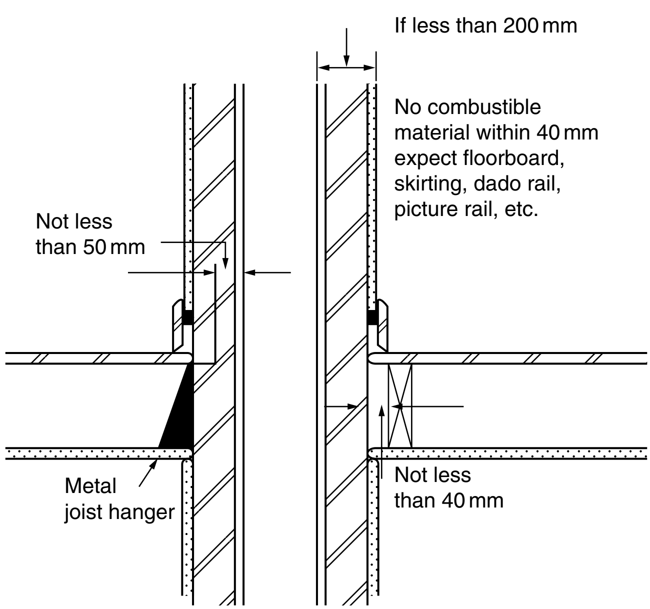


Fig. 14.17 Proximity of combustible materials – appliances burning solid fuel.

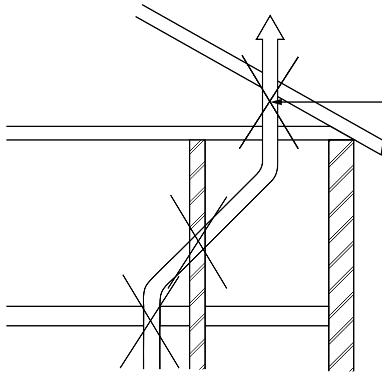


Fig. 14.18 Connecting the flue pipes for appliances burning solid fuel.

Connecting flue pipes serving appliances burning solid fuel

Connecting flue pipes serving appliances burning solid fuel should not pass through any roof space, partition, internal wall or floor, although they are allowed to pass through the wall of a chimney and a floor supporting a chimney, and should only be used to connect an appliance to a chimney (see Fig. 14.18). The obvious intention is that connecting flue pipes should be as short as possible and should only be used to connect an appliance to a proper chimney. They should also be guarded if:

- the burn hazard they present is not immediately apparent to people; or
- they are so sited as to be at risk of damage.

A horizontal connection is permitted to connect a back outlet appliance to a chimney, but this should not exceed 150 mm in length (see Fig. 14.6).

Placing and shielding of connecting flue pipes for appliances burning solid fuel

A connecting flue pipe should be located so that it does not risk igniting combustible material. Horizontal and sloping runs should be limited in length, and where the connecting flue pipe is adjacent to combustible material, the following examples show how the risk could be minimised (see Fig. 14.19):

- By a combination of separation and shielding so that the flue pipe is at least 1.5 times its external diameter from the combustible material and a shield of non-combustible material is placed so that there is an airspace of at least 12 mm between the shield and the combustible material. The non-combustible shield must extend past the flue pipe by at least 1.5 times its external diameter;
- By separation so that the flue pipe is at least 3.0 times its external diameter from the combustible material; or
- By using a factory-made metal chimney whose performance is at least equal to designation T400 N2 D3 G and following the guidance in section 14.6.4.

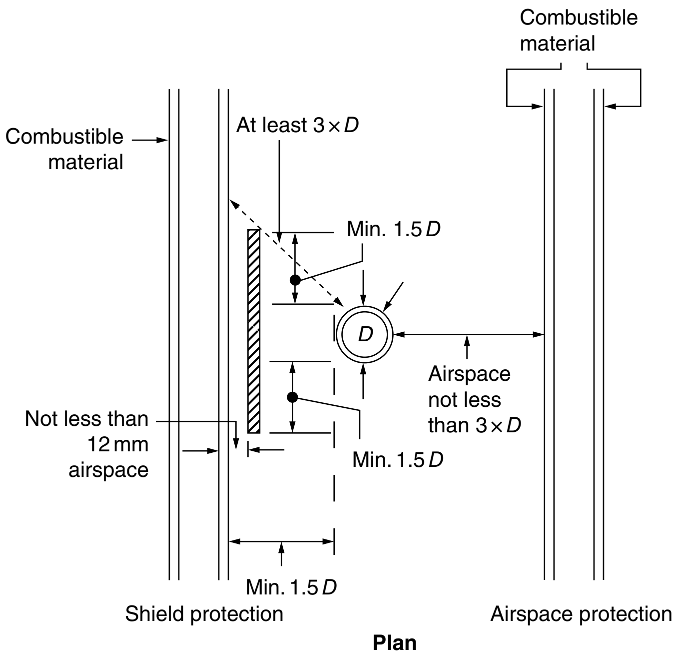


Fig. 14.19 Protection of combustible materials next to uninsulated flue pipes for appliances burning solid fuel.

14.7.2 Protection of the building against fire and heat: Appliances burning gas

Hearths for appliances burning gas

The decision as to the type of hearth to provide, if indeed one is required, will depend on the type of appliance installed. For example, a hearth is not required in the following circumstances:

- If the appliance is installed so that no part of any flame or incandescent material is less than 225 mm above the floor; or
- The manufacturer's instructions state that a hearth is not required.

Where a hearth is required, it should be constructed of solid non-combustible material and meet guidance detailed in Figs 14.20 and 14.21.

For a back boiler behind a gas fire, the hearth should be constructed of solid non-combustible material and meet the following specifications:

- be at least 125 mm thick (i.e. as for solid fuel appliances); or
- be at least 25 mm thick on 25 mm non-combustible supports.

It should extend at least 150 mm beyond the back and sides of the back boiler and extend forwards in front as required for the type of fire fitted (see Fig. 14.20).

The hearth for a decorative fuel effect fire (DFE) or inset live fuel effect fire (ILFE) should consist of a top layer of non-combustible, non-friable material at least 12 mm

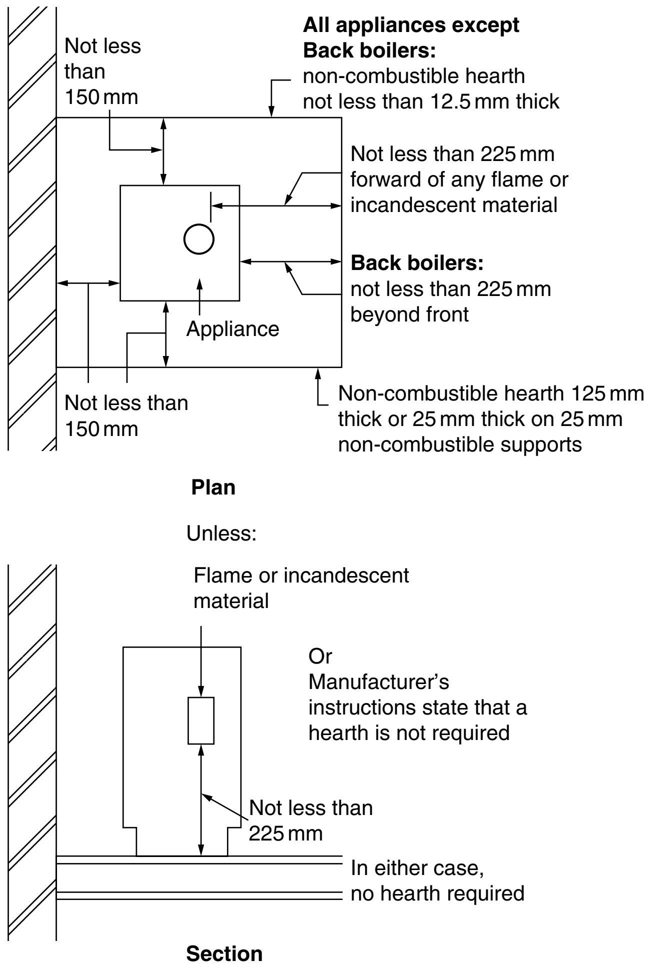


Fig. 14.20 Hearths for appliances burning gas.

thick. The extent of any projections will depend on the type of appliance and whether it is free standing or situated in a fireplace recess (see Fig. 14.21). The edges of the hearth should be designed to be apparent to building occupiers so as to discourage the laying of combustible floor finishes too close to the appliance. This could be achieved by providing a change in levels.

Shielding of appliances burning gas

Gas-fired appliances should be positioned so that the possibility of accidental contact is minimised, and separated from combustible materials as shown in Fig. 14.22 by a non-combustible surface such as:

- a shield of non-combustible material at least 25 mm thick; or
- at least 75 mm airspace.

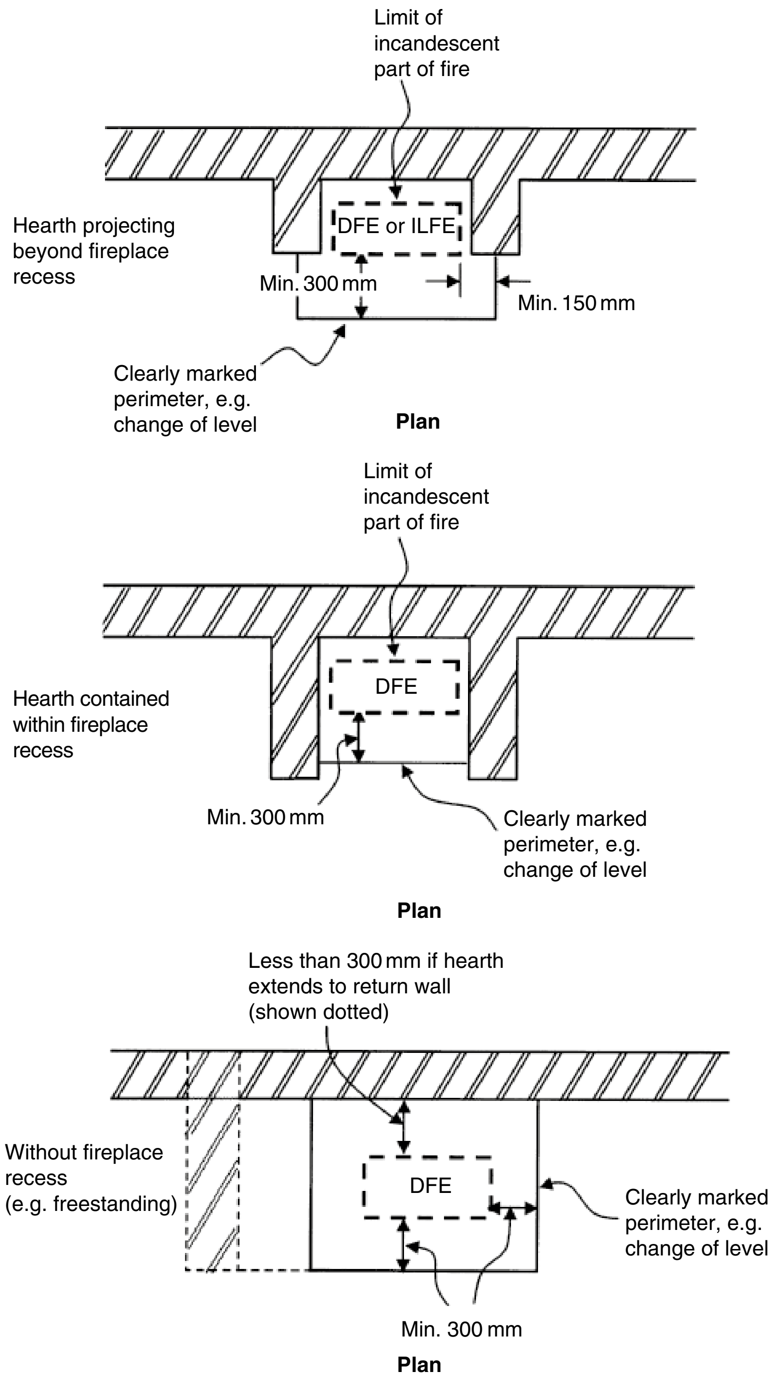


Fig. 14.21 Hearths for decorative fuel effect (DFE) and inset live fuel effect (ILFE) fires burning gas.

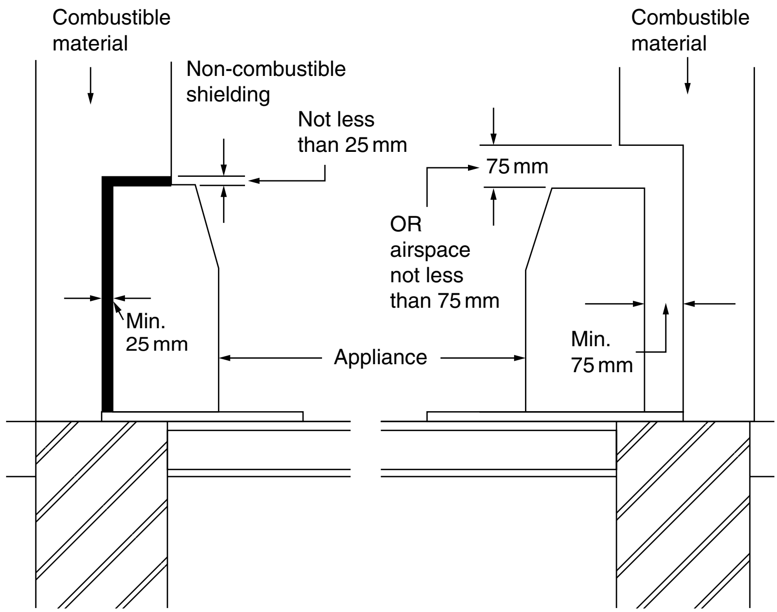


Fig. 14.22 Shielding of appliances burning gas.

Alternatively, for appliances that are CE marked as compliant with the Gas Appliances (Safety) Regulations 1995, the manufacturer's instructions regarding shielding should be followed.

Chimneys for appliances burning gas

Where gas appliances are served by masonry chimneys, there should be at least 25 mm of masonry between the flues and any combustible material. Similarly, where a flue block chimney serves a gas appliance, the flue block walls should be at least 25 mm thick. Where a chimney penetrates a fire compartment wall or floor, it must also comply with the fire separation requirements of Part B (see Chapter 7).

Placing and shielding of flues for appliances burning gas

Connecting flues and factory-made chimneys complying with BS EN 1856-1:2003, serving appliances burning gas should be placed as shown in Fig. 14.23 to ensure the following:

- Every part of the flue is at least 25 mm from any combustible material. The distance is measured from the outer surface of the flue wall, or the outer surface of the inner wall for multiwalled products.
- Where the flue passes through a roof, floor or wall formed of combustible materials (other than a compartment roof, floor or wall), it is enclosed in a sleeve of non-combustible material, and there is at least 25 mm airspace between the flue and the sleeve. The airspace could be wholly or partially filled with non-combustible insulating material.

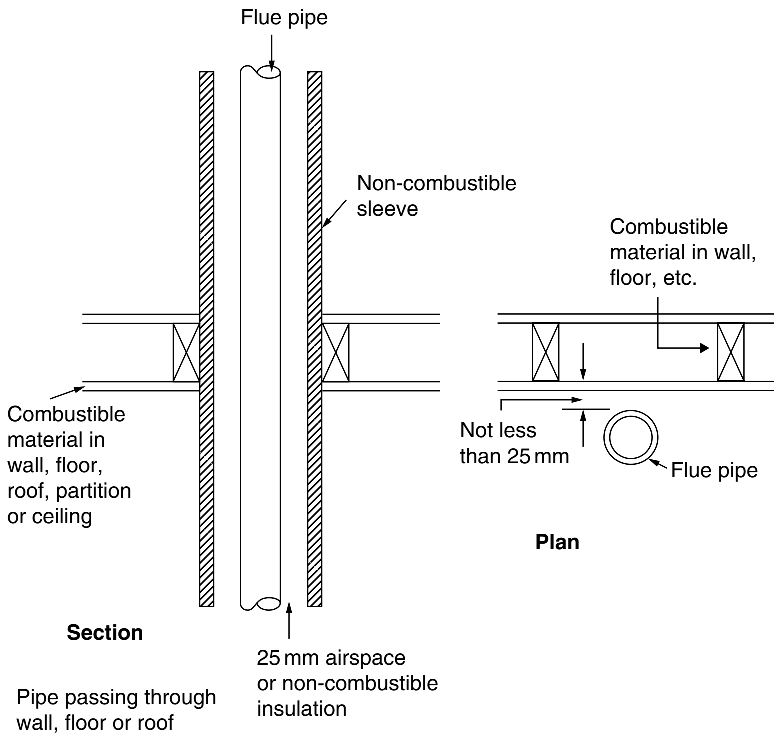


Fig. 14.23 Placing and shielding of flues from combustible materials – appliances burning gas.

Factory-made chimneys complying with BS EN 1856-1:2003 and BS EN 1856-2:2004 should also be separated from combustible materials. This is dealt with in section 14.6.4. Factory-made chimneys and connecting flue pipes should also be guarded if:

- the burn hazard they present is not immediately apparent to people; or
- they are so sited as to be at risk of damage.

14.7.3 Protection of the building against fire and heat: Appliances burning oil

Hearths for appliances burning oil

The basic function of a hearth is to stop the building from catching fire. Where oil is the fuel, it is customary to place a non-combustible tray on top of the hearth to collect any spilled fuel although this is not a health and safety provision.

The decision as to the type of hearth to provide will depend on the temperature reached by the floor below the hearth as a result of the operation of the appliance as follows:

- For hearth temperatures which are unlikely to exceed 100°C (as shown by a suitable test procedure such as that contained in *OFTEC Oil-Fired Appliance Standards OFS*

A 100 and OFS A 101), it is usual to provide a rigid, imperforate, non-absorbent non-combustible sheet (e.g. a steel tray) which can be part of the appliance. No other special measures are necessary.
- Where hearth temperatures could exceed 100°C, the guidance on hearths for appliances burning solid fuel should be followed (see section 14.7.1).

The hearth surface surrounding the appliance should be kept clear of any combustible material by maintaining the following minimum clearances:

- At the back and sides – 150 mm (clear space or distance to a suitably heat resistant wall); and
- At the front:
  (a) 150 mm; or
  (b) 225 mm if the appliance provides space heating by means of visible flames or radiating elements.

The edges of the hearth should be designed to be apparent to building occupiers so as to discourage the laying of combustible floor finishes too close to the appliance. This could be achieved by providing a change in levels.

Shielding of appliances burning oil

Combustible materials adjacent to oil-fired appliances may only need special protection if they are subjected to temperatures which exceed 100°C. In these cases they should be separated from combustible materials by a non-combustible surface such as:
a shield of non-combustible material:

- at least 25 mm thick; or
- at least 75 mm airspace.

Alternatively, shielding would not usually be needed for appliances that are independently certified as having surface temperatures of not more than 100°C during normal operation.

Chimneys and flues for appliances burning oil

Where oil-fired appliances are served by masonry chimneys, there should be at least 25 mm of masonry between the flues and any combustible material. Similarly, where a flue block chimney serves an oil-fired appliance, the flue block walls should be at least 25 mm thick.

Where a chimney penetrates a fire compartment wall or floor, it must also comply with the fire separation requirements of Part B (see Chapter 7).

Flues which are likely to serve appliances burning Class D oil (gas oil) should be made of materials which are resistant to acids of sulphur with minimum designation of D2 for non-condensing appliances and W2 for condensing appliances.

Placing and shielding of flues for appliances burning oil

Where flue gas temperatures are unlikely to exceed 250°C, the building fabric may be protected from heat dissipation from connecting flues and factory-made chimneys complying with BS EN 1856-1:2003, serving appliances burning oil by making sure of the following:

- Every part of the flue is at least 25 mm from any combustible material. The distance is measured from the outer surface of the flue wall, or the outer surface of the inner wall for multiwalled products.
- Where the flue passes through a roof, floor or wall formed of combustible materials (other than a compartment roof, floor or wall), it is enclosed in a sleeve of non-combustible material, and there is at least 25 mm airspace between the flue and the sleeve. The airspace could be wholly or partially filled with non-combustible insulating material.

Factory-made chimneys complying with BS EN 1856-1:2003 and BS EN 1856-2:2004 should also be separated from combustible materials. This is dealt with in section 14.6.4. Factory-made chimneys and connecting flue pipes should also be guarded if:

- the burn hazard they present is not immediately apparent to people (e.g. when they cross intermediate floors which are not visible from the appliance); or
- they are so sited as to be at risk of damage.

Where a flue assembly for a room-sealed appliance passes through a combustible wall, it should be:

- surrounded by insulating material with a thickness of at least 50 mm; and
- provided with a minimum clearance of 50 mm, from any combustible wall cladding to the edge of the flue outlet.

14.8 Repair and reuse of existing flues

14.8.1 Introduction

Until the coming into force of the 2002 version of Part J on 1 April 2002, it was possible to open up disused flues in buildings undergoing refurbishment for the purposes of connecting new appliances without having to comply with the Building Regulations. In many cases this led to the installation of appliances burning inappropriate fuels for the old flue and, of course, the use of flues which were in a poor state of repair. Inevitably this resulted in danger to the health and safety of building occupants from fire and noxious fumes.

14.8.2 Repairs to flues

Under Regulation 3 of the Building Regulations 2010, building work to which Part J imposes requirements constitutes work to a controlled service or fitting. This means that the following types of work must be notified to a Building Control Body and will need to comply with Part J:

- Renovation, refurbishment or repair work involving the provision of a new or replacement flue liner (e.g. the insertion of new linings such as rigid or flexible prefabricated components, or a cast *in situ* liner that significantly alters the flue's internal dimensions); and
- Proposals to bring a flue in an existing chimney back into use or to reuse a flue with a different type or rating of appliance.

The Building Control Body will need to be assured that any altered flues comply with the Regulations. This will involve the inspection and testing of the altered flue by a competent person and is described more fully below.

14.8.3 Relining and repairing existing flues

General provisions

In many older buildings with flues designed for use with open fires, flues are likely to be larger than normal and unlined (or they may originally have been parged with lime mortar which has subsequently deteriorated). Since oversize flues can be unsafe, lining may be necessary in order to reduce the flue area to suit the intended appliance.

It is usually possible to refurbish old or defective flues by relining them using materials and components designed to suit the appliance and/or fuel which it is intended to burn. Before being relined, flues should be swept to remove deposits.

It may be the case that a chimney has been relined in the past using a metal lining system to suit a particular appliance. Where a decision is taken to replace the appliance, the metal liner should also be replaced unless it is in good condition or it can be shown that it has recently been installed and is suitable for the intended use. Details of the lining materials and components that are suitable for the various appliances and fuels are considered below.

Chimneys can be relined using independently certified flexible metal flue liners which have been specifically designed to suit the particular fuel being burnt. Such flue liners should only be used for relining purposes and should not be used as the primary liner of a new chimney.

Relining flues serving appliances burning solid fuel

Liners for existing flues serving appliances burning solid fuel should have an independently certified performance at least equal to that corresponding to the BS EN 1443:2003 designation of T400 N2 D3 G; see definition of 'designation system' in section 14.2.

Examples of liners which comply with this include the following, provided that they are independently certified as being suitable for appliances burning solid fuel:

- Factory-made flue lining systems to BS EN 1856-1:2003 or BS EN 1856-2:2004 (e.g. double-skin flexible stainless steel);

- Cast *in situ* flue relining systems for solid fuel burning appliances to BS EN 1857:2003+A1:2008 (materials and installation procedures must be independently certified as suitable); and
- Any other systems meeting the BS EN 1443 designation and independent certification criteria or described in section 14.6.2.

Relining flues serving appliances burning gas

Liners for existing flues serving appliances burning gas can be:

- any of the liners described in section 14.6.2 as being suitable for all fuels;
- any of the liners described in the section on relining flues serving appliances burning solid fuel immediately above;
- flexible stainless steel liners independently certified as complying with BS EN 1856-1:2003; or
- any other lining systems independently certified as being fit for purpose.

When installing flexible metal flue liners, the following points should be noted:

- Install the liner in one complete length (without joints in the chimney).
- Leave the space between the liner and the chimney empty (other than for sealing at top and bottom) unless the manufacturer's instructions say otherwise.
- Double-skin flexible flue liners should be installed in accordance with manufacturer's instructions.

Relining flues serving appliances burning oil

Liners for existing flues serving appliances burning oil with flue gas temperatures which are expected to exceed 250°C can be:

- any of the liners described in section 14.6.2 as being suitable for all fuels;
- any of the liners described in the section on relining flues serving appliances burning solid fuel immediately above;
- flexible stainless steel liners independently certified as complying with BS EN 1858:2008; or
- any other lining systems independently certified as being fit for purpose.

Liners for existing flues serving appliances burning oil with flue gas temperatures which are unlikely to exceed 250°C can be:

- any of the liners described above for flue gas temperatures exceeding 250°C;
- any other lining systems independently certified as being fit for purpose; or
- for new appliances of known type, flue lining systems which have been independently certified as complying with the performance requirements corresponding to the designations given in Table 8 from AD J (see section 14.6.7).

When installing flexible metal flue liners, the following points should be noted:

- Install the liner in one complete length (without joints in the chimney).
- Leave the space between the liner and the chimney empty (other than for sealing at top and bottom) unless the manufacturer's instructions say otherwise.
- Double-skin flexible flue liners should be installed in accordance with manufacturer's instructions.

14.8.4 Checking and testing refurbished and repaired flues

Reference has been made in section 14.4 regarding the need to inspect and test combustion installations before they are first used. This requirement also applies to flues which have been refurbished or repaired in line with the guidance given in this section. The tests, inspections and report should be done by a specialist firm, and copies should be supplied to the main contractor, client or developer and the Building Control Body.

Guidance on methods of checking and testing for compliance with Requirement J2 (*Discharge of products of combustion*) is given in Appendix E of AD J. The guidance applies to new and existing reused or relined natural draught flues intended for open-flued appliances.

The described procedures cover flues in chimneys, connecting flue pipes, and flue gas passages in appliances to ensure that these are acceptably gas tight and free of obstruction. Furthermore, when an appliance is commissioned to check for compliance with Part L (see Chapter 16) and as required by the Gas Safety (Installation and Use) Regulations 1998, it will also be necessary to carry out appliance performance tests (including flue spillage tests to check for compliance with J2).

It is not necessary to wait for all the building work to be complete before carrying out tests on flues. In fact, the most appropriate time to carry out a test may be before the application of plaster finishes or dry lining to the structure of a chimney, because at such times possible smoke leakage will be unobscured by surface finishes.

14.9 Test methods

14.9.1 Tests on existing flues

Flues in existing chimneys may suffer from the following defects:

- Obstruction caused by bird nests, soot, tar and debris resulting from deterioration of the structure (e.g. pieces of brickwork and chimney pot and decaying flue lining materials);
- Leakage of flue gases as a result of holes or cracks appearing in the structure and linings, particularly at joints; and
- Decay of the exposed part of the chimney above the roof.

The following methods can be used to determine the state of repair of a flue before it is brought back into reuse:

- Sweeping – to clean the flue and show that it is substantially free from obstructions. It will also enable better visual inspection and testing of the flue. Some deposits (such as tar from burning wood) may be especially hard to dislodge and should be removed. Examine the debris that comes down the chimney when sweeping to see if it contains excessive quantities of flue lining or brick. These are signs that further repairs may be necessary.

- Visual inspection of the accessible parts – to identify the following:
  (a) Deterioration in the structure, connections or linings which could affect the gas tightness and safe performance of the flue and its associated combustion appliance. Examine the exterior of the chimney (including the part in the roof space) and the interior of the flue. Look for the presence of smoke or tar stains on the exterior of a chimney breast. These are signs of leaks and could indicate possible damage.
  (b) Modifications made whilst the flue was no longer in service. Look out for the presence of ventilator terminals. These could be incompatible when the flue is used with the intended appliance.
  (c) Correct specification and size of the lining for the proposed new application.
  (d) Freedom from restriction in the flue. A visual inspection may be sufficient where the full length of the flue can be seen. In other cases it may be better to carry out a coring ball test.
- Smoke testing to check the operation and gas tightness of the flue.

14.9.2 Tests on new masonry and flue block chimneys

Flues in new masonry and flue block chimneys should be checked to demonstrate that they have been correctly constructed, are free of restrictions and are acceptably gas tight. The following defects may occur:

- Incorrect installation of flue liners. Checks should be made during construction that liners are installed with sockets facing upwards and joints are sealed so that moisture and condensate will be contained in the chimney.
- Obstructions (particularly at bends), caused by:
  (a) debris left during construction;
  (b) excess mortar falling into the flue; or
  (c) jointing material extruded from between liners and flue blocks.

Before bringing a new flue into use, its condition should be checked as follows:

- Carry out a visual inspection of the accessible parts to check that the lining, liners or flue blocks are correctly specified and of the correct size for the proposed application;
- Carry out a coring ball test or sweep the flue to remove flexible debris if a visual examination cannot confirm that the flue is free from restrictions; or
- Carry out a smoke test to confirm the correct operation and gas tightness of the flue.

14.9.3 Tests on new factory-made metal chimneys

Newly completed factory-made metal chimneys should follow the checklist for visual inspection given in BS EN 15287-1:2007. This covers the following:

- Chimney route – to be in accordance with installation design;
- Openings for testing, cleaning and maintenance – must be accessible;

- Components, joints, connections, locking bands, etc. – to be secure;
- Combustible material – to be at least the manufacturer's specified distance xxmm from the chimney (see section 14.6.4);
- Firestops, firestop spacers and ceiling supports – to be in position;
- Weatherproofing where the chimney penetrates the roof – use only cover flashing and sealing material specified by either the installation designer or the chimney manufacturer;
- Enclosure – to be clear of all rubbish and extraneous matter; and
- Aerials, etc. – not to be attached to the chimney structure.

Additional checks or particular variants may be included in manufacturer's installation instructions. A smoke test should be carried out after the inspection.

14.9.4 Tests on relined flues

Apply the same tests for freedom from restrictions and gas tightness as for newly built flues. A flue for a gas appliance which has been relined with a flexible metal liner (see section 14.8.3) may be assumed to be unobstructed and acceptably gas tight. (The use of a coring ball or inappropriate sweeps brushes can seriously damage a flexible metal flue liner.)

14.9.5 Testing appliances

Where the building work involves the complete installation of combustion appliance and flue system, the entire system should be tested for gas tightness in addition to testing the flue separately as above. Appropriate spillage test procedures for different fuels are given in:

- BS 5440: Part 1: 2008 – gas appliances;
- BS 5410 Part 1: 1997 – oil-fired appliances; and
- BS EN 15287-1:2007 Annex O – solid fuel appliances.

14.9.6 Test procedures for flues

Coring ball test

In this test a heavy ball (about 25 mm less in diameter than the flue) is lowered on a rope from the flue outlet to the bottom of the flue. On encountering any obstruction, the flue should be unblocked and the test repeated. It should be carried out before smoke testing.

The test can be used for:

- proving the minimum diameter of circular flues; and
- checking for obstructions in square flues (but it will not detect obstructions in the corners unless a purpose-made coring ball or plate for rectangular flues is used).

The test is not applicable to flue pipes and, as explained above, should not be used with flexible metal flue liners.

Smoke testing

Smoke tests are carried out in order to check that flue gases can rise freely through the flue and to identify any faults that would cause the flue gases to escape into the building (e.g. incorrectly sealed joints or damage to the flue).

Two types of smoke test are described in Appendix E of AD J. Smoke Test 1 is the most stringent and should be used to test flues serving appliances burning solid fuel or oil, since it tests the gas tightness of the whole flue. It can be used for flues serving appliances burning gas if there is any doubt about the state of the flue. Smoke Test 2 is used exclusively for appliances burning gas and does not involve sealing the flue.

These tests are in addition to any spillage test carried out when the appliance is commissioned. Where an approved flue or relining system is installed, it is possible that other tests could be a requirement of the installation procedure.

Smoke Test 1 is carried out as follows:

- Close all doors and windows in the room served by the flue.
- Warm the flue to establish a draught (e.g. with a blow lamp or electric heater).
- Place and ignite a suitable number of flue testing smoke pellets at the base of the flue (e.g. in the fireplace recess or in the appliance, where fitted).
- When smoke starts to form, seal off the base of the flue or fireplace opening, or close the appliance if fitted, so that smoke can only enter the flue (e.g. close off the recess opening with a board or plate, sealed at the edges or, where an appliance is fitted, close its doors, ashpit covers and vents).
- Establish that there is a free flow of smoke from the flue outlet or terminal.
- Seal the top of the flue.
- Check the entire length of the flue to establish that there is no significant leakage (see also notes below on checking flues for leakage).
- Allow the test to continue for at least five minutes.
- Remove the closures at the top and bottom.

Smoke Test 2 is carried out as follows:

- Close all doors and windows in the room served by the flue.
- Warm the flue to establish a draught (e.g. with a blow lamp or electric heater).
- Place and ignite a suitable flue testing smoke pellet at the base of the flue (e.g. in the fireplace recess or in the intended position of the appliance).
- Partially close off the opening between the recess and the room with a board to leave an air entry gap of about 25 mm at the bottom.
- Establish that smoke is issuing freely from the flue outlet or terminal and not to spilling back into the room.
- Check the entire length of the flue to establish that there is no significant leakage inside or outside the building.

Smoke Tests 1 and 2 conform to the recommendations for testing given in BS 5440: Part 1: 2008.

Further guidance on smoke testing of flues

The following notes should read in conjunction with the procedures for smoke testing referred to above:

(1) Flues should be warmed for a minimum of ten minutes in order to establish a draught. Large or cold flues may take longer than this.
(2) Where an appliance is fitted, it should not be under fire at the time of carrying out the test.
(3) When being tested, smoke should only emerge from the flue under test. Smoke issuing from any other flue would indicate leakage between the flues.
(4) If leaks do occur during the test, they may be quite remote from the area of the fault. This may make it difficult to pinpoint the exact location. For example, where a chimney is located on a gable wall, smoke can track down the verge and emerge from under the bargeboard overhang, or it may issue from window reveals where it has penetrated into the cavity of the wall.
(5) Smoke pellets create a significantly higher pressure than that required in the product standards for natural draught chimneys and for flues having a gas-tightness designation of N1 (negative pressure chimney tested at a pressure of 40 Pa). BS EN 1443 permits flues to this designation to have a leakage rate of up to 2 l/s/m^2 of flue wall area. Therefore, when assessing the extent of any smoke leakage seen during the test, the following points should be considered:
   - Wisps of smoke seen on the outside of the chimney or near joints between chimney sections are not necessarily indicative of a fault.
   - Evidence of forceful plumes or large volumes of smoke could indicate a major fault (e.g. an incorrectly made connection or joint or a damaged section of chimney).

   Therefore, evidence of smoke leakage during a test may not necessarily indicate failure, and it can be a matter of expert judgement as to whether this is, in fact, the case. Where leakage is established, it will be necessary to conduct an investigation and carry out any remedial action before repeating the smoke test.

14.10 Requirement J5: Provision of information

It has been shown in the preceding parts of this chapter that safe installation of a combustion appliance depends on making sure that the appliance is compatible with the hearth, fireplace, flue or chimney to which it is connected. It is vital, therefore, that anyone carrying out work to such an installation is aware of its performance capabilities so that an appliance is not connected to an inappropriate flue.

Accordingly, requirement J5 of Part J states that ‘where a hearth, fireplace, flue or chimney is provided or extended, a durable notice containing information on the performance capabilities of the hearth, fireplace, flue or chimney shall be affixed in a suitable place in the building for the purpose of enabling combustion appliances to be safely maintained’.

14.10.1 Notice plates for hearths, fireplaces, chimneys and flues

A robust and indelibly marked notice plate containing information essential to the correct application and use of the combustion installation should be permanently posted up in an unobtrusive but obvious position in the building where any of the following are being provided or extended:

- A hearth and fireplace (including a flue box); and/or
- A flue or chimney (including the provision of a flue as part of the refurbishment work).

A suitable location in the building for the notice plate might be next to the:

- electricity consumer unit;
- chimney or hearth described on the plate; or
- water supply stopcock.

The notice plate should convey the following information:

- Location of the hearth, fireplace (or flue box) or the location of the start of the flue;
- Category of flue and the generic types of appliances that the flue can safely accommodate;
- Type and size of the flue (or liner for relined flues) and the name of the manufacturer; and
- Date of installation.

AD J section 1

Diagram 16 Example notice plate for hearths and flues.

Essential information	**IMPORTANT SAFETY INFORMATION** **This label must not be removed or covered**	
	Property address...	20 *Main Street* *New Town*
	The hearth and chimney installed in the	*lounge*
	are suitable for	*decorative fuel effect gas fire*
	Chimney liner	*double skin stainless steel flexible,* 200 *mm diameter*
	Suitable for condensing appliance	*no*
	Installed on	*date*
Optional additional information	Other information (optional) .... *e.g. installer's name, product trade names, installation and maintenance advice, European chimney product designation, Warnings on performance limitations of imitation elements e.g. false hearths*	*Designation of stainless steel liner stated by manufacturer to be T450 N2 S D 3*

An example of a typical notice plate is given in Diagram 16 from section 1 of AD J, which is reproduced below. Where a chimney product has had its performance characteristics assessed in accordance with a European Standard (EN) and it is supplied or marked with a designation as described in section 14.2, this designation may be included on the notice plate at the option the installer.

14.11 Alternative means of compliance

As has been shown in Chapter 2, it is possible to achieve the levels of performance described in the Approved Documents (and which are needed to satisfy the requirements of the Building Regulations) by using other sources of guidance, such as British and European Standards. AD J lists a number of alternative guidance sources according to the fuel being burnt. These are outlined below.

Alternative sources of guidance for appliances burning solid fuel

For appliances burning solid fuel, the requirements of the Regulations will be met if the relevant recommendations of the following publications are adopted:

- BS EN 15287-1:2007: *Design, installation and commissioning of chimneys – Chimneys for non-room-sealed heating appliances*; and
- BS 8303:1994 *Installation of domestic heating and cooking appliances burning solid mineral fuels*: Parts 1 to 3.

Alternative sources of guidance for appliances burning gas

For appliances burning gas, the requirements of the Regulations will be met if the relevant recommendations of the following publications are adopted:

- BS 5440 Part 1: 2008: *Installation and maintenance of flues and ventilation for gas appliances of rated input not exceeding 70 kW net (1st, 2nd and 3rd family gases) – Specification for installation and maintenance of flues;* Part 2: 2009 *Specification for installation and maintenance of ventilation for gas appliances.*
- BS 5546:2000 *Specification for installation of hot water supplies for domestic purposes, using gas-fired appliances of rated input not exceeding 70 kW.*
- BS 5864:1984 *Specification for installation in domestic premises of gas-fired ducted-air heaters of rated input not exceeding 60 kW.*
- BS 5871 Part 1: 2005 *Specification for installation of gas fires, convector heaters, fire/back boilers and decorative fuel effect gas appliances, Gas fires, convector heaters and fire/back boilers and heating stoves (1st, 2nd and 3rd family gases);* Part 2: 2005 *Inset live fuel effect gas fires of heat input not exceeding 15 kW and fire/back boilers (2nd and 3rd family gases);* Part 3: 2005 *Decorative fuel effect gas appliances of heat input not exceeding 20 kW (2nd and 3rd family gases).*
- BS 6172:2004 *Specification for installation of domestic gas cooking appliances (1st, 2nd and 3rd family gases).*

- BS 6173:2001 *Specification for installation of gas-fired catering appliances for use in all types of catering establishments (2nd and 3rd family gases).*
- BS 6798:2009 *Specification for installation of gas-fired boilers of rated input not exceeding 70 kW net.*

Alternative sources of guidance for appliances burning oil

For appliances burning oil, the requirements of the Regulations will be met if the relevant recommendations of the following publication are adopted:

- BS 5410 Part 1: 1997 *Code of practice for oil firing – Installations up to 45 kW output capacity for space heating and hot water supply purposes.*

14.12 Requirement J6: Protection of liquid fuel storage systems

Requirements J6 of Part J state that:

'*Liquid fuel storage systems and the pipes connecting them to combustion appliances shall be so constructed and separated from buildings and the boundary of the premises as to reduce to a reasonable level the risk of the fuel igniting in the event of fire in adjacent buildings or premises.*

This requirement is limited in application to the following:

- "*fixed oil storage tanks with capacities in excess of 90 litres and their connecting pipes; and*
- *fixed liquefied petroleum gas (LPG) storage installations with capacities in excess of 150 litres and associated connecting pipes which are outside the building and serve fixed combustion appliances (including incinerators) in the building*".

14.12.1 Limitations on the Approved Document guidance

It will be noticed that in the above regulatory technical requirement, there are no upper limits set on the size of the liquid fuel storage systems described above and that the requirements apply to all building types and all types of tanks (even those that are buried). However the guidance in AD J is restricted to the following types of installation:

- Oil storage systems with above-ground or semi-buried tanks of up to 3500 litres capacity, used exclusively for heating oil burning:
  (a) Class C2 oil (kerosene); or
  (b) Class D oil (gas oil); and
- LPG storage systems of up to 1.1 tonne capacity comprising one tank standing in the open air, or LPG storage systems consisting of sets of cylinders, under the conditions described below.

For oil storage tanks with capacities exceeding 3500 litres, AD J recommends that advice should be sought from the Fire Authority regarding suitable fire precautions. Further guidance may also be obtained from BS 5410: Part 1: 1997 for oil storage systems and from the UKLPG Code of Practice 1: *Bulk LPG storage at fixed installations* Part 1: 2009 *Design, installation and operation of vessels located above ground* and BS 5482-1:2005.

14.12.2 Protection of oil storage tanks against fire

Oil and LPG fuel storage installations (including the pipework connecting them to combustion appliances in the buildings they serve) should be located and constructed so that they are reasonably protected from fires which may occur in buildings or beyond boundaries. To this end Table 10 from section 5 of AD J (which is reproduced below) contains guidance on measures that can be taken to protect the tank from a fire occurring within the building. Additionally the guidance offered would help to reduce the risk of fuel storage fires igniting buildings although this is thought (in BS 5410) to be unlikely to happen.

In addition to the measures described in Table 10, the following issues should also be addressed:

- To prevent the storage installation becoming overgrown by weeds, ensure that the ground under the tank is hard surfaced with 100 mm concrete or paving slabs at least 42 mm thick extending at least 300 mm beyond the edge of the tank (or the face of the external skin of the tank if it is of the integrally bunded type).
- Ensure that the recommended firewalls are structurally stable and do not pose a danger to people coming near them. Since the Building Regulations do not apply to free-standing walls of this description, other guidance should be sought. The former DCLG has published a guide to the construction of garden walls entitled *Your garden walls: Better to be safe than sorry*. Guidance can be found in this publication relating wall thickness to height.

AD J section 5

Table 5.1 Fire protection for oil storage tanks.

Location of tank	Protection usually satisfactory
Within a building	Locate tanks in a place of special fire hazard which should be directly ventilated to outside. Without prejudice to the need for compliance with all the requirements in Schedule 1, the need to comply with Part B should particularly be taken into account
Less than 1800 mm from any part of a building	(a) Make building walls imperforate (1) within 1800 mm of tanks with at least 30 minutes fire resistance (2) to internal fire and construct eaves within 1800 mm of tanks and extending 300 mm beyond each side of tanks with at least 30 minutes fire resistance to external fire and with non-combustible cladding; or (b) Provide a firewall (3) between the tank and any part of the building within 1800 mm of the tank and construct eaves as in (a). The firewall should extend at least 300 mm higher and wider than the affected parts of the tank
Less than 760 mm from a boundary	Provide a firewall between the tank and the boundary or a boundary wall having at least 30 minutes fire resistance to fire on either side. The firewall or the boundary wall should extend at least 300 mm higher and wider than the top and sides of the tank
At least 1800 mm from the building and at least 760 mm from a boundary	No further provisions necessary

Notes:

1. Excluding small openings such as airbricks.
2. Fire resistance in terms of insulation, integrity and stability.
3. Firewalls are imperforate non-combustible walls or screens, such as masonry walls or steel screens.

A way to protect the oil supply pipework is to install it so that it is resistant to the effects of fire and to fit a proprietary fire valve system. More information on this can be gained by reading sections 8.2 and 8.3 of BS 5410: Part 1: 1997.

14.12.3 Protection of LPG storage installations against fire

Because of the potential hazards presented by liquefied petroleum gas (LPG) installations, they are controlled by legislation enforced by the Health and Safety Executive or its agents. There is a considerable amount of legislation dealing with the safe use of LPG in different branches of industry, and compliance is usually demonstrated by constructing an LPG storage installation in accordance with an appropriate industry Code of Practice, prepared in consultation with the HSE. Therefore, the amount of building work that is needed in order for an installation to comply will depend on:

- the capacity of the installation;
- whether or not tanks are installed above or below ground; and
- the nature of the premises served.

However, by following the guidance in Approved Document J as outlined in this section and the relevant guidance in Approved Document B (see Chapter 7), no further building work will normally be necessary to comply with other legislation if the tank stands in the open air and the installation has a capacity not exceeding 1.1 tonne.

LPG tank location

Since liquefied petroleum gas is heavier than air, the LPG tank should be installed outdoors and not within an open pit or bund which would trap the vapour and not allow it to disperse. In fact, safe dispersal is essential should accidental venting or leakage of the tank occur, and this necessitates adequate separation of the tank from buildings, boundaries and any fixed sources of ignition to reduce the risk of fire spread. Safe separation distances from buildings, boundaries and firewalls are shown in Figs 14.24 and 14.25. It also follows that drains, gullies and cellar hatches should be protected from gas entry if they are within the separation distance shown in the figures.

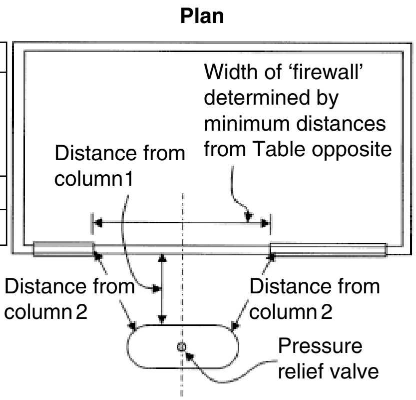
Firewalls

Firewalls can be free-standing walls which separate the tank from the building, the boundary or a fixed source of ignition. They can also be part of the building itself or a boundary wall belonging to the property. All these options are illustrated in Figs 14.24 and 14.25 together with their respective separation distances.

Acceptable firewalls should:

- be imperforate and constructed of masonry, concrete or similar materials;
- have fire resistance in terms of stability, integrity and insulation (see Chapter 7 for details of these concepts) of at least:
  (a) 30 minutes if a free-standing or boundary wall, or
  (b) 60 minutes if part of a building;

Max. capacity of Tank (tonnes)	Minimum separation distance from:	
	Tank to fire wall (metres) (*Column* 1)	Tank to unprotected area (metres) (*Column* 2)
0.25	0.3	2.5
1.1	1.5	3



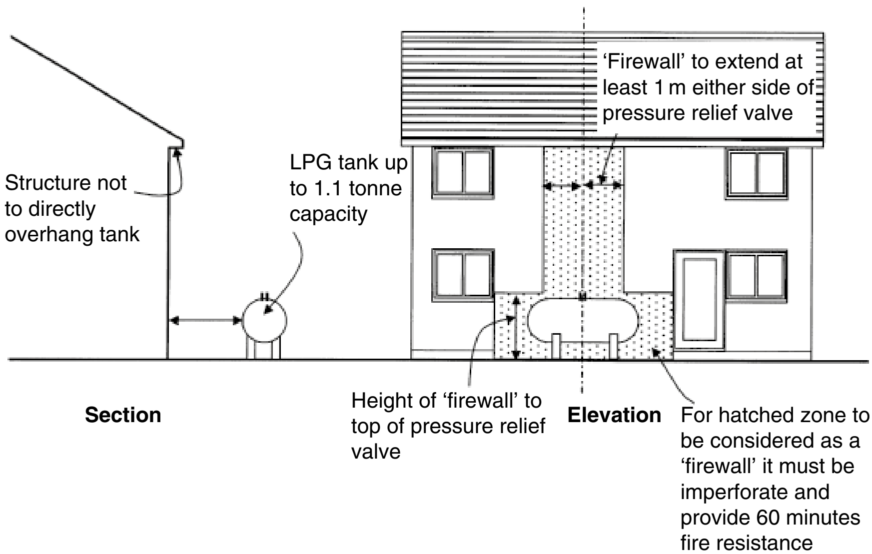


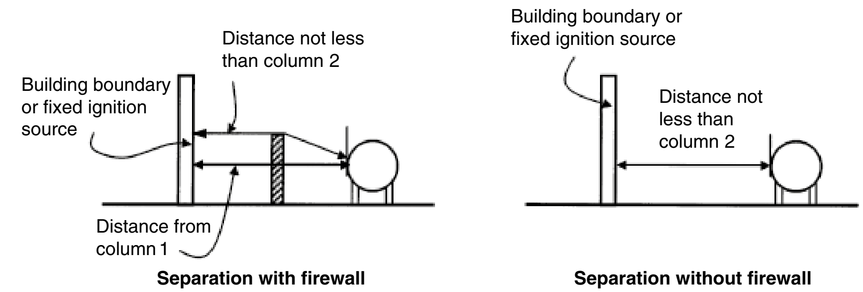
Fig. 14.24 Separation of LPG tank from firewall which is part of a building.

- only be built on one side of a tank (to assist ventilation and dispersal of the gas in the event of a leak);
- be at least as high as the pressure relief valve on the tank; and
- extend horizontally so that the separation shown in Figs 14.24 and 14.25 is maintained.

Sets of cylinders: Location and support

LPG storage installations that consist of sets of cylinders should be adequately supported and sufficiently far enough away from openings into the building to not present a risk to the health and safety of the occupants. In terms of support they should:

- stand upright;
- be readily accessible;
- be reasonably protected from physical damage; and
- not obstruct exit routes from the building.



Max. capacity of Tank (tonnes)	Minimum separation distance from tank to:	
	Building boundary or fixed ignition source not shielded by firewall (metres) (*Column* 1)	Building boundary or fixed ignition source not shielded by firewall (metres) (*Column* 2)
0.25	0.3	2.5
1.1	1.5	3

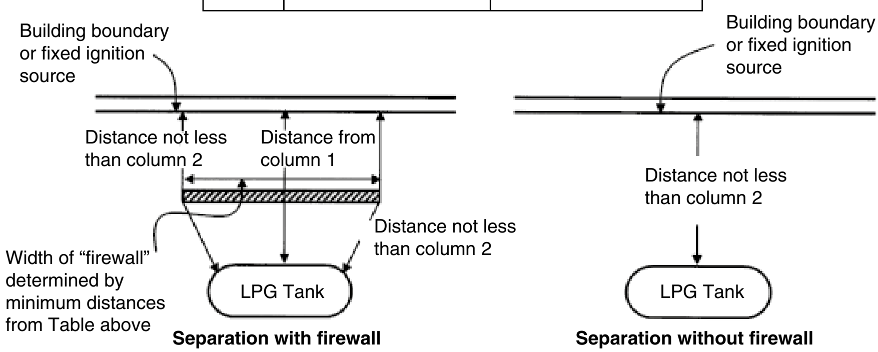


Fig. 14.25 Separation of LPG tank from building boundary or fixed source of ignition with and without firewall.

It is usual to secure the cylinders by means of chains or straps against a wall outside the building at ground level in a well-ventilated position. They should be placed on a firm level base (e.g. concrete at least 50 mm thick or paving slabs bedded in mortar).

In terms of separation distances, these should be sufficient to prevent the entry of gas into the building should venting or a leak occur. Examples of acceptable separation distances include the following from AD J:

- From openings through the wall of the building (doors, windows, airbricks, etc.) and from heat sources such as flue terminals or tumble-dryer vents – at least 1 m horizontally and 300 mm vertically measured from the nearest cylinder valve; or
- From drains without traps, unsealed gullies, cellar hatches and similar entries at ground level – at least 2 m horizontally measured from the nearest cylinder valve, unless an intervening wall is provided at least 250 mm high.

Figure 14.26 shows how sets of cylinders should be located in relation to any doors, windows or other openings into the building.

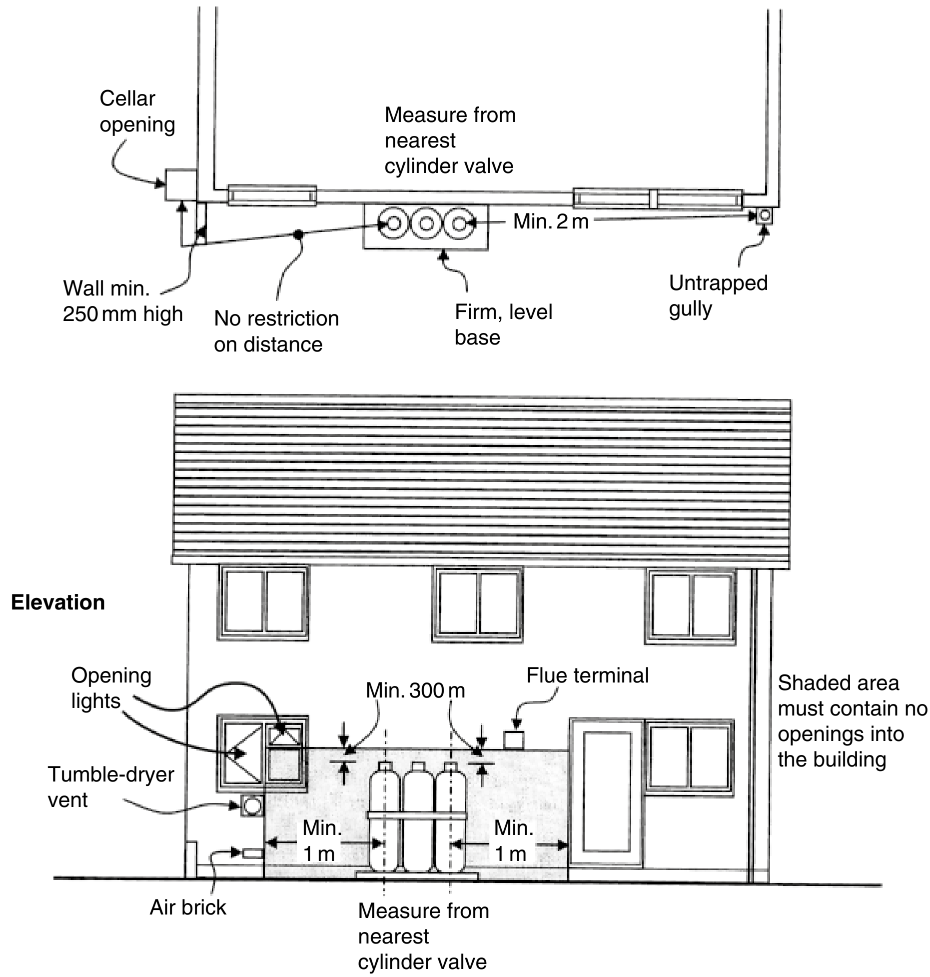


Fig. 14.26 Location and separation of LPG cylinders.

14.13 Requirement J7: Protection against pollution

Requirement J7 of Part J states that:

'*Oil storage tanks and the pipes connecting them to combustion appliances, must:*

- *be constructed and protected so as to reduce to a reasonable level the risk of oil escaping and causing pollution; and*
- *have affixed in a prominent position a durable notice containing information on how to respond to an oil escape so as to reduce to a reasonable level the risk of pollution*'.

This requirement is limited in application to the following:

- *Fixed oil storage tanks with capacities of 3500 litres or less and their connecting pipes which are:*
  (a) *located outside the building; and*

(b) serve fixed combustion appliances (including incinerators) inside a building which is used wholly or mainly as a private dwelling, but does not apply to buried systems.

In addition to requirement J7 of Part J of the Building Regulations, there are controls exercised over storage tanks in England under the provisions of the Control of Pollution (Oil Storage) (England) Regulations 2001 (SI 2001/2954), which came into force on 1 March 2002. These regulations apply to a wide range of oil storage installations, but they do not apply to any premises which are wholly or mainly used as private dwellings where the storage capacity of the oil installation is less than 3500 litres. These regulations are policed by the Environment Agency in the event of any oil pollution.

14.13.1 Provisions to prevent oil pollution

As has been stated above, requirement J7 applies to oil storage tanks with capacities of 3500 litres or less serving combustion appliances in buildings used wholly or mainly as private dwellings. In these circumstances, secondary containment (the provision of bunds, etc.; see below) should be provided where there is considered to be a significant risk of oil pollution. For the purposes of this requirement, there is a significant risk if the oil storage installation:

- has a total capacity exceeding 2500 litres;
- is closer than 10 m from 'inland freshwaters' (see definition below) or coastal waters;
- is located where an open drain or loose fitting manhole cover could be affected by spillage;
- is closer than 50 m from sources of drinkable water (e.g. wells, boreholes or springs);
- is situated where oil spillage from the installation could reach inland freshwaters or coastal waters by running across hard ground;
- is located where tank vent pipe outlets are not visible from the intended filling point (possibly resulting in accidental overfilling of the tank); or
- is located within zone 1 (inner protection zone) of an Environmental Agency Groundwater Source Protection Zone (SPZ).

For the purposes of this requirement, the term INLAND FRESHWATERS means, streams, rivers, reservoirs and lakes and the ditches and ground drainage (including perforated drainage pipes) that run into them.

Secondary containment, when considered necessary, can be provided by means of:

- integrally bunded prefabricated tanks; or
- bunds constructed from masonry or concrete.

General advice on the construction of masonry or concrete bunds can be obtained from the Environment Agency in their publication – Pollution Prevention Guidelines PPG2 – *Above ground oil storage tanks*. They can also supply specific advice for bunds constructed of masonry or concrete in their publications – *Masonry bunds for oil storage tanks and concrete bunds for oil storage tanks*.

When constructing bunds, the following points should also be taken into account:

- They should have a capacity of at least 110% of the largest tank they contain, whether they are part of a prefabricated tank system or constructed on-site.

- Where the walls of a chamber or building enclosing a tank act as a bund for the purposes of this section, any door through such walls should be above bund level.
- Where the bund has a structural role as part of a building, specialist advice should be sought.

Labelling of oil storage installations

A label should be placed on an oil storage installation in a prominent position to advise on what to do in the event of an oil spill. It should contain the Environment Agency's Emergency Hotline telephone number.

Useful addresses

Reference is made throughout this chapter to a number of organisations concerned with various aspects of the design, construction and use of combustion installations and who were involved in the development of the 2002 edition of Approved Document J, either directly or as consultees. Contact details are given in the list below:

ACE (Amalgamated Chimney Engineers): White Acre, Metheringham Fen, Lincoln LN4 3AL
Tel 01526 32 30 09 Fax 01526 32 31 81

BFCMA (British Flue and Chimney Manufacturers Association): Henley Road, Medmenham, Marlow, Bucks SL7 2ER
Tel 01491 57 86 74 Fax 01491 57 50 24
info@feta.co.uk www.feta.co.uk

BRE (Building Research Establishment Ltd): Bucknalls Lane, Garston, Watford, Hertfordshire WD25 9XX
Tel 01923 66 4000 Fax 01923 66 4010
enquiries@bre.co.uk www.bre.co.uk

BSI (British Standards Institution): 389 Chiswick High Road, London W4 4AL
Tel 020 8996 9000 Fax 020 8996 7400
www.bsi-global.com

CIBSE (Chartered Institution of Building Services Engineers): 222 Balham High Road, London SW12 9BS
Tel 020 8675 5211 Fax 020 8675 5449
www.cibse.org

CORGI (The Council for Registered Gas Installers): 1, Elmwood, Chineham Business Park, Crockford Lane, Basingstoke, Hampshire RG24 8WG
Tel 01256 37 22 00 Fax 01256 70 81 44
www.corgi-gas.com

Environment Agency: Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol BS32 4UD Tel 0845 9333111 Fax 01454 624 409
www.environment-agency.gov.uk
(Publication enquiries to: Tel 01454 624 411 Fax 01454 624 014)
Environment Agency Emergency Hotline 0800 80 70 60

HETAS (Heating Equipment Testing and Approval Scheme): PO Box 37, Bishops Cleeve, Gloucestershire, GL52 4TB
Tel 01242 673257 Fax 01242 673463
www.hetas.co.uk

HSE (Health and Safety Executive): Rose Court, 2 Southwark Bridge, London SE1 9HS
Tel 020 7717 6000 Fax 020 7717 6717
www.hse.gov.uk
Gas safety advice line 0800 300 363

IGasE (Institution of Gas Engineers): 21 Portland Place, London W1B 1PY
Tel 020 7636 6603 Fax 020 7636 6602
www.igaseng.com

LP Gas Association: Pavilion 16, Headlands Business Park, Salisbury Road, Ringwood, Hampshire BH24 3PB
Tel 01425 461612 Fax 01425 471131
www.lpga.co.uk

NACE (National Association of Chimney Engineers): PO Box 5666, Belper, Derbyshire, DE56 0YX. Tel 01773 599095 Fax 01773 599195
www.nace.org.uk

NACS (National Association of Chimney Sweeps): Unit 15, Emerald Way, Stone Business Park, Stone, Staffordshire, ST15 0SR
Tel 01785 811732 Fax 01785 811712
nacs@chimneyworks.co.uk
www.chimneyworks.co.uk

NFA (National Fireplace Association): 6th Floor, McLaren Building, 35 Dale End, Birmingham B4 7LN
Tel 0121 200 13 10 Fax 0121 200 13 06
www.fireplace.co.uk

OFTEC (Oil Firing Technical Association for the Petroleum Industry): Century House, 100 High Street, Banstead, Surrey, SM7 2NN
Tel 01737 37 33 11 Fax 01737 37 35 53
enquiries@oftec.org www.oftec.org

SFA (Solid Fuel Association): 7 Swanwick Court, Alfreton, Derbyshire, DE55 7AS
Tel 0800 600 000 Fax 01773 834 351
sfa@solidfuel.co.uk www.solidfuel.co.uk

15 Protection from falling, collision and impact (Part K)

K.T. Bright

15.1 Introduction

Controlling the provision of stairways, ramps and guards has always been an important part of Building Regulations. They play a vital role in enabling easy and safe accessibility for building users and in many situations provide the only exit route in the event of an emergency. Building users also need protection from the risk of falling when using exposed areas such as landings, balconies and accessible roofs.

Changes to the Building Regulations in 2013 extended the Approved Document to Part K (AD K) to incorporate some of the provisions for stairs and ramps previously included in the Approved Document to Part M (AD M 2004). The new AD K (AD K 2013) was also extended to include all of the requirements for manifestation that had previously been shared by AD M and the Approved Document to Part N (AD N). These changes to AD K and AD M in 2013 and a rationalisation of the overlapping guidance covered within them allowed the withdrawal of AD N.

The changes to AD M in 2013 have subsequently been subsumed into the latest version of Part M (2015) and its Approved Document (AD M 2015).

Important Note:
Whilst Scotland and Northern Ireland have had their own Building Regulations for some time, those relating to England and Wales have been linked. As a result of devolution, the power for making Building Regulations in Wales passed to the Welsh government in December 2011. Amendments to the Regulations after that date are relevant only in the country in which the changes have been made.

Therefore the changes made in 2013 to Parts K and M and the withdrawal of Part N and the introduction of Part M 2014 and its Approved Document (AD M 2015) apply only to England. They do not apply to Wales.

Whilst Wales is in the process of reviewing these and other Regulations the versions of Parts K, M and N that are relevant in Wales at the time of publication of this book are those that were in force in England and Wales prior to April 2013.

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

Other changes introduced in AD K 2013 included changes to definitions, the simplification of diagrams and updating of dimensions.

The 2013 amendments mean that Part K now has six main Requirements, with Requirement K5 having four subsections. The Requirements are:

Requirement K1: Stairs, ladders and ramps
Requirement K2: Protection from falling
Requirement K3: Vehicle barriers and loading bays
Requirement K4: Protection against impact
Requirement K5: (1) Protection from collision with open windows, etc.
(2) Manifestation and glazing
(3) Safe opening and closing of windows, etc.
(4) Safe access for cleaning windows, etc.
Requirement K6: Protection against impact from and trapping by doors

15.2 Stairways, ladders and ramps (K1)

Stairways, ladders and ramps which form part of the building must be designed, constructed and installed so that people may move safely between levels within or about the building. Regulation K1 applies to all areas of a building which need to be accessed, including those used only for maintenance.

Stairs, ladders and ramps must provide safe access for people and the acceptable standard of provision required will vary across building types and uses and according to circumstances. For example, buildings accessed by the public are likely to be used by a high number of people who may be unfamiliar with the building. The standard provided will therefore need to be higher than that for dwellings. Lower standards may also be acceptable in situations where those using the stairs, ladders or ramps are also expected to exercise a greater level of care, such as when gaining access for maintenance.

It should be noted that compliance with Regulation K1 prevents action being taken against the occupier of a building under regulation 17 of the Workplace (Health, Safety and Welfare) Regulations 1992 when the building is eventually in use. (Regulation 17 relates specifically to permanent stairs, ladders and ramps on routes used by people in places of work – which includes access to areas used for maintenance.)

15.3 Application

To comply with Requirement K1, it is necessary to ensure the appropriate provision of stairs, ladders and ramps between levels in terms of steepness, rise and going, handrails, headroom, length and width to afford reasonable safety for people gaining access to and moving about buildings.

Outside stairways and ramps are covered by the Regulation if they form part of the building. In most cases, the proximity of the steps to the building and the way they are associated with it (for example, if they are giving direct access to the principal or accessible entrances) will dictate whether or not they are part of the building.

Other steps and ramps on paths leading to the building are not covered by Part K although they may need to comply with other parts of the Building Regulations if:

- they form part of a means of escape in case of fire (Part B: Fire safety – Chapter 7); and
- they are intended for use by disabled people (Part M: Access to and use of buildings – Chapter 17).

In general, normal access routes in assembly buildings such as sports stadia, theatres, cinemas, etc. should follow the guidance in AD K 2013 (see section 15.6.6). For sources of further guidance, see section 15.19.

15.4 Interpretation

Some definitions are given which apply generally throughout AD K 2013 whilst others relate more to the design of specific features and facilities such as the provision of stairs and ramps and general accessibility.

Definitions related to general accessibility are:
ACCESSIBLE ENTRANCE – An entrance which is accessible to people regardless of their disability, age or gender.

CONTRAST VISUALLY – The perception of a visual difference between two elements of a building or fittings within a building so that the difference in Light Reflectance Value is of sufficient points to distinguish between the two elements.

LIGHT REFLECTANCE VALUE (LRV) – The total quantity of visible light reflected by a surface at all wavelengths and directions when illuminated by a light source.

PRINCIPAL ENTRANCE – An entrance which a visitor who is not familiar with the building would normally expect to approach.

Definitions specific to stairs, ramps and ladders are:
ALTERNATING TREAD STAIR – A stair with paddle-shaped treads where the wide portion is on alternate sides on consecutive treads.

COMMON STAIR – A stair serving more than one dwelling.

FLIGHT – A continuous series of steps or a continuous slope (ramp) between landings.

GENERAL ACCESS STAIR – A stair intended for all users of a building on a day-to-day basis, as a normal route between buildings.

GOING – The depth from the front to the back of a tread, less any overlap with the next tread above. For Ramps – the length of the ramps between landings (Fig. 15.1).

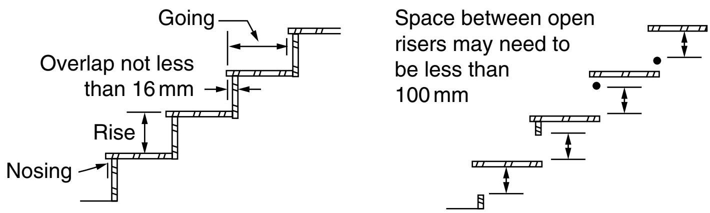


Fig. 15.1 Rise and going.

HANDRAIL – A rail, at hand height or a little higher, for people to hold for support.

HELICAL STAIR – A stair in a helix around a central void.

LADDER – A means of access to another level, formed by a series of rungs or narrow treads. People normally ascend or descend facing the ladder.

NOSING – The leading edge of a stair tread.

PITCH – The angle of inclination (slope) between the horizontal and a line connecting the nosings of a stair.

PRIVATE STAIR – A stair intended to be used for only one dwelling.

RAMP – A slope steeper than 1:20 on which a pedestrian or wheelchair user can move from one level to another.

RISE – The height between consecutive treads. For Ramps – the vertical distance between each end of the ramp flight.

SPIRAL STAIR – A stair in a helix around a curved column.

STAIR WIDTH – The clear width between the walls or balustrades.

TAPERED TREAD – A step in which the going reduces from one side to the other.

UTILITY STAIR – A stair used for escape, access and maintenance, or purposes other than as a usual route for moving between levels on a day-to-day basis.

Other general Definitions are:
BARRIER – A structure that is either a raised rail or a solid wall and which denies access to between areas.

GUARDING – A barrier that denies pedestrians or vehicles access to another area, for example, the floor below.

RADIAL GANGWAY – A gangway at an angle to the rows of seats/wheelchair spaces or a stepped gangway in a tiered seating.

VOMITORY EXITS – Storey exits provided within the body of a seating layout.

15.5 General recommendations for stairways and ramps

15.5.1 Landings

As a general rule, a landing should be provided at the top and bottom of every flight of steps or ramp. Where a stairway or ramp is continuous, part of the floor of the building may count as a landing. The length and width of the landing should not be less than the smallest width of the flight.

Landings should be level and free from permanent obstructions. Placing a child's safety gate between a landing and a flight of steps or ramp would not constitute a permanent obstruction.

For buildings other than dwellings, the landing to a stair or ramp should have an unobstructed length of at least 1200 mm on each landing.

Cupboard and duct doors are permitted to open onto a landing at the **top** of a flight of stairs or ramp providing there is a clear unobstructed area remaining which is at least 400 mm long and extending the full width of the flight or ramp.

This 400 mm rule also applies to any door at the **bottom** of a flight in a dwelling. Doors are not permitted to open onto landings in buildings other than dwellings.

Approved Document B volume 1 – Dwellinghouses and volume 2 – Buildings other than dwellinghouses (AD B) also contain details of restrictions on the use of cupboards situated in means of escape staircases.

A landing formed from permanently firm ground or paving at the top or bottom of an external flight or ramp may slope at a gradient of not more than 1 in 60.

15.5.2 Handrails for stairs and ramps

Handrails can have a major impact on the accessibility and usability of a building. That can be a positive impact if they are appropriately designed, installed and readily identifiable by visual contrasting, and a negative impact if they are not. For many people the provision of appropriate handrails is critical to their safe and independent use of an environment. They should always provide firm support and be easy to grip.

AD K 2013 (K1) states that stairs and ramps in all buildings should be provided with suitable handrails that are continuous on each side of a flight and around landings. They should be located between 900 mm and 1100 mm above the pitch line of the steps, the surface level of the ramp or the floor of the landing. The handrail may be formed by the top of a guarding providing heights can be appropriately matched (see also section 15.9).

AD K 2013 (K1) and AD M 2015 (Chapter 17) also identify several requirements and make detailed recommendations about the provision of handrails to steps and ramps.

In essence, handrails in buildings other than dwellings **should**:

- be provided on at least one side to all ramps and stairs (where the width of the stair or ramp is 1000 mm or more, then a handrail must be provided on both sides);
- extend horizontally at least 300 mm beyond the top and bottom of a ramped or stepped access (the design should ensure that the extension does not project hazardously into a circulation route and the end of the handrail should be designed to minimise the risk catching clothing);
- be placed between 900 mm and 1000 mm above the surface of the ramp or pitch line of the stairs, and between 900 mm and 1100 mm above the surface of any landings (if a second lower handrail is provided, its top should be 600 mm above the surface level or pitch line);
- be easy to grip (the profile of the handrail should be circular or oval; if round, the profile should be between 32 mm and 50 mm, and if oval, the width should be 50 mm wide and 39 mm deep with a 15 mm radius at the corners);
- minimise any risk of hand injury by incorporating a clearance between the handrail and any adjacent supporting wall of between 50 mm and 75 mm (there should also be a clearance of at least 50 mm between the underside of the handrail and any cranked support or supporting wall (for example, when the handrail is provided on top of a parapet wall or guarding)); and
- contrast visually with the background against which they will be viewed.

