ACI 121R-08

Guide for Concrete Construction Quality Systems in Conformance with ISO 9001

Reported by ACI Committee 121

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Guide for Concrete Construction Quality Systems in Conformance with ISO 9001

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American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331
U.S.A.
Phone: 248-848-3700
Fax: 248-848-3701

www.concrete.org

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Guide for Concrete Construction Quality Systems in Conformance with ISO 9001

Reported by ACI Committee 121

Paul Hedli
Chair

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Martin J. Fradua	Stephen Marchese	Johan C. F. Schor*	Paul Zoltanetzky, Jr.
Alejandro Graf			

*Subcommittee members who prepared this report.
Additional recognition to C. Raymond Hays, who led the subcommittee that developed this document, Lawrence G. Mrazek, who actively participated, and Anthony R. Ameruso, posthumously, for his work on the committee.

ACI Committee 121 developed this manual to provide ISO 9001:2000-based quality management system requirements and guidance to the concrete construction industry. Discussion is offered for each clause of the ISO 9001:2000, providing advice and construction-specific information that can be used as a reference to either produce a new quality management system compliant with ISO 9001:2000, or to upgrade an ISO 9001:1994 or other quality management system to meet the ISO 9001:2000 requirements.

Appendix A, "Model Quality Management System Manual for Designers, Construction Managers, and Constructors," is based on the "NYC MTA Bridges and Tunnels, Engineering and Construction Department," and is recommended for use as a template for any company beginning to write a quality manual.

Keywords: quality assurance; quality control; procedures.

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FOREWORD

This manual has been developed to address quality management for design and construction, with particular emphasis on concrete construction. It is based on the requirements of the ISO 9001:2000, "Quality Management Systems—Requirements," which is referred to herein as ISO 9001:2000 or the "Standard."

As an internal advantage, basing the quality management system on the Standard brings the concept of process management to the forefront of an organization. Rather than using the production control methods as an end in themselves, the organization uses them as tools and measures of process effectiveness, aids to continual improvement, elements of employee involvement, and indicators of customer satisfaction.

As an external advantage, the ISO 9001:2000 has international recognition. Compliance with the Standard has become a necessity for conducting business internationally and, more recently, in the United States. Because it places the responsibility for quality management on the vendor, those in compliance are seen as well-managed organizations with methods of quality management that can be assessed against a recognized standard. International and U.S. government agencies and private companies are requiring International Organization for Standardization (ISO) compliance or sometimes registration to conform to contract requirements or to become a preferred vendor.

Review of this publication and assessment of an organization's quality management system may indicate that many of the requirements of the Standard are already in place. Therefore, the objective should not be to reinvent the organization's quality management system in the image of the Standard, but rather to conduct a gap analysis to determine where compliance is already in place and in what areas it is weak or lacking.

ISO history

In the 1920s, statistical theory began to take shape and the first control chart was developed by Walter Shewart at Bell Labs for use in production. It was the first use of a formalized quality control technique. Out of this grew an approach to manufacturing that expanded after World War II. Inspectors had been a specialized function in production facilities since World War I, but the emphasis was on avoidance of the defects without a statistical basis.

In the 1950s, W. Edward Deming and Joseph Juran were invited to Japan by General McArthur to bring new life to a damaged industry by teaching a total management approach to production. By the beginning of the 1960s, the phrase "made in Japan" took on a new meaning, and the West began to follow suit.

Throughout the 1950s, manufacturing developed in the West without a formal quality management standard. In 1959, the United States developed MIL-Q-9858, "Quality Program Requirements," for military procurement (U.S. Department of Defense 1959). Following this, NASA developed "Quality System Provisions for Space System Contractors" (NPC 200-2) in 1962, and NATO adopted the Allied Quality Assurance Publications for procurement of equipment in 1968 (NATO 1968).

Throughout the 1960s, various systems of quality assurance were required of the manufacturers in the United Kingdom and Canada. In 1971, to standardize the systems, the British Standards Institute (BSI) published the first UK standard for quality assurance. This was followed in 1974 by BS 5179 (British Standards Institute 1974). These publications placed the responsibility of quality management in the hands of the third-party inspection.

In 1979, after meetings and agreements with key industry bodies, the British Standards Institute published BS 5750. Key industry bodies agreed to drop their own standards and use BS 5750 as a common contractual document. Process improvement was not addressed; only production control was addressed. The requirements were enforced by audit. The BS 5750 carried the core 20 elements that would form the backbone of ISO 9000:1987, and were continued into the ISO 9000:1994 series.

ISO was originally created in 1947 to facilitate world trade. Its emphasis up to the late 1970s had been on technical standards, engineering practices, and manufacturing. The development of quality management and increasing international trade led to the need for an international standard, which was pursued by ISO Committee TC176.

The result was that BS 5750 was adopted by ISO in 1987 as ISO 9000:1987. It carried the 20 core elements found in the BS 5750, and was enhanced with information from other documents in use around the world. It addressed quality systems for service industries, though the emphasis was still heavily on the manufacturing sector, which was the focus of BS 5750. In spite of attempts to focus on management processes, the emphasis was mainly on conformance alone.

In 1994, the Standard was again revised as the ISO 9000:1994 series. The emphasis was shifted toward preventive action, but continued to require documented procedures. This inclined organizations to create a system of procedural manuals, but without emphasis on improvement of processes.

The ISO 9001:2000 places the focus on processes and their interaction. The format has been changed, but the objectives have not. Aside from the addition of continual improvement and customer satisfaction, the goals remain the same. The focus on written procedures is reduced, as long as clear evidence (metrics) can be shown that the process is working. Controls to production, which once served as documentation of compliance, are now indicators for performance and tools for improvements. Audits are not intended to measure compliance alone. They are used to see if the process will attain the goals.

ACI Publication 121 history

ACI Committee 121 was founded in 1977 with the intent of developing an overall quality standard for the concrete construction industry. With the rise of the nuclear power industry, members within ACI believed a quality management standard for concrete work was in order to provide a framework for the quality activities necessary to deliver a project. The original ACI 121 document, published as ACI 121R-85 (ACI Committee 121 1985), was based on current ANSI standards for nuclear power plants and the Military Standard MIL-Q-9858A (U.S. Department of Defense 1963). It proposed basic definitions, activities, records, and responsibilities. It was the first ACI document that addressed overall quality management.

The document was revised in 1998, and ACI 121R-98 (ACI Committee 121 1998) was modeled after the ISO 9004:1994. It was expanded to incorporate 18 of the 20 elements found in the ISO 9004:1994 and addressed them using much of the information presented in the original document in addition to some new text and tables. The emphasis again was on the steps to set up a quality management system for a concrete construction project and assign responsibilities.

In 2004, the ACI 121 document was again revised, but was still based on the ISO 9001:1994 standard. With the advent of ISO 9001:2000, the definitions and intent of ACI 121R-04 (ACI Committee 121 2004) had to be modified. Additionally, the increase in project delivery by the design-build method, which often specifies the ISO 9001:2000 system, has outdated ACI 121R-04.

ACI 121R-08 is based on ISO 9001:2000. The language has been generalized to suit the myriad of contractual arrangements found in the present market, and examples from concrete construction are provided. An appendix has been added to provide a template to creating a quality manual following ISO 9001:2000.

For ACI 121R-08, the transition to the ISO 9001:2000 represents a shift in focus to a process approach for quality management, placing the emphasis on continual improvement rather than on avoidance of nonconformity alone.

9000 series explained

The following documents comprise the ISO 9000:2000 series:

- ISO 9001:2000: American National Standard "Quality Management Systems—Requirements"
  (Gives basic requirements for compliance.)
- ISO 9000:2000: "Quality Management Systems Fundamentals and Vocabulary"
  (Explains terms and definitions. Was upgraded to ISO 9000:2005 without significant change to definitions.)
- ISO 9004:2000: "Quality Management Systems—Guidelines for Performance Improvements"
  (Provides enhancements and examples beyond ISO 9001:2000, with additional recommendations for improvements to systems.)

Layout of text, discussion, and commentary

Following is the text of the publication ISO 9000:2001. The Standard is organized into sections numbered 0 through 8. Each section contains a number of subsections, which are identified as clauses. The section, clause, and clause titles in this document coincide with those in the Standard.

A reference to each clause of the Standard is followed by discussion, interpretation, and examples in terms and situations familiar to those in the concrete construction industry.

INTRODUCTION

0.1—General

Refer to ISO 9001:2000, Section 0.1.

Discussion for Section 0.1

These clauses (0.1, 0.2, and 0.3) do not contain any requirements. Therefore, your quality management system (QMS) is not evaluated against these introductory items for compliance with the Standard.

0.2—Process approach

Refer to ISO 9001:2000, Section 0.2.

Discussion for Section 0.2

The model in Fig. 1 can be viewed as the essence of the Standard distilled into a single model; the activities represented by management responsibility, resource management, product realization, and measurement correspond to the main sections of the Standard, numbered 5 to 8, respectively. Section 4, Quality Management System, can be seen as an overview or executive summary of what is required to implement a QMS.

In Fig. 1, inputs from the customer (in terms of specifications or requirements) and outputs to the customer (in terms of products and satisfaction) reflect a dominant theme of the International Standard. If the customer is not satisfied, then

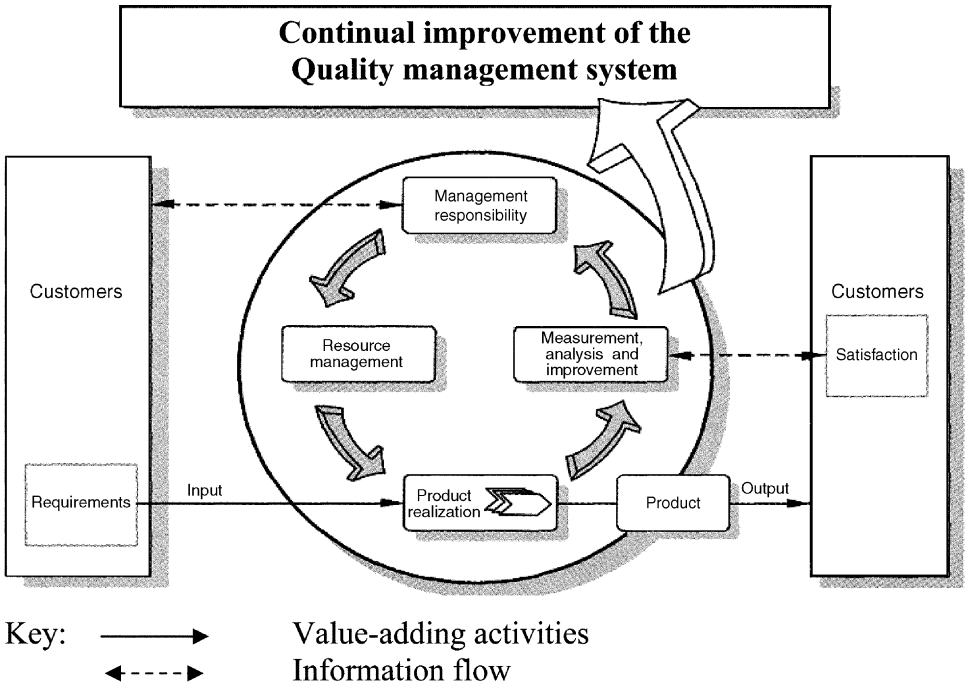

Fig. 1—Model of a process-based quality management system. This figure as taken from ISO 9001:2000 Quality Management Systems—Requirements—Figure 1.

an opportunity has been missed for repeat business and the ability to leverage past successes into future projects.

The process approach is based on the concept that all work gets done by a process, that is, a system of activities that turns inputs and resources into outputs.

It is important to take the time to think through this process approach, as the requirements of the Standard are based on this concept. This provides a tool for breaking down big tasks or projects into a series of inputs, processes, and subprocesses, which can then be monitored and measured before being used as outputs to the next stage. When the work performed by the organization involves a number of processes and subprocesses, the process approach model can be applied by means of:

- Identifying inputs (from the output of the previous stage);
- Planning;
- Monitoring; and
- Improving.

This approach can achieve results when used as a base for planning, analysis, and resource allocation. Construction projects involve a number of stages and processes. Each project stage or element can be considered as a series of inter-related subprocesses. As examples, concrete construction involves subprocesses such as structural design, mixture proportioning, procurement and control of the materials, selection of the subcontractors and suppliers, formwork design and procurement, scheduling, logistics of supply and access, inspection and testing, and curing.

0.3—Relationship with ISO 9004

Refer to ISO 9001:2000, Section 0.3.

Discussion for Section 0.3

The 2000 editions of ISO 9001 and 9004 have a common structure and numbering system, which simplifies using the Standard with the recommendations of ISO 9004. ISO 9004 is not a guide to ISO 9001.

0.4—Compatibility with other management systems

Refer to ISO 9001:2000, Section 0.4.

Discussion for Section 0.4

The environmental standard, ISO 14001, is aligned with ISO 9001:2000. Although environmental and safety topics are not addressed in this guide, it should be noted that many firms seeking ISO 9001 registration address environmental and safety requirements in their processes. It should be noted that Annex A of ISO 9001:2000 (not contained herein) provides a comparison between the ISO 9001:2000 requirements versus the ISO 14001 requirements.

Additional discussion related to the Introduction

Quality construction is achievable within an organization when all levels of management insist on quality and all employees know what is expected of them. It is always less costly to build it right the first time.

How do employees know that quality is important within their organization? They become aware when they are trained in what level of quality is expected, and when they see poor workmanship or materials removed and replaced voluntarily by their organization regardless of the cost.

Consistent quality construction can only occur when each employee within the organization has been properly trained and is empowered to produce quality work. Quality construction then becomes the norm.

QUALITY MANAGEMENT SYSTEMS—REQUIREMENTS

SECTION 1—SCOPE

1.1—General

Refer to ISO 9001:2000, Section 1.1.

Discussion for Section 1.1

This general clause explains the scope of ISO 9001 and the reasons to apply it. In this section of a quality manual, it is good practice to describe the scope or project(s) for which the Quality Management System (QMS) is applicable. The QMS can apply to all or only some projects. The QMS can also state whether the organization is registered to ISO 9001:2000 or simply complies without registration.

1.2—Application

Refer to ISO 9001:2000, Section 1.2.

Discussion for Section 1.2

The title of this section, "Quality Management Systems—Requirements" truly gives meaning to all that follows. These are the requirements of an ISO 9001:2000-compliant QMS, and are not optional. The extent to which each organization details each element in their quality manual, however, is open to interpretation.

What if some of the requirements in Clause 7 don't apply?

If any requirements in Clause 7.3, Design and Development, are not applicable to particular processes, they can be excluded. The exclusion and the reasons for the exclusion should be stated clearly in the organization's quality manual.

For many organizations in the construction industry, the requirements in Section 7.3, Design and Development, would not apply. For organizations that design concrete mixtures, formwork, or temporary shores, however, the section on design applies. Most contractors subcontract the supply of concrete to a concrete contractor or have a laboratory prepare the concrete mixture proportions. Formwork is usually designed by the form manufacturer. Shoring design can be outsourced or done in-house. Regardless, it is the organization's responsibility to verify that the input to the design is consistent with the requirements and uses of the output, be it mixture design specifications, formwork pressures, or construction loadings.

