Preparation of Construction Specifications for Civil Projects

Prepared by

Committee on Specifications of the Construction Institute of the American Society of Civil Engineers

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1.0 Introduction

1.1 General Purpose and Goals

1.1.1 Guide Introduction

In order to promote efficient project engineering, the Construction Institute Committee on Specifications (Committee) has developed this guide *Preparation of Construction Specifications for Civil Projects*. The Committee reviewed the original manual published in the year 2000 and updated it to include the latest revisions. During the more than 37 years of the Committee's existence, the goals have been the improvement of specifications and the reduction of problems caused by poorly written specifications. The Committee has, through questionnaires, papers, articles, and symposia, endeavored to share experiences and provide guidance in the area of specifications and their relationships to civil engineering projects. This guide is not intended to apply to specifications for Design-Build Contracts.

The Committee would like to recognize as an additional resource for guidance in specification production the Project Resource Manual (PRM) published by the Construction Specifications Institute (CSI). The PRM provides additional detail and expands upon many principles presented in this guide. While this guide provides a ready, convenient resource for the recommended principles and approaches used for specification production in civil-engineered projects, the Committee also recognizes and recommends the use of the CSI PRM as a source for additional information on required skills and recommended practices for writing specifications that provide the controls needed to construct a quality project.

The American Society of Civil Engineers (ASCE) *Manual No. 73, Quality in the Constructed Project* establishes certain guidelines related to preparation of specifications including project team composition, allocation of time and resources, quality input, coordination between disciplines, coordination between drawings and specifications, reviews, interfacing with outside agencies and site personnel, developing contract document components, quality assurance for documents, and computer assisted design. Further guidance for this reference may be found in Appendix A.

The Committee on Specifications has recognized and emphasized similar organizational points over the years and has incorporated and expanded upon them in this guide.

1.1.2 Contractual Relationships

Contract documents describe the relationships between the owner, the engineer and the contractor or supplier. They include the description of the work to be done and the materials and equipment to be furnished. For a more complete description of specification coverage, see Article 2.0 of this document. A large percentage of the misunderstandings and disputes concerning work responsibilities can be prevented if more emphasis is placed on development and review of specifications. Construction specifications should be clear, concise, and well organized. They should be based on detailed standards that include clearly stated requirements and acceptance criteria.

Satisfying the needs of all parties on a project depends on promoting a clear understanding of these concerns early in the project, and carrying that understanding through the completion of the project by developing and maintaining a professional degree of trust and confidence between the parties.

1.1.3 Bid and Contract Documents

Construction bid and contract documents contain the information that is used to obtain bids and to perform and monitor construction work. The documents include pricing and scheduling information, terms and conditions, scope definition, specifications, and drawings related to the work.

- The pricing and work (chronological) schedule are usually located in the proposal or bid forms prior to award and in the agreement or contract document after award.
- The commercial terms and conditions or conditions of the contract are included in general conditions covering the rights and responsibilities of the parties and the special conditions covering the requirements specific to the site or particular contract.
- Specifications are the written portion of the construction contract documents and include the scope of work, administrative requirements, and technical design requirements for a particular part of the project.
- Drawings are those documents that graphically show the relationships and requirements for the finished project. Drawings may contain specifications in the form of notes, charts, and other instructions.

Specifications are an important part of the system for obtaining bids and administering construction contracts. To be efficiently applied, the specifications must be prepared and utilized within the context of the total system.

The purpose of specifications is to convey specific written, technical information from the design engineer to contractors, suppliers, and inspectors so that the required materials can be provided and construction can be performed and monitored.

The relationships between the specifications and the complement of documents and the methods by which specifications are integrated into the system will be explained in this guide. Included is a detailed discussion of the use of a standardized format, professional preparation, independent checking of contents, and a means to relate the specifications and drawings to the work.

Definitions that apply to this guide are contained in Appendix B.

1.2 Challenges and Suggested Solutions

1.2.1 Introduction

One of the major concerns voiced by construction professionals, engineers and contractors, is that of poorly written specifications. Poorly written and ambiguous specifications often result in construction claims, increased cost, and litigation.

Specifications which are not clear to all parties lead to inconsistent interpretation and require correction of faulty work. Re-performing work due to unclear specifications is costly, time consuming, and demoralizing.

1.2.2 Specification Deficiencies

What types of specification deficiencies create challenges for specification users? The following areas have often been cited in the results of previous Committee questionnaires:

- Conflicts between specification sections or between the specifications and the drawings can simply be due to a lack of coordination in document preparation, or they may be a symptom of a lack of understanding by the specification engineer of the total intended scope of the project.

- Complicated grammatical instructions and poor use of English are symptoms of a lack of critical review in checking the specification requirements, and cause interpretation challenges in the field.
- Information that is out of place or difficult to locate within a specification may not be referenced when a change to that information is made in the document. When that occurs, the missing modified requirement may not be found until after the work is already performed.
- Lack of specific information required to ascertain the type, quality, or importance of a work item creates guesswork and disagreement in the field.
- The existence of unattainable results or inappropriate tolerances leads to ignoring other reasonable requirements, due to loss of confidence in the document as a whole.
- Ambiguous or unclear specification intent results in high contingencies during bidding and leads to arguments during construction.
- Extraneous and superfluous information confuses the contracting process. References to unneeded specifications and standards and items not part of the scope of work lead to questions about the applicability of all requirements.
- Inappropriate use or overuse of codes and standards leads to administrative difficulty if the codes and standards are either not commonly used or not available in the field.
- Over-specification of methods, rather than results, can reduce the intended responsibility of the contractor.
- Lack of coordination between specification sections and between specifications and drawings (including repetition of information shown on drawings) consumes undue administration time.
- Poorly compiled bid documents decrease confidence in meeting the project goals.
- Lack of standard format leads to confusion on where things are located and can result in a failure to include important information.

1.2.3 Complicating Circumstances

Why are these types of deficiencies so predominant if they are so well recognized? It is difficult and time consuming to engineer a comprehensive and correct set of contract documents. Shortcuts in development and review

allow substandard specifications to be issued. While many companies have specification writing procedures, numerous exceptions on each project allow significant variances in final product. Corrective measures only hit the obvious and least challenging areas. Corrections occur in the field on a day-to-day basis in the form of change orders. Construction input may not be available for the design phase, and design engineers may not be involved in the project when the issues occur in the field. Therefore, the lack of feedback can lead to a failure to correct previous errors in future documents.

Many of the above issues become magnified when several specification sections covering various types of work to be performed are included in the document. Often each section of the technical specifications has its own "scope" section or definition of the work involved. This invites conflicts of scope between sections and may lead to incomplete scope coverage.