Handrails **should not** be:

- formed from materials or provided with surface finishes that are highly reflective; and
- formed from materials that become excessively hot or cold to touch if they will be used in locations where exposure to extreme high or low temperatures is possible (in situations where the handrails could be subjected to damage by vandalism or where minimising maintenance is a key factor, metal handrails may be used but they should have a relatively low thermal conductivity).

In a building that contains flats but is not provided with a lift, a general access stair should also be provided. Where a lift is provided, it should be accompanied by a utility stair suitable to meet the needs of people with impaired sight. For both situations, handrails should meet the guidance described above.

For steeply sloping plots where a change of level within the entrance storey of a dwelling may be unavoidable, steps can be provided. If the flight comprises three or more risers, a handrail must be provided on each side of the flight and on any intermediate landings. Handrails are not required in dwellings if the flight of steps comprises less than three risers or where the rise of a ramp is 600 mm or less.

Additional details on handrails can be found in Chapter 17.

15.5.3 Headroom

Clear headroom of 2000 mm should be provided over the whole width of any stairway, ramp or landing. There are reduced dimensions for the headroom over stairs in loft conversions (see section 15.6.7).

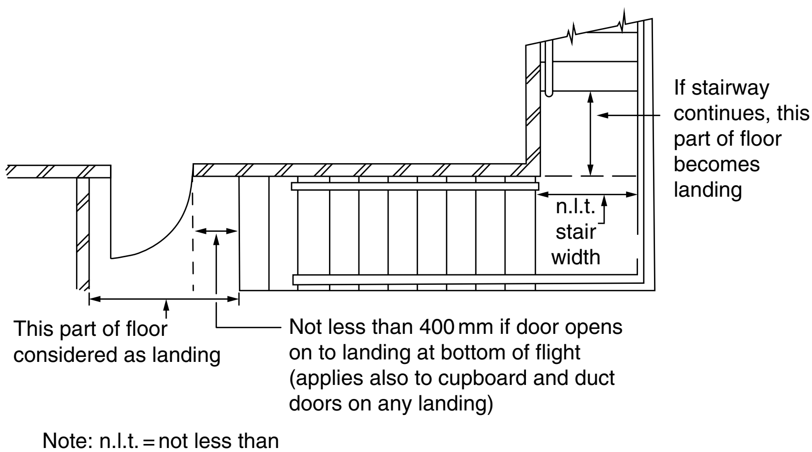


Fig. 15.2 General requirements.

Headroom is measured vertically from the pitch line, or where there is no pitch line, from the top surface of any ramp, floor or landing (see Fig. 15.2).

15.5.4 Width of stairs and ramps

Prior to 2013, minimum width Requirements for stairs and ramps were described in AD M 2004 and AD B.

As a result of the amendments in 2013, the Requirements previously in AD M 2004 (with some minor alterations) are now included in AD K 2013. The Requirements of AD B remain the same.

For buildings other than dwellings, AD K 2013 (K1) identifies that the minimum width of stairs between enclosing walls, strings or upstands should be 1200 mm with a minimum clear width between handrails of 1000 mm. Flights greater than 2000 mm wide should be divided into individual flights at least 1000 mm in width (measured between handrails).

For ramps, AD K 2013 (K1) identifies that any ramp that provides access for people must have a width between walls, upstands or kerbs of at least 1500 mm.

If the stairs and/or ramps form a route for means of escape, then reference should also be made to the minimum width guidance given in AD B (see Chapter 7).

15.6 Stairway construction

15.6.1 Rules applying to all stairways

The general rules are that:

- the rise and going of each step must be consistent throughout the flight;
- all treads must be level;
- the rise of each step must be consistent throughout its length;

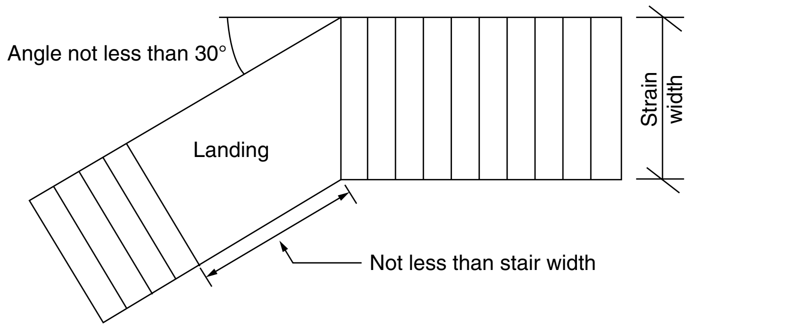


Fig. 15.3 Length of flights.

- individual steps must have an appropriate nosing profile and each nosing must contrast visually with the riser and the tread;
- there should not be more than thirty-six rises in consecutive flights in any stairway, unless there is a change in the direction of travel of at least 30° (see Fig. 15.3); and
- the normal relationship between the rise and the going in any step is that the sum of twice its rise plus its going ($2R+G$) should not be more than 700 mm nor less than 550 mm (this rule is subject to variation at tapered steps, for which there are special rules).

15.6.2 Additional rules applying to individual stair types

In buildings other than dwellings:

- Stairs should not incorporate open risers.
- The visual contrast applied to highlight each nosing should wrap around the nosing and extend for at least 55 mm on both the tread and the riser.
- Wherever possible protruding nosings should be avoided but if provided the maximum protrusion should be 25 mm. The nosing should also be designed to ensure that it does not present a tripping hazard for people using callipers or who experience restricted hip or knee mobility. Examples of how this may be achieved are given in Fig. 17.3.
- To minimise the risk of head collision and injury, if the soffit below a stair or a half landing is less than 2000 mm above floor level, it should be protected with guarding and a low-level tapping rail to assist people using mobility canes, or a barrier designed to meet the requirements of AD K 2013 (K5-1). BS 8300:2009+A1 2010 section 5.7 also has further guidance on the provision of appropriate protection.

For common areas in buildings that contain flats:

- Stairs should not incorporate open risers.
- The visual contrast applied to highlight each nosing should be the full width of the step and wrap around the nosing extending to a width of between 50 mm and 65 mm on the tread and 30 mm and 55 mm on the riser.

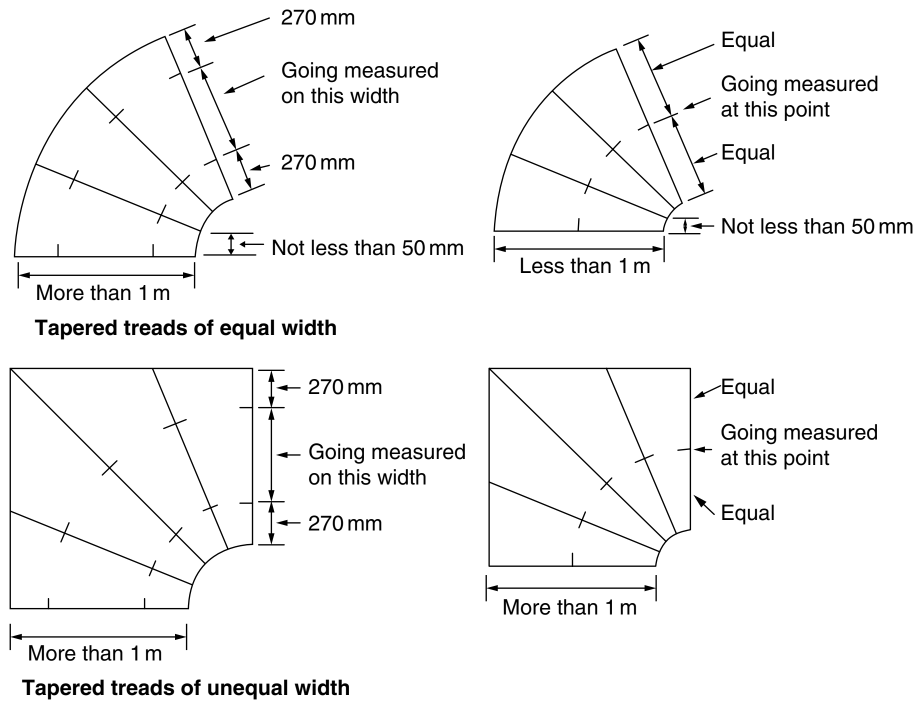


Fig. 15.4 Tapered treads.

- Wherever possible protruding nosings should be avoided but if provided the maximum protrusion should be 25 mm. The nosing should also be designed to ensure that it does not present a tripping hazard for people using callipers or who experience restricted hip or knee mobility. Examples of how this may be achieved are given in Fig. 17.3.

In dwellings:

- Stairs may incorporate open risers as long as the treads overlap by at least 16 mm and the risers are designed and constructed such that a 100 mm diameter sphere cannot pass through any part of the open riser.

Tapered treads should comply with the following rules (see also Fig. 15.4):

- The minimum going at any part of a tread within the width of a stairway is 50 mm.
- The going should be measured:
  - (a) if the stairway is less than 1000 mm wide – at the centre point of the length or deemed length of a tread; and
  - (b) if the width of the stairway is 1000 mm or wider – at points 270 mm from each end of the length or deemed length of a tread (when referring to a set of consecutive tapered treads of different lengths, the term 'deemed length' means the length of the shortest tread; this term is not used in AD K 2013 (K1)).

- All consecutive tapered treads in a flight should have the same taper.
- Where stairs contain straight and tapered treads, the going of the tapered treads should not be less than that of the straight flight.

15.6.3 Rules applying to private stairways

A private stair is one which is intended for use by only one dwelling and there are recommendations in AD K 2013 which control their steepness, rise and going. These are:

- The height of any rise should be between 150 mm and 220 mm.
- The going of any step should generally be between 220 mm and 300 mm (see also the rules relating to tapered treads in section 15.6.2).
- For external steps and stairs to dwellings that form part of the building and which contain tapered treads, the minimum going of each tapered tread should be 280 mm.
- The pitch should not be more than 42°.

15.6.4 Rules applying to 'General Access Stairs'

AD K 2013 identifies a 'General Access Stair' as one which is intended for use on a day-to-day basis by everyone using a building as a normal route between levels. It is therefore a major access route between floor levels and one that is likely to be used on a regular basis by disabled and non-disabled people, either as employees or visitors.

For general access stairs, the following rules apply:

- The height of any rise should be between 150 mm and 170 mm.
- The going to any step should be between 250 mm and 400 mm (but see the rules relating to tapered treads above).
- For a general access stair in school buildings, the preferred rise is 150 mm and the preferred going is 280 mm.
- The maximum number of risers per flight is 12. This may be increased to 16 however in small buildings with a restricted plan area.

15.6.5 Rules applying to 'Utility Stairs'

AD K identifies a 'Utility Stair' as one that is used for escape, access for maintenance or for purposes that are other than as a usual day-to-day route for moving between different levels.

For utility stairs, the following rules apply:

- The height of any rise should be between 150 mm and 190 mm.
- The going to any step should be between 250 mm and 400 mm (but see the rules relating to tapered treads above).
- The maximum number of risers per flight is 16.

15.6.6 Rules for stepped gangways in assembly buildings

In addition to the rules identified above for general access stairs and utility stairs, AD K 2013 also contains general guidance on the provision of stepped gangways in assembly buildings where consideration will need to be given to provide appropriate sight lines and circulation routes for spectators. Such assembly buildings will include sports stadia, theatres and cinemas.

In such situations:

- To maintain sight lines for spectators in assembly buildings, gangways are permitted to be pitched at up to 35°.
- The ends of all rows of seats and wheelchair spaces should be aligned to ensure that the width of the gangway remains constant.
- Stepped tiers within the gangway, if any, should be between a minimum of 100 mm and a maximum 190 mm in height. If there are two or more rises to each row of seats, each step should be of equal height.
- Transverse gangways should be provided within the main body of the seating area to give access from the side to storey exits, known as 'vomitory exits'.
- If an auditorium with tiered seating is provided with both transverse and radial gangways, it is important to ensure that the paths of these do not cross. Any connections between the gangways should be offset to ensure the smooth flow of people towards the exits.
- For a tier that is not interrupted by a cross-gangway and for which the pitch exceeds 25°, the maximum number of steps that can be used is 40.
- For exits that are approached from a stepped gangway, a landing should be provided immediately in front of the exit doors which covers the full width of the exit and is at least 1100 mm deep.
- An appropriately designed and fitted handrail should be provided to all stepped side gangways (see section 15.5.2).
- In stepped tiers the floor surface to the seating section should be level with that of the nearest step.
- For gangways in auditoria designed to be used by less than 50 people, the gangways should be at least 900 mm wide. If designed to be used by more than 50 people, the minimum width should be 1100 mm.

15.6.7 Stairs to loft conversions

When carrying out loft conversions, it is often difficult to incorporate a conventional staircase without also incurring a substantial alteration to the existing structure and a considerable loss of space within both the dwelling and the conversion itself.

AD K 2013 contains a number of recommendations relating to the provision of stairs to a loft conversion which are intended to assist in optimising the use of available space.

Headroom

Where there is insufficient height to achieve the recommended 2 m headroom over a stairway, 1.9 m at the centre of the stair is acceptable reducing to 1.8 m at the side (see Fig. 15.5).

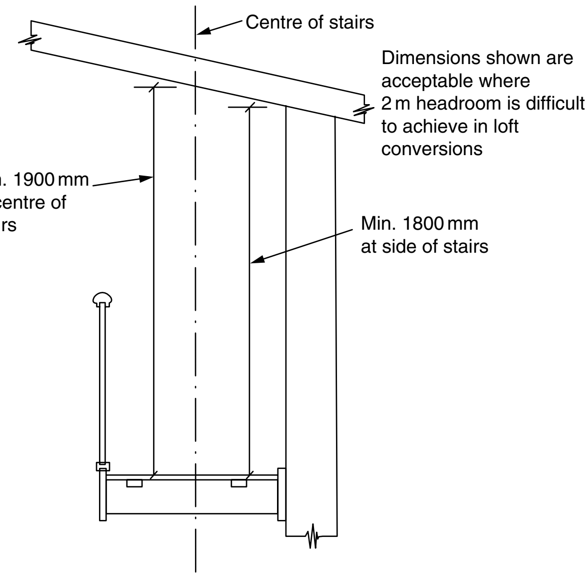


Fig. 15.5 Reduced headroom over stairs – loft conversions.

Ladders

If an existing space has insufficient room available within it to accommodate a conventional staircase, a fixed ladder may be installed as the means of access to a loft conversion if it conforms to the following:

- there are fixed handrails on both sides;
- the ladder serves only one habitable room; and
- retractable ladders are not provided if they may be used as a means of escape in case of fire (see also Chapter 7).

Note: A definition of habitable room is not included in AD K 2013 and definitions vary within Approved Documents. AD M 2014 identifies a habitable room as:

'… a room intended to be used for dwelling purposes. This includes a kitchen but not a utility room or bathroom'.

AD K 2013 offers guidance for the use of 'alternating tread stairs' (see section 'Alternating tread stairs') which states that such stairs should be for:

'… access to only one habitable room and, if desired, a bathroom and or/WC (although this must not be the only WC in the dwelling)'.

This would suggest that in terms of AD K 2013 bathrooms and WCs are not habitable rooms and that it is acceptable for a ladder to be used to access one habitable room and (if provided) an additional bathroom and/or WC.

15.6.8 Spiral and helical stairs

Spiral and helical stairs designed in accordance with BS 5395 *Stairs, ladders and walkways*, Part 2: 1984 *Code of practice for the design of helical and spiral stairs* will satisfy the requirements of AD K 2013.

15.6.9 Alternating tread stairs

Alternating tread stairs caused some controversy when they were first introduced because they do not have treads of uniform width and the staircase is steeper than that of a conventional flight. They also rely on a degree of familiarity on the part of the user since it is necessary to start the ascent or descent using the correct foot.

Alternating tread stairs should only be installed for loft conversion work where insufficient space is available to accommodate a conventional staircase. Where used, they should:

- be a straight flight or a series of straight flights;
- have a minimum clear headroom of 2 m;
- provide access to only one habitable room plus bathroom or WC (provided it is not the only WC in the dwelling);
- be fitted with handrails on both sides;
- have slip-resistant surfaces to the treads;
- have uniform steps with parallel nosings;
- have a minimum going of 220 mm and a maximum rise of 220 mm when measured over the wider part of the tread; and
- be designed and constructed such that a 100 mm diameter sphere cannot pass through any part of the open riser.

A typical design for an alternating tread stair is shown in Fig. 15.6.

15.7 Internal and external ramps which form part of a building

The guidance contained in AD K 2013 covers the provision of internal and external ramps where they are part of the building. AD M 2015 offers guidance for ramps which form part of an external access route from the car parking or boundary of the site or as part of the principal entrance or an alternative accessible entrance.

Many of the design factors that apply to the gradient, length, width, landings, headroom, surface finish, handrails and guarding of ramps covered by AD M 2014 are the same as those that apply to those ramps covered by AD K 2013.

In essence, for buildings other than dwellings to comply with the Requirement of Part K, internal and external ramps that form part of a building should meet the guidance in Chapter 17 (sections 'Ramped provision' and 'Handrails to steps and ramps').

For ramps in dwellings and common areas in buildings that contain flats, AD K 2013 states that handrails:

- should be provided on both sides of ramps more than 1000 mm wide;
- should be provided on one or both sides for ramps that are less than 1000 mm wide; and
- are not a requirement on ramps with a rise of less than 600 mm.

The requirements for the height of the handrails above surface level, firmness, grip and role as guarding are as described in sections 15.5.2, 15.8, 15.11.1 and Chapter 17 (section 'Ramped provision').

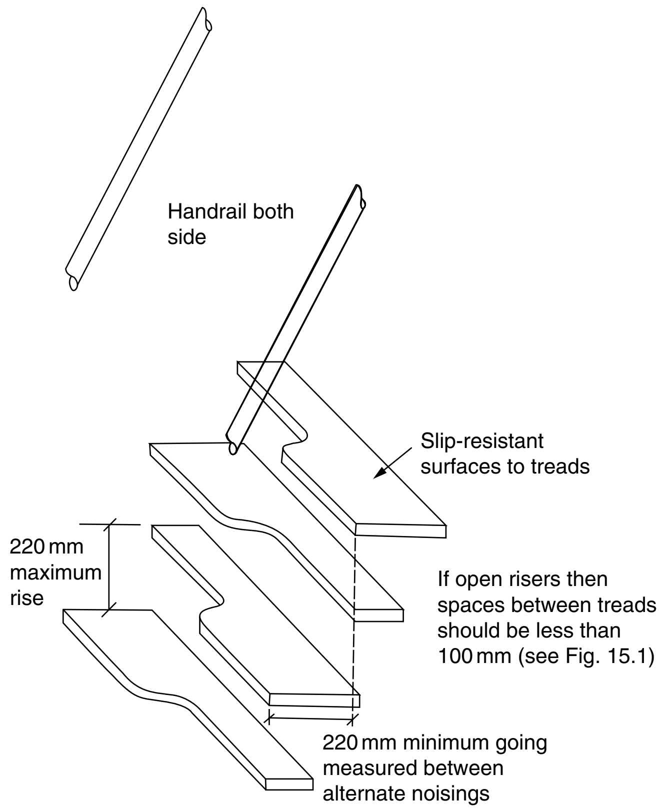


Fig. 15.6 Alternating tread stairs.

15.8 Guarding of stairways, ramps and landings

Guarding should be provided at the sides of every flight, ramp or landing although there are some specific exceptions to this rule (see section 15.9).

The rules which apply to prevent small children from being trapped in open riser staircases also apply to guarding; that is, there should be no opening of such size as to allow the passage of a sphere of 100 mm diameter. This relates to the guarding on any staircase except one that is in a building which is unlikely to be used by children under the age of five years. It may be difficult in certain circumstances to decide where this exemption should apply. For example, some public houses have a policy of not admitting young children whereas others actively encourage the family customer.

The design of guarding should prevent it being easily climbed by small children. This is likely to preclude the use of horizontal 'ranch' style balustrading.

Minimum heights for the guarding to flights, ramps and landings given in AD K 2013 (K2) are illustrated in Fig. 15.7. It should be noted that the guarding should be strong enough to resist at least the horizontal forces given in BS EN 1991-1-1 with its National Index and PD 6688-1-1.

If glazing is to be used as guarding or incorporated within it, it must comply with AD K 2013 (K4), which is described in section 15.12.1. Additional guidance on the design of barriers and infill panels to guarding is given in BS 6180.

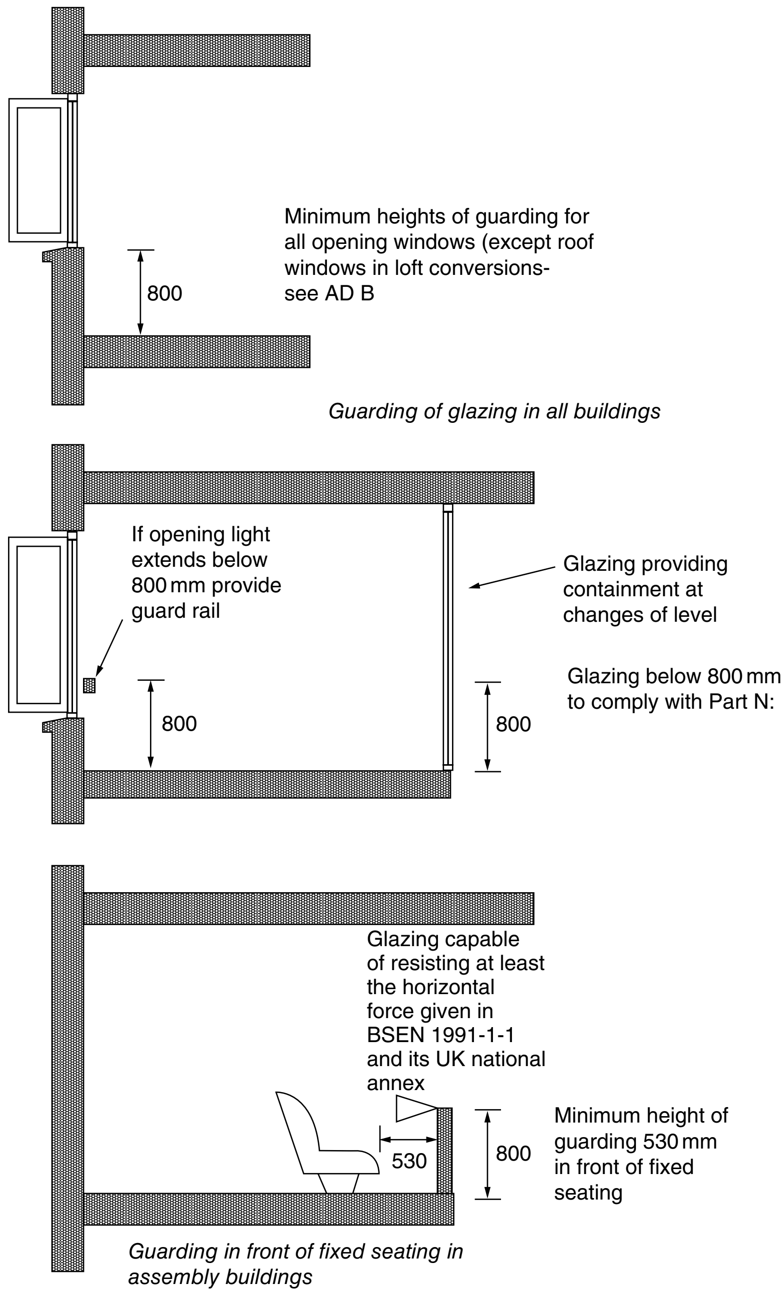


Fig. 15.7 Minimum height of guarding in all buildings.

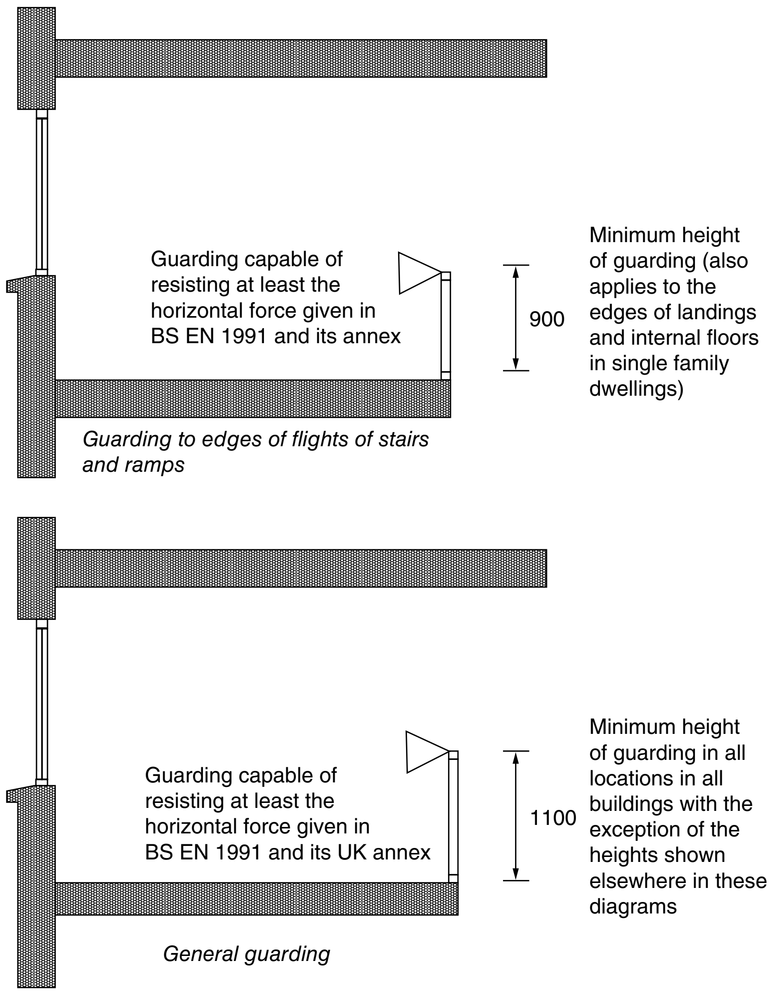


Fig. 15.7 (*Continued*)

15.9 Access to maintenance areas

In determining the appropriateness of access and guarding to areas needing maintenance, it is important to first consider frequency of use. If likely to be more than once per month, then permanent stairs or ladders and guarding such as those suggested in AD K 2013 (K1) for private stairs in dwellings may need to be provided (for guarding, see Fig. 15.7).

Alternatively, the requirement may be satisfied by following the guidance in BS 5395-3:1985 *Code of practice for the design of industrial type stairs, permanent ladders and walkways* and its subsequent amendments.

If maintenance areas are accessed less frequently than once a month, portable ladders, temporary guarding and warning notices may be appropriate. These are not covered in the Building Regulations, but AD K 2013 identifies that provisions can be found in The Construction (Design and Management) Regulations and the Work at Height Regulations 2005. Warning notices should meet the requirements of the Health and Safety (Safety, Signs and Signals) Regulations 1996.

15.10 Alternative approach to stairway design

It is permissible to use other sources of guidance when designing stairs.

- BS 5395-1:2010 *Stairs, ladders and walkways*: *Code of practice for the design of stairs with straight flights and winders* contains recommendations which will meet the steepness requirements of AD K.
- BS 5395-2:1984 *Stairs, ladders and walkways: Code of practice for the design of helical and spiral stairs*.
- Wood stairs designed in accordance with BS 585-1:1989 and BS585-2:1985 will offer reasonable safety to users.
- Stairs, ladders or walkways in industrial buildings should follow the recommendations of BS 5395-3:1985, *Code of practice for the design of industrial type stairs, permanent ladders and walkways* (and its subsequent amendments), or BS 4211:2005+A1:2008 *Specification for permanently fixed ladders*.

15.11 Protection from falling

The provisions for guarding contained in AD K 2013 (K1) are extended by the requirements described in AD K 2013 (K2) which identifies that guarding should be provided in those places within a building where it is reasonably necessary to ensure the safety of people by protecting them from falling.

Areas where this risk will need to be addressed include at the sides of stairs and ramps, around openable windows, around balconies or the edges of roofs, around sunken areas such as light wells and basements, and in vehicle parks.

The recommendations contained in AD K 2013 (K2) regarding the provision of pedestrian barriers to provide protection from falling only apply in situations where there is a change of level:

- in dwellings of more than 600 mm; or
- in buildings other than dwellings where there is a risk of falling a depth greater than the height of two risers or 300 mm if not part of a stair.

AD K 2013 (K2) also applies to areas used only for maintenance but does not apply to situations where guarding would obstruct normal use activities (for example, at the edges of loading bays) or on ramps that are used solely for vehicle access.

Similar to the provision of stairs, ladders and ramps described earlier in section 15.2, circumstances will usually dictate what constitutes an acceptable level of safety for guarding within in a building. For example, the standard required within a dwelling may be lower than that recommended for a building accessed by the public because it is likely to be used by fewer people and they will be familiar with its layout. Similarly, the standard of access to maintenance areas will be lower than that recommended for normal use areas to reflect the greater care expected of those gaining access.

It should be noted that compliance with AD K 2013 (K2) prevents action being taken against the occupier of a building under Regulation 6 of the Work at Height Regulations 2005 when the building is eventually in use. Regulation 6 relates to requirements designed to protect people from the risk of falling a distance likely to cause personal injury.

15.11.1 Guarding recommendations

Guarding provided to meet the requirements of AD K 2013 (K2) should:

- have a minimum height as shown in Fig. 15.7;
- be capable of resisting the horizontal force given in BS EN 1991-1-1 with its National Annex and PD 6688-1-1; and
- have any glazed part designed in accordance with AD K 2013 (K4) (see section **15.13**).

Additional guidance on the design of barriers and infill panels to guarding is given in section 15.6.9 and in BS 6180.

Guarding can consist of a wall, balustrade, parapet or similar barrier but should be designed so that it cannot be easily climbed by small children if they are likely to be present in the building. In such situations, horizontal rails should be avoided.

For guarding recommendations for maintenance areas, see section 15.7.

15.12 Vehicle barriers and loading bays

Vehicle ramps and any levels in a building to which vehicles have access are required to have barriers in order to protect people in or about the building. Additionally, vehicle loading bays must either be constructed in a way that protects people from collision with vehicles or they must contain features which achieve the same outcome.

15.12.1 Vehicle barriers

If the perimeter of any roof, ramp or floor to which vehicles have access forms part of a building and is level with or above any adjacent floor, ground or vehicular route, it should have barriers to protect it.

Vehicle barriers can be formed by walls, parapets, balustrading or similar obstructions and should be at least the heights shown in Fig. 15.8. Barriers should be capable of resisting the horizontal forces as set out in BS EN 1991-1-1 with its UK National Annex and PD 6688-1-1.

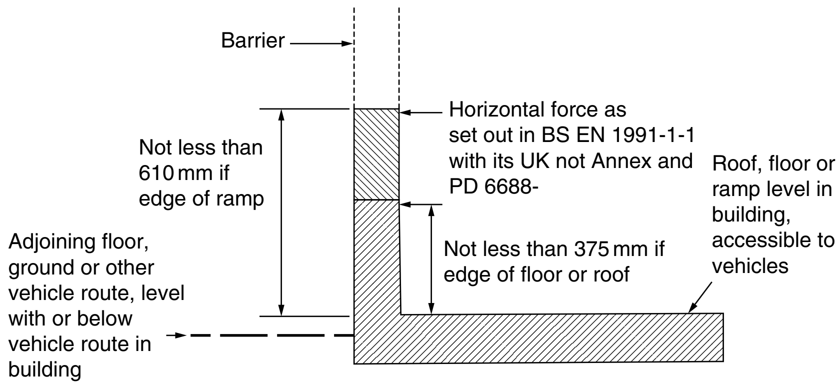


Fig. 15.8 Vehicle barriers – any building.

15.12.2 Loading bays

Ramps and loading bays for vehicles should be designed appropriately and provided with barriers or other features to ensure that people using the building are protected from collision or falling. The measures adopted need to provide an acceptable level of safety and should take into account that people using a public building are likely to be less familiar with the layout and how it operates than they would be when using a dwelling.

To meet the requirements of AD K 2013 (K3), loading bays for less than three vehicles should be provided with one exit point (e.g. steps) from the lower level, ideally near to the centre of the rear wall. Larger loading bays (i.e. for three or more vehicles) should be provided with:

- one exit point at each side; or
- a refuge where people can avoid the path of a vehicle and which is accompanied by one stepped exit point (see also Fig. 15.9).

In situations where people could be in danger of falling, loading bays should be provided with appropriate guarding. If there are particular circumstances where this may not be practicable, alternative measures to safeguard people from falling should be agreed with the appropriate building control body.

15.13 Protection against impact (with glazing)

AD K 2013 (K4) is a rationalisation of the guidance contained in the former Part N: Glazing – safety in relation to impact, opening and cleaning, which was withdrawn in April 2013. However, the section of the former Part N that related to manifestation on glazed screens is now contained in AD K 2013 (K5-2): Manifestation of glazing (see section 15.14).

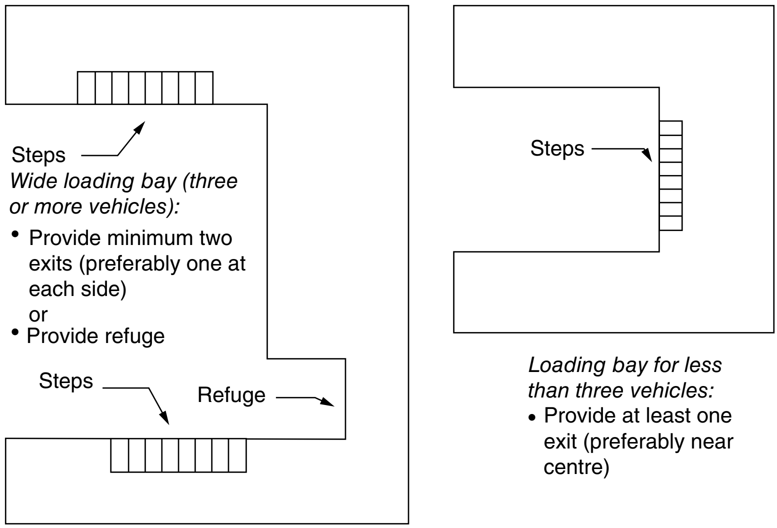


Fig. 15.9 Vehicle loading bays.

15.13.1 Generally for all buildings

When people are moving around a building, they are likely to come into contact with glazing in certain critical locations. Therefore, under AD K 2013 (K4), glazing must:

- if broken on impact, break safely so that the dangers of injury are minimised; or
- resist impact without breaking; or
- be permanently protected or shielded to prevent impact.

Areas that are considered critical with regard to safety are shown in Fig. 15.10.

Two main areas to be considered where an accident may result in cutting or piercing injuries are in:

- doors and side panels up to 1500 mm above floor level; and
- internal and external walls and partitions up to 800 mm above finished floor level.

In doors and door side panels, the main risk is in the area of door handles and push plates, especially as doors are prone to stick. Also it is possible that an initial impact above waist level may result in a fall through the glass. In low level glazing away from doors, the main risks are to children.

15.13.2 Possible solutions to Requirement K4 identified in AD K 2013

AD K 2013 lists a number of solutions which can be adopted in order to minimise the risk of injury in the critical areas described above. These are:

(1) **If breakage occurs, the glazing should break safely.**

Note: The concept of safe breakage is taken from BS EN 12600:2002 *Glass in building – Pendulum test. Impact test method and classification for flat glass*:

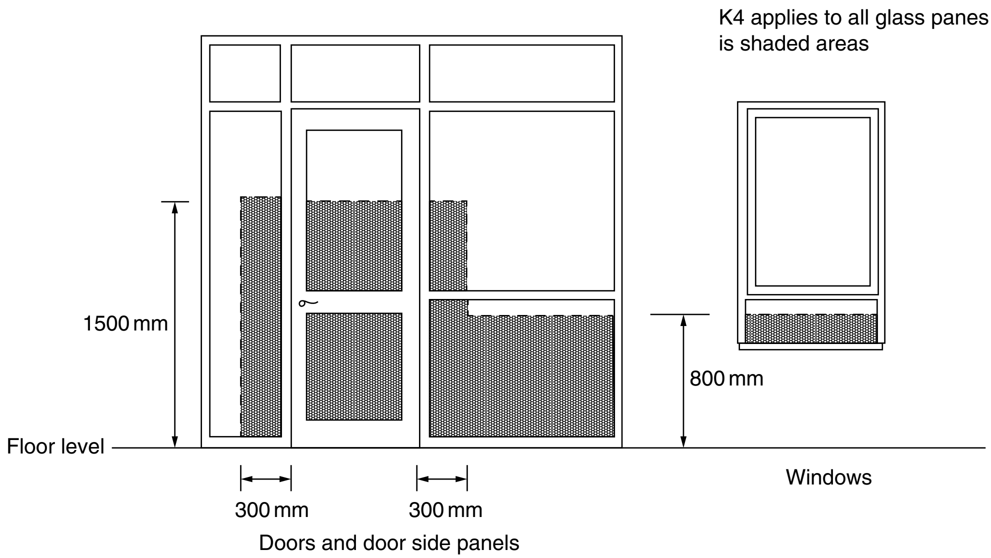


Fig. 15.10 Internal and external walls – critical locations.

section 4, and BS 6206:1981 *Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings*: clause 5.3.

To meet the requirements of K4, a piece of glass is required to remain unbroken upon impact – but if it does break, it should do so in one of the following ways:

- cracks and fissures are allowed to develop providing it is not possible to pass a sphere of 76 mm through any openings and any detached particles of glass are of a limited size; or
- disintegration is allowed to occur provided the particles are of a small size; or
- breakage is allowed to occur provided the pieces are not sharp or pointed.

A glazing material in a critical location will be satisfactory if it can be classified under the requirements of Class 3 of BS EN 12600 or Class C of BS 6206. If it is installed in a door or a door side panel and has a pane width which exceeds 900 mm, then it should meet the requirements of Class 2 of BS EN 12600 or Class B of BS 6206.

(2) **The glazing should be robust.**
Robustness refers to the strength of the glazing material. Some materials such as glass blocks or polycarbonates are inherently strong. Annealed glass gains its strength through increased thickness and requirement K4 describes the use of this material for large glazed areas forming fronts to shops, showrooms, factories, offices or public buildings. The dimensions of these glazed areas and their related glass thicknesses are shown in Table 15.1.

(3) **The glazing should be in small panes.**
This relates to the use of a single pane or one of a number of panes within glazing bars in critical areas where, in either case, the smallest dimension does not exceed 250 mm and the overall area of the individual pane does not exceed 0.5 m^2.

Table 15.1 Annealed glass – thickness/dimension limits.

Height (mm)		**Length (mm)**		**Thickness (mm)**
From	To	From	To	
0	1100	0	1100	8
1100	2250	1100	2250	10
2250	3000	2250	4500	12
3000	any	4500	any	15

Note:
Annealed glass sizes and thickness for use in large areas to shopfronts, showrooms, offices, factories and public buildings.

Small annealed glass panes should have a minimum thickness of 6 mm, but for traditional leaded or copper lights where fire resistance is not important, this thickness may be reduced to 4 mm.

(4) **The glazing should be permanently protected.**
Permanent protection means that the glazing should be installed behind a permanent screen which:

- prevents a sphere of 75 mm touching the glazing; and
- is itself robust; and
- is difficult to climb in cases where the glazing forms part of protection from falling.

Where permanent screen protection is provided, then the glazing does not need to comply with the Requirement K4 (see Fig. 15.11).

15.14 Protection from collision with open windows, skylights or ventilators

AD K 2013 (K5-1) requires that provision is made to prevent people who are moving in or about a building from colliding with open windows, skylights or ventilators.

This requirement applies to all buildings except dwellings and, in a limited form, to areas of the building used exclusively for maintenance purposes.

It is often desirable to open windows and skylights for ventilation, and it is important that this can be done without presenting a collision hazard for people using the building. Generally, this can be achieved by:

- providing windows, skylights and ventilators so that projecting parts are kept away from people moving in and about the building; or
- providing features which guide people away from these projections.

In certain situations, for example, in spaces used only for maintenance purposes, it is reasonable to expect those gaining access to exercise an appropriate level of care. Less demanding provisions may therefore satisfy the regulation than those required for a normal access situation.

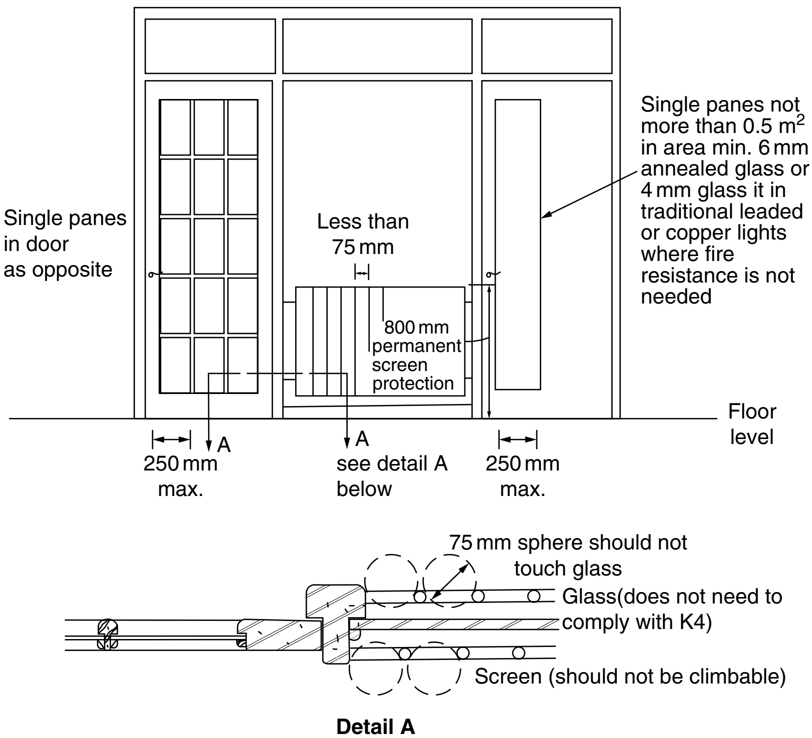


Fig. 15.11 Small panes and permanent screen protection.

Compliance with this regulation prevents action being taken against the occupier of a building under Regulation 15(2) of the Workplace (Health, Safety and Welfare) Regulations 1992 when the building is eventually in use. Regulation 15(2) relates to projecting windows, skylights and ventilators.

15.14.1 Avoiding projecting parts

AD K 2013 makes it clear that the requirements of Regulation K5(1) do not apply to the opening parts of windows, skylights or ventilators which:

- are at least 2000 mm above ground or floor level; or
- do not project more than about 100 mm internally or externally into spaces in or about the building where people are likely to be present.

The siting of opening light above 2000 mm may not always be possible. In such cases an acceptable solution might be achieved by fitting them with restraint straps designed to restrict the projection to about 100 mm. An ordinary casement stay would probably not be considered suitable for this purpose, but the acceptability of any solutions should be checked with the appropriate building control body. Restraints should only be removed for maintenance and cleaning purposes.

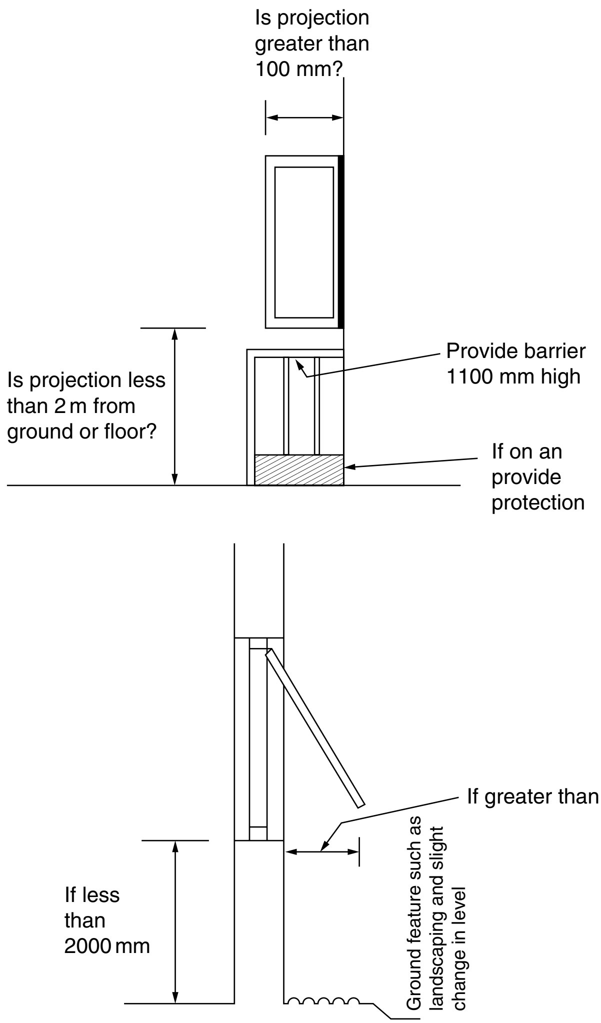


Fig. 15.12 Marking projections – barriers and ground features.

Alternative solutions given in AD K 2013 (K5-1) include:

- marking the projection with a feature such as a barrier or rail about 1100 mm high to prevent people walking into it (if the design of the barrier includes vertical rails that extend to ground level, the bottom 100 mm of the barrier should be provided with a solid section to prevent mobility canes becoming caught in the barrier); or
- guiding people away from the projection by providing ground or floor surfaces with strong tactile differences or suitable landscaping features (see also Fig. 15.12).

In spaces that are used either infrequently or only for maintenance purposes, making the projecting part clearly visible using appropriate visual contrast will satisfy Regulation K5(1).

15.15 Manifestation of glazing

Where there is a risk that people using a non-domestic building may come into contact with large, uninterrupted areas of transparent glazing when moving into, out of or around a building, Requirement K5(2) requires that features are incorporated to make the glazing apparent. Requirement K5 does not apply to dwellings.

The risk of collision and consequent injury is most serious where areas on the same level are separated by transparent glazing and users are presented with the visual impression that direct access from one area to the other is possible without interruption.

Critical locations for this include internal and external walls and doors of shops, showrooms, offices, factories and public or other non-domestic buildings.

AD K 2013 (5-2) identifies that suitable forms of making glazing apparent include:

- designing the doors or partition walling in such a way that the mullions, transoms, door frames or large pull/push handles identify the presence of the glazing; or
- providing permanent manifestation of adequate size and at appropriate heights to the glazing to make its presence apparent (manifestation can be provided in various ways, perhaps using individual company logos, patterns or signs at least 150 mm high (that are repeated if denoting the presence of a glazed screen) or by continuous or broken lines at least 50 mm high); and
- providing the manifestation at two heights, one between 850 mm and 1000 mm and another between 1400 mm and 1600 mm above floor level.

These examples are illustrated in Fig. 15.13.

All applied manifestation must contrast visually with the backgrounds against which it will be viewed and in all lighting conditions. That includes when the glazing is being approached on entering or exiting the building and under both artificial and daylighting situations.

Glazed doors that are part of a glazed screen or are adjacent to it should be clearly marked by the incorporation of a visually contrasting strip at the top and both sides of the door. Where glass doors may be held in the open position, the leading edge should be protected with guarding to minimise the risk of people colliding with it.

15.16 Safe use of windows, skylights and ventilators

Where windows, skylights and ventilators in or around a building are positioned so they can be operated by users, Requirement K5(3) states that they must be constructed or equipped so that they can be opened, closed or adjusted safely. This requirement does not apply to dwellings.

In order to meet the performance standard for safe operation of windows, skylights and ventilators, controls should typically be located not more than:

- 1900 mm above the floor or other stable surface where there is unobstructed access (small recesses such as window reveals would not constitute an obstruction); and

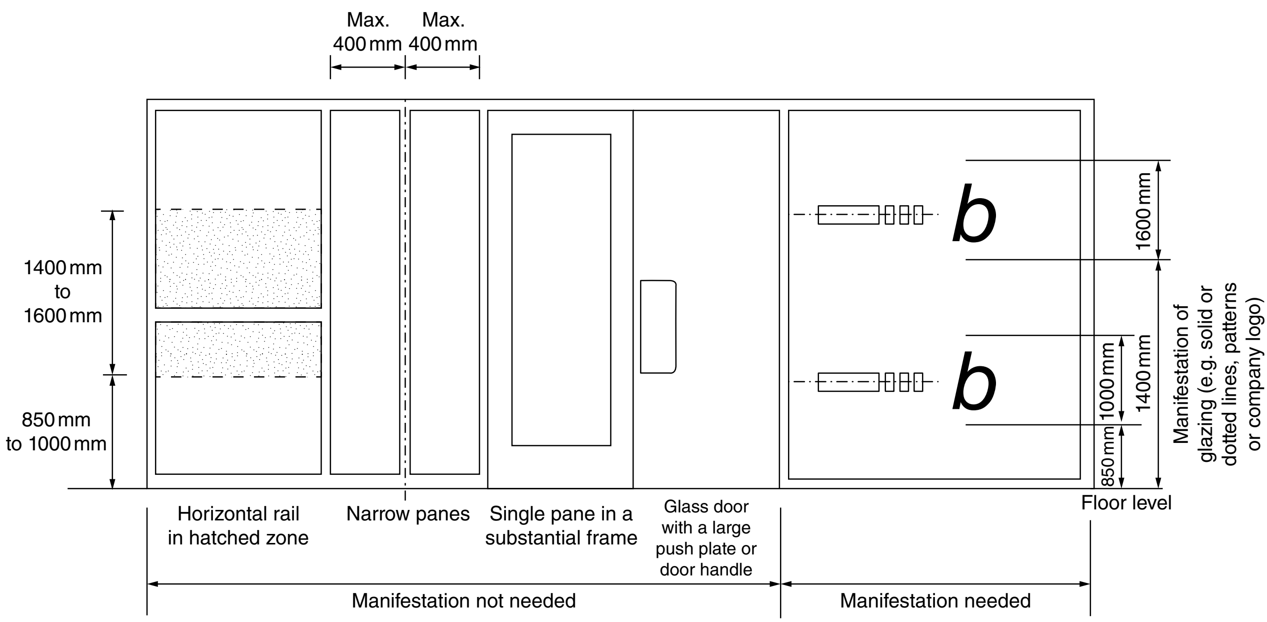


Fig. 15.13 Manifestation of large glazed areas (internal and external).

- 1700 mm above floor level where there is an obstruction which is up to 600 mm deep and not more than 900 mm high.

If controls cannot be positioned at a safe distance from a permanent stable surface, then it may be necessary to install either manual or electrical remote controls.

For windows above ground floor and where there may be a danger of the operator or other person falling through the window, suitable opening limiters should be fitted or the window should be guarded with appropriate guarding such as that described in Requirement K4 (see sections 15.12.1 and 15.13.1).

Additional guidance for using window controls, switches and controls in sleeping accommodation is contained in A D M 2015 (see Chapter 17).

15.17 Safe access for cleaning glazed surfaces

Regulations K5(4) requires that provision is made for glazed surfaces such as windows, skylights, translucent walls, ceilings and floors that are intended to be cleaned to be safely accessible for that purpose. This Regulation does not apply to dwellings.

In this case, compliance with Requirement K5(4) prevents action being taken against the occupier of a building under Regulation 16 of the Workplace (Health, Safety and Welfare) Regulations 1992 when the building is eventually in use. Regulation 16 relates to requirements for cleaning glazed surfaces in buildings.

In the context of K5(4), it will be necessary to make provision for safe means of access for cleaning *both* sides of any glazed surfaces which are positioned such that there is a danger of falling more than 2000 mm. In addition, glazed surfaces which cannot be cleaned safely by a person standing on the ground, a floor or other suitable permanent stable surface will need to be catered for in other ways. Figures 15.14 and 15.15 illustrate typical examples of how it may be possible to satisfy Regulation K5(4).

In essence, the following should be adopted:

- Install windows of a suitable design and size so that they can be cleaned from inside the building. Reversible type windows should be capable of being fixed in the reverse position for cleaning purposes (see Fig. 15.14). For additional information on windows, see BS 8213-1:2004 *Windows, doors and rooflights*.

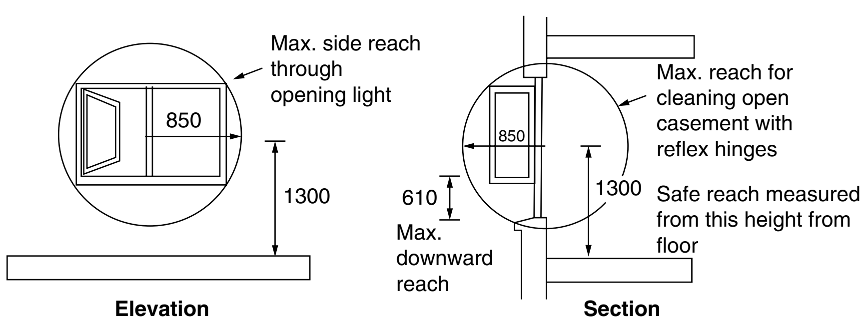


Fig. 15.14 Typical safe reaches for cleaning windows.

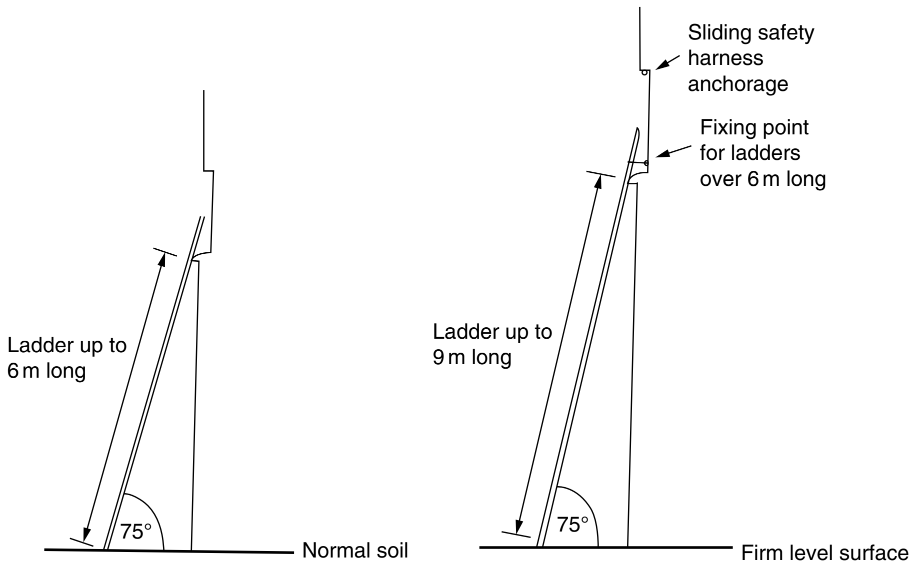


Fig. 15.15 Ladder access to cleaning windows. (**Note:** Since designers will need to relate the length of access ladders to window sill heights, the maximum sill heights from ground level are shown for both 6 m and 9 m ladders.)

- If there is an adequate area of firm, level ground situated in a safe place for sitting the ladder, use portable ladders up to 9 m long. Portable ladders up to 6 m long may be sited on normal soil. For ladders over 6 m long, provide permanent tying or fixing points (see Fig. 15.15).
- Provide catwalks at least 400 mm wide with either 1100 mm high guarding or provision for anchorages for sliding safety harnesses.
- Provide access equipment such as suspended cradles or travelling ladders with safety harness attachments.
- Provide adequate anchorage points for safety harnesses or abseiling hooks.
- In exceptional circumstances where other means of access cannot be used, provide suitably located space for scaffold towers from which the glazed surfaces can be cleaned.

15.18 Generally

Other provisions relating to safety on common circulation routes in buildings are contained in the Building Regulations. In particular, reference should be made to AD B: Fire Safety (Chapter 7) for guidance on the clear widths of escape routes.

Prior to 2013, details of the requirements for hazards on access routes were contained in AD M 2004 – Access to and use of buildings. Revisions to AD M in 2013 transferred these details to AD K 2013, and this was also adopted in the latest Approved Document to Part M 2015 (AD M 2015). In that respect, for hazards on access routes, AD M 2015 now simply refers to the need for compliance with AD K.

15.19 Safe use of doors

To ensure their safe use, provision should be made to prevent doors and gates which:

- slide or open upwards from falling onto any person; or
- are powered from trapping any person.

In addition, powered doors and gates must be openable in the event of a power failure and all swing doors and gates must allow a clear view of the space on either side. Regulation K6 does not apply to dwellings or to any door or gate which is part of a lift.

Compliance with this regulation prevents action being taken against the occupier of a building under Regulation 18 of the Workplace (Health, Safety and Welfare) Regulations 1992 when it is eventually in use. Regulation 18 relates to requirements for doors and gates.

15.19.1 Door and gate safety features

Regulation K6 requires the opening and closing doors should not present a safety hazard.

AD K 2013 offers the following guidance on how this may be achieved:

- Door leaves and side panels that are wider than 450 mm should be provided with vision panels towards the leading edge of the door which provide as a minimum clear zones of visibility between 500 mm and 800 mm and between 1150 mm and 1500 mm above floor level.
- Where a door in everyday use intrudes more than 1000 mm into an access route, the swing of the door should be guarded to protect against collision with users. This does not apply to fire escape doors or doors that are appropriately recessed.
  Note: If the design of any guarding includes vertical rails that extend to ground level, the bottom 100 mm should be provided with a solid section to prevent mobility canes becoming caught in the barrier (see Fig. 15.12).
- Sliding doors and gates should be prevented from leaving the end of the suspension track by a stop or other suitable means. If the suspension system fails or the rollers leave the track, the door or gate should be prevented from falling by means of a retaining rail.
- Upward opening doors and gates should be designed to prevent them from falling and causing injury.
- If doors and gates are power operated, safety features that could be incorporated include:
  - devices to prevent injury to people from being struck or trapped (for example, a reopening activator using a photo-eye or infrared detector);

    Note: AD K 2013 suggests that a suitable safety feature for doors would be a pressure-sensitive door edge which operates the power switch. However, AD M 2014 suggests that to prevent passengers becoming trapped by closing doors when using a lift it is necessary to provide an override to the door controls and a door reopening activator using a photo-eye or infrared detector or similar non-contact sensor. It also states that door-edge pressure-activated systems are not suitable as they may cause a disabled person to lose their balance.

Wherever possible therefore, the use of pressure systems to doors, and especially lifts, should be avoided.

- readily accessible and identifiable stop switches; and
- manual or automatic opening provisions in the event of power failure if this is necessary for health and safety reasons.

Reference should also be made to other provisions in the Building Regulations which relate to the design and use of doors in buildings. In particular, see AD B *Fire Safety* for guidance on the provision of doors on escape routes (see Chapter 7) and A D M 2004:13 *Access to and use of buildings* for guidance on the design of internal and external doors (see Chapter 17).

15.20 Sources of further guidance

Accessible stadia: A good practice guide to the design of facilities to meet the needs of disabled spectators and other users: http://www.safetyatsportsgrounds.org.uk/sites/default/files/publications/accessible-stadia.pdf.

Accessible sports facilities design guide 2010: published by Sport England: http://www.sportengland.org/facilities-planning/tools-guidance/design-and-cost-guidance/accessible-sports-facilities/.

BS 9999:2008 *Code of practice for fire safety in the design, management and use of buildings*: http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030158436.

16 Conservation of fuel and power (Part L)

16.1 Introduction

National and international concerns with respect to fuel resources, atmospheric pollution, the greenhouse effect and global warming have led to a generally accepted need to conserve energy. This problem is being treated with increasing urgency at all levels of society, and a particular consequence is that relevant legislation is subject to regular and frequent change and expansion. This is particularly true of the requirements for the conservation of fuel and power, which are dealt with by the Energy Efficiency requirements of the Building Regulations including the Schedule 1 technical requirement Part L1. This chapter describes the 2013 editions of the Approved Documents published to provide guidance on meeting these energy efficiency requirements. These continue the trend towards higher standards of energy conservation thereby ensuring compatibility with the European Energy performance of Buildings Directive (EPBD) and the national governments stated objective to achieve a zero carbon standard for new dwellings by 2016 and in new non-domestic buildings by 2019.

There are four separate Approved Documents published to support the requirements, each of which is self-contained. Unlike other Approved Documents the guidance is not restricted to demonstrating how compliance with the schedule 1 technical requirement might be achieved; they instead give guidance on how to comply with the *Energy efficiency requirements of the regulations.* This is a subtle but important distinction reflecting the fact that on the path to achieving the objective of a nearly zero carbon built environment, many of the drivers for this are contained with the regulations themselves as opposed to the Part L1 technical requirement.

For the 2013 requirements two of the Approved Documents were wholly rewritten in the new style format as per the 2013 versions of Approved Documents for parts K and P and Regulation 7. These covered the requirements for new dwellings (L1A) and new buildings other than dwellings (L2A). The Approved Documents providing guidance for alterations, extensions and material changes of use, L1B and L2B remain the 2010 versions but incorporating amendments from 2011 and 2013.

Despite this there remains a substantial amount of material which is common to all four documents, including

- key terms, definition and abbreviations,
- energy efficiency requirements of the Building Regulations,

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

- Part L technical requirement from Schedule 1,
- exemptions from the energy efficiency requirements of the regulations,
- tables of the self-certification schemes and exemptions from various requirements, as given in Schedule 3 of the regulations,
- general guidance which is common to all buildings.

For convenience the first part of this chapter deals with this common material.

16.2 Definition and interpretation of terms

In Approved Documents L1A and L2A, the definitions are provided in Appendix A under the heading *key terms and abbreviations*, whilst in documents L1B and L2B they are given in section 3. They are collected together here in overall alphabetic order. The list includes additional useful definitions, some of which have been taken from previous versions of the Approved Documents.

AIR PERMEABILITY – Air Permeability is the air leakage rate in cubic metres per hour per square metre of envelope area at the reference pressure differential of 50 Pa across the building envelope.

The envelope area of the building or measured part of the building is the total area of all floors, walls and ceilings bordering the space being tested, including walls and floors below external ground level. This is in effect the overall internal dimensions of the building with no subtractions for the area of the junctions where internal elements meet the external envelope.

See also the definitions of:

- assessed air permeability,
- design air permeability, and
- limiting air permeability.

ASSESSED AIR PERMEABILITY – The measured air permeability of a building or part of a building used in the *DER* and *DFEE* calculations. It may be based on specific measurements of the building but also in the case of dwellings, may be based on measurements of dwellings of the same type.

BCB – A BCB is a building control body, a local authority or an approved inspector.

BER – The BER, or the Building Emission Rate, is the predicted CO_2 emission rate from a building other than a dwelling.

BPEC – Is the Building Primary Energy Consumption. It is expressed in terms of kWh/m^2.year and is a result of the energy used for space and water heating, ventilation and lighting for a standardised occupancy. It must be assessed using an approved calculation software tool.

BUILDING – For the purposes of Part 6 of the Regulations, the *Energy Efficiency requirements,* building means the building as a whole or parts of it that have been designed or altered to be used separately.

BUILDING ENVELOPE – Means the walls, floor, roof, windows, doors, roof windows and roof lights.

CHANGE TO A BUILDING'S ENERGY STATUS – Any change which results in a building becoming a building to which the Energy Efficiency Requirements of the Regulations apply, where previously it was not.

COGENERATION – Means the simultaneous generation in one process of thermal energy and one or both of electrical energy or mechanical energy

COMMISSIONING – When a fixed building service is installed, replaced or altered, it will normally require commissioning to ensure that not only it is working correctly and to specification but also that it meets the requirement L1(b)(iii) and Regulation 44. For each system (or part of a system, if appropriate), commissioning includes:

- setting the system to work,
- repetitive adjustment and testing (i.e. regulation) to achieve the specified performance,
- calibration, setting-up and testing of associated automatic control systems,
- recording of those system settings and performance test results that show that the installation has been accepted as satisfactory.

CONSEQUENTIAL IMPROVEMENT – Consequential improvement means those energy efficiency improvements required by Regulation 28. This applies where an existing building with a useable floor area greater than 1000 m^2 is either extended or where the installed capacity of any fixed building service is being increased. The required improvements are additional to the principal works and are designed to raise its energy efficiency standards.

CONSERVATORY – Circular letter 29 July 2013 issued by the DCLG clarified the definition of a conservatory as follows:

- It must be at ground level.
- It must be less than 30 m^2 in area.
- Any glazing must comply with the relevant sections in Part K.
- Thermal separation between the existing building and the conservatory must be maintained.
- The building's heating system must not be extended into the conservatory.

Subject to meeting all the above criteria, the conservatory would benefit from the exemptions contained in the regulations. Note that any reference to specific minimum areas of the roof or walls to be glazed has now been removed. It is for the individual BCB.

CONTROLLED SERVICE OR FITTING – A controlled service or fitting is a service or fitting to which one or more of the following parts of the Building Regulations impose a requirement:

- Part G – Sanitation, hot water safety and water efficiency,
- Part H – Drainage and waste disposal,
- Part J – Combustion appliances and fuel storage systems,
- Part L – Conservation of fuel and power,
- Part P – Electrical safety.

DER – The DER, or the Dwelling Emission Rate, is the predicted CO_2 emission rate from a dwelling in kg of CO_2/m^2.year.

DELIVERED ENERGY – Means energy supplied to the building and its systems to satisfy the relevant energy demands of the fixed building services. It also includes renewable energy produced on site but any exported energy.

DESIGN AIR PERMEABILITY – The design air permeability is the value of air permeability selected by the designer of a building for use in the preliminary calculation of the DER (for dwellings) or the BER (for buildings other than dwellings).

DFEE – The DFEE is the Dwelling Fabric Energy Efficiency rate expressed as kWh/m^2.year.

DISPLAY LIGHTING – Display lighting is lighting intended to highlight displays of exhibits or merchandise or lighting used in spaces for public leisure and entertainment such as dance halls, auditoria, conference halls, restaurants and cinemas.

DISPLAY WINDOW – A display window is an area of glazing, including glazed doors, intended for the display of products or services on offer within a building, positioned:

- at the external perimeter of the building;
- at an access level; and
- immediately adjacent to a pedestrian thoroughfare.

There should be no permanent workspace within one glazing height of the perimeter. Glazing more than 3 m above such an access level should not be considered part of a display window except:

- where the products on display require a greater height of glazing,
- in existing buildings, when replacing display windows that already exist to a greater height, or
- in cases of building work involving changes to the façade and glazing requiring planning consent, where planners should have discretion to require a greater height of glazing. For example, the greater height may be required to fit in with surrounding buildings or to match with the character of the existing façade.

Table 16.1 Building classes.

Class	Usage
A1	Shops, including retail warehouse, undertakers, showrooms, post offices, hairdressers, shops for the sale of cold food for consumption off the premises
A2	Financial and professional services, including banks, building societies, estate and employment agencies, betting offices
A3	Food and drink, including restaurants, pubs, wine bars, shops for sale of hot food for consumption off premises
D2	Assembly and leisure buildings, including cinemas, concert halls, bingo halls, casinos, buildings used for sports and leisure

It is expected that display windows will be found in the usage classes A1, A2, A3 and D2 as shown in Table 16.1.

DISTRICT OR BLOCK HEATING OR COOLING – Means the distribution of thermal energy in the form of steam, hot water or chilled liquids, from a central source of production, through a network of multiple buildings or sites, for the use of space or process heating or cooling.

DWELLING – A dwelling is a self-contained unit, including a house or flat, designed to be used separately to accommodate a single household. Note that rooms for residential purposes are not dwellings.

DWELLING TYPE – A dwelling type is the particular group allocated to each dwelling on a development. They provide the basis for assessing the air pressure testing regime. It should be the responsibility of the person carrying out the testing to allocate each dwelling to a group type.

To be classed as the same dwelling type, two or more dwellings must:

- have the same generic form (i.e. detached, semi-detached, mid-terrace, end terrace, ground mid or top floor flat, or ground or top floor maisonette),
- have the same number of storeys,
- have the same design air permeability,
- have similar adjacency to unheated spaces such as stairwells, integral garages, etc.,
- have the same principal construction details,
- have no more than one more nor one less than the same number of significant penetrations through the building envelope for windows, doors, flues or chimneys, supply/exhaust terminals, waste water pipes, etc.,
- have envelope areas that do not differ by more than 10%.

Small variations in floor area do not necessarily constitute a different dwelling type.

EMERGENCY ESCAPE LIGHTING – Emergency escape lighting is that part of emergency lighting that provides illumination for the safety of people leaving an area or attempting to terminate a dangerous process before leaving an area.

ENERGY EFFICIENCY REQUIREMENTS – Energy efficiency requirements are the requirements of Regulations 23, 25A, 25B, 26, 26A, 28, 29 and 40 and Part L of Schedule 1.

ENERGY FROM RENEWABLE SOURCES – Means energy from renewable non-fossil sources, namely, wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases.

ENERGY PERFORMANCE CERTIFICATE – Energy performance certificate means a certificate which complies with the requirements of Regulation 7A of the Energy Performance of Buildings Regulations 2012.

FABRIC ENERGY EFFICIENCY – Means the space heating and cooling requirements per square metre of floor area of a new dwelling.

FIT-OUT WORK – Fit-out work is that work needed to complete the partitioning and building services within the external fabric of the building (the building shell) to meet the specific needs of incoming occupiers. Fit-out work can be carried out in whole or in parts:

- in the same project and time frame as the construction of the building shell; or
- at some time after the shell has been completed.

FIXED BUILDING SERVICES – Any part of or any controls associated with:

- fixed internal or external lighting systems but does not include emergency escape lighting or specialist process lighting; or
- fixed systems for heating, hot water service, air conditioning or mechanical ventilation; or
- any combination of systems of the kinds referred to above.

HEAT PUMP – Means a machine, a device or an installation that transfers heat from natural surroundings such as air, water or ground to buildings or industrial applications by reversing the natural flow of heat such that it flows from a lower to a higher temperature.

HIGH-USAGE ENTRANCE DOOR – A high-usage entrance door is a door to an entrance primarily for the use of people that are expected to experience large traffic volumes and where robustness and/or powered operation is the primary performance requirement. To qualify as a high-usage entrance door, the door should be equipped with automatic closers, and except where operational requirements preclude, be protected by a lobby.

HISTORIC AND TRADITIONAL BUILDINGS – These could include:

- buildings listed in accordance with section 1 of the Planning (Listed Buildings and Conservation Areas) Act 1990,
- buildings situated in conservation areas designated according to section 69 of the same Act,
- buildings included in the schedule of monuments maintained under section 1 of the Ancient Monuments and Archaeological Areas Act 1979,

- buildings of architectural and historical interest and which are referred to as a material consideration in a local authority development plan or local authority framework,
- buildings of architectural and historical interest within national parks, areas of outstanding natural beauty, registered historic parks and gardens, registered battlefields, curtilages of scheduled ancient monuments, and world heritage sites,
- buildings of traditional construction with permeable fabric that both absorbs and readily allows the evaporation of moisture.

LARGE EXTENSION An extension is considered to be large when its total useful floor area is both:

(a) greater than 100 m^2; and
(b) greater than 25% of the total useful floor area of the existing building.

LIMITING AIR PERMEABILITY – The limiting air permeability is the worst allowable air permeability.

NCM – Is the National Calculation Method. Information is available at www.ncm.bre.co.uk.

PRIMARY ENERGY – Energy that has not been subjected to any conversion or transformation process. For a building it is the *delivered energy* plus the energy used to produce the energy delivered to the building. It is calculated from *delivered energy* using primary energy conversion factors (see Table 16.2).

Table 16.2 Fuel CO_2 emission and primary energy factor adjustments, EFA, for some common fuels.