SECTION 2—NORMATIVE (STANDARD) REFERENCE

Refer to ISO 9001:2000, Section 2.

Discussion for Section 2

The word "normative" herein means "standard." The reference to ISO 9000:2000 directs you to that document as a source for fundamentals, principles, and definitions of the terms used in ISO 9001 and ISO 9004.

SECTION 3—TERMS AND DEFINITIONS

Refer to ISO 9001:2000, Section 3.

Discussion for Section 3

The terms used in ISO 9001:2000 are set out in ISO 9000:2000. With the revision of the 2000 Standard, the terms are now in line with common American English terms. Concrete contractors are encouraged to become familiar with the definitions contained in "ACI Concrete Terminology" (American Concrete Institute 2008). Note that the term "quality assurance" as defined by ISO applies to the activities of the producer or contractor as well as the owner.

It is noted that the ACI Web site presently carries the "ACI Concrete Terminology" publication, which can provide definitions of terms as they are commonly used in the industry.

Terms used under discussion sections

Note that ISO does not impose terms on the user other than those indicated in ISO 9000:2000. Even the name or title of an organization's quality system is left to choice. The following terms are commonly used in the discussion section of this guide.

quality control—actions taken by an organization to provide control and documentation over what is being done and what is being provided so that the applicable standard of good practice and the contract documents for the work are followed.

quality assurance—actions taken by an organization to provide and document assurance that what is being done and what is being provided are in accordance with the contract documents and standards of good practice for the work.

quality manual—this term identified in Clause 4.2.1(b) can be thought of as the entire body of quality documents or binders that collectively describe the quality management system.

quality plan—the overview document that describes the objectives of a quality management system.

work methods—the processes used to produce and supply a product of service.

SECTION 4—QUALITY MANAGEMENT SYSTEM

4.1—General requirements

Refer to ISO 9001:2000, Section 4.1.

Discussion for Section 4.1

Setting up a quality management system

The requirements of Section 4.1 provide the framework to set up and document a QMS. It requires the following:

- Identify the processes an organization uses to provide its products or services;
- Determine the sequence of and interactions of those processes; and
- Manage and continually improve the effectiveness of the system.

One way to accomplish the above is to draw a flow chart of the processes. This provides a simple way to understand all of the inputs and interfaces and to evaluate a system. A suggestion for Section 4.1 of a quality plan is to reproduce the six items (from 4.1(a) to (f)) and identify where this information is provided in the quality manual. For Example 4.1(c), (d), and (e) may be described and provided with an organization's work methods.

4.2—Documentation requirements

4.2.1 *General*

Refer to ISO 9001:2000, Section 4.2.1.

Discussion for Section 4.2.1

Documenting a quality management system

Each organization should determine the approach that best suits its needs. Field conditions and sequences of installation not within the bounds of common practice need to be detailed. However, the construction industry relies on the competence of operating personnel. When people are highly skilled and experienced, the need to document may be less, and common processes may require only a minimum amount of documentation (for example, working from drawings without detailed work instructions, but only when the methods and means of installation are within the common operating procedures of the industry).

The requirements described in the following six clauses should be included in the documented procedures:

- 4.2.3 Control of documents;
- 4.2.4 Control of records;
- 8.2.2 Internal audit;
- 8.3 Control of nonconforming product;
- 8.5.2 Corrective action; and
- 8.5.3 Preventive action.

These are the only clauses where the existence of a documented procedure is a specific requirement.

While Clause 4.2.1, Item (c) of the International Standard requires "documented procedures" in regard to the six clauses listed above, the titles, format, and grouping of these procedures is for the user to determine. Please note that this manual uses the term "process documents" to cover the documentation referred to in both Items (c) and (d) of this clause.

It is important to remember that employees should have the information needed to do their job. Some common terms are:

- Work practices, work procedures, work methods, or work instructions;
- Operating practices or instructions;
- Production schedules;
- Preferred supplier list (see Section 7.4, Purchasing);
- Specifications; and
- Drawings.

Many engineering firms have standards for drawing lettering size and plan orientation as well as procedures to check their work.

Documentation should indicate—to the extent necessary—which positions within an organization perform a specific task, where the task is performed, and when the task is performed. How the activity shall be performed depends on the qualifications of individuals performing the task.

4.2.2 *Quality manual*

Refer to ISO 9001:2000, Section 4.2.2.

Discussion for Section 4.2.2

What is a quality manual?

A quality manual is simply a document that describes a QMS. It is presented in a way that suits the organization's operations.

The format, title, and how much detail is included in the manual is up to each organization. It can contain all management system documentation, or only part of it.

One recommendation is to use ISO 9001:2000 as a checklist for the production of a document called the "quality plan." Each item in the Standard is identified in the quality plan with a description of how the organization addresses the item. The quality manual is then the entire collection of documents related to quality, including the quality plan, quality procedures, and work methods that constitute many separate documents.

What should be included in the quality manual?

Clause 4.2.2 lists items that should be covered in a manual: the scope of its application; identification of any excluded requirements (such as Clause 7.3, Design); the documented procedures (in detail or by reference); and a description of the sequences and interaction of the processes.

It is convenient to provide the manual in tiers such that the quality plan spells out the objectives of the QMS for the project, the procedures (which are referenced in the plan) provide the methods by which those objectives are realized, and work methods provide the details of execution. Depending on the complexity of the project, work methods and procedures can be combined or separate. Procedures and work methods should describe the particulars of execution such as the application, test methods, acceptance criteria, references, documentation requirements, and responsibilities. By constructing the QMS in tiers, procedures and methods can be added or revised individually without reissuing the plan.

Example quality plan outline

The quality plan should follow the same section and clause numbering used in ISO 9001:2000. The following outline provides recommended section names and content for a quality plan. Furthermore, Appendix A can be used as a template to assist in the development of a quality plan for an organization or project. See also Appendix A, "Model Quality Management System Manual for Designers, Construction Managers, and Constructors."

Section 1—Scope:

- Describe the organization and its products or services it provides; and
- Explain the scope covered by the QMS.

Section 2—Normative reference:

Identify the source of reference standards for the QMS.

Section 3—Terms and definitions:

- Identify source document or documents providing these definitions; and
- Add other definitions specific to an organization, if appropriate.

Section 4—Quality management system:

- Describe the structure of the QMS documents, such as quality plan, quality manual, quality procedures, and work methods;
- Include a detailed description of how an organization

fulfills the requirements of ISO 9001:2000; and
- Include a flow chart of the processes; it is useful in this section.

Section 5—Management responsibility:
- Use Clause 5.3 to present the organization's quality policy; and
- Include an organizational chart.

Section 6—Resource management:
- Create a matrix of training requirements that compares positions and the "must know" procedures for each position requiring training.

Section 7—Product realization:
- If the QMS will be used by a design firm, then:
  - Include design requirements in this section; and
  - Reference any design or engineering procedure(s) in this section.
- If the QMS will be used by a construction firm, then:
  - Reference work methods in this section; and
  - Identify and describe the typical elements of the organization's work methods in Clauses 7.1 and 7.5.

Section 8—Measurement, analysis, and improvement:
- Address the organization's important monitoring issues, such as inspection, testing, auditing, nonconformance, and improvement.

4.2.3 *Control of documents*

Refer to ISO 9001:2000, Section 4.2.3.

Discussion for Section 4.2.3

Document control provides a method to ensure that the document in use is the correct document and is approved as required. Document control is the first of the ISO 9001:2000 required procedures.

Typical internal documents include:
- Working drawings;
- Shop drawings;
- Procedures;
- Instructions;
- Reference materials; and
- Check prints of designs, drawings, and specifications.

Typical external documents include:
- Regulations;
- Codes;
- Specifications;
- Contract drawings;
- Change orders;
- Request for information; and
- Field change notices.

What does "controlled" mean?

"Controlled" means having a systematic, planned approach to document preparation, identification, review, approval, distribution, availability, storage, and revision control.

The controls needed and the extent of control possible might be different from document to document. Controls will be different for internal and external documents, and need to be established appropriately. For internal documents, Clauses (a) through (e) and (g) apply. For external documents, Clauses (c) through (g) apply.

Which documents need to be controlled?

Examples of documents covered by this clause include:
- Design outputs (such as drawings and specifications);
- Contract documentation (including variations with the customer and with suppliers);
- Outputs from planning activities such as design verification, schedules, and checklists;
- Documents describing the operation of your QMS (quality manual, procedures [including those required by ISO 9001], and forms);
- Policies or guidelines;
- Organizational structure and position descriptions;
- Design input including standards, codes, design briefs, and environmental impact statements; and
- Software used for design.

What about electronic documents?

Where electronic documents are used, the version on the network should be identified as the latest version. A statement can be added to indicate that any paper copy is uncontrolled, and it is up to the reader to verify that it is the latest copy by checking the network.

4.2.4 *Control of records*

Refer to ISO 9001:2000, Section 4.2.4.

Discussion for Section 4.2.4

Records are a statement of the facts existing at the time an activity occurred, and they cannot be revised. Superseded or revised documents can become records.

Control of records is the second required procedure. This clause requires the organization to implement a procedure to provide evidence that the project requirements and specifications have been met.

In the construction industry, appropriate records may also provide protection for an organization (for example, records of delay, photos of completed work before covering, or inspection showing criteria being met).

Typical types of records

The types of records to keep include:
- Design files and calculations;
- Customers orders and contract reviews;
- Meeting notes;
- Internal audit reports;
- Details of nonconformities;
- Corrective and preventive action reports;
- Purchase orders;
- Suppliers' test records;
- Inspection records;
- Calibration reports;
- Training records;
- Details of goods received and delivered; and
- Construction photos and check prints.

For concrete construction, the following records should be kept:
- A recorded diary of a construction project (this is extremely valuable, especially when a problem develops);

- Daily photographs that are properly dated;
- Identification, examination, acceptance, and testing of materials and subassemblies;
- Inspection before casting concrete, including a check of form dimensions, size and position of reinforcing or prestressing steel, joint materials, inserts, form condition, cleanliness of reinforcement, shoring and support for forms, location of pipe, conduits and inserts, and the condition of soil in excavations;
- Preparation of concrete specimens and their proper storage while awaiting testing;
- Stressing records for post-tensioned construction;
- Performance of tests for temperature, slump, cylinder strength, air content, and unit weight;
- Inspection of form removal and finishing of formed and unformed surfaces; and
- General observation of equipment, working conditions, weather, and other items that could affect the long-term durability of the concrete. (Curing and protection from the elements should also be observed. Temperature records are particularly important.)

Because the buildings and engineering facilities may last longer than the construction organization, the project principal needs to give particular consideration to the long-term accessibility of design and construction records.

How much detail is needed in process documentation?

An organization will determine what records are required in addition to what is required by ISO 9001:2000. Each type of record should have a plan for how long it needs to be kept, where it will be stored, and how it will be disposed of.

SECTION 5—MANAGEMENT RESPONSIBILITY

5.1—Management commitment

Refer to ISO 9001:2000, Section 5.1.

Discussion for Section 5.1

Top management is defined in ISO 9000:2000, Clause 3.2.7, as "the person or group of people who directs and controls the organization at the highest level." This clause specifically identifies the responsibilities of top management, and emphasizes the need for effective leadership.

Evidence of commitment can be achieved through:

- Business-planning processes that identify customers, and the regulatory requirements applicable to the organization;
- Identifying the organization's policies and objectives;
- Communicating the quality policy and objectives to the people;
- Management review; and
- Providing resources.

5.2—Customer focus

Refer to ISO 9001:2000, Section 5.2.

Discussion for Section 5.2

What does the customer want?

This clause makes it clear that, irrespective of who actually undertakes interaction with the customer, it is the responsibility of top management to make certain that those requirements are understood and that the necessary resources are available.

5.3—Quality policy

Refer to ISO 9001:2000, Section 5.3.

Discussion for Section 5.3

A quality policy establishes a commitment to:

- Quality;
- Continual improvement of the QMS;
- Framework for quality objectives; and
- Internal communication and review.

In the most general sense, a quality policy should be a clear statement of the organization's commitment to a standard of quality. This should provide evidence of commitment from the top management that quality will not be compromised when it is in conflict with other interests.

5.4—Planning

5.4.1 *Quality objectives*

Refer to ISO 9001:2000, Section 5.4.1.

Discussion for Section 5.4.1

Satisfying the requirements in Section 5.3 establishes an organization's quality policy. To put that policy into effect, top management needs to establish clearly defined objectives for the organization. The established objectives should be realistic and related to achievable and measurable outcomes such as:

- Meeting specified technical, safety, environmental, time, and financial requirements for a product or service;
- Documenting various internal business processes;
- Improving contract documentation;
- Improving training;
- Controlling operations/projects;
- Identifying and controlling nonconformance;
- Gaining repeat business; and
- Identifying new market and service opportunities.

Objectives should focus on areas that will bring a return to the business in both financial terms and in terms of increased customer satisfaction.

What about setting quality objectives on projects?

Project objectives are appropriate and should be consistent with an organization's objectives. They need to be in agreement with the project intent. Project objectives can be more specific to project deliverables and the client's objectives.

For example, if an organization is responsible for the management of the project, it may need to:

- Ensure that the project objectives are realistic and are able to be communicated to all levels within the project;
- Identify the suppliers involved with the project that are required to establish quality objectives consistent with the project quality policy;
- Ensure that it has identified its objectives appropriately; and
- Ensure that it includes a review of its performance in meeting these objectives as part of the management review (see 5.6).

5.4.2 *Quality management system planning*

Refer to ISO 9001:2000, Section 5.4.2.

Discussion for Section 5.4.2

Control is the act of comparing planned results to achieved results, so that corrective action can be taken when there is deviation. If there is no plan, there is no control.

This clause deals with planning at two levels:

1. Planning necessary to meet the requirements of 4.1; and
2. Planning necessary to meet quality objectives.

What about project planning?

For construction, a project is a one-time, multitask job with a definite starting point, a defined scope of work, a budget, and a team of professionals, often brought together for the first time with different formats, methods, and business cultures. The lack of a clearly defined scope can become a major problem with construction projects. It is the customer's (owner's) responsibility to communicate with bidders to ensure the scope is clearly defined.

The recommended model is:

- Definition:
  - Define the problem;
  - Develop the vision; and
  - Write the mission statement.
- Planning:
  - Develop strategy;
  - Develop implementation planning; and
  - Develop risk management.
- Execution:
  - Do the work;
  - Monitor the progress; and
  - Take corrective action.

5.5—Responsibility, authority, and communication

5.5.1 *Responsibility and authority*

Refer to ISO 9001:2000, Section 5.5.1.

Discussion for Section 5.5.1

Who does what?

Top management needs to ensure that people in the organization know what is expected (responsibility), and what is allowed (authority). An organizational chart should be included in the organization's QMS to define lines of responsibility. This chart could be included as an appendix to allow for frequent revision.

Attention should be paid to interfaces between project participants to ensure continuity between participants and organizations. Phases of projects should also be considered for interface issues.

Although individuals should be aware of his or her quality responsibilities, there should be a system of quality control, including inspections or checking, to ensure accountability. One of the first tasks of management is to develop a written plan for quality control (QMS) that includes all activities critical to quality, criteria, and frequency of inspections or checking, and the assignment of responsibilities. Qualified personnel can then develop a checklist for inspection.

