

ACI 121.1R-16

Guide to Quality Management Auditing in the Concrete Industry

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Guide to Quality Management Auditing in the Concrete Industry

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Guide to Quality Management Auditing in the Concrete Industry

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This guide provides the background and methods for conducting an audit of an organization's quality management system. Such an audit can assess the organization's commitment to quality management and conformance to standards, codes, and contract requirements. Audits can also identify portions of the quality management system that need correction or improvement.

Keywords: audit; nonconformance; opportunity for improvement; process audit; quality management system; quality manual.

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CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

An effective means of determining an organization's commitment to quality management is an audit, whether the organization is involved in design, construction, inspection, testing, or other operations. Before procurement, an initial audit can evaluate operations of a supplier or subcontractor. During the course of a project, an audit can verify an organization's quality management, efficiency, and conformance to contract, codes, procedures, and standards. By looking closely into a supplier's operations and asking key questions, a customer can be assured that what is presented or proposed in the bid, proposal, promotional literature, or quality plan is consistent with the supplier's capabilities and methods in their normal course of business.

Furthermore, an organization can assess the effectiveness of its own quality management system and, thereby, its internal performance, efficiency, and conformance by conducting an internal audit. The results of such an audit can be the basis for determination of capabilities, self-declaration of conformance to a standard, and discovery of opportunities for improvement.

This guide incorporates some of the principles contained in **ISO 19011:2011**, which can be used as reference should the auditor determine that ISO 19011 is applicable.

The level of expectations can vary depending on the needs of the client and what the client determines as adequate. A high order of performance can be determined by using the criteria established in **ISO 9001:2008**, in which case it is recommended that **ACI 121R** be used as a guide to determine the level of performance as it applies to the concrete industry.

The questions presented herein are intended to cover a broad range of issues, and some organizations may not be able to respond to them affirmatively. That does not necessarily indicate the organization is not a good choice for the task, as the questions themselves are not necessarily the

criteria for acceptance or rejection. In the absence of well-defined criteria, as would be required by contract, code, or self-proclaimed conformance, there is no right or wrong answer, only the facts, which are to be interpreted by the party requesting the audit. The quality management system capabilities encountered can range from the simple and basic to the robust. The level of quality management necessary to perform the task is determined by the party requesting the audit.

1.2—Scope

This guide is intended for use in the concrete construction industry. Recommendations and practices presented are intended to be nonmandatory and only meant as guidance. This document is not intended to offer guidance in initiating a quality management system or to serve as a standard for third-party registration audits.

This guide addresses several disciplines within the concrete construction industry with questions specific to those disciplines. It begins with the principles and objectives of audits, followed by audit protocol, methods, techniques, and competency of auditors. **Chapter 7** covers common processes of quality management typical to all industries with an emphasis on their application within the concrete construction industry. **Chapters 8 and 9** cover the processes for design and construction. Processes are presented with background information, their impacts on operations, common pitfalls, and sample questions to prompt audit investigations and discussions. For someone not familiar with quality management considerations for a certain discipline within the industry, this guide provides background and a starting point with some of the appropriate questions to ask.

The application of this guide is suited for assembling a list of good practices to use in an audit procedure that is commensurate with the size and complexity of the organization's assigned or proposed task. Its application is also relevant to audits of large organizations with more complex systems and the resources to support them.

CHAPTER 2—DEFINITIONS

ACI provides a comprehensive list of definitions through an online resource, "ACI Concrete Terminology," <https://www.concrete.org/store/productdetail.aspx?ItemID=CT16>.

as-built drawings—generally considered a revised set of drawings provided upon completion of a project, which reflect changes made in the drawings during the construction process; responsibility for providing the drawings, the level of detail required, the liability for the accuracy and completeness of the information provided, and the legal definition differ by the governing bodies of the geographic area and the agreement with the entity purchasing the service. Also known as "record drawings".

audit—systematic, independent, and documented process for obtaining evidence and evaluating it objectively to determine the extent to which criteria are fulfilled.

auditee—organization (or person) that is being audited.

auditor—person with the competence to conduct an audit; also indicates the lead auditor when an audit team is led by one person.

audit criteria—set of policies, documented information, or requirements used as reference against which audit evidence is compared.

audit plan—description of the activities and arrangements for an audit.

audit program—set of one or more audits planned for a specific time frame and directed toward a specific purpose.

audit scope—extent and boundaries of an audit.

back-checker—architect or engineer within the architect-engineer organization that ensures that all corrections have been addressed; can be one and the same with the checker.

CADD manager—person responsible for the overall management of the computer-aided design and drafting (CADD) portion of the project.