Fuel type	**Emissions, kgCO$_2$/kWh**	**Primary energy, kWh/kWh**
Natural gas	0.216	1.22
LPG	0.241	1.09
Biogas	0.098	1.10
Fuel oil	0.319	1.10
Coal	0.345	1.00
Anthracite	0.394	1.00
Manufactured smokeless fuel	0.433	1.21
Dual fuel (mineral + wood)	0.226	1.02
Biomass	0.031	1.01
Grid displaced electricity	0.519	3.07
Grid supplied electricity	0.519	3.07
Waste heat	0.058	1.34
Heating oil	0.298	1.10

PRINCIPAL WORKS – Principal works means the works necessary to achieve the client's purposes in extending a building and/or increasing the installed capacity of any fixed building services. The value of the principal works is the basis for determining a reasonable provision of consequential improvements.

RENOVATION/MAJOR RENOVATION – Renovation in relation to a thermal element means the provision of a new layer in the thermal element or the replacement of an existing layer but excludes decorative finishes, and 'renovate' shall be construed accordingly. Major renovation means the renovation of a building where more than 25% of the surface area of the building envelope undergoes renovation.

ROOM FOR RESIDENTIAL PURPOSES – A room for residential purposes means a room, or a suite of rooms, which is not a dwellinghouse or a flat and which is used by one or more persons to live and sleep and includes a room in a hostel, a hotel, a boarding house, a hall of residence or a residential home but does not include a room in a hospital or other similar establishment used for patient accommodation (see also the definition of dwelling).

SAP 2012 – The Government's Standard Assessment Procedure for Energy Rating of Dwellings, 2012 edition.

SBEM and iSBEM – SBEM is the Simplified Building Energy Model. This is a computer-based model designed to undertake CO_2 emission calculations, and iSBEM is a user interface to the SBEM.

SEDBUK – SEDBUK is the Seasonal Efficiency of a Domestic Boiler in the UK. See sedbuk.com for details.

SIMPLE PAYBACK – Simple payback is the amount of time it will take to recover an initial investment in an energy saving measure through energy savings. It is found by dividing the marginal initial cost of implementing the energy efficiency measure by the value (excluding VAT) of the annual energy savings achieved by that measure. Note that:

(a) The marginal additional cost is the additional cost (materials and labour) of incorporating the energy saving measure (e.g. additional insulation) and not the whole cost of the work.
(b) The cost of implementing the measure should be based on prices current at the date the proposals are made known to the BCB and be confirmed in a report signed by a suitably qualified person.
(c) The annual energy savings should be estimated using SAP 2012 (for dwellings) or an approved energy calculation tool (for buildings other than dwellings).
(d) Energy prices current at the time of the application to building control should be used to calculate annual energy savings. Current energy prices can be obtained from the DECC website, www.decc.gov.uk/en/content/cms/statistics/publication/prices.

SPECIALIST PROCESS LIGHTING – Specialist process lighting is lighting intended to illuminate specialist tasks within a space rather than the space itself. It could include theatre spotlights, projection equipment, lighting in TV and photographic studios, medical lighting in operating theatres and doctors' and dentists' surgeries, illuminated signs, coloured or stroboscopic lighting and art objects with integral lighting such as sculptures, decorative fountains and chandeliers.

TER – The TER, or Target Emission Rate, is the target (i.e. maximum permissible) CO_2 emission rate from a building in kg of CO_2/m^2.year.

TFEE – The TFEE is the Target Fabric Energy Efficiency rate expressed as kWh/m^2.year.

THERMAL ELEMENT – Thermal element means a wall, floor or roof but not windows, doors, roof windows or rooflights, which separate a thermally conditioned part of the building ('the conditioned space') from:

(a) the external environment (including the ground); or
(b) in the case of walls or floors, another part of the building which is:
  (i) unconditioned;
  (ii) an extension falling within class 7 of Schedule 2; or
  (iii) where this paragraph applies, conditioned to a different temperature (see note 1 below),

and includes all parts of the element between the surface bounding the conditioned space and the external environment or other part of the building as the case may be.
Note 1: b (iii) above applies only to a building which is not a dwelling, where the other part of the building is used for a purpose which is not similar or identical to the purpose for which the conditioned space is used.
Note 2: The definition of a thermal element includes the walls and floor of a swimming pool basin where this is part of an existing dwelling.

TOTAL USEFUL FLOOR AREA – Total useful floor area is the total floor area of all enclosed spaces measured to the internal face of the external walls. In this convention:

(a) the area of sloping surfaces such as staircases, galleries, raked auditoria and tiered terraces should be taken as their area on plan; and
(b) areas that are not enclosed such as open floors, covered ways and balconies should be excluded.

It is the gross floor area as measured in accordance with the guidance issued to surveyors by the Royal Institution of Chartered Surveyors (RICS).

TPEC – Is the target Primary Energy Consumption. It is expressed in terms of kWh/m^2.year and is a result of the provision of the standardised fixed building services including space and water heating, ventilation and lighting for a standardised occupancy. It must be assessed using an approved calculation software tool.

16.3 The Buildings Regulations 2010 relevant to Part L

16.3.1 The energy efficiency requirements of the regulations

Part 6 of the Building Regulations 2010 provides the *Energy Efficiency Requirements* of the Regulations including 21, 22, 23, 24, 25, 25A, 25B, 26, 26A, 27 to 35. In addition to this the definition of 'energy efficiency requirements' includes the provisions of regulation 40. These provide the legislative background to the conservation of fuel and power requirement and Part L. The requirements are quoted here from the most recent edition of the Building Regulations 2010 (as amended).

Regulation 21

Application of the energy efficiency requirements
The energy efficiency requirements apply to any of the following:

(1) The erection of a building
(2) The extension of a building
(3) The carrying out of any work to such a building

In the above building is defined as a roofed construction having walls which uses energy to condition the indoor climate.

There are some specific types of building which are exempt from this definition and therefore the energy efficiency requirements, these being:

(1) Listed Buildings
(2) Buildings in a conservation area
(3) Scheduled ancient monuments
There is a caveat to the exemption for (1) to (3) in that it will only apply where achieving compliance with the energy efficiency requirements would unacceptably alter the character or appearance of the building:
(4) Places of worship
(5) Temporary buildings with a planned use of less than two years, industrial sites, workshops and non-residential agricultural buildings with low energy demand.
(6) Buildings falling within Class 7 in Schedule 2 of the Regulations, except extensions. It is important to note that a conservatory or porch which has had the thermal separation from the existing building removed or had the existing building heating system extended into it is not covered by the exemption.

Regulations 22 and 23

Requirements relating to change of energy status and the renovation or replacement of thermal elements

Where work is to be carried out on an existing building, Regulations 22 and 23 apply, as follows:

Regulation 22

(1) Where there is a change to a building's energy status, such work, if any, shall be carried out as is necessary to ensure that the building complies with the applicable requirements of Part L of Schedule 1.
(2) In this regulation 'building' means the building as a whole or parts of it that have been designed or altered to be used separately.

Regulation 23

Where the renovation of an individual thermal element:

(1) Where a person intends to undertake a major renovation or to renovate more than 50% of an individual element's surface area, the renovation must be carried out to ensure that the whole thermal element complies with the requirements of paragraph L1(a)(i) of Schedule 1, in so far as it is technically, functionally and economically feasible.
(2) Where the whole or part of a thermal element is proposed to be replaced and this constitutes a major renovation or replacement of more than 50% of an individual thermal elements surface area, the new thermal element shall comply with the requirements of paragraph L1(a)(i) of Schedule 1. The whole of the thermal element must be replaced to ensure that it complies with the requirements of paragraph L1(a)(i) of Schedule 1, in so far as it is technically, functionally and economically feasible.

Regulation 24

Methodology of calculation and expression of energy performance

(1) The Secretary of State shall approve:
    (a) a methodology of calculation of the energy performance of buildings, including methods for calculating asset ratings and operational ratings of buildings, and
    (b) ways in which the energy performance of buildings, as calculated in accordance with the methodology, shall be expressed.
(2) In this regulation:
    (a) 'asset rating' means a numerical indicator of the amount of energy estimated to meet the different needs associated with a standardised use of the building, and
    (b) 'operational rating' means a numerical indicator of the amount of energy consumed during the occupation of a building over a period of time.

    One set of methodologies has been approved for dwellings and a different set for buildings which are not dwellings.

Regulation 25

Minimum energy performance requirements for buildings

The Secretary of State shall approve minimum energy performance requirements for new buildings which shall be based upon the methodology approved pursuant to regulation 24:

(1) For all new buildings, including dwellings in the form of target CO_2 emission rate; and
(2) For all new dwellings in the form of target fabric energy efficiency rates.

Regulation 25A

Consideration of high efficiency alternative systems for new buildings

Before construction of a new building starts, the person who proposes to carry out the works must analyse and take into account the technical, environmental and economic feasibility of using a high efficiency alternative system in the construction.

The regulation gives some examples of such systems including:

(1) decentralised energy systems based on *energy from renewable sources*
(2) combined heat and power systems also known as *cogeneration*
(3) *district or block heating or cooling*
(4) *heat pumps*

The person carrying out the work must give to the BCB a notice that this analysis has been undertaken and documented no later than the beginning of the day before the day on which works are due to commence. A copy of the analysis must be available to the BCB when requested so that they can, if they so wish, confirm that the requirement has been complied with.

The analysis may be carried out for individual buildings, groups of similar buildings or common typologies of buildings. In so far as it relates to collective heating or cooling systems, it may be carried out for all buildings connected to the system:

(1) For all new buildings, including dwellings in the form of target CO_2 emission rate; and
(2) For all new dwellings in the form of target fabric energy efficiency rates

Regulation 25B

Nearly zero-energy requirements for new buildings

Where a building is erected, it must be a nearly zero-energy building (*1 January 2019 in respect of new buildings occupied by public authorities, 31 December 2020 in respect of all new buildings*).

Regulation 25C

New buildings: Minimum energy performance requirements

Minimum energy performance requirements may be approved by the Welsh ministers, in accordance with the methodology approved pursuant to regulation 24, for:

(a) new buildings (other than new dwellings), in the form of target primary energy consumption rates; and
(b) new dwellings in the form of target fabric performance values

Regulation 26, 26A and 26B

CO_2 emission rates new buildings

Regulation 26
Where a building is erected, it shall not exceed the target CO_2 emission rate for the building that has been approved pursuant to Regulation 25.

Regulation 26A
Where a dwelling is erected, it shall not exceed the target fabric energy efficiency rate for the dwelling which has been approved pursuant to Regulation 25.

Regulation 26A (Building Regulations Wales only)
Where a building (other than a dwelling) is erected, it must not exceed the target primary energy consumption rate for the building which has been approved pursuant to regulation 25C(a).

Regulation 26B (Building Regulations Wales only)
Where a dwelling is erected, it must not exceed the target fabric performance values for the dwelling which has been approved pursuant to Regulation 25C(b).

The limiting factor on the design and operation of a building is the amount of CO_2 released into the atmosphere and not the total amount of energy consumed. This in turn means that the source of energy is crucial. Buildings which are designed to rely on energy sources with low CO_2 emission rates per unit of consumed energy will be better able to meet the target. In addition to this for new dwellings, under regulation 26A, the performance of the fabric in limiting the energy demand of the space heating and cooling systems maintains a balance between the use of renewable technology and the building fabric in demonstrating compliance.

Regulation 27, 27A and 27B

Emission rate calculations

Regulation 27

(1) This regulation applies where a building is erected and regulation 26 applies.
(2) Not later than the day before work starts, the person carrying out the work shall provide to the BCB a notice which specifies:
   (a) the target CO_2 emission rate for the building,
   (b) the calculated CO_2 emission rate for the building as constructed,
   (c) a list of specifications to which the building is to be constructed.
(3) Not later than five days after the work has been completed, the person carrying out the work shall give to the BCB:
   (a) a notice which specifies:
      (i) the target CO_2 emission rate for the building
      (ii) the calculated CO_2 emission rate for the building as constructed

(iii) whether the building has been constructed in accordance with the list of specifications referred to in paragraph 2(c) and if not a list of any changes to those specifications; or

(b) a certificate of the sort referred to in (4) accompanied by the information referred to in sub-paragraph (a)

(4) A local authority is authorised to accept, as evidence that the requirements of regulation 26 would be satisfied, a certificate to that effect by an energy assessor who is accredited to produce such certificates for that category of building.

(5) In this regulation 'specifications' means specifications used for the calculation of the CO_2 emission rate.

Regulation 27A

(1) This regulation applies where a dwelling is erected and regulation 26A applies.

(2) Not later than the day before work starts, the person carrying out the work shall give the local authority a notice that specifies:

(a) the target fabric energy efficiency rate for the dwelling;

(b) the calculated fabric energy efficiency rate for the dwelling as designed; and

(c) a list of specifications to which the dwelling is to be constructed.

(3) Not later than five days after work has been completed, the person carrying out the work shall give the local authority:

(a) a notice which specifies:

(i) the target fabric energy efficiency rate for the dwelling

(ii) the calculated fabric energy efficiency rate for the dwelling as constructed

(iii) whether the dwelling has been constructed in accordance with the list of specifications referred to in paragraph (2)(c) and if not a list of any changes to those specifications; or

(b) a certificate of the sort referred to in paragraph (4) accompanied by the information referred to in sub-paragraph (a).

(4) A local authority is authorised to accept, as evidence that the requirements of regulation 26A have been satisfied, a certificate to that effect by an energy assessor who is accredited to produce such certificates for that category of building.

(5) In this Regulation, 'specifications' means specifications used for the calculation of the fabric energy efficiency rate.

Regulation 27A (Building Regulations Wales only)

(1) This regulation applies where a building (other than a dwelling) is erected and regulation 26A applies.

(2) Not later than the day before work starts, the person carrying out the work shall give the local authority a notice that specifies:

(a) the target primary energy consumption rate for the building;

(b) the calculated primary energy consumption rate for the building as designed; and

(c) a list of specifications to which the building is to be constructed.

(3) Not later than five days after work has been completed, the person carrying out the work shall give the local authority:
 (a) a notice which specifies:
  (i) the target primary energy consumption rate for the building;
  (ii) the calculated primary energy consumption rate for the building as constructed;
  (iii) whether the building has been constructed in accordance with the list of specifications referred to in paragraph (2)(c) and if not a list of any changes to those specifications; or
 (b) a certificate of the sort referred to in paragraph (4) accompanied by the information referred to in sub-paragraph (a).
(4) A local authority is authorised to accept, as evidence that the requirements of regulation 26A have been satisfied, a certificate to that effect by an energy assessor who is accredited to produce such certificates for that category of building.
(5) In this Regulation, 'specifications' means specifications used for the calculation of the fabric energy efficiency rate.

Regulation 27B (Building Regulations Wales only)

(1) This regulation applies where a dwelling is erected and regulation 26B applies.
(2) Not later than the day before work starts, the person carrying out the work shall give the local authority a notice that specifies:
 (a) the target fabric performance values for the dwelling;
 (b) the calculated fabric performance values for the dwelling as designed; and
 (c) a list of specifications to which the dwelling is to be constructed.
(3) Not later than five days after work has been completed, the person carrying out the work shall give the local authority:
 (a) a notice which specifies:
  (i) the target fabric performance values for the dwelling;
  (ii) the calculated fabric performance values for the dwelling as constructed; and
  (iii) whether the dwelling has been constructed in accordance with the list of specifications referred to in paragraph (2)(c) and if not a list of any changes to those specifications; or
 (b) a certificate of the sort referred to in paragraph (4) accompanied by the information referred to in sub-paragraph (a).
(4) A local authority is authorised to accept, as evidence that the requirements of regulation 26B have been satisfied, a certificate to that effect by an energy assessor who is accredited to produce such certificates for that category of building.
(5) In this Regulation, 'specifications' means specifications used for the calculation of the fabric energy efficiency rate.

Regulation 28

Consequential improvements to energy performance

(1) Paragraph (2) applies to an existing building with a total useful floor area over $1000\,m^2$ where the proposed building work consists of or includes:
   (a) an extension;
   (b) the initial provision of any fixed building services; or
   (c) an increase to the installed capacity of any fixed building services.
(2) Subject to paragraph (3), where this regulation applies, such work, if any, shall be carried out as is necessary to ensure that the building complies with the requirements of Part L of Schedule 1.
(3) Nothing in paragraph (2) requires work to be carried out if it is not technically, functionally and economically feasible.

Regulation 28 means that if any building above a useful floor area of $1000\,m^2$ is extended, its fixed building services installed for the first time or existing services increased, then the whole building must be brought up to a standard compatible with the current Part L requirements for that building, subject to the caveats mentioned in section (3) above.

Regulation 28 (Building Regulations Wales only)

Consequential improvements to energy performance

(1) Paragraph (3) applies to an existing building with a total useful floor area over $1000\,m^2$ where the proposed building work consists of or includes:
   (a) the initial provision of any fixed building services, or
   (b) an increase to the installed capacity of any fixed building services.
(2) Paragraph (3) applies to an existing building where the proposed building work consists of or includes:
   (a) an extension; or
   (b) the extension of the building's heating system or the provision of a fixed heating appliance to heat a previously unheated space.
(3) Subject to paragraph (4), where this regulation applies, such work, if any, shall be carried out as is necessary to ensure that the building complies with the requirements of Part L of Schedule 1.
(4) Nothing in paragraph (2) requires work to be carried out if it is not technically, functionally and economically feasible.

Regulation 28 for Wales differs from the English version. If any building above a useful floor area of $1000\,m^2$ has its fixed building services installed for the first time or existing services increased, then the whole building must be brought up to a standard compatible with the current Part L requirements for that building, subject to the caveats of mentioned in section (4) above. The difference occurs where an existing building of any floor area is extended by an extension of any size then under the welsh version of the regulation; the existing building must be brought up to a standard compatible with the current Part L requirements for that building, again subject to the caveats of mentioned in section (4) above.

Regulation 35

Interpretation

Where a building is being extended or altered, 'building' means the building as a whole or parts of it that have been designed or altered to be used separately.

Regulation 40

Provision of information

(1) This regulation applies where paragraph L1 of schedule 1 imposes a requirement in relation to building work.
(2) The person carrying out the work shall not later than five days after the work has been completed provide to the owner sufficient information about the building, the fixed building services and their maintenance requirements so that the building can be operated in such a manner as to use no more fuel and power than is reasonable in the circumstances.

16.3.2 Testing and commissioning

Part 9 of the Building Regulations 2010 provides the testing and commissioning requirements of the regulations, including Regulations 43 and 44 which impose the statutory requirements for pressure testing and commissioning.

Regulation 43

Pressure testing

(1) This regulation applies to the erection of a building in relation to which paragraph L1(a)(i) of Schedule 1 imposes a requirement.
(2) Where this regulation applies, the person carrying out the work shall, for the purpose of ensuring compliance with regulation 26 and paragraph L1(a)(i) of Schedule 1:
    (a) ensure that:
        (i) pressure testing is carried out in such circumstances as are approved by the Secretary of State, and
        (ii) the testing is carried out in accordance with a procedure approved by the Secretary of State, and
    (b) subject to paragraph (5), give notice of the results of the testing to the local authority.
(3) The notice referred to in paragraph (2)(b) shall:
    (a) record the results and the data upon which they are based in a manner approved by the Secretary of State, and
    (b) be given to the local authority not later than seven days after the final test is carried out.

(4) A BCB is authorised to accept, as evidence that the requirements of paragraph (2)(a)(ii) have been satisfied, a certificate to that effect by a person who is registered by the British Institute of Non-destructive Testing in respect of pressure testing for the air tightness of buildings.
(5) Where such a certificate contains the information required by paragraph (3)(a), paragraph (2)(b) does not apply.

Regulation 44

Commissioning

(1) This regulation applies to building work in relation to which paragraph L1(b) of Schedule 1 imposes a requirement but does not apply to the provision or extension of any fixed building service where testing and adjustment is not possible or would not affect the energy efficiency of that fixed building service.
(2) Where this regulation applies the person carrying out the work shall, for the purpose of ensuring compliance with paragraph L1(b) of Schedule 1, give to the BCB a notice confirming that the fixed building services have been commissioned in accordance with a procedure approved by the Secretary of State.
(3) The notice shall be given to the BCB:
    (a) not later than the date on which the notice required by regulation 16(4) is required to be given; or
    (b) where that regulation does not apply, not more than 30 days after completion of the work.

16.4 Part L: Exemptions and relaxations from Part L

Buildings and works which have overall exemption from the Building Regulations are covered in Regulation 9(1) and by the exempt buildings and work classes detailed in Schedule 2 of the Building Regulations 2010. There are also specific types of building and building work which are exempt from the energy efficiency requirements of the regulations including Part L in Regulation 21 as detailed above. Supplementary to this the approved documents L1B and L2B give details of other buildings where special circumstances may lead to some relaxation of the requirements or procedures (e.g. traditional buildings – see section 16.4.5). For the purposes of considering the exemptions offered to buildings, it is best to consider new buildings and existing buildings separately as follows.

16.4.1 New buildings: Dwellings

No new dwellings are exempt from the requirements of Part L. However parts of the building work in such cases may be certificated by under a competent person self-certification scheme referenced in Schedule 3 of the Building Regulations 2010. Typically this might involve the following types of work:

- Electrical installations,
- Plumbing installations,
- Installation of fixed building services such as heating, hot water, air conditioning and mechanical ventilation.

Where such work is carried out by a registered competent person, then:

- such work must fully comply with the requirements of Part L1A,
- it is not necessary to notify a BCB in advance of work which is to be carried out,
- within 30 days of completion, the occupier of the building must be given a certificate confirming that the work fully complies with all applicable requirements,
- within 30 days of completion, a notice of the work carried out must be given to the BCB,
- local authority inspection and enforcement powers still apply but would normally be invoked only in response to a complaint.

16.4.2 New buildings: Buildings other than dwellings

Buildings other than dwellings that are exempt from the energy efficiency requirements of the regulations are:

- buildings used primarily or solely as places of worship,
- stand-alone buildings (other than dwellings) with a total useful floor area of less than $50\,m^2$,
- temporary buildings with a planned time of use of two years or less (note that portable or modular buildings, whether on one or more sites, which have a planned service life longer than two years, are not exempt),
- industrial sites, workshops and non-residential agricultural buildings with low energy demand.

Places of worship include those buildings or parts of a building used for formal public worship, including adjoining spaces used as part of that worship (e.g. a church vestry). It does not include spaces used separately, such as offices, catering facilities, day centres, meeting halls, accommodation, etc.

Industrial sites, workshops and non-residential agricultural buildings are exempt *only* if the energy used by fixed heating and/or cooling systems meets the low energy demand criterion. The amount of energy required for or created by process needs is not relevant in determining the exemption. It is important to note that there is no specific criterion for determining whether or not a building in this category qualifies as having low energy demand. Furthermore, similar buildings (e.g. some types of warehouse), even if they have a low energy demand, are not exempt because they do not fall into any of the above categories.

Special considerations may also apply to certain types of building where some degree of relaxation from the full Part L requirements may be possible for the following three types of building:

(1) Non-exempt buildings with low energy demand;
These are normally buildings where fixed building services:

- are not provided for heating and/or cooling,
- are provided only to heat or cool a localised area but not the entire enclosed volume, or
- are provided but used only to heat the space in the building to a temperature substantially less than normally provided for human comfort (e.g. to protect a warehouse from condensation or frost).

In these situations a Regulation 26 TER/BER calculation may not be required subject to any fixed building services meeting the guidance in the *DCLG non-domestic building services compliance guide.* The fabric should be insulated to a reasonable level.

- Modular and portable buildings with a planned time use of more than two years;
- Shell and core developments.

Further details of the relaxations which may apply to non-exempt buildings are given throughout section 16.8.

16.4.3 Existing buildings: Dwellings

Building work and/or extensions to existing dwellings may be exempt for:

- historical and traditional dwellings (see section 16.4.5),
- carports, covered yards and covered ways,
- a conservatory (as defined in section 16.2) or porch,
- dwellings of traditional construction with permeable fabric that both absorb and readily allow the evaporation of moisture.

16.4.4 Existing buildings: Buildings other than dwellings

Existing buildings other than dwellings that are normally exempt are:

- buildings used primarily or solely as places of worship (see section 16.4.2);
- stand-alone buildings (other than dwellings) with a total useful floor area of less than $50\,m^2$;
- temporary buildings with a planned time of use of two years or less but *not* portable or modular buildings with a planned service life greater than two years even if they are moved from site to site;
- industrial sites, workshops and non-residential agricultural buildings with low energy demand;
- historic and traditional buildings (see section 16.4.5);
- carports, covered yards and covered ways;
- a conservatory (as defined in section 16.2) or porch.

16.4.5 Historic and traditional buildings

New extensions to historic or traditional buildings (as defined in section 16.2) should normally meet the energy efficiency standards of L1B or L2B. The only exception to this occurs when there is a demonstrable need to match the external appearance of the extension to that of the host building.

Under regulation 21 building works on certain historic and traditional buildings are normally exempt but only if compliance with the energy efficiency requirements would unacceptably alter their character or appearance. This applies whether the building is a dwelling or a building other than a dwelling. Any work should be carried out so as to comply as far as possible and practicable with the energy efficiency standards set out in approved document L1B or L2B.

In addition to internal building work or extensions, issues that may arise are:

- restoration of the historic character of a building,
- replacement windows, doors and rooflights,
- rebuilding due to, say, fire damage or filling a gap in a terrace,
- carrying out work to control moisture and/or long-term decay problems.

In all such cases, special considerations will apply, as any work on a historic building must balance the need to improve energy efficiency requirements against the following factors:

- The need to avoid prejudicing the character of the historic building;
- The danger of increasing the risk of long-term deterioration of the building fabric;
- The danger of increasing the risk of long-term deterioration of the building's fittings;
- The extent to which energy conservation measures are a practical possibility.

Advice on achieving the correct balance should be sought from the conservation officer of the local authority and from English Heritage (www.english-heritage.org.uk). The English Heritage publication *Energy efficiency and historic buildings* [1] should also be consulted for guidance on determining appropriate energy performance standards. Advice from other sources, e.g. NPPF [2], BS 7913 [3] and SPAB publications [4], may also be appropriate. Particular consideration should be given to:

- the restoration of the historic character of a building that has been the subject of inappropriate alteration, such as the replacement of windows, doors or rooflights;
- the rebuilding of a former historic building, which may have been damaged or destroyed due to some mishap (such as a fire) or infilling a gap in a terrace;
- the provision of a means for the fabric of a historic building to 'breathe' so that moisture movement may be controlled and the potential for long-term decay problems reduced.

16.4.6 Self-certification, exemptions from requirements to give notice, etc.

Building Regulation 12(6) provides for self-certification schemes providing relaxation from the requirement to give building notice or deposit full plans. Schedule 3 gives details, and as these are of particular relevance to Part L, they are reproduced here in Tables 16.3 and 16.4.

Table 16.3 Schedule 3 – Self-certification schemes and exemptions from requirement to give building notice or deposit full plans.

Type of work	Person carrying out the work
1. Installation of: a heat-producing gas appliance. (this paragraph does not apply to the provision of a masonry chimney)	A person, or an employee of a person, who is a member of a class of persons approved in accordance with regulation 3 of the Gas Safety (Installation and Use) Regulations 1998
2. Installation of: a heating or hot water system connected to a heat-producing gas appliance or associated controls	A person registered, in respect of that type of work, by: 1, 2, 3, 5, 6, 8, 9, 13
3. Installation of: (a) an oil-fired combustion appliance; (b) oil storage tanks and the pipes connecting them to combustion appliances; or (this paragraph does not apply to the provision of a masonry chimney)	A person registered, in respect of that type of work, by: 1, 2, 5, 6, 8, 9, 13, 14
4. Installation of: a solid fuel burning combustion appliance; (this paragraph does not apply to the provision of a masonry chimney)	A person registered, in respect of that type of work, by: 1, 2, 5, 9, 13
5. Installation of: a heating or hot water system connected to an oil-fired combustion appliance or its associated controls	A person registered, in respect of that type of work, by: 1, 2, 5, 6, 8, 9, 13, 14
6. Installation of: a heating or hot water system connected to a solid fuel burning combustion appliance or its associated	A person registered, in respect of that type of work, by: 1, 2, 5, 6, 8, 9, 13, 14
7. Installation of: a heating or hot water system connected to an electric heat source or its associated controls	A person registered, in respect of that type of work, by: 1, 2, 5, 6, 8, 9, 13, 14
8. Installation of: a mechanical ventilation or air-conditioning system or associated controls, which does not involve work on a system shared with parts of the building occupied separately, in a building other than a dwelling	A person registered, in respect of that type of work, by: 2, 9, 13
9. Installation of: an air-conditioning or ventilation system in a dwelling, which does not involve work on systems shared with other dwellings	A person registered, in respect of that type of work, by: 2, 9, 13
10. Installation of: a lighting system or electric heating system or associated electrical controls in buildings other than dwellings	A person registered, in respect of that type of work, by: 2, 9,13, 14
11. Installation of: fixed low or extra-low voltage electrical installations in dwellings	A person registered, in respect of that type of work, by: 2, 6, 9, 10, 13
12. Installation of: fixed low or extra-low voltage electrical installations in dwellings as a necessary adjunct to or arising out of other work being carried out by the registered person	A person registered, in respect of that type of electrical work, by: 1, 2, 6, 8, 9, 13
13. Installation, as a replacement, of: a window, rooflight, roof window or door in an existing building	A person registered under the Fenestration Self-Assessment Scheme, in respect of that type of work, by: 10, 11, 12, 15, 16

Table 16.3 (*Continued*)

Type of work	Person carrying out the work
14. Installation of: a sanitary convenience, sink, washbasin, bidet, fixed bath, shower or bathroom in a dwelling, which does not involve work on shared or underground drainage	A person registered, in respect of that type of work, by: 1, 2, 6, 9
15. Installation of: a wholesome cold water supply or a softened wholesome cold water supply	A person registered, in respect of that type of work, by: 1, 2, 6, 9
16. Installation of: a supply of non-wholesome water to a sanitary convenience fitted with a flushing device which does not involve work on shared or underground drainage	A person registered, in respect of that type of work, by: 1, 2, 6, 9
17. Installation in a building of a system to produce electricity, heat or cooling (a) by microgeneration (b) from renewable sources	A person registered, in respect of that type of work, by: 1, 2, 6, 9, 14
18. Insertion of insulation material into the cavity walls of an existing dwelling	A person registered, in respect of that type of work, by the Cavity Wall Insulation Self Certification Scheme
19. Installation as a replacement of the covering of a pitched or flat roof and work carried out by the registered person as a necessary adjunct to that installation. This paragraph does not apply to the installation of solar panels	A person registered by the National Federation of Roofing Contractors Ltd
21. Installation as a replacement of a window, rooflight, roof window or door in an existing building other than a dwelling. This paragraph does not apply to glass which is load bearing or structural or which forms part of glazed curtain walling or a revolving door	A person registered, in respect of that type of work, by: 12, 14, 15
22. Installations of insulating material to the internal walls of a building	A person registered, in respect of that type of work, by: 6, 9, 12, 13, 14
23. Installation of insulating material to the external walls of a building, not including insulation of demountable clad buildings	A person registered, in respect of that type of work, by: 6, 9, 12, 13, 14
24. Installation of insulation material to both external and internal walls of a building not including insulation of demountable clad buildings	A person registered, in respect of that type of work, by: 6, 9, 13

Notes:
The references in column 2 are to the following:

1. Association of Plumbing and Heating Contractors (Certification) Limited
2. Building Engineering Services Competence Accreditation Limited
3. Capita Gas Registration and Ancillary Services Limited
4. GAS-SAFE Services Limited
5. HETAS Limited
6. NAPIT Registration Limited
7. NICEIC Group Limited
8. Oil Firing Technical Association Limited
9. Certsure LLP (in respect of work carried out in England and excepted energy buildings in Wales)
10. British Standards Institution
11. Fensa Ltd
12. CERTASS Limited
13. Benchmark Certification Ltd
14. Stroma Certification Ltd
15. BM TRADA certification Ltd
16. Network VEKA Ltd

Table 16.4 Schedule 2B – Descriptions of work where no building notice or deposit of full plans is required.

Type of work	Description
1. Work consisting of:	(a) in relation to an existing fixed building service, which is not a fixed internal or external lighting system: (i) replacing any part which is not a combustion appliance; (ii) adding an output device or; (iii) adding a control device where resting and adjustment of the work is not possible or would not affect the use by the fixed building service of no more fuel and power than is reasonable in the circumstances; (b) providing a self-contained fixed building service, which is not a fixed internal or external lighting system, where: (i) it is not a combustion appliance; (ii) any electrical work associated with its provision is exempt from the requirement to give a building notice or to deposit full plans by virtue of regulation 9 or regulation 12(5)(b); (iii) testing and adjustment is not possible or would not affect its energy efficiency; and (iv) in the case of a mechanical ventilation appliance, the appliance is not installed in a room containing an open-flued combustion appliance whose combustion products are discharged through a natural draught flue; (c) replacing an external door (where the door together with its frame has not more than 50% of its internal face area glazed); (d) in existing buildings other than dwellings, providing fixed internal lighting where no more than 100 m^2 of the floor area of the building is to be served by the lighting; (e) replacing: (i) a sanitary convenience with one that uses no more water than the one it replaces, (ii) a washbasin, sink or bidet, (iii) a fixed bath, (iv) a shower, (v) a rainwater gutter, or (vi) a rainwater downpipe, where the work does not include any work to underground drainage and includes no work to the hot or cold water system or above ground drainage, which may prejudice the health or safety of any person on completion of the work; (f) in relation to an existing cold water supply: (i) replacing any part, (ii) adding an output device, or (iii) adding a control device; (g) providing a hot water storage system that has a storage vessel with a capacity not exceeding 15 litres, where any electrical work associated with its provision is exempt from the requirement to give a building notice or to deposit full plans by virtue of regulation 9 or regulation 12(5)(b); (h) installation of thermal insulation in a roof space or loft space where: (i) the work consists solely of the installation of such insulation, and (ii) the work is not carried out in order to comply with any requirement of these Regulations
3A. Installation of thermal insulation to suspended timber floors where the work: (a) consists of the installation of such insulation only; and (b) the work is not carried out in order to comply with any requirements of these Regulations	

16.5 Part L: The requirement and general applicability

The formal requirement for Part L, as stated in technical requirement L1 of Schedule 1, is given in Table 16.5. In general, under regulation 21 the energy efficiency requirements of the Building Regulations including Part L apply to:

- any new building;
- the extension of any existing building;
- the carrying out of work to or in connection with any such building or extension if:
  - (a) it is a roofed construction having walls,
  - (b) it uses energy to condition the indoor climate, and
  - (c) it does not fall within the list of exemptions in regulation 12(3).

Methods by which the requirement set out in Table 16.5 may be satisfied are given in the Approved Documents, of which there are four, as shown in Table 16.6. Each of the Approved Documents gives details of more specific cases of applicability and exemptions. The Energy Efficiency Requirements of the Regulations are restated in the documents (according to their relevance to that document) and also the formal Part L Requirement as given in Table 16.5.

Table 16.5 Schedule 1 – Part L conservation of fuel and power.

Reasonable provision shall be made for the conservation of fuel and power in buildings by:
(a) limiting gains and losses:
  (i) through thermal elements and other parts of the building fabric; and
  (ii) from pipes, ducts and vessels used for space heating, space cooling and hot water services;
(b) providing fixed building services which:
  (i) are energy efficient;
  (ii) have effective controls; and
  (iii) are commissioned by testing and adjusting as necessary to ensure they use no more fuel and power than is reasonable in the circumstances

Table 16.6 List of Approved Documents.

Reference	Title	Date of coming into effect
Approved Document L1A	Conservation of fuel and power in new dwellings (2013 edition)	6 April 2014
Approved Document L1B	Conservation of fuel and power in existing dwellings (2010 edition), further amended in 2013	1 October 2010
Approved Document L2A	Conservation of fuel and power in new buildings other than dwellings (2013 edition)	6 April 2014
Approved Document L2B	Conservation of fuel and power in existing buildings other than dwellings (2010 edition) (further amended in 2013)	1 October 2010

16.6 Approved Document L1A: Conservation of fuel and power in new dwellings

16.6.1 General guidance

This approved document was redrafted in 2013 and is divided into a number of sections and appendices:

Section 1 – Legal requirements and an overview to demonstrating compliance
Section 2 – Design standards
Section 3 – Quality of construction and commissioning
Section 4 – Providing information
Section 5 – Model design
Appendix A – Key terms and abbreviations
Appendix B – Types of work covered
Appendix C – Reporting evidence of compliance
Appendix D – Documents referred to
Appendix E – Standards referred to

Types of work covered by AD L1A

As detailed in appendix B the guidance in AD L1A covers the following types of work:

(a) New dwellings created through new construction works.
(b) A new building which contains both living accommodation and space used for commercial purposes (live-work units), provided the commercial part could revert to domestic use on change of ownership, this may be the case if:
  - there is direct access between the living accommodation and the commercial space;
  - both are contained within the same thermal envelope;
  - the living accommodation occupies a substantial portion of the total area of the building. This rules out the case of a small manager's or caretaker's flat in a large non-domestic building. It is implied that the building must primarily be conceived of as being a dwelling in which part of the space is used commercially, e.g. a dwelling in which a room is used as an office or utility space.
(c) A new dwelling or dwellings constructed as part of a larger building that contains other types of accommodation (sometimes known as mixed use development). The non-dwelling parts of such a building (common areas, commercial or retail space) must be considered using AD L2A.

Approved document AD L1A does not apply to:

- Rooms for residential purposes (see section 16.2 for definition). These include nursing homes, student hostels and similar types of accommodation to which AD L2A applies.
- Dwellings created by material change of use of an existing building, AD L1B should be used in these cases.

Conservatories and porches

A conservatory or porch which is installed at the same time as the construction of a new dwelling, but outside the external fabric of the building, is therefore thermally separated from the building. In this case the performance of the dwelling must be assessed as if the conservatory or porch were not there. The dwelling's heating system must not be extended into the conservatory or porch.

If there is no effective thermal separation between a conservatory or porch and a dwelling or the dwelling's heating system is extended into the conservatory, then, by definition, the space is neither a conservatory nor a porch and must be included as an integral part of the dwelling when assessing compliance.

In the case of a conservatory or porch added as an extension to an existing dwelling, the guidance in AD L1B applies.

Swimming pool basins

Where a swimming pool is constructed as part of a new dwelling, heat loss from the pool basin should be limited by achieving a U-value of 0.25 $W/m^2.K$ or less. When assessing the dwelling, the TER/DER calculations should:

- include the pool hall,
- assume the pool basin is not there and has been replaced by an equivalent area of floor with the same U-value as the pool surround.

Demonstrating compliance

In order to demonstrate compliance, it is necessary to meet all of the following five criteria:

Criterion 1 The calculated rate of CO_2 emissions from the dwelling as built is less than or equal to the target emission rate from the dwelling.

$$\text{DER} \leq \text{TER}$$

Note that this is mandatory (Regulation 26).

In addition it is also necessary to show that the calculated fabric energy efficiency rate is less than or equal to the target energy efficiency rate.

$$\text{DFEE} \leq \text{TFEE}$$

Note that this is mandatory (Regulation 26A).

Criterion 2 The performance of the building fabric and the fixed building services should achieve reasonable overall standards of energy efficiency.

Criterion 3 The dwelling should have appropriate measures to limit the effect of heat gains on indoor temperatures in summer, whether or not the dwelling has mechanical cooling.

Criterion 4 The performance of the dwelling as built is consistent with the calculated DER.

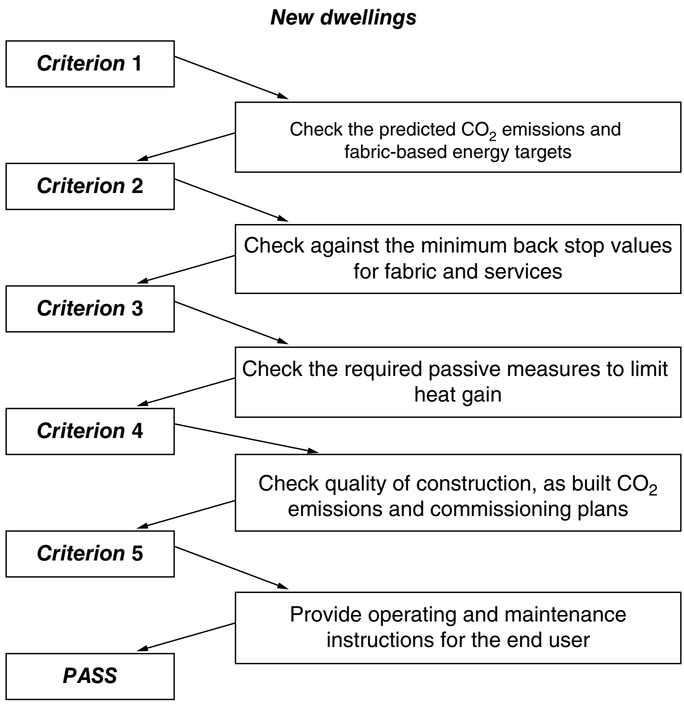


Fig. 16.1 New dwellings – the five criteria.

Criterion 5 The necessary provisions for energy-efficient operation of the dwelling are put in place.

These criteria are illustrated in Fig. 16.1 and are dealt with in turn in detail in subsequent sections of AD L1A. However, it should be noted that they are not wholly independent of each other. In particular, air permeability and pressure testing come under criterion 4, but the result affects the calculations necessary for criterion 1.

16.6.2 Design Standards: Criterion 1

Section 2 of AD L1A discusses criteria 1, 2 and 3. We begin with criterion 1.

The TER/DER and TFEE/DFEE

The essential feature of criterion 1 is the calculation of both the CO_2 emission rate and the Fabric Energy Efficiency Rate. The calculation of these must be in accordance with the procedures and data given in SAP 2012 [7] and carried out using an approved calculation tool. Table 16.7 lists those calculation tools that were approved at the date of publication. Further detail may be found at the SAP website: www.bre.co.uk/sap2012/.

It is worth noting at this stage that provided a dwelling satisfies the limits on design flexibility set out in Criterion 2 (see section 16.6.3), the designer can meet compliance

Table 16.7 Approved calculation tools for dwelling.

Official tools		
All dwellings	Government Standard Assessment Procedure SAP 2012	
Commercial implementations		
Elmhurst Energy Systems	www.elmhurstenergy.co.uk	EES SAP Design 2012
National Energy Services	www.nesltd.co.uk	NHER Plan Assessor v 6.1
Stroma Certification Ltd	www.stroma.com	Stroma FSAP 2012

with criterion 1 using fabric energy efficiency, system measures and low and zero carbon technologies in whatever mix is appropriate.

The Target Emission Rate (TER) and Dwelling Emission Rate (DER) calculations are carried out as follows:

(1) Calculate the TER from a notional dwelling of the same size and shape as the actual dwelling.
(2) Calculate an initial value of the DER from the actual dwelling, based on the plans and specifications of the dwelling as it is to be constructed. This must be done to enable both the builder and the BCB to discover whether or not the dwelling is likely to be compliant.
(3) Provide the BCB, not later than the day before work starts, with a notice which specifies:
    (a) the TER,
    (b) the initial DER,
    (c) a list of the specifications to which the building is to be constructed.
(4) Calculate a final value of the DER from the actual dwelling as constructed, allowing for any changes in specifications made during construction and using the measured value of air permeability.
(5) Not later than five days after completion, provide the BCB with:
    (a) a notice which specifies:
        (i) the TER and DER of the building as constructed,
        (ii) whether or not the building has been constructed according to the originally submitted list of specifications and if not, a list of any changes to those specifications, or
    (b) instead of the notice described in (a) above, a certificate, issued by an appropriately accredited energy assessor, stating that the dwelling as constructed and completed satisfies the CO_2 emission rate requirement of Regulation 17C (i.e. criterion 1).

In order to calculate the TER, the construction of the notional dwelling must be assumed to be according to the reference values given in Appendix R of SAP 2012. Table 16.8 gives these reference values.

Table 16.8 Reference values for TER calculation.

Element or system	Value
Climate data	UK average
Size and shape	Same as actual dwelling
Opening areas – windows and doors	Same as the actual dwelling up to a maximum for total area of openings of 25% of total floor area If the total area of openings in the actual dwelling exceeds 25% of the total floor area, reduce to 25% as follows: (1) Include all opaque and semi-glazed doors with the same areas as the actual dwelling (excluding any doors not in exposed elements, e.g. entrance door to a flat from a heated corridor) (2) Reduce area of all windows and roof windows by a factor equal to (25% of total floor area less area of doors included in 1) divided by (total area of windows and roof windows in actual dwellings)
Walls	U = 0.18 W/m^2.K
Party walls	U = 0
Floors	U = 0.13 W/m^2.K
Roofs	U = 0.13 W/m^2.K
Opaque door (<30% glazed area)	U = 1.00 W/m^2.K
Semi-glazed door (30–60% glazed area)	U = 1.20 W/m^2.K
Windows and glazed doors (>60% glazed area)	U = 1.40 W/m^2.K, double glazed, low-E hard coated Frame factor 0.7 Solar energy transmittance 0.63 Light transmittance 0.80 Orientation same as the actual dwelling Overshading same as the actual dwelling
Thermal mass	Medium (TMP = 250 kJ/m^2.K)
Roof windows	U = 1.4 W/m^2.K (adjustment factor of +0.3 W/m^2.K applied to roof window; resultant U-value = 1.7 W/m^2.K)
Curtain wall	To be treated as standard glazing and opaque wall with the same areas as the actual dwelling. When the total opening area exceeds 25% of total floor area, the glazed area to be reduced to 25% as for opening areas above U-value of opaque wall = 0.18 W/m^2.K U-value of glazing = 1.5 W/m^2.K (which includes an allowance of 0.1 for thermal bridging within the curtain wall)
Living area fraction	Same as actual dwelling
Number of sheltered sides	Same as the actual dwelling

Table 16.8 (*Continued*)

Element or system	Value
Allowance for thermal bridging	(1) If the thermal bridging in the actual dwelling has been specified by using the default y-value of 0.15 W/m².K, the thermal bridging is defined by y = 0.05 W/m².K (2) Otherwise the thermal bridging allowance is calculated using the lengths of junctions in the actual dwelling and the psi values provided in the Table R2 of the SAP 2012 document Note: Where the area of openings is >25% of the total floor area, the lengths of junctions in the notional dwellings remains the same as the lengths in the actual dwelling, even though window area is reduced as described for 'opening areas' above
Ventilation system	Natural ventilation with intermittent extract fans
Air permeability	5 m³/h.m² at 50 Pa
Chimneys	None
Open flues	None
Extract fans	2 for dwellings with floor area greater than 70 m² 3 for dwellings with floor area 70 to 100 m² 4 for dwellings with total floor area >100 m²
Main heating fuel for space and water	Mains gas
Heating system	Boiler and radiators; central heating pump in heated space
Boiler	If gas or oil combi boiler in the actual dwellings – Combi boiler Otherwise – Regular boiler Efficiency SEDBUK(2009) 89.5%, room sealed, fan-assisted flue, modulated burner control No hot water test for combi boiler
Heating system controls	(1) For a single-storey dwelling in which the living area is greater than 70% of total floor area, programmer and room thermostat (2) For any other dwelling, time and temperature zone control In all cases boiler interlock and weather compensation providing +3% boiler efficiency adjustment
Hot water system	Stored hot water, heated by boiler, separate time control for space and water heating

(Continued)

Table 16.8 (*Continued*)

Element or system	Value
Hot water cylinder	If cylinder specified in the actual dwelling – Volume of cylinder in actual dwelling If Combi boiler – No cylinder Otherwise – 150 litre cylinder If cylinder, declared loss factor = $0.85 \times (0.2 + 0.051V^{2/3})$ kWh/day, where V is the volume of the cylinder in litres
Primary water heating losses	Fully insulated primary pipework Cylinder temperature controlled by thermostat Cylinder in a heated space
Water use limited to 125 litres per person per day	Yes
Secondary space heating	None
Low-energy light fittings	100% of fixed outlets
Air conditioning	None

The TFEE is calculated by determining the fabric energy efficiency from a notional dwelling of the same size and shape as the actual dwelling and which is constructed according to the reference values set out in Appendix R of SAP 2012. This is then multiplied by 1.15 to give the TFEE.

The notional dwelling is evaluated using the appropriate calculation tool (currently based on CO_2 emission factors from SAP 2012), and from the results of the calculation, the following parameters must be extracted:

C_H – The CO_2 emissions arising from heating and hot water;
C_L – The CO_2 emissions arising from internal fixed lighting;
Cpf – The CO_2 emissions arising from pumps and fans.

The TER is then calculated using the formula

$$TER = C_H \times FF + Cpf + C_L$$

where FF is the Fuel Factor detailed in Table 16.9.

The fuel actually used is decided according to the following rules:

- When all the heating appliances in the dwelling burn the same fuel, then the fuel factor for that fuel must be chosen.

Table 16.9 The fuel factor FF for the most common fuels.

Heating fuel	**Fuel factor**
Mains gas	1.00
LPG	1.06
Oil	1.17
B30K	1.00
Grid electricity for direct acting and storage systems	1.55
Grid electricity for heat pumps	1.55
Solid mineral fuel	1.35
Any fuel with a CO_2 emission factor less than that of mains gas	1.00
Solid multi-fuel	1.00

- If a dwelling has more than one heating system served by different fuels, then choose the fuel factor for either:
  (i) mains gas if any of the heating appliances are fired by mains gas, or
  (ii) the fuel used in the main space heating system.
- Where a dwelling is served by a community heating scheme, choose:
  (i) mains gas if the community scheme uses gas for any purpose, or
  (ii) the fuel factor for the fuel that provides the most heat for that scheme.
- If an individual appliance burns only one fuel, then the fuel factor for that specific fuel is the appropriate one.
- If a heating appliance is classed as multi-fuel and the dwelling is NOT in a Smoke Control Area, use the multi-fuel factor FF = 1.
- If a heating appliance is classed as multi-fuel and the dwelling IS in a Smoke Control Area, then if the appliance IS approved for use in a Smoke Control Area, use the multi-fuel factor FF = 1.
- If a heating appliance is classed as multi-fuel and the dwelling IS in a Smoke Control Area but the appliance is NOT approved for use in a Smoke Control Area, use the solid mineral fuel factor FF = 1.35.

For a single building containing multiple dwellings such as a terrace of houses or a block of flats, a floor-area-weighted average TER can be calculated as follows:

$$TER_{av} = \frac{TER_1 \times A_1 + TER_2 \times A_2 + TER_3 \times A_3 + \cdots}{A_1 + A_2 + A_3 + \cdots}$$

where TER_1 and A_1 are, respectively, the TER and floor area of dwelling 1.

The average TFEE rate can be calculated according to an identical formula, replacing TER with TFEE.

The calculation of the DER and DFEE must be carried out with the same calculation tool that was used for the TER and TFEE but using values for the actual building. However, there are two exceptions, viz. secondary heating and lighting.

There may be circumstances where a secondary heating system provides part of the dwellings demand for space heating. The fraction of the demand provided by the secondary system must be as defined by SAP 2012. The rules regarding the use of a secondary heating appliance to be used in the DER calculation are:

(a) where a secondary heating appliance is fitted, the efficiency of the actual appliance with its appropriate fuel;
(b) where a chimney or flue is provided but no appliance is installed, the presence of one of the following appliances must be assumed:
  (i) if a gas point is located adjacent to the hearth, a decorative fuel effect fire open to the chimney or flue with an efficiency of 20%, or
  (ii) if there is no gas point, then an open fire with an efficiency of 37% burning multi-fuel, unless the dwelling is in a smoke control area in which case the fuel must be assumed to be smokeless solid mineral fuel;
(c) if neither (a) or (b) above applies, it must be assumed that the secondary heating system has the same efficiency as the main heating system and uses the same fuel, therefore effectively having no secondary system fitted.

The proportion of secondary heating which should be used depends on the particular combination of primary and secondary systems. It is necessary to consult SAP 2012, especially Appendix A and Table 11, for details.

Regarding internal lighting, the DER calculation must use the proportion of low-energy lamps actually installed in fixed lighting locations. It is important to note that the reference value for low-energy lighting for the notional building in SAP 2012 is 100% of fixed outlets when calculating the TER. AD L1A itself does not specify a minimum provision for low-energy lighting but refers to the *Domestic building services compliance guide* [8] for recommendations for a minimum which is 75%.

Buildings containing multiple dwellings

In the case of a building containing multiple dwellings, such as a terrace or a block of flats, criterion 1 can be tested by comparing the TER and DER of each dwelling individually. Alternatively, the average TER for all dwellings in the building can be compared with the average DER, in each case using the floor area-weighted average. The formula for the average TER is given in section 'The TER/DER and TFEE/DFEE', and a similar formula may be used for the average DER substituting the DER figure for the TER.

In terms of meeting the requirements of regulation 26A and TFEE, a building containing multiple dwellings will meet compliance if each DFEE is no greater than each individual dwelling's TFEE. Alternatively the average TFEE for all dwellings in the building can be compared with the average DFEE, in each case using the floor area-weighted average.

Where the option to demonstrate compliance using averages is used, it is still necessary to provide the calculation information for each individual dwelling. An average DER or DFEE cannot be calculated across separate multiple buildings on a site.

The common areas of buildings containing multiple dwellings are dealt with subject to whether they are heated or unheated, in the case of heated common spaces, the guidance in AD L2A. For unheated spaces the individual fabric of the space should follow the requirements of criterion 2 (see section 16.6.3).

Strategies for achieving criterion 1

The only way of being absolutely certain that a particular dwelling will satisfy criterion 1, i.e. that the DER is less than the TER and the DFEE is less than the TFEE, is to construct the actual dwelling entirely in accordance with the reference values detailed in Appendix R of SAP 2012 (see section 16.6.7 regarding model designs). However, there are also a number of design features and strategies which can improve the chances of success, such as:

- adopting roof, wall or floor constructions with U-values lower than the reference values,
- installing windows and doors with lower U-values than the reference values and/or restricting their total area to below 25% of the total floor area,
- achieving, by attention to construction detailing, an air permeability significantly less than 10 $m^3/h.m^2$,
- adopting low- or zero-energy supply systems, as discussed in *Low or zero carbon energy sources – strategic guide* [9].

The effectiveness of each of these or any other strategies depends on the overall design of the building, making it difficult to formulate rules for general guidance. In particular, although air permeability well below 10 $m^3/h.m^2$ may be easily achievable, any value less than 5 $m^3/h.m^2$ will have significant implications for the provision of adequate ventilation, and Part F (Chapter 11) should be consulted.

16.6.3 Design standards: Criterion 2

Criterion 1 does not lay down specific minimum standards for the thermal performance of a dwelling and its installed services (e.g. by specifying maximum permitted U-values). However the Part L requirement from schedule of the regulations requires that reasonable provision be made to limit heat gains and losses through the building fabric and that energy-efficient and effectively controlled building services are provided. This therefore allows a substantial measure of design flexibility and some trade-off between aspects of the design. In order to meet the requirement of Part L and prevent this flexibility being used unwisely, criterion 2 imposes limits on design flexibility. These limits apply to:

- the insulation standards (U-values) of the external envelope,
- the air permeability of the external envelope,
- the efficiency of fixed building services.

The details are as follows.

Design limits for the external envelope – U-values

Table 16.10 gives limiting (i.e. maximum) U-values which should not be exceeded. In this table, U_{av} is the area-weighted average U-value of all elements of each type:

$$U_{av} = \frac{U_1A_1 + U_2A_2 + U_3A_3 + \cdots}{A_1 + A_2 + A_3 + \cdots}$$

where U_1A_1 etc. refer to all the individual elements of that type. It should be noted that:

- if one element, for example, part of the external wall, has a high U-value, then the U-value of other elements of the external wall would have to have a sufficiently low U-value to bring the average down to the permitted maximum, i.e. 0.30 W/m².K for an external wall;
- the U-value of a window can be taken as that for:
  - the smaller of the two standard windows defined in BS EN 14352-1,
  - the standard configuration set out in BR 443, or
  - the specific size and configuration of the actual window;
- the U-value of a door can be taken as that for:
  - the standard size as laid out in BS EN 14352-1, or
  - the specific size and configuration of the actual window;
- the figures given in Table 16.10 for the U-values of windows assume that they are in the vertical position; if they are not mounted vertically, an adjustment to the U-value must be applied (see section 16.10 and BR 443) before making a comparison with the limiting maximum value in the table;
- in the absence of either measured or calculated values, the U-values for different window configurations given in Table 6e of SAP 2012 may be used.

The U-values themselves must be measured or calculated according to an approved method. Section 16.10 gives details.

Table 16.10 Limiting U-values – dwellings.

Element	**Maximum U_{av}, W/m².K**
Wall	0.30
Party wall	0.20
Floor	0.25
Roof	0.20
Windows, roof windows, glazed rooflights, curtain walling and doors	2.00
Swimming pool basin	0.25
Air permeability (m³/h.m² at 50 Pa)	10.0

Design limits for the external envelope: Air permeability

The limiting (i.e. maximum) value for the air permeability is 10 $m^3/h.m^2$ at a pressure difference of 50 Pa. It is important to note here that the reference value which must be used in the calculation of TER is less than this at 5 $m^3/h.m^2$. In practice this means that assuming any figure greater than 5 will result in the need for improvements above the other reference values for the dwelling in order to meet compliance.

Values of air permeability below 5 $m^3/h.m^2$ are achievable and could be assumed in the DER calculation in order to ensure that the initial DER is less than the TER. However this will affect the required amount of ventilation for the dwelling (see Part F). A failure of criterion 1 is possible if the measured air permeability, and hence the final post-completion value of the DER, is not as low as had been anticipated. Therefore it may be advisable to use the limiting value of 10 $m^3/h.m^2$ in the initial DER calculation. Hence, if the measured value of the air permeability satisfies the air permeability requirement, it is probable that the final DER will satisfy criterion 1.

Design limits for fixed building services

These include:

- heating and hot water systems;
- insulation of pipes and ducts;
- mechanical ventilation;
- mechanical cooling;
- fixed internal lighting;
- fixed external lighting.

Comprehensive and extensive details of the minimum acceptable performance for all these fixed building services are given in the *Domestic building services compliance guide* [8]. The purpose of that document is to provide guidance appropriate to the energy efficiency requirements of the building regulations and is therefore an essential accompaniment to the approved documents. The reader is therefore advised to consult the guide for specific details on all aspects of fixed building services. Some additional advice on dealing with fixed lighting is shown below.

Fixed internal and external lighting

The TER calculation specifies that 100% of the fixed outlets are low-energy light fittings; there is however no requirement to provide a specific proportion. The DER is calculated using the proportion actually installed. This means that if the proportion is less than 100%, compensatory measures will be required elsewhere.

The *Domestic building services compliance guide* [8] recommends that fixed internal lighting must include a reasonable proportion of low-energy light fittings. The minimum standards are as follows:

- Provide at least three low-energy light fittings (fixed lights or lighting units) per four of all light fittings (i.e. a minimum of 75% of the total) in all main dwelling areas, and

- Ensure that all lamps in the low-energy light fittings have a luminous efficacy of at least 45 lamp lumens per circuit-watt, where circuit-watt refers to the power consumed by the lamp and all its associated components, including control gear and power factor correction device.

Areas of a dwelling that are frequented only occasionally, such as cupboards and storage areas, do not count. Note also that mains frequency discharge lamps can give rise to stroboscopic effects with rotating or oscillating machinery and are therefore not recommended for areas where this might occur, such as garages. Further information on low-energy lighting is given in GIL 20 [10].

Fixed external lighting is defined as lighting fixed to the external surface of a dwelling and supplied from the occupier's electrical system. It does not include the lighting of common areas and access ways in buildings containing multiple dwellings. The recommended minimum standard is to provide light fittings with the following characteristics:

- Either ensure that the lamp capacity does not exceed 100 lamp-watts per light fitting and that all lamps switch off automatically when there is enough daylight or, if there is insufficient daylight, when the area being lit is unoccupied,
- Ensure that the external light fittings have sockets that can only be used with lamps whose efficacy is greater than 45 lumens per circuit-watt, that all lamps switch off automatically when there is enough daylight and that all light fittings are manually controllable by the occupants.

16.6.4 Design standards: Criterion 3

Limiting the effects of solar gain in summer

The 2013 edition of AD L1A does not directly specify a minimum standard for passive solar control measures. Nevertheless criterion 3 requires that provision should be made to limit internal temperature rise due to heat gains in summer. This is intended to eliminate, or at least minimise, the need for mechanical cooling. Suggested strategies for limiting solar gains, either singly or in combination, include:

- choosing window size and orientation to minimise solar gains;
- protecting windows with solar control measures such as shading, solar control glazing, etc.;
- providing the capability for adequate ventilation at night as well as during the day;
- choosing a structure (e.g. predominantly brick, concrete or similar masonry products) with high thermal capacity;
- if a balanced mechanical ventilation system is installed, consideration which should be given to either a summer bypass function during warm weather or by providing means for allowing sufficient natural ventilation.

However, these strategies can conflict with other requirements, for example:

- a desire to take advantage of solar gains in winter,
- the need to provide adequate daylight, and hence to avoid excessive use of electric lighting, daylight tends to become inadequate when the area of glazing falls below 20% of the total floor area,
- if the dwelling has a high thermal capacity structure, the need to increase the capacity of the heating system to provide adequate performance during preheating from cold.

Compliance with this aspect of criterion 3 can be checked by means of a procedure contained in Appendix P of SAP 2012. If the dwelling has mechanical cooling, the procedure should be carried out with the cooling system off but with an appropriate assumption concerning a ventilation rate through openable windows. If the SAP procedure indicates a low risk of high internal temperatures, then reasonable provision for satisfying criterion 3 has been achieved. Further general design guidance is given by *Reducing overheating – A designers guide* [11].

Heat losses and gains from circulation pipes

The *Domestic building services compliance guide* [8] provides guidance on the insulation of pipework to meet the permissible heat losses:

- Primary heating system circulation pipes passing through unheated spaces or certain voids,
- Primary hot water circulation pipes throughout their length,
- Pipework connected to how water storage vessels for a length of 1 m,
- All pipework heated by secondary circulation.

16.6.5 Quality of construction and commissioning: Criterion 4

The purpose of Criterion 4 is to ensure that the finished dwelling has been constructed and equipped in such a way that its performance is consistent with the final calculated value of its DER and DFEE. Minimum standards are set for two aspects of the completed dwelling, that is, the quality of construction of the building fabric (i.e. the external envelope) as built and the commissioning of the heating and hot water systems as installed. The first of these, the building fabric, is to ensure that:

- thermal insulation is reasonably continuous over the whole-building envelope, including thermal bridges and party walls;
- the air tightness of the external envelope is sufficient to ensure that the air permeability is within reasonable limits;
- it has been adequately demonstrated that both of these have been achieved.

The main sources of information on the continuity of thermal insulation and air tightness are:

- *Accredited construction details* [12]
- *Limiting thermal bridging and air leakage* [13].

Continuity of insulation and thermal bridges

The building fabric should be constructed so that there are no reasonably avoidable thermal bridges in insulation layers caused by gaps:

- within various elements,
- at joints between elements, and
- at the edges of elements such as windows and doors.

That reasonable provision which has been made may be demonstrated by:

- adopting quality-assured accredited construction details from an approved scheme, in which case the thermal bridge (linear thermal transmittance) values for those details provided by the scheme are acceptable,
- using a non-accredited detail, in which case suitable supporting calculations for quantifying the thermal bridge values must be carried out and provided by a person with suitable expertise and experience,
- using the thermal bridge values in the 'default' column of Table K1 in SAP 2012,
- using unaccredited details without suitable quantification of the thermal bridge values, in which case a default value of 0.15 $W/m^2.K$ is to be used in the DER calculation instead of individual thermal bridge values.

It is acceptable for both accredited and non-accredited details to be used in the same dwelling. Further details of thermal bridging parameters and calculations are given in section 16.10.6.

In addition, when using the approved construction detail approach, it may be necessary to demonstrate that an appropriate system of site inspection is in place to ensure that construction procedures achieve the required standards of consistency and performance.

A person of suitable expertise and experience may be assumed where suitable training and testing in the software used to carry out the calculation can be demonstrated.

Party walls

Party walls can also give rise to thermal bridging. If the wall penetrates an insulation layer, for example, where blockwork penetrates the insulation at ceiling level, a thermal bridge is likely to occur and must be accounted for.

Whereas the U-value of a party wall is taken as zero in the TER and TFEE calculation, the U-value used for the DER and DFEE calculation must be the as-built value. For a cavity party wall, the as-built U-value may not be zero, due to the possibility of heat being

Table 16.11 U-values for party walls.

Party wall construction	U-value, $W/m^2.K$
Solid	0.0
Unfilled cavity with no effective edge sealing	0.5
Unfilled cavity with effective sealing around all exposed edges and in line with insulation layers in abutting elements	0.2
Fully filled cavity with effective sealing at all exposed edges and in line with insulation layers in abutting elements	0.0

lost by external air circulating around and through the cavity. Because a party wall fulfils more than one function, its design and construction must therefore take into account not only this potential heat loss but also all other requirements of Schedule 1, especially the requirements of Part B (Fire) and Part E (Sound). Solutions to the heat loss problem may possibly conflict with the requirements of Part B and/or Part E.

When calculating the DER and DFEE and in the absence of specific independent evidence, an appropriate value selected from Table 16.11 may be used. It should be noted from this table that sealing the edges of the cavity reduces the U-value from 0.5 to 0.2 $W/m^2.K$ and that if in addition the cavity is fully filled, the U-value is further reduced to zero. In order to claim these reductions, it is necessary to demonstrate that the design will be robust and effective under normal site conditions. In particular, the edge sealing system should be applied in such a way as to be in line with the thermal envelope. This may require especially careful detailing in the case of a room-in-roof design. The general principle is that the seal forming the air barrier must be contiguous with the insulation layer.

Air permeability and pressure testing

Pressure testing is a mandatory requirement from regulation 43 but need only be carried out on a sample of the dwellings in a particular development. The approved test procedure is given in *Measuring air permeability of building envelopes (dwellings)* [14], specifically the method that tests the building envelope. Trickle ventilators should be sealed rather than just closed. In all cases it is the right of the BCB to select the sample to be tested, usually in consultation with the pressure tester. The rules governing the number of air pressure tests on each development are:

- test three units of each dwelling type or 50% of all instances of that dwelling type, whichever is the less,
- for each dwelling type, choose the test dwellings from the first completed batch of those dwellings,
- for each dwelling type, arrange for about half of the total number of required tests to be carried out during construction of the first 25% of those dwellings,
- for blocks of flats, treat each block as a single separate development, irrespective of the number of flats on the site,
- report all test results, including failures, to the BCB.

Compliance is demonstrated if both:

- the assessed air permeability is less than or equal to the limit value of 10 $m^3/h.m^2$ at a pressure difference of 50 Pa; and
- when the assessed air permeability is used to calculate the DER and DFEE, the DER and DFEE are less than or equal to both of, the corresponding TER and TFEE.

It is important to note that the air permeability used to calculate the TER and TFEE is 5 $m^3/h.m^2$. This means that even if the assessed air permeability is less than the limit value of 10 $m^3/h.m^2$ and meets compliance with the limiting value, it may nevertheless count as a fail if, when used in the DER and DFEE calculation, either of the resulting DER and DFEE figures are greater than the corresponding TER and TFEE. In some cases, the air permeability may need to be significantly less than 10 $m^3/h.m^2$ in order to produce a low enough result for a compliant DER and DFEE.

When calculating the DER and DFEE, the assessed air permeability is the measured figure for the dwelling. Where a dwelling has not been measured, the assessed figure used in the calculation is the average measured figure for dwellings of that type increased by 2 $m^3/h.m^2$.

The design value chosen for the air permeability for the preliminary calculation of DER ceases to be relevant once a measured value from the completed dwelling becomes available.

Failure of an air pressure test and its consequences

When a dwelling fails an air pressure test, remedial work and repeat test become necessary, but the remedial strategy will depend on the nature of the failure. An air pressure test may fail for one of the following three reasons:

(1) The measured air permeability exceeds the limit of 10 $m^3/h.m^2$.
(2) The measured air permeability does not exceed 10 $m^3/h.m^2$, but either of the resulting DER and DFEE exceeds the corresponding TER or TFEE.
(3) The measured air permeability exceeds the limit of 10 $m^3/h.m^2$, and also the resulting DER exceeds the TER.

For case 1, it is essential to improve the air tightness of the external envelope in order to get within the limiting permeability. This should be possible, because the target figure of 10 $m^3/h.m^2$ is not excessive and should be easily attainable with proper attention to design details and their execution on site. A permeability above the target is likely to indicate a major omission in sealing, draught proofing or membrane fixing, though it may not be easy to find the error.

Case 2 is most likely to arise if the design air permeability was chosen to be less than 10 $m^3/h.m^2$ in order to ensure that the predicted DER and DFEE were below the TER and TFEE. In this case remedial action to reduce the air permeability is possible but may be more difficult. Other features of the dwelling should also be considered for treatment.

Case 3 is similar to case 1, and improvements to the air tightness of the external envelope are essential. If, after retest, it is found that the air permeability satisfies the limit value but the DER and/or DFEE is still too high, case 3 then becomes an example of case 2 and must be treated accordingly.

If, after failing an air permeability test, a dwelling is found to be satisfactory after a retest, then it is necessary to pressure test one additional dwelling of the same dwelling type. Other untested dwellings of the same type should be inspected by the person undertaking the work and where necessary remedial measures applied.

Alternative to air pressure testing on small developments

On a development where only one or at most two dwellings are to be erected, air pressure testing can be avoided by either:

- demonstrating that during the preceding 12-month period a dwelling of the same dwelling type constructed by the same builder was pressure tested and achieved its design air permeability; or
- avoiding the need for pressure testing by using a value of 15 $m^3/h.m^2$ for the air permeability when calculating the DER and DFEE.

However, using 15 $m^3/h.m^2$ will result in an unusually high value of DER and DFEE and hence increased difficulty in satisfying criterion 1; if this approach is used, it would be advisable to include compensatory measures elsewhere in the design.

Commissioning of heating and hot water systems

Heating and hot water systems, including their controls, must be left such that:

- they have been correctly commissioned;
- they are in full and proper working order;
- they can operate efficiently for the purposes of the conservation of fuel and power.

It is recommended that a commissioning plan is prepared, identifying the systems and tests to be carried out. This plan could be provided to the BCB along with the design-stage TER/DER and TFEE/DFEE calculations, thereby enabling the commissioning work to be checked as work proceeds. A template for this purpose is available in the *Model commissioning plan* [15].

In some cases, commissioning, although possible or even advisable, is not necessary. Those fixed building services which do not require commissioning include:

- systems where adjustment is not possible; for example, if the only controls are 'on' and 'off' switches (some simple mechanical extract systems or single fixed electric heaters),
- systems where some adjustment is possible but where that would have no effect on energy use.

Commissioning must be carried out using approved procedures. For heating and hot water services, these are set out in:
Domestic building services compliance guide [8].

For ventilation systems they are set out in:
Domestic ventilation installation and commissioning compliance guide [16].

Commissioning may be carried out by a person registered with a competent person scheme, who may also be the person who installed the system. Alternatively it may be carried out by a subcontractor or a specialist firm.

Notice of completion of commissioning work should be given within the following timescales:

(1) Where a building notice or full plans have been given to a local authority BCB, the notice should be given to that BCB within five days.
(2) Where an approved inspector is the BCB, the notice should be given to the approved inspector within five days.
(3) Where the work is carried out by a person registered with a competent person scheme within 30 days.

Note also that where the installation of fixed building services is carried out by a person registered with a competent person scheme, the notice of commissioning must be given by that person.

16.6.6 Providing information: Criterion 5

Criterion 5 deals with the requirements of Regulation 40 provisions for energy-efficient operation of the dwelling and requires that the owner of a dwelling be provided with sufficient information about the dwelling, its fixed building services and their maintenance requirements so that the dwelling can be operated in an energy-efficient manner.