Inspection does not take responsibility away from the construction worker. It provides management with a quality measure, data for improving the system, and the ability to take corrective action. Every contractor should be responsible for quality and should communicate to all employees that, "We do quality construction and are proud of each of our projects."

5.5.2 *Management representative*

Refer to ISO 9001:2000, Section 5.5.2.

Discussion for Section 5.5.2

Who looks after the quality management system?

Top management assigns one person to have overall responsibility and authority as the management representative. An organization, however, may have more than one person performing similar roles—such as in different branches or on projects—and in such cases, their roles, delegated authority, and lines of reporting need to be defined.

In smaller organizations, the management representative may do the administrative and training activities in addition to other functions within the organization.

The quality management representative should be independent from the management of the project organization to avoid conflicts of interest. This person should report directly to the upper management at least one level above that of production. This should be clearly shown on the organizational chart and in the job descriptions for the various positions on the organizational chart.

5.5.3 *Internal communication*

Refer to ISO 9001:2000, Section 5.5.3.

Discussion for Section 5.5.3

Keeping people informed

For a QMS to work effectively, good communication is essential. To be effective, communication processes should provide the organization's employees with the ability to:

- Transmit and receive information quickly and to act on it;
- Build trust with each other;
- Transmit the importance of customer satisfaction and process performance; and
- Identify opportunities for improvement.

All information should be clear, understandable, and adapted to the intended audience. Unfortunately, good communication within an organization is rare; it is often perceived by top management as better than it actually is.

Communicating information about the effectiveness of a QMS could be through a variety of means such as bulletins, newsletters, internal meetings, meeting minutes, nonconformance logs, preventive action suggestions, and circulation of reports.

5.6—Management review

5.6.1 *General*

Refer to ISO 9001:2000, Section 5.6.1.

5.6.2 *Review input*

Refer to ISO 9001:2000, Section 5.6.2.

5.6.3 *Review output*

Refer to ISO 9001:2000, Section 5.6.3.

Discussion for Section 5.6.3

Is the quality management system working?

Top management should review the QMS on a regular basis. A new system should be reviewed quarterly, with reviews given annually thereafter. To be effective, the review should be preplanned; it is recommended that the requirements of 5.6.2 and 5.6.3 be specifically addressed at each management review.

The management review will usually be recorded in a form that includes identification of:

- Date and location of the review;
- Scope of review (for example, full system or part of the system);
- Identity of participants (name and functions);
- Minutes of proceedings; and
- Actions (if any) and responsibilities, including target dates.

This record will typically be minutes of a meeting, but for a small organization, a less formal record, such as a diary note, may be appropriate.

Actions resulting from the review meeting are typically those that require top management understanding or endorsement, such as trends, amendments to policy, improvements, and preventive actions involving capital expenditure. Other responsibilities, such as follow-up actions, are typically delegated.

The record of a management review becomes an important part of the organization's quality records and becomes the first input into the next management review.

SECTION 6—RESOURCE MANAGEMENT

6.1—Provision of resources

Refer to ISO 9001:2000, Section 6.1.

Discussion for Section 6.1

What is needed?

Organizations need to make sure the resources needed to implement, maintain, and improve the QMS are available. Within the construction industry, resource management occurs in response to a change in workload such as winning a new contract, scope changes to an existing contract, or dealing with unpredictable conditions. Management needs to be flexible and quickly respond to resource issues. Resources include not only the personnel required, but also finance, facilities, and equipment. For example, it might be necessary to:

- Develop new procedures or work methods;
- Obtain additional equipment that can be rented, leased, or purchased; and
- Acquire the resources and skills through a subcontract.

6.2—Human resources

6.2.1 *General*

Refer to ISO 9001:2000, Section 6.2.1.

Discussion for Section 6.2.1

Are the people able to do what is required?

The most important factor in achieving a desired outcome and customer satisfaction is having competent people doing the right job.

Note that this clause specifically refers to personnel performing work that affects product quality.

6.2.2 *Competence, awareness, and training*

Refer to ISO 9001:2000, Section 6.2.2.

Discussion for Section 6.2.2

Checking competence and training

Organizations should regularly compare the experience, qualifications, capabilities, and abilities of the people relative to the skills and qualifications needed by the business for current and future contracts.

Evaluating the effectiveness of training programs

The ACI certification programs can be a key element in ensuring that concrete testing technicians and craftsmen are trained for their role in the concrete construction process.

Records of the assessment process, such as ACI certifications and programs, should be kept.

Training programs may be developed to fill needs or to further develop the organization's capabilities. Training on the QMS or on specific work methods can be effectively provided by a review meeting.

Other sections of the Standard that relate to training are:

- Clause 8.5.3, Preventive action;
- Clause 8.2.2, Internal audit; and
- Clause 5.6, Management review.

How is employee awareness raised?

Typical ways to raise employee awareness of their contribution to achieving quality objectives include:

- Orientating employees to the organization's quality policy when safety orientation is conducted;
- Holding team briefings (for example, design and construction start-up);
- Holding toolbox meetings on the work sites when safety toolbox meetings are conducted (to generate quality awareness at the craft level, it is practical to generate job-specific handouts that express topics in short bullets with illustrations and photos);
- Ensuring that quality objectives are highly visible to employees (for example, on meeting agendas and displays);
- Recognizing and rewarding good work performance; and
- Reporting nonconformances and actively giving employees information about why nonconformances occurred and how they were resolved.

6.3—Infrastructure

Refer to ISO 9001:2000, Section 6.3.

Discussion for Section 6.3

The right tools for the job include not only the construction equipment, but also the computers, software, reference materials, cell phones, and other peripherals that are necessary to operate a project.

6.4—Work environment

Refer to ISO 9001:2000, Section 6.4.

Discussion for Section 6.4

This clause explicitly states that the work environment affects product conformity. For concrete contractors, these clauses apply to all installations and to hot and cold weather construction.

This section also applies to suitability of the environment for the workers. Change rooms break areas, sanitary facilities, adequate parking, sources of hot food, and a culture of safety are key elements in supporting productive environments.

Safety and environmental issues can be generalized in this section.

SECTION 7—PRODUCT REALIZATION

7.1—Planning of product realization

Refer to ISO 9001:2000, Section 7.1.

Discussion for Section 7.1

Planning process management

In this Standard, product realization is the delivery of a service or the manufacturing of a product.

The clause requires planning for all of the activities necessary for product realization. Some examples for designers include:

- Considering what the customer wants;
- Providing a procedure for checking drawings and specifications before issue; and
- Reviewing design outputs against input specifications.

Some examples for construction activities include:

- Determining the resources needed;
- Determining the criteria for acceptance of all items in each work method; and
- Determining the records required (final inspection reports).

The construction industry is unique in that projects are generally short term, and each new project consists of different parties that are typically working together for the first time.

The ability to bring together a project team to deliver what the customer wants requires careful selection of the parties involved. Some bidding methods and assumptions do not make it easy to bring projects in on time and on budget.

To mitigate the effects of short-term construction projects and the delivery of custom teams for each project, planning activities are very important in the construction industry.

The output of the planning for a specific project can be a project plan, project schedule, work method, or a combination thereof. It is the organization's decision how the plan is recorded; if the organization decides that a formal project plan is needed, it can be as brief as a checklist or flow chart with references to the documents or parts of the QMS.

For complex projects, detailed plans are appropriate.

Plans could include:

- Responsibilities (the person or organization responsible for verification);
- Stages in the process when verification is to be carried out (hold points);
- Method(s), equipment, and cycle time;
- Frequency of inspection and criteria for acceptance;
- Records of verification to be made, and their format; and
- Review, distribution, and retention.

The plans should be no more detailed than what is necessary to obtain consistent results for the competency level of the people involved on the project. Where applicable, the organization also needs a plan to address handling of materials and items accepted on the basis that evidence of compliance would subsequently be available (for example, concrete delivery acceptance for which the strength at 28 days or a water-cement ratio are a specific requirement).

7.2—Customer-related processes

7.2.1 *Determination of requirements related to the product*

Refer to ISO 9001:2000, Section 7.2.1.

7.2.2 *Review of requirements related to the product*

Refer to ISO 9001:2000, Section 7.2.2.

Discussion for Section 7.2.2

The purpose of a construction QMS is to ensure that the project is being constructed in compliance with plans and specifications. Specifications are a legal contract and should be treated as such. The purpose of a specification is to ensure that the quality of workmanship, tolerance control, or materials needed for the finished construction satisfies the customer's requirements.

Sometimes a specification may conflict with local practice or the experience of the contractor. If a contractor finds that a specified item of the project can't be achieved, a meeting should be arranged with the designer to fully discuss the issue. All such meetings, and the decisions reached, should be recorded and kept with the contract documents.

Understanding the customer requirements

This section of the Standard requires a process of review of the contract to ensure that all of the requirements can be met. Contractors should determine if there are any design requirements.

Some requirements not specified should be given due consideration; formed finishes and color consistency, though not always stated, can often cause problems with customer satisfaction. Functional considerations, such as durability and resistance to cracking, are not always written into contracts. It is sometimes possible to meet the minimum contract requirements and still not satisfy the customer.

Bid requests and proposals should be reviewed to ensure that:

- The requirements are understood;
- The requirements can be met; and
- The project management system can deliver.

A record of the review is required, and can be as simple as a notation on the contract. Many construction firms have a formal contract review committee.

For construction projects, the further definition of product requirements in Clause 7.2.1 is aimed at clarifying—rather than extending—the scope of the supplier's responsibility. (See also Clause 7.3.2.)

7.2.3 *Customer communication*

Refer to ISO 9001:2000, Section 7.2.3.

Discussion for Section 7.2.3

Communicating with the customer

To ensure that the customer's expectations are met, identify and document the customer's requirements. As noted in Clause 5.2, achieving customer satisfaction usually requires more than just meeting technical requirements.

Concerns regarding customer requirements should be resolved with the customer before signing the contract.

What about changes?

Any change to a contract should be reviewed in the same manner as the original contract. Everyone affected by the change should be informed.

In a project, the team responsible for managing the project needs to ensure that there is a process for managing changes in the scope of the work. No work should proceed until the customer has approved scope changes.

7.3—Design and development

7.3.1 *Design and development planning*

Refer to ISO 9001:2000, Section 7.3.1.

Discussion for Section 7.3.1

Providing a disciplined approach to design and development

It is important for the organization to analyze and determine if this clause is applicable. It is applicable only to those firms that actually carry out design and development. In the construction industry, design can apply not only to the permanent construction, but also to temporary construction that enables the construction of the permanent structure. For example, the methodology presented in Clause 7.3 could also be applied to designing forms for concrete or a concrete mixture. Activities pertaining to the management and performance of design continue into the construction phase and to completion of the project (such as review and signoff that the design's specifications have been met by the constructed work).

Design firms need to plan the design activities and to the individuals who will perform them. Responsibilities for design should be clearly assigned, and methods for implementing and updating the design plans should be established. It is not essential to identify whether an activity is design or development because the Standard treats these as part of the same continuous process.

If there is more than one designer, or if the design is packaged into separate stages (that is, different disciplines or project stages), then it is possible to allocate the design stages to different designers. If this happens, it should be shown in the design plan. A small business may only have one designer. Even in a small business, communication with other parties is important. These include customers, regulatory bodies, and suppliers. If design is outsourced, the requirements of 4.1 should be met.

7.3.2 *Design and development inputs*

Refer to ISO 9001:2000, Section 7.3.2.

Discussion for Section 7.3.2

What needs to be considered?

This clause requires defining and documenting the inputs for performance of design and development (if not otherwise documented), and reviewing them for completeness and adequacy (particularly where they have been provided by others).

The customer's needs, which are a major consideration, may not always be clearly stated. Other factors that need to be considered and recorded include:

- Use of the facility, the environment in which it functions, and the expected lifespan;
- Aesthetics;
- Available technology and materials; and
- Constructibility issues that concern common practices, logistics, limitations of materials, and accepted standards.

7.3.3 *Design and development outputs*

Refer to ISO 9001:2000, Section 7.3.3.

Discussion for Section 7.3.3

What is the result?

This clause requires documenting design output, which may occur at a number of stages in the design process.

The developer of a design package is required to document its design output in a way that it can be verified against the requirements contained in the design input (see Clause 7.3.5). There may be requirements regarding the form of the design output that need to be covered in the planning stage.

In the construction industry, the design output is usually design drawings and specifications. Specifications should be clear in stating what is required.

Design output should identify the characteristics that are essential for the intended use of the facility. Design output becomes input for purchasing, construction, or other activities; therefore, it needs to contain clear and sufficient criteria for the acceptance of the work.

Design output may also need to include requirements relevant to the procurement, construction, maintenance, and operating processes. Requirements may relate to protecting existing conditions or to ensuring the suitability of the completed work or processes (for example, the accuracy and calibration requirements for instruments, the construction processes that require validation, or the specific construction records and requirements for spare parts).

Design output documents should be approved before issue and treated as controlled documents. (see 4.2.3). They should be approved and signed off by the Engineer of Record Lead Design Professional in Charge and the owner's representative, if applicable per the design contract, or the owner her/himself alone, if the owner has assumed the role of Engineer of Record.

7.3.4 *Design and development review*

Refer to ISO 9001:2000, Section 7.3.4.

Discussion for Section 7.3.4

Do the pieces fit?

Design review is the formal checking of design planning, inputs, and outputs. Design reviews may take a variety of forms, including meetings and circulation of design documentation. Design reviews can take place at any stage of the design process. Simple designs may only require one review,

whereas complex designs involving many disciplines will require more frequent reviews.

Figure A shows a simplified diagram of the relationship between review, verification and validation of the design, and the development process. For some design-build contracts, the designer will only be responsible until completion of design drawings and specifications. In those cases, the designer will not be responsible for validation. Beyond this point, it is the contractor's responsibility (perhaps in concert with the owner) to validate the design and assure constructibility and relevance to the objectives.

Who is involved in design reviews?

Those involved in the construction should be involved in design review, which is often referred to as a constructibility review.

If the organization is responsible for overall management of the design, it needs to plan (see 7.3.1) and ensure the performance of design reviews. Designers can be expected to participate in design reviews that are relevant to or interface with their design package.

7.3.5 *Design and development verification*

Refer to ISO 9001:2000, Section 7.3.5.

Discussion for Section 7.3.5

Is it right?

Verification is checking that the results of the design process meet the requirements identified at the start of the design process.

Methods of design verification include:

- Performing alternative calculations;
- Comparing the new design with a similar proven design;
- Undertaking tests;
- Checking the design documents before release; and
- Peer review.

What is the difference between design review and design verification?

Design verification is confirming that design output meets the design input requirements for each design element and design package individually.

Design review involves project participants at specified stages (typically at 25, 50, and 75%, and completion) to ensure that the design packages meet the needs and requirements of the other project functions and are capable of achieving their objectives.

7.3.6 *Design and development validation*

Refer to ISO 9001:2000, Section 7.3.6.

Discussion for Section 7.3.6

Does it work?

Validation is the process of checking that the final product or service will be capable of meeting the customers' requirements.

For construction projects, validation can mean checking that the completed component will meet the requirements for the project (Clause 7.3.2).