Hard-to-find information, hard-to-decipher requirements, and hard-to-reach results cause extra administration time and inspection effort. Information that is duplicated in several specification sections or which is slightly different in several places requires a complicated unraveling exercise under the pressure of a construction schedule.

Besides the challenges associated with multiple technical sections, issues regarding the interpretation of bidding or contract documents are often related to specifications. Contract documents that consist of a set of seemingly unrelated sections and an incomplete table of contents may generate bidder confusion and unnecessarily increase the time and effort required for bidders to understand the required components, their relative importance, and overall applicability.

Project bid documents are typically converted to “Issued for Construction” document sets that are provided to the construction project team members. These sets include all addenda and any other information that was properly added to the bid set during the procurement process. In the past, this information was often incorporated in the “Issued for Construction” set by simply attaching it to the front of the specifications manual. Unfortunately, this process increased the potential for contractors to miss modifications that were made by addenda during construction because they failed to recognize the addenda requirements that were located elsewhere in the contract documents.

1.2.4 Engineering Concerns

Besides the issues encountered by specification users, engineers responsible for developing project specifications express the following areas of concern:

- Failure to make proper decisions early in the engineering phase concerning what subjects must be included in specifications and what can be shown on drawings or other documents
- Failure to produce generic specifications that satisfy the design and procurement procedures
- Failure to obtain and incorporate input and comments from the owner's maintenance and operational groups as well as other disciplines. This is often tedious, poorly scheduled, and rushed near completion.
- Failure to include budget hours and schedules for specification production during overall design planning

1.2.5 Rising to the Challenge

When asked for solutions to the challenges associated with specification production, industry responses to previous Committee-sponsored questionnaires included the following suggestions:

- Provide a clear, concise work scope.
- Promote cooperation between field engineers, contractors, designers and owners.
- Review plans and specifications in a truly comprehensive manner.
- Use simple language, provide uniformity and standardization and avoid ambiguity and superfluity.
- Use updated standard specifications.
- Use Construction Specifications Institute (CSI) format or other applicable industry standard formats (e.g. AASHTO).
- Coordinate drawings and specifications.
- Customize specifications to the specific job; do not include inapplicable specifications.
- Emphasize performance specifications over prescriptive.

- Provide clear descriptions of requirements, limiting the need for interpretation by the inspector in the field.

Committee-recommended actions for meeting the challenge include:

- Team approach - Select the appropriate project delivery system at the beginning of the project with input from the owner, engineer, and construction manager.
- Time - Provide time for specification engineers to do their job right and demand reviews of their work by both construction and engineering peers.
- Codes and standards - Clearly define the codes and standards, or the portions thereof that apply. Allow flexibility in the use of these requirements when possible. In lieu of referencing, incorporate code and standard language directly in the specification when possible. Reference the latest codes and standards available.
- Pre-qualifying contractors and suppliers - Where possible, pre-qualify suppliers and contractors before the request for bids is issued. Closely scrutinize potential bidder qualifications to provide confidence that they can effectively perform the contract requirements.
- Checklists - Use a generic checklist to review work. Utilize checklists varying from very general to very specific, as used in audits and verification checks, covering technical areas of design. With a little forethought, a checklist can be developed to cover all needed requirements. Time spent to obtain field input of identified problems and add to these lists is more than justified. Article 2.2.3 provides a summary of contents for a specification by article, and Appendix F provides a basic checklist for specification writing.
- Acceptance criteria - Ensure the designer, the inspector and the contractor have clear tolerances and acceptance requirements, whether prescriptive, performance, or combination specifications (prescriptive combined with performance) are involved.
- Field conditions/field dimensions – Research existing field conditions properly during the design. Do not simply depend on a statement in the specification assigning the contractor responsibility for verifying existing field dimensions and other field conditions. While it is acceptable to include this statement in the contract, attempting to use the requirement to save engineering time is a poor approach. The contractor often fails to make these checks, increasing the risk of schedule delays and cost impacts.

Any recognized unknown or suspect field condition should be resolved and verified with the owner as a contract requirement.

- Communications - Establish communication procedures at all levels during the design phase; including with other designers, the project team, and the owner's chain of command. This increases the possibility of:
  - meeting the original project scope and schedule;
  - reducing interferences; and
  - maintaining owner acceptance throughout the project.
- Contractor and supplier drawings - Establish the level of detail that the engineer must provide in checking contractor- and supplier-provided drawings. Not providing review of all structural and design details produces significant risk that cannot be delegated.
- Furnish "Issued for Construction" contract documents that incorporate individual addenda corrections and modifications at the specific location in the documents that they apply. Readily available, cost efficient Computer Aided Drafting and Word Processing software now enables designers to make these changes to the original documents as they are identified during the bid phase. This process has been adopted by many owners as a requirement in an effort to minimize errors created when field personnel constructing the Work fail to catch changes that were made in the documents during the procurement phase. The requirement also has the added benefit of expediting the production of Record Drawings at the completion of the project, since addenda items have already been incorporated into the record set.
- Scope of Work - Develop a single, separate scope of work memorandum to gather the project requirements in one location for ease of development, reference, and administration of the design. What areas or buildings are affected? What types of work are included? What is being furnished by "others"? These questions should be covered in the scope of work. The scope of work is a project planning document that must be developed early in the process and list the anticipated specification sections and drawings. Once the specifications and drawings are prepared, the scope should be rechecked for consistency with those documents. The scope of work is an organizational tool for preparing the contract documents, but it is not included within the contract documents.

1.2.6 Specification Writing Procedures

The recommendations and procedures that follow were the focus for development of this guide and have been established to provide positive results.

A comprehensive specification preparation procedure which recognizes the above concerns, the use of standard or guide specifications, and a separate scope of work memo can help to reduce pressure on the engineer by minimizing the time spent on non-technical aspects of specification development.