The operating and maintenance instructions should be provided in durable form and should:

- relate directly to the particular dwelling and to the particular services installed within it;
- should include relevant information in an easily understood format;
- include essential design information about the fabric and other key features;
- include plans detailing the location of the main heating and ventilation components;
- provide operating, control and maintenance details for the space heating, hot water and ventilation system;
- provide the same for any other technology or equipment provided in the dwelling;
- signpost other important documentation such as appliance manuals;
- include the data used to calculate the TER and DER (it would also be useful to retain an electronic copy of the input file to facilitate analysis of future alterations/ improvements);
- include the recommendations report generated in parallel with the 'on-construction' Energy Performance Certificate.

16.6.7 Model designs

L1A is framed to be as flexible as possible in order to encourage new and imaginative approaches to the task of designing energy-efficient dwellings. Excessive reliance on model designs would not only be contrary to this objective but may also result in the stereotyping of dwelling designs. Builders, especially those who develop large sites, may, over a period of time, develop a number of standard designs which they know will be likely to pass. This approach may not always be available to the small builder, doing one-off designs, but they may prefer to adopt a model design package rather than engage in design themselves. The 2013 version of approved document L provides for the first time a model design.

The TER and the TFEE are based on a dwelling of the same size and shape as the actual dwelling, constructed to a concurrent specification which is summarised in the approved document, and detailed in Appendix R of SAP 2012 (see Table 16.8). A dwelling constructed wholly in accordance with this specification will meet the required TER and be better than the required TFEE.

Although the use of the concurrent specification will guarantee a pass in terms of criterion 1, the requirements of the other criterion will still need to be considered. It is important to note that this concurrent specification cannot be guaranteed to be the most economical specification. In spite of the existence of a model design, it remains acceptable for designers to explore the most economic way of meeting the energy efficiency requirements.

Construction industry model designs may become available at www.modeldesigns.info.

16.6.8 Appendix A: Reporting evidence of compliance

Appendix A gives recommendations for facilitating communication between the builder and the BCB. The main recommendation is that the software chosen for the SAP 2012 calculation should include provision for producing suitable standardised outputs, as follows.

Output Version 1 – produced before commencement of the works, to include as a minimum:

- the initial TER/DER and TFEE/DFEE calculation,
- a supporting list of specifications.

This first version should assist the BCB in checking the design against that which is being built.

Output Version 2 – produced after completion, to include as a minimum:

- the as-built TER/DER and TFEE/DFEE calculation,
- a list of any changes to the specifications provided in version 1.

It is also strongly recommended that the software has the ability to trace input data back to the source of that data. For example, when a U-value for an element is entered into the software, it should be possible to identify the full product specification of that element, i.e. its composition and the source of its U-value (i.e. has it been calculated or measured

Table 16.12 Threshold values for alerting particular attention, AD L1A.

Parameter	Threshold value
Wall U-value	0.15 W/m^2.K
Roof U-value	0.13 W/m^2.K
Floor U-value	0.13 W/m^2.K
Window or door U-value	1.20 W/m^2.K
Part wall U-value	0.20 W/m^2.K
Thermal bridging value	0.04 W/m^2.K
Design air permeability	4.0 m^3/h.m^2 at 50 Pa
Any secondary heating appliance	
Any item involving SAP Appendix Q	
Use of any low-carbon or renewable energy technology	

using the correct procedures or measurement standards). A particular concern arises when the specification for a component includes an item of input data which is more favourable to the DER/DFEE calculation than would normally be expected for its type. Table 16.12 gives examples of threshold values which, if bettered, could attract particular attention from the BCB.

16.7 Part L1B: Conservation of fuel and power in existing dwellings

16.7.1 General guidance

This section includes:

- types of work covered by AD L1B;
- exemptions from AD L1B;
- historic buildings (see section 16.4.5);
- thermal elements and U-values.

The types of work to which the regulations apply and are covered by AD L1B include:

- the extension of a dwelling, and
- the carrying out of any building work to or in connection with an existing dwelling or an extension to an existing dwelling.

Extensions that fall within Class 7 in Schedule 2 to the Building Regulations may be exempt. These are the extensions of a building by the addition at ground level of:

- a conservatory, porch, covered yard or covered way, or
- a carport open on at least two sides,

where the floor area of that extension does not exceed 30 m^2.

The guidance in AD L1B covers:

- extensions to dwellings;
- the creation of a new dwelling, or part of a dwelling, through material change of use of an existing structure;
- work which results in a change in the energy status of a dwelling or part of a dwelling;
- the provision or extension of a controlled service or a controlled fitting;
- the replacement or renovation of a thermal element.

If the building work includes or affects areas which are not classified as a dwelling, for example, because they are part of a mixed use building or because they are common areas in a multiple dwelling building, then it will also be necessary to consult AD L2B.

The energy efficiency requirements of the regulations apply to work in existing dwellings, and so the BCB must, in most circumstances, be notified in the usual way, the exceptions being:

- Where the work is being carried out under the terms of an approved Competent Persons Scheme (see Table 16.3).
- Where the work involves an emergency repair (e.g. a failed boiler or leaking hot water cylinder). The repair work can be commenced without the need for advanced notification to the BCB. Nevertheless the work must comply with the requirements. Either the BCB must be given notice at the earliest opportunity, or if the installer is registered under an approved Competent Persons Scheme, a completion certificate must be issued.
- Where the work is minor, as described in Schedule 2B (see Table 16.4). The work must still comply but need not be notified to a BCB.

16.7.2 Guidance relating to building work

There is considerable cross-referencing in the approved document between this section and section 5 (U-values). This is because in all cases covered by AD L1B, one of the main criteria for compliance with the requirements of heat loss through the building envelope is the U-values of the thermal elements. Sections 4 and 5 should therefore be consulted together.

A new extension to an existing dwelling: Normal approach

When constructing a new extension to an existing dwelling, it is necessary to take into account:

- maximum U-values for all the newly constructed thermal elements of the external fabric;
- maximum U-values and a maximum total area for the windows, doors and rooflights;
- improvements to existing fabric elements that become thermal elements as a result of the building work (see sections 'Renovation of thermal elements' and 'Retained thermal elements');

Table 16.13 U-value standards.

Thermal element or controlled fitting	New thermal element or fitting in an extension	Upgrade of a renovated or retained thermal element or fitting	
	Maximum U-value, $W/m^2.K$	Threshold U-value, $W/m^2.K$	Improved U-value, $W/m^2.K$
Column no.	1	2	3
Wall suitable for insulation in cavity	0.28	0.70	0.55
Wall insulated externally or internally	0.28	0.70 (see note 1)	0.30 (see note 1)
Pitched roof – insulation at ceiling level	0.16	0.35	0.16
Pitched roof – insulation at rafter level	0.18	0.35 (see note 2)	0.18 (see note 2)
Flat roof or roof with integral insulation	0.18	0.35 (see note 3)	0.18 (see note 3)
Floors (see notes 4 and 5)	0.22	0.70	0.25
Window, roof window or rooflight	1.60 or WER band C or better	n/a	n/a
Door, 60% or more of internal face glazed	1.80 or DSER band E or better	n/a	n/a
Other doors	1.80	n/a	n/a
Swimming pool basin	0.25		

Note 1: A lesser provision may be permissible if achieving this standard requires a reduction of 5% or more in the floor area of the room bounded by the wall.

Note 2: A lesser provision may be permissible if achieving this standard creates limitations on headroom. If so, the depth of insulation should be not less than the depth of the rafters less any required ventilation, and the insulation materials should achieve the best practicable U-value.

Note 3: A lesser provision may be permissible if there are particular problems associated with the load-bearing capacity of the frame or the upstand height.

Note 4: A lesser provision may be permissible if achieving this standard creates significant problems in relation to adjoining floor levels.

Note 5: The U-value of the floor of an extension can be calculated using the exposed perimeter and floor area of the whole enlarged building (see section 16.10.4).

- minimum requirements for fixed building services which are provided or extended including heating, lighting, hot water, mechanical ventilation, etc. (see section 'Requirements for fixed building services').

Maximum U-values for newly constructed thermal elements and controlled fittings should be chosen from column 1 of Table 16.13. The maximum area of windows and doors and rooflights should be calculated from

$$\text{Maximum area} = 0.25A_F + A_{old}$$

where A_F is the floor area of the extension and A_{old} is the area of any windows or doors which no longer exist or are no longer exposed as a result of the new extension. The BCB may allow some flexibility in the calculation of the maximum area if there is a problem in achieving sufficient daylight in the extension. This flexibility may also be allowed if it is agreed that a greater area of glazing is needed to make the extension consistent with the external appearance of the building to which it is attached. However, it would be expected that an increase in the allowed area above the normal minimum would be accompanied by compensatory measures elsewhere in the building, e.g. by lower U-values to the external fabric or to the windows themselves.

If the normal approach to demonstrating compliance is found to be too restrictive, there are two alternatives:

- The area-weighted U-value method, or
- The whole dwelling calculation method.

The first of these allows for some modest flexibility in achieving a compliant design, whereas the second allows a much greater degree of flexibility.

A new extension to an existing dwelling: The area-weighted U-value method

Some design flexibility in the choice of U-values and opening areas is possible, provided that the area-weighted U-value of all the elements in the extension is equal to or less than the area-weighted U-value for an extension of the same shape and size that complies with the standard limits on U-values and opening areas. The area-weighted average U-value is calculated in the usual way from

$$U_{av} = \frac{U_1A_1 + U_2A_2 + U_3A_3 + \cdots}{A_1 + A_2 + A_3 + \cdots}$$

When using this approach, the guidance on thermal elements in section 16.7.3 should be borne in mind

A new extension to an existing dwelling: The whole dwelling calculation method

This approach provides greater design flexibility than the area-weighted U-value method. It requires the following steps:

- Using SAP 2012, calculate the CO_2 emission rate from the dwelling and its proposed extension.
- Using SAP 2012, calculate the CO_2 emission rate from the dwelling with a notional extension, of the same size and shape as the proposed extension, built to the reference standards for U-values and opening areas (i.e. as in section 'A new extension to an existing dwelling – Normal approach'). The openings in the notional extension should

be such that the door area equals that of the proposed extension, with the remainder of the openings being classified as windows.
- Show that the CO_2 emission rate for the dwelling plus proposed extension is equal to or less than that for the dwelling plus notional extension.
- If, in order to achieve 3 above, it is necessary to improve the thermal performance of parts of the existing dwelling which will be retained, then they should, after improvement, have a U-value that is equal to or less than the 'improved' value in column 3 of Table 16.13.

If the thermal performance of elements of the existing dwelling is not known, the data in Appendix S of SAP 2012 or in section 16.10 can be used in the SAP calculation. Where upgrades to the existing dwelling are proposed, it is recommended that it would be cost effective to implement them in full, even if the standard of the extended dwelling is better than that required.

Conservatories and porches

Conservatories and porches which are not exempt must be thermally separated from the heated area of a dwelling. To be regarded as providing thermal separation, the walls, doors and windows between the conservatory or extension and the heated space must be insulated and draught stripped to at least the same standard as the rest of the existing dwelling, together with the following requirements:

- The U-values of glazed elements must not exceed the relevant values for new glazed elements in column 1 of Table 16.13.
- The U-values of all other elements must not exceed the values for new thermal elements in column 1 of Table 16.13.
- Any heating system in the conservatory or porch must have independent temperature and ON/OFF controls.
- Any fixed building service installed in the conservatory or porch must satisfy the requirements described in section 'Requirements for fixed building services'.

Note that the limitation on the total area of windows, roof windows and doors for extensions (section 'A new extension to an existing dwelling – Normal approach') does not apply to a non-exempt conservatory that meets the above requirements.

In the case of an existing conservatory or porch extension the exemption will cease to apply if:

- the thermal separation between the dwelling and the extension is removed and not replaced, or
- the dwelling's heating system is extended into the extension.

If either or both of these apply, the extension is no longer exempt. This means that the extension must be treated as a new extension and is therefore subject to all the relevant requirements.

Swimming pool basins

Where a swimming pool basin is being provided, the U-value of the basin (walls and floor) should not exceed 0.25 $W/m^2.K$, as calculated according to BS EN ISO 13370 [6].

Material change of use and change of energy status

According to Regulation 5, a dwelling is said to be formed by material change of use when:

- the building is used as a dwelling where previously it was not,
- the building contains a flat where previously it did not, or
- the building, which contains at least one dwelling, contains a greater or lesser number of dwellings than it did previously.

A change in energy status occurs when any building which was previously exempt from Part L is altered in such a way that the exemption is no longer valid. Examples of alterations which constitute a change in energy status include:

- any building being provided with heating whereas previously it was not,
- parts of a building that have been designed or altered to be used separately being heated whereas previously they were not,
- any previously exempt building that has been subject to any change which results in it being no longer in an exempt category.

In carrying out a material change or a change in energy status, attention must be paid to:

- the provision or extension of controlled fittings, i.e. windows, roof windows, rooflights and doors;
- the provision of new or extended fixed building services;
- the possible need to replace an existing window, roof window, rooflight or door;
- new, replaced, renovated or retained walls, roofs and floors (i.e. thermal elements).

Controlled fittings and fixed building services should adhere to the guidance in sections 'Controlled fittings' and 'Requirements for fixed building services', respectively.

New and replacement thermal elements should meet the U-value standards given in column 1 of Table 16.13. Retained thermal elements should be upgraded to meet the standards given in section 'Retained thermal elements'.

The area of openings should not be more than 25% of the total floor area of the newly created dwelling. If a greater area is necessary or if any other flexibility in the design is desired, SAP 2012 should be used to demonstrate that the CO_2 emissions from the completed dwelling are no worse than if the dwelling had been created following the standard guidance. If more than one dwelling has been created, the total CO_2 emissions from all the dwellings should be no greater than if each dwelling had been created following the standard guidance.

Controlled fittings

In this context, a controlled fitting means a window, roof window, rooflight or door and in all cases refers to the complete unit, including the frame. It follows that replacing the glazing whilst retaining the existing frame is not providing a controlled fitting; such work is therefore not notifiable and there is no U-value requirement.

Where a new or replacement controlled fitting is provided, it should meet the U-value standard given in column 1 of Table 16.13. In addition:

- units should be draught proofed,
- cavity closers should be installed where appropriate.

If replacement windows cannot meet the U-value standard of Table 16.13 due to a need to maintain the character or external appearance of the dwelling, then it would be acceptable to provide replacement windows with:

- a maximum centre pane U-value of 1.2 $W/m^2.K$, or
- single glazing with weather-stripped low-e secondary glazing.

If a window is enlarged or a new one is created, then the total area of windows, roof windows, rooflights and doors should not exceed 25% of the total floor area of the dwelling unless compensating measures are made elsewhere.

See sections 'Renovation of thermal elements' and 'Retained thermal elements' for further details of renovated and retained units and also section 16.10 for further details on the U-values of controlled fittings.

Requirements for fixed building services

The minimum requirements for all fixed building services, including renewable systems, may be demonstrated by following the guidance set out in the *Domestic building services compliance guide* [8]. Three cases are highlighted in AD L1B:

- When replacing an existing appliance, the efficiency should not be significantly less than the efficiency of the appliance being replaced. If the replacement involves a change of fuel, then the relative carbon emissions of the new and existing fuels should be considered – section 'Heating and hot water systems' gives details regarding the replacement of the primary heating appliance.
- If a renewable energy device such as a wind turbine or photovoltaic array is being replaced, the new system should have an electrical output no less than the original installation.
- When replacing a heating appliance, connection to a local heat network should be considered, and if a network does not already exist, the possibility of providing capped off connections to pipework to facilitate connection to any future planned network should be considered.

If the proposed fixed building services include a technology not covered in the *Domestic building services compliance guide* [8], then it is reasonable to show that the proposed technology gives a performance no worse than a reference system of the same type whose details can be found in the guide.

Heating and hot water systems

If the heating and/or hot water system of the existing dwelling is to be extended or altered or if as a result of the building work, a new appliance or system is to be installed, then it is necessary to install an appliance and controls that meet minimum requirements and to ensure that pipes and ducts are suitably insulated. The *Domestic building services compliance guide* [8] provides all the relevant criteria. When replacing the primary heating appliance, the requirement depends on whether or not the replacement unit uses the same fuel or energy source. If the new appliance does not involve a change in fuel or energy, then:

- the seasonal efficiency of the new equipment should be as stated in the relevant fuel-based section of the compliance guide, and
- not worse than 2% points lower than the seasonal efficiency of the controlled service being replaced. If the efficiency of the appliance to be replaced is not known, efficiency values may be taken from Table 4a or 4b of SAP 2012.

If the new appliance uses a different fuel, the same comparison is made as above, but before making the comparison with the old appliance, the efficiency of the new appliance must be adjusted according to the CO_2 emission factors of the new and old fuels from Table 12 of SAP 2012 to create a carbon equivalent efficiency. Table 16.14 details the emission factors for the commonly used fuels.

Table 16.14 The CO_2 emission factors for various fuels.

Fuel	CO_2 emission factor, $kgCO_2/kWh$
Mains gas	0.216
Bulk LPG	0.241
Biogas (including anaerobic digestion)	0.098
Heating oil	0.298
House coal	0.394
Anthracite	0.394
Manufactured smokeless fuel	0.433
Dual fuel appliances (mineral + wood)	0.226
Biomass	0.016
Electricity, grid supplied	0.519
Electricity, displaced from grid	0.519
Waste heat from power stations	0.058

Commissioning of fixed building services

This is essentially the same as for new dwellings (see section 'Commissioning of heating and hot water systems').

16.7.3 Guidance on thermal elements

Section 5 of AD L1B gives details of the requirements for the U-values of thermal elements etc. when carrying out work on existing dwellings. Further information on U-values and thermal bridging can be found in section 16.10.

The U-values of thermal elements and windows

The principal standards for maximum U-values for work on existing dwellings are collected together in Table 16.13. In this table, column 1 applies to new thermal elements and to both new and replacement controlled fittings (i.e. windows, roof windows, rooflights and doors). Column 3 applies to renovated thermal elements (see section 'Renovation of thermal elements'), and columns 2 and 3 apply to retained thermal elements (see section 'Retained thermal elements'). Note that the U-values for roof windows and rooflights in this table assume that the unit has been assessed in the vertical position. When making the comparison with the quoted value for a unit, the U-values should be adjusted so that they correspond to the actual slope of the installed unit.

The Window Energy Rating (WER) is found from

$$\mathrm{WER} = 196.7 \times \left(\left(1 - \mathrm{f}\right) \times g_{\mathrm{glass}}\right) - 68.5 \times \left(\mathrm{U} + \left(0.0165 \times \mathrm{AL}\right)\right)$$

where

f, the frame factor, is the percentage of the widow obscured by frame and gaskets,
g_{glass} is the normal total solar energy transmittance of the glass (BS EN 410),
U is the U-value of the whole window including frame,
AL is the air leakage through the whole window area, $m^3/h.m^2$ averaged over the whole window area (BS 6375-1:2009 [18]).

The rating bands are as shown in Table 16.15. Band A indicates the best performance and so, for a particular case, the band nearest to A is chosen. For example, if WER is calculated to be −16, the window would good enough to be rated as band C but not good enough for band B.

Table 16.15 Window Energy Rating Bands, WER.

Band	A	B	C	D	E	F	G
Numerical BFRC rating value	0	−10	−20	−30	−50	−70	−71

Where appropriate, the average U-value of an element is the area-weighted value found from

$$U_{av} = \frac{U_1A_1 + U_2A_2 + U_3A_3 + \cdots}{A_1 + A_2 + A_3 + \cdots}$$

where U_1A_1 etc. are the individual U-values and areas of the parts of the element.

Renovation of thermal elements

Renovation occurs when a thermal element is either provided with a new layer or has an existing layer replaced. The manner in which this may be done is as follows.

A new layer may be provided by either:

- cladding or rendering the external surface of the thermal element, or
- dry lining the internal surface of a thermal element.

An existing layer may be replaced by either:

- stripping down the element to expose the basic structure and then rebuilding to achieve the required performance, or
- replacing the waterproof membrane on a flat roof.

The relevant maximum permissible U-value is given in column 3 of Table 16.13, but this is only a specific requirement if the area to be renovated exceeds either:

- 50% of the area of the individual element, or
- 25% of the total area of the building envelope.

Note that the area to be renovated need pass only one of these tests for the U-value requirement to apply. Care should be taken in deciding which area is to be used as the reference in calculating the percentages. The following examples illustrate this:

- Removal of plaster finish from the inside of a solid brick wall – The area of the element is the area of the external wall of the room.
- Removal of the external render from a wall – The area is the elevation in which that wall sits.
- Stripping all the roofing from a flat roof extension – The area is the roof area of the extension.
- Removal of the external render from the rear wall of a single-storey extension – The area is the wall of the extension (not the rear elevation of the property when viewed from the rear).

If it is neither technically nor functionally feasible to renovate a thermal element to meet the standard given in column 3 of Table 16.13 or if in achieving this standard the element could not achieve a simple payback of 15 years or less, then the element should be upgraded to the best achievable standard that does provide a simple payback of 15 years or less. Details of possible cost-effective renovation strategies are given in Appendix A of the approved document.

Retained thermal elements

A retained thermal element comes about when:

- an existing thermal element is part of a building subject to a material change of use;
- an existing element becomes part of the thermal envelope of a building where previously it was not, e.g. part of a loft or garage conversion where a previously unheated space is now heated.

A retained thermal element whose U-value is greater than the threshold in column 2 of Table 16.13 should be upgraded to a U-value equal to or less than the improved value given in column 3 of Table 16.13, provided that this is technically, functionally and economically feasible. In this context, economic feasibility is satisfied when a simple payback of 15 years or less is achieved.

If the improved U-value standard in column 3 cannot be achieved technically, functionally or economically, then the retained thermal element must be upgraded to the lowest possible U-value that will still give a simple payback of 15 years or less. This could apply when, for example:

- the necessary thickness of extra insulation reduces the usable floor area by more than 5%,
- the extra insulation creates difficulties with adjoining floor levels,
- the weight of additional insulation is too great for the existing structure.

If these problems cannot be resolved, then the element should be upgraded to the best standard possible, such that it achieves a simple payback of 15 years or less. Even so, the finished U-value must not be higher than 0.7 $W/m^2.K$.

16.7.4 Consequential improvements to energy performance

If an existing building has a useful floor area of more 1000 m^2, there is a requirement to carry out consequential improvements when any proposed work consists of:

- an extension,
- the initial provision of any fixed building service (other than a renewable energy generator), or
- an increase in the installed capacity of any fixed building service (other than a renewable energy generator).

Very few existing dwellings exceed 1000 m^2 floor area, and so the relevant guidance for such cases is given in AD L2B.

16.7.5 Providing information

On completion of the work, the owner of the dwelling must be provided with sufficient information about the building, the fixed building services and their operating and maintenance requirements so that the dwelling can be operated to use no more fuel and power than is reasonable. This requirement applies only to the work that has actually been carried out. The operating and maintenance instructions should be provided in durable form, and should:

- relate directly to the particular dwelling and to the particular services that have been provided;
- explain how to achieve economy in the use of fuel and power;
- be written in layman's language so that they are comprehensible to the householder;
- specifically, explain how to make adjustments to any time, temperature and flow settings;
- specify the routine maintenance that is necessary to maintain optimum operating efficiency over the service life of the system.

16.7.6 Work to thermal elements

When carrying out any of the work to which AD L1B applies, the renovation or upgrading of thermal elements is a possibility or even a necessity. Table A1 in Appendix A of AD L1B gives numerous practical examples of cost-effective methods for renovating typical roofs, walls and floors in order to achieve a specified target U-value. See section 16.10 for details on thermal bridging, continuity of insulation, etc.

16.8 Part L2A: Conservation of fuel and power in new buildings other than dwellings

16.8.1 General guidance

This approved document was redrafted in 2013 and is divided into a number of sections and appendices:

Section 1 – Legal requirements and an overview to demonstrating compliance
Section 2 – Design standards
Section 3 – Quality of construction and commissioning
Section 4 – Providing information
Section 5 – Model design
Appendix A – Key terms and abbreviations
Appendix B – Types of work covered
Appendix C – Reporting evidence of compliance
Appendix D – Documents referred to
Appendix E – Standards referred to

Types of work covered by AD L2A

The guidance covers:

- the construction of new buildings other than dwellings;
- fit-out works where the work is part of the construction of a new building;
- fit-out works where the work is part of the construction of a new building or the first fit-out of a shell and core development where the shell is sold or let before the fit-out work is carried out (Note AD L2B applies to fit-out works in other circumstances);
- the construction of extensions to existing buildings that are not dwellings where the total useful floor area of the extension is greater than 100 m^2 and is also greater than 25% of total useful floor area of the existing building;
- the construction of new buildings which contain rooms for residential purposes (e.g. hostels, student accommodation blocks, boarding houses etc.) but do not contain a dwelling (see section 16.2 for definitions for rooms for residential purposes and for dwellings);
- where a building contains one or more dwellings, the construction of those parts of the building which are used for other purposes, including heated common areas between and providing access to dwellings and in mixed use buildings, commercial areas, retail space, etc. (but see exception below).

Document AD L2A does not apply to a new building which contains both living accommodation and space used for industrial or commercial purposes, subject to the following conditions:

- the commercial part could revert to domestic use on change of ownership;
- there is direct access between the living accommodation and the commercial space;
- both are contained within the same thermal envelope;
- the living accommodation occupies a substantial portion of the total area of the building;
- a dwelling in which a room or rooms is used for office work or as utility space.

The implication of these conditions is that the building must be conceived of primarily as being a dwelling in which part of the space is used commercially; in this case AD L1A applies. Note, however, that in the case of a large non-domestic building in which a small proportion of its floor is designed as dwelling space (e.g. a manager's or caretaker's flat), only the flat would be treated as being a dwelling to which AD L1A applies, the remainder of the building being subject to AD L2A. Note also that conservatories, porches and swimming pool basins that are installed at the same time as the construction of a new building are covered by AD L2B and not AD L2A.

Buildings which are exempt from Part L are listed in section 16.4.

Demonstrating compliance

In order to demonstrate compliance, it is necessary to meet all of the following five criteria.

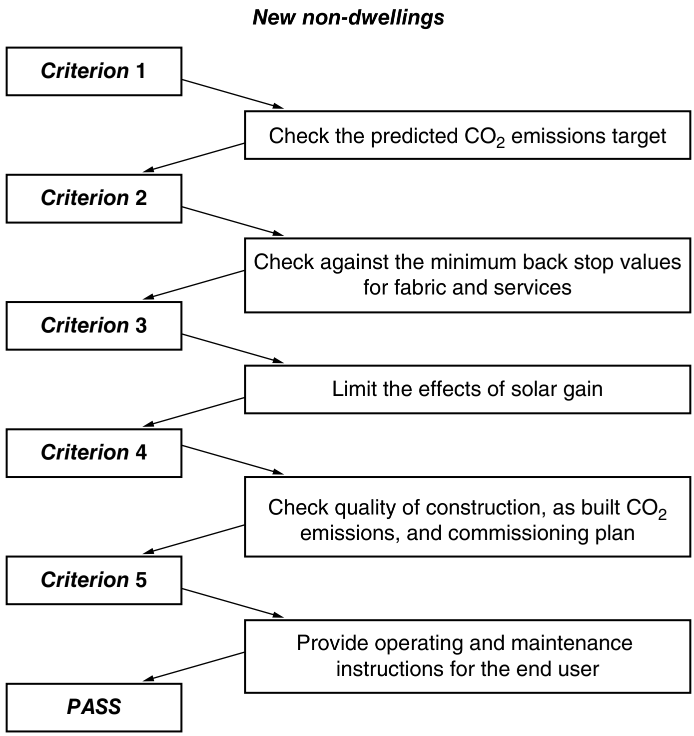


Fig. 16.2 New non-dwellings – the five criteria.

Criterion 1 The calculated CO_2 emission rate from the building as constructed is less than or equal to the target emission rate from an equivalent notional building, i.e.:

$$BER \leq TER$$

Criterion 2 The performance of the building fabric and the heating, hot water and fixed lighting systems meets or exceeds certain minimum standards for energy efficiency.

Criterion 3 The building has appropriate passive control measures to limit heat gains in the summer.

Criterion 4 The performance of the building as built is consistent with the calculated BER.

Criterion 5 Provisions enabling energy-efficient operation of the building are in place.

These criteria are illustrated in Fig. 16.2 and are dealt with in turn in detail in subsequent sections of the AD L2A. However, it should be noted that they are not wholly independent of each other. In particular, air permeability and pressure testing come under criterion 4, but the results affect the calculations necessary for criterion 1.

16.8.2 Design standards: Criterion 1

Section 4 of AD L2A discusses criteria 1, 2 and 3. We begin with criterion 1.

Criterion 1: The TER and the BER

The essential feature of criterion 1 is the calculation of CO_2 emission rates. The calculation must be carried out using an approved calculation tool. The calculation tools are normally available in the form of computer software, and new software may be approved from time to time. Currently approved calculation tools are shown in Table 16.16. It will be necessary, when applying to the BCB, to show that the chosen software tool is appropriate for the application.

The TER and BER calculations are carried out as follows:

(1) Calculate, using one of the approved calculation tools, the CO_2 emission rate from a notional building of the same size and shape as the actual building but constructed with specified properties. The TER is set equal to the CO_2 emission rate of the notional building with no further adjustment.
(2) Calculate, using the same calculation tool, a design-based value of the BER from the actual building, based on the plans and specifications of the building as it is to be constructed.
(3) Check that the

$$BER \leq TER$$

If the check is satisfied, provide the BCB with:

- the TER,
- the calculated BER,
- a list of the specifications of the building envelope and the fixed building services that were used in the BER calculation.

(4) On completion, calculate a new value of the BER for the actual building as constructed, allowing for any changes in performance specifications made during construction and using measured values of the air permeability.

Table 16.16 Approved Part L 2013 calculation tools for buildings other than dwellings.

Company	Software name	Software version	Date approved
IES Ltd	Virtual Environment	v 7.0.2	15 Sep 2014
Environmental Design Solutions	TAS	v 9.3	03 Oct 2014
Bentley Systems (UK) Ltd	Design Database	v 26.03	19 Sep 2014
DesignBuilder Software Ltd	DesignBuilder SBEM	v 4.2.0	30 Sep 2014
BuildDesk Ltd	Carbon Checker	v 1.8.1	16 Sep 2014
G-ISBEM	G-ISBEM	v 18.0	12 Sep 2014
NES Ltd	NHER	v 1.4	23 Sep 2014
Property Tectonics Ltd	Lifespan SBEM	v 5.2d	19 Sep 2014
DCLG	iSBEM	SBEM 5.2d	30 Jul 2014

(5) Provide the BCB with:
- a notice specifying the TER and the final as constructed BER,
- a statement that the building has been constructed in accordance with the design-stage list of specifications originally submitted or if not, a statement detailing all changes to that list. BCB's are authorised to accept, as evidence of compliance, a certificate to this effect signed off by a suitably qualified energy assessor.

Calculating the TER: The notional building

In order to calculate the TER, the construction of the notional building must be assumed to be according the reference concurrent specification given in the 2013 edition of the *National Calculation Methodology (NCM) modelling guide* [19]. Full details of the reference specification are extensive, and so only the headline issues are provided here (see Table 16.17).

The new concurrent specification provided in the modelling guide is designed to achieve an overall improvement in CO_2 emissions of 9% across the new build mix for the non-dwellings sector. Some building types will be required to improve by more than 9% and some by less, but all should achieve the required level of improvement at approximately the same cost of carbon mitigation.

Calculating the BER: The actual building

The BER must be calculated, using the same approved calculation tool as for the TER, but using data for the actual building as constructed, allowing for any changes made during construction to performance specifications and using measured values of the air permeability. The BER calculation requires the carbon emission factors of the fuels actually used. A full list of emission factors is given in Table 12 of SAP 2012 [7]. Emission factors for the most commonly used fuels are listed in Table 16.14.

When there is only one fuel to be considered, the appropriate value may be selected directly from the table. In the case of ambient energy sources or multiple fuels, the following should be taken into account.

All systems

For all the following cases, the BER submission must be accompanied by a report, signed by a suitably qualified person and showing in detail how the average carbon emission factor has been calculated.

Grid displaced electricity

This comprises all electricity generated in or on the building premises by, for example, PV panels, wind-powered generators, CHP, etc. The associated CO_2 emissions are deducted from the total CO_2 emissions for the building before calculating the BER. However, the CO_2 emissions arising from fuels used by the building's power generation system (e.g. to power a CHP engine) must be included in the calculation of the building CO_2 emissions.

Table 16.17 Reference specification for the notional building.

Element	Side lit or unlit (heating only)	Side lit or unlit (includes cooling)	Top lit
Roof U-value	0.18	0.18	0.18
Wall U-value	0.26	0.26	0.26
Floor U-value	0.22	0.22	0.22
Window U-value	1.6 (10%FF)	1.6 (10%FF)	n/a
G-value	40%	40%	n/a
Light transmittance	71%	71%	n/a
Roof light U-value	n/a	n/a	1.8 (15%FF)
G-value	n/a	n/a	55%
Light transmittance	n/a	n/a	60%
Air permeability			
GIA 250–3500 m^2	5	5	7
GIA 3501–9999 m^2	3	3	5
GIA over 10,000 m^2	3	3	3
Lighting luminaire (lm/circuit-watt)	60	60	60
Occupancy control	Yes	Yes	Yes
Daylight control	Yes	Yes	Yes
Maintenance factor	0.8	0.8	0.8
Constant illuminance control	No	No	No
Heating efficiency	91%	91%	91%
Central ventilation SFP (W/l/s)	1.8	1.8	1.8
Terminal unit SFP (W/l/s)	0.3	0.3	0.3
Cooling (A/C) (SEER/SSEER)	n/a	4.5/3.6	4.5/3.6
Cooling (mixed mode) (SSEER)	n/a	2.7	2.7
Heat recovery efficiency	70%	70%	70%
Variable speed control of fans and pumps, controlled via multiple sensors	Yes	Yes	Yes
Demand control (mechanical ventilation only) variable speed control of fans via CO_2 sensors	Yes	Yes	Yes

Waste heat

The emission factor for waste heat takes into account the reduction in electricity generation that occurs where heat is produced at a high enough temperature to provide community heating.

Biomass heating

Where a biomass heating appliance is supplemented by an alternative appliance (e.g. gas), the CO_2 emission factor should be calculated as an average of the emission factors of the two fuels weighted according to their anticipated usage.

Dual fuel appliances burning biomass and a fossil fuel

The CO_2 emission factor for dual fuel appliances should be used, except that the figure for anthracite should be used when the building is in a smoke control area.

All other cases where more than one fuel can be used

The highest of the emission factors of those fuels should be used.

Thermal energy supplied from a district or community heating or cooling system

The emission factor should be based on the annual average performance of the whole system, including:

- the distribution circuits,
- all heat-generating plant,
- any Combined Heat and Power (CHP),
- any waste heat recovery or heat dumping.

Trigeneration schemes

CO_2 emissions associated with the thermal energy stream should be attributed in proportion to the output energy streams. The calculation to give the emission factor for the heat and cooling output may be carried out using the equation

$$\text{Emission factor} = \frac{1}{H \times \left(F \times CO_{2F} - E \times CO_{2E}\right)}$$

where

F is the total kWh of input fuel burnt to produce:

E kWh of electricity,

H kWh of useful heat, and

C kWh of useful cooling,

CO_{2F} is the emission factor for the input fuel,

CO_{2E} is the emission factor for grid electricity.

Electricity generated by any CHP or trigeneration scheme

Electricity generated by these schemes should be credited at an emission factor equal to the grid average.

The result obtained for the BER may be reduced if certain management and control features are incorporated in the actual building. These and their adjustment factors are listed in Table 16.18. Each reduction and its appropriate adjustment factor apply only to:

- the CO_2 emissions from the system to which the feature is applied;
- in the case of the power factor, only if the whole-building power factor is corrected;
- one or other of the power factor adjustment factors (i.e. the most appropriate, not both) can be chosen.

Table 16.18 Adjustment factors for management and control features.

Management and control feature	Adjustment factor
Automatic monitoring and targeting with alarms for out of range values	0.050
Power factor correction to achieve a whole-building power factor greater than 0.90	0.010
Power factor correction to achieve a whole-building power factor greater than 0.95	0.025

Notes:
1. Automatic monitoring and targeting with alarms for out of range values means a complete installation that measures, records, transmits, analyses, reports and communicates meaningful energy management information to enable the operator to manage the energy it uses.
2. The power factor adjustment can be taken only if the whole-building power factor is corrected to the level stated. The two levels of power factor correction are alternative values and cannot be added together.

For example, consider a building whose total BER is calculated to be 130 kg CO_2 per m^2 per year, of which 70 kg CO_2 per m^2 per year is due to electricity consumption. The provision of equipment to give a whole-building power factor correction of 0.95 allows an adjustment factor of 0.025, and the adjusted BER is

$$\text{BER} = 130 - 0.025 \times 70 = 130 - 1.75 = 128.25\text{kgCO}_2 \text{ per m}^2 \text{ per year}$$

Further reductions in the BER may also be achieved by using low or zero carbon energy sources (LZC) or any other fabric or system measure or technique, either singly or in combination, provided that the overall design of the building can be shown to be viable, appropriate to the scheme and within the limits on design flexibility set out in criterion 2. Approved compliance tools are expected to have the ability to assess the effect of LZC technologies and other measures for achieving a low BER and hence ensure that the BER is below the target TER. In order to encourage the introduction of techniques for reducing the BER, the approved document recommends that designers should:

- consider using heating and/or cooling systems that employ low distribution temperatures,
- where multiple systems serve the same end use, organise the control strategies to give priority to the option with the lowest carbon emissions,
- consider future adaptability to allow the incorporation of additional or more advanced LZC technologies at a later date (e.g. capped off connections to link into a possible future community heating scheme),
- be aware of the possible effect of climate change on the performance of the building in the future, as this could alter the effectiveness of both passive and active systems for controlling the internal environment.

The final value of BER, incorporating data for the actual building as built and any applicable adjustment factors is compared with the TER, the requirement being:

$$\text{BER} \leq \text{TER}$$

Special considerations may apply when calculating both the TER and the BER for certain types of non-exempt building such as as follow.

TER/BER calculations for non-exempt buildings with low energy demand

In certain circumstances it may not be seen as reasonable to expect the entire building envelope to be insulated to the expected standard, and in such situations no TER/BER calculation would be required; these situations are

- buildings in which fixed building services for heating and/or cooling are either not provided or only to service a localised area,
- buildings in which fixed building services are used to heat space to temperatures substantially less than would be required for human comfort.

Where this occurs it would be acceptable to meet the following standards:

- All fixed building services are installed to meet the energy efficiency standards as set out in the Non-domestic building services compliance guide.
- The building fabric is insulated to achieve a minimum U-value no worse than 0.7 $W/m^2.K$.

TER/BER calculations for modular and portable buildings

Special considerations apply to modular and portable buildings. Such buildings are within the scope of Building Regulations, including Part L. Indeed, an existing module or structure when moved to and placed on a new site is considered to be a new building. There are two cases to consider:

- Case 1: Modular and portable buildings intended to be assembled at a specific location and to have a planned time of use at that location of more than two years,
- Case 2: Portable buildings which have a planned time of use at specific location of less than two years and are then dismantled and moved elsewhere.

Case 1 At a specific location for more than two years

Compliance with all the normal five compliance criteria for a new non-domestic building must be demonstrated, including calculation of the TER and BER using an approved calculation tool. However, modular and portable buildings may in part be assembled from modules which were manufactured prior to 1 April 2014 (when this edition of Part L came into force). To take account of this, an adjustment to the calculated TER is allowed if more than 70% of the sub-assemblies making up the external envelope were manufactured prior to a specified date. The adjustment is carried out by multiplying the calculated TER by a factor which has the effect of increasing the TER and therefore easing the L2A requirement. Table 16.19 gives the TER multiplying factor for different dates of manufacture. It is often possible to identify the date of manufacture of a sub-assembly from the serial number fixed to it and the manufacturer's records. If the units are

Table 16.19 TER multiplying factors for modular and portable buildings.

Date of manufacture of at least 70% of modules making up the external envelope		
Manufactured on or after	**Manufactured before**	**TER multiplying factor**
After 6 April 2014	—	1.00
1 October 2010	5 April 2014	1.10
6 April 2006	1 October 2010	1.47
1 April 2002	5 April 2006	1.93
—	1 April 2002	1.93 or 2.59*

*The figure of 2.59 applies only to buildings with a planned time of use in a given location of less than two years.

refurbished (e.g. windows, lighting, etc.) prior to assembly, then AD L2B gives guidance on the standards to be achieved.

Case 2 At a specific location for less than two years

For modular and portable buildings with a planned time of use at a given location of less than two years but will ultimately be moved to another location, the TER and BER calculations should be carried out when a module is first constructed and may be based on a generic configuration. This calculation can be provided as evidence of compliance when the building is moved to a new location. The supplier should provide in writing:

- confirmation that the intended time of use in the new location is less than two years,
- details of the TER and BER calculations,
- confirmation that the modules as provided meet or exceed the elemental energy standards of the generic module on which the calculation was based,
- confirmation that the activities assumed in the generic module are reasonably representative of the planned use of the module.

When the planned time of use at a given location is less than two years, the only practicable heating technology may be electric resistance heating. If this is the case, then:

- reasonable provision would be to provide energy efficiency measures that are 15% better than required if using conventional fossil fuel heating,
- demonstrate compliance by assuming in the TER/BER calculations that the heating in the generic configuration is provided by a gas boiler with an efficiency of 77%,
- if a TER/BER calculation is not available for a module constructed prior to 1 April 2014, a new calculation should be carried out and the TER adjusted by the relevant factor from Table 16.19.

As with case 1, if a unit is refurbished (e.g. windows, lighting, etc.) prior to assembly, then AD L2B gives guidance on the standards to be achieved.

TER/BER calculations for shell and core developments

A building may be sold or let as a shell so that an incoming occupier may perform fit-out work to his own specification. For such a building, the developer must demonstrate that the building shell, as offered, could meet the energy efficiency requirements. This will require the following:

- Calculation of the TER in the normal way,
- Assumptions for the efficiencies of those services that will be installed as part of the first fit-out work,
- Calculation of the BER using where necessary the assumed efficiencies,
- In the submission to the BCB, identification of the services that will not be provided in the base build and the efficiencies that have been assumed for these services,
- At practical completion of the base building, calculate an as-built TER/BER using only data for the building and systems as actually constructed and assuming that the fit-out areas are conditioned to temperatures appropriate to their designated use but with no energy demand.

When an incoming occupier does first fit-out work on all or part of the building through the provision or extension of any of the fixed services for heating, hot water, air conditioning or mechanical ventilation, a new TER/BER calculation must be performed. This new calculation must be based on the building shell as constructed and the fixed building services as installed and must be submitted to the BCB to demonstrate compliance for that part of the building covered by the fit-out work. However, if the fit-out work does not include the provision or extension of any of the fixed services for heating, hot water, air conditioning or mechanical ventilation, then reasonable provision would be to demonstrate that any lighting systems that are installed are at least as efficient as those assumed in the initial submission.

Prior to fit-out, a formal Energy Performance Certificate (EPC) is not required, but a predicted EPC rating should be available to give prospective occupiers information on the potential energy performance. After fit-out, a new formal EPC is required for that part of the building covered by the fit-out. This is because the fit-out is specific to the needs of the occupier and is controlled by him for his benefit, thus creating a new 'part designed or altered for separate use'. A new EPC will be required for each part of the building that is separately fitted out.

Industrial sites, workshops and non-residential agricultural buildings

In many cases it may not be practicable or possible to evaluate carbon emissions using the procedures laid down in AD L2A. Reasons for this could include:

- the relevant CO_2 target is provided by other regulatory frameworks,
- the generic National Calculation Methodology which cannot adequately take into account the proposed industrial process or agricultural use,
- the possibility of creating negative impacts on cost effectiveness or technical risk.

In these circumstances reasonable provision would be to provide fixed building services that satisfy the standards set out in AD L2B.

Strategies for achieving criterion 1

Should the test for criterion 1 result in a fail, remedial work will be necessary. This would be a most unwelcome consequence. Nevertheless, it is unlikely that the final test for criterion 1 will fail, provided that:

- the calculation of BER which was carried out at the design stage was found to be less than TER, preferably by a reasonable margin;
- the design was executed according to the original design and specifications with all due care to construction detail;
- the consequences of any changes to the design or to the specifications of any components were fully explored by recalculating the BER before those changes were implemented.

The design features and strategies which can help to bring the BER below the TER could include:

- adopting a highly insulating external envelope, i.e. low U-values for the roof, wall, floor, windows etc.;
- adopting a design which minimises summer overheating and the need for comfort cooling;
- achieving, by attention to construction detailing, an air permeability less than that described in the reference notional building ;
- adopting low or zero-energy (LZC) supply systems (see, for example, *Low or zero carbon energy sources – Strategic guide* [9]).

However, the effectiveness of each of these or any other strategies depends on the function and the overall design of the building, making it difficult to formulate rules for general guidance.

16.8.3 Design standards: Criterion 2

Criterion 1 does not lay down specific minimum standards for the thermal performance of a building and its installed services (e.g. by specifying maximum permitted U-values). This is intended to allow a substantial measure of design flexibility which in practice allows some trade-off between some aspects of the design. However, in addition to criterion 1 and in order to prevent this flexibility being used unwisely, criterion 2 imposes limits on design flexibility; these are commonly referred to as the 'back stop values'. These limits apply to:

- insulation standards (U-values) of the external envelope;
- the air permeability of the external envelope;
- controls and energy meters;
- system efficiencies for each fixed building service.

The details are as follows.

Table 16.20 Maximum permissible fabric U-values.

Element	Maximum U_{av}, $W/m^2.K$
Wall	0.35
Floor	0.25
Roof	0.25
Windows, roof windows, rooflights and curtain walling	2.2
Pedestrian doors	2.2
Vehicle access and similar large doors	1.5
High-usage entrance doors	3.5
Roof ventilators (including smoke vents)	3.5
Air permeability ($m^3/h.m^2$ at 50 Pa)	10

Design limits for the external envelope: U-values

Table 16.20 gives limiting (i.e. maximum) U-values which should not be exceeded. In this table, U_{av} is the area-weighted average U-value of the particular element

$$U_{av} = \frac{U_1A_1 + U_2A_2 + U_3A_3 + \cdots}{A_1 + A_2 + A_3 + \cdots}$$

where U_1A_1 etc. refer to all the individual elements of that type. It should be noted that:

- although these limiting maxima U-values are described in the approved document as being the worst acceptable, in practice significantly lower U-values are not only advisable but may be necessary to ensure that the BER is less than the TER;
- if one part of an element, for example, part of the external wall, has a high U-value (say, 0.70 $W/m^2.K$), then the U-value of the other parts of the external wall would have to have a very low U-value to bring the average down to the permitted maximum of 0.35 $W/m^2.K$;
- the figures given in Table 16.20 for the U-values of roof windows and rooflights assume that they have been measured or calculated in the vertical position; if they are not mounted vertically, an adjustment to the U-value must be applied (see section 16.10) before making a comparison with the limiting maximum value in the table;
- display windows are not subject to any of the above limiting values and therefore may have any U-value. However, they are included in the CO_2 emission calculations, and so a poor thermal performance (e.g. a high U-value and/or a large area) could lead to an unacceptably high value for the BER;
- in buildings with high internal gains, a high U-value for the glazing may help to lower cooling demand and hence reduce overall CO_2 emissions and the BER. If this can be demonstrated, the maximum permissible U-value for windows may be increased to 2.7 $W/m^2.K$.

The U-values themselves must be measured or calculated according to an approved method. Section 16.10 gives details.

Design limits for the external envelope: Air permeability

The limiting (i.e. maximum) value for the air permeability is 10 $m^3/h.m^2$ at a pressure difference of 50 Pa. This is higher than the reference value which must be used in the calculation of TER (see Table 16.17). In practice values of air permeability down to 3 $m^3/h.m^2$ should normally be achievable. Achieving a low value for the air permeability not only helps to ensure that the final BER is less than the TER but also is advantageous for buildings with mechanical ventilation and air conditioning. See section 'Pressure testing to determine air permeability' for methods of measurement and Table 16.21 for possible exemptions from pressure testing.

Table 16.21 Possible exemptions from pressure testing.

Exempt building	Description and procedure
Buildings with a total useful floor area of less than 500 m^2	Pressure testing may be avoided by using a value for the air permeability of 15 $m^3/h.m^2$ at 50 Pa in the calculation of the BER. This will require compensating measures elsewhere in the design to ensure that criterion 1 is satisfied
Factory-made modular buildings with a total useful floor area of less than 500 m^2 and: (i) a planned service life of at least two years at more than one location, and (ii) where no site assembly work is needed other than making linkages with standard link details	The building as installed must conform to one of the standard configurations of modules and link details for which the installer has pressure test data from a minimum of five in situ measurements on the same module types and link details. The results must indicate that the average test result is at least 1.0 $m^3/h.m^2$ at 50 Pa below the design air permeability used in the BER calculation
Large extensions, whose compliance is being assessed as if they were new (see AD L2B), where sealing off the extension from the existing building is impractical	Guidance on how extensions can be tested and where pressure tests are inappropriate is given in reference [26]. If the BCB agrees that testing is impractical, the extension should be treated as a large complex building, see following text
Large complex buildings whose size and/or complexity make pressure testing of the whole building impractical.	Before construction work commences, developers must produce, in accordance with the approved procedure, a detailed justification of the impracticality of pressure testing. This must be endorsed by a suitably qualified person, e.g. a Competent Person approved for pressure testing. Compliance may be demonstrated by appointing a suitable qualified person to carry out a detailed programme of design development, component testing and site supervision to ensure that a continuous air barrier will be achieved. In such cases, the air permeability cannot be taken to be less than 5 $m^3/h.m^2$ at 50 Pa
Compartmentalised buildings made up of self-contained units with no internal connections, making it impractical to perform a whole-building pressure test	Reasonable provision would be to pressure test a representative area of the building as detailed in reference [26]. In the event of a test failure, remedial measures must be carried out on the whole building. It would then be reasonable to test the original area plus an additional representative area to confirm that the expected standard has been achieved throughout

Design limits for building services: Controls and energy meters

In principle, all systems which consume energy should:

- use an appropriate control system capable of achieving a reasonable standard of energy efficiency;
- be capable of having their energy consumption monitored.

The control features considered appropriate for heating, ventilation and air-conditioning systems should include all the following:

- separate control zones corresponding to each area of the building that has a significantly different solar exposure, pattern of use, or type of use;
- in each separate control zone, independent controls for timing, temperature and (where appropriate) ventilation and air recirculation rate;
- the ability to respond to the requirements of the space (i.e. the control zone) being served – in particular, if both heating and cooling are provided, the control system should ensure that they do not operate simultaneously;
- the ability to switch off the central plant when it is not needed and to switch it on only when one or more of the control zones require it, i.e. the default condition should be off.

Energy meters must be capable of monitoring energy consumption for each fuel. The consumption for each fuel must be further broken down according to its end-use category so that the amount used for heating, lighting, etc. can be identified. Any LZC (including renewable) energy system is considered as a separate fuel and must be monitored separately. The metering system is considered reasonable if it can measure at least 90% of the estimated annual energy consumption of each fuel assigned to the various end categories. Automatic meter reading and data collection facilities should be provided in buildings with a total useful floor area greater than 1000 m^2. Detailed guidance is given in CIBSE TM 39 [20].

Design limits for fixed building services

The essential, and also principal, source of information on all fixed building services is the *Non-domestic building services compliance guide* [21]. This includes information and minimum standards for demonstrating that reasonable provision has been made for suitably efficient equipment and systems to provide:

- heating,
- hot water,
- cooling,
- ventilation and air handling,
- lighting.

If a proposed appliance or system is not covered by the guide, then it is reasonable to demonstrate that it is at least as efficient as a comparable system that is covered. Where efficiency data is provided to a BCB from a notified body, it will normally accept this data at face value. In the absence of this, the BCB may need to satisfy itself that the claimed performance will be achieved.

16.8.4 Design standards: Criterion 3

Criterion 3 is concerned with the limiting of heat gains in summer and applies to all buildings regardless of whether or not they are fitted with any form of ventilation, cooling or air conditioning.

The purpose is to limit solar gains in summer so as to:

- eliminate or reduce the need for air conditioning,
- if air conditioning is unavoidable, minimise the installed capacity of the system,
- for buildings which are not fitted with a cooling system, prevent an excessive rise in internal temperature in summer.

However, in buildings or parts of a building where a cooling system is not provided and where internal temperatures in summer are controlled only by natural or mechanical ventilation, adherence to the requirements of criterion 3 does not guarantee that internal temperatures will always be satisfactory.

The criterion must be evaluated for all spaces in a building which are mechanically cooled and also for any space that is not cooled but which is intended to be occupied by the same person or persons for a substantial part of the day. Spaces which are not mechanically cooled and meet the following requirements are not covered by this criterion:

- Those not intended to be occupied (e.g. display windows),
- Those occupied on a transient basis (e.g. toilets), or
- Circulation spaces.

For each space to which criterion 3 does apply, reasonable provision would be to show that the solar gains through the glazing aggregated over the period April to September inclusive are no greater than would occur for a reference system with a defined total solar energy transmittance (g-value) calculated according to BS EN 410 [17]. The reference system is defined in the National Calculation Methodology (NCM) database. There are three variants of the specification for this reference system depending on the type of glazing of the actual space:

Specification 1 – Side lit spaces
Specification 2 – Top-lit spaces with an average zone height not greater than 6 m
Specification 3 – Top-lit spaces with an average zone height greater than 6 m

Table 16.22 gives details of the three variants.

Note that in double-height spaces, particularly those where industrial activities take place, the effect of solar gains in the occupied area may be reduced due to:

- dirt on the rooflights and absorption within the rooflight system,
- temperature stratification causing warm air to accumulate above the occupied zone.

Table 16.22 Reference specifications for evaluating criterion 3, solar gain limit.

Benchmark reference	Glazing description	Glazing dimensions
Specification 1		
Side-lit spaces	Vertical glazing facing east 10% frame factor Glazing g-value 0.68	Height: 1 m Width: full width of the external façade of the space being considered
Specification 2		
Top-lit spaces up to an average zone height of 6 m	Horizontal glazing 25% frame factor Glazing g-value 0.68	Area equal to 10% of the total exposed roof area, measured on the horizontal plane
Specification 3		
Top-lit spaces with an average zone height greater than 6 m	Horizontal glazing 15% frame factor Glazing g-value 0.46	Area equal to 20% of the total exposed roof area, measured on the horizontal plane

Note:
For specification 1, the width of the glazing should include all opaque and translucent elements, external doors, windows and curtain walling elements.

The possibility of a reduction in the effect of the solar gain may make it possible to justify an increase in the rooflight area above the limiting value.

Strategies for limiting solar gains include:

- choosing window size and orientation to minimise solar gains;
- protecting windows with solar control measures such as shading, solar control glazing, etc.;
- providing the capability for adequate ventilation at night as well as during the day;
- choosing a structure (e.g. predominantly brick, concrete or similar masonry-like products) with high thermal capacity.

However, these strategies can conflict with other requirements, for example:

- a desire to take advantage of solar gains in winter;
- the need to provide adequate daylight and hence to avoid the excessive use of electric lighting;
- if the building has a high thermal capacity structure, the possible need to increase the capacity of the heating system to provide adequate performance during preheating from cold.

Further information relevant to criterion 3 is given in CIBSE TM37 [22] and in BB 101 for education buildings [38].

16.8.5 Quality of construction and commissioning: Criterion 4

The purpose of criterion 4 is to ensure that the performance of a building as actually constructed is consistent with its calculated BER and the requirements of regulations 43 and 44 have been achieved. To do this, criterion 4 sets minimum standards for two aspects of the completed building, that is, the quality of construction of the building fabric (i.e. the external envelope) as built and the commissioning of the building services systems as installed. The first of these, the building fabric, is to ensure that:

- thermal insulation is reasonably continuous over the whole-building envelope;
- the air permeability of the external envelope is within reasonable limits;
- it has been adequately demonstrated that both of these have been achieved.

The achievement of a sufficiently low air permeability normally requires the provision of a continuous air barrier. To do this and at the same time maintain continuity of insulation can present a challenge for both designers and builders. The approved document recommends that either the insulation layer or the air barrier is contiguous at all points in the building envelope or that any spaces between them should be filled with solid material as in a masonry wall. Construction details for achieving both continuity of insulation and low air permeability are given in three principal references:

- *Accredited construction details* [12];
- *Limiting thermal bridging and air leakage* [13] for buildings using similar design details to dwellings;
- MCRMA Technical note 17 [23] for cladding systems.

Continuity of insulation

The building fabric should be constructed so that there are no reasonably avoidable thermal bridges in the insulation layers at gaps, joints and edges. Junctions between elements, lintels and surrounds of windows and doors require particular attention, as these will create a thermal bridge. The additional heat loss due to thermal bridges is included in the BER calculation by means of the linear thermal transmittances, or ψ-values, of all the thermal bridges in the external envelope. Thermal bridges also cause an additional lowering of the temperature of the inside surface of an external element, with an attendant risk of condensation and mould growth. This can be assessed by means of the temperature factor. Details of thermal bridges and their assessment are given in section 16.10.6. For non-dwellings methods 2 and 3b are the acceptable means of demonstrating compliance.

Pressure testing to determine air permeability

Pressure testing is a mandatory requirement for all buildings that are not dwellings (including extensions which are being treated as new buildings) under regulation 43, with the possible exceptions listed in Table 16.21. The approved procedure for carrying out pressure tests, collecting data and recording results is given in the ATTMA guide *Measuring air permeability of buildings envelopes* [26]. The procedure must be carried out by a person who is qualified and registered to test the specific class of building concerned. The preferred method is that the test should be carried out with trickle ventilators temporarily sealed rather than merely closed.

Compliance conditions for an air pressure test

Compliance is demonstrated if both:

- the measured air permeability is less than or equal to the limit value of 10 $m^3/h.m^2$; and
- when the measured air permeability is used to calculate the BER, the BER is less than or equal to the TER, i.e.

$$BER \leq TER$$

This means that even if the measured air permeability is less than the limit value of 10 $m^3/h.m^2$, it will nevertheless count as a fail if, when used in the BER calculation, the resulting BER is greater than the TER. In some cases, the air permeability may need to be significantly less than 10 $m^3/h.m^2$ in order to produce an acceptable result for the BER. Note that the design value chosen for the air permeability for the preliminary calculation of BER ceases to be relevant once a measured value from the completed building becomes available.

Failure of an air pressure test and its consequences

When a building fails an air pressure test, remedial work and a repeat test become necessary. Remedial work on a large building is likely to be a difficult and time-consuming task, and so it is recommended that pressure testing is scheduled to occur at the earliest opportunity, for example, before internal fit-out work has made access to the external fabric difficult or even impossible. It is further recommended that the design air permeability is set to the applicable reference value unless there are strong reasons for supposing a lower value which will be achieved.

The remedial strategy will depend on the nature of the test result. An air pressure test result may be insufficient or regarded as a 'fail' for one of the following three reasons:

(1) The measured air permeability exceeds the back stop limit of 10 $m^3/h.m^2$, but the resulting BER is less than the TER.
(2) The measured air permeability satisfies the back stop limit value but the resulting BER exceeds the TER.
(3) The measured air permeability exceeds the back stop limit and also the resulting BER exceeds the TER.

For case 1, it is essential to improve the air tightness of the external envelope in order to get within the limiting permeability. This should be possible, because the target figure of 10 $m^3/h.m^2$ is not excessive and should be attainable with proper attention to design details and their execution on site. A permeability above the target is likely to indicate a major omission in sealing, draught proofing or membrane fixing, though it may not be easy to find the error. However, if remedial work and a repeat test show that the air permeability has been sufficiently reduced to satisfy the limit value, then the recalculated BER must also have been reduced and must therefore still be satisfactory.

Case 2 is most likely to arise if the design air permeability was chosen to be less than 10 $m^3/h.m^2$ in order to ensure the predicted BER was below the TER. In this case remedial action to reduce the air permeability is possible but may be more difficult. Other features of the building should also be considered for treatment. For example, improvements to the U-values of some components by adding insulation will reduce the BER and may bring it within the TER without making changes to reduce the air permeability.

Case 3 is similar to case 1, and improvements to the air tightness of the external envelope are essential. If, after retest, it is found that the air permeability satisfies the limit value but the BER is still too high, case 3 then becomes an example of case 2 and must be treated accordingly.

Commissioning of the fixed building services systems

The fixed building services must be commissioned by testing and adjustment so that at completion the systems and their controls are left in working order and can operate efficiently for the purposes of conserving fuel and power. It is useful to prepare a commissioning plan in order to identify the systems to be tested and the tests to be performed. This plan can be presented with the design-stage TER/BER calculation to assist the BCB in checking that commissioning is being carried out as work proceeds. The templates in the *Model commissioning plan* [15] are a possible aid to documentation.

All fixed building services should be commissioned with the exception of:

- systems where in the circumstances adjustment has no effect on their energy use,
- systems which can only be switched ON or OFF and have no other means of adjustment.

Fixed building services which do not require commissioning should be identified in the commissioning plan, giving the reason for them not being commissioned.

The approved procedures are given in *CIBSE code M: commissioning management* [27]. The notification which must be given to the BCB should include a declaration that:

- commissioning has been followed so that every system has been inspected and commissioned in an appropriate sequence and to a reasonable standard; and
- results of the tests confirm that the measured performance is reasonably in accordance with the design performance for the actual building, with written commentaries where excursions are proposed to be accepted.

Ductwork leakage testing should be carried out according to the procedures set out in B&ES DW/143 and DW/144 [28] for sections of ductwork where the system is served by a fan with a design flow rate greater than 1 m^3/s; note that:

- DW/143 does not call for any testing of low-pressure (class A) ductwork.
- However, if at least 10% of low-pressure ductwork is tested and passes, this is recognised as an improvement in the BER.

Table 16.23 Ductwork pressure classes.

Pressure class	Design static pressure, Pa — Maximum positive	Design static pressure, Pa — Maximum negative	Maximum air velocity, m/s	Air leakage limit l/s.m^2 of duct surface area, l/s
Low pressure (class A)	500	500	10	$0.027\Delta P^{0.65}$
Medium pressure (class B)	1000	750	20	$0.009\Delta P^{0.65}$
High pressure (class C)	2000	750	40	$0.003\Delta P^{0.65}$
High pressure (class D)	2000	750	40	$0.001\Delta P^{0.65}$

Note:
ΔP is the pressure differential in pascals.

On this basis a decision to test low-pressure ductwork should be made at the initial design phase prior to commencement of work.

The relevant pressure classes are shown in Table 16.23. If a ductwork system fails to meet the leakage standard, sufficient remedial work must be carried out to achieve the standard in a retest. Additionally, further sections of ductwork should be tested, as described in DW/143.

All commissioning and testing should be carried out by suitably qualified persons. The following are likely to be acceptable:

- for heating, ventilating and air-conditioning systems, a member of the Commissioning Specialists Association [29] or of the Commissioning Group of B&ES [30];
- for leakage testing of ductwork, a member of the Ductwork Group of B&ES [30];
- for lighting systems, a member of the Lighting Industry Commissioning Scheme [31]; or
- other persons with relevant training and experience who are acceptable to the BCB, for example, persons registered with a relevant competent person's scheme.

Building regulations require that a notice of completion be given to the relevant BCB, stating that commissioning has been carried out according to approved procedures. The notice should include a declaration that:

- a commissioning plan has been followed so that every system has been inspected and commissioned in an appropriate sequence and to a reasonable standard,
- the test results confirm that the performance is reasonably in accordance with the actual building design, including written commentaries where excursions are proposed to be accepted.

The notice should be given within five days of the completion of the commissioning work where:

- a building notice or full plans have been given to a local authority, or
- an approved inspector is the BCB.

In other cases, e.g. when the work is carried out by a person registered with a competent person's scheme, the notice should be given within 30 days of the completion of the commissioning work. Where the installation of fixed building services is carried out by a person registered with a competent person's scheme, the notice of commissioning will be given by that person.

16.8.6 Providing information: Criterion 5

Criterion 5 derives from regulation 40 and requires that the owner of a building should be provided with sufficient information about the building, its fixed building services and their maintenance requirements so that the building can be operated so as to use no more fuel and power than is reasonable. The information should be provided in the form of a building log book, and a way of demonstrating compliance would be to follow the guidance in CIBSE TM 31 *Building log book toolkit* [32]. The information should be presented in the form of templates the same as or similar to those in TM 31. If convenient, the information may draw on or refer to information available in other documentation such as:

- operation and maintenance manuals;
- the Health and Safety file required by CDM regulations.

The log book should include the data used to calculate both TER and BER, and preferably an electronic copy of the input file for the energy calculation should be retained to facilitate any future analysis that may be required should the building be altered or improved. The occupier should also be provided with the recommendation report generated in parallel with the 'on-construction' Energy Performance Certificate as this will also assist the occupier in seeking further improvements in energy performance.

16.8.7 Model designs

L2A is framed to be as flexible as possible in order to encourage new and imaginative approaches to the task of designing energy-efficient dwellings. Excessive reliance on model designs would not only be contrary to this objective but may also result in the stereotyping of building designs. Builders, especially those who develop large sites may, over a period of time, develop a number of standard designs which they know will be likely to pass. This approach may not always be available to the small builder, doing one-off designs but they may prefer to adopt a model design package rather than engage in design themselves. The 2013 version of approved document L provides for the first time a model design.

The TER and the TFEE are based on a building of the same size and shape as the actual building, constructed to a concurrent specification which is summarised in the approved document and detailed in the NCM modelling guide 2013. A building constructed wholly in accordance with this specification will meet the required TER and therefore pass criterion 1. The approved document contains a summary of the concurrent building specification (see Table 16.17).

Although the use of the concurrent specification will guarantee a pass in terms of criterion 1 the requirements of the other criterion will still need to be considered. It is important to note that this concurrent specification cannot be guaranteed to be the most economical specification. In spite of the existence of a model design it remains acceptable for designers to explore the most economic way of meeting the energy efficiency requirements.

Construction industry model designs may become available at www.model designs.info.

16.8.8 Reporting evidence of compliance

The reporting of evidence from the builder to the BCB is a necessary part of the procedure for demonstrating compliance with the energy efficiency requirements. In order to facilitate this process and to make communication clear, efficient and transparent, it is recommended that the evidence for compliance be presented in a standardised format. In most cases, it should be possible for the compliance software to produce the majority of the required data and evidence in a suitable standardised form. The advantages of standardised reporting include:

- assisting the BCB to assess the proposed design,
- assisting the BCB to check the design against that which is being built,
- enabling the source of evidence to be indicated and allowing the credentials of those submitting it to be declared,
- making it easier to show the connection between product specifications and the data inputs required by the compliance.

Two versions of the standardised report should be produced. The first report would be pre-construction, would contain the TER/BER calculation plus specifications, and would assist the BCB in checking the design against that which is built. The second report would be post-completion and would include the as-built TER/BER calculation plus any changes to the specifications.

An important aspect of demonstrating compliance is linking the data input to the software with the actual specification for any particular element. Ideally the software should:

- provide each date input with a reference to the construction specification,
- provide a free text facility which would ultimately link the data input to a particular construction specification in an output report, or
- ensure that the data input is derived directly from a construction specification.

The report should also highlight any performance specification which is better than would be typically expected. The BCB will be expected to pay particular attention to such cases especially if the claimed specification delivers an energy efficiency standard better than that shown in Table 16.24

Table 16.24 Threshold values for alerting particular attention, AD L2A.

Parameter	Threshold value
Wall U-value	0.23 W/m^2.K
Roof U-value	0.15 W/m^2.K
Floor U-value	0.20 W/m^2.K
Window or door U-value	1.50 W/m^2.K
Design air permeability	5.0 m^3/h.m^2 at 50 Pa

Notes:
Any fixed building service efficiency that is 15% better than that recommended for its type in the *Non-domestic building services compliance guide* [21].
Use of any low-carbon or renewable energy technology.

16.9 Part L2B: Conservation of fuel and power in existing buildings other than dwellings

The principal objectives of AD L2B are:

- to ensure that all new work in an existing building meets the relevant current Part L standards for the conservation of fuel and power; and
- to oblige the owner (or developer or contractor) to carry out 'consequential improvements', that is to say, to improve the rest of the building and bring it up to current Part L standards insofar as such improvements are technically, functionally and economically feasible.

Such is the variety and complexity of carrying out work on existing buildings that are not dwellings; the first consideration will normally be to determine:

- the extent to which AD L2B is applicable to the proposed works;
- the extent to which consequential improvements will have to be carried out;
- the possibility that some or all of the works may be more appropriately treated using one of the other approved documents, e.g. AD L1B or AD L2A;
- the possibility that some or all of the works may be exempt form Part L.

In many cases it may be prudent to obtain the opinion of the BCB at an early stage.

16.9.1 General guidance

This section includes:

- types of work covered by AD L2B;
- historic buildings (see section 16.4.5);
- thermal elements and U-values.

The types of work covered by AD L2B include:

- the construction of an extension;
- the material change of use or a change to the building's energy status;
- the provision or extension of a controlled service or fitting;
- the replacement or renovation of a thermal element;
- consequential improvements.

Note that, because they are not dwellings, rooms for residential purposes fall within the scope of AD L2B.

Certain types of work in or on an existing building fall more properly within the guidance of one of the other approved documents, usually either AD L1B or AD L2A. Some of the circumstances where this might or might not occur are:

- First fit-out works in new shell and core developments: these are considered to be new buildings to which AD L2A applies (see section 'TER/BER calculations for shell and core developments'). However, any subsequent fit-out work is considered to be work on an existing building, and so AD L2B applies.
- Large extensions (see section 16.2 for a definition): the extension itself is considered to be a new building, and AD L2A applies. Nevertheless, the existing building may also be subject to consequential improvements as specified in AD L2B.
- Modular and portable buildings where the work involves an extension formed from sub-assemblies obtained from centrally held stock or from the disassembly or relocation of other buildings: the extension is considered to be a new building, and AD L2A applies. Nevertheless, the existing building is likely to be subject to consequential improvements as specified in AD L2B.
- Buildings containing dwellings: if the work involves a building that either before the work is started or after the work is completed contains one or more dwellings, then AD L1B would apply to each dwelling.
- A new building on an existing site: provided the new building is free standing, AD L1A or AD L2A applies as appropriate.

Regulation 26, which requires that the building's CO_2 emission rate (DER) does not exceed the target CO_2 emission rate (TER), does not apply to work in existing buildings. However with the exception also of regulation 26A, the energy target, all the other energy efficiency requirements do apply, and so the BCB must, in most circumstances, be notified in the usual way prior to the commencement of work. In the case of a local authority, this must be by deposit of full plans. Where the BCB is an Approved Inspector, there is no set procedure provided the required procedure and time scale for the submission of an Initial Notice are allowed for. Exceptions to the requirement for advanced notice are as follows:

- Where the work is being carried out under the terms of an approved Competent Persons Scheme listed in Schedule 3 (see Table 16.3), advance notice to the BCB is not necessary. However, regulation 20 of the Building Regulations require that the occupier of the building be given, within 30 days of completion, a certificate to confirm that the work fully complies with all applicable requirements. In addition, the local authority must also be notified of the work carried out, again within 30 days of completion. Although a certificate can be accepted as evidence of compliance, local authority powers of inspection and enforcement remain and may still be exercised, normally but generally only in response to a complaint.

- Where the work involves an emergency repair (e.g. a failed boiler or leaking hot water cylinder), the repair work can be commenced without the need for advanced notification to the BCB. Nevertheless the work must comply with the requirements. Either the BCB must be given notice at the earliest opportunity or if the installer is registered under an approved Competent Persons Scheme, a completion certificate must be issued.

There are some classes of work which need not be notified but must nevertheless still satisfy the energy efficiency requirements. Furthermore, if non-notifiable work is carried out by a member of a competent person's self-certification scheme, there is no requirement for a compliance certificate to be given to either the occupier or the BCB. Non-notifiable work includes work which is of a minor nature, as described in Schedule 4 (see Table 16.4). The work must still comply but need not be notified to a BCB.

See section 16.6.4 for further details of exemptions and relaxations to AD L2B.