CADD manual—manual, usually written by the CADD manager, that coordinates and standardizes the CADD operation and style.

checker—architect or engineer within the architect-engineer organization who performs quality control by detailed examination of the calculations, specifications, and drawings.

compliance—adherence to laws or regulatory requirements.

conformance—adherence to standards, procedures, specifications, or work methods and instructions.

corrective action—efforts made to eliminate and prevent recurrence of the cause of a detected nonconformity or other undesirable situation.

deficiency—physical work item or condition identified by project personnel that is not in conformance with the construction documents and that has a predetermined remedial action by means of existing specification, previously closed nonconformance report, or by an accepted repair procedure (also known as a “minor nonconformance”).

disposition—process of identifying a proposed correction for a nonconformity to bring the item into conformance with project requirements.

external audits—generally second- and third-party audits.

findings—results of the evaluation of the collected audit evidence against audit criteria.

first-party audits—conducted by, or on behalf of, the organization itself for management review and for process improvement and for conformance, and may form the basis for an organization’s self-declaration of conformity.

hold point—point in a process where it cannot proceed further without a specified inspection, test, or acceptance.

inspection and testing plan—list of the elements of the project and the required testing and inspection for each one.

internal audits—generally known as first-party audits.

lead auditor—auditor in charge of the audit team.

nonconformance—product, material, or process that does not meet established standards or criteria.

opportunity for improvement—documented notification to the auditee that may be issued by the auditor when, by adopting an improvement to the process, the

system is thought to have an increased ability of fulfilling a requirement.

placing drawings—drawings used by reinforcing steel installers to place reinforcing steel (refer to *CRSI Manual of Standard Practice* [CRSI 2009]).

preventive action—elimination of the cause of a potential nonconformity or other undesirable potential situation.

preventive action request—notification to the auditee issued by the auditor when a process is seen to be in danger of delivering a nonconforming product.

procedure—document that explains the process for achieving a task and typically addresses who, when, where, what, and why associated with the process and may contain one or several work methods.

quality management procedure—procedure that details the methodology for a particular process related to the quality management system (also known as “quality management procedures”).

quality management system—management system to direct and control an organization with regard to quality (also referred to as “quality system”).

quality manager—person responsible for the oversight of the quality management system to include coordination, quality control activities, reviews, auditing of the processes, and recognition of opportunities for improvement.

quality manual—document or set of documents specifying the quality management system of an organization.

quality plan—document specifying which procedures and associated resources should be applied by whom and when to a specific project, product, process, or contract.

quality policy—overall intentions and direction of an organization related to quality as formally expressed by top management.

resolution—proposed or approved correction for a nonconformance or deficiency to bring the item into conformance with project requirements.

root cause—initiating cause of either a condition or a casual chain of events that leads to an undesirable outcome.

second-party audits—conducted by parties having an interest in the organization, such as customers.

sign-off—to concur with the contents of a document by signature or initial and date.

supplier—entity that provides a service or a product to the organization; this can be internal or external to the organization, or in a contractual situation sometimes called a contractor or subcontractor (also referred to as “vendor”).

surveillance audits—spot or random checks to ensure that systems presented in previous audits or plans are in use and functioning adequately.

third-party audits—conducted by external, independent auditing organizations.

traceability—ability to follow the history, origin, application, destination, or location of a product or components through documentation.

validation—process of assuring that the design meets the customer’s needs.

verification—assurance that all the requirements are

witness point—location in a process wherein a specific position, role, or inspector should be given adequate notice of the scheduled inspection or test.

work method—document that details how a specific task is to be completed (also known as “work instructions”).

CHAPTER 3—PRINCIPLES OF AUDITING

To ensure that audits are conducted in a professional, honest, and objective manner, **ISO 19011:2011** provides auditing principles. These principles should produce information that is valuable and relevant and ensure that different auditors use the same criteria and evaluate data in a consistent, unbiased manner.

a. Ethical conduct is the overriding attribute of an auditor from which all other principles should branch. Auditors need to be honest, maintain the integrity and confidentiality of information gathered, exercise discretion, and be sensitive and respectful to the organization’s culture. Audits need to be directed toward a win-win objective recognizing that an audit is an information bridge between the auditor and the auditee. Audits should be implemented as tools to enhance the relationship between parties and benefit both.

b. Fair presentation refers to the obligation of reporting objectively and without bias. This principle includes unbiased reporting of any obstructions or differences of opinion encountered during an audit. Personal preferences should be avoided; auditor should refer to applicable standards, procedures, or specifications.

c. Due professional care includes the application of diligence and follow-through in all matters related to the audit. The auditor should be well prepared; have adequate knowledge and competency regarding the subject; have a clear picture of what they are looking for; and provide relevant, meaningful results.

d. Independence requires audits to be performed by auditors that have no vested interest in the subject activity, be it through financial incentive, supervisory affiliation, or other relationship detrimental to impartiality. An auditor should not be subordinate to the auditee unless hired as an independent consultant to conduct internal audits. This structure will allow auditors to remain objective and report the audit findings in an impartial manner.

e. An evidence-based approach means the information gathered during the audit is verifiable. Auditors should collect authentic, factual information in the form of documents, data, and samples. Conclusions cannot be based on suspicions, assumptions, or conjecture.