An organization needs to clearly identify, document, and agree with a customer about the requirements that are subject to design validation, the criteria for assessment, and the organization's role. This generally involves trial runs to determine if the equipment functions as specified.

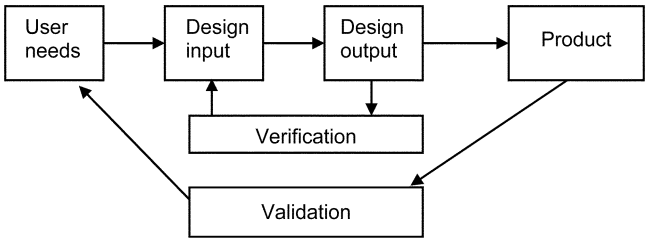

Fig. A—Design review.

Some examples of design validation include:

- Commissioning of process plants, such as wastewater and water treatment plants; and
- Pressure testing of piping systems or pressure vessels.

It is also acceptable for the customer to perform the validation and provide feedback to the designer.

7.3.7 *Control of design and development changes*

Refer to ISO 9001:2000, Section 7.3.7.

Discussion for Section 7.3.7

This clause requires management of design changes that occur. A study performed by the Construction Industry Institute (1989) indicated that over 50% of rework costs are due to design changes. Therefore, controlling design change is critical.

The QMS requires formal document and change control procedures that must be followed. A design firm's protocols that detail how revisions are initiated and communicated on drawings is an important element. It should be included in this section or in the firm's engineering procedures.

Once construction has started, changes should be completed in a timely manner to prevent items from being built before the change can be conveyed to the contractor. Most contractors maintain a hot stick drawing file that contains the latest revisions. As previously pointed out, electronic files should carry only the most current revisions. Superintendents are required to sign off daily to make sure that any changes that affect their areas are realized.

In a typical construction project, those involved in the actual construction will not have authority and competency to approve design changes; therefore, site changes involving design matters will need to be referred to the appropriate designer. A request for information (RFI) log is a useful tool for ensuring that all questions of the design from the field are answered and that the information is made available to all who might require it. Checklists and signoffs should reference the drawing and revision plus any RFIs, field change notices (FCNs), or nonconformance report dispositions not yet incorporated into the drawings. Checklists and signoffs should be reviewed to ensure that changes have been addressed. It is the responsibility of the organization managing the project to ensure that resources are available to manage this interface.

7.4—Purchasing

7.4.1 *Purchasing process*

Refer to ISO 9001:2000, Section 7.4.1.

Discussion for Section 7.4.1

Planning and managing purchasing

Management of purchasing requires a planned approach that includes selecting suppliers, specifying requirements, and evaluating if specifications have been met.

Ready mixed concrete supply is an example of a product that is outsourced. An organization can continue to use existing suppliers when developing a QMS; however, ISO 9001:2000 requires that selection be carried out in a controlled manner. Before the final selection of a supplier, it is wise to conduct an audit of batching facilities, review strength histories, evaluate the supplier's response to previous issues, and review documentation control. Organizations should outline quality requirements, including the selection criteria that are used for the selection of suppliers.

Records should be maintained of approved suppliers and an organization's basis for its approval. ISO recognizes that price is a factor.

7.4.2 *Purchasing information*

Refer to ISO 9001:2000, Section 7.4.2.

Discussion for Section 7.4.2

Stating purchasing requirements

The purchase order should leave no doubt as to what is wanted. Instructions should be a written order. Phone orders are subject to misunderstanding by suppliers; phone orders should be confirmed by fax or e-mail.

Written purchase orders should be checked before issue. In simple cases, this may just involve reading, initialing, and dating the order.

In the construction industry, purchase orders are often in the form of catalog cuts or specifications. They need to define, as applicable:

- Scope;
- Timing;
- Constraints;
- Performance requirements, technical requirements, and acceptance criteria for the work;
- QMS requirements for suppliers and subcontractors; and
- Documentation to be provided and applicable controls to provide confidence about compliance to specified requirements.

Organizations should reserve the right to carry out surveillance activities and audits. This includes access for a planned surveillance (see Clause 7.4.3).

Purchasing documents should be reviewed to ensure their adequacy. Purchasing documents (requests for proposals [RFPs], quotes, and contracts) should be maintained at least until contract closeout to avoid misunderstandings and oversights.

7.4.3 *Verification of purchased product*

Refer to ISO 9001:2000, Section 7.4.3.

Discussion for Section 7.4.3

Did you get what was ordered?

The quality control measures for a project need to be established in the purchasing instructions (Clause 7.4.2).

Most businesses have some form of monitoring and measuring, such as a simple checklist, to determine that what was delivered matches the purchase order, or a surveillance process at the supplier's plant to inspect what is ordered. In construction, it is typical to assign an inspector to the batch plant on major concrete placements. Shop inspection of reinforcing steel suppliers is often conducted to verify bending and coating practices and to confirm traceability of the materials. The interval between off-site inspections can be determined by contractual requirements, confidence level, possible schedule impacts, and on-site inspection capabilities. The detailed requirements of an organization's inspection plans will be derived from codes, standards, and specifications. Many firms develop standard inspection checklists that are modified to account for any special requirements. The checklist should be signed off by all parties, including production supervisors, subcontractors, inspection staff, and owner's representatives as applicable.

There are many sources of checklists:

- ACI *Manual of Concrete Inspection* (SP-2) (ACI Committee 311 1999);
- International Conference of Building Officials *Construction Inspection Manual* (Raebar 1998); and
- National Ready Mix Concrete Association batch plant certification checklist.

These sources are recommended, and can be modified to suit your needs.

Design work that is subcontracted to subconsultants should be reviewed by the consultant to verify that the design meets the design criteria.

7.5—Production and service provision

7.5.1 *Control of production and service provision*

Refer to ISO 9001:2000, Section 7.5.1.

Discussion for Section 7.5.1

Controlling what you do

This clause describes the various types of controls that need to be in place to actually produce and supply the product or service.

The control of the processes needs to address applicable statutory and legal requirements, whether or not these are stated in the contract.

Processes should be documented to the extent necessary to get consistent and acceptable results; how this is done is up to each organization. The current process should be evaluated; it should be determined if the requirements of (a) through (f) are adequately covered.

Documented work methods are often employed to control the work. They reference specifications and include work instructions, equipment requirements, inspection and testing requirements, post-delivery requirements, inspection records, and often a log or index of inspection records.

ACI certification programs are recommended to establish competence for concrete construction (see Clause 6.2.2). It should also be ensured that the personnel involved are familiar with any site or customer-specific requirements.

The National Ready Mixed Concrete Association has a certification program that provides details for the production of concrete mixtures. The three-part quality control manual is a comprehensive guide for a concrete producer's production control.

The Prestressed Concrete Institute has a certification program for prestressed concrete producers. It is referenced in MNL 116-85 (PCI 1985).

The Post-Tensioning Institute (PTI) sponsors training and certification programs for installers, inspectors, and manufactures of post-tensioning systems.

This clause also requires that any service or maintenance required for the product after its delivery should be provided in a controlled manner. An example of this is the maintenance of a highway facility (for example, snow removal) after the highway is opened for traffic, but before the customer formally accepts the facility.

7.5.2 *Validation of processes for production and service provision*

Refer to ISO 9001:2000, Section 7.5.2.

Discussion for Section 7.5.2

There are some processes where: 1) the results of measurements to confirm that the product meets requirements are not immediately available; 2) the measurements cannot be carried out without destroying the product and, therefore, the processes are conducted with certain controls as a condition of their acceptance; or 3) both.

An example of the first situation is the placing of concrete. The properties of the hardened concrete are not known at the time of placing; control of the mixing and delivery system is essential.

Welding is an example of the second situation. Welding procedures are an example of a validated process. The welder is required to be trained and qualified to perform the welding in accordance with a qualified welding procedure.

The specification needs to identify those processes that require validation, and determine what evidence of validation is needed by the organization.

Constructors need to identify and document any processes that require validation outside of those required in the project specification.

7.5.3 *Identification and traceability*

Refer to ISO 9001:2000, Section 7.5.3.

Discussion for Section 7.5.3

Keeping track of what you are doing

Identification means knowing the product or service identification that results from a particular process.

The identification methods should be documented for each product or service identified, and the records kept about its identification should be described.

Traceability is knowledge or record of where the product or service came from, where it is currently, and, in the case of services, its current status. Examples include:

- Job card entries;
- Batch cards;
- Inspection records;
- Tagging; and
- Recording of the location of particular materials (for example, batches of concrete).

Traceability is often an underemphasized issue in concrete construction. Tracing the structure to the truck load is usually recorded adequately. Sources of aggregate and cements, however, require solid control to prevent variances by suppliers due to price or availability. Reinforcing bar sources are often not closely monitored.

Records that provide traceability should be retained in a QMS.

7.5.4 *Customer property*

Refer to ISO 9001:2000, Section 7.5.4.

Discussion for Section 7.5.4

Looking after customer property

This clause requires appropriate care to be taken of customer's property that is either being used by the organization or under its control.

What is customer property?

Examples of customer property are:

- Supply of a particular piece of equipment for inclusion in a facility;
- Testing equipment supplied by the customer;
- Technical information (for example, geotechnical reports or a land survey) (if not covered by the provisions for design input under Clause 7.3); and
- Intellectual property or confidential documents (for example, computer software and specifications).

On receiving property from a customer, its condition should be checked and it should be determined that it is suitable for its intended purpose. In some cases, it may be advantageous to do this jointly with the customer, but in any event, the customer should be promptly notified of any deficiency in the provided property.

An organization is responsible for ensuring that the controls in place to protect customer property are sufficiently documented. Within this documentation, it should be described how the property is identified and protected. Any special storage, handling, segregation, security, stock rotation, hazardous materials, or maintenance requirements should be defined by the owner. Records should be kept for all inspections and maintenance.

7.5.5 *Preservation of product*

Refer to ISO 9001:2000, Section 7.5.5.

Discussion for Section 7.5.5

Looking after the product, service, or both

Depending on the nature of the organization, some or all of the requirements of this clause may apply to a project plan; how this is done is flexible. Procedures should not be unnecessarily documented when normal work practices adequately address the requirements.

Note that this requirement covers constituent parts (for example, deliveries to and from storage at your site as well as product provided to your customer).

Organizations should to be aware of any regulations or requirements of each supplier regarding handling, packaging, and storage. Examples of these include:

- Lifting requirements;
- Appropriate storage of equipment (for example, weather-proof storage of electrical and mechanical equipment);
- Handling and labeling of hazardous materials; and
- Expiration dates of paints and chemicals.

7.6—Control of monitoring and measuring devices

Refer to ISO 9001:2000, Section 7.6.

Discussion for Section 7.6

Confidence in equipment used to check work

It is important to understand the difference between monitoring and measurement. Monitoring implies the observation and supervision activities. Measurement deals with the determination of quantity, magnitude, or dimension (for example, concrete cylinder strength).

PCI MNL 116 (PCI 1985) contains requirements for calibration of equipment and records required.

The testing laboratory should not be overlooked when verifying calibration. It is advisable to audit labs before any work is performed and request calibration documents of all equipment to be used on the project.

For each reference standard to be valid, it needs to be traceable to an appropriate recognized (that is, accurate) source. This will normally be a national or international standard.

SECTION 8—MEASUREMENT, ANALYSIS, AND IMPROVEMENT

8.1—General

Refer to ISO 9001:2000, Section 8.1.

Discussion for Section 8.1

A plan for monitoring and measuring activities should be developed. This plan will apply to:

- Customer satisfaction (8.2.1);
- QMS performance (8.2.2); and
- Product (or service) performance (8.2.4).

These clauses provide the data to be analyzed as per Section 8.4.

8.2—Monitoring and measurement

8.2.1 *Customer satisfaction*

Refer to ISO 9001:2000, Section 8.2.1.

Discussion for Section 8.2.1

Are you giving the customers what they want?

Each customer's perception of a QMS's performance needs to be monitored and measured. There can be a wide range of customers. With some projects, particularly those being contracted (such as design-build-own-operate), the organization may consider the end users as customers. A design organization could view the users of its design output (for example, the contractor and the owner) as customers. In the case of a manufacturer supplying materials or equipment to the construction industry, the customers could include the architects/engineers, the contractors, and the end users.

In the construction industry, it is not unusual for organizations to have close relationships with their customers. Customers are often involved in the review of designs and, in some cases, even the inspection of construction.

It is important to understand how the customer's perception of the product quality relates to their degree of satisfaction. If the customer's requirements are met and they perceive that they are not, or that the quality is insufficient, then the customer will be dissatisfied; thus, the requirements of this clause have not been met.

It can be difficult to obtain accurate information about customer satisfaction, but direct customer contact is probably the most effective.

8.2.2 *Internal audit*

Refer to ISO 9001:2000, Section 8.2.2.

Discussion for Section 8.2.2

What is an audit?

An audit involves an independent examination of how work processes are being performed (or have been performed). Owners who specify compliance with this Standard should have qualified auditors perform audits on a planned basis.

The importance of the internal audit process is recognized in the Standard by the requirement in this clause for a documented procedure.

The audit process should include:

- Planning the audit;
- Reviewing the relevant QMS documentation (the basis for the audit);
- Reviewing production reports, failure trends, and customer complaints;
- Conducting the audit;
- Reporting the results; and
- Verifying corrective action.

The frequency of audits should be based on the maturity of the organization. It should, as a minimum, cover all requirements of the Standard annually.

The information obtained from internal audits should provide input into the management review.

8.2.3 *Monitoring and measurement of processes*

Refer to ISO 9001:2000, Section 8.2.3.

Discussion for Section 8.2.3

Generally, the most effective way to ensure output quality is to monitor and control the processes that provide the product or service. Inadequate control of the process may render product verification inappropriate or may compromise delivery times or other requirements.

Requirements for recording and reporting on the performance of the processes should be considered. Examples include:

- A quality plan;
- An inspection and test plan; and
- A sampling plan.

Monitoring and measurement of processes may already be normal to the process and a standard way of working in the construction industry (that is, laser-controlled graders, or temperature control of concrete mixtures).

Measurement and monitoring of processes may only require limited documentation to demonstrate compliance (for example, for a small contractor owner/manager, a diary record of site visits confirming the performance of the foreman may suffice). It is up to the organization to determine the process requirements, criteria for acceptance, frequency of inspection, and documentation requirements. These are typically addressed in the work method (or engineering procedure) for each activity.

8.2.4 *Monitoring and measurement of product*

Refer to ISO 9001:2000, Section 8.2.4.

Discussion for Section 8.2.4

Checking to make sure things are right

This clause concerns verifying that the customer's requirements have been met.

This verification should be conducted in accordance with a predetermined plan that identifies methods, sampling plans, criteria for acceptance, task responsibilities, and records to be kept.

The level of detail of the plans and the acceptance criteria should be no more than is necessary to obtain consistent results for the competency of people involved. Where applicable, organize and plan for material accepted on the basis of future test evidence (for example, developing a protocol for acceptance of concrete on the basis of plant inspection and field tests upon delivery before the 28-day strengths can be determined).

8.3—Control of nonconforming product

Refer to ISO 9001:2000, Section 8.3.

Discussion for Section 8.3

What constitutes a nonconforming product?

A nonconforming product is any product or service that does not conform to established requirements. The product needs to be clearly identified and controlled to prevent unintended use.