16.9.2 Guidance relating to building work

There is considerable cross-referencing in the approved document between sections 4 and 5, and so they should be consulted together.

Extensions must meet acceptable standards for the fabric and for the services. When constructing a new extension to an existing building, it is necessary to observe:

- a maximum area for openings, including windows, doors and rooflights,
- minimum standards for the performance of new thermal elements and controlled fittings (i.e. maximum U-values),
- minimum standards for any existing fabric which becomes a thermal element whereas previously it was not (i.e. maximum U-values),
- minimum standards for the energy-efficient operation of all services (both fixed building services and controlled services).

There are three methods of demonstrating compliance:

- the reference method,
- the area-weighted U-value method, and
- the whole-building calculation method.

The second and third of these are intended to provide a greater degree of design flexibility than is afforded by the reference method. The greater flexibility is usually achieved by allowing the limits on some elements of the design to be relaxed in return for compensatory measures elsewhere.

Whichever of the three methods is used, an additional consideration is that rooflights in some buildings are the primary source of useful daylight. A significant reduction in their area could lead to an increased use of electric lighting and hence to an increase in energy consumption which outweighs any potential savings due to reduced heat loss or gain. The NARM publication [33] gives guidance.

If an existing building has a total useful floor area over 1000 m^2 and an extension of any size (including a large extension) or any change to the fixed building services is proposed, then consequential improvements to the existing building must be considered. Details are given in section 16.9.4.

A new extension to an existing building: The reference method

The maximum areas for openings should not normally exceed the values given in Table 16.25. However, it may be reasonable to increase the proportion of glazing up to the proportion which exists in that part of the existing building to which the extension is attached. If this is done, it would be at least advisable and perhaps necessary to consider introducing compensating measures elsewhere in the construction of the extension.

Controlled fittings and controlled building services must meet the standards set out in sections 'Controlled fittings' and 'Controlled building services'.

Requirements for maximum permissible U-values are given in section 16.9.3 and Table 16.26.

A new extension to an existing building: Area-weighted U-value method

Some design flexibility in the choice of U-values and opening areas is possible, provided that the area-weighted U-value of all the elements in the extension is equal to or less than the area-weighted U-value for an extension of the same shape and size that complies with the reference method for limits on U-values and opening areas. The area-weighted average U-value is calculated in the usual way from

$$U_{av} = \frac{U_1A_1 + U_2A_2 + U_3A_3 + \cdots}{A_1 + A_2 + A_3 + \cdots}$$

All other requirements are the same as for the reference method.

Table 16.25 Normal maximum areas of openings in an extension.

	Windows and personnel doors	Rooflights
Building type	**Percent of exposed wall area**	**Percent of roof area**
Residential buildings where people temporarily or permanently reside	30	20
Places of assembly, offices and shops	40	20
Industrial and storage buildings	15	20
Vehicle access doors, display windows and similar glazing	As required	n/a
Smoke vents	n/a	As required

Table 16.26 U-values for new, replacement and upgraded elements.

	New or replacement thermal element or fitting in an extension	**Upgrade of a renovated or retained thermal element or fitting**	
Thermal element or controlled fitting	**Maximum U-value, W/m².K**	**Threshold U-value, W/m².K**	**Improved U-value, W/m².K**
Column no.	1	2	3
Cavity wall	0.28	0.70	0.55
All other walls	0.28	0.70	0.30
Pitched roof – insulation at ceiling level	0.16	0.35	0.16
Pitched roof – insulation at rafter level	0.18	0.35	0.18
Flat roof or roof with integral insulation	0.18	0.35	0.18
Floors	0.22	0.70	0.25
Swimming pool basin	0.25	n/a	n/a
Window, roof window and glazed rooflight	1.80 for the whole unit	n/a	n/a
Alternative for windows in buildings essentially domestic in character	WER Band C or 1.6 W/m².K	n/a	n/a
Pedestrian door, 60% or more of internal face area glazed	1.8	n/a	n/a
High-usage entrance doors for people	3.5	n/a	n/a
Vehicle access and similar large doors	1.5	n/a	n/a
Other pedestrian doors	1.8	n/a	n/a
Roof ventilators, including smoke extract ventilators	3.5	n/a	n/a

A new extension to an existing building: Whole building calculation method

Where maximum flexibility of design is required, it is acceptable to use an approved calculation tool to demonstrate that the CO_2 emissions from the building and its proposed extension are reasonable. The procedures for this are:

- Set up a notional extension, of the same size and shape as the proposed extension, which complies with the reference method.
- Decide on all upgrades to the existing building which will be carried out in fulfilment of the need for consequential improvements.

- Using an approved calculation tool, calculate the CO_2 emissions from the existing building and its notional extension.
- Using the same calculation tool, calculate the CO_2 emissions from the existing building with its proposed extension.
- For both calculations, ensure that the building incorporates all the necessary and proposed consequential improvements.
- Show that the emissions from the actual building and its proposed extension are less than or equal to the emissions from the building plus notional extension.

If additional upgrades to the actual building are proposed in order to compensate for lower performance in the extension, such upgrades must meet the standards set out in AD L2B. Retained thermal elements should be improved so that their U-values do not exceed the maximum given in column 3 of Table 16.26.

In general, the standards set out in AD L2B are expected to be cost effective, and so it is recommended that they be implemented in full even if this is more than necessary to achieve compliance.

Conservatories and porches

For conservatories and porches which are not exempt, reasonable provision would be as follows:

- The conservatory or porch must be thermally separated from the heated area of the building. To be regarded as providing thermal separation, the walls, doors and windows between the conservatory or extension and the heated space must be insulated and draught stripped to at least the same standard as the rest of the existing building. If the construction is not thermally separated from the building, then it must be considered as a conventional extension.
- The U-values of glazed elements must not exceed the relevant values for new or replacement glazed elements in column 1 of Table 16.26.
- The U-values of all other elements must not exceed the values for replacement thermal elements in column 1 of Table 16.26.
- Any heating system installed within the conservatory or porch must have independent temperature and ON/OFF controls.
- Any fixed building service must satisfy the requirements described in section 'Controlled building services'.

Note that the limitation on the total area of windows, roof windows and doors given in Table 16.25 does not apply to a non-exempt conservatory or porch which meets the above criteria.

In the case of an existing exempt extension (including a conservatory or porch), the exemption will cease to apply if:

- the thermal separation between the building and the extension is removed and not replaced, or
- the building's heating system is extended into the extension.

If either or both of these apply, the extension is no longer exempt. This means that the extension must be treated as a new extension and is therefore subject to all the relevant requirements.

Swimming pool basins

Where a swimming pool basin is being provided, the U-value of the basin (walls and floor) should not exceed 0.25 $W/m^2.K$, as calculated according to BS EN ISO 13370 [6].

Material change of use and change of energy status

According to Regulation 5, a building other than a dwelling is said to be formed by material change of use when:

- the building is used as a hotel or boarding house where previously it was not;
- the building is used as an institution where previously it was not;
- the building is used as a public building where previously it was not;
- the building is not a building described in Classes I to VI in Schedule 2 where previously it was;
- the building contains a room for residential purposes where previously it did not;
- the building, which contains at least one room for residential purposes, contains a greater or lesser number than it did previously;
- the building is used as a shop where previously it was not.

In nearly all cases, a material change of use will bring about a change of energy status, thus making the building subject to the energy efficiency requirements. Therefore attention must be paid to:

- the provision of windows, roof windows, rooflights and doors (i.e. controlled fittings);
- the possible need to replace an existing window, roof window, rooflight or door;
- new, replaced, renovated or retained walls, roofs and floors (i.e. thermal elements);
- the provision of new or extended fixed building services.

If controlled services or fittings are being provided or extended, the area of openings in the newly created building should be limited to a maximum of 25% of the total floor area. (Note that this 25% limit differs from the limits given in Table 16.25 for an extension.) If the 25% maximum cannot be met or is unsuitable, a greater area can be allowed if it can be shown that sufficient compensating measures have been taken elsewhere.

All new and replacement windows, roof windows, rooflights, doors and any other thermal elements within a newly constructed part of the building should have a U-value that does not exceed the maximum given in column 1 of Table 16.26. For renovated or retained thermal elements, see sections 'Renovation of thermal elements' and 'Retained thermal elements'. However, any existing window, roof window, or rooflight which separates a conditioned space from an unconditioned space or the external environment may be retained unaltered if its U-value is 3.3 $W/m^2.K$ or less. If it is more than 3.3 $W/m^2.K$, it must, except in certain circumstances, be replaced, and column 1 of Table 16.26 applies. The exceptions are display windows and high-usage entrance doors, for which a lower standard (i.e. higher U-value) may be reasonable.

A material change of use or a change in a building's energy status may also require consequential improvements (see section 16.9.5).

Controlled fittings

In this context, a controlled fitting means a window, roof window, rooflight or door and in all cases refers to the complete unit, including the frame. It follows that replacing the glazing whilst retaining the existing frame is not providing a controlled fitting; such work is not notifiable and there is no U-value requirement.

Where a new or replacement controlled fitting is provided, it should meet the U-value standard given in column 1 of Table 16.26. In addition:

- units should be draught proofed,
- cavity closers should be installed where appropriate.

If replacement windows cannot meet the U-value standard of Table 16.26 due to a need to maintain the character or external appearance of the dwelling, then it would be acceptable to provide either:

- replacement windows with a maximum centre pane U-value of 1.2 $W/m^2.K$, or
- if the existing window is single glazed, low-e secondary glazing fitted and weather sealed internally.

If a window, pedestrian door or rooflight is enlarged or a new one is created, then the total area of windows, pedestrian doors and rooflights should not exceed the relevant percentage of the total floor area of the building, as given in Table 16.25, unless compensating measures are taken elsewhere.

For curtain walling, the maximum permissible U-value or U_{limit} is calculated from

$$U_{limit} = 0.8 + (1.2 + 0.5 \times FOL) \times GF$$

where

GF, the glazed fraction, is the proportion of the curtain wall that is glazed,

FOL, the fraction of opening lights, is the fraction of the glazed area that is openable.

If this formula gives a result greater than 1.8 $W/m^2.K$, then U_{limit} is set equal to 1.8 $W/m^2.K$. For example, if 60% of the curtain wall is glazed and 50% of the glazed area is openable, then GF is 0.6 and FOL is 0.5. This gives

$$U_{limit} = 0.8 + (1.2 + 0.5 \times 0.5) \times 0.6 = 1.67\ W/m^2.K$$

As this is less than 1.8, the maximum U-value is $U_{limit} \approx 1.67\,W/m^2.K$ (which may be rounded up to $U_{limit} = 1.7\,W/m^2.K$). However, if the proportion of glazed area had been 75%, then GF would be 0.75 and then

$$U_{limit} = 0.8 + (1.2 + 0.5 \times 0.5) \times 0.75 = 1.89\,W/m^2.K$$

As this is greater than 1.8, the maximum U-value would be set at $U_{limit} = 1.8\,W/m^2.K$.

See sections 'Renovation of thermal elements' and 'Retained thermal elements' for details of renovated and retained units and section 16.10 for further details on the U-values of controlled fittings, especially on the orientation of rooflights and roof windows.

Controlled building services

Where the work involves the provision or extension of services, the normal expectation is that new services which meet reasonable standards of energy efficiency will be provided. Acceptable standards are as follows.

Fixed building services
These should have:

- an efficiency not less than that set out in the *Non-domestic building services compliance guide* [21], and
- an efficiency not less than that of the controlled service being replaced.

If the new service uses a different fuel, then before the comparison can be made, the efficiency of the new appliance must be adjusted according to the CO_2 emission factors of the new and old fuels (see Table 16.14 and Table 12 of SAP 2012). The formula is

$$\eta_{adjusted} = \eta_{new} \times \left(\frac{E_{old}}{E_{new}} \right)$$

For example, an old mains gas fired boiler of efficiency 64% is replaced by a new oil-fired boiler of efficiency $\eta_{new} = 86\%$. The new boiler would meet the requirement for a new building, but in this case it must also be compared with the old boiler. The CO_2 emission factors are:

$$E_{old} = 0.216\,kgCO_2 \text{ per kWh for gas} \qquad E_{new} = 0.298\,kgCO_2 \text{ per kWh for oil}$$

The adjusted efficiency is therefore

$$\eta_{adjusted} = 86 \times \left(\frac{0.216}{0.298} \right) = 62\%$$

As this is below the efficiency of the old boiler, it is unacceptable. The new oil-fired boiler would have to have an efficiency of 89% to raise $\eta_{adjusted}$ above 64%. Note that the 2%

margin which is allowed in this calculation for replacement boilers in dwellings does not apply to non-dwellings. However, for the full recommendations and requirements for replacement boilers, see paragraphs 2.6 and 2.7 of the *Non-domestic building services compliance guide* [21].

Controls

New HVAC systems must be provided with appropriate controls. Normally, the following features should be incorporated:

- Fixed building services should be divided into separate control zones to correspond to each area of the building with a significantly different type of use, occupancy period or solar exposure.
- Each separate zone should have independent switching and control of set point.
- The service should respond to the requirements of the space it serves.
- If any space or zone is provided with both heating and cooling, the control system should not allow them to operate simultaneously.
- Central plant should operate only as and when required, with off being the default condition.
- In addition to the above, control systems should meet relevant specific requirements and energy efficiency criteria in the *Non-domestic building services compliance guide* [21].

Energy meters

The main purpose of energy meters is to enable building occupiers to assign at least 90% of the annual energy consumption of each fuel to various end-use categories. Reasonable provision would be to follow the recommendations in CIBSE TM 39 [20]. However, in addition:

- the metering should provide separate monitoring of the performance of any renewable energy system installed as part of the works,
- automatic meter reading and data collection should be provided in buildings with a total useful floor area greater than 1000 m^2,
- metering should be designed to allow benchmarking of energy performance as set out in CIBSE TM 46 [34].

Other matters

If a renewable energy generator (e.g. a wind turbine or a photovoltaic array) is being replaced, the replacement system should have an electrical output at least as good as the appliance which is being replaced.

If a heating appliance is being replaced, consideration should be given to:

- connecting to an existing local heat network,
- if pipework changes are being made, providing capped off connections for connection to any subsequent planned local network.

For buildings with a total useful floor area greater than 1000 m^2, be aware that under the Energy Services Directive, there may be a legal obligation to notify the energy supply companies of any plans for building work.

Commissioning of fixed buildings services

Commissioning is essentially the same as for new non-domestic buildings, as described in section 'Commissioning of the fixed building services systems'.

16.9.3 Guidance on thermal elements

Section 5 gives details of the requirements, in particular U-values, for thermal elements when carrying out work on existing dwellings. Further information on U-values and thermal bridging can be found in section 16.10.

The U-values of thermal elements and windows

The principal standards for maximum U-values for work on existing buildings are collected together in Table 16.26. In this table, column 1 applies to new thermal elements and to both new and replacement controlled fittings (i.e. windows, roof windows, rooflights and doors). Column 3 applies to renovated thermal elements (see section 'Renovation of thermal elements') and columns 2 and 3 apply to retained thermal elements (see section 'Retained thermal elements').

Renovation of thermal elements

Renovation occurs when a thermal element is either provided with a new layer or has an existing layer replaced. The manner in which this may be done is as follows.

A new layer may be provided by either:

- cladding or rendering the external surface of the thermal element, or
- dry lining the internal surface of a thermal element.

An existing layer may be replaced by either:

- stripping down the element to expose the basic structure and then rebuilding to achieve the required performance, or
- replacing the waterproof membrane on a flat roof.

The relevant maximum permissible U-value is given in column 3 of Table 16.26. If the area to be renovated exceeds either:

- 50% of the area of the individual element, or
- 25% of the total area of the building envelope,

then the whole of the element should be improved to this standard. Care should be taken in deciding which area is to be used as the reference in calculating the percentages. The following examples illustrate this:

- Removal of plaster finish from the inside of a solid brick wall – The area of the element is the area of the external wall of the room.
- Removal of the external render from a wall – The area is the elevation in which that wall sits.
- Stripping all the roofing from a flat roof extension – The area is the roof area of the extension.
- Removal of the external render from the rear wall of a single-storey extension – The area is the wall of the extension (not the rear elevation of the property when viewed from the rear).

If it is either technically or functionally not feasible to renovate a thermal element to meet the standard given in column 3 of Table 16.26 or if in achieving this standard the element could not achieve a simple payback of 15 years or less, then the element should be upgraded to the best achievable standard that does provide a simple payback of 15 years or less. Some of the cost-effective renovation strategies given in Appendix A of AD L1B may be applicable.

Retained thermal elements

A retained thermal element comes about when:

- an existing thermal element is part of a building subject to a material change of use; or
- an existing element becomes part of the thermal envelope of a building where previously it was not, e.g. part of a loft or garage conversion where a previously unheated space is now heated.

A retained thermal element whose U-value is greater than the threshold in column 2 of Table 16.26 should be upgraded to a U-value equal to or less than the improved value given in column 3 of Table 16.26, provided this is technically, functionally and economically feasible. In this context, economic feasibility is satisfied when a simple payback of 15 years or less is achieved.

If the improved U-value standard in column 3 cannot be achieved technically, functionally or economically, then the retained thermal element must be upgraded to the lowest possible U-value that will still give a simple payback of 15 years or less. This could apply when, for example:

- The necessary thickness of extra insulation reduces the usable floor area by more than 5%.
- The extra insulation creates difficulties with adjoining floor levels.
- The weight of additional insulation is too great for the existing structure.

If these problems cannot be resolved, then the element should be upgraded to the best standard possible, such that it achieves a simple payback of 15 years or less. Even so, the finished U-value must not be higher than 0.7 $W/m^2.K$.

16.9.4 Consequential improvements

If an existing building has a total useful floor area of over 1000 m^2, consequential improvements to that building are required when proposed work (i.e. the principal works) includes any of the following:

- an extension;
- the initial provision of any fixed building service (except a renewable energy generator); or
- an increase in the installed capacity of any fixed building service (except a renewable energy generator).

The purpose of consequential improvements is to bring the existing building up to current Part L standards insofar as it is technically, functionally and economically feasible. The principal works themselves must of course comply with the energy efficiency requirements, and so it is not acceptable to use consequential improvements to the existing building in order to compensate for an extension of poor standard, unless the whole-building calculation method (see section 'A new extension to an existing building: Whole building calculation method') has been used to demonstrate compliance.

Consequential improvements on extending a building

When an existing building is extended or when the habitable area within an existing building is increased, compliance is judged to have been achieved if:

- the value of the consequential improvements is at least 10% of the value of the principal works, and
- the consequential improvements have a simple payback not exceeding the remaining life of the building, or 15 years whichever is the less.

The values should be calculated by a suitably qualified person (e.g. a chartered quantity surveyor) using prices current on the date that the proposals are made known to the BCB. This calculation should be submitted as part of the initial notice or deposit of plans. Where the proposals include an upgrade or full replacement of central plant (boilers, HVAC equipment, etc.) in order to service the extension, the BCB should be consulted as to whether or not the cost of the work to the central plant should be assigned to the principal works or to the consequential improvements.

The approved document suggests a number of measures which can be expected to have a payback of no more than 15 years and which are practical. These are listed in Table 16.27.

Consequential improvements on installing building services

This applies to:

- the installation of a fixed building service as a first installation; or
- an installation which increases the installed capacity per unit area of an existing service.

Table 16.27 Improvements that have a simple payback of 15 years or less, and are practical.

No.	Improvement measure
1	Upgrading heating systems more than 15 years old by the provision of new plant or improved controls
2	Upgrading cooling systems more than 15 years old by the provision of new plant or improved controls
3	Upgrading air-handling systems more than 15 years old by the provision of new plant or improved controls
4	Upgrading general lighting systems that have an average lamp efficacy of less than 40 lamp lumens per circuit-watt and that serve areas greater than 100 m^2 by the provision new luminaires or improved controls
5	Installing energy metering following the guidance of CIBSE TM 39 [20]
6	Upgrading thermal elements which have U-values higher than those listed in column 1 of Table 16.25
7	Replacing existing windows, roof windows or rooflights (excluding display windows) or doors (excluding high-usage entrance doors) which have U-values higher than 3.3 W/m^2.K. See column 1 of Table 16.25
8	Increasing the on-site low and zero carbon (LZC) energy-generating systems if the existing on-site systems provide less than 10% of on-site energy demand, provided the increase would achieve a simple payback of seven years or less
9	Adopting measures specified in the Recommendations Report produced in parallel with a valid Energy Performance Certificate

Installed capacity is taken to mean the design output of the distribution system output devices (the terminal units) serving the space in question divided by the total useful floor area of that space.

Reasonable provision would be to carry out the improvements in two stages.

(1) Improve those parts of the building served by the service, where this is economically feasible.
This normally means that the thermal performance of the fabric must be improved. The purpose is to ensure that the capacity and energy consumption of the new or extended installation is not excessive. The value of the principal works is the value of the work due to the new or expanded building service, excluding the value of the improvements. However, these improvements *cannot* contribute to the value of the consequential improvements made under this heading.

(2) Carry out consequential improvements to the rest of the building served by the service, where this is practical and economically feasible.
If these additional consequential improvements were not carried out, it is probable that the new or expanded system capacity would result in the building having a higher rate of CO_2 emissions than before. Improvements under this heading *do* count towards the value of consequential improvements.

The required improvements depend on the exact nature of the new or expanded service, there being three cases which cover nearly all possibilities.

(1) Increase in the size/capacity of the central plant solely for the purpose of serving a new extension whilst maintaining the same level of provision elsewhere. The required

Table 16.28 Criteria for demonstrating the adequacy of improvements to solar control measures.

No.	Criterion
1	The maximum solar gain averaged over the period 06.30 to 16.30 GMT is reduced to 25 W/m^2 or less for July, using design irradiances taken from CIBSE *Design guide A* [37]
2	The design solar load is reduced by at least 20%
3	The effective g-value is a maximum of 0.3
4	The zone or zones satisfy the criterion 3 check in AD L2A based on calculations using an approved software tool (see section 16.8.4)

***Note*:**
Guidance on solar gain calculations and g-values is available in CIBSE TM37 *Design for improved solar shading control* [22].

improvements are as for a new extension, and so section 'The U-values of thermal elements and windows' and Table 16.27 apply.

(2) A heating system with whose installed capacity per unit area has been increased. The required improvements are items 6 and 7 in Table 16.27. However, there is no 10% threshold on the value of the improvements.

(3) A cooling system whose installed capacity per unit area has been increased. The required improvements are:
- item 6 of Table 16.27, and
- if, within the area served, either
  - (a) the area of windows (excluding display windows) and roof windows exceeds 40% of the façade area, or
  - (b) the area of rooflights exceeds 20% of the area of the roof,

  and the design solar load for July exceeds 25 W/m^2, improve solar control measures to meet at least one of the criteria specified in Table 16.28, and
- for any general lighting system within the area served by the fixed building service which has an average lamp efficacy of less than 45 lamp lumens per circuit-watt, upgrade to new luminaires and or controls, following guidance in the *Non-domestic building services compliance guide* [21].

16.9.5 Providing information

On completion of the work the owner should be provided with sufficient information about the building and the fixed building services and their operating and maintenance requirements so that the building can be operated in an energy-efficient manner. This applies only to such work as has been carried out.

It is recommended that the information be provided in the form of a building log book, and a way of demonstrating compliance would be to follow the guidance in CIBSE TM 31 *Building log book toolkit* [33] or to add to an existing log book. The information should be presented in the form of templates the same as or similar to those in TM 31. If convenient, the information may draw on or refer to information available in other documentation such as:

- operation and maintenance manuals;
- the Health and Safety file required by CDM regulations.

The new or updated log book should include details of:

- any newly provided, renovated or upgraded thermal elements or controlled fittings;
- any newly provided fixed building services, their method of operation and maintenance;
- any newly installed energy meters;
- any other details, either singly or collectively arising from the works that have been carried out, that are relevant to the monitoring and control of energy consumption.

16.9.6 Work on thermal elements

When carrying out any of the work to which AD L2B applies, the renovation or upgrading of thermal elements is a possibility or even a necessity. Table A1 in Appendix A of AD L1B, which is intended for dwellings, gives numerous practical examples of cost-effective methods for renovating typical roofs, walls and floors in order to achieve a specified target U-value. These examples may also, in some cases, be suitable for other buildings. See also section 16.10 on U-values.

16.10 U-values

Although U-values themselves are no longer a sufficient means for demonstrating compliance, they remain an essential part of the compliance procedures. It is therefore necessary to know the U-values of the external elements of a building. The usual sources are:

- measurement of an actual building element;
- tables or charts of U-values from an authoritative source;
- calculation from materials' properties.

Of these, the most reliable are those U-values obtained by measurement of the exact building element. However such measurements are available for a relatively small number of constructions. If measured data is not available, the next most convenient source is precalculated data, usually in the form of a table or chart, provided the particular case for which a U-value is required is within the range of the data. If neither measured nor precalculated data is available, the U-value must be calculated from the properties of the constituent materials. If the U-value of a particular element is not already known, then the best approach to obtaining a value depends on the type of element, i.e. whether it is wall, roof window or floor.

When considering a particular fabric element for installation in a building, it is useful to have in mind the U-value which is appropriate both to the element itself and to the circumstances in which it is being used. Table 16.29 summarises the principal maximum U-values as specified in the approved documents, SAP 2012 and National Calculation Methodology. Measured and calculated U-values may be compared to the values given in this table.

Table 16.29 Summary of maximum permitted U-values.

		Maximum U-value, W/m².K			
Element	**Source**	**Walls**	**Roofs**	**Floors**	**Windows, etc.**
Dwelling, TER reference value	L1A/SAP2012	0.18	0.13	0.13	1.40
Dwelling, limiting value	L1A	0.30	0.20	0.25	2.00
Dwelling, new and replacement	L1B	0.28	0.16/0.18	0.22	1.60
Dwelling, renovated and retained	L1B	0.30/0.55	0.16/0.18	0.25	n/a
Non-dwelling, TER reference value	L2A/NCM	0.26	0.18	0.22	1.60
Non-dwelling, limit value	L2A	0.35	0.25	0.25	2.2
Non-dwelling, new and replacement	L2B	0.28	0.16/0.18	0.22	1.80
Non-dwelling, renovated and retained	L2B	0.30/0.55	0.16/0.18	0.25	n/a

Table 16.30 Measurement methods for building elements.

Element	**Title**	**Reference**
Building materials and products	Thermal performance of building materials and products – determination of thermal resistance by means of guarded hot plate and heat flow meter methods – dry and moist products of medium and low thermal resistance	BS EN 12664:2001
Building materials and products	Thermal performance of building materials and products – determination of thermal resistance by means of guarded hot plate and heat flow meter methods – products of high and medium thermal resistance	BS EN 12667:2001
Building materials and products	Thermal performance of building materials and products – determination of thermal resistance by means of guarded hot plate and heat flow meter methods – thick products of high and medium thermal resistance	BS EN 12939:2001
Windows and doors	Thermal performance of windows and doors – determination of thermal transmittance by hot box method – Part 1: complete windows and doors	BS EN ISO 12567-1:2010
Windows and doors	Thermal performance of windows and doors – determination of thermal transmittance by hot box method – Part 2: roof windows and other projecting windows	BS EN ISO 12567-2:2005

16.10.1 Measured U-values

For a measured value to be acceptable, it must have been obtained in accordance with an approved method. Table 16.30 lists the most suitable methods. Where measured U-values are provided in trade (or any other) literature, they should be certified as having been obtained according to the appropriate standard.

16.10.2 Calculation methods for U-values

Calculation methods for all thermal elements must be sufficiently sophisticated to take account of thermal bridging effects. This is particularly true of windows, roof windows, rooflights and doors, where the U-value refers to the complete unit and therefore includes the frame. Consequently, in order to be acceptable, a calculated value must have been obtained by an approved procedure. Table 16.31 lists the principal sources of information on approved calculation methods. The first of these, i.e. BR 443, is specified in the approved documents as being the most suitable for the majority (but not all) of wall and some other constructions. It utilises the methods given in the British Standards, and a version of it in the form of a computer software programme is available from the

Table 16.31 Calculation methods for building components.

Element	Title	Reference
All building elements	Conventions for U-value calculations	BR 443, Building Research Establishment, 2006
Buildings and building components	Building components and building elements – thermal resistance and thermal transmittance – calculation method	BS EN ISO 6946:2007
Windows, doors and shutters	Thermal performance of windows, doors and shutters – calculation of thermal transmittance – general	BS EN ISO 10077-1:2006
Windows, doors and shutters	Thermal performance of windows, doors and shutters – calculation of thermal transmittance – numerical methods	BS EN ISO 10077-2:2012
Thermal bridges	Thermal bridges in building construction – heat flows and surface temperatures – detailed calculations	BS EN ISO 10211:2007
Ground floors	Thermal performance of buildings – heat transfer via the ground – calculation methods	BS EN ISO 13370:2007
Heat transfer coefficients	Thermal performance of buildings – transmission and ventilation heat transfer coefficients – calculation method	BS EN ISO 13789:2007
Internal temperatures in summer without cooling – windows, doors and shading devices	Thermal performance of buildings – calculation of internal temperatures of a room in summer without mechanical cooling – general criteria and validation procedures	BS EN ISO 13791:2012
Internal temperatures in summer without cooling – windows doors and shading devices	Thermal performance of buildings – calculation of internal temperatures of a room in summer without mechanical cooling – simplified methods	BS EN ISO 13792:2012
Glass	Glass in building – determination of thermal transmittance (U-value) – calculation method	BS EN 673:2011
Curtain walling	Thermal performance of curtain walling – calculation of thermal transmittance	BS EN 13947:2006

Building Research Establishment [35]. The methods described here are suitable for many common situations.

16.10.3 U-value calculations for walls and roofs

The theory described here is suitable for thermal elements which contain a regularly repeated thermal bridge. It is based on the calculation of thermal resistances. For a single layer of material, the thermal resistance R is given by

$$R = \frac{d}{\text{»}}$$

where d is the thickness of the layer in metres and λ is the thermal conductivity. The combined resistance of several materials depends on whether the heat flows through them sequentially, i.e. in series or in parallel as shown in Fig. 16.3.

Resistances in series

For three materials in series (Fig. 16.3a), the total combined resistance R_{Series} is given by

$$R_{Series} = R_1 + R_2 + R_3$$

Resistances in parallel

For three materials in parallel (Fig. 16.3b), the total combined resistance $R_{Parallel}$ is given by

$$\frac{1}{R_{Parallel}} = \frac{F_1}{R_1} + \frac{F_2}{R_2} + \frac{F_3}{R_3}$$

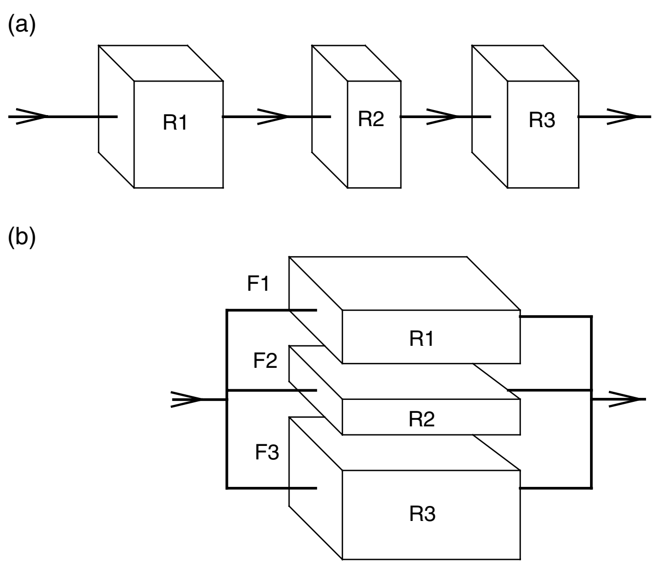


Fig. 16.3 Resistances in series (a) and in parallel (b).

where F_1, F_2 and F_3 are the cross-sectional areas of each material expressed as a fraction of the total.

If the structure consists solely of elements in series or solely of elements in parallel, then the U-value is found from

$$U = \frac{1}{R_{Series}} \quad \text{or} \quad U = \frac{1}{R_{Parallel}}$$

Construction elements with materials in series and in parallel

Many practical construction elements consist of several layers through which heat passes in series, with some components embedded within them through which the heat passes in parallel (the thermal bridges). The total thermal resistance can be calculated in several ways, the method given here being one of the simplest and most direct. The method is suitable when the bridging material is timber or mortar or some other material which is thermally similar. It is not suitable when the bridging material is metal, nor is it suitable for ground floors and basements. The method calculates an upper resistance limit for the construction element, R_{upper}, and a lower resistance limit, R_{lower}, and then finds the total combined resistance, R_T, by taking the average

$$R_T = \frac{1}{2}\left(R_{upper} + R_{lower}\right)$$

The U-value for the total construction is then found from

$$U_T = \frac{1}{R_T}$$

The U-value found in this way can then be corrected for a number of additional factors, including:

- air gaps which penetrate an insulation layer;
- mechanical fasteners which form a thermal bridge effect;
- inverted roofs (a roof where the insulation layer is above the waterproof membrane);
- an unheated space on the exterior face of an element and the outside environment.

For the first three, a correction factor, U, is added to U_T to give a corrected value U_c as follows:

$$\text{Corrected U-value} \quad U_c = U_T + U$$
$$U = U_g + U_f + U_r$$

U_g, correction for air gaps
U_f, correction for mechanical fasteners
U_r, correction for inverted roofs

Table 16.32 Correction factors for air gaps.

Level	ΔU^{11}, W/m².K	Type of air gap
0	0.00	Insulation installed in such a way that no air circulation is possible on the warm side of the insulation. No air gaps penetrating the entire insulation layer
1	0.01	Insulation installed in such a way that no air circulation is possible on the warm side of the insulation. Air gaps may penetrate the insulation layer
2	0.04	Air circulation is possible on the warm side of the insulation. Air gaps may penetrate the insulation layer

Correction for air gaps

$$\Delta U_g = \Delta U^{11} \times \left(\frac{R_l}{R_T}\right)^2$$

R_l, thermal resistance of layer containing the gaps
R_T, total thermal resistance of the whole component
U^{11} is obtained from the Table 16.32.

Correction for mechanical fasteners

$$\Delta U_f = \alpha \frac{\lambda_f n_f A_f}{d_{ins}} \left(\frac{R_1}{R_T}\right)^2$$

ΔU_f, thermal conductivity of the fastener
n_f, number of fasteners per square metre
A_f, cross-sectional area of one fastener
d_{ins}, thickness of the insulation layer which is penetrated by the fastener

For most cases, $\alpha \approx 0.8$ If the fastener is recessed (i.e. less than the thickness of the insulation layer) as in some roof systems, then $\alpha \approx 0.8(d_f / d_{ins})$ where d_f is the length of the fastener within the insulation layer.

Corrections for fasteners must NOT be applied when:

the wall ties are across an empty cavity;
the wall ties are between a masonry leaf and timber studs;
the thermal conductivity of the fastener, or part of it, is less than 1 W/m.K.

Correction for inverted roofs
This correction, if required, may be obtained from BS EN ISO 6946.

Correction for a U-value via an unheated space
The precise calculation of the heat flow through a building element, and then via an unheated space to the outside, requires complex procedures. These can be found in BS EN ISO 13789. However, for the purposes of Part L, a simpler procedure in which the

unheated space is assumed to behave like an additional homogeneous plane layer is often adequate. With this assumption, the extra thermal resistance of an unheated space may be included in the calculation of the U-value of an element using the formula

$$U = \frac{U_c}{1 + R_{extra} \times U_c}$$

where

U is the U-value of the element including the effect of the unheated space,

U_c is the U-value of the element between the heated and unheated spaces, calculated as if exposed directly to the outside,

R_{extra} is the effective extra thermal resistance due to the unheated space.

This formula is acceptable provided the correction term is small, such that

$$R_{extra} \times U_c < 0.3$$

Values of R_{extra} are given in SAP 2012 for some typical unheated spaces attached to dwellings, including:

- single and double garages in various configurations;
- stairwells;
- access corridors;
- roof spaces adjacent to a room in a roof.

These values, which are shown in Tables 16.33 and 16.34, may not be suitable for similar situations in other buildings. Conservatories are, by definition, thermally separated

Table 16.33 Extra thermal resistance due to unheated spaces – garages.

	R_u, m²K/W	
Garage type and description	**Garage is within the insulation layer of the building**	**Garage is outside the insulation layer of the building**
Single, fully integral, sharing side wall, end wall and floor with building	0.68	0.33
Single, fully integral, sharing side wall and floor with building	0.54	0.25
Single, partially integral, projecting forward, sharing part of side wall, part of floor and end wall with building	0.56	0.26
Double, fully integral, sharing side wall, end wall and floor with building	0.59	0.28
Double, half integral, sharing side wall, half of end wall and half of floor with building	0.34	n/a
Double, partially integral, projecting forward, sharing part of side wall, part of floor and end wall with building	0.28	n/a

Table 16.34 Thermal resistance of unheated spaces – various.

Type and description of unheated space	R_u, m²K/W
Stairwell between heated space and external (exposed) wall	0.82
Stairwell between heated space and internal (not exposed) wall	0.90
Access corridor between heated space and external (exposed) wall, with another corridor above *or* below	0.31
Access corridor between heated space and external (exposed) wall, with another corridor above *and* below	0.28
Access corridor between heated space and internal (not exposed) wall, with another corridor above *or* below	0.43
Loft space, between the roof covering and the wall of a heated room formed within a pitched roof above an insulated ceiling, for heat flow horizontally through the wall of the heated room	0.50
Loft space, between the roof covering and the wall of a heated room formed within a pitched roof above an insulated ceiling, for heat flow vertically through the insulated ceiling of the room below	0.50

from the building to which they are attached, and so for a conservatory R_{extra} should be taken as zero.

For other unheated spaces, it may be possible to calculate R_{extra} from

$$R_{extra} = \frac{A_{INT}}{\Sigma\left(A_{EXT} \times U_{EXT}\right) + 0.33NV}$$

where A_{INT} is the total area of the elements separating the heated space from the unheated space
A_{EXT} is the total area of the elements separating the unheated space from the outside, excluding ground floors
U_{EXT} is the U-value of the external elements of the unheated space, excluding ground floors
N is the ventilation rate in air changes per hour of the unheated space (if this is not known, it is reasonable to assume $N = 3$)
V is the volume in m^3 of the unheated space.

Calculation of U-values for pitched roofs

Flat roofs can be treated in the same way as walls, but for pitched roofs the calculation can be particularly difficult as it may be necessary to allow for:

- the irregular shape of loft spaces;
- the many different possible positions for the insulation layer;
- air leakage into the loft through hatches, access doors and light fittings;
- the flow of external air through the loft.

Because of this it is recommended that a calculation tool (e.g. the BRE U-value calculator [36]) is used rather than manual calculation. However, the following example gives an indication of a typical construction that would meet the L1B and L2B standard for a replacement roof.

Pitched roof with insulated ceiling, consisting of:

Tiled roof with felt or sarking boards;
100 mm ceiling joists with 100 mm mineral wool quilt ($\lambda = 0.040$ W/m.K) laid between the joists and 150 mm mineral wool quilt ($\lambda = 0.040$ W/m.K) laid across the joists;
Plasterboard ceiling;
Loft hatch with 50 mm of insulation;
U-value = 0.16 W/m^2.K.

Example calculations for walls

The calculation method is most conveniently explained by means of examples.

Example 1 Cavity wall

Figure 16.4 shows a cavity wall consisting of external brickwork, cavity, lightweight blockwork, mineral wool insulation within a timber subframe and internal plasterboard. The blockwork and the mineral wool are the main providers of thermal insulation in this construction, and both suffer from thermal bridging. The blockwork is bridged by the mortar joints and the mineral wool by the timber frame. In each case, the proportion of the area bridged is:

- blockwork 93% of area, mortar joints 7% of area;
- mineral wool 88% of area, timber battens 12% of area.

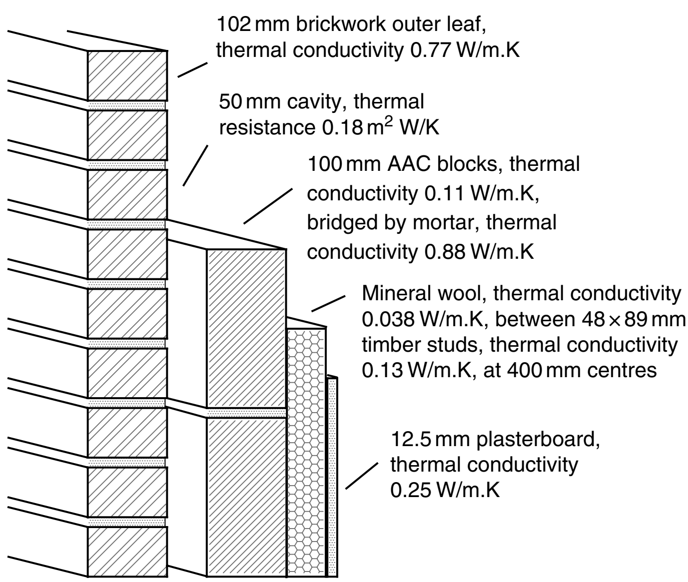


Fig. 16.4 Brick and blockwork cavity wall.

Table 16.35 gives the thermal data for the wall.

The upper resistance limit: R_{upper}

Each possible heat flow path through the wall is considered separately, and in this case it can be seen that there are four such paths, as shown in Fig. 16.5. The resistance of each path is calculated on the basis that the materials are in series, and then the four paths are combined on the basis that they are in parallel. The first part of the calculation is illustrated in Table 16.36.

The four paths are now combined in parallel to find R_{upper}.

$$\frac{1}{R_{upper}} = \frac{F_1}{R_1} + \frac{F_2}{R_2} + \frac{F_3}{R_3} + \frac{F_4}{R_4} = \frac{0.818}{3.783} + \frac{0.062}{2.988} + \frac{0.112}{2.126} + \frac{0.008}{1.331} = 0.2957$$

Table 16.35 Thermal data for cavity wall.

Material	Thickness, mm	Thermal conductivity, W/m.K	Thermal resistance, m^2K/W
External surface			0.040
Outer brickwork	102	0.77	0.132
Cavity, unvented			0.180
AAC blocks	100	0.11	0.909
Mortar	100	0.88	0.114
Mineral wool insulation	89	0.038	2.342
Timber battens	89	0.13	0.685
Plasterboard	12.5	0.25	0.050
Internal surface			0.130

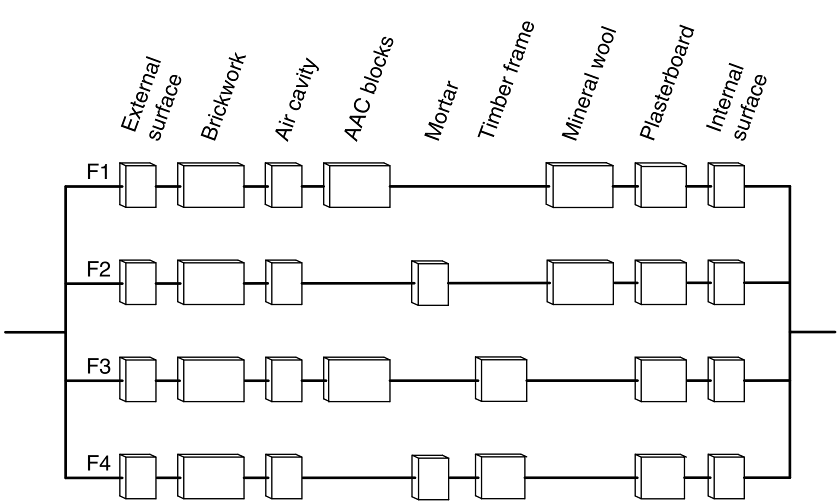


Fig. 16.5 Brick and blockwork cavity wall – upper resistance limit.

Table 16.36 Calculation of the upper resistance limit, cavity wall.

	Thermal resistance, m^2K/W			
	Path 1	**Path 2**	**Path 3**	**Path 4**
External surface resistance	0.040	0.040	0.040	0.040
Resistance of brickwork	0.132	0.132	0.132	0.132
Resistance of cavity	0.180	0.180	0.180	0.180
Resistance of AAC blocks	0.909		0.909	
Resistance of mortar		0.114		0.114
Resistance of mineral wool	2.342	2.342		
Resistance of timber			0.685	0.685
Resistance of plasterboard	0.050	0.050	0.050	0.050
Internal surface resistance	0.130	0.130	0.130	0.130
Total thermal resistance of path	3.783	2.988	2.126	1.331
Fractional area of path	93% × 88% = 0.818	7% × 88% = 0.062	93% × 12% = 0.112	7% × 12% = 0.008

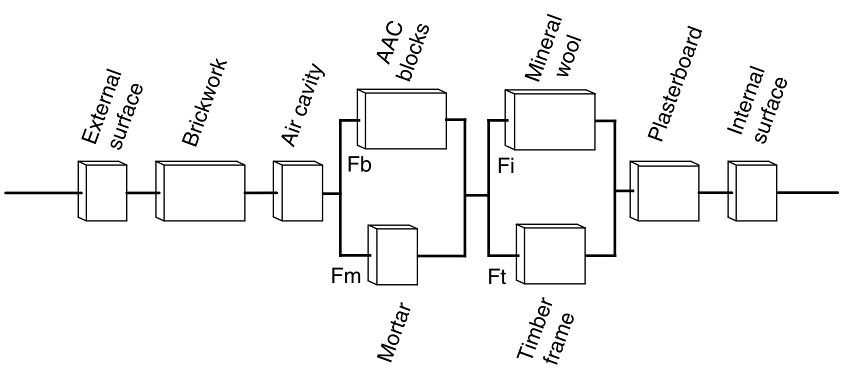


Fig. 16.6 Brick and blockwork cavity wall – lower resistance limit.

$$R_{upper} = 3.382 m^2K/W$$

The lower resistance limit: R_{lower}

Each thermal bridge in the construction element is first converted to a single combined resistance, as shown in Fig. 16.6. Using these combined resistances, the construction can then be considered as a single heat flow path with all components in series. Thus in the present example:

- First bridged layer (blockwork and mortar)

$$\frac{1}{R_{bm}} = \frac{F_{blocks}}{R_{blocks}} + \frac{F_{mortar}}{R_{mortar}} = \frac{0.93}{0.909} + \frac{0.07}{0.114} = 1.637$$

$$R_{bm} = 0.611 m^2K/W$$

- Second bridged layer (insulation and timber)

$$\frac{1}{R_{it}} = \frac{F_{insulation}}{R_{insulation}} + \frac{F_{timber}}{R_{timber}} = \frac{0.88}{2.342} + \frac{0.12}{0.685} = 0.5509$$

$$R_{it} = 1.815 m^2K / W$$

These combined resistances may now be used to find the lower resistance limit, as shown in Table 16.37. Note that R_{upper} is an overestimate of the true resistance, whereas R_{lower} is an underestimate. The average of these is very close to the true value. Hence, the total resistance of the wall is found from

$$R_T = \frac{1}{2}\left(R_{upper} + R_{lower}\right) = \frac{1}{2}\left(3.382 + 2.958\right) = 3.170\ m^2K / W$$

and the U-value is

$$U_T = \frac{1}{R_T} = \frac{1}{3.170} = 0.315 W / m^2.K$$

Corrections to the U-value for air gaps and mechanical fixings
If there are small air gaps or mechanical fixings (such as wall ties) penetrating the insulation layer, it may be necessary to add a correction, U_c, to the U-value. The correction is required if U_c is 3% or more of the uncorrected U-value but may be ignored if it is less than 3%. In this case, the only correction is for air gaps and is calculated from

$$U_c = \Delta U_g = \Delta U^{11} \times \left(\frac{R_1}{R_T}\right)^2$$

Table 16.37 Calculation of the lower resistance limit, cavity wall.

	Thermal resistances, m²K/W		
	Thermal bridges		
	Components	Combined	
External surface resistance			0.040
Resistance of brickwork			0.132
Resistance of cavity			0.180
Resistance of AAC blocks (93%)	0.909	0.611	0.611
Resistance of mortar (7%)	0.114		
Resistance of mineral wool (88%)	2.342	1.815	1.815
Resistance of timber (12%)	0.685		
Resistance of plasterboard			0.050
Internal surface resistance			0.130
Total thermal resistance, R_{lower}			2.958

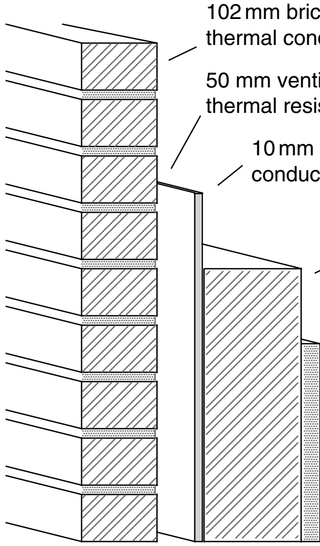


Fig. 16.7 Timber frame wall.

We have $R_1 = 1.815$, $R_T = 3.170$ and from Table 16.32 $\Delta U^{11} = 0.01$. Thus $U_c = \Delta U_g = 0.003\ W/m^2.K$. As this is less than 3% of U, it may be ignored. The final U-value is rounded to 2 decimal places, and so the result is

$$U = 0.32\ W/m^2.K$$

Example 2 Timber-framed wall

Figure 16.7 shows a timber-framed wall consisting of an outer layer of brickwork, a clear ventilated cavity, 10 mm plywood, 38 × 140 mm timber stud framing with 140 mm mineral wool quilt insulation placed between the studs and 2 sheets of 12.5 mm plasterboard with an integral vapour check. The timber studs account for 15% of the area, corresponding to 38 mm studs at 600 mm centres, with allowances for horizontal noggins and additional framing at junctions and around openings. Thermal data is given in Table 16.38.

The upper resistance limit: R_{upper}

Each possible heat flow path through the wall is considered separately, and in this case it can be seen that there are two such paths. This is illustrated in Fig. 16.8. The resistance of each path is calculated on the basis that the materials are in series, and then the two paths are combined on the basis that they are in parallel. The first part of the calculation is illustrated in Table 16.39.

The two paths are now combined in parallel to find R_{upper}.

$$\frac{1}{R_{upper}} = \frac{F_1}{R_1} + \frac{F_2}{R_2} = \frac{0.85}{4.253} + \frac{0.15}{1.646} = 0.291$$

$$R_{upper} = 3.437\ m^2K/W$$

Table 16.38 Thermal data for timber-framed wall.

Material	Thickness, mm	Thermal conductivity, W/m.K	Thermal resistance, m^2K/W
External surface			0.040
Outer brickwork	102	0.77	0.132
Cavity, vented			0.090
Plywood	10	0.13	0.077
Mineral wool quilt insulation	140	0.038	3.684
Timber framing	140	0.13	1.077
Plasterboard	25	0.25	0.100
Internal surface			0.130

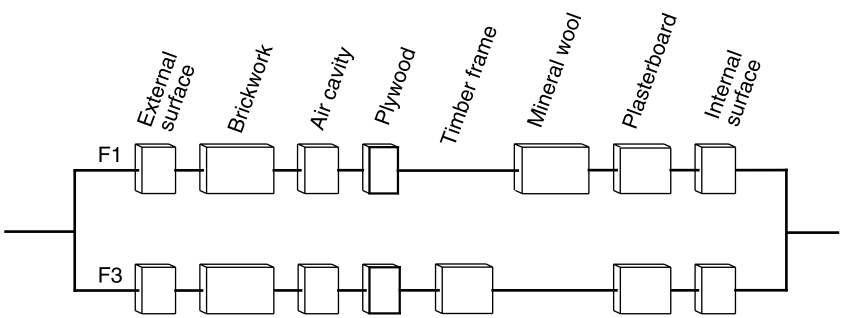


Fig. 16.8 Timber frame wall – upper resistance limit.

Table 16.39 Calculation of the upper resistance limit, timber-framed wall.

	Thermal resistance, m^2K/W	
	Path 1	Path 2
External surface resistance	0.040	0.040
Resistance of brickwork	0.132	0.132
Resistance of cavity	0.090	0.090
Resistance of plywood	0.077	0.077
Resistance of mineral wool quilt	3.684	
Resistance of timber		1.077
Resistance of plasterboard	0.100	0.100
Internal surface resistance	0.130	0.130
Total thermal resistance of path	4.253	1.646
Fractional area of path	85% = 0.85	15% = 0.15

The lower resistance limit: R_{lower}

Each thermal bridge in the construction element is first converted to a single combined resistance, as shown in Fig. 16.9. Using these combined resistances, the construction can then be considered as a single heat flow path with all components in series. In this example there is one bridged layer, insulation and timber:

$$\frac{1}{R_{it}} = \frac{F_{insulation}}{R_{insulation}} + \frac{F_{timber}}{R_{timber}} = \frac{0.85}{3.684} + \frac{0.15}{1.077} = 0.370$$

$$R_{it} = 2.703 m^2 K/W$$

This combined resistance may now be used to find the lower resistance limit, as shown in Table 16.40. Note that R_{upper} is an overestimate of the true resistance, whereas R_{lower} is

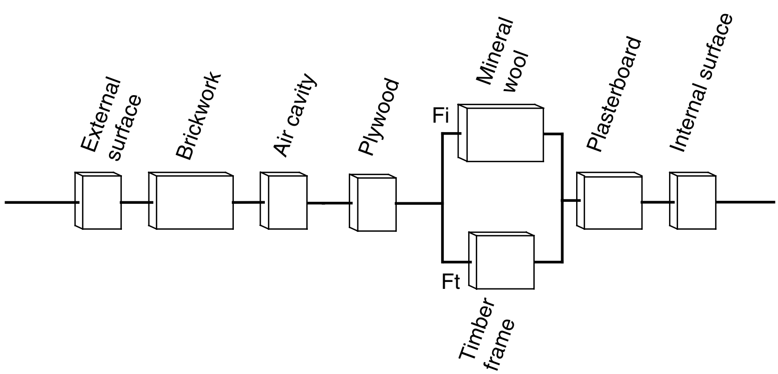


Fig. 16.9 Timber frame wall – lower resistance limit.

Table 16.40 Calculation of the lower resistance limit, timber-framed wall.

	Thermal resistances, m^2K/W		
	Thermal bridges		
	Components	Combined	
External surface resistance			0.040
Resistance of brickwork			0.132
Resistance of cavity			0.090
Resistance of plywood			0.077
Resistance of mineral wool (85%)	3.684	2.703	2.703
Resistance of timber (15%)	1.077		
Resistance of plasterboard			0.100
Internal surface resistance			0.130
Total thermal resistance, R_{lower}			3.272

an underestimate. The average of these is very close to the true value. Hence, the total resistance of the wall is found from

$$R_T = \frac{1}{2}\left(R_{upper} + R_{lower}\right) = \frac{1}{2}\left(3.437 + 3.272\right) = 3.354\,m^2K/W$$

and the U-value is

$$U_T = \frac{1}{R_T} = \frac{1}{3.354} = 0.298\,W/m^2.K$$

Corrections to the U-value for air gaps and mechanical fixings

If there are small air gaps or mechanical fixings (such as wall ties) penetrating the insulation layer, it may be necessary to add a correction, U_c, to the U-value. The correction is required if U_c is 3% or more of the uncorrected U-value but may be ignored if it is less than 3%. Again only air gaps are relevant, and so the correction is calculated from

$$U_c = \Delta U_g = \Delta U^{11} \times \left(\frac{R_1}{R_T}\right)^2$$

In this case, ΔU^{11} is 0.01, R_1 is 2.703 and R_T is 3.354, and so ΔU_g is 0.006 W/m²·K. As this is less than 3% of U, it may be ignored. The final U-value is rounded to 2 decimal places, and so the result is

$$U = 0.30\,W\,/\,m^2.K$$

16.10.4 U-values for ground floors

The accurate calculation of the U-value of ground floors is difficult and requires the rigorous procedures given in BS EN ISO 13370 or in CIBSE Guide A [37]. However, the full rigour of these methods may not be necessary, and the following simple approach may be adequate for most of the common constructions and ground conditions to be found in the UK. The method is based on precalculated tabulated values. There are several points to be noted:

- For solid ground floors, if the perimeter to area ratio is less than 0.12 m/m^2, the U-value will normally be 0.25 $W/m^2.K$ or less without the need for insulation.
- For suspended ground floors, if the perimeter to area ratio is less than 0.09 m/m^2, the U-value will normally be 0.25 $W/m^2.K$ or less without the need for insulation.
- For ground floors the U-value depends on the type of soil beneath the building; clay soil is the most typical in the UK, and this is assumed to be the case in the following tables.
- Where the soil is neither clay nor silt, the U-value must be calculated in accordance with BS EN ISO 13370.

As the U-value of a ground floor depends on the ratio of the perimeter to the area, the rules for calculating this ratio must be observed. These are:

- Floor dimensions should be measured between the finished internal faces of the external elements of the building and must include any projecting bays.
- For semi-detached houses, terraced houses, blocks of flats and similar structures, the floor dimensions can be either those of the individual unit or the whole building.
- When considering extensions to existing buildings, the floor dimensions may be taken as those of the complete building including the extension.
- Unheated spaces outside the insulated fabric (e.g. attached garages and porches) are excluded from the perimeter and area calculation, but the length of common wall between them must be included in the perimeter.

In addition to meeting U-value requirements, it is also important that the floor design should prevent excessive thermal bridging at the floor edge. This is to reduce the risk of condensation and mould growth.

Solid ground floors

For solid ground floors with all-over insulation, as shown in Fig. 16.10, the U-values in Table 16.41 apply.

Solid ground floors with edge insulation

It is often better to insulate a floor with horizontal or vertical edge insulation *instead of* all-over insulation. When this is done, as shown in Fig. 16.11, a correction factor is subtracted from the U-value for the equivalent uninsulated solid ground floor. The correction factor is a combination of the perimeter to area ratio and an edge insulation factor. Thus

$$U = U_0 - \frac{P}{A}\Psi$$

where U_0 is the value for an uninsulated floor taken from Table 16.41 (the column for zero thermal resistance) and is obtained from Table 16.42. There are no tables for floors with both types of insulation. For such cases, the calculation method of BS EN ISO 13370 must be used.

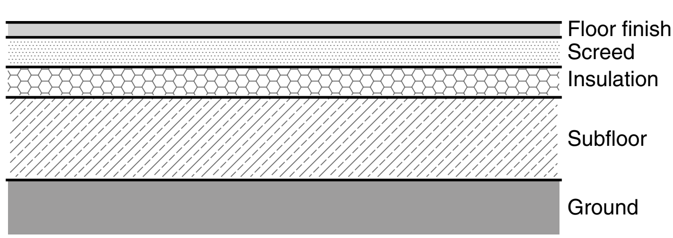


Fig. 16.10 Solid floor in contact with the ground.

Table 16.41 U-values for solid ground floors.

Perimeter to area ratio, m/m²	Thermal resistance of all-over insulation, m²K/W					
	0	0.5	1	1.5	2	2.5
	U-value of solid ground floor, W/m².K					
0.05	0.13	0.11	0.10	0.09	0.08	0.08
0.10	0.22	0.18	0.16	0.14	0.13	0.12
0.15	0.30	0.24	0.21	0.18	0.17	0.15
0.20	0.37	0.29	0.25	0.22	0.19	0.18
0.25	0.44	0.34	0.28	0.24	0.22	0.19
0.30	0.49	0.38	0.31	0.27	0.23	0.21
0.35	0.55	0.41	0.34	0.29	0.25	0.22
0.40	0.60	0.44	0.36	0.30	0.26	0.23
0.45	0.65	0.47	0.38	0.32	0.27	0.23
0.50	0.70	0.50	0.40	0.33	0.28	0.24
0.55	0.74	0.52	0.41	0.34	0.28	0.25
0.60	0.78	0.55	0.43	0.35	0.29	0.25
0.65	0.82	0.57	0.44	0.35	0.30	0.26
0.70	0.86	0.59	0.45	0.36	0.30	0.26
0.75	0.89	0.61	0.46	0.37	0.31	0.27
0.80	0.93	0.62	0.47	0.37	0.32	0.27
0.85	0.96	0.64	0.47	0.38	0.32	0.28
0.90	0.99	0.65	0.48	0.39	0.32	0.28
0.95	1.02	0.66	0.49	0.39	0.33	0.28
1.00	1.05	0.68	0.50	0.40	0.33	0.28

Uninsulated suspended ground floors

The U-values for uninsulated suspended ground floors are given in Table 16.43. These values can be used when

- the floor deck is not more than 500 mm above the external ground level;
- the wall surrounding the underfloor space is uninsulated.

The U-values depend on the amount of ventilation which is provided to the underfloor space. This is expressed as the area in square metres of ventilation opening per unit length in metres of floor perimeter, and the table provides data for two typical values.

Insulated suspended ground floors

The U-value of an insulated suspended floor, Figs 16.12 and 16.13, is calculated from the parameters U_0, R_f and U_f where:

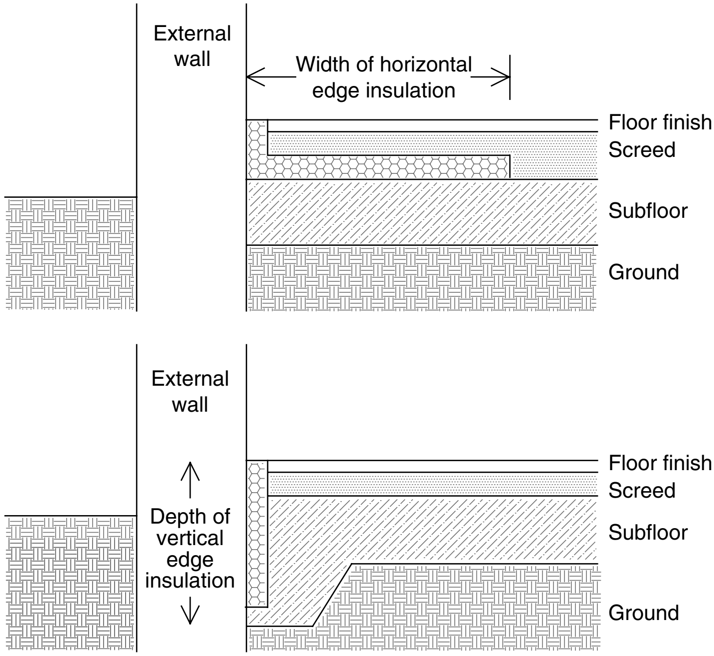


Fig. 16.11 Edge insulation of solid ground floors.

Table 16.42 Edge insulation factors for solid ground floors.

	Thermal resistance of insulation, m²K/W			
	0.5	**1.0**	**1.5**	**2.0**
Width of horizontal insulation, m	**Edge insulation factor Ψ, W/m.K**			
0.50	0.13	0.18	0.21	0.22
1.00	0.20	0.27	0.32	0.34
1.50	0.23	0.33	0.39	0.42
Depth of vertical insulation, m				
0.25	0.13	0.18	0.21	0.22
0.50	0.20	0.27	0.32	0.34
0.75	0.23	0.33	0.39	0.42
1.00	0.26	0.37	0.43	0.48

- U_0 is the U-value of the equivalent uninsulated floor taken from Table 16.43;
- U_f is the U-value of the floor deck, including allowances for thermal bridging, and calculated according to the methods recommended in BS EN ISO 6946 or by a numerical modelling method; and
- R_f is the thermal resistance of the floor deck itself.

Table 16.43 U-values for uninsulated suspended ground floors.

Perimeter to area ratio, m/m²	Ventilation opening area per unit perimeter of underfloor space	
	0.0015 m²/m	0.0030 m²/m
	U-value of suspended ground floor, W/m².K	
0.05	0.15	0.15
0.10	0.25	0.26
0.15	0.33	0.35
0.20	0.40	0.42
0.25	0.46	0.48
0.30	0.51	0.53
0.35	0.55	0.58
0.40	0.59	0.62
0.45	0.63	0.66
0.50	0.66	0.70
0.55	0.69	0.73
0.60	0.72	0.76
0.65	0.75	0.79
0.70	0.77	0.81
0.75	0.80	0.84
0.80	0.82	0.86
0.85	0.84	0.88
0.90	0.86	0.90
0.95	0.88	0.92
1.00	0.89	0.93

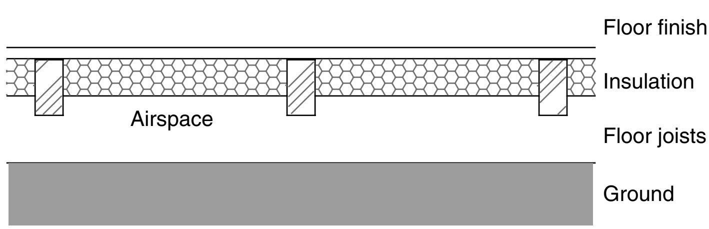


Fig. 16.12 Suspended timber ground floor.

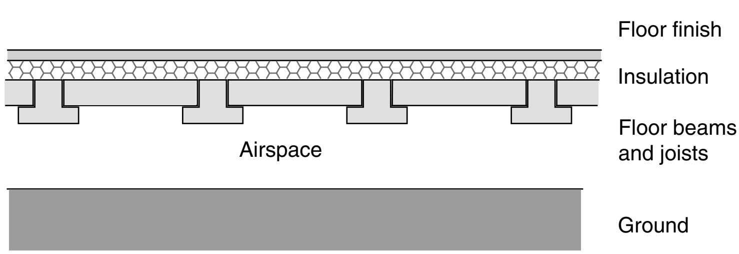


Fig. 16.13 Suspended concrete ground floor.

The procedure is to first obtain U_f and then find R_f from the formula

$$R_f = \frac{1}{U_f} - 0.17 - 0.17$$

The two values of 0.17 are the surface resistances. The U-value of the floor is then found from

$$U = \frac{1}{\left[(1/U_o) - 0.2 + R_f\right]}$$

Determining the thickness of insulation for upper floors

For upper floors, i.e. floors above an external space, the U-values given in Table 16.44, which is derived from the approved document for Part L 2002 edition, should be sufficient to give an indication of the minimum thickness of insulation required to achieve a given U-value. The table assumes that the proportion by area of structural timber in the timber floor construction is 12%, corresponding to 48 mm wide timber joists at 400 mm centres. The U-value for other proportions of timber must be calculated using the method of section 16.10.3.

Example calculations for floors

Example 1 Solid ground floor over clay subsoil

Figure 16.14 illustrates the floor plan of a detached house. The subsoil is clay, and the floor is uninsulated. First, calculate the perimeter to area ratio:

$$P = 2 \times (10.2 + 6.7) = 33.8\text{m}$$
$$A = 10.2 \times 6.7 - 3.5 \times 2.7 = 58.89\text{m}^2$$
$$\frac{P}{A} = \frac{33.8}{58.89} = 0.57\text{m/m}^2$$

Table 16.44 Insulation thicknesses for upper floors.

	U-value, W/m².K	Thermal conductivity of insulation material, W/m.K						
		0.020	0.025	0.030	0.035	0.040	0.045	0.050
		Thickness of insulation layer, mm						
Timber construction	0.20	167	211	256	298	341	383	426
	0.25	109	136	163	193	225	253	281
	0.30	80	100	120	140	160	184	208
Concrete construction	0.20	95	119	142	166	190	214	237
	0.25	75	94	112	131	150	169	187
	0.30	62	77	92	108	123	139	154

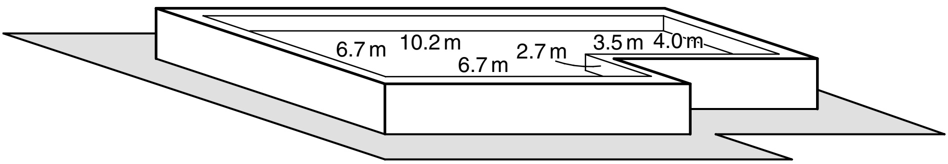


Fig. 16.14 Solid ground floor.

The U-value is found from Table 16.41, using the column for zero thermal resistance. It is normally recommended that the row nearest to the actual P/A value is used; in this case the nearest row to 0.57 is P/A = 0.55. It is not necessary to interpolate between rows because the change in U-value between rows is not large enough to warrant the extra work. The U-value of this floor is therefore

$$U = 0.74\,\text{W/m}^2.\text{K}$$

Example 2 Solid ground floor over clay subsoil with all-over insulation

The floor in Fig. 16.14 is now provided with all-over insulation between the screed and the structural floor. The insulation layer is 75 mm thick and has a thermal conductivity of 0.040 W/m.K. The resistance of the insulation layer is:

$$R_{ins} = \frac{0.075}{0.040} = 1.875\,\text{m}^2\text{K/W}$$

In Table 16.41 we again use the row for P/A = 0.55, but this time we must interpolate between the columns for $R_{ins} = 1.5$ and $R_{ins} = 2.0$. This interpolation is necessary because the change in U-value between columns is more significant than the change between rows. Thus

$$\text{At } R_{ins} = 1.875, \quad U = 0.34 - \left(\frac{1.875 - 1.5}{2.0 - 1.5}\right) \times (0.34 - 0.28) = 0.295\,\text{W/m}^2.\text{K}$$

Example 3 Solid ground floor over clay subsoil with vertical edge insulation

The floor in Fig. 16.14 is provided with vertical edge insulation instead of all-over insulation. The insulation is to a depth of 750 mm, and the insulation is 75 mm thick with a thermal conductivity of 0.040 W/m.K. The resistance of the insulation layer is

$$R_{ins} = \frac{0.075}{0.040} = 1.875\,\text{m}^2\text{K/W}$$

From example 1, the perimeter to area ratio of this floor is 0.57, and its uninsulated U-value is 0.74 W/m^2.K. We require to obtain the edge insulation factor from Table 16.42, and it is necessary to interpolate between the columns for $R_{ins} = 1.5$ and $R_{ins} = 2.0$. Hence

¤ $$= 0.39 + \left(\frac{1.875 - 1.5}{2.0 - 1.5}\right) \times (0.42 - 0.39) = 0.413\,\text{W/m.K}$$

The U-value of the floor is now

$$U = 0.74 - 0.57 \times 0.413 = 0.50\,\text{W/m}^2.\text{K}$$

Example 4 Uninsulated, suspended ground floor

Now assume that the floor in Fig. 16.14 is an uninsulated suspended timber ground floor. The floor deck is less than 500 mm above external ground level, and the underfloor ventilation openings amount to approximately 0.0015 m^2/m of floor perimeter. The perimeter to area ratio is 0.57, and taking 0.55 as the nearest value in Table 16.43, the U-value is

$$U = 0.69\,\text{W/m}^2.\text{K}$$

Example 5 Insulated, suspended ground floor

Now let the floor in Example 4 be insulated, with insulation fitted between the floor joists. The U-value of this floor deck may be calculated in the same way as the U-value of a wall, using the method of Chapter 5. Assuming the result of this calculation is a U-value of 0.45 $W/m^2.K$, the U-value of the floor is found as follows:

$$R_f = \frac{1}{U_f} - 0.17 - 0.17 = \frac{1}{0.45} - 0.34 = 2.22 - 0.34 = 1.88\,\text{m}^2\text{K/W}$$

The uninsulated U-value from example 4 is $U_0 = 0.69$, and so

$$U = \frac{1}{\left[\left(1/U_0\right) - 0.2 + R_f\right]} = \frac{1}{\left[1.45 - 0.2 + 1.88\right]} = 0.32\,\text{W/m}^2.\text{K}$$

16.10.5 U-values of windows, doors, roof windows and rooflights

The U-values of windows, doors, roof windows and rooflights must normally include the effects of heat flow through the frame, the calculation of which requires advanced techniques. It is therefore usual to select values from pre-prepared data. When available, manufacturer's certified U-values (by approved methods of measurement or calculation) should be used. If these are not available, values for single, double and triple glazing may be taken from Tables 16.45, 16.46 and 16.47, modified where necessary for metal frames according to Table 16.48. Low emissivity (low-e) coatings are of two main types, 'hard' and 'soft'. If the exact value of the emissivity, ε_n, is not known, then for hard coatings or where the type of coating is unknown, use the data for $\varepsilon_n = 0.2$, and for soft coatings use the data for $\varepsilon_n = 0.1$.