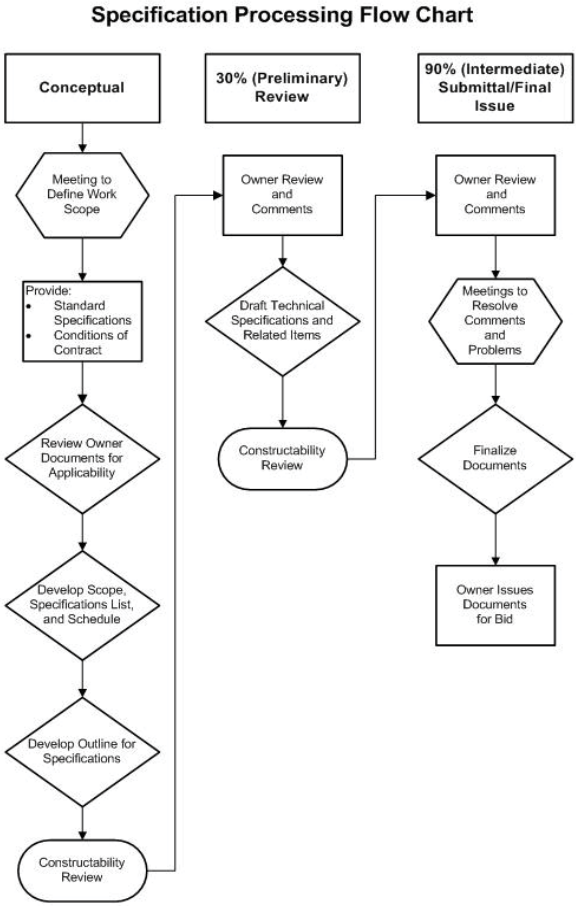
Availability of a current library of standard specifications eliminates reliance on specifications from past projects and the need to reinvent specifications for each new project. Standard specifications that are updated periodically are superior to specifications from the last similar project since project specifications are usually customized and thus may be more project-specific than is readily apparent. In addition, specifications from previous projects most likely will not incorporate lessons that have been learned since the project bid, leading the specification engineer to a repeat of past omissions and mistakes. Schedules can be more realistically prepared, by both engineers and project personnel, when all the steps required for specification preparation and approval are spelled out. If specification writing procedures are made part of the specification writing policy, they provide a sturdy framework for systematic and budgeted production. Care must always be exercised in reviewing the completed document to ensure applicability to the project.

1.3 Specification Development Planning

To be effective, specification writing should follow a well thought out plan that can be used for most projects. Specification development is improved through the use of a specification processing flow chart. The chart may be enhanced and expanded with the specific project in mind. Use of an established procedure, such as a flow chart, can help the specification engineer manage the time required for engineer and owner review. Receipt of delayed review comments is common and can result in major changes late in the process.

The following is an example flow chart that might be used to detail the process to be followed to provide specifications on a project. The example uses a specifications engineer as the key individual controlling the production of the overall project specifications. The Committee recommends this approach

because our consensus opinion is that this person must be a specialist in the area of specification production. However, the Committee also recognizes that not all design firms have a designated specifications engineer and may instead delegate these duties to the project manager. The Committee understands the reasoning behind this approach, but emphasizes that a project manager serving in this role should possess the same qualifications of a specifications engineer as detailed in Appendices B and E of this guide.



Step 1: The scope of work is developed as agreed upon between the owner and the engineer. It is important for the specifications

engineer to meet with the owner in the beginning of a project to formalize the project specification philosophy.

Step 2: Some owners provide the engineer with contract terms and conditions and standard or master technical specifications; some owners provide only basic minimum requirements or none at all.

Step 3: The specifications engineer reviews the owner's documents (if provided) and determines applicability to the scope and type of project.

Step 4: The specifications engineer coordinates with the project manager and develops an outline of the scope of work, determines the specification sections necessary, and develops a preliminary production schedule.

Step 5: The specifications engineer starts the development of outline specifications and suggests certain clauses to be used in conjunction with the technical specifications such as:

- Schedule incentives
- Differing site conditions
- Price escalation
- Disputes review boards
- Escrow bid documents

Step 6: Technical reviews by project, construction, and engineering personnel will reveal whether the engineer is on the right track.

Step 7: The owner reviews the preliminary output and suggests revisions.

Step 8: The bulk of the work involves expanding the list of sections and working the applicable owner-provided documents into draft sections.

Step 9: Documents are reviewed for constructability and engineering quality.

Step 10: The owner reviews and suggests additional revisions, if desired.

Step 11: Meetings should be conducted often and as required to respond to comments from the owner and to resolve the differences. The

specifications engineer should be part of the review process and participate in these meetings.

Step 12: The specifications engineer prepares the final draft document, incorporates all comments, and submits for final review. The owner's checks and reviews could be continuous and go back and forth repeating steps 10, 11, and 12 several times during fine-tuning.

Step 13: The owner issues documents for bidding purposes after all issues have been addressed.

1.4 Specification Writing Groups

1.4.1 Construction Document Production Organization

Integrated specification production can be implemented through an in-house organization responsible for construction documents, as maintained by many engineering companies. Engineers from each engineering discipline/department involved in the project should channel their input and requirements through this document group for consistency and coordination of the documents. The specifications group, through familiarity on a wide range of projects, will bring their extensive experience to bear on the current work and will prevent the necessity of relearning specification writing for each project.

Assignment of a group, or at least an experienced individual, to obtain specification information from other engineers will assist the design effort. A specification writing group that is responsible for all aspects of document production can reduce the turnaround time for development, review, and issuance. The group's basic functions are to correctly separate the technical, commercial, and legal information; to ensure that all required article categories are included such as reference codes, required submittals, and inspection criteria; and to check that the format for all technical sections is consistent for the project and is compatible with the complete bidding or contracting document. They can also assist engineering by coordinating internal and owner reviews, incorporating comments, and issuing the final documents.

Keys to a successful specification writing program include formalization of a specification writing procedure and development and maintenance of standard or guide specifications.

Charging the specification writing group with full responsibility for construction document production will result in an efficiently prepared and professionally organized product.

1.4.2 Group Functions

The specification writing group should perform the following tasks for each project:

- Develop a project-specific procedure for handling specifications and specification format.
- Develop a listing of specification subjects required for the project.
- Obtain input from discipline engineers.
- Number and log specifications.
- Ensure appropriate format.
- Review for grammar and clarity.
- Eliminate misplaced commercial and legal information.
- Type and proofread document.
- Issue document for each review.
- Discuss and incorporate comments.
- Update codes and standards for latest revision and alert discipline engineer of the change.
- Maintain a revision and approval history.
- Transmit documents for final use.

1.4.3 Maintaining Standards and Procedures

The maintenance of standard specifications may be performed by a specialist within each engineering discipline/department or by the specification processing group. In either case, it is critical that the task be performed in accordance with established procedures.

The maintenance of the specification writing procedure should be handled by the specification processing group with appropriate input from management and the appropriate engineering disciplines/departments.

2.0 Writing the Specifications

2.1 Philosophy

2.1.1 Coverage

Specifications provide the written administrative and technical requirements for a construction project and are a part of the contract documents. They describe the work to be performed, list applicable references, codes, and standards, dictate the type and quality of materials to be supplied, the methods of construction or required finished properties, and list the testing and inspection required. Separate measurement and payment paragraphs in each technical specification are discouraged; these provisions should be consolidated instead in one location, elsewhere in the contract documents.

Since specifications provide written direction for a project and generally define the overall quality of the project, clarity and fairness are essential ingredients. Arbitrary or ambiguous language will create uncertainty that can lead to increased project costs. Specification writing requires close coordination with drawings, consistency in terminology, clarity of intent, and the elimination of superfluous information. Proper grammar and sentence structure are absolutely necessary.