A documented procedure is required for handling nonconformity. This procedure should clearly establish the means of identifying, documenting, and subsequently responding to any nonconforming products or services.

When a nonconforming product or service is identified, the following options may apply:

- Rework the product to make it conform to specifications;
- Repair it with customer's approval;
- Rework it with customer's approval;
- Relegate it to another application;
- Scrap it; or
- Use it as is with customer's or designers' approval.

The item should be rechecked to assure compliance.

8.4—Analysis of data

Refer to ISO 9001:2000, Section 8.4.

Discussion for Section 8.4

This requirement should not be underestimated. Analyzing data is essential for any possible improvement. Collecting data has no meaning if the information is not examined and evaluated.

Some examples of information that should be evaluated are:

- Nonconformance reports;
- Customer complaints;
- Missed schedule dates;
- Performance of suppliers;
- Downtime;
- Customer changes;
- Engineering changes or errors;
- Vendor changes or errors; and
- Statistical analysis of measurable product qualities.

8.5—Improvement

8.5.1 *Continual improvement*

Refer to ISO 9001:2000, Section 8.5.1.

Discussion for Section 8.5.1

Continual improvement should be interpreted as a recurring (step-by-step) activity. This clause restates one of the requirements of Clause 8.1: processes for achieving improvement to your QMS need to be planned. Whereas Clause 8.1 is concerned with planning the processes for obtaining performance data, however, Clause 8.5.1 also focuses on managing the implementation of the planning process by using captured data described in Clause 8.4.

8.5.2 *Corrective action*

Refer to ISO 9001:2000, Section 8.5.2.

Discussion for Section 8.5.2

Corrective action is not correction (rework) of a nonconformance; it is corrective action applied to the procedure to prevent reoccurrence of the problem.

This continuous improvement strategy should have procedures documented and in place.

When something goes wrong and has not been rectified at the stage of conformance verification, or when it causes a customer complaint, then there is generally a need for corrective action. One recommendation is to review every nonconformance for possible corrective action. Corrective action is often provided by improvement of the procedure or work method, thus reducing the risk of reoccurring nonconformance.

The need for corrective action is identified by factors such as:

- Customer complaints;
- Warranty claims;
- Problems with suppliers;
- Nonconformities;
- Rework;
- Audit reports; and
- Statistical indicators of poor production control, such as wide grouping of compressive strengths.

Corrective action should be recorded, and time limits should be set for verification.

8.5.3 *Preventive action*

Refer to ISO 9001:2000, Section 8.5.3.

Discussion for Section 8.5.3

Preventive action is more difficult to address than corrective action because it anticipates circumstances that are likely to cause nonconformities, rather than respond to problems.

Training is one example of preventive action. A constructibility review is another example of preventive action. When establishing a design plan, the key risks to poor design outputs can be identified and can then be reviewed at each stage of design development. Similarly, when planning a construction process, those aspects of the process that present a significant risk to achieving the intended outcomes should be identified.

Preventive action procedures should be open; all employees should be invited to make preventive action suggestions. Tool box meetings, where safety issues are reviewed, are excellent forums to review quality procedures and work methods for risks of poor quality output.

REFERENCES

ACI Committee 121, 1985, "Quality Assurance Systems for Concrete Construction (ACI 121R-85)," American Concrete Institute, Farmington Hills, MI, 7 pp

ACI Committee 121, 1998, "Quality Management System for Concrete Construction (ACI 121R-98)," American Concrete Institute, Farmington Hills, MI, 9 pp.

ACI Committee 121, 2004, "Quality Management System for Concrete Construction (ACI 121R-04)," American Concrete Institute, Farmington Hills, MI, 33 pp.

ACI Committee 311, 1999, *Manual of Concrete Inspection*, SP-2, American Concrete Institute, Farmington Hills, MI, 209 pp.

American Concrete Institute, 2008, "ACI Concrete Terminology," American Concrete Institute, Farmington Hills, MI, http://terminology.concrete.org (accessed Apr. 28. 2008).

British Standards Institute, 1974, "Guidelines for Quality Assurance," BS 5179, British Standards Institute, London.

British Standards Institute, 1979, "Specification for Design, Development, Production, and Servicing," BS 5750, British Standards Institute, London.

Construction Industry Institute, 1989, "Measuring the Cost of Quality in Design and Construction," *CII Publication* 10-2, The University of Texas at Austin, Austin, TX.

ISO 9001:2000, "Quality Management Systems—Requirements," American Society for Quality, Milwaukee, WI, 36 pp.

ISO 9000:2000, "Quality Management Systems—Fundamentals and Vocabulary," American Society for Quality, Milwaukee, WI, 36 pp.

ISO 9004:2000, "Quality Management Systems—Guidelines for Performance Improvements," American Society for Quality, Milwaukee, WI, 66 pp.

National Aeronautics and Space Administration (NASA), 1962, "Quality Assurance Provisions for Space System Contractors," NPC 200-2, NASA Headquarters, Washington, DC.

National Ready Mixed Concrete Association (NRMCA), 2002, "Plant Certification Checklist," *Quality Control Manual*, Section 3, NRMCA, Silver Spring, MD.

North Atlantic Treaty Organization (NATO), 1968, "Allied Quality Assurance Publication 1," AQAP-1, NATO, Brussels.

Precast/Prestressed Concrete Institute (PCI), 1985, "Manual for Quality Control for Plants and Protection of Precast and Prestressed Concrete Products," MNL 116-85, fourth edition, PCI, Chicago.

Raebar, J., 1998, *Construction Inspection Manual*, seventh edition, Craftsman Book Co., Carlsbad, CA.

U.S. Department of Defense, 1959, "Quality Program Requirements," MIL-Q-9858, U.S. Department of Defense, Washington, DC.

U.S. Department of Defense, 1963, "Quality Program Requirements," MIL-Q-9858A, U.S. Department of Defense, Washington, DC.

APPENDIX A—MODEL QUALITY MANAGEMENT SYSTEM MANUAL FOR DESIGNERS, CONSTRUCTION MANAGERS, AND CONSTRUCTORS

Revised and edited by ACI Committee 121, Quality Assurance Systems for Concrete

Summary of revisions:

ACI Committee 121 added Sections 1, 2, and 3, and revised the numbering system of the entire document so that it corresponds exactly with that of ISO 9001:2000. Revisions have been made to further adapt the document to the concrete construction industry.

CONTENTS

ORIGIN OF DOCUMENTS

Revision per ACI Committee 121, Quality Assurance Systems for Concrete

The NYC MTA Bridges and Tunnels, Engineering and Construction Department, has graciously provided this document of the same name to the American Concrete Institute (ACI) Committee 121 so that ACI can provide concrete construction practitioners with a model to implement the ANSI/ISO/ASQ 9001:2000 (herein referred to as ISO 9001:2000) requirements within their organizations. Committee 121 has made changes to this document by adding Sections 1, 2, and 3, and then revising the numbering of the sections and clauses so that they are identical to those used in the ISO 9001:2000. The committee has also updated the content of the document, especially from the constructor's viewpoint.

This revised document is provided as Appendix A in "Guide for Concrete Construction Quality Systems in Conformance with ISO 9001" so that it can be used as a template or model for organizations that are writing or updating quality manuals in the construction industry.

The committee wishes to express appreciation to Mr. Robert Nespeco, the author, and the NYC MTA for the provision of this very practical tool for utilization of ISO 9001:2000 to produce a quality management system manual (QMSM) for ACI members and concrete construction practitioners.

Instructions for use of this model Quality Management System Manual

The committee has revised and updated this model QMSM to assist designers, construction managers, and constructors (including students) that do not have (or who require an update for) a QMSM modeled to ISO 9001:2000.

This model addresses the requirements of ISO 9001:2000 from a construction perspective, and it is general in nature. The designer, construction manager, or constructor is solely responsible for the content and implementation of a QMSM that meets contract requirements.

No representation is made for this QMSM. All efforts to provide a template that will conform to the requirements of ISO 9001:2000 have been taken, but guarantees to that effect are not stated or implied.

In some cases, portions of individual elements in ISO 9001:2000 may not apply, or apply in a limited way. In other cases, the scope of work (design versus construction versus construction management) may necessitate different wording approaches.

There is a model QMSM section that corresponds to each of the eight sections in ISO 9001:2000 that need to be implemented. The introduction written at the beginning of each of these sections provides general guidance on the intent of the section and identifies a suggested QMSM wording for designers, construction managers, and constructors, where such differentiation is appropriate.

Italics and underlining are used to highlight areas where specific requirements or information applicable to your organization should be inserted or identified, such as your organization's name or titles of appropriate positions in your organization.

[Italicized words in brackets] indicate guidance or suggested options.

[Bold italicized words in brackets] indicate suggested or recommended language, text, or both.

SECTION 1—SCOPE

[Introduction (do not include this introduction in the QMSM):

This section corresponds to Section 1 of the ISO 9001:2000 and is used to state the scope of application of this QMSM.

An organization may choose to either register to ISO 9001:2000 or to comply without certification/registration to ISO 9001:2000.

Regardless of whether your organization is seeking certification/registration to ISO 9001:2000 or just seeks to comply without certification/registration to ISO 9001:2000, you can choose the projects that will utilize this QMSM and, thus, the projects that will comply (with or without certification/registration) to ISO 9001:2000.]

1.1—General

The Company [name of your company] will utilize the quality management system manual (QMSM) for *Project* located at *address* and *will* or *will not* register or certify this project to ISO 9001:2000. *[The user of this template is advised that this very first instance of "the Company" requires the introduction of the name of the company that is writing this QMSM. All subsequent locations of "the Company" in this document may remain unchanged if you choose to use the Company in parentheses as the reference to your company name. In that way, when joint venture companies are formed, the document is still accurate after the initial name revision.]*

The Company strives to enhance customer satisfaction through the effective application of the QMSM, including processes for continual improvement and assurance of conformity to customer, regulatory, and code requirements.

1.2—Application

The quality management system (QMS) applies to all operations within the organization *[or state the operations of your organization for which this QMSM applies]*. Certain clauses addressed in Section 7 of the ISO 9001:2000 are excluded by *the Company* on this *project*. These clauses are *[list clauses. Usually Clause 7.3 only may be excluded and listed in this section].*

SECTION 2—NORMATIVE REFERENCE

Normative means standard. This QMSM references both ISO 9000:2000, "Quality Management Systems—Fundamentals and Vocabulary," and ISO 9001:2000 "Quality Management Systems—Requirements."

SECTION 3—TERMS AND DEFINITIONS

This QMSM utilizes the definitions provided in ISO 9000:2000 as well as specific terms that are listed in this section. *[Terms may be added and defined in this section.]*

[Note that ISO 9001:2000 does not impose terms on the user other than those indicated in ISO 9000:2000. Even the name or title of your quality system is left to your choice. For that reason, the following terms are defined to recognize commonly used construction QMS terms. Add and edit as required.]

The Company or Organization—these terms are utilized interchangeably in this document.

Contract—this term is utilized interchangeably with Agreement in this document and refers to the contract agreement between the Organization (the subject of each item of this QMSM) and their client.

engineering procedures—this term is utilized by designers and construction managers to describe the body of information requested in Clause 7.5.1.

inspection and test plan—this term is utilized to identify a document often utilized as part of a work method that provides method of inspection or testing, criteria for acceptance, frequency of inspection or testing, position or title that provides the verification, owner's requirements for "hold point" or "witness point," and the document used to record the evidence.

quality management system manual (QMSM)—this term identified in Clause 4.2.1 can be thought of as the entire body of quality documents or binders that collectively describe the QMS.

quality plan (this document *[after editions have been made to fully describe our QMS]***)**—the term "quality plan" is utilized within the context of quality manual as the overview document that *the Company* has produced to describe the QMS. *[If the organization is in fact utilizing this definition of quality plan, then they are advised to review and revise many instances of the term QMSM to quality plan throughout this document.]*

work methods—this term is utilized in construction to indicate the body of information requested in Clause 7.5.1. The work method references specifications and includes work instructions, equipment requirements, inspection and testing requirements, post-delivery requirements, inspection records, and often a log or index of inspection records.

SECTION 4—QUALITY MANAGEMENT SYSTEM

[Introduction (do not include in QMSM):

This section corresponds to Section 4 of ISO 9001:2000. Use it to describe your overall QMS and identify those processes, procedures, and other documents that ensure effective operation and control over your processes.]

4.1—General requirements

ISO 9001:2000 requires that the Organization establish, document, implement, and maintain a QMS and continually improve its effectiveness.

[ISO 9001:2000 provides Section 4.1 and bullets (a) through (f) and thus identifies requirements for all of the processes needed for your QMSM. Identify how each of these requirements will be satisfied and where the elements fulfilling the requirements are found in your QMSM.]

The Company has:

a) Identified the processes needed for management of quality and their application throughout the organization including any exclusions permitted by Clause 1.2 of ISO 9001:2000. Our *QMSM (or quality plan) (decide the name you prefer after consulting Section 3)* is the document that describes our methods and procedures for maintenance of our QMS;

b) Determined the sequence and interaction of these processes *[for example, as depicted in flow charts or process diagrams that you might also include in your QMS]*;

c) Determined the criteria and methods needed to ensure that both the operation and control of these processes are effective *[for example, as shown in work methods and inspection and test plans for each field process, or engineering procedures for each design office procedure]*;

d) Ensured the availability of resources and information necessary to support the operation and monitoring of these processes *[For example, where resources and information pertain to the whole organization, they are identified in this QMSM or quality plan document. Where resources and information pertain to a work activity, they are identified in the applicable work method.]*;

e) Provided procedures that describe how we monitor, measure, and analyze these processes *[For example, monitoring such as internal audits, nonconformance, and corrective action can be found in a procedures manual. Monitoring activities such as inspection and testing will be found in individual work methods.]*; and

f) Implemented actions necessary to achieve planned results and continual improvement of these processes. These actions are described in this QMSM, and are audited to determine compliance.

4.2—Documentation requirements

4.2.1 *General*

The Company has established the following documentation for its QMS:

- Quality policy and quality objectives (see Clauses 5.3 and 5.4, respectively);
- QMSM *[or quality plan]* (this document);
- Documented procedures as follows *[describe applicable procedures and refer to them as bound separately, or indicate that procedures are included in the text of this QMS]*);
- Planning, operation, and process control documents, such as:
  - Scheduling and cost control tools;
  - Work methods, work instructions, or engineering procedures;
  - Internal reviews;
  - Inspection and test reports (if used);
  - Internal/external audit reports;
  - Nonconformance and corrective action procedures; and
  - Other documents used to ensure effective planning, operation, and control.
- Records showing compliance to ISO 9001:2000. *[Describe record types as appropriate.]*

4.2.2 *Quality manual*

The Company has established and maintained a QMSM. The QMSM identifies the scope of the QMS, and details any exclusions to the requirements of ISO 9001:2000. It *references or includes* documented procedures governing work activities. It includes a description of sequences and interaction of processes that fall under the scope of the QMS.

The QMSM is a controlled document. *Title* is responsible to ensure the initial issue and subsequent changes are acknowledged by those authorized to receive the QMSM.