For doors that are half-glazed, the U-value is the average of the non-glazed door and the appropriate U-value for the glazing.

For windows and rooflights with metal frames where the thermal break differs from 4 mm, the corrections in Table 16.48 should be applied. Note that if corrections for thermal break *and* rooflight are applicable, both should be made.

Table 16.45 Single glazing U-values for windows, rooflights and doors.

Single glazing type	$W/m^2.K$
Windows in wood or PVC-U frames	4.8
Rooflights in dwellings in wood or PVC-U frames	5.1
Rooflights in buildings other than dwellings in wood or PVC-U frames	4.8
Windows in metal frames (4 mm thermal break)	5.7
Solid wood door	3.0

Table 16.46 Double glazing indicative U-values for windows and rooflights, $W/m^2.K$.

	Gap between panes			
Double glazing description	**6 mm**	**12 mm**	**16 mm or more**	**Adjustment for rooflights in dwellings**
Wood or PVC-U frames				
Air filled	3.1	2.8	2.7	For dwellings only, add 0.2 for all wood and PVC-U frames
Low-E, $\varepsilon_n = 0.2$	2.7	2.3	2.1	
Low-E, $\varepsilon_n = 0.15$	2.7	2.2	2.0	
Low-E, $\varepsilon_n = 0.1$	2.6	2.1	1.9	
Low-E, $\varepsilon_n = 0.05$	2.6	2.0	1.8	
Argon filled	2.9	2.7	2.6	
Low-E, $\varepsilon_n = 0.2$, argon filled	2.5	2.1	2.0	
Low-E, $\varepsilon_n = 0.1$, argon filled	2.3	1.9	1.8	
Low-E, $\varepsilon_n = 0.05$, argon filled	2.3	1.8	1.7	
Metal frames, 4 mm thermal break				
Air filled	3.7	3.4	3.3	For metal frames, see Table 16.48
Low-E, $\varepsilon_n = 0.2$	3.3	2.8	2.6	
Low-E, $\varepsilon_n = 0.1$	3.2	2.6	2.5	
Low-E, $\varepsilon_n = 0.05$	3.1	2.5	2.3	
Argon filled	3.5	3.3	3.2	
Low-E, $\varepsilon_n = 0.2$, argon filled	3.1	2.6	2.5	
Low-E, $\varepsilon_n = 0.1$, argon filled	2.9	2.4	2.3	
Low-E, $\varepsilon_n = 0.05$, argon filled	2.8	2.3	2.1	

Minimum specifications for windows

Inspection of Table 16.29 shows that the required maximum U-value for a window is between 1.6 and 2.2 $W/m^2.K$, depending on the exact circumstances. From Table 16.46 it can be seen that double glazing with a 6 mm air gap in a wood or PVC-U frame is not able

Table 16.47 Triple glazing indicative U-values for windows and rooflights, $W/m^2.K$.

Triple glazing description	Gap between panes 6 mm	12 mm	16 mm or more	Adjustment for rooflights in dwellings
Wood or PVC-U frames				
Air filled	2.4	2.1	2.0	For dwellings only, add 0.2 for all wood and PVC-U frames
Low-E, $\varepsilon_n = 0.2$	2.1	1.7	1.6	
Low-E, $\varepsilon_n = 0.1$	2.0	1.6	1.5	
Low-E, $\varepsilon_n = 0.05$	1.9	1.5	1.4	
Argon filled	2.2	2.0	1.9	
Low-E, $\varepsilon_n = 0.2$, argon filled	1.9	1.6	1.5	
Low-E, $\varepsilon_n = 0.1$, argon filled	1.8	1.4	1.3	
Low-E, $\varepsilon_n = 0.05$, argon filled	1.7	1.4	1.3	
Metal frames, 4 mm thermal break				
Air filled	2.9	2.6	2.5	For metal frames, see Table 16.48
Low-E, $\varepsilon_n = 0.2$	2.6	2.2	2.0	
Low-E, $\varepsilon_n = 0.1$	2.5	2.0	1.9	
Low-E, $\varepsilon_n = 0.05$	2.4	1.9	1.8	
Argon filled	2.8	2.5	2.4	
Low-E, $\varepsilon_n = 0.2$, argon filled	2.4	2.0	1.9	
Low-E, $\varepsilon_n = 0.1$, argon filled	2.2	1.9	1.8	
Low-E, $\varepsilon_n = 0.05$, argon filled	2.2	1.8	1.7	

Table 16.48 Corrections for metal frames with various thermal breaks.

Thermal break, mm	Correction to U-value, $W/m^2.K$: Window or rooflight in buildings other than dwellings	Rooflight in dwellings
0 (no break)	+0.3	+0.7
4	0	+0.3
8	−0.1	+0.2
12	−0.2	+0.1
16	−0.2	+0.1

to satisfy the U-value requirement for any of the listed types of glass. Either a larger air gap must be chosen or to achieve the lowest required U-value of 1.6 $W/m^2.K$, triple glazing may be required. However, the U-values quoted in Tables 16.46 and 16.47 are indicative values only and are not necessarily the same as a measured value for a specific product.

Table 16.49 Correction for inclination to glazing U-values.

Inclination of component from the horizontal	Correction to U-value, $W/m^2.K$	
	Twin skin or double glazed	Triple skin or triple glazed
70° or over (taken as vertical)	0.0	0.0
69° to 61°	+0.2	+0.1
60° to 41°	+0.3	+0.2
39° to 21°	+0.4	+0.2
20° to 0° (taken as horizontal)	+0.5	+0.3

A particular problem arises with U-values for windows, roof windows and rooflights. The values quoted are normally correct for the component mounted in a vertical plane, i.e. at 90° to the horizontal. If the component is not mounted vertically, then the U-value must be increased to take account of its increased exposure to the sky. The increase above the normally quoted vertical U-value is given in Table 16.49. Although not precise, the corrections in Table 16.49 are normally adequate.

16.10.6 Thermal bridging and continuity of insulation

Thermal bridges in insulation layers can seriously reduce the effectiveness of the insulation. Every care should be taken to avoid such bridges and to ensure continuity of insulation over the building envelope, and this can be most conveniently done by adopting accredited robust details [12,13]. There are three main types of thermal bridge:

- repeating thermal bridges, which repeat in regular fashion throughout a thermal element, for example, the roof joists which interrupt the insulation laid in a roof space or the studding in a timber-framed wall;
- linear thermal bridges, such as lintels, door posts, etc.;
- isolated thermal bridges, typically a concrete floor slab extended through an external wall and its insulation layers to create a balcony.

Testing of the continuity of insulation may be carried out on the completed building. This is usually done by measuring the temperature of the external surface, and the most widely used technique is infrared photography. This should reveal any weaknesses, especially any thermal bridging which has not been properly detailed.

Repeat thermal bridges

The effect of repeating bridges is usually accounted for in the calculation of the U-value of a building element (as demonstrated in section 'Example calculations for walls'). The result is a single U-value which describes the overall heat loss through the whole of the building element, and so and no further allowance for the thermal bridging effect is necessary.

Linear thermal bridges

Linear thermal bridges cannot be incorporated in the element which they adjoin, and their effect must be calculated independently. The simplest method for demonstrating compliance is to calculate a heat loss coefficient, H, by summing the effects of all linear thermal bridges in the building from

$$H = \Sigma(L \times \Psi)$$

where L is the length of each thermal bridge and Ψ is its linear thermal transmittance. In order to use this equation it is necessary to know the value of Ψ for every thermal bridge in the construction. Unfortunately the calculation or measurement of Ψ is a complex process and not amenable to simple methods. Calculations should be carried out in accordance with the guidance set out in BR 497 [24] or BS EN ISO 10211:2007 (see Table 16.31). See also BRE IP 1/06 [25]. There are three methods for obtaining values of Ψ and hence finding the value of H.

Method 1 The use of approved quality-assured construction details

Any quality approved and quality-assured scheme may be used as a source of information. One such scheme is available at www.planningportal.gov.uk, where the following series of documents can be found, each giving a substantial number of examples:

- *Accredited construction details* [12] (June 2007 edition or later if available)

which includes details for:

- Masonry cavity wall insulation,
- Masonry external wall insulation,
- Masonry internal wall insulation,
- Wood frame illustrations,
- Steel frame illustrations.

If all detailing conforms with *Accredited construction details* or another government-approved source involving independent assessment of the construction method, then the values provided by the approved source may be used directly. The Ψ-value may be listed with the detail, or it may be cross-referenced to Table K1 of SAP 2009 [7] (see Table 16.51) or to BRE IP 1/06 [25]. These values can then be used with the length of each thermal bridge in the above equation to calculate H.

Method 2 The use of details that have not been subjected to independent assessment

If the detail has not been assessed for its construction method, then the BCB must be provided with a process flow sequence showing the way in which the detail should be constructed, and the Ψ-value must be calculated by a person with suitable experience using one of the approved methods. In this case the calculated Ψ-value must be increased by 0.02 W/m.K or 25% (whichever is the greater) before being used in the calculation.

Method 3a Dwellings using details that are neither accredited nor assessed

If neither method 1 or 2 applies, then it may be permissible to use details that have been neither accredited nor assessed to establish the Ψ-value of their thermal bridge. For dwellings only use instead the following equation:

$$H = y\Sigma A_e$$

where y is an empirical coefficient and A_e is the total area of all exposed external elements. There are two methods of determining the value of y. The simplest is to assume that y = 0.15. Otherwise, for dwellings which are a repeat of a particular dwelling design which has been accepted and approved and where H was previously calculated using method 1 or 2, y may be calculated from

$$y = \frac{H_p}{\Sigma A_{ep}}$$

where H_p and A_{ep} are the known values from that particular dwelling. If y is found in this way, documentary evidence of its calculation may be required.

Method 3b Non-dwellings using details that are neither accredited nor assessed

If neither method 1 or 2 applies, then it may be permissible to use details that have been neither accredited nor assessed to establish the Ψ-value of their thermal bridge. For non-dwellings the generic linear thermal transmittance values given in BRE IP 1/06 [25] may be used. These values must be increased by 0.04 W/m.K or 50% (whichever is the greater) before being used in the BER calculation. Methods 1 and 2 can be used for different details in the same building project. In such cases, the 0.02 W/m.K or 25% increase applies only to the details assessed by method 2.

Values of the linear thermal resistance can be found not only in Table 16.50 (which is derived from SAP 2009) but also in the technical sections of many trade catalogues. Metal roofing and cladding systems can present particular problems with thermal bridging, and guidance specifically relevant to Part L is given in MCRMA Technical Paper 17 [23].

Isolated thermal bridges

Isolated thermal bridges are potentially a serious breach of the insulation layer of a building and should for preference be avoided. If they are included, it is necessary to enter an appropriate thermal bridge value in the calculation. Unfortunately it is difficult to calculate a suitable value with any degree of reliability, and data on the thermal bridging caused by isolated thermal bridges is scarce. Specialist advice will be required.

Table 16.50 Linear thermal transmittance values for accredited construction details and default values for non-accredited details.

	Linear thermal transmittance Ψ, W/m.K	
Junction detail	**Accredited values**	**Default values**
Junctions with an external wall		
Steel lintel with perforated steel base plate	0.50	1.00
Other lintels (including other steel lintels)	0.30	1.00
Sill	0.04	0.08
Jamb	0.05	0.10
Ground floor, exposed upper floor, and floor above garage or unheated space	0.16	0.32
Intermediate floor within a dwelling	0.07	0.14
Intermediate floor between dwellings (in blocks of flats) and also floor above heated space (see note 1)	0.07	0.14
Balcony within a dwelling (see note 2)	0.00	0.00
Balcony between dwellings (see notes 1 and 2)	0.02	0.04
Eaves (insulation at ceiling level)	0.06	0.12
Eaves (insulation at rafter level)	0.04	0.08
Gable (insulation at ceiling level)	0.24	0.48
Gable (insulation at rafter level)	0.04	0.08
Flat roof	0.04	0.08
Flat roof with parapet	0.28	0.56
Corner (normal) and walls to garage, unheated corridor, unheated stairwell or other unheated space	0.09	0.18
Corner (inverted – internal area greater than external area)	−0.09	0.00
Party wall between dwellings and wall to heated corridor, heated stairwell or other heated space	0.06	0.12
Junctions with a party wall (see note 1)		
Ground floor	0.08	0.16
Intermediate floor within a dwelling	0.00	0.04
Intermediate floor between dwellings (in blocks of flats)	0.00	0.04
Roof (insulation at ceiling level)	0.12	0.24
Roof (insulation at rafter level)	0.02	0.04

Note 1: The value of Ψ should be applied to each dwelling.

Note 2: These are externally supported balconies (i.e. the balcony slab is not continuous with the floor slab) where the insulation is continuous and not bridged by either the balcony slab or any of its supports.

Thermal bridges and temperature factors

A thermal bridge causes a lowering of the internal surface temperature relative to its surroundings, thus creating the risk of unwanted condensation and mould growth. This can be assessed by means of the temperature factor, defined as

$$f_{Rsi} = \frac{T_{si} - T_e}{T_i - T_e}$$

where

T_{si} is the temperature of the inside surface
T_e is the temperature of the external environment
T_i is the temperature of the internal environment

For the majority of buildings, if f_{Rsi} is 0.75 or higher, then an exposed element or thermal bridge is unlikely to suffer from condensation or mould growth problems. Values of the temperature factor are usually calculated at the same time as the Ψ-value, and both are often quoted together.

16.10.7 Thermal conductivity and density of building materials

Table 16.51 lists the thermal conductivities and densities of some common building materials.

Table 16.51 Thermal conductivity and density of common building materials.

	Density, Kg/m³	Thermal conductivity, W/m.K
Walls		
Brickwork (outer leaf)	1700	0.77
Brickwork (inner leaf)	1700	0.56
Lightweight aggregate concrete block	1400	0.57
Autoclaved aerated concrete block	600	0.18
Concrete, medium density (inner leaf)	1800	1.13
Ditto	2000	1.33
Ditto	2200	1.59
Concrete, high density	2400	1.93
Reinforced concrete, 1% steel	2300	2.30
Reinforced concrete, 2% steel	2400	2.50
Mortar, protected	1750	0.88
Mortar, exposed	1750	0.94
Gypsum	600	0.18
Ditto	900	0.30
Ditto	1200	0.43
Gypsum plasterboard	900	0.25

Table 16.51 (*Continued*)

	Density, Kg/m^3	Thermal conductivity, W/m.K
Sandstone	2600	2.30
Limestone, soft	1800	1.10
Limestone, hard	2200	1.70
Fibreboard	400	0.10
Plasterboard	900	0.25
Tiles, ceramic	2300	1.30
Timber, softwood	500	0.13
Timber, hardwood	700	0.18
Timber, plywood and chipboard	500	0.13
Wall ties, stainless steel	7900	17.0
Surface finishes		
External rendering	1300	0.57
Plaster, dense	1300	0.57
Plaster, lightweight	600	0.18
Roofs		
Aerated concrete slab	500	0.16
Asphalt	2100	0.70
Felt/bitumen layers	1100	0.23
Screed	1200	0.41
Stone chippings	2000	2.00
Tiles, clay	2000	1.00
Tiles, concrete	2100	1.50
Wood wool slab	500	0.10
Floors		
Cast concrete	2000	1.35
Metal tray, steel	7800	50.00
Screed	1200	0.41
Timber, softwood	500	0.13
Timber, hardwood	700	0.18
Timber, plywood and chipboard	500	0.13
Insulation		
Expanded polystyrene (EPS) board	15	0.040
Mineral wool quilt	12	0.042
Mineral wool batt	25	0.038
Phenolic foam board	30	0.025
Polyurethane board	30	0.025

16.11 Part L 2010 Wales

The energy efficiency requirements of the Building Regulations 2010 as detailed in section 16.3.1 highlight some variations as applied to buildings in Wales. On the 31 December 2011 the Welsh Government became responsible for powers and functions related to the Building regulations and on the 31 July 2014 brought into force changes to Part L as they apply to buildings in Wales. To support these changes the Welsh Government published their own versions of the four Approved Documents L1A, L1B, L2A and L2B to support the amended Welsh version of the Building Regulations 2010. Copies of these documents can be downloaded from www.wales.gov.uk.

The variations in the regulations are detailed in section 16.3.1 but can be summarised as follows.

- The requirement in England for newly erected dwellings to meet a target fabric energy efficiency rate, Regulation 26A, does not apply to buildings in Wales. Newly erected dwellings in Wales will alternatively need to meet a new '*target fabric performance value*' detailed in a new regulation 26B. This target is in effect a series of prescribed fabric U-values as detailed below.

Worst acceptable fabric performance U-values ($W/m^2.K$)	
External walls	0.21
Party walls	0.20
Floor	0.18
Roof	0.15
Windows, roof windows, glazed roof lights, curtain walling and pedestrian doors	1.60
Air permeability	10.00 $m^3/h.m^2$ at 50 Pa

- For newly erected buildings (other than dwellings), a new requirement, a new Welsh Regulation 26A, which applies to buildings in Wales, only states that the calculated '*building primary energy consumption rate*' (BPEC) must not be greater than the '*target primary energy consumption rate*' (TPEC). As per the Regulation 26 CO_2 emission requirement, the rate for individual buildings must be calculated using one of the approved software tools as detailed in Table 16.16.
- For existing dwellings, where these are extended or part of the dwelling is converted, thereby increasing the habitable area of the property by more than 10 m^2, then the following energy efficiency improvements '*Consequential improvements*' should be undertaken to meet the requirements of Regulation 28:
  (a) if the dwelling has uninsulated or partially insulated cavity walls, fill with insulation where suitable;
  (b) if there is no loft insulation or it is less than 200 mm thick, provide 250 mm insulation or increase it to 250 mm;
  (c) if hot water (HW) cylinder is uninsulated, provide a 160 mm jacket;
  (d) if the existing HW cylinder jacket is <160 mm, then add insulation to total thickness of 160 mm;
  (e) If the HW cylinder has factory fitted foam at <25 mm, add an 80 mm insulated jacket; and

(f) in loft conversions provide the required insulation from (a) or (b) above to the eaves where the proposed new heated volume does not extend to the eaves.

- For buildings (other than dwellings) although the requirement under Regulation 28 is different, the guidance on meeting the obligations for consequential improvements are the same as those for England and are detailed in Section 4 of Approved Document L2B published by the Welsh Government.

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17 Access to and use of buildings (Part M)

K.T. Bright

17.1 Introduction

The law concerning access for disabled people to buildings has a relatively short history. The first provisions were contained in the Chronically Sick and Disabled Persons Act 1970. These provisions were mostly advisory and were only applied if it was reasonably practicable to do so. There were no enforcement powers contained in the Act, and it proved to be rather ineffective. It was clear that some form of enforceable requirement was needed, and it was considered that the Building Regulations were the most suitable medium for any future legislation.

This resulted in the fourth amendment to the 1976 Regulations, which introduced Part T, Facilities for disabled people. Part T was later recast in format as Part M, supported by Approved Document M (AD M), and this has been the subject of further revisions to extend its scope and coverage. The 1999 revision to Part M and its Approved Document extended the requirements of M1 to M3 in so far as they affected buildings other than dwellings and also for new dwellings (M4).

Part M and its Approved Document were subsequently updated in 2004 and amended in 2010 (AD M 2004:2010 edition) and 2013 (AD M 2004:2013 edition).

Note:
In terms of the amendments introduced to AD M in 2004, 2010 and 2013, all the substantive changes made related to the guidance for 'Buildings other than dwellings' (Regulations M1, M2 and M3). No substantive changes were made to the guidance relating to 'dwellings' (Regulation M4).

AD M 2013 edition was issued in conjunction with changes to the Approved Documents to Part K (AD K 2013) and Part N (AD N) to rationalise overlapping guidance covered within them and to allow the withdrawal of Part N.

On the 1 October 2015, the Approved Documents were replaced by a new two volume AD M 2015. AD M 2015 consists of two parts:

Volume 1 – Dwellings; and
Volume 2 – Buildings other than dwellings.

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

Important Note:
Whilst Scotland and Northern Ireland have had their own Building Regulations for some time, those relating to England and Wales have been linked. As a result of devolution, the power for making Building Regulations in Wales passed to the Welsh government in December 2011. Amendments to the Regulations after that date are relevant only in the country in which the changes have been made.

Therefore the changes made in 2013 to Parts K and M, the withdrawal of Part N and the introduction of Part M 2014 and its Approved Document (AD M 2014) apply only to England. They do not apply to Wales.

Whilst Wales is in the process of reviewing these and other Regulations, the versions of Parts K, M and N that are relevant in Wales at the time of publication of this book are those that were in force in England and Wales prior to April 2013.

The guidance contained in AD M 2015 – Volume 1 draws on work undertaken in 2013 and 2014 to develop appropriate technical requirements and guidance for housing standards in England as part of the governments Housing Standards Review.

The design guidance for buildings other than dwellings in AD M 2015 – Volume 2 is substantially the same as that given in AD M 2004:2013 edition.

17.1.1 The general relationship between Parts K, M and N

Changes made to Parts K, M and N in 2013 and 2014 mean that AD K 2013 now covers the design issues that are more relevant to the general safety and usability of a building or space for all users. AD M 2015 now focuses more on issues relating to the provision of accessible housing and in addressing the specific access needs of older people and disabled people when creating inclusive and accessible buildings and spaces.

The overall content of AD M 2015 volume 2 as it relates to buildings other than dwellings remains largely the same as that contained in AD M 2004:2013 edition including the transfer of some guidance (for example, that on manifestation to glazing and the provision of steps and ramps for general use) to AD K 2013. A number of minor changes to dimensions and definitions have also been made in both Approved Documents to harmonise details with those described in BS 8300.

Comments introduced into AD M 2004:2013 edition regarding the use of an Access Strategy (a change of name and emphasis from the previous 'Access Statement') and the provision of Changing Places Facilities (CPFs) within larger buildings accessed by the public have also been retained in AD M 2015.

Other changes introduced in AD M 2004:2013 edition which have been incorporated into AD M 2014 include:

- the relationship between AD M and the Equality Act 2010; and
- clearer guidance on the ten-year exemption rule on reasonable adjustments for service providers, local authorities and associations where the physical features of the building they use complied with the objectives, design considerations and provisions of Part M at the time of construction.

Part M 2015 and AD M 2015 continue to apply to the following types of work:

- Newly constructed, non-domestic buildings.
- Newly constructed dwellings.
- Material alterations of and extensions to existing non-domestic buildings.
- Material change of use to some non-domestic uses including public buildings, shops, hotels or boarding houses and institutions.
- The application to Historic buildings is also covered.

When dealing with the provision of equal access to employment opportunities, services, transport and education for older people and disabled people, reference should also be made to the Equality Act 2010.

17.1.2 The Equality Act 2010

The Equality Act 2010 brought together several pieces of equality and anti-discrimination legislation (including the Disability Discrimination Acts) to streamline them into one Act and strengthen their effectiveness.

The Act now provides a legal framework to protect the rights of individuals and advance equality of opportunity for all. The Act covers discrimination due to age, disability, gender reassignment, marriage and civil partnerships, pregnancy and maternity, race, religion or belief, gender and sexual orientation. These categories are known in the Act as 'protected characteristics'.

The Act sets out the different ways in which it is unlawful to treat someone. These are by direct and indirect discrimination, harassment, victimisation and failing to make a reasonable adjustment for a disabled person.

With regard to the use of buildings and environments, the Act does not directly require buildings to be accessible to all disabled people nor does it include standards or technical specifications for accessible building design. It is the equality of provision of the services and opportunities offered within buildings or spaces that are the concern of the Act, and that will not always involve the design of premises or alterations to them. Therefore, it is not appropriate in any situation to refer to the design and construction of a new building or alteration works to an existing one as being 'Equality Act compliant'.

In general terms, following the guidance contained in AD M 2015 (or other good practice documents agreed with building control bodies in an Access Strategy) will usually demonstrate compliance with Part M. However, compliance with Part M does not necessarily mean that the obligations and duties set out in the Act are also being met.

This is because the Act places a duty on public bodies, associations, employers, service providers and educators to make reasonable adjustments to a physical feature, if not doing so might place a disabled person at a substantial disadvantage. Achieving this may include making reasonable adjustments to elements of the built environment that are outside the scope of the guidance in AD M 2014.

For employers, this may involve situations where the buildings they use fail to meet the specific and identifiable needs of a disabled employee even though they were designed to follow the general guidance for common building situations given in AD M 2014.

The responsibility for deciding whether the general guidance contained in AD M 2014 is the appropriate standard to adopt or whether duties imposed by the Equality Act on those using the completed development suggest that a higher or more specific standard is needed rests with the person undertaking the building works – not the building control body.

17.1.3 Exemption for service providers, local authorities and associations

Regulation 9 (Reasonableness and design standards) and the Schedule to the Equality Act 2010 lay down circumstances in which it is not reasonable for a provider of services, a public authority (when undertaking its functions) or an association to remove or alter a physical feature which has been provided to assist access to a building or its facilities and which complied with the 'relevant design standard' at the time of construction.

The Schedule identifies that a physical feature will satisfy the 'relevant design standard' if it meets the requirements of Part M (or its equivalent in Northern Ireland, Wales or Scotland) at the time of construction. This includes design standards that are referred to in AD M but which are described in AD K.

If it meets the above, a physical feature will be exempt from the need to be considered for a reasonable adjustment for ten years from the day on which construction or installation of the feature was completed. If the physical feature provided is part of a larger project, the exemption runs from the day on which the project was completed.

Importantly, this is not a blanket exemption from the need to address duties imposed by the Equality Act as it relates only to those features and facilities to which Part M (or its equivalent) applies.

In this respect, a new entrance door or corridor width which meets the guidance in AD M 2015 at the time of construction may be exempt from a reasonable adjustment under the ten-year rule. Other aspects of a building that also affect accessibility and which are not covered by Part M – for example, signage, surface texture, floor finishes, and lighting – will not.

The exemption also does not apply to situations that involve equality issues or the provision of reasonable adjustments to address the access needs of disabled employees.

17.1.4 The access statement process: In general

In the mid-1990s the Disability Rights Commission issued guidance on the benefits of developing a strategic approach to ensure that the providers, managers and occupiers of new and refurbished buildings could address anti-discrimination duties brought in by the Disability Discrimination Act 1995.

This strategic approach involved the development of an 'Access Statement' which would grow with the project from inception, through planning and building control to occupancy management. The Statement would act as a vehicle to record and explain the design, material selection and management decisions that could affect equality, accessibility and inclusion of the completed building or space for all users – including disabled people.

The concept of the 'Design and Access Statement' (DAS) was first introduced into the Planning and Compulsory Purchase Act 2004 as a mandatory accompaniment to most planning applications in England and Wales. Subsequent changes to simplify the Planning process have limited this mandatory requirement to planning applications relating to major developments, listed buildings and those affecting conservation areas.

The concept of an Access Statement to accompany all building control applications was first introduced as a recommendation in AD M 2004:2010 edition. Since then it has proved to be a useful tool for designers to communicate the merits of their proposals and demonstrate how their chosen approach meets the requirements of Part M, even if it does not follow precisely the guidance contained in AD M. The Statement has also provided a useful reference for discussion by applicants, users, access groups, building control and planners in the application assessment process.

The amendment to ADM 2004 in 2013 altered the name of the 'Access Statement' to that of 'Access Strategy', and this title is still adopted in AD M 2015. Whilst being broadly similar in concept to its predecessor, the Access Strategy places a greater emphasis on achieving the desired outcome rather than of simply following a process. It also acknowledges that the methods adopted for informing, justifying, agreeing and achieving appropriate levels of accessibility will differ according to the size and complexity of the project. It also addresses the need to ensure that the recommended Access Statement process does not introduce unacceptable administrative burdens, especially on smaller projects.

Further reading on the development of DAS and Access Strategies can be found in *The access manual* (see section 17.8).

17.1.5 The Access Strategy at Part M application stage

AD M 2015 identifies the importance for applicants in ensuring that they communicate clearly with building control bodies on the appropriateness of their chosen design and how it meets the requirements of Part M.

It also identifies that

> '… there may well be alternative ways of achieving compliance with the requirements. Thus there is no obligation to adopt any particular solution contained in an Approved Document if you prefer to meet the relevant requirement in some other way.'

The guidance contained in AD M 2015, therefore, is not prescriptive and represents only one potential way in which the requirements of Part M may be met.

New buildings and spaces are usually created with a freely conceived design philosophy unencumbered by the restrictions of existing structures. Full physical accessibility is therefore expected and is achievable by following the guidance contained in the AD M or in other established evidence-based documents.

Refurbishment work or alterations to historic buildings however can encounter constraints caused by the existing design and fabric which make precise application of the guidance described in AD M either impracticable or unreasonably difficult to achieve. Therefore, compromises are sometimes needed.

For all projects, regardless of their size, scale, nature and intended use, an Access Strategy can act as a useful tool for designers to demonstrate that the quality of their proposals meets or exceeds the standard required by Part M.

AD M 2015 emphasises that a Strategy is not a compulsory component of a building control application, and where used, it should not be a document that provides exhaustive explanations on those features that are in accordance with AD M.

Developing a Strategy, however, can enhance the development of innovative and creative design solutions by acting as a means of identifying and justifying the use of alternative sources of appropriate good practice guidance and in informing discussions with building control bodies and access groups. A Strategy can also act as a record of the decision-making process should subsequent challenges be made under the Equality Act 2010 on design solutions that do not precisely follow the guidance contained in AD M.

To minimise any potential administrative burdens for smaller projects, AD M 2015 offers guidance on when less formal methods of agreeing design proposals with building control bodies might be appropriate. It suggests that where there are few, if any, deviations in the design from the guidance in AD M, agreement on accessibility issues with building control bodies could simply be achieved by a conversation supported by correspondence. In larger projects, where there is likely to be a significant number of deviations, a more formal Access Strategy may be required.

Importantly, the focus should be on ensuring that applicants and building control bodies agree on an appropriate level of accessibility to be achieved in the completed development and ensure that it is delivered. How that is done should be considered as being of less importance than actually achieving an appropriate outcome.

17.2 Interpretation

Part M requires reasonable measures to be taken to ensure that buildings are accessible and usable – and that regardless of their disability, age or gender, the people visiting, working or living in them are able to gain access to the building and use the facilities it contains.

The minimum baseline requirements for dwellings in Part M 2015 (M4(1) – Category 1) are intended to provide new dwellings that will enable some disabled visitors and occupants to access and use the dwelling and its facilities. It does not expect or require a level of provision that will facilitate fully independent living for all disabled people.

The optional design requirements for dwellings, M4(2), Category 2 and, M4(3), Category 3 are intended to create new dwellings that offer, or could readily be adapted to offer, a provision that:

- addresses specific user needs;
- enables disabled and older occupants to maximise their own individual abilities;
- minimises any adverse effects in the use of the dwelling caused by reductions in their mobility; and
- facilitates independent living in their own homes for as long as possible.

A number of terms defined in AD M 2015 that apply throughout the document are as follows:

ACCESS – approach, entry or exit.

ACCESSIBLE – with respect to buildings or parts of buildings means that people, regardless of disability, age or gender, are able to gain access.

BUILDING – in addition to dwellings (see later), the rules in AD M apply to the following buildings:

- Shops, offices, factories and warehouses
- Schools, other educational establishments and student residential accommodation in traditional halls of residence
- Institutions
- Premises which admit the public, whether on immediate payment, subscription, fee or otherwise

The rules apply to the whole building and equally to any parts of the building that comprise separate individual premises:

CONTRAST VISUALLY – the term used to identify the contrast of one element of a building or fitting within the building against another means that the difference in light reflectance value (LRV) between the two surfaces is greater than 30 points. Where the illuminance on the surfaces is greater than 200 lux, the difference in LRV may be reduced to a minimum of 20 points. Where door furniture projects beyond the face of the door or otherwise creates enhanced differentiation and shade, the minimum difference in LRVs may be 15 points.

GENERAL ACCESS STAIR – a stair intended for all users of a building on a day-to-day basis, as a normal route between levels.

ILLUMINANCE – the amount of light falling on a surface, measured in lumens per square metre (lm/m^2) or lux (lx)

INDEPENDENT ACCESS – access to part of a building (from outside and therefore from the site boundary and from any car park on site) that does not pass through the rest of the building.

LEVEL – with respect to surfaces of a level approach, access routes and landings associated with steps, stairs and ramps means predominantly level but with a maximum gradient along the direction of travel of 1:60.

LIGHT REFLECTANCE VALUE – the total quantity of visible light reflected by a surface at all wavelengths and directions when illuminated by a light source.

OPENING/CLOSING FORCE – the effort (measured in Newtons) required to either open a door from the closed position or to close a door.

For disabled people to have independent access through single or double swing doors, the opening force, when measured at the leading edge of the door, should be not more than 30 N from 0° (the door in the closed position) to 30° open and not more than 22.5 N from 30° to 60° of the opening cycle.

PRINCIPAL ENTRANCE – The entrance that a visitor who is not familiar with a building would normally expect to use when approaching it.

SUITABLE – means of access and facilities that are designed for use by people regardless of disability, age or gender but subject to the usual gender-related conventions regarding sanitary accommodation.

USABLE – with respect to buildings or parts of buildings, means they are convenient for independent use.

UTILITY STAIR – a stair for escape, access or maintenance or purposes other than as a usual route for moving between levels on a day-to-day basis.

In addition to the general definition of terms identified above, the following definitions are also used in AD M 2015 volume 1 and relate specifically to the provision of dwellings:

BED-SPACE – A suitable sleeping area for one person. (A single bedroom provides one bed-space and a double or twin bedroom provides two bed-spaces where these rooms also meet any other requirements specified in the requirements for the relevant Category of dwelling.)

COMMUNAL OR COMMON (AREA) – Shared area accessed by or intended for the use of more than one dwelling.

DWELLING – A house or flat. Student accommodation is treated as hotel/motel accommodation.

ENTRANCE STOREY – The floor level on which the principle private entrance is located.

HABITABLE ROOM – a room intended to be used for dwelling purposes. This includes a kitchen but not a utility room or bathroom.

POINT OF ACCESS – The place where a person would alight from a car prior to approaching the dwelling. The point of access may be within or outside the plot.

PRINCIPAL COMMUNAL ENTRANCE – The communal entrance to the core of the building containing the dwelling which a visitor who is not familiar with the building would normally be expected to use as an approach. This would typically be the common entrance to a block of flats.

PRINCIPAL PRIVATE ENTRANCE – The entrance to the individual dwelling which a visitor not familiar with the dwelling would normally expect to approach (usually the 'front door' to a house or a ground floor flat).

PRINCIPAL STOREY – Where this is *not* the entrance storey, the floor level of the dwelling on which the main living space is located.

PLOT GRADIENT – The slope measured between the point of access and the finished floor level of the dwelling.

STANDARD PARKING BAY – a bay which is a minimum of 2400 mm wide × 4800 mm long.

STEEPLY SLOPING PLOT – A plot where the underlying gradient exceeds 1:15.

STEP FREE – An access route into a building without steps but which may include a ramp or lift suitable for a wheelchair user.

SUITABLE GROUND SURFACE – a surface which is firm, even and smooth, not covered with loose laid materials and with a maximum cross fall of 1:40.

WHEELCHAIR ACCESSIBLE – Category 3 dwelling constructed to be suitable for immediate occupation by a wheelchair user and only where the planning authority specifies that Regulation M4(3)(2)(b) applies.

WHEELCHAIR ADAPTABLE – Category 3 dwelling constructed with the potential to be adapted for occupation by a wheelchair users where Regulation M4(3)(2)(b) applies.

17.3 Application

Part M 2015 applies to the following:

- A newly erected non-domestic building or a newly erected dwelling;
- An extension to an existing non-domestic building;
- An existing building that is undergoing a material alteration; or
- An existing building or part of a building that is undergoing a material change of use to become a hotel or boarding house, institution, public building or shop.

The term shop includes uses such as restaurants, bars and public houses.

It is important to note that the requirements of Part M do not apply to areas that are used solely to gain access for inspecting, repairing or maintaining parts of a building or its services.

17.3.1 Dwellings

Part M does not apply to an extension or material alteration to a dwelling. However, if a dwelling is extended or undergoes a material alteration, any work carried out must not make the building less satisfactory in terms of access than it was before the work or material alteration was carried out. A dwelling that was previously constructed to meet Part M must not be extended or altered in any way which lessens or negates the previously approved work.

17.3.2 Alterations and extensions

Under the provisions of Regulation 3, a material alteration is the term applied to work being undertaken to a building:

- that currently complies with Part M but, as a result of the new work, would no longer comply; or
- that does not currently comply with Part M and, as a result of the work, will be less satisfactory in relation to Part M than it currently is.

Regulation 4 then goes on to state that any alteration that has the potential to reduce the compliance of the building as a whole with Part M must be undertaken in a manner that ensures the existing level of compliance is not lessened in any way.

If a non-domestic building is to be extended, the extension should be treated as a new building and should fully meet the requirements of Part M. If the extension has its own independent access from the outside, the site boundary or, if provided, the car parking area and has its own sanitary accommodation, there may be no requirement to alter the existing part of the building. However, if access to the extension is through the existing building or the sanitary facilities in the existing part are to be used to support activities in the extension, the routes through the existing building to the extension and/or the sanitary accommodation should be accessible to current Part M standards.

17.4 Volume 1: Dwellings

AD M 2015 has replaced the technical requirement M4 in the regulations (Sanitary conveniences in dwellings) with a new requirement M4 entitled 'Access to and use of dwellings'. The guidance relating to dwellings in AD M 2015 replaces that in previous editions of the AD for those areas relating to 'means of access to and into a dwelling', 'circulation within the entrance storey of a dwelling', 'accessible switches and sockets', 'passenger lifts and communal stairs in blocks of flats' and 'WC provision in the entrance storey of a dwelling'.

Regulation M4 now differs from other Regulations by describing a mandatory baseline of provision and then going on to describe two sets of additional 'Optional Requirements' that go beyond that baseline and which may be appropriate in given situations. M4 is therefore divided into the following parts:

The Mandatory baseline requirement:

- M4(1) Category 1 – Visitable dwellings.

The Optional enhanced Requirements:

- M4(2) Category 2 – Accessible and adaptable dwellings
- M4(3) Category 3 – Wheelchair user housing.

The definition given in AD M 2014 for each category is as follows:

- Category 1 – dwellings that can, as a minimum, be visited by a wide range of people including some wheelchair users
- Category 2 – dwellings that provide a higher level of accessibility that is beneficial to a wide range of people who occupy or visit the dwelling and provide particular benefit to older and disabled people, including some wheelchair users
- Category 3 – dwellings that are suitable or potentially suitable through adaptation to be occupied by wheelchair users

Each category is subdivided into two sections (A and B) which describe requirements and guidance relating to the 'approach to the dwelling' and 'private entrances and spaces within the dwelling'.

17.4.1 Selecting the appropriate requirement

As you might expect the mandatory Category 1 requirement M4(1) applies to all new dwellings.

The optional enhanced requirements, Categories 2 and 3 requirements M4(2) and M4(3), respectively, apply only where a local planning authority sets a planning condition for a new development that it should contain one or more dwellings that meet a particular Optional Requirement.

> *Note:*
> *The change introduced by Part M 2015 with regard to the provision of dwellings has considerably extended both the volume of guidance and the level of detail within AD M 2015 from that given in previous editions. At the time of the preparation of this publication some details relating to the design details for the optional requirements for Categories 2 and 3 for dwellings had not been fully confirmed.*
>
> *Details given in AD M 2014 identifying the mandatory baseline requirement for all new Category 1 dwellings in England are given below.*

17.4.2 Category 1: Visitable dwellings

M4(1) requires reasonable provision to be made for people to gain access to and use the dwelling and its facilities.

The intention of the requirement is to ensure that people visiting and using a dwelling, including ambulant disabled people and some wheelchair users, can achieve safe and convenient access into the dwelling and be able to use sanitary facilities and have access to services such as wall-mounted switches and sockets. It is not the intention of the requirement to facilitate full independent living for all disabled people.

Sanitary facilities should be provided on the 'entrance storey' of the dwelling (the storey that contains the principle private entrance). If no habitable rooms are provided on that storey, sanitary facilities may be provided on the 'principle storey' of the dwelling (the floor level on which the main living space is located).

Section 1A: Approach to a dwelling

Scope

The provisions of section 1A relate to those areas that form the approach route from the public realm (typically the pavement) to the principle private entrance of the individual dwelling (usually the front door) and which fall within its plot or curtilage.

They also apply to an approach route that gives access for disabled and non-disabled people to the dwelling from a point at which they may alight from a car. This point of access may be either inside or outside the plot of the individual dwelling (for example, in a block of flats).

Generally

In general terms, a visitor should be able to gain access into a dwelling from the point of leaving a vehicle parked either within or outside the plot boundary.

In most cases it should be possible to provide a safe and convenient approach which is level, gently sloping or ramped, thereby permitting all visitors including some wheelchair users to gain access to the dwelling.

The provision of a suitable approach to the dwelling from the point of access to the plot will be influenced by the topography of the site, the available area of the plot and the distance to the dwelling from the point of access. Local planning requirements may also influence the accessibility of an approach route, for example, with new developments in conservation areas.

On steeply sloping plots (where the plot gradient exceeds 1:15) providing a stepped approach may be the only practicable solution. In such situations, the approach should be suitable for use by an ambulant disabled person using a mobility aid.

Reducing the effect of a steeply sloping plot by the provision of a suitable driveway could allow for a parking space within the plot boundary at a location that would permit a level or ramped approach from the parking space to the dwelling.

Surface materials used for the approach route to the dwelling should be firm, smooth, and slip resistant (especially when wet). The approach route should be sufficiently wide to enable safe, easy manoeuvring and passage and could be in addition to any surface provided as a car parking space. Cross falls should not exceed 1 in 40.

Loose or soft surface materials such as unbonded gravel or grass should not be used for either an approach route or a car parking area.

Developers are advised to discuss the access requirements of Part M with their local planning authority and the appropriate building control body at an early stage to minimise the risk of conflicts developing later in the design process.

The specific provisions in AD M 2015 for the approach to Category 1 dwellings can be summarised as follows.

General approach

A suitable approach should be provided:

- from a reasonably level point of access (i.e. from the vehicle parking position) to the dwelling entrance (i.e. the principal private entrance or a suitable alternative private entrance if it is not possible to provide a step-free access to the principal private entrance);
- may be separated or can be included as part of a vehicle driveway providing a clear access; route is available at all times to enable a disabled person to move past any parked car.
- A level or gently sloped approach will have a:
  - gradient not exceeding 1:20;
  - Firm, even and smooth surface; and
  - 900 mm width clear of obstructions including a parked car where the approach is a driveway.

Ramped approach

A ramped approach will be required where the overall plot gradient exceeds 1:20 but does not exceed 1:15. Where provided a ramped, approach should have:

- a gradient of between 1:20 and 1:12;
- a firm, even and smooth surface;
- a minimum unobstructed width of 900 mm;
- individual flights no longer than 10 m for gradients up to 1:15, or 5 m in length for gradients up to 1:12; and
- top, bottom and, if necessary, intermediate landings (between individual flights and at any changes of direction) at least 1200 mm long and clear of any door or gate swing.

External stepped approach

Achieving a step-free access to the private principle entrance may not be possible on steeply sloping sites (with a gradient steeper than 1:15) or when a dwelling is located on an upper floor.

In such situations, a stepped approach is acceptable providing:

- steps have a minimum unobstructed flight width of 900 mm;
- steps have a maximum rise for each individual flight of not more than 1800 mm between landings;
- top, bottom and, if necessary, intermediate landings at least 900 mm long;
- a suitable tread profile as illustrated in Fig. 17.10; and
- uniform risers between 75 mm and 150 mm and goings minimum 280 mm measured 270 mm in from the narrow edge of the tread for tapered steps.

Flights consisting of three or more risers should have a suitable handrail provided on one side. If the stair exceeds 1000 mm in width, a handrail should be provided on both sides. The handrail should be placed 850–1000 mm above the pitch line and extend at least 300 mm beyond the final nosings

Car parking and drop-off points

The provision of appropriate car parking and/or locations where dropping off can be easily facilitated is important for many occupiers and visitors to dwellings, and especially those with restricted mobility or who are easily fatigued.

The Category 1 requirement includes no specific requirements for this element merely stating that it should be possible to gain access to the dwelling or the building containing the dwelling from the most likely point of alighting from a car.

By Contrast Category 2 and 3 requirements make specific reference to both car parking and drop-off points with specific requirements for both these categories. Ideally car parking areas and drop-off points should be level or gently sloping and the surface should be firm and slip resistant, especially when wet.

Parking in communal areas, such as that provided for flats, should be provided with at least one standard parking bay (see section **17.2**) which:

- has a clear opening zone to one side that is a minimum of 900 mm wide; and
- is located close to the communal entrance/s or if the car parking bay is inside the building, close to the lift giving access to the other floor levels.

Drop-off points, where provided, should also be located close to the principal communal entrance or private entrance, be level or gently sloping, have a firm surface finish that is slip resistant (especially when wet) and also be provided with a flush kerb giving reasonably easy access to the adjacent accessible approach route.

Communal entrances

Irrespective of whether the approach to a principal communal entrance door is level, ramped or stepped, the threshold should be accessible.

The principal communal entrance door (or gate) to the building containing the dwelling should be wide enough to accommodate a person using a wheelchair. This requirement can be satisfied if such a door has a minimum clear opening width of 775 mm (see Fig. 17.1). If double doors are provided, only the main leaf need to meet this requirement.

Floor finishes should be firm and slip resistant, especially when wet, and should not impede wheelchair users.

Communal lifts and stairs

The most convenient way for most people of achieving easy and safe vertical movement between floors is by lift. However, AD M 2015 does not require the installation of a lift and recognises that providing one is not always possible or practical. If the provision of a lift cannot reasonably be achieved a general access stair, as defined in AD K 2013, should be provided.

Where a lift is to be provided, there should also be a utility stair suitable for use by people with impaired sight (see section **17.2** for definitions of a general access stair and a utility stair). For both types of stair, the requirements of Part M will be satisfied if the provision meets AD K 2013 (see Chapter 15).

Where provided, a lift should be suitable to accommodate the needs of all users including older people, wheelchair users and people with sensory impairments.

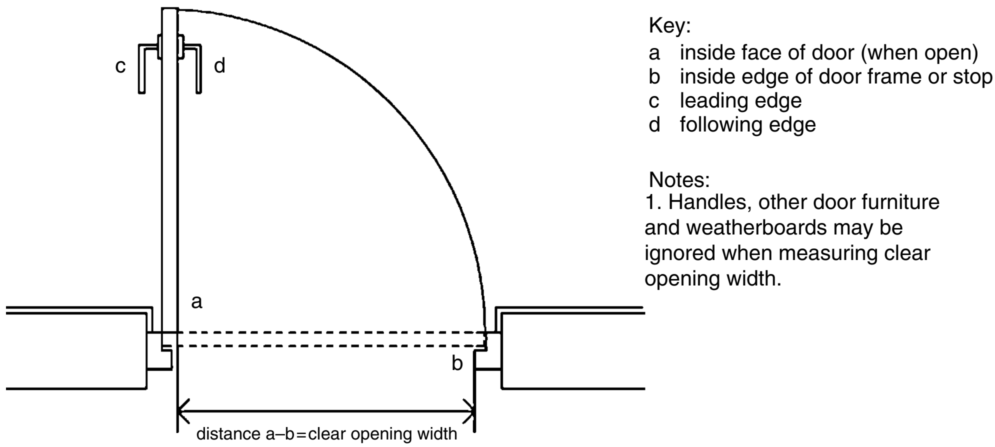


Fig. 17.1 Measuring clear opening width for internal and external doors.

This will be achieved if a lift has:

- a minimum load capacity of 400 kg;
- an accessible, unobstructed landing space at least 1500 mm square in front of the lift doors;
- a door or doors with a clear opening width of 800 mm;
- a car at least 900 mm wide by 1250 mm deep. Other dimensions may be suitable if it can be demonstrated by evidence-based testing or experience in use that they are suitable for use by an unaccompanied wheelchair user;
- landing and car controls between 900 mm and 1200 mm from landing or car floor levels and at least 400 mm from the front wall;
- tactile indicators:
  - adjacent to the lift call button on each level to identify the floor; and
  - on or adjacent to the lift buttons in the lift car to assist when selecting the required floor;
- a system which gives a visual warning that the lift is about to stop at a floor and when it has stopped;
- visual and audible floor indication where the lift serves more than three floors;
- a dwell time for the open doors of at least five seconds.

To prevent passengers becoming trapped by closing doors, it is necessary to provide an override to the door controls and a door reopening activator using a photo-eye or infrared detector or similar non-contact sensor. Door edge pressure-activated systems are not suitable as they may cause a disabled person to lose their balance. A lift car meeting the BS EN 81-70 type 1 standard will meet the requirement.

Section 1B: Private entrances and spaces within a dwelling

The provisions of section 1B in AD M volume 1 apply to all dwelling types including upper floor flats. They relate to the principal private entrance of a dwelling and to critical areas within the entrance storey to the dwelling. If the entrance storey does not contain any habitable rooms, then the provisions relate to the principal storey.

Private entrances

The approach to the principle private entrance to a dwelling should be level, gently sloping or ramped, and the threshold should be accessible.

In exceptional circumstances where for practical reasons it is unavoidable and where the approach route to the entrance is also stepped, a step may be provided at the entrance if it does not exceed 150 mm in height and is situated either on the line of the door or at least 1200 mm outside it.

The entrance door should have a clear opening width of at least 775 mm.

Circulation areas and internal doors

AD M 2015 M4(1) requires that access must be facilitated to habitable rooms and to a WC (which may be in a bathroom) in the entrance storey or (if the entrance storey does not contain any habitable rooms) the principal storey of the dwelling, as appropriate.

Where it is not possible to make the principal private entrance accessible and an alternative is provided instead, the route to the remainder of the entrance storey from the alternative entrance must be carefully considered, especially if the route passes through other rooms. Corridors and passageways should therefore be wide enough to allow convenient access for a person in a wheelchair and offer sufficient manoeuvring space to enable easy passage past local obstructions such as radiators and other fixtures.

Steps within the entrance storey of a dwelling should be avoided wherever possible. On severely sloping plots where it may not be possible to avoid a change of level involving steps in the entrance storey, any stair provided should be wide enough to allow easy and safe negotiation by an ambulant disabled person with assistance if required. Internal steps and stairs should comply with the requirements of Part K for a 'private stair' (see Chapter 15).

A stair used for vertical circulation within an entrance storey will satisfy the requirements of Part M if the provision meets AD K 2013 (see also Chapter 15).

Doors to rooms should be wide enough to enable a wheelchair user to approach and use them either head-on or at a right angle. The rules for access within the entrance or principal storey of a dwelling are illustrated in Fig. 17.2.

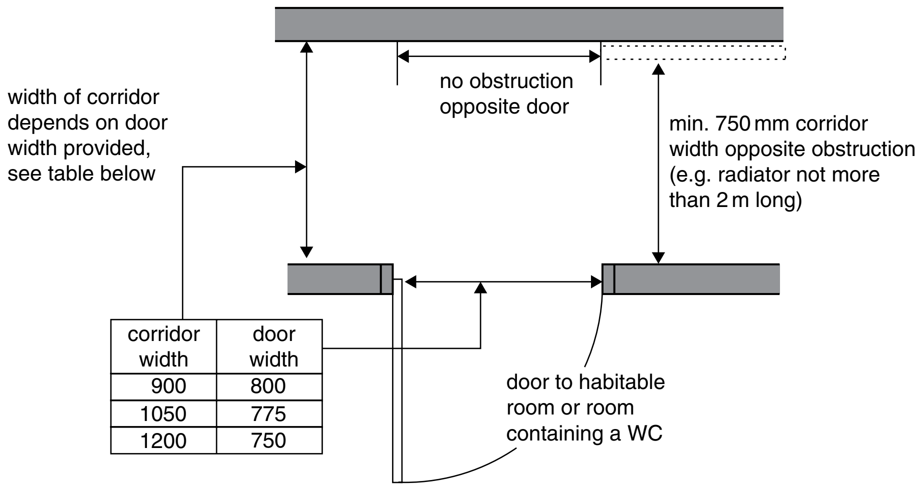
Access to socket outlets, controls and switches in dwellings

The need to safely reach and use sockets and switches within a house is important for everyone but especially so for disabled and older people who may experience restrictions in mobility, reach and strength. Switches and socket outlets for electrical appliances, lighting, television aerials, telephone points, etc. should be mounted at a convenient height that can be easily and safely reached.

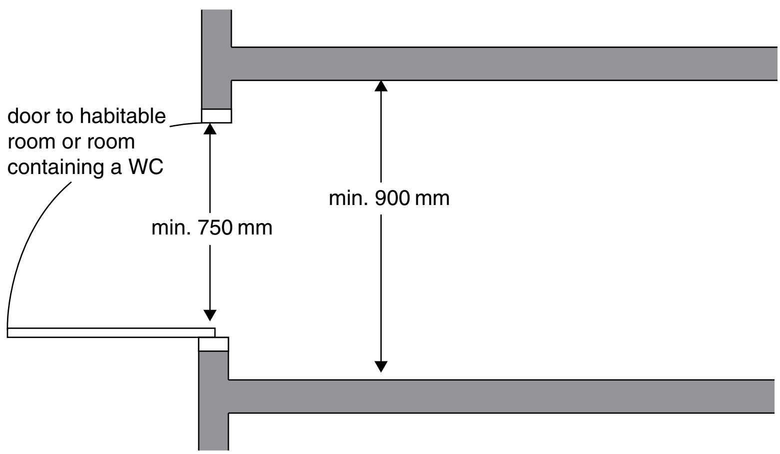
To achieve this in a Category 1 dwelling, AD M 2015 suggests that sockets and switches in habitable rooms should be located between 450 mm and 1200 mm above finished floor level.

Provision of sanitary facilities in dwellings

A WC facility must be provided on the entrance storey of the dwelling. Where the entrance storey does not contain a habitable room (or rooms), the WC may be located on



Right-angled approach to door



Head-on approach to door

Fig. 17.2 Minimum doors and hall widths and obstructions.

either the entrance storey or the principal storey. Sanitary conveniences in single-storey dwellings and individual flats can clearly only be provided in the entrance storey.

The WC may be provided within a bathroom or in a separate WC/cloakroom and should be accessed by an outward opening door. There should be sufficient manoeuvring space in front of the WC pan to allow most people, including wheelchair users, to have reasonable access to a WC and to use it comfortably, safely and, wherever possible, independently.

A wash-hand basin should be situated so that it does not impede access.

Minimum widths, dimensions and typical layouts, see Figs 17.3 and 17.4.

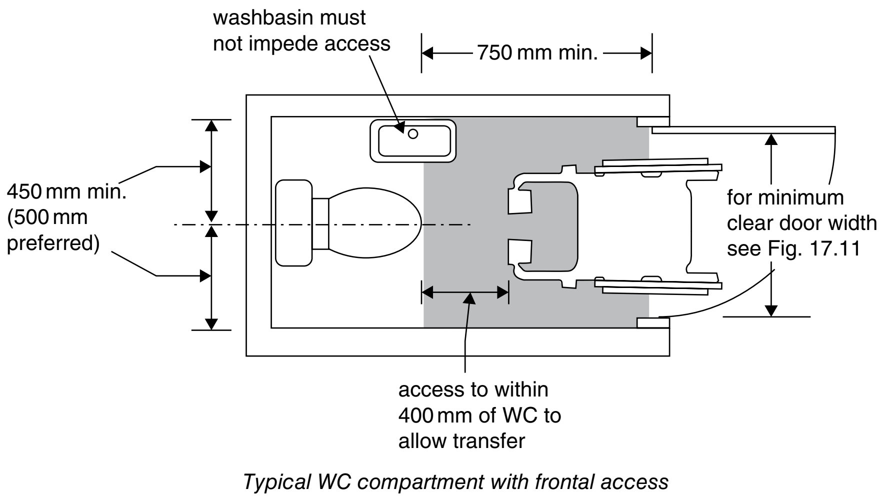


Fig. 17.3 WC access area.

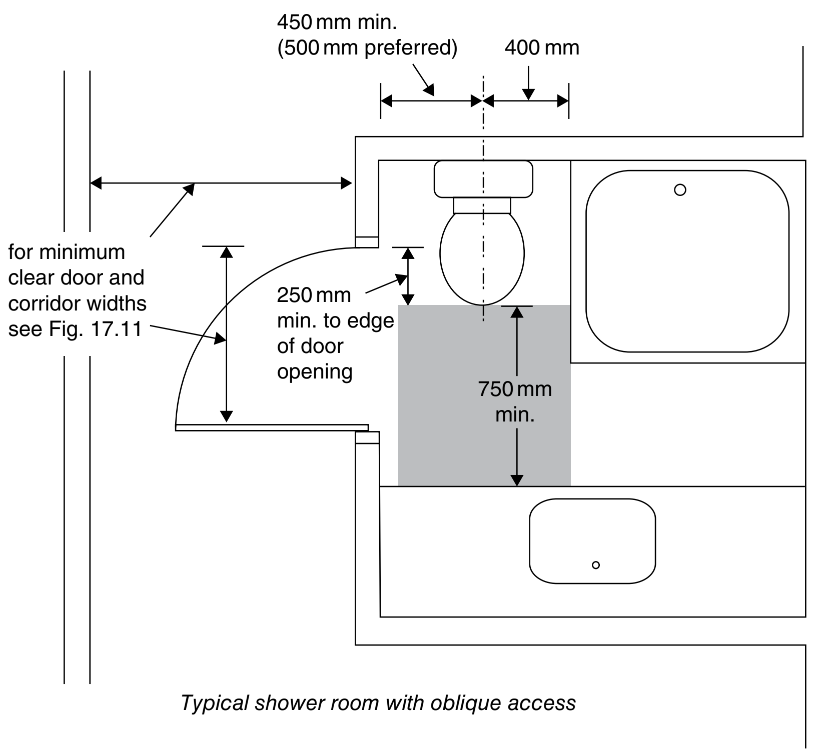


Fig. 17.4 Compliant WC/cloakrooms in dwellings.

17.4.3 Category 2: Accessible and adaptable dwellings

M4(2) is the first of the optional requirements of Part M and under the requirements of Regulation 4 will apply to building work in substitution for M4(1) where compliance is required by a condition of planning permission. M4(2) requires reasonable provision for most people to access the dwelling and incorporates features that make it potentially suitable for a wide range of occupants, including older people, those with reduced mobility and some wheelchair users. It can be regarded as a replacement for the former 'Lifetime Homes' standard previously used by planning authorities to set standards for accessibility above the building regulations. The new Housing Technical Standards of which M4(2) forms a part were designed to replace these non-statutory technical standards and ensure consistency in the application of accessibility standards across England. It is important to note that although category 2 is in some ways aligned with the lifetime homes guidance, there are many variations between the two standards.

The typical variations in this category from that contained in the mandatory category 1 are as follows:

- Approach to the dwelling requirements are level or gently sloping approach (must be step free), level landings, external lighting requirements and door entry controls
- Minimum communal door and gate widths (850 mm)
- Entrance lobby and porch requirements
- Communal stair design to ADK (general access stair)
- Communal lift requirements (where a lift is provided)
- Access to all rooms and facilities on entrance storey should be step free
- Entrance storey living, kitchen and eating area requirements
- Minimum bedroom standards
- Sanitary facility requirements in addition to entrance storey WC
- All walls, ducts and boxings strong enough to support grab rails, seats and other adaptations
- Bathroom requirements
- Glazing and control heights, services and controls as per Category 1 plus boiler timer and thermostat controls

17.4.4 Category 3: Wheelchair user dwellings

M4(3) is the highest of the optional requirements of Part M and under the requirements of Regulation 4 will apply to building work in substitution for M4(1) where compliance is required by a condition of planning permission. M4(3) requires reasonable provision either at completion or at a point following completion, for a wheelchair user to live in the dwelling and use any associated private outdoor space, parking and communal facilities that may be provided for the use of the occupants. It can be regarded as a replacement for the former 'Wheelchair Housing Design Guide' standard previously used by planning authorities to set standards for accessibility above the building regulations. The new Housing Technical Standards of which M4(3) forms a part were designed to replace these non-statutory technical standards and ensure consistency in the application of accessibility standards across England. It is important to note that although category 3 is in some ways aligned with the aforementioned guidance, there are many variations between the standards.

This category is effectively separated into two subcategories where a dwelling design should either meet the needs of wheelchair users at the point of completion, known as M4(3)(2)(b), or a dwelling which, by simple adaptation, would meet the needs of occupants who use a wheelchair, known as M4(3)(2)(a). Where this category is triggered by a planning condition, that condition must specify the situations where M4(3)(2)(b) applies explicitly; otherwise any reference to M4(3) should be regarded as reference to the adaptable version of the requirement.

The typical variations in this category from that contained in the mandatory category 1 and 2 are as follows:

- Approach to the dwelling requirements as Category 2 plus passing or turning spaces on approach routes, parking bay and headroom requirements, gradient maximum 1:15 and additional lighting options.
- Private outdoor space requirements
- Entrance doors should be power assisted where opening weight exceeds 20 N.
- Wheelchair storage and transfer space within the home.
- Combined internal floor areas of living, dining and kitchen space and clear access zones (minimum 1500 mm) in front of and between all kitchen units and appliances.
- Minimum worktop lengths.
- All dwellings should have a WC, basin and installed level access shower on entrance level.
- Through the floor lift provision (or easy to install).
- Power socket suitable for a stairlift close to the foot or head of any stair.
- Hoist routes, bedroom manoeuvring and space requirements.

17.5 Volume 2: Buildings other than dwellings

The main provisions

Reasonable provision must be made in buildings for people, regardless of disability, age or gender, to:

- reach the principal entrance to a building and its other entrances from the site boundary, the car parking area and between other buildings (if any) on the same site;
- have safe access into and within any storey within the building and to the facilities available;
- have access to appropriate sanitary accommodation;
- expect suitable accommodation to be provided for wheelchair users, or people with other disabilities, in audience or spectator seating; and
- expect aids to communication to be present in auditoria, meeting rooms, reception areas, ticket offices and at information points.

These access provisions should be available to all people who use the building, including employees and visitors.

17.5.1 Means of access

The approach to the building

All people, regardless of disability, age or gender, should be able to reach the principal entrance into the building or any other entrances that are provided (see section **17.5.2**).

Level, firm and safe access should be provided to the principle visitor and staff entrances of the building from the boundary of the site and from any car parking designated for disabled people that is provided within the site.

Routes between buildings on a site should be accessible to all users and include appropriate provision for people, including those using mobility aids, to pass safely and easily.

Unavoidable changes in level, perhaps due to site constraints, may be addressed by incorporating gentle gradients. Steep gradients should be avoided but, if unavoidable, should be appropriately designed in terms of lengths of flight, gradient and the provision of resting places.

The approach to the building and access routes around it should be appropriately illuminated to minimise risks to people who are visiting the building or working in it.

The following recommendations are given in volume 2 of AD M 2015 regarding the approach to a building.

Level approach

- Wherever possible, the approach to a building should be level (maximum gradient of 1:60). If this cannot be achieved, the gradient of the approach may be up to 1:20 providing it incorporates an appropriately designed and constructed level landing for each 500 mm vertical rise. If the approach needs to be steeper than 1 in 20, an appropriately designed ramped approach should be provided (see section 'Ramped provision' and Fig. 17.5). In all situations cross falls to access routes (including, if provided, landings) should not be steeper than 1:40.
- Approaches to the principle and/or the accessible entrance should be easy to identify, clearly defined and well lit.
- A surface width of 1800 mm will allow any amount of non-vehicular traffic to use the approach without the need for passing places. A surface width of 1500 mm may be acceptable if appropriately sized passing places (1800 mm wide and 2000 mm long) are also provided. If this width is not possible, perhaps on a restricted site, 1200 mm may be acceptable if the case for the narrowness of the approach is addressed in an Access Strategy (see section 17.1.5).
- People should be able to use an approach without excessive effort and without the risk of slipping, tripping or falling. Surfaces should be firm, durable and slip resistant, especially when wet.
- Any undulations in formless surface finishes should not exceed 3 mm when measured under a 1000 mm straight edge. Bonded gravel surfaces can provide a suitably firm surface, but materials such as loose gravel and sand must be avoided. Joints in surfaces formed from paved units should not exceed 5 mm in depth and, if filled, 10 mm in width and, If unfilled, they should be no wider than 5 mm.
- Where different surface materials are used in an approach, there may be an increased risk of users stumbling. To reduce this risk, the frictional characteristics of adjacent materials (or materials used in close proximity) should be similar.
- To minimise the danger of inadvertently walking into a vehicle access route, pedestrian routes should be appropriately separated. Where crossing points for pedestrians are necessary across the vehicular route, a blister pattern tactile surface should be provided to warn of the potential danger (see Fig. 17.6).

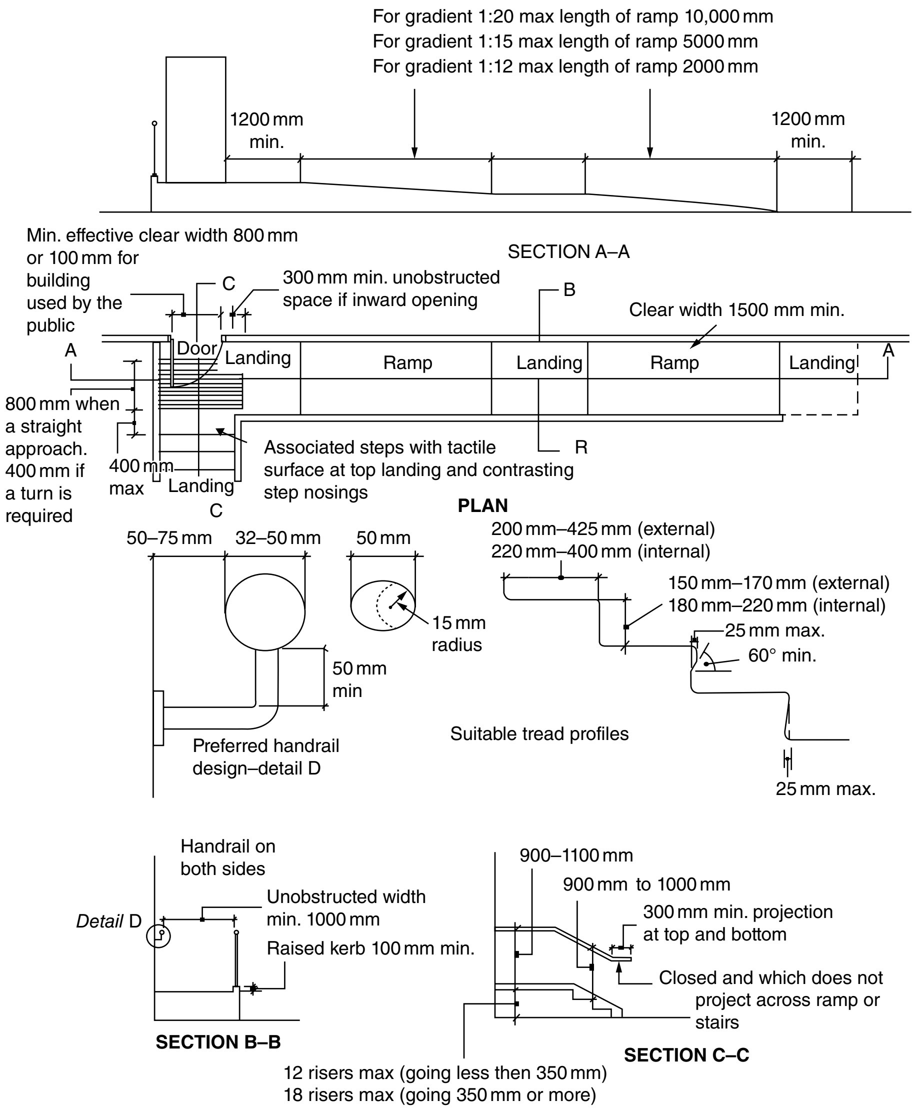


Fig. 17.5 Access to the building.

Note: The colour of tactile warning surfaces at controlled crossings should be 'red'. At uncontrolled crossings, the colour of the surface should be 'buff' or any colour that visually contrasts with the adjacent pavement – except red.

- Some people find it easier to negotiate steps rather than ramps. Therefore, appropriately designed steps should complement a ramped approach (see section 'Stepped access' and Fig. 17.5).
- To alert visually impaired people of an imminent potential hazard, corduroy pattern tactile warning surfaces should be provided at the top of and bottom of flights of steps. Examples of appropriate designs for tactile hazard surfaces are shown in Fig. 17.6.

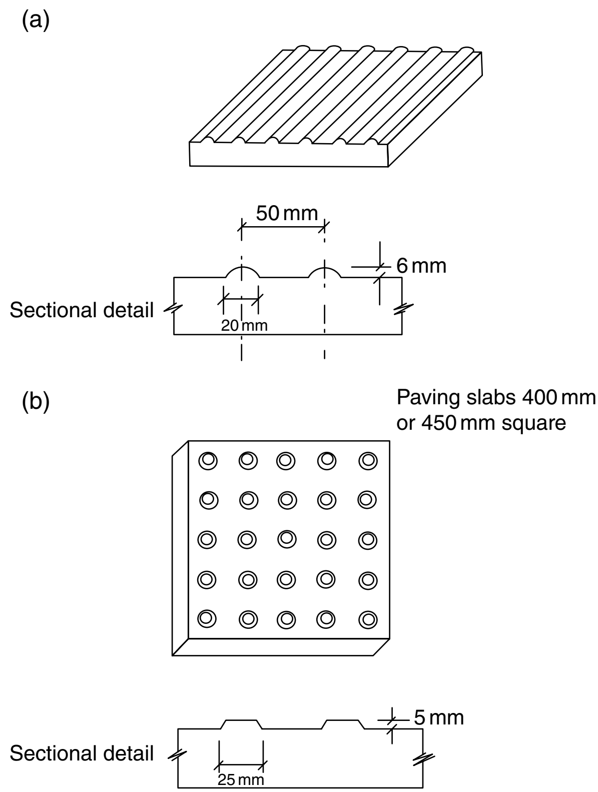


Fig. 17.6 Tactile paving. (a) Corduroy paving used at the top of steps (see Fig. 17.5). (b) Modified blister paving used at carriageway crossings.

- To reduce the risk of head collisions for all users, but especially for those with restricted vision, the area up to 2100 mm above ground level should always be kept clear (see also section 'Hazards on access routes' and AD K 2013).

On site car parking and setting down

People who travel to a building by car should be provided with car parking facilities appropriate to their needs. This includes the position of the parking spaces within the site, the design of the bays and the approach from the car parking area to the entrances into the building.

Generally, the surfaces to car parks should be firm, and the marking out of bays should allow sufficient space for motorists to exit and enter their vehicle comfortably and without undue hazard.

If barriers are used to control entry into and/or out of the car park, or payment is required to use the car park, the facilities provided should be usable by all people using the car park.

For people who arrive at a building as passengers, a setting-down point should be provided to allow them to exit the vehicle close to the entrance.

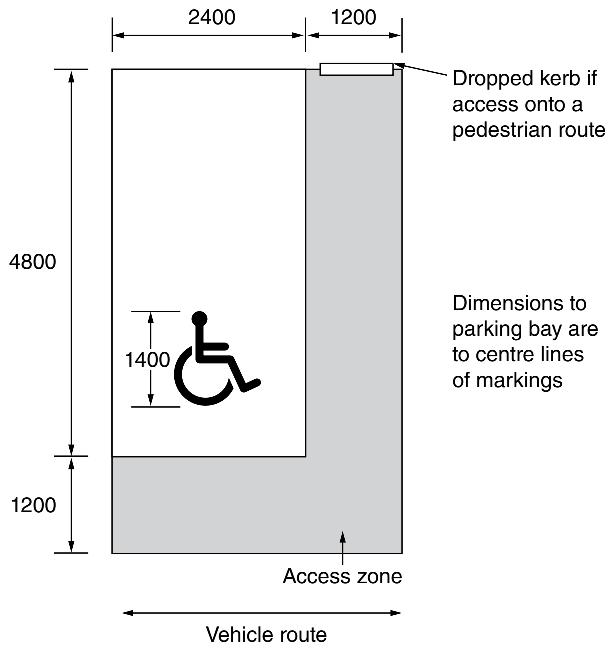


Fig. 17.7 Designated parking bay.