The specifications for completing a project such as a highway, bridge, treatment plant, or office building consist of an accumulation of subordinate requirements for the performance of each phase of construction, e.g. earthwork, structural steel, concrete, building enclosure, and other features. The number of subordinate requirements depends on the complexity of the project.

Each technical or project specification commonly consists of the following major sections or parts:

- Description of specification coverage
- Materials and fabrication requirements
- Installation or construction requirements
- Testing and quality requirements

The complexity of the project will dictate the level of detail needed in the specifications. An analytical approach to the preparation of specifications is advised. The work to be done or the result to be accomplished should be divided into various components, such as materials required or test results to be achieved. Each part should then be scrutinized to evaluate its relationship to the project. An outline should be prepared for the project that covers, in logical order, the subject matter to be considered.

After the outline has been prepared, the individual specifications may be written or provisions from other guide specifications may be used to the extent that they apply. Project requirements are generally prepared from guide specifications written by trade associations, government agencies, institutes, and similar groups, and from manufacturers' specifications that describe the properties of materials and installation details. Some organizations and firms develop their own set of guide specifications that are updated as needed, and then utilized in the preparation of a specific project requirement. Reference standards are another source of information, such as ASTM and AASHTO.

Through advances in word processing and similar automated techniques, cutting and pasting can now be accomplished electronically. This is a powerful tool that has enabled reviewers to streamline the specification editing process, reducing cost and expediting the preparation of contract documents. This technique however, when carelessly applied, can often lead to conflicts between sections of the contract and even internally, within an individual specification. Grammar may be adversely impacted, formatting may be erased or overwritten, and information directly related to another project may be mistakenly included in the subject contract.

Copying specifications from previous jobs, while seemingly efficient, can be dangerous, as well, and may result in incomplete specifications or specifications with meaningless requirements. Specifications and project-specific references that have no direct relationship to the current project may be mistakenly included.

There are two basic types of specifications:

- Prescriptive – See Article 2.1.4.
- Performance – See Article 2.1.5.

Many specifications contain a combination of these two approaches, but care must be taken not to overlap the two.

2.1.2 Coordination of Contract Documents

The contract terms and conditions, the drawings, and the specifications must all work together. Drawings show the quantities, dimensions and geometric relationships of the work. The specifications cover the qualitative aspects of the materials and workmanship. Each of these parts of the contract has a defined purpose; they must mesh without overlap or gaps. Duplication should be avoided because it can often lead to contradictions.

Coordination with the drawings is especially critical. Extensive written material and equipment requirements should be avoided on the drawings as much as possible and placed in the specifications. Terms used on the drawings should be consistent with the specifications. Dimensions should appear only on the drawings.

Coordination problems can be avoided by:

- Assigning one person to coordinate the contract documents.
- Establishing a communication process between the various disciplines or groups involved with the project.
- Requiring the design team to keep well-organized notes about materials and products that are incorporated in the design. These notes must be readily available to the specification writer.
- Having the drawings completed before finalizing the specifications.

Well-coordinated contract documents will reduce construction problems and delays, and will ultimately reduce project costs.

2.1.3 Project Complexity

The level of detail in the specifications should be a function of the complexity of the project, the type of work, and the size. A small project or a project that can withstand a considerable construction tolerance should have abbreviated specifications. For example, the requirements for paving a small parking area or a driveway at an office complex are quite different from the paving needs on an interstate highway. The material needs and installation requirements differ in both complexity and tolerances. Abbreviated specifications for a small project can equate to reduced preparation and construction costs. This needs to be considered when copying previously used specifications. For example, do not use an interstate paving specification to pave a driveway.

While the need for extensive detailing and complexity may be reduced on smaller projects, the specification engineer is cautioned that the need for completeness and coordination is not. It is fairly common for smaller projects to produce very large claims, often due to careless mistakes or incomplete requirements being present in the contract documents as a result of a specifier's assumption that the smaller project did not require the same level of attention to detail and quality control effort as a larger one.

As a project becomes more complicated, so does the need for more complex specifications. Elaborate construction requires exacting details. Complicated designs and construction schedules also require well-defined specifications.

While guide specifications should be used when available to create project specifications, they are not always available for complicated and complex design components. In those cases, the specifier should research information from a variety of industry sources and choose the best match for the project needs. The specifier should understand the relationship of the various materials, complexity of the materials, and construction and installation problems associated with those materials, when creating the detailed specifications. Most importantly, the specifier should not over-specify or set a higher standard of performance than is necessary.

2.1.4 Prescriptive Specifications

Prescriptive specifications provide the recipe for completing a project. These specifications describe the products, the installation procedures, and the workmanship that is required. Work performed in accordance with a prescriptive specification is expected to accomplish the desired end result, although the end result is not always precisely defined.

Since prescriptive specifications describe the exact materials to be used and sometimes even the construction procedures to be followed, extensive research is needed to ensure that essential requirements are not overlooked. Preparatory steps to develop specifications for the product, installation, and testing requirements include:

- Determining the end product
- Determining the primary features that make up the end product.
- Reviewing product data and manufacturers' literature to determine which equipment is best suited to the project

- Developing an outline of project specific installation and construction procedures
- Determining the extent of testing needed and the responsible party for accomplishing the testing

Remember that the prescriptive specification is a "how-to" specification. Accomplishing the desired end result is directly related to the adequacy of the specifications. A contractor cannot be faulted if the construction follows the specification requirements and the desired result is not achieved. In such a case, the engineer will be deemed responsible for the failure.

Specifying a product by trade name or brand name is a form of prescriptive specification. One method is to specify the exact product by name, another is to list a group of suitable suppliers; yet another is to specify the name with an "or equal" qualification. Specifying a product by name may seem like a good procedure, but it often introduces other complications such as reduced competition, limited opportunity for innovation, and allowing vendors to "package" the named product with other non-specified products that they also represent in a "take it or leave it" demand to the contractor.

The "or equal" approach can save specification preparation time and may allow for options and increased competition. However, when used incorrectly, it can also appear to be unfair and partial. For instance, if there are no practical equals available as a result of the way a specification is written, an "or equal" clause may be construed as unlawful under certain governmental contracts. In addition, using an "or equal" may result in differences of opinion about the equality of a product. If a bidder has few parameters to base his choice of equals upon, he may choose items which the engineer does not consider as being equal. This can affect bid preparation and result in administrative problems.

In order to address these concerns, it is critical for a specifier to include all necessary salient characteristics of the desired product when an "or equal" clause is used. This will provide the basis that will be used to evaluate the equality of the proposed "or equal" product submitted by the contractor. When "or equal" provisions are used, the submittal specification should also include details of what product information is required and the process that will be used to evaluate it.