4.2.3 *Control of documents*

A documented procedure shall be established to control documents required for the QMS. *[This procedure is typically expanded to include incoming and outgoing correspondence, and drawings and specifications.]*

[Your organization's QMS should specify the flow of documents, be they contract modifications, design change documents, submittals, or other. This section of the QMSM is an appropriate place for this information. It may include a flow chart for those documents requiring approvals, a responsibility matrix, specific retention times for reviews, and any limitations to authorizations to proceed with provisional approvals.]

[Suggested language for designers:]

Project documents shall be maintained at the following location: *identify the location*. Access to these files shall be limited to: *Title(s)*.

Only the latest authorized issue of project documents shall be available for use by the designer's personnel. Documents not authorized for use, voided documents, or superseded documents shall be identified and the procedure shall describe how they shall be kept from use *[for example, be marked and placed in a different file at a different location as a means to prevent unintended use]*.

Title is responsible to review all design documents for conformance to the contract prior to transmittal to the owner's representative. This review shall be indicated on each item by: *indicate method; for example, stamp, signature, or statement*.

The recipient shall use methods to track the status of transmittals that require action. *Articulate the methods you will use. Incorporate any specific contract requirements.*

Qualified and authorized individuals, as required by the contract, will approve documents issued for construction.

[Submittal document control recommendations for designers:]

The review of constructor submittals shall conform to contract requirements. Constructor submittals shall be reviewed *how and by whom* for conformance to the original design. *[How is conformance indicated; for example, stamp or signature.]* Requests for "or equal" items shall be reviewed for conformance to design intent. A review of comments received from internal sources or from the owner's representative shall be made to ensure the design intent is accurately understood. A submittal log and status shall be maintained by *Title*.

[Suggested language for construction managers:]

Project documents shall be maintained in *file cabinets, stack files, etc.* at the following location: *identify location*. Access to these files shall be limited to: *Title(s)*. The file index system used shall be coordinated with the owner's representative.

Only the latest authorized issue of project documents shall be available for use by the construction manager's personnel. Documents not authorized for use, voided documents, or superseded documents shall *identify how they shall be kept from use; for example, be marked and placed in a different file at a different location* as a means to prevent unintended use.

All documents transmitted to the owner's representative for review shall identify the action to be taken by the engineer *attach transmittal form to plans and specifications*. The document's status shall be updated based upon the response.

Methods shall be used to process and track the status of transmittals that require action by the recipient. *Articulate the methods you shall use. Incorporate any specific contract requirements.*

Methods shall be employed to process and control requests for extra work, claims, and progress reports for constructor payments. *Articulate the methods you shall use.*

Reports required by the contract shall be signed or otherwise authenticated before release.

[Suggested language for constructors:]

Project documents shall be maintained in *file cabinets, stack files, etc.* at the following locations: *identify home office, field, etc.* Access to these files shall be limited to: *Title(s)*.

As-built documents shall be maintained by *Title* at *identify location*. An index of as-built documents shall be maintained as part of the file.

As-built conditions shall be recorded on as-built documents by *identify method; for example, redline or blueline. Indicate who shall audit or verify annotated documents for accuracy*. As-built documents shall be transmitted to the owner's representative at project conclusion by *Title*.

Only the latest authorized issue of project documents shall be available for use by the constructor's personnel. Documents under review, voided documents, or superseded documents shall *identify how they shall be kept from use; for example, be marked and placed in a different file at a different location* as a means to prevent unintended use.

Title is responsible to review all items for conformance to the contract before transmittal to the owner's representative. This review shall be indicated on each item by *indicate method; for example, stamp, signature, or statement*.

All documents transmitted to the owner's representative for review shall use a transmittal form that identifies the item transmitted and the action to be taken by the owner's representative. The document status shall be updated based on transmittal information.

Title is responsible for reviewing the contract and identifying submittals and deliverables to be transmitted to the owner's representative. *Describe how you will control this activity; for example, status list, marked contract, submittal log, or drawing log.* Controls shall be established to track the status of any item on the list that requires authorization or approval. These items shall not be released until approved or authorized. *Articulate the methods used. Incorporate any specific contract requirements.*

4.2.4 *Control of records*

A documented procedure to control the identification, storage, retrieval, protection, retention, and disposition of quality records shall be established.

Project records shall be stored in a suitable environment to prevent damage or deterioration and to prevent loss. Records shall be filed by *articulate your storage methods (such as subject, date, and file category*).

An index of project records shall be part of the documented procedure. *[It is recommended that the log of records (sometimes called a record status log) from each type of activity requiring verification be detailed at the beginning of the project. Control of records for each activity or work method is achievable if each log preidentifies all of the final records required (table format works well) and the log is reviewed and audited regularly.]*

Responsibility for the accuracy and completeness of the records is assigned to *Title*. Access to records shall be under control of *Title*. Removal of records to an out-of-file location shall be restricted to the following authorized persons: *indicate Titles*. Measures to identify removed files and their current location shall be maintained.

Title shall identify those records to be transmitted to the owner's representative upon completion of the project.

Note: Construction managers shall maintain all project records using the file index system determined by the owner's representative.

Company records that provide evidence of conformance to requirements and of the effective operation of this QMS shall be identified, stored, protected, and retained. Retrieval shall be controlled. *Title* is responsible for identifying the records to be retained, retention time, disposal method, and for arranging for their protection and controlled retrieval.

SECTION 5—MANAGEMENT RESPONSIBILITY

[Introduction (do not include in QMSM):

This section corresponds to Section 5 of ISO 9001:2000. Its purpose is to identify how your QMS addresses key management elements of ISO 9001:2000. Consider the following questions when completing this section: What is your organization's commitment to quality? Do you consider the customer? What is your organization's existing quality policy? How does your organization plan work to deliver a quality product? How will your organization administer the quality program? How often will you regularly review your QMS for improvement? How will you make your employees aware of your organization's quality policy, goals, and objectives?]

5.1—Management commitment

The top management of *the Company* is committed to the development and improvement of the QMS by:

- Communicating the importance of meeting customers (as well as regulatory and legal) requirements by *identify how you communicate this information*;
- Establishing a quality policy and quality objectives *identify your quality policy (per Clause 5.3) and your quality objectives (per Clause 5.4.1) for this project*;
- Conducting management reviews in accordance with Paragraph 5.6 of this QMSM; and
- Ensuring the availability of necessary resources in accordance with Section 6 of this QMSM.

5.2—Customer focus

The Company ensures customer satisfaction by:

1. Reviewing the contract requirements, organization capabilities, and our QMSM *[modify as appropriate]*;
2. Allocating trained and qualified staff resources to perform project tasks;
3. Scheduling and reporting progress in sufficient detail to control project schedule and cost;
4. Training personnel as required;
5. Performing internal quality audits at regular intervals that ensure compliance with the QMSM;
6. Establishing a program for problem identification and resolution and problem prevention *[Clauses 8.2.2, 8.5.2, and 8.5.3 are typically required procedures that address these issues]*; and
7. Maintaining data control systems and records of project activities.

List any other activities you shall perform to ensure customer satisfaction.

5.3—Quality policy

The Company has the following policy regarding the quality of the goods and services we offer our customers:

Articulate your Company policy here.

"It is the policy of XYZ to provide a commitment to meeting customer requirements and to improve the delivery of our services." The quality policy is regularly reviewed *state the interval* for effectiveness and appropriateness of quality objectives. The policy is communicated to those performing the work. *Identify your practices of review for relevancy and appropriateness, communication, and control.*

5.4—Planning

5.4.1 *Quality objectives*

Top management of *the Company* has identified the following quality objectives for the project. The objectives are measurable, consistent with policy, and relevant to the successful completion of the project. Attainment of objectives is considered as part of our effort for improvement. *Identify your quality objectives. Include such things as meeting contract requirements,*

resource allocations, cost control, schedule control, and other relevant quality objectives. [Effective quality objectives should be established at multiple levels in the company in accordance with the responsibilities and authorities of each department.]

5.4.2 *Quality management system planning*

The elements that comprise the quality planning process are this QMSM, project organization charts (describing personnel allocations, *Titles* of individuals, subcontractors/subdesigners necessary to complete the work) and the integration of quality improvement initiatives described in Paragraph 5.6. *[A reference to 7.1 (by means of work method for constructors or engineering procedures for designers) is appropriate for the description of a detailed planning process.]*

When conditions require change, the process is controlled, and the integrity of the QMS is maintained. *[How do you control changes to your system? Consider how your organization handles resource allocations, changes in work scope, and internal procedure/work instruction modifications.]*

5.5—Responsibility, authority, and communication

5.5.1 *Responsibility and authority*

The Company is organized in the following manner. *Include a general organization chart for the company and a specific organization chart for the project. Title* is responsible for maintaining the organization charts.

The Company has assigned responsibilities and authority in the following manner.

Use functional titles instead of names of individuals to reduce the frequency of QMSM revisions. Describe the specific functions, responsibilities, and authorities of each position/title. Focus your description of activities on prevention of nonconforming conditions, problem identification, problem solution, verification of corrective action, and follow-up to ensure problem resolution. Correlate the information you provide with the organizational chart. Describe how this information is communicated to your personnel.

5.5.2 *Management representative*

The Company has assigned *Title* as the management representative for quality. He/she shall ensure that the QMS is established, maintained, and implemented, and shall report to top management on an *identify interval* and make recommendations for QMS improvements. Reports shall be issued in writing to top management and items maintained in an open status until outstanding items are resolved. The management representative for quality shall ensure that the project manager is aware of customer requirements regarding the project.

5.5.3 *Internal communication*

The Company ensures the processes of the QMS and their effectiveness are communicated throughout the organization by: *identify your methods of communication; that is, distribution of audit reports, management reviews, procedures, work instructions, and newsletters.*

5.6—Management review

5.6.1 *General*

The Company's top management shall review the QMS at *indicate interval* and more often as needs dictate to ensure its suitability, adequacy, and effectiveness. The QMSM, quality policy, and quality objectives will be evaluated for any needed change. Records of these reviews shall be maintained.

5.6.2 *Review input*

Management reviews shall include the following agenda items:

- Internal and external quality audit results;
- Customer performance evaluations (feedback);
- Process performance and product conformance results;
- Preventive and corrective action status;
- Follow-up on actions from previous management reviews;
- Other changes (that is, business climate and scope of work changes) that could affect the QMS; and
- Recommendations for improvement.

5.6.3 *Review output*

Results of management reviews shall be recorded and addressed as appropriate regarding:

- Improvements in the QMS and its processes;
- Improvements in product related to customer requirements; and
- Resource needs.

Action items will be followed up at subsequent management reviews to ensure closure.

SECTION 6—RESOURCE MANAGEMENT

[Introduction (do not include in your QMSM):

This section corresponds to Section 6 of ISO 9001:2000, and its purpose is to assure that personnel assigned to perform work under the QMS are competent to perform the assigned tasks.]

6.1—Provision of resources

Title(s) is responsible to assess organizational and project needs including oversight functions and develop resource requirements to assure resources necessary to implement and improve the processes of the QMS and address customer satisfaction issues are provided in a timely manner.

6.2—Human resources

6.2.1 *General*

The Company shall assign personnel to the project that are competent on the basis of applicable education, training, skills, and experience. *Title* is responsible to review the contract to determine any customer requirements for competency of personnel assigned to the project.

6.2.2 *Competence, awareness, and training*

The Company shall:

- Identify competency needs for personnel performing activities affecting quality. *The Company* has developed position descriptions, which identify competency requirements for those personnel performing activities affecting quality. *Title* maintains the latest issue of such position descriptions;
- Provide training to satisfy competency needs. *Title* is responsible to identify training needs and assure training is performed *[Note: training can be formal, informal, on the job, union classes, or apprenticeship. Include in this paragraph the type(s) of training performed for personnel on this project]*;
- Evaluate the effectiveness of the training provided *describe how you evaluate effectiveness of your training [You may consider internal audit indications of the following: noncompliance, individual performance evaluation, failure to satisfy the customer, nonbillable work, error and omissions, rework, nonconformances, and other indicators of effectiveness]*;
- Ensure employees are aware of how their work activities contribute to the achievement of quality objectives. Describe how you shall achieve this. *[You may consider newsletters, performance evaluations, project kick-off meetings, project position descriptions, project organization charts, and other means of enhancing awareness]*; and
- Maintain records of education, training skills, and experience. *Title(s)* is responsible to ensure that appropriate records, including records of training activities and the subject matter of the training, are maintained.

6.3—Infrastructure

The Company provides a work environment suitable to achieve its business objectives and satisfy project requirements.

Identify in general terms how your organization addresses work place and associated facilities, equipment, hardware, software, and support/administrative services. [Consider workspace, work environment, accessibility to computers, appropriate software, and other tools necessary to assure an acceptable product. Also, consider if workers provide their own tools and equipment.]

6.4—Work environment

The Company has identified and is managing those factors of the work environment needed to assure conformity to product requirements.

Identify in general terms how your organization addresses the work environment. [Consider safety orientation and manuals, safety inspections, OSHA compliance, safety plans, toolbox meetings, compliance to applicable building codes, right to know, and contracts or agreements.]

SECTION 7—PRODUCTION REALIZATION

[Introduction: (Do not include in your QMSM):

This section corresponds to Section 7 of ISO 9001:2000 and those activities related to the production of a product that meets customer requirements. In general, the products or services produced for design include drawings, specifications, studies, reports and, in some cases, inspection services. Products for construction management services include inspection and contract management. Products produced for construction include physical construction of new or rehabilitated buildings and structures. This section provides language appropriate for designers, construction management (CM) services, and constructors. Include only the text and explanations that apply to your organization.]

7.1—Planning of product realization

The Company shall plan and document the product realization process. The documentation for the planning process is included in *this QMSM or other document that you specify herein: describe*.

The quality objectives for product output or service *design, CM services, or construction* are identified in *this QMSM per Clause 5.4.1 or in other documents that you specify* to align the customer's objectives with stated quality objectives for each process *consider the contract and specifications.*

Design, CM services, construction processes, documentation, resources, and facilities shall be established for this project. *Describe how you will comply with this requirement. [Consider reference to other sections of this QMSM including the resource loaded schedule, work methods, engineering procedures, or other document.]*

Verification and validation are incorporated into the planning process as follows: *describe how verification and validation activities are incorporated. [Consider design review, acceptance testing, planned inspections, and design document approvals. Consider mock-ups for construction validation of high-risk processes. Work methods or engineering procedures are recommended to plan and identify verification, validation, and recording activities. You may also wish to reference Clauses 7.3.5 and 7.3.6 for design validation.]*

Acceptance criteria will be developed where appropriate, and product acceptance shall be documented by *describe your acceptance process. [For designers: consider documenting engineering procedures to detail the process—signed drawings, specifications, reports, log entries, and progress reports—as the output. For constructors: consider inspection and test plans that provide acceptance criteria, inspection or test frequency, by whom, and owner's representative witness requirements for each work method.]*

Records attesting to conformity of process and resulting product shall be maintained by: *indicate Title(s)*.

Records will include:

- Training records;
- Quality control procedure records;
- Internal quality audit results and closure;
- Product acceptance records; and
- Records of management reviews.
- *Add to this list as appropriate for your organization*.

7.2—Customer-related processes

7.2.1 *Determination of requirements related to the product*

The Company will review the contract to determine customer requirements. *Title* will evaluate these requirements and determine whether any additional requirements including regulatory and legal (which may not have been identified by the customer) must be implemented to support the delivery of the *design, inspection, or construction*.