AD M 2015 identifies the existence of further and complementary good practice guidance on the above issues in BS 8300.

The following recommendations are given in AD M regarding the designated disabled car parking provision for a building:

- At least one designated and appropriately identified parking bay should be provided close to the principal entrance of the building for use by disabled people.
- The location of the parking bay should be clearly signposted both from the entrance to the car park and at the bay itself.
- The car park surface should be firm, level and durable. The area within the access zones to the side and rear of the designated parking bay should be slip resistant, especially when wet (see Fig. 17.7);
- If they are required to be used by disabled people, ticket machines should be accessible in terms of the approach to the machine and the height of the controls (between 750 mm and 1200 mm above ground level).

Ramped provision

Note: The amendments to AD K and AD M in 2013 have located the principle source of guidance on the provision of internal and external steps, stairs and ramps into AD K. AD M does however contain additional guidance for external stepped and ramped access where they form part of the:

- *access to principle entrances or, if provided, alternative accessible entrances; and/or*
- *access route to the building from the boundary of the site and the car parking.*

If a conflict exists between the guidance given in Part K and Part M then the guidance given in Part M takes precedence.

If ramps are necessary, perhaps because constraints within a site necessitate the use of approaches at 1:20 or steeper, they should be as shallow as practicable, of sufficient width and provided with surfaces that are slip resistant, especially when wet.

No flight within a ramp should have a greater going than 10 m or have a rise exceeding 500 mm. If the total rise of the of the flights exceeds 2000 mm, an alternative means of access such as a lift should be available for wheelchair users.

Appropriately designed handrails, visually contrasted with the background against which they will be viewed, should be provided on both sides of the ramp, and lighting to the ramp should be appropriate in daylight and under artificial lighting conditions (see Fig. 17.3).

Ramps can present difficulties for many users of a building or space including older people, wheelchair users, those with restricted mobility and helpers – all of whom may need to make frequent rest stops when negotiating long ramps. Therefore, the width and steepness of the ramp and the slip resistance and firmness of the surface finish are important design issues for everyone.

The recommendations in AD M 2015 regarding the provision of ramps on an approach route can be summarised as follows.

Ramps should:

- be readily identifiable or their location clearly signposted;
- at 1:20 have no flight with a going greater than 10 m or a rise of more than 500 mm;
- at 1:15 have no flight with a going greater than 5 m or a rise of more than 333 mm;
- at 1:12 have no flight with a going greater than 2 m or a rise of more than 166 mm;
- have no gradient steeper than 1:12;
- have a landing at the top and bottom of at least 1200 mm long, clear of any door swing;
- have intermediate landings at least 1500 mm long, clear of any door swing;
- have intermediate landings of 1800 mm × 1800 mm where wheelchair users cannot see along the whole length of the ramp before starting to use it or if the ramp has three flights or more;
- have a maximum cross fall on landings of 1:40;
- have any open side of a flight or landing a raised kerb at least 100 mm high, appropriately visually contrasted with the ramp or landing;
- be provided with guarding that meets the requirements of Part K;
- have a surface width between upstands, kerbs or enclosing walls of at least 1500 mm;
- have an appropriately designed and visually contrasted handrail on both sides;
- have a slip-resistant surface with having similar frictional characteristics with any adjacent surface finishes;
- have a surface colour to the ramp which contrasts visually with that of the landings; and
- have clearly signed alternative steps where the rise of the ramp is more than 300 mm.

Stepped access

Many of the design factors that apply to ramps also apply to steps (see Fig. 17.5). However, any sudden change of level such as that caused by a step or steps can create dangers for users including people with impaired sight, those with impaired hearing (who may be communicating with companions or others when walking along and using their less sensitive peripheral vision to identify hazards in front of them) and those who are simply not paying attention.

Additional factors which need to be considered therefore include providing appropriate visual contrast to the nosing of each step in a flight and not incorporating single steps on any access route.

Some ambulant disabled people experience stiffness in their hip or knee joints or may need to wear calipers. Steps with projected nosings or open risers can allow feet or calipers to catch, presenting a potentially serious safety risk for people using the stair. Sharply projecting nosings and open risers should therefore not be used on an access route.

People with physical weakness on one side, older people or those with sight impairments often need to prepare themselves when ascending and descending a stair by identifying the position of the first step and the presence of the handrails. They also often need to able to place their feet squarely onto the treads. Therefore, stairs should:

- have a level landing with an unobstructed length of not less than 1200 mm at the top and bottom of each flight; and
- be provided with a 'corduroy' hazard warning surface to the top and bottom landings.

In addition, stairs should:

- have treads that are slip resistant, especially when wet;
- have clear widths of 1200 mm at surface level and 1000 mm between handrails;
- not have channels within a flight which are greater than 1800 mm wide;
- have a rise and going which are consistent throughout the flight and risers that are not open;
- have uniform rises between 150 mm and 170 mm high and uniform goings between 280 mm and 425 mm long; in schools, the preferred dimension for the riser is 150 mm and for the going is 280 mm;
- if provided, have projecting nosings that blend smoothly with the tread and riser (see Fig. 17.3);
- have no more than 12 risers between landings if the going of each step is less than 350 mm;
- have no more than 18 risers between landings if the going of each steps is 350 mm or greater; and
- have nosings that contrast visually with the surface of the tread and the riser and which extend 55 mm wide on both surfaces

Handrails to steps and ramps

Handrails can have a major impact on the accessibility and usability of a building that can be a positive impact if they are appropriately designed, installed and visually contrasting and a negative impact if they are not. For many users, the provision of appropriate handrails is critical to their safe and independent use of an environment.

AD M 2015 makes several recommendations about the provision of handrails to steps and ramps. In essence, handrails should:

- extend horizontally at least 300 mm beyond the top and bottom of a ramped or stepped access; the design should ensure that the extension does not project hazardously into a circulation route, and the end of the handrail should be designed so that the risk of catching clothing is minimised;
- be placed between 900 mm and 1000 mm above the surface of a ramp or pitch line of stairs and between 900 mm and 1100 mm above the surface of any landings; if a second lower handrail is provided, the top of the handrail should be 600 mm above surface level or pitch line;
- be easy to grip. The profile of the handrail can be circular or oval, with oval being preferred. If round, the diameter should be between 32 mm and 50 mm, and if oval, the width should be 50 mm and the depth 39 mm with a 15 mm radius at the corners (see Fig. 17.5);
- visually contrast with the background against which they will be viewed; and
- be continuous on each side of a flight and around landings.

Other recommendations are described in Fig. 17.5 and in Chapter 15 (AD K).

Hazards on access routes

The amendments to AD K and AD M in 2013 have located the principle source of guidance on hazards on access routes into AD K (see Chapter 15).

17.5.2 Access to the building

In general, buildings should be designed with convenient access and egress, and all entrances and exits should be suitable for the people who use the building. This includes doors and, if provided, lobbies.

In exceptional circumstances, space restriction, congestion or sloping ground may prevent the provision of a single accessible main entrance. Similarly, physical constraints may prevent the provision of car parking spaces close to the principal entrance.

In such cases, justifying the provision of an alternative accessible entrance may be possible using an Access Strategy (see also section 17.1.4). Any alternative entrance, however, must be designed and used as an additional entrance for general use, rather than as a segregated facility for disabled people. Its location should be clearly identifiable, and it should be positioned to ensure that suitable access is possible to all internal areas, including the principal entrance and main staff entrances.

All accessible entrances should be appropriately signed using the International Symbol of Access.

The entrance into the building should not be obstructed with hazards such as canopy supports, entry phones or controls for powered opening devices. Thresholds should be level. If an upstand threshold is required, it should have a maximum height of 15 mm. Any upstand in excess of 5 mm should be chamfered or rounded.

If an entrance door is opened manually (i.e. without the assistance of a manually activated power-assisted door opener or an automatic opening device), an appropriate means of weather protection should be provided for people entering and leaving the building. A firm slip-resistant landing at least 1500 mm × 1500 mm and clear of any door swings should also be provided immediately in front of the entrance. Entry systems, if provided, must be suitable for use by people with vision, hearing and speech impairments.

Any entrance matting, if provided, must be suitable for use by wheelchair users and should not provide a tripping hazard for other users. If a mat well is provided, the upper level of the mat should be level with the surrounding floor area. Coir matting should not be used.

Entrance doors and lobbies

Everyone entering and exiting a building requires sufficient manoeuvring space, but this is especially so for wheelchair users, people carrying luggage, people with assistance dogs and parents with pushchairs and small children. For all new buildings, the entrance door should, when open, provide an effective clear width that is sufficient to allow all users to pass through safely and with relative ease.

If, in exceptional circumstances, the minimum effective clear widths identified in AD M cannot be achieved, a justification of the reasons why and the suitability of alternative proposals in maintaining an appropriate level of accessibility should be made using the Access Strategy process.

For an entrance door in a new building to be used by the general public, the effective clear width should be 1000 mm. For entrance doors into other buildings, the minimum effective clear width should be 800 mm; although if the door is approached from an access route less than 1200 mm wide, the minimum effective clear width should be 825 mm. These dimensions apply to a door which is a single leaf or for one leaf of a double leaf door.

Whichever type of door is used, it is important to allow sufficient room for the door to be opened by a person in a wheelchair. Therefore, for manually opened doors, there should be an unobstructed space of at least 300 mm on the pull side of the door between the leading edge of the door and the return wall.

Vision panels that meet the requirements of AD K 2013 should be provided to assist all users of a building, including children. If the provision of a vision panel is not appropriate, perhaps because of security reasons, this should be explained and argued using the Access Strategy process.

Manually operated non-power-assisted doors should be easy for people to use and details of the maximum forces that should be exerted to open and close a door are described in section **17.2**. If compliance with the maximum opening forces cannot be achieved, providing assistance using manually activated or automatic power-operated opening and closing systems should be considered.

Door furniture to manually operated doors should be operable using one hand in a 'closed fist' position. This can be achieved with a lever handle design. Furniture should contrast visually with the surface of the door and not be cold to touch (see also Chapter 15 – section 15.5.2).

Glass doors, if provided, should have manifestation that meets the requirements of AD K 2013 (see Chapter 15 – section 15.15).

Powered entrance doors

Powered entrance doors should be provided with controls that are easy to use, visually apparent and reachable by all users and which incorporate safety features to ensure the safety of all users of the building. The speed at which the doors open and close and their dwell time in the open position should be carefully designed and managed.

The position of manual controls for powered door systems should be logical and clearly identified using signage and visual contrast. Any manual controls should be located between 750 mm and 1000 mm above ground level and set back 1400 mm from the leading edge of the door when in the fully open position.

Doors, when open, should not project into an access route. If the doors swing towards people approaching the building, visual and audible warnings should also be provided.

Revolving doors

Revolving doors can present considerable difficulties for many users of a building and especially for older people, disabled people using mobility aids such as canes and walking frames, parents with pushchairs and/or children and people with goods or luggage. They can also present considerable safety risks for people using assistance dogs and for the dogs themselves. Therefore, revolving doors are not considered to be accessible and should never be provided as the sole means of access or egress at a principle entrance.

Where a revolving door is provided, it should always be accompanied by a manually operated non-powered door as described in section 'Entrance doors and lobbies' or a manually activated power-assisted or automatic door (swing, sliding or bifolding) with appropriate controls as described in section 'Powered entrance doors'.

Entrance lobbies

The design of a lobby should allow people to easily and safely avoid others who may be passing in the opposite direction and allow for assistance to be given if required. It should also be possible to move clear of the swing of one door when opening the next. For this reason entrance doors and lobbies need to conform to certain minimum dimensions. Figure 17.8 shows the design principles stated in AD M 2015.

The force required to open doors to lobbies should not exceed the maximum forces described in section **17.2**. If glazing is used in the doors, it should meet the requirements of AD K 2013 in terms of size and robustness (see also section 15.13) and should not create distracting reflections.

The floor surface within lobbies should be firm and assist in the removal of rainwater from shoes and the tyres of wheelchairs. Coir matting should not be used.

17.5.3 Horizontal access within the building

Once inside the building, users must be able to identify the location of, travel to and use the facilities that are provided.

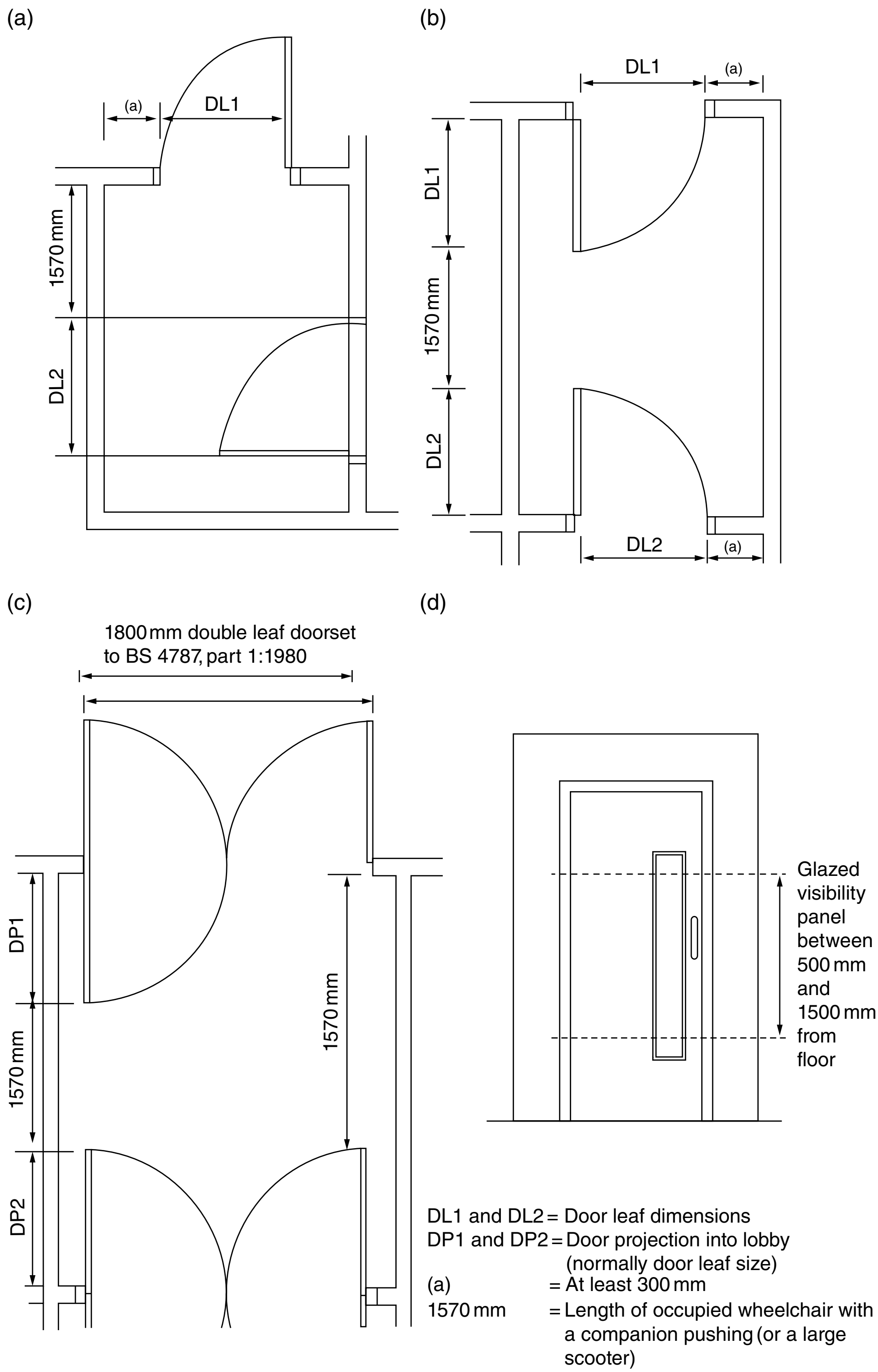


Fig. 17.8 Entrance doors and lobbies. (a) Right-angled lobby, (b) straight lobby (single-leaf doors), (c) straight lobby (double leaf doors) and (d) elevation (single-leaf door).

Different building types will have a variety of facilities, and some may be unique to a particular use. AD M 2015 does not attempt to provide exhaustive guidance on all the facilities that may be relevant. It divides guidance into design considerations and provisions for both vertical and horizontal circulation.

In general terms, it is clear that the objective of any building design should be to allow all people to travel vertically and horizontally within the building to reach and use facilities and for that to be done conveniently, safely, independently and without undue discomfort.

AD M 2014 presents its guidance by considering the journey around a building as a sequential horizontal and vertical route, starting with the entrance hall and reception areas.

Entrance hall and reception area

For all users of a building, the entrance hall and reception point (if any) represent very important interfaces with a building. They are critical for people unfamiliar with the building as a source of assistance and as a focal point for understanding the functions taking place and how to gain access to them. It is very important that entrance halls and reception points are appropriately designed and have sufficient manoeuvring space to ensure the comfort and safe use of all those visiting the building.

Reception areas and entrance halls should be appropriately illuminated, and floor surfaces should be firm and slip resistant, especially when wet.

If a reception point is provided, its position should be logical and easily identifiable to anyone entering the building. There should be sufficient space for all users to approach the point and manoeuvre around with relative ease. The design of the desk should allow easy and comfortable communication between the visitor and reception staff. The design of the reception desk should allow easy use by standing or seated visitors when undertaking activities such as signing in or obtaining directions or instructions.

There is no requirement within AD M 2015 for a reception desk to be provided with a knee recess. Not providing one however could have implications for service providers, employers and others when addressing any duties places on them by the Equality Act 2010 (see also section 17.1.2).

Generally, a reception desk should have:

- appropriate illuminance;
- clear locational and directional signage;
- an approach route from the principle entrance or the accessible entrance which is clear and free of obstructions;
- a clear manoeuvring space of 1200 mm deep by 1800 mm wide in front of the desk (if a knee recess of at least 500 mm deep is provided);
- a clear manoeuvring space of 1400 mm deep by 2200 mm wide (if no knee recess is provided);
- one section of the desk that is at least 1500 mm wide and with a writing surface between 700 mm and 760 mm above finished floor level;
- a hearing enhancement system; and
- slip-resistant floors on the approach to and adjacent to the desk.

Internal doors

All doors are potential barriers to free and easy access into and around buildings. Therefore, their use should be restricted to places where their use is essential to address the activities taking place in the building. If doors are required, they should have a suitable effective clear width (see Fig. 17.1) and an unobstructed space at the leading edge (minimum 300 mm). Internal doors should be suitable for all users to open and close with relative ease or provided with assisted openers or, where appropriate, hold-open devices that will minimise the impact of their presence in everyday use.

Recognising the guidance laid down in BS 8300:2009 on the installation and use of internal doors, AD M 2015 recommends that internal doors:

- have an effective clear opening width (see section 'Entrance doors and lobbies');
- are able to be opened by the user with a force applied at the leading edge that is in accordance with the requirements identified in section **17.2**;
- are provided with appropriate visual contrast to the door furniture, the leading edge of the door (if it could present a collision hazard) and between the door frame and the surrounding wall;
- that are fully glazed have a vision panel, and/or manifestation are provided as described in AD K:2013 (see section 15.15); and
- are designed not to open into circulation routes (except doors to minor utility facilities). The door to a unisex wheelchair-accessible WC may open onto a non-major access route or escape route providing that a minimum clear width of 1800 mm exists in the corridor when the door is open.

If double doors are provided across a corridor that forms a major access route or an escape route and the doors within the set are of unequal width, the wider leaf should be located on the same side throughout the length of the corridor.

Corridors

Corridors and passageways generally should have a clear unobstructed width of at least 1800 mm. Where this is not possible, they should have a clear unobstructed width of 1200 mm and passing places at least 1800 mm long by 1800 mm wide at reasonable intervals along the route. In school buildings where lockers may be provided in corridors, the preferred width is 2700 mm.

Floors should be level (maximum gradient 1:60). Where that is not possible, a gradient of up to 1:20 can be provided as long as the overall vertical change in level does not exceed 500 mm without an appropriately designed level rest area being provided (minimum 1500 mm long).

Any sloping floor section should extend for the full width of the corridor or, where this is not possible, the exposed edge should be identified with visual contrast and/or a protective barrier meeting the requirements of AD K 2013 (see section 15.11).

Gradients steeper than 1:20 should be designed as a ramp (see section 'Ramped provision' and Chapter 15 – section 15.5).

Floor surfaces should be firm and slip resistant, and finishes should not be visually confusing in terms of the pattern or design used.

The materials and surface finishes used in corridors should contribute to a good acoustic design for the space, rather than detract from it.

If glazed screens are provided alongside a corridor, the potential hazard should be identified using appropriate manifestation (see Chapter 15 – section 15.15).

Internal lobbies

The principles of design that apply to the provision of internal lobbies are the same as described in section 'Entrance doors and lobbies' for entrance lobbies. Therefore, internal lobbies should meet the minimum dimensions shown in Fig. 17.8.

17.5.4 Vertical access with the building

Generally

A passenger lift is the recommended way of providing vertical access for people moving from one storey to another in all buildings. New developments should have a passenger lift serving all storeys.

If site or other constraints preclude the provision of a passenger lift, an appropriately designed platform lift may be suitable. However, the case for providing it in preference to a passenger lift should be argued in an Access Strategy. Whichever lift is used, a staircase that is suitable to address the needs of people with ambulant and sensory impairments should also be provided.

In existing buildings only and also in very exceptional situations where neither a passenger or platform lift can be installed, vertical access may be possible using a wheelchair platform stairlift. It is important to ensure that the stairlift does not impinge on or conflict with any means of escape provisions or practices.

In most cases, providing a stairlift will effectively remove the availability of one handrail. This can have implications for users who have limited movement or strength to one side of their body and who require access to a handrail when both ascending and descending the stairs.

The reasons for proposing the use of a wheelchair platform stairlift and the consequences of limiting access to one handrail will need to be satisfactorily explained and justified using the Access Strategy process.

General requirements for lifting devices

AD M 2014 requires any installed lifting device to be fit for its intended purpose, and it also identifies a series of relevant pieces of legislation that should be addressed.

Other general requirements relate to the provision of appropriate illuminance and general lighting design on the approach to the lift and in the lift car, controls that allow relatively easy and safe use by all users and the importance of surfaces that do not cause visual confusion for users of the lift.

To achieve the above, AD M 2015 identifies that:

- routes to any lift should be accessible, and it should be possible to access the lift from all areas of the storey it serves;

- there should be:
  - a straight approach to the doors at least 900 mm wide; or
  - an unobstructed area to manoeuvre of at least 1500 mm × 1500 mm outside the lift doors;
- tactile lift call buttons on the landings visually contrast with their surroundings. They should be located between 900 mm and 1100 mm above finished floor level and at least 500 mm from any return wall;
- the floor of the car should be provided with light-coloured coverings to reassure visually impaired people when entering a lift of the presence of a suitable surface on which to walk. Dark colours may make the presence of a floor difficult to confirm, causing uncertainty and increasing decision times;
- floor coverings within the lift car have similar frictional characteristics to the surfaces provided to the landings;
- a handrail should be provided on at least one side of the lift car. The top surface of the handrail should be 900 mm above the finished floor level of the car;
- for lifts which do not have sufficient manoeuvring space to allow a wheelchair user to turn around within the car, a mirror should be provided to the rear wall to assist them when reversing out of the lift; and

  Note: Full-height floor-to-ceiling mirrors can cause confusion for visually impaired people when entering the lift and present an impact hazard for wheelchair users. It is important therefore that mirrors in a lift car do not extend below handrail height.

- an emergency call system should be provided that is suitable for all people using the lift including those with sensory impairments or restricted dexterity or strength.

Passenger lifts

To meet the requirements of Part M, passenger lifts must conform to the requirements of the Lift Regulations 1997, SI 1997/831. This can be achieved by following the guidance contained in relevant British Standards such as BS EN 81-70:2003 *Safety rules for the construction and installation of lifts*.

The number and size of the lifts provided should be suitable to address the needs of all users of the building. This will depend on anticipated demand and the number of disabled people who may be using the building.

In addition to the general recommendations described above, AD M 2015 identifies the following issues that should also be addressed in the provision of passenger lifts (see Fig. 17.9):

- The minimum dimensions suitable for a passenger lift are 1100 mm wide and 1400 mm deep. This size is suitable to accommodate a wheelchair user and an accompanying person.
- A larger lift with internal dimensions of 2000 mm wide by 1400 mm deep will accommodate a wheelchair user and several other passengers, as well as people using larger wheelchairs. A lift of this size will also allow a wheelchair user or someone using mobility aids to move through 180° and exit the lift travelling forwards.

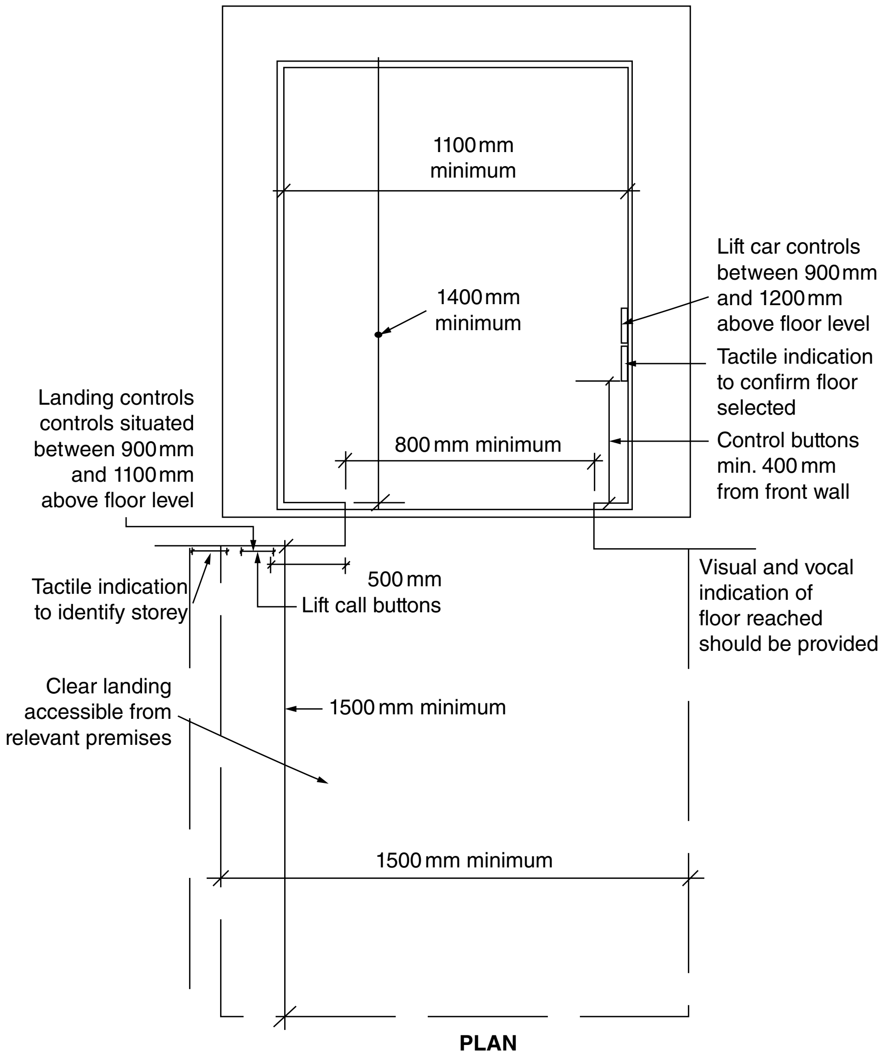


Fig. 17.9 Lift (suitable for use by disabled people).

- The landings and the doors to lift cars should contrast visually with the surrounding walls and the lift doors should have a minimum clear open width of 800 mm.
- Dwell times of doors must allow adequate time for all users, including those with assistance dogs, to enter and leave the lift without undue hazard.
- Within the lift car, controls should be located between 900 mm and 1200 mm above finished floor level (1100 mm preferred). They should not be closer than 400 mm to any return wall.
- Audible and visual information should be provided to indicate the location of the lift, its arrival and the floor level it has reached.

- On a landing, call buttons should be reachable and provided between 900 mm and 1100 mm above finished floor level. They should also be at least 500 mm from any return wall.
- The lift car should be designed as a visually and acoustically accessible environment that can be used by all users, including people with sensory impairments. If glass is provided in the enclosure to the lifts, its presence should be clearly identifiable using appropriate manifestation (see section 15.15).
- Lifts that are designed to evacuate people in an emergency should conform to the recommendations in BS 9999:2008.

To prevent passengers becoming trapped by closing doors, it is necessary to provide an override to the door controls and a door reopening activator using a photo-eye or infrared detector or similar non-contact sensor. Door edge pressure-activated systems are not suitable as they may cause a disabled person to lose their balance.

Lifting platform

Lifting platforms in buildings should be restricted to use by wheelchair users, ambulant disabled people and their companions/carers. Lifting platforms are not suitable as a means of providing vertical access for other users and should not be installed for that purpose.

Controls should be installed in a manner that enables easy, safe and independent operation by a wheelchair user or by their carer. Clear instructions on how to use the platform should be given. Instructions should be provided in a way that meet the communication needs of all disabled people likely to require them, including those with sensory impairments.

In general, platforms are operated by applying continuous pressure to the call button and the movement controls. The means of providing continuous control should take into account the needs of users who experience restricted mobility or limited dexterity and those who are easily fatigued. The position of the controls differs slightly from that described earlier for passenger lifts in that the controls should be located between 800 mm and 1100 mm above finished floor level, although the distance of 400 mm from any return wall is the same. The position of landing call controls for lifting platforms is identical to that for passenger lifts (see section 'Passenger lifts').

The speed of movement of the platform should not exceed 0.15 m/sec.

The minimum clear dimensions of a lifting platform also vary from that specified for a passenger lift with two smaller sized platforms being identified as acceptable in certain circumstances. Recommendations are generally as follows:

(a) Where a disabled person will be unaccompanied when using the lift, the minimum clear dimensions of the platform should be 900 mm × 1400 mm if it is enclosed and 800 mm × 1250 mm if it is not enclosed.

    The minimum clear opening width of the access door for both of these situations should be 800 mm.

(b) Where a disabled person will, or may, be accompanied or where the doors provided to enter or exit the platform are not opposite each other (requiring the disabled person to turn 90° to exit the platform), the minimum clear dimensions should be 1100 mm × 1400 mm.

The minimum clear opening width of the access door in this situation should be 900 mm.

The vertical rise of a lifting platform without a lift-way enclosure should not exceed 2000 mm. This can be exceeded if an enclosure is provided.

Entrance doors should contrast visually with the surrounding wall, and if glass doors or enclosures are provided, their presence should be identified using appropriate manifestation (see section 15.15).

As with passenger lifts, people using a lifting platform should be given audible and visual advice on the position of the lift, the arrival of the lift and the floor level reached.

Wheelchair platform stairlifts

Wheelchair platform stairlifts should only be considered for use in existing buildings that are being converted or altered and where the provision of a full passenger lift or platform lift is not practicable. They are not suitable where general independent, unmanaged access by users is possible and active management practices should be in place to prevent such use. Management practices should also include appropriate training for users in operating the stairlift and how such use will be supervised.

The minimum clear dimensions of the platform should be 800 mm wide by 1250 mm long and access to the platform should be a minimum of 800 mm effective clear width. Requirements relating to the provision of controls for continuous pressure controls, user fatigue, visual contrast, speed of movement, etc. are the same as those that apply to lifting platforms (see section 'Lifting platform').

Internal stairways

The design requirements for internal stairs and handrails are now described in AD K (see Chapter 15), although AD M 2015 does identify the following differences from the guidance contained in AD K:

- Hazard warning surfaces are not required at the top and bottom of an internal flight of steps. AD M 2015 does however advise designers to consider other methods of reducing the potential risk posed by stairs by, for example, providing appropriate visual contrast and ensuring stairs are not sited in the direct line of an access route.
- To assist people with mobility impairments who generally prefer being able to place their whole foot onto a tread or to rest whilst negotiating a flight of steps, the preferred going is 300 mm.

Internal ramps

Internal ramps and handrails will meet the requirements of Part M if they comply with AD K (see Chapter 15).

17.5.5 Facilities in buildings other than dwellings

All people, regardless of disability, age or gender should be able to get access to and use all of the facilities within a building. This includes those used for educational, business, leisure and social activities and regardless of whether the person using the facility is a spectator, a participant or a member of staff.

Access to bar, restaurant and refreshment facilities

Refreshment areas including restaurants and bars should be accessible to all users whether they are using them independently or with companions. The provision of permanent or temporary seating should always allow for disabled people to have a choice of position from which to participate in or view any activity taking place, and seating should be located in a position that affords a clear view without obstructing the views of others. If the design of an area includes the provision of different levels, perhaps to designate different functions or enhance aesthetics, all levels should be fully accessible. This applies to public and staff areas.

The full range of services offered should be accessible including, where provided, at individual tables, self-service counters and bars.

To enable independent use by wheelchair users, serving counters and bars should incorporate a lowered section not more than 850 mm above finished floor level. Worktops provided in shared refreshment facilities should also include a lowered section not more than 850 mm above finished floor level and a clear space underneath of not less than 700 mm above finished floor level (see also Fig. 17.10).

Any additional facilities provided such as toilets, telephones and/or external terraces should also be fully accessible to all users.

Audience and spectator facilities

In addition to the guidance described earlier for reception counters (see section 'Entrance hall and reception area'), consideration should also be given to how all members of an audience can view, listen to, communicate during or participate in the activities taking place. This is important for everyone but especially so for those with restricted mobility and sensory impairments.

In general:

- routes to and from all seating areas and associated facilities should be accessible;
- disabled people should have the opportunity of sitting next to a non-disabled companion or carer. Seating for disabled people therefore should be integrated into the auditoria – not segregated into separate areas;
- wheelchair-accessible seating areas should have sufficient space to enable easy manoeuvring;
- some seats should have sufficient space available under or in front of the seat to accommodate an assistance dog;
- some seats should be provided with detachable or lift-up arms.

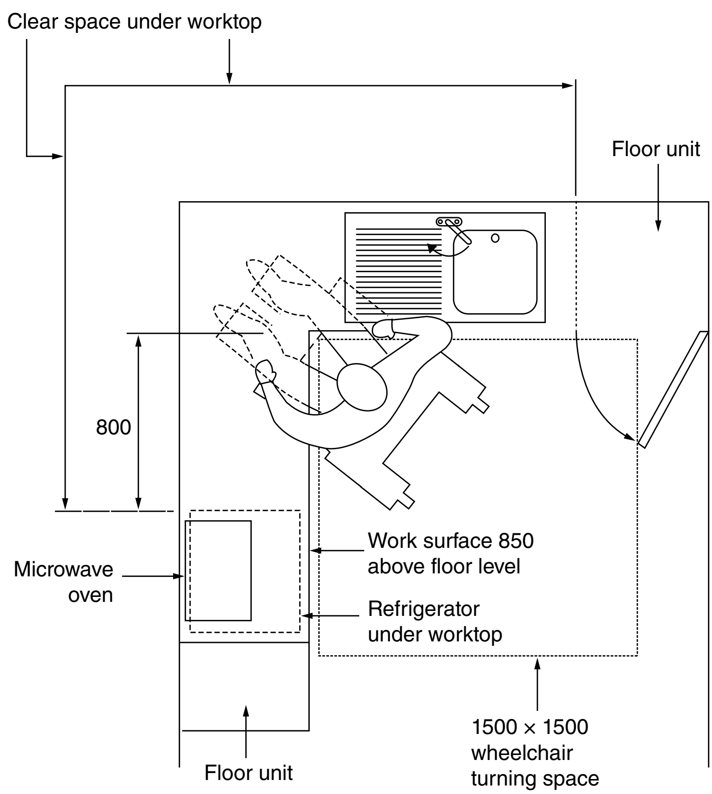


Fig. 17.10 Refreshment facilities (suitable for use by disabled people).

- people with sensory impairments should be able to view speakers or events for lip-reading or to observe sign interpreters; and
- where possible, seating should contrast visually with its surroundings.

Auditoria provided with sections of seating that are removable will offer a greater choice of seating location for disabled people and also improve flexibility in terms of the number of disabled people who can be accommodated at any one time. Some sections, perhaps at the back of a block of seats or at the end of rows, may be provided with extra legroom to accommodate users of large stature.

AD M 2014 suggests that for auditoria with a seating capacity of up to 600 seats, at least 1% of the total seating capacity should be permanently available for wheelchair users with, if required, further removable seating being available to bring the overall total up of wheelchair-accessible seating to six seats.

For auditoria of between 600 and 10,000 seats, at least 1% of the total seating capacity is required. The provision of any additional removable seating in addition to this amount is left to the discretion of the designer or the venue providers.

For larger auditoria AD M 2015 draws attention to the guidance contained in a Football Foundation and Football Licensing Authority document entitled *Accessible*

Stadia: A good practice guide to the design of facilities to meet the needs of disabled spectators and other users (see section 17.8). Additional comprehensive guidance on accessible seating for spectators is contained in BS 8300.

Lecture and conference facilities

In lecture and conference facilities, the lighting, acoustical properties and general décor within of the space and its supporting areas should be designed to enhance the communication process. Sight lines to the speaker, screen, lectern and, if required, sign interpreters should be appropriate to meet the needs of all those attending events or participating in the activities taking place.

To assist people with sensory impairments, good general and task specific lighting should be provided and bold, highly contrasting patterned wall and floor finishes should be avoided.

Podiums and presentation facilities (where provided) should be accessible to all, and a hearing enhancement system should be provided to conference, meeting rooms and associated areas (see also section 'Aids to communication').

Entertainment, leisure and social facilities

In cinemas, theatres or other places of entertainment where seating may be closely sited, the location of accessible seating should always ensure that all users can enjoy the atmosphere of the area. In all cases, reference should be made to *Technical standards for places of entertainment*, published by the District Surveyors Association and the Association of British Theatre Technicians (see section 17.8).

Details of requirements for stepped gangways in assembly buildings are described in AD K 2013 (see section 15.6.6).

Sports facilities

For sports facilities, AD M 2014 identifies the guidance given in *Accessible stadia,* and other good practice guidance can be found in *Accessible sports facilities design guide 2010* published by Sport England (for both see section 17.8) and in BS 8300.

Sleeping accommodation

AD M 2015 contains several recommendations related to the design of accessible bedrooms, associated sanitary facilities and the provision of switches, outlets and controls.

In essence, where sleeping accommodation is provided, for example in hotels, motels and student accommodation, it should be designed to be convenient for all users (see Fig. 17.11). Wheelchair users, people with restricted mobility and those with assistance dogs are likely to have increased spatial needs, and some rooms should be designed to accommodate this. However, all facilities within the building should be accessible to everyone who will be using it.

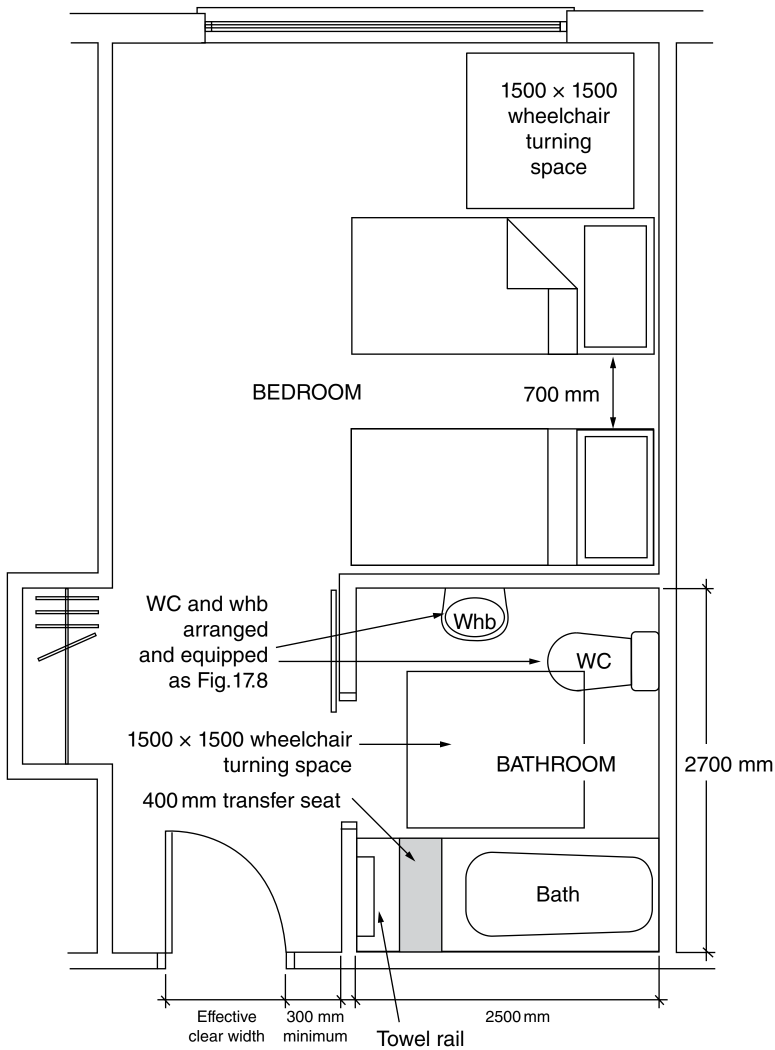


Fig. 17.11 Guest bedroom (hotels and motels).

AD M 2015 requires that:

- at least one appropriately designed wheelchair-accessible bedroom should be provided for every 20 bedrooms, or part thereof, in the building. Therefore, if 21 guest bedrooms are provided, two of them should be accessible for a wheelchair user;
- accessible bedrooms should have a standard of facilities and amenities that are equivalent to that provided in other bedrooms and should offer wheelchair users a reasonable choice of location within the buildings;
- the internal design of bedrooms should provide sufficient space to enable a wheelchair user independent or assisted transfer to at least one side of the bed and to enable easy

access to en suite facilities, switches, controls and facilities such as wide-angle viewers in doors (if provided);
- an emergency assistance alarm and associated reset button are provided in each wheelchair-accessible bedroom and en suite facility. The call signal associated with the alarm should be located at a central control point and also in a position outside the accessible bedroom where, if activated, it will be visually and audibly obvious to other users of the building.

When on holiday or attending residential conferences/courses, wheelchair users may wish to visit colleagues or companions in other bedrooms, and the design of the building should allow for this. Whilst rooms not specifically designed for independent use by a wheelchair user are likely to have limited internal manoeuvring space, the entrance door into all bedrooms should be appropriate in terms of position, width and maximum opening force to enable a wheelchair user to access the room as a visitor (see also sections 'Entrance doors and lobbies' and 'Internal doors').

In wheelchair-accessible rooms provided with a balcony, the door from the room to the balcony should be accessible in terms of clear approach, effective clear opening width, level threshold and viewing zones (see also Chapter 15).

Facilities for hanging or stacking clothes and other belongings and the location and controls for telephones and televisions should be accessible and convenient to use. For ease of use and convenience, consideration should also be given to providing automatic or remotely triggered controls for facilities such as curtains and blinds.

Switches, outlets and controls in buildings other than dwellings

All switches, outlets and controls in a building intended to be used by visitors or staff should be easy to locate and operate. This usually relates to their design, position and visibility within the overall space.

In terms of location:

- wall-mounted outlets and sockets such as telephone points and television sockets should be located between 400 mm and 1000 mm above floor level. For permanently wired appliances, outlets and sockets should be between 400 mm and 1200 mm although this latter dimension can be exceeded for high level appliances;
- in situations such as open plan offices, some outlets and sockets will be set at floor level, but this should be seen as the exception rather than the rule;
- switches and controls whose operation requires precise hand movements should be located between 750 mm and 1200 mm above floor level. Those requiring a simple push button operation should be sited at a level no higher than 1200 mm above floor level; and
- light switches for use by the public should be located between 900 mm and 1100 mm above floor level and aligned horizontally with the door handle.

In terms of operation, unless there are clear reasons of safety, activating a switch, outlet and control should not require the simultaneous use of both hands.

In terms of visibility, and unless there are exceptional and specific reasons not to identify their location, the front plates of sockets, outlets and controls should always contrast visually with their backgrounds.

Pull cords for emergency alarm systems should be coloured red and located close to the wall. When used in a wheelchair-accessible toilet or facility, the pull cord should be within easy reach when seated on the WC. The cord should extend to just above floor level and be provided with two 50 mm diameter bangles, one set at 100 mm above floor level and the other between 800 mm and 1000 mm above floor level.

Aids to communication

All building users benefit from an environment that enables effective communication. This can be achieved by careful attention to design, by installing appropriate public address systems or by a combination of both.

Lighting, visual contrast and acoustics all play important roles in the creation of a satisfactory environment for communication. How they are utilised within a design is important for all users – but especially so for those with sensory impairments.

In that respect, recommendations include the following:

- Avoid shiny, reflective surfaces and designs that do not adequately control glare.
- Avoid bold or highly visually contrasting patterns on walls and floors.
- Artificial lighting, where used, should not create glare, strong pools of bright light or strong shadows.
- Avoid lighting regimes that provide uplighters at floor or low level.
- At reception desks, in meeting rooms or in other areas where communication is required, provide lighting that appropriately illuminates the face of the person speaking.
- Ensure that the design of artificial lighting includes compatibility with the frequencies of any radio or electronic installations.
- Avoid acoustically 'live' environments within a design. This can be achieved by careful design to dampen the effects caused by 'hard' surfaces (floor, wall and ceiling finishes) in areas where communication is important.
- Provide an induction loop or infrared hearing enhancement system at service or reception desks and in rooms or spaces designed for meetings, lectures, classes, performances, spectator sports, films, etc. Always provide appropriate signage to advise building users of its availability.
- Consider of the guidance in BS 8300 when selecting surface finishes, visual, audible and tactile signs and the use of hearing enhancement systems.

The type and quality of public address systems can be critical in gathering information. Systems should be carefully chosen to suit the environment and the purpose for which they will be needed. Audible public address systems should be supported by appropriately designed and located directional and informational signage.

Further good practice guidance on the use of colour, light and contrast can be obtained from *The colour, light and contrast manual* (see section 17.8).

17.5.6 Sanitary accommodation in buildings other than dwellings

It is necessary to provide sanitary conveniences for all users of a building, whether they are visitors, customers or staff.

Sanitary accommodation generally

Details relating to the provision of sanitary accommodation are given in the Approved Document to Part G (AD G) (see Chapter 12) and in AD M 2004:2013.

AD M 2015 suggests that the following general design principles should be followed:

- Suitably designed sanitary accommodation should be provided in a new or extended building. In an extended building the sanitary accommodation can be either in the extension or, if the approach is accessible, in the existing part of the building being extended.
- The location of sanitary accommodation within the building should be logical and consistent. It should include facilities for people of either gender, disabled people (including those using assistance dogs) and those using the facility encumbered with children, luggage, etc.
- The appropriate number of toilets to be provided will depend on the size and nature of the building and on the ease of access to the facility. AD M 2014 suggests that the number of WC cubicles available for women should be at least equal to the number of urinals available to men. This figure for female cubicles could increase to double the number of male urinals however for buildings where visitor numbers are likely to be high (for example, in large retail developments or in entertainment and leisure centres).
- Male standard toilet facilities should always include low-level urinals located at a height suitable for use by men of short stature and children. AD M 2015 refers to BS 8300 which recommends that the rim for a standard urinal should be 500 mm above floor level and 380 mm for a low-level urinal.
- Where a separate-sex male toilet can be accessed by wheelchair users, it should be possible for them to use a urinal. They should also have access to a low-level handwashing facility.

  Note: BS 8300 identifies that a wheelchair user may be able to use a urinal in a standard separate-sex toilet facility if:
  - *the clear opening width of the door is sufficient to permit a wheelchair to pass through; and*
  - *there is sufficient manoeuvring space within the toilet; and*
  - *there is an appropriate hand washing facility; and*
  - *appropriately designed and fitted vertical grab rails are provided adjacent to each side of the urinal.*

  Further details are given in BS 8300 (section 12.6.3.5).

- Travel distances to sanitary facilities should always reflect the fact that some disabled people may need to reach a WC quickly.

- Facilities such as taps, door locks, flush controls and light controls should be suitable to meet the needs of all users, including those with restricted dexterity or strength.
- The needs of users with visual or hearing impairments should be taken into account in terms of, for example, visual contrast, lighting, surface finishes and the provision of visual and audible alarm systems.
- All doors to WC cubicles, changing rooms and shower rooms should open outwards. If this is not possible, there should be a clear manoeuvring space of 450 mm between the door and the WC pan, and doors should be capable of being opened outwards. This will enable assistance to be given if someone collapses inside the cubicle.
- At least one unisex wheelchair-accessible facility should be provided at every location where there are standard single-sex facilities. If the space available within the building precludes more than one toilet being provided, it should be a unisex wheelchair-accessible facility. The internal width should be increased from 1500 mm to 2000 mm to accommodate a standing height wash basin in addition to the finger rinse basin provided adjacent to the WC.
- Within separate-sex toilets, at least one cubicle should be designed and equipped to meet the needs of ambulant disabled people (see Fig. 17.12).
- If more than four cubicles are provided within a standard toilet facility, one cubicle should be wider to accommodate the needs of people who need extra space (for example, parents with children and people with luggage, shopping and/or assistance dogs). This wider cubicle is in addition to the cubicle designed and equipped for ambulant disable people.
- Specific guidance on the provision of sanitary facilities in sports buildings is given in *Accessible sports facilities design guide 2010* and in BS 8300.

In larger developments and buildings to which the public have access, AD M 2014 identifies the desirability of providing a unisex changing and toilet facility for people with profound and multiple learning disabilities and other serious impairments such as spinal injuries, muscular dystrophy or multiple sclerosis. Such developments and buildings might include, for example, educational establishments, sports and leisure venues, shopping centres, transport interchanges and town centres.

Known as a ‘Changing Places’ toilet, the room should be at least 3 m wide by 4 m wide, have a peninsular layout WC to allow assisted transfer from both sides and facilities such as a height adjustable wash-hand basin, changing bench and a hoist. Further guidance is given in BS 8300 and on www.changing-places.org.

Consideration should also be given to the provision of baby-changing facilities in male and female standard toilets. If the baby-changing facilities are located in standard toilets that are not accessible to wheelchair users (see above), they should also be provided in the unisex wheelchair-accessible toilets.

To ensure that disabled people have ready access to a suitable facility when needed (see also section ‘Wheelchair-accessible unisex sanitary accommodation’), a unisex wheelchair toilet should never be used as the sole provision for baby-changing facilities in a building.

AD M 2015 also suggests that in larger buildings, consideration is being given to locate baby-changing facilities in their own separate unisex area.

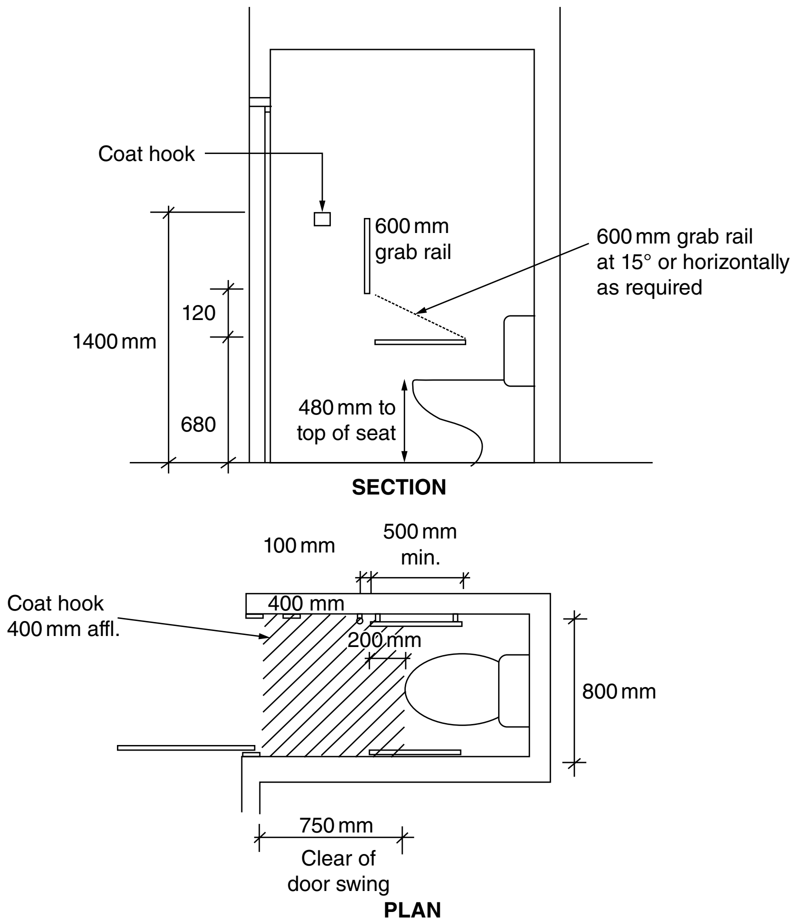


Fig. 17.12 WC for ambulant disabled people.

Wheelchair-accessible unisex sanitary accommodation

AD M 2015 indicates a preference for unisex wheelchair-accessible WC facilities and identifies the following advantages over facilities integrated into standard toilet accommodation:

- The unisex facility has an independent approach separate from other sanitary accommodation.
- Direct access to the unisex facility allows a partner or carer of a different gender to enter the toilet with the disabled person and offer assistance if required.
- The facility is more easily identified.
- It is more likely to be available when needed.
- A unisex facility offers a potential space saving over the provision of accessible facilities in standard toilets.

Wheelchair users transfer onto a WC from the left or right-hand side or from the front. A person who transfers from the left, perhaps because it is difficult or causes pain or discomfort to transfer from the right, may be unable to use a right-hand transfer toilet, and vice versa. AD M 2015 requires that where more than one wheelchair-accessible WC is provided within a building, a choice of left and right-hand transfer should be available.

For a wheelchair user, a suitable sanitary facility is one that they are able to use safely and independently.

AD M 2015 requires that to reach a suitable sanitary facility on the same floor, a wheelchair user should not have to travel more than 40 m. If located on another floor, the maximum combined vertical and horizontal distance must not exceed 40 m and:

- access between floors is by passenger lift or lifting platform; and
- the vertical travel distance includes not more than one storey.

Distances greater than 40 m may be suitable if it can be shown that the route is unobstructed and doors on the route (if any) are provided with assisted door openers or are fitted with hold-open devices. However, the case for this must be justified as part of an Access Strategy (see also section 17.1.4).

Note: Although not covered by AD M 2015, the appropriateness of any travel distance for disabled people is also reliant on the floor covering provided. For example, travelling 40 m on a firm floor surface is likely to be quicker and require much less effort from a disabled person than for the same travel distance on a deep-piled carpet. Service providers and employers should consider the effects of floor coverings and travel distances to a suitable sanitary facility when assessing whether any duties placed on them by the Equality Act 2010 are being appropriately addressed.

The design of individual wheelchair-accessible toilets should enable ease of access and use. AD M 2015 suggests that this can be achieved by providing:

- adequate space for a wheelchair to manoeuvre and for the presence of a carer to assist with transfer if required;
- handwashing and drying facilities that may be reached from the WC before transferring back to the wheelchair;
- a layout that is either a left-hand or right-hand transfer;
- consistency in the layout and the provision of facilities;
- a design and provision that ensures the privacy of users;
- an audible and visual alarm emergency call system that can be reached from the WC and the area close to the WC. A reset control should also be provided that can be reached when seated on the WC and from a wheelchair;

Note: *If activated, the call signal associated with the alarm should be visible and audible within the toilet and at a central control point or a position outside the accessible toilet where it will be visually and audibly obvious to other users of the building. The sound of the alarm should be different to that installed as part of any fire alarm system.*

- outward opening doors. If there is sufficient space to manoeuvre internally to allow the door to open inwards, it is necessary to provide an emergency release system to allow the door to open outwards in an emergency;
- a lever action or automatically controlled flush mechanisms located on the open or transfer side of the space;
- appropriate visual contrast between the walls and the sanitary fittings and at wall/floor junction (see also 17.2); and
- appropriate illumination.

Where standard guest bedrooms in hotels and other places of accommodation are provided with en suite sanitary facilities, a similar level of provision should also be available for disabled people.

If ensuite facilities are not provided, appropriate standard facilities and unisex sanitary accommodation for disable peopled should be provided within easy reach. There is also a necessity to provide additional sanitary accommodation for use by staff and non-resident visitors.

Figure 17.13 illustrates a typical layout for a WC compartment suitable for wheelchair users in either unisex or integral facilities.

Wheelchair-accessible shower facilities and changing rooms

AD M 2015 contains several recommendations for the provision of suitable wheelchair-accessible changing and shower facilities.

In essence, any changing and shower facilities provided should be suitable for disabled people to use safely and, wherever possible, independently. Changing and shower facilities should always permit disabled people the opportunity for privacy if required. There should also always be sufficient space for the wheelchair users to manoeuvre and for a carer or helper to offer assistance if required.

In addition:

- where more than one individual changing compartment or shower compartment is provided, there should be a choice of left-hand and right-hand transfer layout for seating and the WC (if provided);
- wall-mounted drop-down rails and a wall-mounted, slip-resistant and manually operated tip-up seat should be provided;
- an audible and visual alarm emergency call system should be provided that can be reached with ease from the shower seat, a WC (if provided) and the area close to them. A reset control should also be provided that can be reached when seated on the WC and from a wheelchair. For details of the alarm call signal, see section 'Wheelchair-accessible unisex sanitary accommodation';
- floor surfaces to showers should be slip resistant and self-draining; and
- controls to showers should be positioned between 750 mm and 1000 mm above floor level.

In changing rooms:

- suitable storage should be provided for artificial limbs;

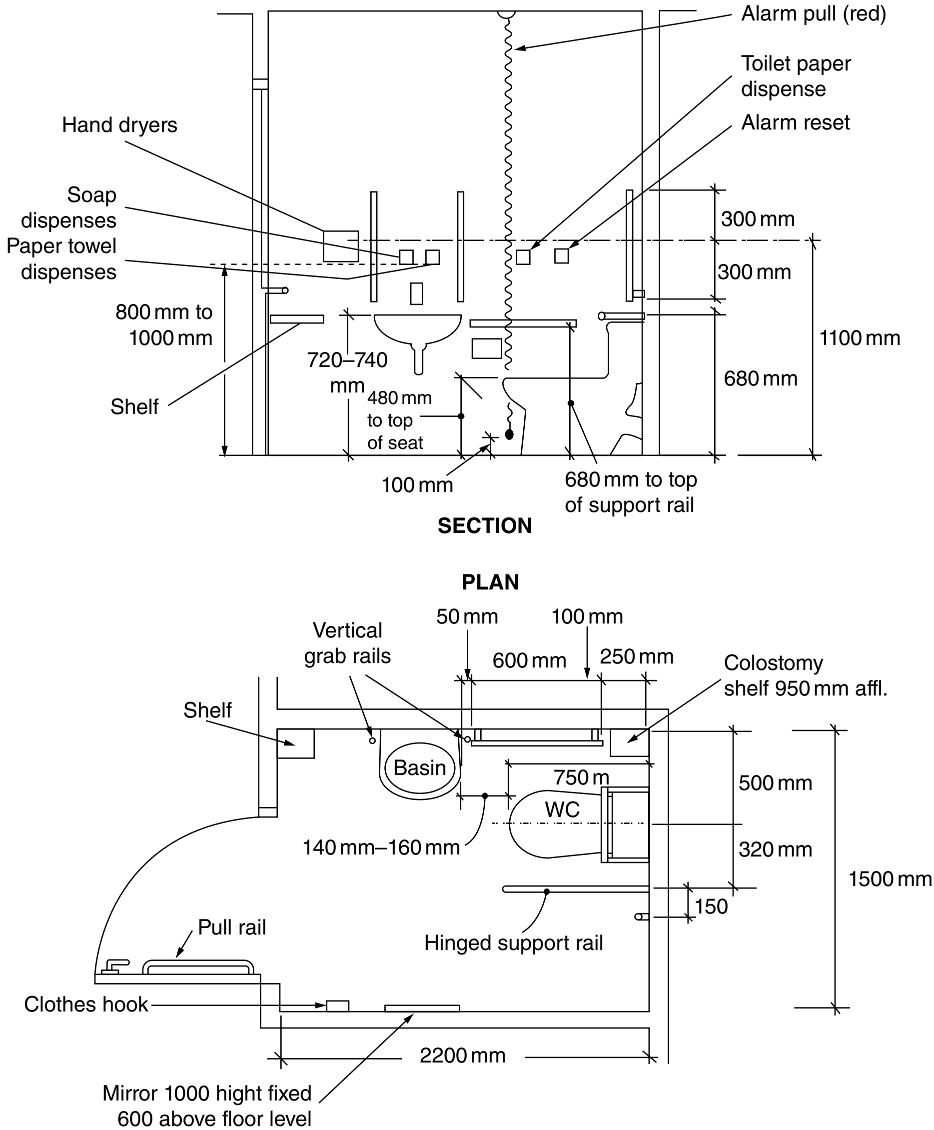


Fig. 17.13 WC for wheelchair users.

- a manoeuvring space at least 1500 mm deep should be provided in front of lockers; and
- floor surfaces should be slip resistant and self-draining;

In non-domestic buildings where showers and changing facilities are provided for the use of staff, at least one shower compartment and associated changing area should be wheelchair accessible.

Wheelchair-accessible bathrooms

AD M 2015 makes recommendations for wheelchair-accessible bathing facilities in buildings such as hotels, motels, student accommodation and sports facilities.

It recommends that all accessible bathroom facilities should be designed to enable wheelchair users and ambulant disabled people to safely wash or bathe independently or with assistance from a carer. In terms of minimum dimensions of the space, choice of layouts for transfer, slip-resistant floor coverings, direction of doors swings and the provision of an emergency alarm, the recommendations given in AD M 2014 are similar for those relating to the provision of sanitary accommodations and shower facilities described in sections 'Wheelchair-accessible unisex sanitary accommodation' and 'Wheelchair-accessible shower facilities and changing rooms'. One additional recommendation with regard to bathrooms, however, is for the provision of a seat, 400 mm deep and extending to the full width of the bath to assist transfer into the bath.

17.6 Means of escape in case of fire

Part M and AD M 2015 are primarily concerned with the needs of users, regardless of their disability, age and gender, when gaining access to and exiting a building and in using its facilities. They do not extend to provisions for escape in an emergency although appropriate consideration of such issues should clearly be an inherent part of the design and management of any building or environment. Means of escape for disabled people in the event of a fire is described in the Approved Document B, '*Fire safety*' (see Chapter 7), and BS 9999:2008 *Fire precautions in the design, construction and use of buildings* (see section 17.8).

17.7 In conclusion

This chapter identifies the main changes that have been introduced by Part M 20153, its Approved Document (AD M 2015), changes to AD K and the withdrawal of Part N in 2013.

It is not possible to comprehensively cover all of the changes in Requirements and design guidance, and that is not the purpose of an informative and introductory chapter such as that contained here.

In that respect, designers are advised to refer to AD M 2015 and AD K 2013 for the full range of areas now covered in each of the approved documents.

17.8 Sources of further guidance

Accessible stadia: A good practice guide to the design of facilities to meet the needs of disabled spectators and other users: http://www.safetyatsportsgrounds.org.uk/sites/default/files/publications/accessible-stadia.pdf.

Accessible sports facilities design guide 2010, published by Sport England: http://www.sportengland.org/facilities-planning/tools-guidance/design-and-cost-guidance/accessible-facilities/.
BS 9999:2008 *Fire precautions in the design, construction and use of buildings*: http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030158436.
Technical standards for places of entertainment, published by the District Surveyors Association and the Association of British Theatre Technicians': http://www.technical-standards-for-places-of-entertainment.co.uk/.
The access manual: http://eu.wiley.com/WileyCDA/WileyTitle/productCd-1118730747.html.
The colour, light and contrast manual: http://eu.wiley.com/WileyCDA/WileyTitle/productCd-1405195045.html.

18 Electrical safety (Part P)

18.1 Introduction

Part P of Schedule 1 to the Building Regulations was added by virtue of the Building (Amendment) (No. 3) Regulations 2004 (SI 2004/3210). Originally, it consisted of two requirements related to:

- provision of information; and
- design, installation, inspection and testing of electrical installations.

This was later amended in 2006 and 2010 to a single requirement covering design and installation of electrical installations.

The latest 2013 revision of Approved Document P came into force on 6 April 2013. This commentary is based on the 2013 revision.

The main changes brought about by the latest amendment include changes in the legal requirements as follows:

- The range of electrical installation work that is notifiable (where there is a requirement to certify compliance with the Building Regulations) has been reduced.
- An installer who is not a registered competent person may use a registered third party to certify notifiable electrical installation work as an alternative to using a building control body.

Additionally, Approved Document P now refers to BS 7871:2008 incorporating Amendment No. 1:2011. Since the issue of AD P, there has been a second amendment issued on 1 August 2013, and a third amendment is also anticipated in the near future.

Although Part P has only relatively recently been introduced into the building regulations, other Parts of the regulations have long been concerned with requirements affecting electrical installations.

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

Some examples include:

- Part A (Structure) – depth of chases in walls and size of holes and notches in floor and roof joists to receive services such as electrical trunking and cabling;
- Part B (Fire safety) – fire safety of certain electrical installations, such as lifts and mechanical ventilation and air conditioning systems, provision of fire alarm and fire detection systems and fire resistance of penetrations through floors and walls;
- Part C (Site preparation and resistance to moisture and contaminants) – moisture and radon resistance of cable penetrations through external walls;
- Part E (Resistance to the passage of sound) – soundproofing of penetrations through floors and walls;
- Part L (Conservation of fuel and power) – energy-efficient lighting and reduced current carrying capacity of cables in insulation; and
- Part M (Access to and use of buildings) – wall-mounted socket outlets, switches and consumer units need to be located so as to be easily reachable.

It should be noted that, although Part P covers the safety of fixed electrical installations, it does not cover the functionality of systems such as fire alarms and fans used in ventilation systems. Details of the way in which such systems are required to function may be found in the other Parts of the regulations referred to above and in other legislation.

18.2 Requirement P1

Requirement P1 of the Building Regulations 2010 (as amended) states that 'Reasonable provision shall be made in the design and installation of electrical installations in order to protect persons operating, maintaining or altering the installations from fire or injury'.

The requirement is qualified in the limits on application so that it only applies to electrical installations that are intended to operate at low or extra-low voltage (see section 18.6 for definitions) and are:

- in or attached to a dwelling;
- in the common parts of a building serving one or more dwellings but excluding power supplies to lifts;
- in a building that receives its electricity from a source located within or shared with a dwelling; and
- in a garden or in or on land associated with a building where the electricity is from a source located within or shared with a dwelling.

Requirement P1 can be met if low voltage and extra-low voltage electrical installations in dwellings are designed and installed so that:

- they afford appropriate protection against mechanical and thermal damage; and
- they do not present electric shock or fire hazards to people.

18.3 Design and installation

18.3.1 General

The requirements of Part P regarding electrical installations can be met by designing and installing in accordance with BS 7671:2008 *Requirements for electrical installations* (IET Wiring Regulations, 17th edition, ISBN 978-1-84919-269-9) incorporating Amendment No. 1:2011. Since the issue of AD P, there has been a second amendment issued on 1 August 2013, and a third amendment also is anticipated.

18.3.2 Information provision

In order that an electrical installation can be operated, maintained and altered with reasonable safety, the items listed in BS 7671 should be provided together with other appropriate information including:

- electrical installation certificates which describe the installation and give details of the work carried out;
- permanent labels on, for example:
  - earth connections and bonds, and
  - items of electrical equipment such as consumer units and RCDs;
- log books and operating instructions; and
- detailed plans (only if the installation is unusually large or complex).

It should be noted that Part P covers the safety of electrical installation work, but it does not cover the functionality of the electrical system. System functionality information can be found in other parts of the regulations and in other legislation for products such as fire alarm systems and heating and ventilating equipment such as fans and pumps.

18.3.3 Application to new dwellings

Part M (Access and use of buildings) of the Building Regulations 2010 (as amended) covers the siting of wall-mounted socket outlets, switches and consumer units in new dwellings in that they should be easy to reach. Full details of the siting of switches and socket outlets can be found in Chapter 17 of this book which considers the provisions of Approved Document M. However, AD M does not cover the siting of consumer units. AD P suggests that at a height of between 1350 mm and 1450 mm above floor level, consumer units will be out of the reach of young children but still accessible to other people when standing or sitting.

18.3.4 Application to dwellings formed by a material change of use

Where a material change of use occurs which is covered by Regulation 5(a), (b) or (g) (i.e. by the creation of a dwelling or a conversion to change the number of dwellings in a building), Regulation 6 requires that any necessary work must be carried out to ensure compliance with requirement P1. This could mean that the existing electrical installation might need to be upgraded in some cases. The extent of the work needed would depend on the circumstances, so, for example, if the existing cables were safe and adequate, they would not need to be changed merely because they used the old colour codes.

18.3.5 Application to additions and alterations to existing electrical installations

Regulation 4(3) requires that building work shall be carried out so that, after it has been completed,

(a) any building which is extended or to which a material alteration is made; or
(b) any building in, or in connection with, which a controlled service or fitting is provided, extended or materially altered; or
(c) any controlled service or fitting

complies with the applicable requirements of Schedule 1 or, where it did not comply with any such requirement, is no more unsatisfactory in relation to that requirement than before the work was carried out.

The effect of this is that when a building is extended or altered in a material way (as defined in the regulations), any new work to the electrical installation must comply fully with requirement P1. There would be no need to upgrade the existing electrical installation unless either of the following situations arose:

- The safety of the existing electrical installation was adversely affected by the new work.
- The existing installation was in such a poor state as to affect the safe operation of the new work.

The new work should be carried out in accordance with BS 7671, and the existing installation should be checked to ensure that the following conditions are all satisfied:

- The rating and the condition of the existing equipment belonging to both the consumer and to the electricity distributor can carry the additional loads being allowed for.
- Adequate protective measures are used.
- Satisfactory earthing and equipotential bonding arrangements are in place.

18.4 Application of Part P

18.4.1 General

All electrical installation work carried out in a dwelling is subject to requirement P1 and should follow the design and installation guidance given in section 18.3. It is the case though that although the work must comply with requirement P1, not all electrical work must be notified to the relevant building control body. Such work is termed ‘non-notifiable’ and is discussed fully below.

18.4.2 Scope of Part P

Part P applies to electrical installations in buildings or parts of buildings which comprise:

- dwelling houses and flats;
- dwellings and business premises (other than agricultural buildings) sharing a common supply, e.g. shops and public houses with a flat above;
- common access areas in blocks of flats, e.g. corridors and staircases; and
- amenities that are shared in blocks of flats, e.g. laundries, kitchens and gymnasia.

Part P also applies to parts of the electrical installations mentioned above, such as:

- in or on land associated with the buildings, e.g. fixed lighting and air conditioning units attached to outside walls, photovoltaic panels on roofs and fixed lighting and pond pumps in gardens; and
- in outbuildings like sheds, detached greenhouses and garages.

Part P does not apply to electrical installations:

- in business premises in the same building as a dwelling where the supplies are separately metered; and
- that supply the power for lifts in blocks of flats (however, Part P does cover the electrical supply to a lift in a single dwelling).

Interestingly, although buildings which come within the scope of Schedule 2 (see Chapter 2) are generally exempt from the requirements of the Building Regulations, conservatories, porches, domestic greenhouses, garages and sheds that share their electricity supply with a dwelling are not exempt (see Regulation 9(3) and Chapter 2) and must comply with the regulations.