A reference to standards developed by technical and trade associations is another form of prescriptive specification. These standards include those published by ASTM (formerly American Society for Testing and Materials),

American Institute of Steel Construction (AISC), American Association of State Highway and Transportation Officials (AASHTO), U.S. Army Corps of Engineers, Portland Cement Association (PCA), and other similar organizations. For a partial listing of such organizations, see Appendix C.

Referencing standards is a good specification approach because they are widely available, familiar to those involved in particular specialties, and they have consensus authority. To incorporate the standard, refer to proper title, number, and date. Be sure that revisions are recognized by referring to the latest revision of the standard. Also, consider that reference standards:

- May not be readily available in the home office or field
- May refer to other standards or require that options be designated by the specifier
- May contain inapplicable or undesirable workmanship requirements
- May conflict with other references standards if more than one is used

Read the standards before specifying them; do not use them blindly. Reference standards can be very helpful, but they must be understood, available, and appropriate for the project.

Examples of prescriptive specification statements are:

- Convey concrete from mixer to the place of final deposit by pumping.
- Structural Steel: Conform to the requirements of ASTM A 709.
- Large Pumps: Superpump Model 15E, or equal.

2.1.5 Performance Specifications

Performance specifications describe the end result that is desired, not how to arrive at a result. With performance specifications, the contractor in many cases is allowed to choose products, equipment and construction techniques. The contractor is given the opportunity to develop methods to accomplish the end result.

The preparer of a performance specification needs to consider that:

- The end result must be completely described. Failure to completely define the end result will allow for the possibility of a final product that does not meet the intended outcome.
- The end result must allow for straightforward testing or inspection to avoid conflicts. Testing and inspection criteria must be detailed.
- The bidders may have to undertake preliminary research and developmental work to prepare a bid. This may require a longer bidding period.

Examples of performance specification statements are:

- Concrete compressive strength at 28 days shall equal or exceed 4,000 psi.
- The structure shall be capable of supporting the standard AASHTO HS-20 loading within defined deflection criteria.
- The pump shall be capable of filling the tank within 20 minutes of pump start.

2.1.6 Comparison of Prescriptive and Performance Specifications

Prescriptive specifications are generally used when the end result cannot be adequately defined or where loss of design control cannot be tolerated. Performance specifications are generally used when it is normal practice to specify end results (i.e. concrete strength) or when new processes or products are needed and it is desirable to have the contractor provide the creativity for development.

Some advantages and disadvantages of each specification philosophy are:

- Bidding. Under prescriptive specifications, the contractor has a greater amount of detail available and can develop a bid with relative ease. Under performance specifications, bidding is more difficult because of the unknowns associated with developing a process or system.
- Innovation. Definitely favors performance specifications where the contractor is encouraged to develop efficient and cost effective methods and to use innovative products.

- Design Control. The advantage rests with prescriptive specifications. Each aspect of design is specified. The creativity is generated by the designer and the contractor merely follows the recipe. With performance specifications, certain design functions may be assigned to the contractor.

- Costs. Cost advantages will vary depending on the complexity of the project. For complex projects, performance specifications will generally result in lower total costs because the contractor is not restricted to a specific procedure; the contractor can innovate to reduce costs. On less complex projects, there is probably very little difference in cost between the specification types.

- Testing and Inspection. Depending on the category of work specified, testing and inspection involvement may be heavy for either type of specification. Generally, detailed prescriptive specifications require more testing as the work is put in place, while performance specifications require more testing of the end result to verify that it meets the desired functional criteria.

Prescriptive specifications are more common than performance specifications, although newer project delivery methods such as Construction Manager at Risk and Design-Build typically rely more heavily on performance specifications. Most projects utilize master specifications and reference standards that are applicable to the project, greatly easing the burden of specification preparation. Pure performance specifications are used much less because of their emphasis on development activities and loss of design control. However, performance specifications are preferable if they can be effectively prepared, since the project can benefit from the contractor's construction experience and skills. Unfortunately, with the limited use of performance specifications in the industry to date, few engineers really understand the nuances of writing an effective and enforceable one.

2.1.7 Combining Prescriptive and Performance Specifications

Combining prescriptive and performance requirements in the same specification is a very common practice in specification writing. Combining both types of specifications in the same project is also quite common. These approaches create no significant problems, as long as the specification philosophies are not combined or confused on the same product or activity. As an example, concrete is often specified with both a minimum compressive strength and mix design constraints. This combines an end result and a recipe, a practice that is used frequently when cast-in-place concrete is required on a

project. Care needs to be taken to ensure that conflicting requirements do not occur because of combined prescriptive and performance specifications.

2.1.8 Separate Scope of Work Memorandum

The first document that should be produced for each project is the detailed scope of work memorandum. The scope of work consists of:

- A detailed listing of the areas of work and the types of work required to be performed by the contractor
- A detailed listing of the items to be provided by the owner or by others
- A list of specifications and drawings required

Through the scope of work memorandum, a systematic internal review of the contract requirements can be coordinated, since all specification and drawing requirements are combined in a logical, understandable fashion. It ties drawings and specifications to a particular contract and relates the site-specific requirements to the specifications and the drawings.

The scope of work is a project management tool and should not be used as part of the contract documents. However, there are standard contract documents that provide a location for the information included within the scope of work memorandum to be inserted. Information regarding the areas and types of work on the project, as well as detailed listings of items to be provided by the owner and others can be included under the Summary of Work specification. A list of the specifications and drawings on a project are typically included as part of the actual contract agreement that is executed between the contractor and owner. Including the scope of work information in these documents allows for use of more technically independent, generic specifications without sacrificing the project identity, and it alleviates the issue of having project-related scope in technical specifications and excessive notes related to the extent of the contractor's work on the drawings. The repeated use of terminology such as "furnish all labor, supervision, tools, facilities, and incidentals to perform the work hereunder" is unnecessary in each specification, once it has been covered in a scope of work section.

The scope of work memorandum acts as a single source of information related to the responsibility of each party for the various facets of the work, allowing each engineering discipline a single place to identify and address scope interfacing concerns. The engineer's input is required in regard to intended usage of the specifications in order to develop a comprehensive document, and

a statement of scope from each engineer at the time of document preparation is very useful for developing a complete scope of work memorandum.

2.1.9 Specifications and Sustainability

The sustainability of capital facilities, along with the work processes by which such facilities are developed, are a significant new focus for industry professionals. Specifications can support project sustainability primarily in one of two ways:

New Technical Specifications for New "Green" Products: Just as with traditional, non-sustainable materials, equipment and products that are to be incorporated into a project, new sustainable components must also be thoroughly specified as part of the project design effort. Examples of design components that may require a new specification include energy-saving HVAC equipment or hot-water heaters, forest-friendly bamboo wood flooring, low VOC coatings, permeable pavement, or exterior façade sun shades. Specifications for such new products should be as complete and thorough as those that address older, conventional products.