7.2.2 *Review of requirements related to the product*

The Company has assigned the responsibility to review *proposals or bid documents* to *Title*. *Title* shall ensure that the requirements are sufficiently defined, understood, and that *the Company* has the capability of performing the work. The review shall be documented in the following manner and records maintained.

Articulate your methodology.

Before signing the contract, a review shall be performed by *Title* to ensure that any changes that have been agreed to have been incorporated. The review shall be documented in the following manner.

Articulate your methodology.

Changes to *Contract* shall be controlled. The *Title* is authorized to accept changes to contracts. *Identify any restrictions or levels of acceptance.*

Changes shall be documented and issued to all staff responsible for execution of the original *Contract* by *Title*.

7.2.3 *Customer communication*

Title is responsible to establish and maintain communication with the owner's representative regarding *engineering, inspection, or construction* activities. The communication process established in the *Contract* shall be implemented.

Title is responsible for evaluation of customer feedback and complaints and shall respond to them.

[Address the proposed frequency of project meetings, specific individuals, or titles to whom formal correspondence should be addressed, and various configuration control documents such as RFIs, NCRs, field change notices, extra work orders, requests for changes, proposals, claims, and submittals along with their routing and methods of deposition. This must be done in conjunction with all parties on the project, so it must wait until the methods are worked out and agreed to by all. Defining of the protocol of such communication makes it clear to all parties.]

7.3—Design and development

[For design companies: Develop a document (commonly called "Engineering Procedures") to describe all of the elements of design and design control and design review. Documenting a separate procedure for each primary output of the design-work process has proven effective for designers.]

7.3.1 *Design and development planning*

[This section is not applicable to constructors and construction managers without design and development responsibility.]

[Recommended text for designers and constructors and construction managers with design responsibilities:]

The Company shall plan and control the design and address staging, review, verification, and validation activities, personnel responsibilities and authorities, interfaces between discipline, and any updates in this plan during the project.

Describe your methods of executing this planning process. [Provide references to the resource-loaded schedule and to the project's organizational chart. Describe the duties and responsibilities of in-house personnel. Describe how your organization will coordinate with subconsultants, inspection, testing, interdisciplinary review, coordination of trades, and other methods you employ.]

7.3.2 *Design and development inputs*

[This section is not applicable to constructors or construction managers without design responsibilities; it includes recommended text for designers, constructors, and construction managers who have design responsibility.]

Title shall be responsible to review the owner's request for proposal and develop an *inspection, evaluation, verification plan* of site conditions. Conditions shall be recorded. *Describe how and in what manner they shall be recorded.* Reports of conditions shall be signed and dated by the individual(s) directly responsible for data *gathering and evaluation*. Reports shall be reviewed by *Title*. *Reports* or *recommendations* shall be transmitted to the owner's representative by *Title*.

Title shall be responsible to develop and transmit *describe methods* written design criteria to the *design staff, etc*. *[You may wish to list the generic type of criteria generally supplied to the design staff for this project; for example, codes, standards, or corporate technical information.]*

Title is responsible to ensure that the design schedule is developed, maintained, evaluated for deviations, and adjusted as necessary to ensure that the task milestones in the *Contract* are met.

Design calculations shall be developed to written criteria. Assumptions shall be delineated. Those that require confirmation before finalization of the calculation shall be identified.

Title is responsible to evaluate all design inputs for adequacy and assure any ambiguous or conflicting requirements are resolved. See Clause 7.3.4.

7.3.3 *Design and development outputs*

[This section is not applicable to constructors or construction managers without design responsibilities; it includes recommended text for designers, constructors, and construction managers who have design responsibility.]

Outputs of the design process are documented in a manner that enables verification against design inputs.

Outputs are those deliverables required by the customer per contract and include, but are not limited to, studies, reports, analysis, scope development, designs, and specifications.

Title is responsible to ensure the deliverable addresses the input requirements; is comprehensive in addressing the customers intended use; is constructible; and that the deliverables are approved as required by the agreement and any of *the Company's* QMS requirements.

All calculations shall be signed by and dated by the originator and checked before finalization by an engineer competent in discipline but without direct responsibility for performing the calculation. A system to validate the programs or algorithms for computer-generated calculations is employed. *[The designer may elect to describe the calculation program in detail, including: the forms or format used, the method of affixing verification signatures and dates, and the numbering and tracking system used. Alternatively, you might reference a procedure that covers the details of the calculation process.]*

Specifications shall be developed in conjunction with contract drawings. *Title* is responsible for coordination of the effort between disciplines within the designer's organization, outside agencies (if any), and the owner's representative.

Development of construction schedules and estimated construction costs shall be under the direction of *Title*. The methodology used to develop construction schedules and estimates of construction costs shall be described in written procedures or instructions. The format indicated in the documentation shall conform to owner's standards as required by the *Contract*. *Describe the process or reference the methodology that your organization currently employs.*

Schedules and estimates shall be reviewed by *Title* before their issue to the owner's representative.

7.3.4 *Design and development review*

[This section is not applicable to constructors or construction managers without design responsibilities; it includes recommended text for designers, constructors, and construction managers who have design responsibility.]

Design documents are circulated for internal review and coordination of trades. The process shall be documented *describe how*. A CADD system is employed and controls *indicate which controls* have been established to safeguard the integrity of the drawings.

[Designers may elect to describe the development of drawings and specifications in detail or reference a procedure that accomplishes the same objective.]

The review process shall address the ability of the design to fulfill requirements and identify problem areas and proposed corrective actions.

Owner's comments and any internal comments shall be addressed in written form, and records of resolution kept until completion of the project. *Describe the methods you will employ to resolve internal or owner's comments. Indicate the title that shall resolve conflicts with the owner. Indicate the form that the documentation shall take.*

7.3.5 *Design and development verification*

[This section is not applicable to constructors or construction managers without design responsibilities; it includes recommended text for designers, constructors, and construction managers who have design responsibility.]

Title is responsible to assure the output meets the design inputs.

Describe your methods of performing this verification (such as checking and sealing of drawings) activity for design. A constructibility review *shall or shall not* be performed as part of this contract. *If performed, describe the methods to be employed or reference your organization's procedure.*

Value engineering *shall or shall not* be performed as a part to this contract. *If performed, describe the methods to be employed or reference your organization's procedure.*

Title shall maintain records of verification activities.

7.3.6 *Design and development validation*

[This section is not applicable to constructors or construction managers without design responsibilities; it includes recommended text for designers, constructors, and construction managers who have design responsibility.]

The Company has developed a system to assess if the design was constructible and met customer and end user requirements. *If a computer simulation is used, provide details.*

Title performs this analysis. The results are recorded and used as part of our corrective and preventive activities program.

Describe your method of accomplishing this activity.

7.3.7 *Control of design and development changes*

[This section is not applicable to constructors or construction managers without design responsibilities; it includes recommended text for designers, constructors, and construction managers who have design responsibility. Constructors, however, will have an interest in controlling design changes that affect their contract, and should include and describe such measures. Implementation of a request for information (RFI) log and procedure to be able to efficiently clarify design questions is suggested for constructors.]

Title is responsible to provide the interface with the owner's representative during the prebid, bid, and award stages of the construction contract. Supplements or addenda developed during this period shall receive the same level of review as the original document and be reviewed by *Title* before issue.

This QMSM clause specifies how changes are initiated, reviewed, implemented, and documented. *Describe your change management program.*

As-built drawings shall be developed per *Contract* requirements. As-builts shall be independently reviewed to ensure field-marked prints and other sources of as-built information have been correctly translated onto the original document. If the constructor is charged with keeping as-builts and reporting them to the designer, auditing to ensure compliance may be required.

Revisions to project design documents shall be controlled. Methods *describe your methods* have been established to ensure revisions are reviewed to the same level as the original documents. Previous versions of the documents undergoing change have been appropriately controlled *describe how* to prevent inadvertent use.

Records of these activities are maintained by *Title*.

7.4—Purchasing

7.4.1 *Purchasing process*

[Suggested language for designers and construction managers:]

Title shall evaluate all subconsultants that are engaged to work on projects for their capability to perform the assigned scope of services. Evaluation criteria are defined. Evaluations take place on a *specify time* basis.

Title is responsible to follow up on identified areas of poor performance.

Records of each evaluation shall be maintained by *Title*.

Records of subconsultant performance shall be maintained by *Title*. Subconsultants with a record of poor performance shall be excluded from future consideration.

[Suggested language for constructors:]

Subcontractor/supplier services:

Title shall evaluate all subcontractors and suppliers that are engaged to work on this project on their capability to perform the assigned scope of work. Evaluation takes place on a *specify time* basis.

Title is responsible to follow-up on identified areas of poor performance.

Records of each subcontractor/supplier performance shall be maintained by *Title*. See Clause 7.4.3. Subcontractors/suppliers with a record of poor performance shall be excluded from future consideration. Evaluation criteria are defined.

7.4.2 *Purchasing information*

[The text contained herein is applicable to designers as well as construction managers and constructors.]

Purchase orders with subconsultants/subcontractors will define product requirements, QMS requirements, applicable procedures, processes, equipment, and personnel qualifications in sufficient detail to ensure the work performed meets the purchase order requirements. *Describe how this is done. [Consider that in most cases relevant portions of your contract will provide most of what is necessary to address this requirement. The need to document the specific requirements included in the request for proposal should be emphasized to avoid future disagreements and omissions from the scope of work.]*

Select one or both of the following statements as appropriate. [The method suggested in B is preferred for the following reasons: 1) there are always differences in how organizations execute their work and provide quality; and 2) getting the subconsultant or subcontractor to write their quality plan (perhaps from a template provided by the prime contractor) will enlist buy-in to the process instead of excuses as to why they did not comply.]

A. On this project, the subconsultant/subcontractor/supplier shall be performing work under this QMSM. *Title* shall incorporate the scope of services performed by the subconsultant/subcontractor/supplier into the requirements of the QMSM. The conformance of the

subconsultant/subcontractor/supplier to this QMSM is subject to internal quality audits. *Title* will perform such internal audits on an *identify interval* basis. Areas of noncompliance shall be resolved to the satisfaction of *the Company* and records maintained.

B. On this project, the subconsultant/subcontractor/supplier shall perform work under their own QMSM. *Title* shall review the subconsultant/subcontractor/supplier QMSM for conformance to the ISO 9001:2000 and to *the Company's* QMSM as it applies to the assigned scope of services. *Title* shall perform an evaluation of the subconsultant/subcontractor/supplier implementation of their QMSM on an *identify interval* basis. Reports of this evaluation shall be maintained by *Title* for the duration of the project. Any noncompliances shall be resolved to the satisfaction of *the Company* and records maintained.

7.4.3 *Verification of purchased product*

Work prepared by the subconsultant/subcontractors shall be reviewed for conformance to contract requirements and accepted and documented by *Title. Articulate how you document the acceptance of a subconsultant/subcontractor's work.*

[Additional recommended text for constructors:]

Materials and equipment:

Title is responsible to ensure that the equipment and materials ordered for this project meet contract requirements and are delivered on time. Purchase orders shall be reviewed by *Title* before issue. The following steps shall be taken to ensure that the suppliers are capable of providing appropriate items. *Articulate steps to take.* Some suggestions follow.

1. *Manufacturer/supplier* capability to supply items which meet technical requirements in a timely manner shall be evaluated.
2. The *manufacturer/supplier* has a quality program that shall be evaluated by *Title*.

Equipment/material delivered for use on the project shall be inspected by *Title* at *indicate field, warehouse, manufacturer, or supplier facility* for form, fit, and function as related to contract requirements. Rejected equipment/material shall be returned to the originator or marked in a manner that shall prevent use.

Identify the specific methods to be employed on this project.

7.5—Production and service provision

7.5.1 *Control of production and service provision*

[It is strongly suggested that the production elements planned in Clause 7.1 and controlled and executed in Clause 7.5 be documented in work methods (for constructors) or engineering procedures (for designers). By providing a work method for each construction activity, the constructor gains control and flexibility of these activities. They can be prepared after the quality plan and before the start of each construction activity. Revisions of these individual work methods then do not cause the entire QMSM to be reissued.]

The Company has established the following controls applicable to (design, construction, construction management, or a combination of these) activities *identify all that apply to your contract*.

- Activities are planned;
- Activities are scheduled;
- Acceptance criteria is defined *[often within a work method; an inspection and test plan is utilized for this purpose]*;
- Adequate resources *describe the tools, equipment, and trained personnel* are available to perform the work;
- The work environment is safe and conforms to the health and safety requirements in the contract/agreement;
- Methods are employed to monitor resource expenditure against expected results;
- Procedures, work methods, and installation practices that are important to ensure quality work are available to the work force;
- Codes, standards, and specifications, including applicable portions of the contract, are available to the work force *referenced in the work methods XXX*;
- Standards of workmanship are implemented;
- Where required, licensed or certified personnel are assigned to the project to perform activities requiring such license or certification *as documented in the work method XXX*;
- Criteria for release, approval, and acceptance are established. *Acceptance criteria for inspection and testing activities are typically listed in the inspection and test plan for each work method*; and
- A program to monitor the effectiveness of these process controls is in place and implemented. *[Results of inspection and testing are recorded on inspection and test records for each work method].*

Identify the controls you shall implement on this contract and identify the titles(s) of those responsible to see that commitments made in your quality plan are implemented and documented.

7.5.2 *Validation of processes for production and service*

[Section 7.5.2 does not apply to construction managers.]

[Suggested text for designers:]

The validation of the design is the constructed project or computer simulation that satisfies the customer requirements. See Clause 7.3.6. *Trials required of the constructor, such as load tests, are optional validation processes.*

[Suggested text for constructors:]

The validation of certain construction processes can only be ascertained when load is applied or operation is initiated. For this project, these processes include: *select appropriate items, add others as necessary; this is not a complete list.*

- Welding; and
- Grouting.

The Company assures these processes can achieve planned results through: *select appropriate items, add others as necessary; this is not a complete list.*

- Process qualification;
- Equipment and personnel qualification;
- Defined methods and procedures;
- Field sample development;
- Others as determined by the constructor; and
- Records maintenance, with revalidation performed as necessary.

Where risks associated with noncompliant work are deemed to be high, the constructor may choose to provide a mock-up of the constructed element to validate the construction process before constructing the permanent item.

7.5.3 *Identification and traceability*

[Suggested language for designers and construction managers:]

The Company shall develop and maintain a system to identify design or report documents so that they remain traceable to their originator and contain customer identification as may be required by the agreement. The status of the document (such as preliminary, draft, or final) shall be included.

Describe the system your organization will use to identify and track documents as described previously.

[Suggested language for constructors:]

The Company shall develop, maintain, and implement a system to identify construction materials (product installation) and equipment to the extent required by the contract or applicable codes and standards. This system shall be capable of indicating the acceptance status and material origins(s) of the product at any point in the process. Nonconforming materials shall be traced, identified, or removed to prevent inadvertent use.

For this contract, the following shall be initiated: *describe the system to be employed.*

The Company shall develop and maintain a system for unique identification of product or batches according to the traceability requirements in the contract. *Title* is responsible for implementing the system and retaining appropriate records. Nonconforming materials shall be identified or removed to prevent inadvertent use.