18.4.3 Notifiable work

Notifiable electrical work must be notified to a relevant body such as a local authority or an Approved Inspector. However, in many cases, when electrical work to buildings is carried out, it will not be necessary to give a building notice or deposit full plans with the local authority or notify an approved inspector, since most electrical work will be covered by regulation 12(6), which enables the work to be certified by a competent person under the provisions of Schedule 3 to the Building Regulations 2010 (full details of the competent person procedures are given in Chapter 5). It should be noted that over the years, the amount and type of work that is no longer notifiable have increased.

Notifiable electrical installation work is covered by regulation 12(6A) as follows:

12-(6A) A person intending to carry out building work in relation to which Part P of Schedule 1 imposes a requirement is required to give a building notice or deposit full plans where the work consists of:

(a) the installation of a new circuit;
(b) the replacement of a consumer unit; or
(c) any addition or alteration to existing circuits in a special location.

'Special Location' is defined as:

- (a) within a room containing a bath or shower, the space surrounding a bath tap or shower head, where the space extends:
  - (i) vertically from the finished floor level to:
    - (aa) height of 2.25 m; or
    - (bb) the position of the shower head where it is attached to a wall or ceiling at a point higher than 2.25 m from that level; and
  - (ii) horizontally:
    - (aa) where there is a bathtub or shower tray, from the edge of the bathtub or shower tray to a distance of 0.6 m; or
    - (bb) where there is no bathtub or shower tray, from the centre point of the shower head where it is attached to the wall or ceiling to a distance of 1.2 m; or
- (b) a room containing a swimming pool or sauna heater.

18.4.4 Non-notifiable work

Regulation 12(6A) stated above sets out electrical installation work that is notifiable. All other electrical installation work consisting of additions and alterations to existing installations outside of special locations and replacements, repairs and maintenance is non-notifiable.

Examples of non-notifiable work include:

- installing a built-in cooker except where a new cooker circuit is needed;
- connecting an electric garage door to an existing isolator switch unless a new circuit from the consumer unit is needed; and
- installing prefabricated modular wiring (e.g. for kitchen lighting systems) linked by plug and socket connectors to an existing isolator unless a new circuit is needed from the consumer unit.

18.5 Certification, inspection and testing

18.5.1 General

As is explained in section 18.4.3, notifiable electrical installation work must subject to one of the following three procedures:

- Certification by a relevant Building Control Body (local authority or approved inspector);
- Self-certification by a registered Competent Person; or
- Third-party certification by a registered third-party certifier.

18.5.2 Certification by a relevant building control body (BCB)

This is the traditional route for installers who are not members of a Competent person Scheme and who have not appointed a registered third-party certifier. In these cases the installer must notify the relevant building control body (local authority or approved inspector) before the work commences.

It will be up to the BCB to determine the exact extent of inspection and testing needed in order that it can determine whether or not the work is safe. This will depend on the nature and complexity of the work and the competence of the installer. In some cases the BCB may have the facilities to carry out the necessary inspection and testing itself. Where this is not the case, the BCB may contract a specialist to carry this out on its behalf and then supply a BS 7671 electrical installation condition report.

Where an installer is competent to carry out the inspection and testing, he/she may give the appropriate BS 7671 certificate to the BCB. It will then be up to the BCB to take the certificate and the installer's qualifications into account and to decide whether or not to accept the certificate. They may ask for evidence of the installer's qualifications.

Under the provisions of the *Building (Local Authority Charges) Regulations 2010 (SI 2010/404)*, a charge is levied for all types of building work when an application is made to the local authority for approval where the work is subject to building regulation control. The Charges Regulations require the local authority to take into account the amount of inspection work that it considers it will need to carry. Therefore where an installer is suitably qualified, this may result in a reduced building control charge.

Approved Inspectors are not governed by the Charges Regulations, and their fees are subject to negotiation with the applicant.

Once the BCB has decided that, as far as can be ascertained, the work meets all the requirements of the Building Regulation, it will issue to the building occupier a Building Regulations completion certificate if it is a local authority. An approved inspector will likewise issue a final certificate.

18.5.3 Self-certification by a registered competent person

The Competent Person system of control is fully described in Chapter 5 where details and contact numbers for the various schemes are given. Electrical installers who are registered competent persons should provide to the person ordering the work a BS 7671 electrical installation certificate for every job they undertake.

Additionally, *Regulation 20 of the Building Regulations 2010* places a duty on the 'person carrying out the work' (the courts have held that this can include both the competent person and the consumer; however in a competent person scheme, it would normally be taken as the competent person) to notify the local authority within 30 working days of completion of the work. The notification is in the form of a certificate which is given to the occupier of the premises which confirms that *regs 4* and *7* of the *Building Regulations 2010* have been complied with. The competent person can choose whether to give the local authority the certificate or merely to notify them that the work is complete. Be aware that although the local authority is authorised to accept such a certificate, it is not legally bound to, since circumstances might exist whereby the local authority doubts the authenticity or veracity of the certificate or it may have reason to believe that the work did not comply with the Regulations. Where an approved inspector has assumed the role of BCB, then the building regulation compliance certificate referred to above will be served on the approved inspector instead of the local authority.

18.5.4 Certification by a registered third party

From 6 April 2014 a person who is registered with a third-party certification scheme for electrical installations in dwellings is able to check domestic electrical work that is undertaken by others and certify that it is compliant with the building regulations.

Therefore, an installer who is not registered with a competent person scheme may appoint a registered third-party certifier to inspect and test the work as necessary, but this appointment must take place before the work starts.

The installer must, within five days of completing the work, notify the registered third-party certifier. The certifier will then need to carry out inspection and testing of the installation, complete an electrical installation condition report and give it to the person ordering the work unless the work is unsatisfactory. BS 7671 contains a model form that can be used for this purpose although it is possible for the certifier to use a form specifically designed for Part P purposes.

The third-party certifier's registration body must, within 30 days of a satisfactory condition report being issued, do the following:

- Give a copy of the Building Regulations compliance certificate to the occupier of the premises.
- Either give the certificate or a copy of the information on the certificate to the BCB.

Third-party registration scheme register: Take-up by industry

Although third-party registration has been possible since 6 April 2014, there has been reluctance by some representative industry bodies to set up registration schemes. Both the NICEIC and ELECSA have decided to opt out of the third-party certification schemes amid fears that it could undermine registered electricians. These organisations believe that the register's requirements fall well short of the standards and safeguards that will enhance electrical safety. Furthermore it is argued that the register is not UKAS accredited, meaning that there will be no independent verification that the third-party scheme operators are performing to the required standards. As a result of this, both the NICEIC and ELECSA have decided not to produce such a register.

Therefore, currently, there are only two scheme operators who participate in the third-party certification scheme. These are NAPIT Registration Ltd and Stroma Certification Limited.

Registration is of both the individual certifier and the company that employs them. This ensures that requirements that can only be placed on a legal entity can be enforced. No electrical business can certify any third-party electrical work until they are registered on a Third-Party Certification Scheme. Therefore technical competencies of all electricians are checked before third-party certification is awarded.

18.6 Interpretation

The following definitions apply throughout Approved Document P:

BUILDING CONTROL BODY (BCB) – A local authority or private sector approved inspector.

BUILDING REGULATIONS COMPLIANCE CERTIFICATE – A certificate issued by an installer registered with an authorised competent person self-certification scheme or by a certifier registered with an authorised third-party certification scheme stating that the work described in the certificate complies with regulations 4 and 7 of the Building Regulations 2010 (that is, the work complies with all applicable requirements in the Building regulations).

ELECTRICAL INSTALLATION – BS 7671 defines this as 'an assembly of associated electrical equipment supplied from a common origin to fulfill a specific purpose and having certain coordinated characteristics'. A simpler and more specific definition is given for the purposes of Building Regulations as 'fixed electrical cables or fixed electrical equipment located on the consumer's side of the electricity supply meter'.

EXTRA-LOW VOLTAGE is defined in BS 7671 as 'normally not exceeding 50 volts alternating current or 120 volts ripple free direct current, whether between conductors or to earth'.

LOW VOLTAGE is defined in BS 7671 as 'normally exceeding extra-low voltage but not exceeding 1000 volts alternating current or 1500 volts direct current between conductors, or 600 volts alternating current or 900 volts direct current between conductors and earth'.

These last two definitions are phrased slightly differently to those given in regulation 2 (see Chapter 2) but are essentially the same.

19 Security (Part Q)

19.1 Introduction

Part Q of Schedule 1 to the 2010 Regulations (as amended) is concerned with the prevention of unauthorised access to new dwellings. It was introduced in the Building Regulations &c. (Amendment) Regulations 2015 (SI 2015 No. 767). The amendment regulations came into force generally on 18 April 2015; however, Part Q did not come into force until 1 October 2015. It follows the lead of the Scottish Executive where security provisions have been part of the Scottish Building Regulations and Standards for a number of years.

Therefore, it does not apply to work started before 1 October 2015 or work subject to a building notice, full plans application or initial notice submitted before that date, provided that the work is started on-site before 1 October 2016.

It should be noted that Part Q applies to work on new domestic buildings in England. In Wales the situation is somewhat different. Here Part Q applies to building work carried out on *excepted energy buildings* as defined in the Welsh Ministers (Transfer of Functions) (No. 2) Order 2009.

An *excepted energy building* is a building that satisfies both the first and second conditions set out below.

The first condition is that the building falls within one of the following descriptions:

(a) A generating station whose construction, extension or operation requires or required the consent of the Secretary of State under section 36 of the Electricity Act 1989 or any ancillary development;
(b) A generating station whose construction or extension requires or required development consent;
(c) An electric line whose installation, or continued installation, above ground requires the consent of the Secretary of State under section 37 of the Electricity Act 1989 or any ancillary development;
(d) An electric line whose installation above ground requires or required development consent;
(e) A pipeline whose construction requires or required authorisation under section 1(1) of the Pipe-Lines Act 1962 or development consent; or

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

(f) A facility for the storage of gas underground in natural porous strata by a gas transporter or surface works or pipes associated with such a facility.

The second condition is that the building is not used, or not to be used, entirely as one or more of the following:

(a) A residence;
(b) A shop;
(c) An office;
(d) A showroom;
(e) A canteen; or
(f) An outbuilding ancillary to a building used, or to be used, entirely for one or more of the purposes set out in sub-paragraphs (a) to (e).

19.2 Interpretation

The following terms apply throughout Approved Document Q (AD Q):

DOORSET – A complete door assembly whether it be assembled on-site or delivered as a prefabricated completed assembly. It will consist of:

- the door frame,
- door leaf or leaves,
- essential hardware and
- any integral side panel or fanlight (but excluding *coupled assemblies* – see definition below).

WINDOW – Includes not only windows but also roof lights, roof windows and similar fixtures.

SECURE DOORSET – Means either:

- a doorset that is proven (see definition below) to resist physical attack by a casual or opportunistic burglar, or
- a bespoke doorset incorporating construction features that are proven (see definition below) to reduce crime.

SECURE WINDOW – Means either:

- a window that is proven (see definition below) to resist criminal attack, or
- a bespoke window incorporating construction features that are proven (see definition below) to reduce crime.

EASILY ACCESSIBLE – Means either:

- a window or doorway which has any part within 2 m vertically of an accessible level surface (e.g. ground or basement level, or and access balcony), or

- a window which is within 2 m vertically of a flat or sloping roof (i.e. pitched at less than 30°) that is not more than 3.5 m above ground level.

COUPLED ASSEMBLY – This term is used to describe a window and doorset supplied as separate self-contained frames which are fixed together on-site.

PROVEN – When referring to secure doorsets and secure windows, this means a product designed and constructed in accordance with a specification or design which has been shown by testing to be capable of meeting the required performance standard.

With regard to testing, further information can be obtained from Chapter 8 of this book where we discuss Approved Document 7. Please also note the following:

- Laboratories should have the necessary expertise to conduct the relevant tests and should be accredited by either the United Kingdom Accreditation Service (UKAS) or an equivalent European national accreditation body.
- Test evidence passed from one organisation to another can become unreliable if important details are lost, since even small differences in construction can significantly affect the performance of a doorset or window. Therefore, any test evidence used to confirm the security of a construction should be carefully checked to ensure that it demonstrates compliance that is adequate and that applies to the intended use.
- Schemes that certify compliance with PAS 24:2012 *Enhanced security performance requirements for doorsets and windows in the UK – External doorsets and windows intended to offer a level of security suitable for dwellings and other buildings exposed to comparable risk* (or other standards that offer similar or better performance) may be acceptable for demonstrating compliance. The UKAS website lists UKAS-accredited certification bodies. Reference can also be made to the publication *Secured by design, new homes 2014* (SBD 2014) published by the Association of Chief Police Officers (ACPO).

19.3 Requirement Q1: Unauthorised access

Q1 requires that reasonable provision must be made to resist unauthorised access to:

(a) any dwelling; and
(b) any part of a building from which access can be gained to a flat within the building.

Q1 applies only in relation to new dwellings.

19.4 Requirement Q1: Performance

The result of requirement Q1 is that it applies to easily accessible windows and doors that provide access in any of the following circumstances:

- Into a dwelling from outside;
- Into parts of a building containing flats from outside; or
- Into a flat from the common parts of the building.

Therefore, in the Secretary of State's view, doors and windows will have a sufficient standard of performance to meet requirement Q1 if they can resist physical attack by a casual or opportunist burglar by being both:

(a) sufficiently robust; and
(b) fitted with appropriate hardware.

19.5 Doors

19.5.1 General

All doorsets (including garage doorsets and communal entrance doorsets) that provide access into a dwelling or into a building containing a dwelling should be secure doorsets in accordance with sections 19.5.2 to 19.5.5. With regard to garages, it may be the case that there is no interconnecting doorset between the garage and the dwelling. In this case the garage doors do not need to be secure doorsets. Where there is an interconnecting doorset, then either the garage doorset (pedestrian or vehicular) or the interconnecting doorset should be a secure doorset.

19.5.2 Design of secure doorsets

Secure doorsets should be either:

(a) manufactured to a design that has been shown by test to meet the security requirements of British Standards publication PAS 24:2012; or
(b) designed and manufactured in accordance with Appendix B of AD Q, which is discussed in section 19.7.

Doorsets satisfying other standards that provide similar or better performance are also acceptable. These standards include the following specifications issued by the following technical approvals issuing bodies.

Certisecure: Warrington Certification Ltd

- Security Technical Specification (STS) 201 Issue 5:2013 – *Enhanced security requirements for doorsets to satisfy the requirements of PAS 24 (2013).*
- Security Technical Specification (STS) 202 Issue 3:2011 – *Requirements for burglary resistance of construction products including hinged, pivoted, folding or sliding doorsets, windows, curtain walling, security grilles, garage doors and shutters* – burglary rating BR2 (Classes BR1 and BR2 address the level of attack normally associated with casual or opportunist burglars).

The Loss Prevention Certification Board

- LPS 1175 Issue 7:2010 *Requirements and testing procedures for the LPCB approval and listing of intruder resistant building components, strongpoints, security enclosures and free-standing barriers* – security rating 2 (Products under this rating provide the minimum levels of recognised resistance to opportunist attempts at forced entry using a range of techniques including those that create noise such as those involving breaking glass).

- LPS 2081 Issue 1:2015 *Requirements and testing procedures for the LPCB approval and listing of building components, strongpoints, security enclosures and free-standing barriers offering resistance to intruders attempting to use stealth to gain entry* – security rating B.

See also section 2 of SBD 2014 for more advice.

19.5.3 Letter plates

Potentially, letter plates can provide a means of access to a door key if this has been left in the lock. Therefore, where provided they should:

- have an aperture size that does not exceed 260 mm × 40 mm; and
- be located and/or designed to hinder anyone attempting to remove keys by inserting a stick or their hand, for example, by incorporating a flap or other features to restrict access. The Door and Hardware Federation's (DHF) technical specification TS 008:2012 *Enhanced security and general requirements for letter plate assemblies and slide through boxes* gives details of letter plates that have been shown to protect against such attacks.

19.5.4 Door viewers and chains

The main entrance doors for a dwelling (usually the front door) should have a door viewer unless callers can be seen by other means. This could include clear glass panel within the door or a window next to the doorset.

The same doorset should also have a door chain or door limiter unless there are circumstances where this may not be appropriate, for example, where a warden may need emergency access to residents in sheltered housing. Alternative caller identification measures, such as electronic audiovisual door entry systems, can be used to identify visitors.

19.5.5 Installation and fixing of secure doorsets

Frames of doorsets should be mechanically fixed to the structure of the building in accordance with the manufacturer's installation instructions.

Often in blocks of flats, the wall in which the flat entrance doorset is located may be of a lightweight framed construction. Such a wall should incorporate a resilient layer to reduce the risk of anyone breaking through the wall and accessing the locking system.

The resilient layer should be timber sheathing (e.g. plywood) at least 9 mm thick, expanded metal or a similar resilient material. The resilient layer should be to the full height of the door and should extend 600 mm on either side of the doorset.

19.6 Windows

19.6.1 General

Ground floor, basement and other easily accessible windows (including easily accessible roof lights) should be secure windows in accordance with sections 19.6.2 and 19.6.3.

19.6.2 Design of secure windows

Windows should be made to a design that has been shown by a test to meet the security requirements of British Standards publication PAS 24:2012.

Windows satisfying other standards that provide similar or better performance are also acceptable. These standards include:

- STS 204 Issue 3:2012 *Enhanced security performance for windows to satisfy the requirements of PAS 24:2012*;
- LPS 1175 Issue 7:2010 security rating 1 (see section 19.5.2); and
- LPS 2081 Issue 1:2015 security rating A (see section 19.5.2).

See also section 2 of SBD 2014 for more advice.

19.6.3 Installation and fixing of secure windows

Frames should be mechanically fixed to the structure of the building in accordance with the manufacturer's installation instructions.

19.7 Bespoke timber secure doorsets

19.7.1 General

Appendix B of AD Q gives recommendations for the construction of timber doorsets so that they can be regarded as secure doorsets for the purposes of requirement Q1 under the definition given in section 19.2. It should be noted that the information in the appendix applies only to doors no larger than 1000 mm wide and 2000 mm high. For larger doorsets additional measures may be necessary and so are not covered by the Appendix B recommendations.

19.7.2 Material

The doorset should be manufactured from solid or laminated timber with a minimum density of 600 kg/m^3.

19.7.3 Dimensions

It is important that doors and frames should be sufficiently robust to resist forced entry. Therefore, door rails, stiles and muntins should be at least 44 mm thick, and after rebating, frame components should retain at least 32 mm of timber.

Additionally, any panel within the doorset should be at least 15 mm thick. The panel should be securely held in place. Beading should be mechanically fixed and glued in position.

So as not to present an accessible entry point should a panel be removed, the smaller dimension of each panel (i.e. either the width or the height) should not be greater than 230 mm.

19.7.4 Locks, hinges and letter plates

The main entry door to a dwelling (usually the front doorset) should be fitted with a multipoint locking system that meets the requirements of:

- PAS 3621:2011, Multipoint locking assemblies. Keyed egress. Performance requirements and test methods (i.e. a multipoint lock equivalent to BS 3621, utilising the same methodology, i.e. key operation from both sides);
- PAS 8621:2011, Multipoint locking assemblies. Keyless egress. Performance requirements and test methods (i.e. a multipoint lock equivalent to BS 8621, utilising the same methodology, i.e. key operation from the outside with non-key operation on the inside (thumb turn or similar)); and
- PAS 10621:2011, Multipoint locking assemblies. Dual mode egress. Performance requirements and test methods (i.e. a multipoint lock equivalent to BS 10621, utilising the same methodology, i.e. key operation from the outside with non-key operation on the inside but with an additional facility to deadlock the door from the outside using a deliberate secondary positive action). It should be noted that such locks must only be used on properties with an alternative means of escape.

If it is not practical or desirable to install a multipoint locking system, a mortice lock that conforms to one of the British Standards referred to above (i.e. BS 3621, BS 8621 or BS 10621) can be fitted instead, with a surface-mounted rim lock that conforms to the same standard.

The distance between the locking points for the mortice lock and surface-mounted rim lock should be 400–600 mm.

Non-primary doors for entering a dwelling (e.g. back door or garage interconnecting doors) should also be fitted with a multipoint locking system that meets the requirements referred to above (i.e. PAS 3621, PAS 8621 and PAS 10621).

Again, if it is not practical or desirable to install a multipoint locking system, a mortice lock that conforms with British Standard 3621, 8621 or 10621 can be fitted instead with two morticed bolts. The morticed bolts should be sited at least 100 mm from the top and bottom corners of the door, should have a minimum projection of 20 mm and should avoid any door construction joints.

Hinges accessible from outside should incorporate hinge bolts.

Letter plates, where provided, should comply with the recommendations given in section 19.5.3.

19.7.5 Door limitation and caller identification

The main entrance doors for a dwelling (usually the front door) should have a door viewer unless callers can be seen by other means. This could include clear glass panel within the door or a window next to the doorset.

The same doorset should also have a door chain or door limiter unless there are circumstances where this may not be appropriate, for example, where a warden may need emergency access to residents in sheltered housing. Alternative caller identification measures, such as electronic audiovisual door entry systems, can be used to identify visitors.

19.7.6 Glazing

Any glazing which, if broken, would permit someone to insert their hand and release the locking device on the inside of the door should be a minimum of class P1A in accordance with BS EN 356:2000. (Class P1A is the lowest resistance level in the standard and has a minimum thickness of 6.8 mm. It is tested by dropping a 100 mm steel ball (4.11 kg) from various heights. To pass the test the ball must not penetrate the glass.) Double- or triple-glazed units need to incorporate only one pane of c1ass P1A glass.

Index

absorption area, 10.75
absorption coefficient, 10.73
access
  fire service, 7.28
  maintenance, 15.2, 15.6.5, 15.7, 15.9, 15.11
  safe access for cleaning surfaces, 15.17
  in use, 15.1
access points, 13.28
  construction, 13.32–13.34
  sanitary pipework, 13.15
  siting and spacing, 13.31–13.32
access routes, 17.2, 17.5.2
  hazards, 17.5.1
  indoor access (*see* chapter 15)
  sources of further guidance, 17.8
  steps, stairs, 17.1.1, 17.2, 17.4.2, 17.5.1, 17.5.4
Access Strategy, 17.1.5
  access statement, 17.1.4, 17.1.5
  alternative proposal, accessibility issues, 17.1.5, 17.5.2
  concept of, 17.1.4, 17.1.5
  developing access strategies, 17.1.5
  guidance, 17.1.5
  Part M application stage, 17.1.5
  use of guidance, 17.1
access to and use of buildings, Chapter 17
accommodation stair, 7.7
acoustic ceiling tiles, 10.77
aggregate notional areas, 7.25.6 (fig. 7.58)
agricultural buildings, 2.17
airborne sound insulation, 10.5, 10.89
air conditioning services, 7.15.8
air permeability, 11.2, 16.2, 16.4, 16.7, 16.33
air supply, combustion appliances, 14.13
air tightness, 11.2
alterations and extensions, 17.1.1, 17.1.2, 17.1.5, 17.3.2
    see also material alteration
alternative approaches, 15.10
alternative escape routes, 7.7, 7.8.1, 7.14.2, 7.21.3, (Fig. 7.22)
alternative exits, 7.13.4
aluminium, 6.5
amendment notice, 2.10
anchors, cladding panels, 6.49
ancillary buildings, 2.17
annexes, external walls, 6.40
appeals
  notice of contravention, 2.31
  relaxation of requirements, 2.26–2.27
  to Secretary of State, 1.10, 2.27
appliance
  chamber, prefabricated, 14.9
  combustion, 14.4
  compartment, 14.3
  flueless, 14.7
appliance ventilation ducts, 7.20.2, 7.22.3
application, relaxation of requirements, 2.26–2.27
approaches, 17.5.1
  building (other than dwellings), 17.1, 17.5
  buildings (dwellings), 17.1, 17.3.1
  optional/enhanced requirements, 17.2, 17.4
approval by stages, 1.9
approval, designated bodies, 4.5
Approved Document K (AD K), chapter 15
Approved Document M (AD M)
  alterations and extensions, 17.1.1, 17.1.2, 17.1.5, 17.3.2
  2015 edition brief, 17.1
    volume 2-buildings other than dwellings, 17.5
    volume 1-dwellings, 17.4
  interpretation, buildings to which rules apply, 17.1
  revisions, context, 17.1
approved document, status and use, 1.1, 1.4–1.5, 1.8, 2.6–2.10
approved inspectors, 1.2, 1.3, 1.5, 1.7, 2.10, 3.1, 4.1–4.21
  functions of, 4.16–4.19
  independence, 4.9
  relaxations, 2.26
area, buildings, 7.4

The Building Regulations: Explained and Illustrated, Fourteenth Edition. M.J. Billington, S.P. Barnshaw, K.T. Bright and A. Crooks.

area of ventilator, 11.14
as-built drawings, 7.30.5
assembly buildings, 7.16.5
Association of Consultant Approved Inspectors, 4.2
atria, 7.7, 7.19.3, 7.20.2
audience/spectator seating, 17.5.5
authorised officer, 2.28
automatic control of ventilator, 11.24
avoiding projecting parts, 15.14.1

background ventilator, 11.4, 11.13
balanced compartment, 14.3
balanced-flued appliances, 14.3
balconies, 7.12.1, 7.12.2, 7.13.2, 7.13.5
basement for dwellings, 11.2
basement stairs, fire precautions, 7.14.9
basement storey, 7.2
  smoke and heat venting, 7.28.14. 7.28.15
bathrooms, 11.3 *see also* sanitary accommodation
bedrooms/sleeping accommodation, 17.5.5
below ground foul drainage, 13.19–13.38
Bespoke timber secure doorsets, 19.6
binders, ceiling joists, 6.11, 6.52
blister patterns (tactile paving), 17.5.1
blocks, 6.13, 6.21
  dimensions, 6.21
  walls, 6.20–6.21
boarding houses, 2.14, 2.16
boundaries, 7.2, 7.25.4–7.25.6
boundary, defined, 7.2
branch pipes, 13.5
  discharge, 13.5, 13.11–13.13
  ventilating, 13.6, 13.11–13.13
breach of statutory duties, 1.10
bricks, 6.21
  dimensions, 6.21
British Standards Institution (BSI), 5.4
builders, requirements, 2.24
building
  classes, 16.5
  control body, 18.8
  defined, 1.2, 2.10
  design requirements, 6.14–6.17
  emission rate (BER), 16.2, 16.61
  erection or extension, 2.10
  exempt, 2.5, 2.17–2.19
  notice, 2.2, 3.1–3.4
    defined, 2.10
  proportions, 6.16
  regulations, 1.4–1.5
    application, 2.19–2.24
    compliance certificate, 18.9
    continuing requirements, 2.28
    definitions, 2.10–2.17
    division, 2.1
    exemptions, 1.6–1.7
    relaxation of requirements, 2.26–2.28
    requirements, 2.24–2.25
  on top of drain or sewer, 13.66–13.69
  work
    control of, 2.2
    defined, 2.10
    testing, 2.3, 2.28
    unauthorised, 2.30–2.31
  works, contravening, 2.31–2.32
Building Act 1984, 1.2
  exemptions, 1.7–1.9
building emission rate (BER), 16.2, 16.61
  accessible and adaptable dwellings, category, 2, 3, 17.4
  buildings (dwellings), 17.4
    access/facilities, definitions, 17.2
  buildings (other than dwellings)
    access (around building), 17.5
    access (routes), 17.5.1
    access (to building), 17.5.2
    approaches, 17.5.1
    car-parking and setting down, 17.5.1
    facilities, 17.5
    indoor access, 17.5.1
    ramped provisions, 17.5.1
    sanitary accommodation, 17.5.6
  definitions, 17.2
  provisions, 17.4
  visitable dwellings, category, 1, 17.4.2
  wheelchair user dwellings, category, 3, 17.4.4
Building Engineering Services Competence Assessment Ltd (BESCA), 5.8
Building (Approved Inspectors, etc.) Regulations 2010, 1.2, 4.1, 4.21–4.22
butterfly ties, 10.16
buttressing walls, 6.26–6.28
  defined, 6.8

cables, electrical, 18.1, 18.4, 18.9
calculation of mass, 10.86
calculation tools for dwellings, 16.31
Canopy structures, 7.25.7
Caravan Sites Act 1968, 1.2
Caravan Sites and Control of Development Act 1960, 1.2
car-parking and setting down, 17.11
car parks, PG 7(b), 7.26, 7.28.18
cavities
  interruption, 7.21
  subdivision, 7.21.3–7.21.4
cavity barriers, 7.2
  construction, 7.20.3, 7.21
cavity masonry separating wall, 10.17, 10.18, 10.23, 10.26, 10.43

cavity wall insulation, 2.11, 8.47–8.52, 9.1
cavity walls, 6.39–6.40
  external, 8.47
cavity width, defined, 6.8
ceiling joists, 6.11, 6.13
ceilings, 7.2 *see also* suspended ceilings, fire protection
  construction, 7.215, 10.39
  fire resisting, 7.19.2, 7.21, 7.21.4
  flame spread classification, 7.17.6
cellar *see* basement for dwellings
CE mark, 8.2–8.4, 8.6–8.7
cement, high alumina, 8.7
Certass, 4.8, 5.4, 5.5, 5.10
certificates
  completion, 3.6–3.9
  final, 4.20
  plans, 4.19
  public bodies, 4.22
certification by a registered third party, 18.8
certification, private *see* private certification
Certisecure, 19.4
cesspools, 13.49–13.51
  maintenance, 13.50
change of use *see* material change of use
change to a building's energy status, 16.11
chases, 6.30–6.31
chimneys, 6.30, 6.42, 6.44, 14.4, 14.12, 14.24, 14.58–14.60
  combustible material, proximity to, 14.47
cladding
  external, 6.2, 6.48–6.51, 7.171, 8.44–8.45, 8.49–8.53
  panels
    concrete, 6.48
    glass, 6.50
Class 0 materials, 7.115
Clean Air Acts 1956–1993, 14.2
clear spans, 6.9
closable opening, 11.2
closets *see* water closets
collapse, 6.1, 6.52–6.55
collision with open windows, skylights or ventilators, protection from, 15.14
combustibility, 7.15.3, 7.17.5, 7.25.1
combustion appliances and fuel storage systems, 2.4
  air supply, 14.13
  balanced-flued or room-sealed, 14.3
  Clean Air Acts 1956–1993, 14.2
  discharge, products of combustion, 14.22–14.46
  protection of the building, 14.47
commissioning and operation of building services, 16.3, 16.19, 16.44–16.56
commissioning, operating and maintenance, heating and hot water systems, 2.3
common balcony, 7.29
common escape routes, 7.13.5, 7.14.2
common rafters, 6.10–6.11, 6.52
common spaces, 11.3
common stairs, 7.13.5
communication aids, 17.5.5
compartment, 7.19.1, 7.19.3, 7.20
  floors, 7.3.1, 7.3.2, 7.15.1, 7.16.3
  volume limits, 7.19.3
  walls, 7.3.1, 7.3.2, 7.14.8, 7.16.1, 7.16.3
compartmentation, 7.19.3
competent person, 4.8, 5.1–5.16
  scheme, 4.8, 5.1
completion certificate, 3.8
composite steel and concrete construction, 6.7, 6.54
concealed space, 7.2., 7.21
concrete
  beam with infilling block floor, 10.22
  ground floor, 10.35
  plank floor, 10.22
  prestressed, 6.5
  strip foundations, 6.44–6.47
  structural work, 6.5
  suspended floors, 8.26, 8.33, 8.40
condensate
  from boilers, 13.14–13.15
  in flues, 14.24
condensation
  interstitial, 8.32, 8.35, 8.41, 8.43, 8.52, 8.55, 8.57–8.58
  in roofs, 8.57–8.60
  surface, 8.33, 8.35–8.36, 8.41, 8.43, 8.56–8.57, 8.61
consequential improvements, 16.16
conservation, fuel and power *see* fuel and power conservation
conservatories and substantially glazed spaces, 11.39, 16.3, 16.10, 16.22, 16.29, 16.52
conservatory, 2.18–2.19
constructional hearths, 14.47
Construction Products Directive (CPD), 8.3
Construction Products Regulations 2011, 8.1–8.4, 8.6
The Construction (Design & Management) Regulations 2015, 7.6.4
consultation, 2.2, 3.6, 4.18–4.19
containment, 15.15
contaminants, 8.9–8.11, 8.13–8.32
contaminated runoff, 13.62
continuing requirements, 1.10, 2.28
continuity of insulation, 16, 16.42, 16.76, 122
continuous operation, 11.3
contravening works, 2.31–2.32
contravention, notice of, 4.15
controlled services and fittings, 2.10–2.11
controls for ventilation devices, 11.24
conversion of roof space, 7.12.10, 7.23, 15.6.7, 15.6.9, 15.8

co-ordinating area, 10.86
'corduroy' tactile warning surfaces, 17.5.1
corridor, 7.2, 7.13.5, 7.14, 10.36, 10.55, 10.67, 10.73
  access, 7.2
  width, 17.4
Council for Registered Gas Installers (CORGI), 5.7
coupled assembly, 19.3
cracking, external walls, 8.44, 8.53
Crown building, 1.6
Crown immunity, 1.6

damage, defined, 1.11
dangerous and offensive substances, 8.11–8.23
dangerous structures, 1.10–1.12
dark smoke, 14.2
datum line, 7.25.6
dead ends, 7.2, 7.7, 7.8.2
decibel, 10.90
decorative fuel effect fire, 14.4
definitions, regulations, 2.11–2.17
deflection, 6.1
deformation, 6.1
demolition, 1.11–1.12
deposit of plans, 2.2–2.6, 3.1, 3.4–3.6
design
  requirements, buildings, 6.14–6.20
  wind speed, 6.14–6.20
design air permeability, 16.2
designated bodies, approval of inspectors, 4.2
designation system, 14.5
detached buildings, 2.17–2.18
detention ponds, 13.65
direct distance, 7.7, 7.14.2, 7.16.8
direct transmission, 10.4
disabled people, access, 17.1, 17.2 *see also* access to and use of buildings
discharge pipes, 12.19
discharge, products of combustion, 14.1, 14.23–14.46
discharge stacks, 13.5, 13.14–13, 17
display lighting, 16.4
display window, 16.4
disproportionate collapse, 2.4, 2.7, 6.52–6.56
doors, 10.36, 10.55, 10.67
  door and gate safety, 15.19.1
  fire, 7.20.3, Table B1
  glass doors, 17.5.1, 17.5.3
  hazards, 17.5.1
  internal, 17.4, 17.5.3, 17.5.5
  limitation and caller identification, 19.8
  lobbies, 17.4.3, 17.5.2, 17.5.3
    means of escape (*see* final exits)
  opening/closing forces, 17.5.2
  powered entrance doors, 17.5.2
  Protected shafts, 7.2, 7.15.1, 7.15.7, 7.20.4
  revolving doors, 17.5.2
  safe use of, 15.19
  thresholds, 8.59–8.60
  viewers and chains, 19.5
  vision panels, 17.5.2
  width, 17.4.2–17.4.5, 17.5.1–17.5.3
doorset, 10.62, 19.2
  secure, 19.2
    bespoke timber, 19.6
    installation and fixing, 19.5
double triangle ties, 10.16
drainage, 1.2–1.5, 1.8, 2.4, 2.8, 13.4–13.5
  alterations and discontinued use, 13.1–13.4
  blockages, 13.22
  buildings in combination, 1.4
  cesspools, septic tanks and settlement tanks, 3.38–13.51
  condensate from boilers, 13.14–13.15
  construction over drains, 13.66–13.69
  foul, 12.4, 13.4
    above ground, 13.5–13.19
    below ground, 13.19–13.38
  infiltration, 13.63–13.64
  layout, 13.22
  paved areas, 13.57–13.60
  pumping installations, 13.37–13.38
  rainwater, 13.52–13.57
  sanitary pipework and drainage, 13.4–13.5
    above ground foul drainage, 13.5–13.19
    access points, 13.15
    alternative method of design, 13.18–13.19
    branch discharge pipes, 13.5, 13.11–13.14
    discharge stacks, 13.5, 13.14–13, 17
    dry ventilating stacks, 13.16
    fire safety, 7.22
    flexible pipes, 13.25
    materials for above ground drainage systems, 13.17–13.18
    pipe sizes, 13.7–13.10
    rigid pipes, 13.23–13.25
    rodent control, 13.36–13.37
    separate systems, 13.70–13.72
    special protection for drains adjacent to or under buildings, 13.34–13.35
    special protection to pipes, 13.25–13.26
    stub stacks, 13.6, 13.16
    surcharging, 13.35–13.36
    test for airtightness, 13.18
    test for watertightness, 13.33–13.34
    trap water seals, 13.7–13.10
  soakaways, 13.63–13.64
  subsoil, 8.32–8.33
  testing, 13.18

draught, 14.5
break, 14.5
diverter, 14.5
stabiliser, 14.5
drylining, 10.15
dwelling, 10.89
defined, 2.11, 7.2
dwelling emission rate (DER), 16.4, 16.31
dwelling fabric energy efficiency rate (DFEE), 16.4, 16.29, 16.30, 16.34–16.47, 16.80
dwellinghouse, 2.11
defined, 2.11
means of escape, 7.10.1, 7.12
dynamic stiffness, 10.84

easily accessible, 19.2
eaves, strapping, 6.32
educational buildings, 7.3.2, 7.16.6
Education (School Premises) Regulations 1999, 1.7
Education (Schools and Further and Higher Education) Regulations 1989, 1.7
Education (Schools and Higher and Further Education) (Amendment) (Wales) Regulations 2001, 1.7
electrical installation, 2.11, 18.3–18.4, 18.9
appliances, 17.4.2, 17.5.5
sockets/switches, 17.4.2
work on existing, 18.4
electrical safety, 2.5, 2.9, 18.1–18.9
application, 18.4–18.6
certification, 18.6–18.8
design and installation, 18.3–18.4
inspection and testing, 18.6–18.7
interpretation, 18.8–18.9
elements of structure, 7.2
fire resistance, 7.19
emergency escape lighting, 16.5
emergency lighting, 7.2, 7.7, 7.15.6
enclosing rectangles, 7.25.6
enclosures, pipes, 7.22.1
energy efficiency requirements, 2.11, 16.6, 16.10
energy meters, 16.70
energy performance certificate (EPC), 2.11, 16.6
Energy Performance of Buildings Directive, 16.1
energy status, change of, 2.11
entrance hall, 10.67
entrances doors, 17.4.2
lobbies, 17.4.3, 17.5.2, 17.5.3
not segregated facility, 17.5.2, 17.5.5
powered, 17.5.2
environmental protection, 7.6.5
Environmental Protection Act 1990, 13.73
Equality Act 2010, 17.12
equipotential bonding arrangements, 18.4
equivalent area of ventilation opening, 11.3
erection buildings, 2.10, 2.18
escape corridors, 7.14.2
escape lighting, 7.2, 7.7, 7.15.6
escape routes, 7.2, 7.7, 7.8.1
glazing, 7.17.4, 7.17.7, 7.20.3
escape stairs, 7.9, 7.14.5–7.14.10, 7.15.3, 7.15.4
Essential Requirements (ERs), 8.3
European Standards, 8.3
European technical approval, 8.5–8.7
evacuation lift, 7.15.7
exempt buildings, 2.2, 2.5, 2.17–2.19
exemptions, regulations, 1.7–1.9
extensions, 2.20
external cavity wall, starting 10.15 and throughout, Chapter 10
external cladding, 6.2, 6.48–6.51, 7.25.1–7.25.2, 8.44–8.45, 8.49–8.53
external escape stair, 7.13.6, 7.14.10
external fire spread, 2.4, 7.24
external walls, 6.9, 6.38, 6.40–6.42, 7.25
cladding, 6.2, 6.48–6.51, 8.44–8.45, 8.49–8.53
constructional requirements, 7.25.1
fire resistance, 7.25.1
openings, 7.25.3–7.25.6
weather resistance, 8.44–8.45, 8.49–8.53
extract ventilation, 11.3
extra-low voltage, 2.11, 18.9

facilities, 17.1
audience/spectator, 17.5.5
lectures/conference, 17.5.5
restaurant/bar/refreshment, 17.5.5
sleeping accommodation, 17.5.5
factories, 7.3.2, 7.14.2, 7.29
factor 'X,' 6.30
factory-made metal chimneys, 14.56
failure of tests, 10.13
Fenestration Self-Assessment Scheme (FENSA), 5.2, 5.4
filter drains, 13.65
final certificate, 4.20–4.21
final exits, 7.30
fire, Chapter 7
alarms, detection, 7.10
authorities, 4.10, 4.18, 7.1
brigade access to, 7.28
car parks, PG 7(b), 7.26, 7.28.18
compartmentation, 7.19.3
concealed spaces, 7.2., 7.21
decorative fuel effective, 14.4
doors, 7.20.3, Table B1
firefighting shafts, 7.28
hazards, 7.30.4
hazard, special, 7.2, 7.5.2
hydrants, 7.28.7

fire, Chapter 7 (*cont'd*)
inclusive design, 7.8.5
inset live fuel effect, 14.8
insulating core panels, 7.29
introduction, 7.1
mains, 7.28.5–7.28.5, 7.28.13
means of warning and escape, 7.8
assembly buildings, 7.16.5
building other than dwellinghouses, flats and maisonettes, 7.13
dwellinghouses, 7.10.1, 7.11
flats and maisonettes, 7.13
health care premises, 7.1.1, 7.16.2
hospitals, 7.1.1, 7.10.1, 7.14.2, 7.16.2, 7.19.3
residential care homes, 7.10.1, 7.16.3
schools and other educational buildings, 7.16.6
sheltered housing, 7.16.4
shops and shopping complexes, 7.16.7
small premises, 7.16.8
mechanical ventilation and air-conditioning services, 7.15.8
pathways, 7.12.1
precautions, 7.1.1, 7.30.5
garages, 7.19.3
high buildings, 7.14.7
protection, 7.20
suspended ceilings, 7.17.6
radiant convector gas, 14.9
refuse chutes and storage, 7.15.10
resistance, 7.2
ceilings, 7.19.2, 7.21, 7.21.4
common elements, 7.19.2
doors, 7.20.3, Table B1
elements of structure, 7.2
periods of, 7.19.1
security, 7.8.4
firefighting
access for, 7.28.9
appliance access, 7.28.4
facilities, 7.28
lobbies, lifts, 7.28.2
shafts, 7.28.10–7.28.12
vehicle access routes, 7.28.8
shopping complexes, 7.16.7
smoke outlets, 7.28.15
space separation, 7.25.3
canopy structures, 7.25.7
roofs, 7.25.9
unprotected areas, 7.25.3–7.25.6
spread
external, 7.24
internal, 7.17
stops, 7.22
thermoplastic materials, 7.17.7
varying the provisions
conversion to flats, 7.23.3
dwellinghouses, 7.23.2
raised storage areas, 7.23.1
Wales, 7.1.2
wall, 7.25, 14.75
walls and ceilings, 7.25
fire escapes, 17.5.3, 17.5.4, 17.6
fireplace
opening
calculating size, 14.33
dry lining round, 14.30
recess, 14.6, 14.50
fit-out work, 16.6
fittings
controlled, 2, 10–2.11
defined, 2.11
fixed building services, 2.12, 16.6
fixings, cladding panels, 6.50
flame spread
inhibiting, 7.11
internal surfaces, 7.17.2–7.17.4
roofs, 7.25.9
walls and ceilings, 7.16.7
flanking laboratory, 10.85
flanking transmission, 10.13
flat, defined, 2.12
flat roofs
loading, 6.10
means of escape, 7.13.4, 7.14.4
flats
common access stairs, 17.1.2, 17.2
conversion to, fire safety, 7.23.3
general access stair, 15.4, 15.5.2, 15.6.4, 15.6.6
lifts, 17.4, 17.4.2–17.4.5, 17.5.4
floating floor, 10.37, 10.67
floating layer, 10.39, 10.44, 10.49
floor area
defined, 2.13, 7.4
means of escape, 7.9.1
floorboards, 6.11
floor, defined, 8.34
floor joists, 6.10–6.12
floor lateral support, 6.32
floors
compartment, 7.3.1, 7.3.2, 7.15.1, 7.16.3
fire resistance, 7.104–7.113
ground support, 8.36–8.38
protection against moisture, 8.36–8.37
suspended
concrete, 8.40–8.41
timber, 8.38–8.40
floor spans, 6.26
floor treatment 1, 10.55

floor treatment 2, 10.58
flue
  balanced, 14.3
  box, 14.7
  for gas appliances, 14.36
  inspection and testing, 14.29
  liners, 14.24
  for oil-burning appliances, 14.41
  outlet, 14.7, 14.33, 14.38, 14.42
  pipe, 14.7
    plastic, 14.26
  size, 14.30, 14.37, 14.41
  for solid fuel appliances, 14.31
flueblock chimney, 14.7, 14.25, 14.41, 14.46, 14.53
flues, 7.22, 7.22.3, 14.63
  existing, repair and re-use, 14.63
  relining, 14.63
  testing, 14.29, 14.65–14.69
forms, prescribed, 4.21
foul drainage
  above ground, 13.5–13.19
  below ground, 13.19–13.38
foul water, 13.5
  outfall, 13.5
foundations, 6.3, 6.42–6.47
  drains passing through, 13.34–13.36
  ground movement, 6.3
  trench fill, 6.46–6.47
framed with absorbent material separating wall, 10.44–10.49
free area of ventilator, 11.3
frequency, 10.89
fronting, 3.3
fuel and power conservation, 2.5, 2.9
  insertion of insulating material into a cavity, 2.11, 2.21
fuel factor, 16.34
full plans *see* plans

gallery, 7.2, 7.12.2
garages, fire precautions, 7.19.3
gas appliances
  air supply, 14.19
  flues, 14.36
  hearths, 14.56
gas, landfill, 8.26–8.32
Gas Safety (Installation and Use) Regulations 1998, 14.29
glazing, safety, 15.13
  safe access for cleaning, 15.17
  safe use, 15.16
  security, 19.8
grade, timber, 6.9–6.10
gradients for foul drains, 13.26–13.28
greenhouses, 2.17
greywater recovery systems, 13.17–13.18
  storage tanks, 13.51
gross internal volume, 11.3
ground
  conditions and percolation, 13.43–13.44
  contamination, 8.11–8.23
  movement, 2.4, 6.3
  water, 8.33–8.35
guarding, 2.9, 15.4, 15.8, 15.11, 15.12.2
guards, 15.1, 15.4, 15.8, 15.11, 15.12.2
  gullies, 13.11, 13.13
gutters, 13.53–13.55

habitable rooms, 7.2, 7.10, 7.13, 7.23.2, 11.3
hallway, 10.12, 10.73
handrails, 15.5.2
  to steps and ramps, 15.5.2, 15.7
harmonised standard, 8.2
hazards
  on access routes, 17.5.1
  corduroy tactile warnings, 17.5.1
headroom, 15.6
Health and Safety at Work Act 1974, 7.8
health care premises, 7.1.1, 7.16.2
hearth, 14.7
  gas (*see* gas)
  oil (*see* oil)
  protection of building against fire and heat, 14.47
  solid fuel (*see* solid fuel)
Heating Equipment Testing and Approval Scheme (HETAS), 5.3–5.5
height
  building, 7.4
  defined, 2.13
  disproportionate collapse, 6.52–6.56
  limits, 6.14–6.15
  walls, 6.21
helical stairs, 15.6.8
high alumina cement, 8.7
high-usage entrance door, 16.6
historic buildings, 11.3, 16.23
holes, floor and roof joists, 6.11–6.12
hotel, 2.8, 2.14, 2.16, 2.22–2.23
hotel/motel, bedrooms/sleeping accommodation, 17.1.1, 17.2, 17.3, 17.5.5, 17.5.6
hot water storage, 12.4, 12.15
House Longhorn Beetle infestation, 6.13
houses in multiple occupation, 7.6.2
Housing Act 2004, 7.6.2
hygiene
  sanitary conveniences and washing facilities, 12.2, 12.24

impact sound insulation, 10.5, 10.89
impact sound pressure level, 10.90
imposed loads, 6.2–6.4, 6.8, 6.10–6.12, 6.14–6.15
  snow, 6.4–6.5, 6.8, 6.11
independent access, 2.13
indoor access *see* chapter 15
infiltration, 11.3
infiltration basins, 13.65
information, provision of, combustion appliances, 14.69
initial notice, 4.10–4.16
  cancellation, 4.15–4.16
  private certification, 4.1–4.21
inland freshwaters, 14.78
Inner London, 3.1, 3.2
inner room, 7.2, 7.12.2, 7.14.3
inspectors, approved *see* approved inspectors
institutional buildings, 7.8, 7.10.2, 7.14, 7.21.3, 7.21.4
institution, defined, 2.13
insulating core panels, 7.29
insulation *see* fuel and power conservation
insurance schemes, private certification, 4.1–4.4
intermittent operation of ventilator, 11.3
internal concrete floor, 10.22, 10.23, 10.27, 10.32, 10.35
internal diameters, pipes, 7.22.1
  fire resistance, 7.19
interruption, lateral support, 6.35
interstitial condensation, 8.32, 8.35, 8.41, 8.43, 8.52, 8.55, 8.57–8.58

joints, between walls and door or window frames, 8.54–8.55
joists *see also* ceiling joists; floor joists; roofs
  strutting, 6.12–6.13
junctions, compartment walls and floors, 7.20, 7.21.1, 7.21.5, 7.22.4

key elements, 6.53
kitchens, 17.4.2, 17.5.5, 18.5

ladders, 7.8.3, 7.13.1, 7.15.4, 7.28.8, 15.2, 15.6.6, 15.9, 15.17
landfill gas, 8.26–8.32
landings, 15.5.1, 15.8
large extension, 16.7
lateral support, 6.8–6.9, 6.21–6.22
lateral thrust, 6.26
Legionella, 11.29
legislation, local, building control, 4.12
legislative control, 7.11
length, walls, 6.20–6.21, 6.25–6.26, 6.31–6.35
letter plates, 19.5
level difference, 10.90
lifting platform, 17.5.4
lifts, 7.8.3, 7.12.9, 7.15.7 7.15.9, 7.16, 7.28.10
  AD M, 17.10, 17.14, 17.36, 17.38–17.39
  stairlifts, 17.39
lighting
  buildings other than dwellings, 16.64
  diffusers, 7.17.7
  dwellings, 16.34
  emergency, 7.9
limitation on requirements, 2.2
limited combustibility materials, 7.17.2
linked powers, 1.3–1.4, 4.11
liquid fuel storage systems, 14.72
liquified petroleum gas installations, 14.74–14.77
loading, 2.4, 6.2–6.4
  bays, 15.12.2
  walls, 6.14
lobbies
  entrance, 17.5.2
  internal, 17.5.3
Local Acts of Parliament, 3.3, 4.12
  Fire precautions, 7.1.3, 7.28.1
local authorities
  building control, 1.2, 3.1–3.8
  contravening works, 2.31–2.32
  final certificates, rejection, 4.20
  plans certificates, rejection, 4.19
  rejection of initial notice, 4.13
  relaxation of requirements, 2.26–2.28
  statutory public health functions, 1.3
  testing building work, 2.3, 2.28
local legislation, building control, 3.3, 4.12
locks, hinges and letterplates, 19.7
loft apartment, 10.12
loft conversions, 15.6.7, 15.6.9, 15.8
  fire precautions, 7.12.10, 7.23.2
London Building Acts, 3.1
Loss Prevention Certification Board, 19.4
low and zero carbon energy, 16.31, 16.95
low voltage, 2.13, 18.9

maisonettes, 7.13, 7.14
manifestation, 15.13, 15.15
mansard roofs, 7.4
manual control of ventilator, 11.3
masonry, 6.6, 6.9, 6.14, 6.21–6.23
mass per unit area, 10.15, 10.86
material alteration, 2.13, 2.20–2.21
  defined, 2.13
material change of use, 1.5, 2.13, 2.21–2.23, 4.15
  defined, 2.13
  requirements, 2.21–2.23
materials, 2.2, 2.8–2.9, 2.25, 7.8, 7.15.3, 7.17.3, 7.17.5, 8.1–8.3

access points, 13.32–13.33
combustibility, 7.15.3
drainage system, above ground, 13.17–13.18
drainage system, below ground, 13.28–13.29
fitness, 8.5–8.7
influence of European standards, 8.2–8.5
inhibiting flame spread, 7.15.3, 7.21.4
insulating (*see* fuel and power conservation)
limiting combustibility, 7.17.2, 7.17.5
sanitary pipework, 13.4
short-lived, 1.9–1.10, 8.6–8.7
suitability, 1.9–1.10
walls, 6.13, 6.20–6.21
means of access, 17.1
means of escape, 7.12–7.16.8 *see also* fire, means of warning and escape
commercial buildings, 7.14
means of warning, 7.5
measurement rules, 2.14, 6.22–6.24, 7.4
mechanical ventilation, 11.3, 11.24
metal joist, 10.63, 10.65
Metropolitan Police Authority, 1.7, 2.2
minor works, 4.8–4.9
mist systems, 7.11.2, 7.12.10
mixed-mode ventilation, 11.3
mixed use buildings, 7.13.6, 7.14.2, 7.14.3, 7.14.7
moisture, defined, 8.35
moisture, resistance to, 2.4, 2.8, 8.33–8.51
monopitch roofs, 7.4
mortar, 6.21, 6.23, 6.25
mould growth, 8.56–8.57, 8.61

NAPIT, 5.3–5.5
national calculation method (NCM), 16.7
National Health Service and Community Care Act 1990, 1.6
National House Building Council
building control service, 3.1
National Rivers Authority, 1.9
natural ventilation, 11.3
NICEIC, 5.3–5.5
non-combustibility
compartment walls and floors, 7.2
materials, 7.17.5, 7.22.1, 7.25.9
non-notifiable work, 18.6
non-notification, 5.12
non-residential purpose groups, 7.3
notches, floor and roof joists, 6.11–6.12
notices
approval or rejection of plans, 3.4–3.7
cancellation of initial notice, 4.15
commencement and completion, 2.2
of contravention, 2.26–2.27, 4.15
initial, 4.10–4.16
to local authorities, 3.1–3.8
public bodies, 4.21
notifiable work, 18.5
notional boundaries, 7.2, 7.25.4

occupancy, occupant capacity, 7.3
occupiable room, 11.3
octave, 10.74
oil-burning appliances
air supply, 14.21
flues, 14.41
hearths, 14.60
Oil Firing Technical Association Limited (OFTEC), 5.9
oil separators, 13.62–13.63
oil storage tanks, 14.72–14.73
openings, 6.20, 6.26–6.27, 6.29–6.30
cavity barriers, 7.15.3, 7.21
compartment walls and floors, 7.21
external walls, 7.1.2
open spatial planning, 7.14.3, 7.14.7
overhanging, walls, 6.31

parapets, 6.40
parking and setting down, 17.5.1
Part N *see* Approved Document K (AD K)
passive stack ventilation (PSV), 11.16
paved areas, 13.57–13.60, 17.5.1
design of freedraining surfaces, 13.58–13.59
paving connected to drainage system, 13.59–13.60
pervious paving, 13.59
width and passing places, 17.5.1, 17.5.3
percolation, 13.43–13, 45
performance-based ventilation, 11.30
permanent ventilation opening, 11.39
piers, 6.9, 6.25–6.28
pipes, 7.22
branch
discharge, 13.5, 13.14–13, 16
ventilating, 13.6, 13.11–13.12
flexible, 13.25
flue (*see* flue, pipes)
protection for, 13.25–13.26
rainwater, 13.52–13.67
rigid, 13.23–13.25
sizes and gradients, 13.7, 13.26–13.28
stack, 12.20, 13.5, 13.8
trap and branch, 12.23
pipework, sanitary, 13.4–13.5
airtightness, test for, 13.18
materials for, 13.17–13.18
watertightness, test for, 13.33
plans, 2.2, 2.13, 3.4–3.7
approval by stages, 1.9
certificate, 4.19

plasterboard, 10.15
plastic materials, 7.17.7
platform floor, 7.8
pollution
  oil pollution, protection against, 14.78–14.79
  watercourses and groundwater, 13.4
Post Office, 1.9
power *see* fuel and power conservation
precipitation, 8.33
pre-completion testing, 10.2, 10.9
prescribed forms, 4.1, 4.10, 4.13, 4.15, 4.19–4.21
pressure tests, 16.43, 16.76
pressurisation, 7.13.5, 7.14.7, 7.20.3, 7.20.4
prestressed concrete, 6.5
principal entrance, defined, 7.2
principal works, 16.3, 16.8
private certification, 1.2, 3.1, 4.1–4.21
  function of approved inspectors, 4.16–4.19
  initial notice, 4.10–4.16
    cancellation, 4.15
products of combustion, discharge, 14.23
progressive horizontal evacuation, 7.16.3
projecting parts, avoiding, 15.14.1
protected circuits, 7.15.9
protected corridor/lobby, 7.2, 7.7, 7.8.1, 7.13.5, 7.14.2, 7.14.7, 7.19, 7.20.3, 7.28.1
protected entrance hall/landing, 7.2, 7.7, 7.13.3–7.13.5, 7.20.3
protected shafts, 7.2, 7.14.8, 7.15.1, 7.15.7, 7.19.3, 7.20.4
protected stairways, 7.14.8
protection
  from falling, collision and impact, 15.11, 15.14
  against impact (with glazing), 15.13
proven, 19.3
provision of information, fire precautions, 7.1.1, 7.8, 7.30
public bodies, self-certification, 4.1, 4.9, 4.21
public buildings, defined, 2.16
public health, local authorities, statutory functions, 1.3–1.4
pumping installations, 13.37–13.38
purge ventilation, 11.4, 11.12
purlins, 6.10–6.11, 6.52
purpose groups 7.3.2
purpose-provided ventilation, 11.4

radon gas contamination, 8.8, 8.23–8.27
rafters, 6.10–6.11, 6.52
rain screen cladding, 7.25.1
rainwater drainage, 13.52–13.67
  eaves drop systems, 13.56
  materials, 13.57
  recovery systems, 13.57
  siphonic, 13.56–13.57
raised storage platforms/areas, 7.23.1
ramped provision
  internal (*see* chapter 15)
  outdoor, external, 17.4.2, 17.5.1
ramps, 2.5, 2.9, 15.7, 17.4.2, 17.5.1
reception/desk areas, 17.5.3
recesses, walls, 6.29–6.30
reconstruction, 1.5
reedbeds, 13.42–13.47
refuse chutes, 7.15.10, 13.74–13.77
regulation 41, 10.2, 10.9
Regulation 38, provision of information, fire safety, 7.1.1, 7.8, 7.30
regulations, 1.4–1.5
  application, 2.19–2.24
  continuing requirements, 2.28
  division, 2.1–2.3
  relaxation of requirements, 2.26–2.28
  requirements, 2.24–2.26
Regulatory Reform (Fire Safety) Order 2005, 3.2, 3.8, 7.1, 7.6.1, 7.30
reinforced concrete, 6.5, 7.138
relaxation of requirements, 1.10, 2.2, 2.22–2.24
relevant boundaries, 7.2, 7.24, 7.25
renovation, 2.16
  of a thermal element, 16.8
replacement floorboards, 10.55
residential purpose groups, 7.3.2
resilient bar, 10.40, 10.43
resilient channel, 10.40
resilient layer, 10.44, 10.49
resistance to contaminants, 2.4, 2.8, 8.9–8.11, 8.13–8.32
resistance to moisture, 2.4, 2.8, 8.33–8.51
restaurant/bar/refreshment facilities, 17.5.5
reverberation, 10.8, 10.73
reverberation time, 10.79, 10.83
revolving doors, 17.5.2
rodent control, 13.36
roller shutter, 15.19.1
Ronan Point, 6.52
rooflights, 7.2, 7.17.7
roofs
  condensation, 8.57–8.60
  conversion, 7.12.10, 7.23.2
  coverings, 6.51–6.52, 8.37
  drainage
    eaves drop systems, 13.56
    fire exposure, 7.25.9
    height, 7.2
    joists, 6.11–6.12
    lateral support, 6.9, 6.21, 6.31–6.32
    room, 7.12.10
    siphonic, 13.56–13.57
    space conversion, 15.6.7, 15.6.9, 15.8
    spans, 6.1
    thatch and wood shingle, 7.25.10
    weather resistance of, 8.56–8.58

room-sealed appliances, 14.9
rooms for residential purposes, 10.2, 10.3, 10.66, 16.8
ruinous and dilapidated buildings, 1.11
rules of measurement, 7.4, 7.9

safe breakage, 15.13.2
safety glazing, 15.13
sampling, 2.3, 2.28
sanitary accommodation, 11.2, 17.2
  buildings (dwellings), 17.4
  buildings (other than dwellings), 17.5.6
  shower room, 17.5.6
  unisex, 17.5.6
  WC compartment, 17.4, 17.5.6
  wheelchair accessibility, 17.4, 17.5.6
sanitary conveniences, 12.2, 12.24
sanitary pipework *see under* drainage
SAP *see* Standard Assessment Procedure
SBEM and iSBEM, 16.8
school acoustics, 10.79
schools, 1.7–1.8, 7.87, 10.8
Seasonal Efficiency of a Domestic Boiler in the UK (SEDBUK), 16.5
secondary heating, 16.35
security, Chapter 19
security measures, 7.33
self certification, 4.8, 5.1–5.16, 16.2, 16.20, 16.23, 18.7
self-closing doors, 7.20.3
separated part, 7.7
separating floors, 10.5, 10.37
  type 1, 10.37
  type 2, 10.37
  type 3, 10.37
separating walls, 6.38–6.39, 7.9, 10.5, 10.14 *see also* compartment, walls
  type 1, 10.14
  type 2, 10.14
  type 3, 10.14
  type 4, 10.15
septic tanks, 13.40–13.41
  maintenance, 13.40
services
  controlled, 2.10–2.11, 2.20
  defined, 2.11
sets of tests, 10.10
settlement, 6.1, 6.2
settlement tanks, 13.40–13.41
sewers
  construction over, 13.21
  testing, 13.33
sheltered housing, 7.10, 7.16.4
shop, defined, 2.16
shopping centres, 7.16.7, 7.16.8, 7.26, 7.27, 7.28.10
short-lived materials, 1.9, 8.6–8.7
simple payback, 16.8
single occupancy dwelling, structural work timber, 6.9–6.13
single room heat recovery ventilator, 11.16
single storey building, 9.19.3
site
  investigation, 8.9–8.11, 8.17
  preparation, 2.4, 2.8, 8.8, 8.11–8.13
sleeping accommodation, 17.5.5
small buildings, external walls, 6.18, 6.26, 6.40–6.42
small detached buildings, 2.18
small premises, 7.16.8
smoke alarms, 7.2, 7.7, 7.10
smoke control areas, 14.2
smoke outlets, 7.28.14–7.28.17
snow loads, 6.5, 6.8
soakaways, 13.63–13.64
soil contaminants, 8.11–8.20
solid fuel appliances
  air supply, 14.18
  flues, 14.31
  hearths, 14.47
solid waste storage, 13.4, 13.72–13.77
sound absorption, 10.73, 10.89
sound reduction index, 10.90
space separation, 7.25.3
  canopy structures, 7.25.7
spacing, defined, 6.8
span, defined, 6.8
specialist process lighting, 16.6
special location, 18.6
species/grade combinations, timber, 6.10
spectrum adaptation term, 10.14, 10.80, 10.86
spiral stairs, 7.99, 15.6.8
spray, 8.35
sprinkler systems, 7.11
stack effect, 11.4
stack pipes, 7.22, 13.5
  discharge, 13.5, 13.11–13.14
  stub, 13.6, 13.11–13.17
  ventilating, 13.5, 13.16
stairlifts, 17.5.4
stairs/stairways, 2.5, 2.9, Chapter 15
  additional rules, 15.6.2
  alternating tread, 15.6.9
  application, 15.3
  assembly buildings, 15.6.6, 15.8
  common access, flats, 15.5.2, 15.6.2, 15.7, 17.5.1 (*see also* common stairs)
    construction, 15.6
    definition, 15.4
  escape stairs, 7.9, 7.14.5–7.14.10, 7.15.3, 7.15.4, 15.5, 15.6.5, 15.6.7, 15.18
  gangways, 15.6.6
  general requirements (including ramps and stepped ramps)

stairs/stairways (*cont'd*)
barriers, vehicles, 15.18
guarding, 15.20
handrails, 15.5.2, 15.7, 17.5.1
headroom, 15.5.3, 15.6.7, 15.6.9
landings, 15.5.1, 15.5.2, 15.7, 15.8
rise/going, 15.6
width, 15.3–15.5, 15.5.4, 15.6.2, 15.6.6, 15.6.9, 15.7, 15.13.2, 15.18
handrails, 15.5.2, 15.7
helical, 15.6.8
internal, 15.7 (*see* chapter 15)
interpretation, 15.4
private, 15.6.3
protection from falling, 15.11
ramps, 15.7
tapered treads, 15.6.2–15.6.4
utility, 15.6.5
stair treatment, 10.58
stairwell, 10.74
Standard Assessment Procedure (SAP) 2012, 3.8, 16.8, 16.30
standardised impact sound pressure level, 10.80
standardised level difference, 10.79
statutory duties, breach of, 1.10
statutory undertakers, 1.8–1.9
steel portal frames, 7.25.2
steel, structural, 6.5
stepped access, 17.1.1, 17.2, 17.4.2, 17.5.1, 17.5.4
steps, outdoors, 17.1.1, 17.2, 17.4.2, 17.5.1, 17.5.4
storage areas, raised, 7.23.1
'storey,' change of definition, 17.2
storey exit, 7.2, 7.9.3, 7.14.2
storeys, number of, 4.1, 7.2, 7.4
storeys, plan area, 6.14–6.15, 6.20
storeys, top, 7.2. 7.4
strapping, walls, 6.32–6.33
strip foundations, 6.44–6.47
structural advice, 10.54
structural members, design, 6.2, 6.8
structural stability, 6.1–6.2
structural steel, 6.5
structural work
bricks, blocks and plain concrete, 6.13
timber, single family houses, 6.9–6.13
structure, requirements, 2, 2.4, 7
strutting of joists, 6.12–6.13
stub stacks, 13.6, 13.11–13.17
student accommodation, 17.5.5
subsoil drainage, 8.32–8.33
supported walls, 6.9
surface spread of flame, 7.17
suspended ceilings, fire protection, 7.2
suspended floors
concrete, 8.40–8.41
timber, 8.38–8.40
swales, 13.65

tactile pavings
blister patterns, 17.5.1
colour, 17.5.1
'corduroy' tactile warnings, 17.5.1
target emission rate (TER), 16.9, 16.29, 16.31
target fabric energy efficiency (TFEE), 16.9, 16.29, 16.30, 16.34–16.47, 16.80
technical requirements, 2.25–2.26
temperature relief valves, 12.18
temporary buildings, 2.19
testing drains and sewers, 13.19, 13.33
testing programmes, 10.12
thatch and wood shingle roofs, 7.25.10
thermal cut-outs, 12.17
thermal element, 2.16, 16.9
thermoplastic materials, 7.121
thickness, walls, 6.18, 6.35–6.39
third octave, 10.74
thresholds, 8.54–8.55, 17.29
throat, 14.10
timber
doorsets, secure, bespoke, 19.6
single family houses, structural work, 6.9–6.13
species/grade combinations, 6.10
structural, 6.6
timber floors, 8.38–8.40
suspended, 8.38–8.40
total useful floor area, 16.7, 16.9, 16.16, 16.22, 16.60
toxic substances, 2.4, 2.8, 9.1
TRADA, 6.9–6.11
Transport Act 2000 (air traffic services), 1.9
trap water seals, 13.7–13.8
travel distance, 7.7, 7.9.2, 7.14.2, 7.16.8, table 7.2
type relaxations, 1.10, 2.27–2.28

unacceptable means of escape, 7.8.3
unauthorised access, 19.3
unauthorised building work, 2.2, 2.30–2.31
underpinning, 2.24
unprotected areas, 7.2
calculation of limits, 7.25.6
external walls, 7.25
urea-formaldehyde foam, 9.1
urinals, 12.4
utility room, 11.3
U-values, 16.97
calculation methods, 16.99
limiting values, 16.38, 16.43, 16.71
standards, 16.50, 16.86
windows, roof windows and rooflights, 16.119

vapour control layer, 8.60
varying the requirements, 7.23
vehicle barriers, 15.12
ventilating stacks, 13.5, 13.16
ventilation, 2.4, 2.8
  of buildings other than dwellings, 11.29
  of car parks, 11.29
  controls, 11.13
  definition of, 11.4
  ducts, 7.22.2
  of dwellings, 11.11
    using background ventilators, 11.13
    using continuous mechanical extract, 11.18
    using continuous mechanical supply and extract with MVHR, 11.20
    using passive stack ventilation, 11.16
  fire safety, 7.13.5, 7.15.8, 7.20.2. 7.22.2, 7.26.4, 7.28.16–7.28.18
  opening, 11.2
  rates, 11.12, 11.25
  through a room or conservatory, 11.26
ventilation devices, location of, 11.22
vertical datum, 7.187
vertical loading, walls, 6.28
vision panels, 7.14.2, 7.15.2, 7.16.8, 7.20.3

wall cavities, 7.21
walls, 6.13–6.44
  block and brick dimensions, 6.21
  buttressing walls, piers and chimneys, 6.25–6.29
  cavity walls, 6.39–6.40
  chases, 6.30–6.31
  cladding, 6.48–6.51
  compartment, 6.8, 6.13, 6.26, 6.32, 6.38–6.39, 7.3.1, 7.3.2, 7.14.8, 7.16.1, 7.16.3
  dimensions of chimneys, 6.25–6.26, 6.28, 6.42–6.44
  external cladding, 6.48–6.51
  external walls of small buildings and annexes, 6.40–6.42
  fire resistance, 7.2, 7.19
  flame spread classifications, 7.17
  foundation recommendations, 6.44–6.47
  height and length, 6.20–6.25
  lateral support, 6.31–6.38
  loadbearing, nominal length, 6.53
  loading conditions, 6.20, 6.26
  thickness, 6.38–6.39
wall ties, 6.39–6.40
wall treatment 1, 10.55
warning, means of, 7.5
warranty link rule, 4.2
washbasins, 12.27
washing facilities, 12.2, 12.24
waste disposal, 2.3, 2.5, 13.1, 13.72–13.77
  solid waste storage, 13.72–13.77
wastewater treatment systems, 13.38–13.51
  capacity, 13.40
  primary treatment systems, 13.42
    siting and construction, 13.40
  secondary treatment systems, 13.42–13.43
    constructed wetlands and reed beds, 13.47–13.50
    design and construction, 13.46–13.47
    siting, 13.43–13.44
water closets, 12.6, 13.7–13.11
  notice from local authority, 12.9
Water Industry Act 1991, 1.3
water seals, trap, 13.8–13.9
water supply, 1.4
  preventing waste, 1.1
weather, resistance to, external walls, 8.43–8.53
weighted sound reduction index, 10.8, 10.67
weighted standardised impact sound pressure level, 10.79
weighted standardised level difference, 10.80
wetlands and reed beds, 13.47–13.50
  design and construction, 13.46–13.47, 13.48
  horizontal flow systems, 13.49
  maintenance, 13.49–13.50
  siting, 13.43–13.44
  vertical flow systems, 13.47
wet room, 11.5
wheelchair, 15.6.6
wheelchair platform lifts, 17.5.4
  hazards to other users, 17.5.4
wheelchairs *see* disabled people, access
whole building ventilation, 11.5
width limitations
  means of escape, 7.9, 7.14.2–7.14.7
  stairways, 15.2
wind loads, 6.2–6.4, 6.8, 6.40, 6.48
window
  emergency egress, 7.12.2
  loft conversions, 7.53
  Part Q, 19.2
  secure, 19.2
    design, 19.6
    installation and fixing, 19.6
  unprotected area, permitted limits, 7.25.3–7.25.6
wind speeds, 6.14
work, exempt, 1.6–1.9, 2.2, 2.5, 2.17–2.19
workmanship, 2.2, 2.9, 8.1, 8.4, 8.7–8.8
  adequacy, 8.7–8.8
  influence of European standards, 8.23–8.7
Workplace (Health, Safety and Welfare) Regulations 1992, 7.6.3, 15.2, 15.14, 15.17, 15.19