Modified Technical Specifications that address Sustainability Aspects of Both New and Old Products: Technical specifications for both old and new products and materials can enhance overall project sustainability by addressing specific aspects of the products and related procurement and construction processes. This is perhaps best explained in the context of different elements of the standard three-part specification format, as shown in the outline and examples below:

Part I: General

- References: The specification may provide linkages to associations that certify environmentally-friendly products.
- System performance requirements: The equipment specification may stipulate maximum annual energy consumption.
- Delivery, storage, and handling: The specification may address how material should be transported and stored, so as to minimize waste or energy consumption.
- Waste management and disposal: The specification may address how to maximize recycling of demolition waste or how to store waste material in order to facilitate subsequent recycling.
- Site environmental requirements: The specification may address how to reduce noise or dust on the jobsite.

- System Commissioning: The specification may address how to start up an operating system so as to minimize energy consumption or minimize the generation of off-spec product waste.

Part 2: Products

- Manufacturers: The specification may list those product manufacturers judged to be environmentally superior in the methods they use to manufacture their products.
- Materials, equipment, components: The specification may require energy-efficient equipment or use of materials that promote indoor air quality.

Part 3: Execution

Special construction techniques: The specification may address environmentally-friendly techniques for spray-on coatings or noiseless rock demolition.

2.2 Format

2.2.1 Contract Format

Construction specification organizations including ASCE, as a participating member of the Engineering Joint Contract Documents Committee (EJCDC), and the Construction Specifications Institute (CSI) have prepared categorical contract formats such as the following:

- Bidding requirements and instructions
- Bidding and contract forms, bonds, and certificates
- Conditions of the contract (General and Special Conditions)
- Specifications (including single scope of work section)
- Drawings and attachments

Consistency of the contract format has helped contractors in their review of documents. Contract preparation is also improved.

2.2.2 Specification Numbering

Numbering schemes for contract documents have been prepared by several organizations such as CSI, Departments of Transportation (DOTs) for each

state, Federal Aviation Administration (FAA), and others. CSI divides specifications into Divisions ranging from Procurement and Contracting Requirements to Process Equipment (Division 0 through Division 49). Within each Division, various components of the described work have been assigned a Section Number.

For Example, CSI MasterFormat 2004 is a 49 Division format with Sections having a six digit number.

- Division 26- Electrical
- Section 26 20 00 Low-Voltage Electrical Transmissions
- Section 26 22 00 Low-Voltage Transformers
- Section 26 22 13 Low-Voltage Distribution Transformers

Previously, CSI MasterFormat 95 used a 16 Division format with Sections having a five digit number.

- Division 2 - Sitework
- Section 02200 - Earthwork
- Section 02202 - Embankment

The American Association of State Highway and Transportation Officials (AASHTO) has developed a format for highway construction projects. The Department of Transportation for each State has a similar format as follows:

- Section 200 - Earthwork
- 204 - Subgrade Preparation

Some state transportation departments have adopted the 5-digit Section and 16 Division CSI MasterFormat 95. However, CSI no longer provides support for or endorses the use of MasterFormat 95. Several agencies such as San Francisco BART have adopted the 6-digit Section, 49 Division CSI MasterFormat 2004.

2.2.3 Specification Contents

The contents and length of a particular specification depend on many factors, including intended coverage, importance of the component in the overall project, and degree of complexity.

The following elements may be used for specification development. Few specifications, except the most complex, require inclusion of every category and often categories are combined for non-complex work. For a complete listing of suggested paragraphs for technical specifications, see CSI's Section Format and Page Format.

2.2.3.1 Coverage, Outline, or Scope of Specification

Presents the outline of technical requirements covered by the specification and is usually general and categorical, leaving the details to the succeeding articles

2.2.3.2 Codes and Standards

Lists the codes and standards required for interpretation of the specification, including publishing agency and date of issue. Some reference standards require selections from a list of options, and some state that additional requirements must be provided. Be sure to review the standard for these types of requirements and restrict or supplement it accordingly.

2.2.3.3 Design Requirements

Includes technical data and design criteria for cases where the contractor must provide design services (i.e. drawings, data, specifications, and standards) related to the product or installation. This must be developed within a system capable of monitoring quality and changes.

2.2.3.4 Performance Requirements

Explains in detail the outcome or final results desired when a performance type specification is desired

2.2.3.5 Submittals

Lists the necessary documentation such as shop and erection drawings and the schedule for submission, whether it is at the time of bid, prior to fabrication, prior to installation, or at completion

2.2.3.6 Material or Shop Fabrication

Details the following categories of work which may be required:

- Material components
- Fabrication and assembly
- Special requirements for shop personnel
- Shop inspection and tests
- Cleaning, corrosion protection, and coating
- Marking and identification
- Packaging and shipping
- Acceptance criteria upon receipt

A prescriptive material specification may be quite detailed. Codes and standards may be extensively referenced.

2.2.3.7 Installation or Field Assembly

Describes the following categories of work which may be required:

- Inspection and preparation of existing surfaces
- Actual field installation or assembly
- Adjustment and cleaning

2.2.3.8 Inspection and Testing

Identifies the party responsible for inspection and testing and the required sampling methods and frequencies, testing methods, and reporting formats

2.3 Technical Requirements

2.3.1 Coordination with Drawings

Attention must be paid to ensure compatibility and coordination between specifications and drawings, since they make up the technical information package that contractors, material and equipment suppliers, and subcontractors use to bid and perform the work. Performance and quality requirements must be considered.

Since drawings graphically illustrate the design concept, size and scope of the project, number and size of materials or units, and how they are assembled into

a complete project, it is important that they be clear, concise and uniform. A drafting system that is standard throughout the design office should be developed and instituted. The standard should include basic sheet layout, lettering, dimensioning, and consistent scales.

Drawings and specifications are usually maintained by the project owner as the permanent record. Therefore, it is important that these records contain sufficient information to trace the most important materials and equipment, and design assumptions (loads and material strengths). Complete information in specifications and on drawings simplifies operations and minimizes design errors when future modifications are made to the project.

The following describes what should be included in specifications and on drawings in order for them to serve as a permanent record of the project:

- Qualitative requirements for products and equipment to be incorporated into the project (Specifications)
- A list of codes and standards noting specific sections that are directly applicable (Specifications)
- Design assumptions such as wind, ice, floor live loads, foundation bearing pressures, piping loads, etc. (Drawings)
- Basic material strengths, e.g. concrete, steel, bolts, welds, etc. (Specifications)
- Standard symbols and abbreviations (Drawings and Specifications)
- Specific catalog numbers or other clear references for material and/or equipment (Specifications)

Note that drawings may reference specification sections and specifications may reference drawings to minimize duplication of information. Duplication of information within or between the various contract documents invites, and almost always ensures conflicts. Conflicts should be avoided as they invite disagreements, add additional costs, and are a source of embarrassment to the designer.