For this contract, the following shall be instituted.

Describe the system, if any, to be employed on this contract.

7.5.4 *Customer property*

The Company shall develop and maintain a system to receive, log, and maintain the documents, data, test equipment, materials, equipment, or a combination of these supplied by the owner's representative. *[This is often accomplished by use of overage, shortage, and damage reports (O, S, and D reports)].* *Title* is responsible for this function, and shall advise the owner's representative of any items that are unsuitable for use, lost, or damaged.

Title is responsible for the final disposition of the supplied items at the conclusion of the project as described in the contract.

[If no data, equipment, or materials are provided by the owner, this section does not apply, and a statement to that effect should be included in your QMSM.]

7.5.5 *Preservation of product*

[Recommended language for designers:]

During the development of the plans and specifications, *the Company* shall evaluate construction materials and equipment and include in the plans and specifications any requirements for handling, storage, packaging, preservation, and delivery that are necessary to ensure that form, fit, or function are not compromised. *Title* is responsible for this activity.

Articulate your specific methodology.

[Recommended language for construction managers:]

Title shall review the construction contract and ascertain through the inspection process that requirements for handling, storage, packaging, preservation, and delivery are being implemented by the constructor, subcontractors, and suppliers. Nonconforming conditions shall be documented.

Articulate your program for this project.

[Recommended language for constructors:]

The Company shall establish, maintain, and implement a program for handling, storage, packaging, preservation, and delivery of materials and equipment on the project.

Articulate your specific methodology for handling, storage, and preservation. Include requirements for packaging and delivery if this plan is imposed on equipment or material suppliers or manufacturers.

7.6—Control of monitoring and measuring devices

The Company shall establish, maintain, and implement a program to identify, control, and calibrate measurement and monitoring devices used to assure conformity of product as required by the contract.

The program shall contain the following elements:

- Identification of what needs to be monitored and measured;
- Identification of equipment and instruments that require calibration to maintain capability;
- Listing of such equipment and instruments, frequency of calibration, and evidence calibration took place;
- Availability and use of manufacturer's instructions, codes, or national standards for calibration;
- A program of corrective action to repair or replace items that do not meet acceptance criteria;
- A program to ensure that measuring and monitoring devices are protected from damage deterioration and unauthorized alteration of settings;
- A program of corrective action for previously accepted product if defective equipment and instruments were used to inspect or test the product;
- Confirmation that computer software used as a basis of product acceptance is acceptable for the intended application. Confirm before use and as necessary thereafter;
- A plan to keep, maintain, and preserve measuring equipment and instruments; and
- Records to demonstrate calibration and verification.

Articulate your specific program for this project or include your generic program and indicate those portions that apply to this project.

[For designers: computer programs shall be calibrated, validated for the correctness of output, and shall conform to the requirements of this clause to assure that design or report data is correct.]

SECTION 8—MEASUREMENT, ANALYSIS, AND IMPROVEMENT

[Introduction: (Do not include in your QMSM).

This section corresponds to Section 8 of ISO 9001:2000 and addresses the methods used to measure, report, and improve on both the performance and effectiveness of your processes and the ability of these processes to deliver products that satisfy the customer. It also addresses the need to collect and use data from customer satisfaction measurements and nonconformances to address improvement issues.]

8.1—General

The Company has defined, planned, and implemented the following measurement, monitoring, analysis, and improvement activities needed to assure conformity and achieve improvement. Additional details are provided in 8.2., 8.3, 8.4, and 8.5. *Identify your methodology. The following should be considered add to or delete as appropriate depending on your contracted scope of work:*

- Customer satisfaction surveys;
- Internal audits;
- In-process reviews/inspections/tests;
- Control of nonconformances;
- Data analysis; and
- Corrective, preventive, and improvement activities.

8.2—Monitoring and measurement

8.2.1 *Customer satisfaction*

The Company has developed the following methods to obtain data and monitor customer satisfaction and/or dissatisfaction: *Identify the methods you use. Consider items such as correspondence, surveys, and performance evaluations.*

8.2.2 *Internal audit*

The Company shall establish, maintain, and implement an internal quality audit program to verify that quality activities and related results comply with planned contractual arrangements and to determine the effectiveness of their quality plan and associated procedures. The internal quality audit program shall have the following attributes:

- Written procedures shall govern these activities;
- Internal quality audits shall be scheduled based upon status and importance of the activity to be audited. The schedule shall be transmitted to the owner's representative. (Note: The minimum number of internal quality audits is once during the life of the contract or once a year on multi-year contracts);
- Personnel conducting internal audits must be competent and capable of objectivity and impartiality in conducting the audit. They shall not audit their own work;
- Reports of the results of internal quality audits shall be generated and issued. *The Company's* management and the owner's representative shall receive copies of the reports;
- Corrective action shall be monitored and brought to closure;
- Follow-up internal quality audits shall be conducted, as appropriate, to ensure implementation of corrective action. The results shall be reported to top management;
- The activities of subcontractors working under this QMSM shall be included in the internal quality audit program;
- The activities of subcontractors working under their own QMSM shall be evaluated by *The Company* as described in Paragraph 7.4.1. External audits by *The Company* would apply to these subcontractors.

Title is assigned responsibility to implement the internal quality audit program.

[A procedure that addresses the responsibilities and requirements for planning and conducting internal audits and for reporting results and monitoring records is required. It may be included or referenced in this QMSM.]

8.2.3 *Monitoring and measurement of processes*

This paragraph is applicable to all.

The product realization processes described in Section 4 of this QMSM necessary to achieve customer requirements are measured and monitored as follows:

Describe your measuring and monitoring methods to assure your processes are acceptable. Consider such things as internal audit results, error and omission punch list, and number of nonconformances.

These methods shall confirm the continuing ability of each process to satisfy its intended purpose. When planned results are not achieved, corrective prevention actions shall be taken to assure conformity.

8.2.4 *Monitoring and measurement of product*

This section is applicable to designers, construction managers, and constructors as follows:

[For designers: Consider the processes of 7.3, including the professional engineer's seal on drawings and release of the design by the principal of the firm.]

[Suggested language for designers:]

The Company shall establish, maintain, and implement a program to control the development, review, and release of designs that are in conformance with customer requirements. The program shall be controlled by written procedures, instructions, or checklists as appropriate. *[This process is suggested to be included in the engineering procedures if that document has been implemented.]* Results shall be recorded, authenticated, and distributed as required by the agreement.

The measurement, monitoring, and acceptance of the *design, report, study* is addressed in Clause 7.3.

[For construction managers: Consider the release of reports required by the contract.]

[Suggested wording for construction managers:]

The Company shall establish, maintain, and implement a program to control the assigned inspection and testing responsibilities under this agreement.

The program shall be controlled by written procedures, instructions, and checklists as appropriate. Results shall be recorded, authenticated, and distributed as required by the agreement. Adverse results shall be documented and corrective action instituted as described in this plan, the contract, or as directed by the owner's representative.

All inspection activities shall be documented in writing on forms which then become records or in a format acceptable to the owner's representative. Inspection records shall be signed and dated by the individual performing the inspection. Copies of forms to be used shall be submitted to the owner's representative for acceptance before work.

Inspections shall be performed using written checklists (records) with defined acceptance criteria *often called inspection and test plans [ITPs]*. The checklists shall address the specific types of work to be inspected and be responsive to the construction contract requirements, including the performance of work in a safe manner.

Title shall develop an inspection schedule that shall identify preparatory inspection and acceptance inspections to be performed and indicate those inspections that are hold-point (hold for owner's representative inspections). The status of inspections shall be maintained by *Title*.

Testing performed by *the Company* or under the direction of *the Company* shall be performed to written procedures with identified acceptance criteria *per the ITPs*.

Test results shall be documented in written form and be signed and dated by the individual performing or supervising the performance of the tests. Test results shall be reviewed by *Title* before submission to the owner's representative. Results that do not meet acceptance criteria shall generate a nonconformance report. *Title* shall track the nonconformance report until disposition.

Where tests are to be performed by individuals whose qualifications for conducting the test require verification, *Title* shall be responsible to ensure that the tester has the necessary qualifications. The status of tests shall be maintained by *Title*.

Articulate the details of these and other activities that are performed to cover the scope of services in the agreement.

[For constructors: This section is applicable to the inspection and acceptability of your own work before release to the customer or proceeding with subsequent operations.]

[Suggested language for constructors:]

The Company shall establish, maintain, and implement a program to control inspection and acceptance of equipment, materials, and construction activities performed by the constructors own forces or their subcontractors. Records shall be maintained.

Title shall ensure that incoming equipment and materials are inspected and accepted for project use before incorporation into construction. The process shall be documented. *[Methods of inspection and acceptance are recommended to be included in the ITP for each work method. As well, inspection forms that become inspection records upon use are suggested to be attached to the work method for each activity.]*

Indicate the methods that you will employ to document the process; for example, inspection and test records, material acceptance book, signed delivery ticket, and signed invoice or bill of lading.

During construction, *Title* shall inspect the quality of the construction effort through *periodic, random, specific* inspections of the work in progress. *[Identify the methods to be employed if they differ for individual work activities, or identify the singular*

method used for all work activities.] Activities shall be recorded *where, on what* and acceptance verified against written acceptance criteria obtained from applicable contract documents or referenced codes and standards. *Title* shall also identify any point in construction that requires authorization of the owner's representative *witness or hold point* before work can continue.

Testing, if required by contract, shall be performed by qualified personnel to written procedures, with acceptance criteria defined and results identified and transmitted to the owner's representative.

Testing *will or will not be* performed by the constructor or agency under contract to the constructor.

[List types of tests, responsible agency, witness requirements, and acceptance criteria or commit to developing such a list by a specific date and assign the task to Title.]

All test results shall be documented on forms appropriate to the tests, and shall be dated and signed by test personnel. Results shall be issued as required in the contract.

The status of all constructor-performed inspections and tests shall be maintained. *[A record status log should be attached to each work method to provide for the status of all inspection and testing for the work method.]*

8.3—Control of nonconforming product

[This section is applicable to designers, construction managers, and constructors. Suggested wording is different for each due to the nature of the work. A documented procedure is required to describe controls, related process, responsibilities, and authorities. Such a procedure should describe the tools to track and resolve nonconformances; the authorities of the contract entities for initiating, disposition, and closing them; the definitions of terms; and a description of the path the documentation should follow from initiation to closure. Additionally, such a procedure shall identify the manner in which a nonconforming product is isolated, labeled, and prevented from being inadvertently incorporated into the work, shipped to a customer, or otherwise put into use.]

[Suggested language for designers:]

The Company has a procedure to detect and correct nonconforming *designs, reports, studies.*

A nonconformance in work output occurs when errors are discovered in output documents issued as final documents. Final documents are signed and dated documents ready to be issued for construction, bid, or procurement.

In-process nonconformities are addressed under 8.2.4.

Nonconformances discovered by outside sources shall be processed by *Title*.

Corrective action shall be implemented as described in 8.5.2.

Articulate on your program for this project in a documented procedure. Address elimination of the nonconformity, requirements for product release or acceptance under concession, actions to preclude recurrence, reverification after correction, and your program to mitigate the effects of installing or using defective product.

[Suggested language for construction managers:]

1. Designer nonconformities:

The Company has a program to detect and correct nonconforming conditions relating to work output of their own staff or others under contract to *the Company*.

A nonconformance in work output occurs when errors are discovered in output documents released as signed and dated documents.

Nonconformances discovered by outside sources shall be processed by *Title*.

Corrective action shall be implemented as described in 8.5.2.

2. Constructor nonconformities:

Construction Management Company has a program to promote error prevention and to detect and monitor the correction of nonconforming conditions relating to the constructor's work output.

A nonconformance in constructor work output occurs when errors are discovered during the inspector's inspection/testing activities that cannot be corrected by the constructor in the same shift of discovery.

Articulate your program for this project in a documented procedure. Address elimination of the nonconformity, requirements for product release or acceptance under concession, actions to preclude recurrence, reverification after correction, and your program to mitigate the effects of installing or using defective product.

[Suggested language for constructors:]

The Company has a program to detect and correct nonconforming conditions relating to work output of staff or others under contract to *the Company*.

Any conditions that do not meet contract requirements and that cannot be corrected by the end of the shift shall be documented in written form by *Title* and tracked to closure.

Documentation shall be *a nonconformance log and a nonconformance report or an entry in the title diary.*

Title shall track the condition *indicate how the condition shall be tracked* until restoration to the designed condition or until the as-installed condition is accepted by the owner's representative.

The owner's representative shall be notified (how) of any condition that is requested to be accepted as an as-installed condition or any condition whose correction to contract requirements shall adversely affect project schedule.

Nonconformances discovered by outside sources shall be processed by *Title*.

Corrective action shall be implemented as described in 8.5.2.

Articulate on your program for this project in a documented procedure. Address elimination of the nonconformity, requirements for product release or acceptance under concession, actions to preclude recurrence, reverification after correction, and your program to mitigate the effects of installing or using defective product.

8.4—Analysis of data

The Company collects and analyzes appropriate data to determine the suitability and effectiveness of its QMS and to identify where improvements can be made in the QMS.

The following data are gathered and analyzed, *Title* is responsible for the effort and to ensure closure where QMS improvements are warranted.

Identify the data and analysis methods you will use, considering:

- *Customer satisfaction/dissatisfaction;*
- *Conformity of product to requirements;*
- *Measuring and monitoring of data;*
- *Trends of both positive and negative compliance;*
- *Internal quality audit data; and*
- *Other methods used.*

8.5—Improvement

8.5.1 *Continual improvement*

The Company facilitates continual improvement of the QMS by assessing and acting upon the following:

Identify what you use to facilitate continual improvement of the QMS. Consider quality policy changes, goal/objective changes, implementation of the results of management review, audit findings analysis of nonconformities, and corrective and preventive actions implemented.

Title is responsible to assure implementation of this planning for improvement effort.

8.5.2 *Corrective action*

The Company has established a corrective action program to eliminate the cause of the nonconformity and thus prevent recurrence.

Corrective action will be appropriate to the severity of the nonconformity identified.

A documented procedure for corrective action has been established. *Identify by reference or include in this QMSM.*

The procedure addresses identification of nonconformities (which includes addressing customer complaints) cause determination, preventive action to prevent recurrence, determination of corrective action, documentation of results, and evaluation of the effectiveness of the corrective and preventive actions.

Detail or reference your internal procedure. Identify who is responsible for implementing your corrective action program.

8.5.3 *Preventive action*

The Company has a procedure for preventive action that anticipates the potential causes of nonconformities and works to reduce or eliminate these potential causes.

A documented procedure for preventive action has been established *identify by reference or include in this QMSM.* The procedure identifies potential nonconformities, probable causes, determination of preventive action needed, implementation of preventive action, determination of the effectiveness of the preventive action (if it was implemented) in preventing a nonconformity.

Detail your program or refer to your internal procedure. Identify who is responsible to implement your preventive action program.

[Consider identifying performance risks (things that may prevent you from achieving your objective) and those internal procedures that mitigate or eliminate these risks.]

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American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331
U.S.A.
Phone: 248-848-3700
Fax: 248-848-3701

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Guide for Concrete Construction Quality Systems in Conformance with ISO 9001

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