2.3.2 Workmanship

General requirements for "workmanship" are usually included in the terms and conditions (General Conditions) of the contract. In most cases though, these requirements are quite broad; such as, "work shall be performed in accordance with established practices and standards."

Workmanship refers to quality. It relates to the labor effort that goes into the project and to the appearance of the final product. In very common terms, the workmanship provisions say "Perform Quality."

Wanting work of quality is desirable: specifying it is difficult. For example, concrete quality is controlled through mix design sampling and testing. The placement and finishing is not as easily controlled, even though established practices do exist. If the placement of concrete is of major concern, and it is believed that requirements stronger than "comply with standard practice" are needed, the actual method for placement will have to be defined. This involves a very elaborate prescriptive specification that would include such items as transporting devices and distances, placing and vibrating methods, and curing procedures. Workmanship for finishing concrete can also be prescribed by requiring that certain materials and methods be used or by specifying a level of smoothness for the product.

Tolerances are another means of controlling the quality of work. The precision of survey lines and grades, for example, can designate that it be checked to a tenth, hundredth, or other portion of a foot, depending on the complexity of the work. Site grading work should require tolerances on the elevations to ensure proper drainage.

Reference standards for materials and products usually have built-in tolerances and quality requirements. The installation of the materials and products is usually done in accordance with standard practices, manufacturer's recommendations, or trade association standards. If the specifier wishes to describe the installation, workmanship and standard practices, or wishes to modify the standard practices, then the specifier must detail the step-by-step process through a prescriptive specification. Each increase in level of quality required or reduction in tolerance allowed will have a proportional increase in cost.

2.3.3 Testing and Acceptance

Testing of materials may be performed by the contractor, the owner, or an independent agency. The responsibilities for testing need to be clearly defined.

The use of reference standards such as those published by ASTM and AASHTO provide sampling and testing procedures and these references are recommended for describing the testing procedures.

The terms and conditions may discuss general acceptance procedures for materials and products, based on test results. However, there may be

circumstances that dictate further specification language on the use of test results. For example, the acceptance of strength tests for concrete may be specified; that is, what test results will constitute acceptance or rejection.

2.4 Computerized Specification Systems

2.4.1 Standard Specifications

Efficiencies in specification production can be realized by using standard or guide specifications developed in-house or through commercial specification preparation services. These guide specifications are usually more effectively utilized when administered through an electronic database. The subject matter of each specification should be developed to be usable as a module for projects of varying size and coverage. Guide or standard specifications must be periodically revised to include updated information especially concerning codes, standards, and other references.

In order to prepare specifications for a new project, discipline or department, engineers must review the specifications for applicability and incorporate wording appropriate to the particular work.

Documents that comply with the specification writing procedure and associated standards can then be easily revised to incorporate last minute corrections.

2.4.2 Revisions

Specifications may be transmitted by hard copy or electronically. Regardless of whether the reviewer provides changes through hard copy or electronic format, final changes to the document should only be made by a person proficient in the use of the word processing software that the document was created in so that formatting and language style errors are minimized. The specification writing procedure should require revision of the specifications only by the specification processing group and revisions should be stringently controlled.

2.4.3 Specifications with BIM

Building Information Modeling (BIM) is an emerging information technology in the capital projects industry that will alter and enhance virtually all aspects of capital project delivery, including those aspects pertaining to project specifications. These changes and enhancements will be accomplished with new IT systems that leverage design model information and that possess greater functionality and interoperability than do current systems.

Accordingly, BIM presents new opportunities for those focused on specification-related work processes. For example, the process of specification preparation will eventually be enhanced with BIM, as should the process of specification usage by contractors and vendors.

One vision for BIM-supported specifications entails readily customizable standard specifications that are directly linked to project design model components. Such system linkages to the design model will enable designers and specification writers to more readily focus on those specified design variables (such as material strength or product type, for example) that require modification or update in order to comply with project-specific design objectives and/or related technical constraints.

While such specification process developments are currently primarily the focus of industry researchers and IT system developers, they are advancing at a significant pace, and practitioners should be aware of and prepared for their emergence.

2.5 Specification Writing

2.5.1 Clarity

Specifications describe the character of the work, the desired results, and the materials and procedures needed to complete, inspect, measure, and pay for the work. It is essential that the contract provide a very exact definition of what the owner desires. Clear and exact language will reduce disputes and ease interpretation and inspection.

Clarity is enhanced by:

- Arranging the text in logical order
- Discussing each detail fully and individually
- Using good sentence structure; preferably short sentences
- Being brief; a specification is not intended to be an essay, so only essential characteristics should be described
- Using correct grammar
- Eliminating ambiguous and arbitrary statements
- Preparing fair requirements; limiting the severity of the requirements

- Eliminating uncertainty caused by terms like "as the engineer shall direct"

Analyze the completed specification from the viewpoint of the contractor and the inspector. Is it readable? Can it be understood? Are there any hidden problems? Examples of actual specification language problems are provided in Appendix G.

2.5.2 Consistency

Use the same writing style throughout the specifications. Avoid jumping from one style to another. Use words and terms that are plain and easily understood. Simple sentence structure is desirable.

Specifications are commonly written in the passive voice or indicative mood. This results in excess verbiage through the frequent use of the word “shall,” e.g. “the contractor shall,” “the material shall,” “the finishing shall.” Instead, the specifier should attempt to use an active voice or imperative mood in writing specifications; e.g. finish the concrete, paint the surface, test the material; it should be understood that the conditions of the contract normally specify that the contractor shall furnish, install and test everything unless specifically excluded.

Be consistent with terminology and dimensional data used on the drawings. Adequate coordination between the bid documents, general conditions, and technical specifications and drawings will produce consistency.

2.5.3 Vocabulary

Specifications consist of words. The language should be clear and exact. Although technical terms or vernacular may be used, they should be used correctly. The common or local usage may not be the way that these terms will be interpreted by bidders and contractors from other areas.

Be careful with the use of certain words. Be sure the exact meaning in the specification is easily understood. Coordinate specification terminology with the contract definitions contained in the conditions of the contract.

- Day. This word could refer to a calendar day, working (8-hour) day, or 24-hour day. The conditions of the contract commonly define the term for use in that contract.
- Shall and Will. Do not interchange since it is usually understood that "shall" refers to the contractor and "will" to the owner or

engineer. Part of the problem may be eliminated by using imperative sentences where "contractor shall" is understood, e.g. "Finish concrete with a steel trowel." Again, this should be defined in the contract conditions.

- Any and All. The word "any" refers to a selective action, while "all" means everything. Usually there is no need to use "any" or "all" since they should be understood by the context, e.g. "Steel shall be erected within the tolerances specified."

2.5.4 Abbreviations and Symbols

Abbreviations and symbols are commonplace; however, do not assume that everyone understands them. If there is any doubt, provide definitions. It is better to eliminate abbreviations for short words (i.e., inch, foot, high, and acre).

2.6 Specification Review

In accordance with the Specification Processing Flow Chart referred to in Article 1.3, the draft specification should be subjected to thorough internal review by:

- The designers of the various components of the project
- The field personnel who will eventually have the task of monitoring the implementation of the construction
- Experienced field personnel who can comment on constructability issues and eliminate potential pitfalls or problems

Each of the above parties should review the entire document and provide comments and input related to their knowledge and expertise.

After the internal review is completed and revisions have been made, the specifications should be reviewed by the owner. Following the owner's review, the specification team should incorporate changes and resolve differences.

2.7 Specification Example

A sample specification is included as Appendix D. The specification format follows the requirements of CSI MasterFormat 2004.

3.0 Issuing Specifications

3.1 Issuance for Bidding

3.1.1 Bidding Documents

Upon resolution and incorporation of final review input, the specification portion of the bidding documents should be signed-off by the responsible engineers and the date of issuance should be noted. In some cases, the technical specifications, as well as the drawings, must be signed and sealed by a licensed engineer. If the specification format does not require sign-off of the specification or of the bidding document, documentation of approval should be incorporated in the design document record.

3.1.2 Issuance to Bidders

The bidding documents may be issued to bidders (advertised for bidding) by the owner or if the owner so requires, by the engineer.

3.2 Bidding Phase

3.2.1 Addenda

An addendum is a modification of the drawings, specifications, or other document that is distributed to prospective bidders (planholders of record) after advertisement, but before the opening of bids.

During the bidding phase, after the bidding documents have been issued to bidders, any change to the documents should be made in the form of an addendum to the request for bid. If irregularities, conflicts, or errors are discovered, they should be corrected by the engineer through an addendum.

3.2.2 Issuance and Receipt of Addenda

An addendum, when issued, should allow sufficient time for the bidders to review their bids and prices. A simple addendum can be issued up to 48 hours before the time that bids are due; however, a complicated and extensive addendum should give the bidders at least seven working days to evaluate its impact. If necessary, arrangements should be made to have the bid receipt date extended.

The bid or proposal form in the bid documents should include a space for the bidder to acknowledge the receipt of each addendum.

To document delivery, the addendum should be transmitted to each prospective bidder via one of the following means:

- Certified or registered mail with return receipt
- Expedient means such as courier, express mail, or other express delivery system that provides fast service and documents the delivery with a receipt (for situations where there is insufficient time for mail delivery)
- Facsimile transmittal (fax). This has become an accepted method of delivery for addenda. A copy of the electronic transmission verification should be kept for record purposes to verify that the document was received at the location identified for notification by the bidder.
- E-mail. Rules and security provisions are still being improvised for electronic mail. While provisions exist for electronically verifying that an e-mail was received by the intended recipient, this method of addenda delivery is not currently accepted for use industry-wide. However, with proper safeguards this method can save time and money, especially for addenda that must be submitted to multiple locations.

It is also recommended that each bidder be contacted by telephone and advised that an addendum is forthcoming. This will serve as advance notice to prevent the bidders from finalizing their bid prices, and if the bid is to be sent by mail, from mailing it prematurely.

3.2.3 Addenda Format

The addendum should be prepared and issued using a standard format which includes as a minimum the following information:

- Name of owner
- Title of the contract and date of advertisement
- Date and number of the addendum
- A brief statement that the above referenced contract document is being revised by this addendum

- Itemize each revision to the contract document under its appropriate heading and clearly identify each revised item by Article No., Title, Page No., and Paragraph or Line No., so there is no room for error or misinterpretation
- Signature of an authorized individual

3.2.4 Responding to Questions from Bidders

One very important principle to be observed during the bidding stage is that no response should be given to any one bidder without advising all the other bidders of the same information. Whenever a bidder asks a question, the question should be taken under advisement, and an addendum should be issued, if necessary. An exception is when the question is a request of a simple clarification of the documents, such as where reinforcing steel is specified.

To avoid future problems, every inquiry from a bidder, supplier, or subcontractor should be documented, whether it is in person or by telephone or e-mail. The name of the caller, the firm, telephone number, dates and time of the inquiry, followed by the question and the answer that is given should be recorded. Such simple documentation can be instrumental in resolving future bid related claims or disputes.

3.2.5 Pre-bid Conferences

A pre-bid conference is usually planned to be held about ten days or two weeks before bid receipt date. Conference attendees normally include the owner, project engineer, prospective bidders, suppliers, and subcontractors. During the conference, some questions might arise that require an addendum. However, simple answers may be given during the pre-bid conference. All the questions and answers discussed during the pre-bid conference should be documented in the minutes of the pre-bid conference and a copy of these minutes issued to all attendees, as well as to the plan holders of record who did not attend. These minutes will become part of the contract document record, although not necessarily included in the final contract.

3.3 Contract Award and Construction

3.3.1 Conforming Documents

Following award, the contract documents, including specifications, should be conformed to include all addenda revisions, in order to provide a complete document for use in administration and construction.

3.3.2 Specification Revisions

Revisions to specifications after contract award should be documented in a manner that allows the changes and approvals to be accurately traced.

The revised issue date and other indication of changes (margin notation or italics) should be consistently applied to revised project specifications. This will allow users to locate the changes and to maintain the latest revision in use in the field.

3.4 Final Results

The specifications, if carefully prepared, will provide suitable guidance during construction and will prove to be a key to successful projects.

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Appendix A
Additional ASCE Guidance

Quality in the Constructed Project:
A Guide for Owners, Designers, and Constructors
ASCE Manuals and Reports on Engineering Practice No. 73, Second Edition

This ASCE publication can be very helpful to those seeking a better understanding of the role of specifications on capital projects. The chapters of the document listed below are particularly relevant to the subject of specifications.

Chapter	Title
Chapter 10	**Design Discipline Coordination**
Chapter 11	**Guidelines for Design**
Chapter 12	**Pre-Contract Planning for Construction**
Chapter 13	**The Construction Team**
Chapter 14	**Procedures for Selecting the Constructor**
Chapter 15	**The Construction Contract**
Chapter 16	**Planning and Managing Construction**
Chapter 17	**Construction Contract Documentation and Submittals**
Chapter 18	**Construction Contract Administration**

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