CHAPTER 4—COMMONLY EMPLOYED QUALITY MANAGEMENT SYSTEMS

Quality management systems range in scope and complexity, depending on the organization size and their particular needs. Small locally-based contractors may have self-invented, undocumented systems. Large international contractors have typically used ISO-based systems. Note that many of these systems use common tools. The choice of tools and level to which they are applied varies. Brief descriptions of systems that may be encountered follow.

4.1—Simple, self-invented systems

Some variation can be expected in the way quality management is handled in smaller companies. Firms without a structured approach may have little experience with established quality management standards and simply use a measure of common sense in setting up their processes. It is beneficial to have written procedures, as they standardize operations, specify documentation, assign responsibilities, facilitate training, and provide a point of reference should operations need modification or improvement. These organizations may or may not have written procedures and may not need them considering the level of sophistication required by their customers and the scale of the work.

4.2—Contractually-based systems

Other companies may employ systems based on agency or owner requirements, perhaps driven by specifications that are focused on a particular aspect of the work, such as batch control, placement, and inspection without consideration for the other supporting processes to be found in a total quality management system. Examples are state department of transportation systems that focus on inspection and testing and the **Construction Specifications Institute Series 01-40-00** specifications, which are usually written to an owner’s requirements. There is no single approach to a quality management system, and in the absence of mandated requirements, organizations can tailor a quality management system to their particular needs.

4.3—Systems modeled after ISO formats, current and noncurrent

Common to agency and government work are systems based on the ISO 9000 series. Starting in 1987, the International Standards Organization (ISO), in conjunction with local organizations such as Canadian Standards Association (CSA), the American National Standards Institute (ANSI), and the **American Society for Quality (ASQ)**, has issued the ISO 9000 series of standards to define the requirements for a quality management system and the elements that make it compliant with the ISO standard in effect at the time. Firms are allowed to register as compliant with the current standard if they are found compliant by an ISO-authorized third party known as a registrar. There have been several revisions since 1987 as explained in the following. Registration is typically granted for a 3-year period. Firms who wish to retain their registration need to be registered to a revised standard within 3 years of its issue.

4.3.1 ISO 9001-1994—This is a standard that is out of date and has been withdrawn from the ISO standards. It was composed of 20 elements of quality management, which have specific requirements.

Although the standard has been withdrawn by ISO, many of its elements are still practiced in various quality management systems in use. As stated, many tools (internal and external audit, for example) are common to various quality management systems. ISO did not invent them; they simply defined them in a standard.



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The advantage of ISO 9001:1994 was its simplicity; its concepts were easy to implement by organizations. It addressed quality management elements separately and did not focus on planning processes and their interrelationships. It could require more effort in defining the procedures that were used to build the processes because the standard required a procedure for each element regardless of how essential or nonessential it was to the process. Some processes do not require all the elements.

ISO 9001:1994 is considered obsolete and new registrations are made to the current ISO standards. The tools presented in ISO 9001:1994, however, still remain as the framework for quality management specifications and systems in some spheres such as state department of transportation design-build contracts and manufacturing organizations that are comfortable with its use.

4.3.2 ISO 9001:2000 and ISO 9001:2008—ISO 9001:2000 and its update, ISO 9001:2008, were the next generations of standards after the ISO 9001:1994. They both differ from ISO 9001:1994 in that ISO 9001:2000 and ISO 9001:2008 principles are based on processes. Both set requirements for processes and their interrelationships with other processes that intersect with them. In general, nested within those requirements are the applicable parts of the original 20 elements originally found in ISO 9001:1994, but they now take a subordinate role in the control and improvement of processes. ISO 9001:2000 and ISO 9001:2008 also expanded the process requirements to include continual improvement and customer satisfaction, which ISO 9001:1994 did not specifically address.

The ISO 9001:2008 standard requires, as a minimum, the following be maintained for a quality management system to be compliant:

- a. Written quality policy and quality objectives
- b. Quality manual, which includes:
 1. Scope of the system with any exceptions
 2. Description of the processes and interactions it addresses
 3. An addressing of each of the ISO 9001 requirements
 4. Documented procedures as a minimum as follows:
 - i. Control of documents
 - ii. Control of records
 - iii. Internal audit
 - iv. Control of nonconforming product
 - v. Corrective action
 - vi. Preventive action

ISO 9001:2000 has been withdrawn. ISO 9001:2008 has recently been replaced by ISO 9001:2015, yet is acceptable for existing registrations until September of 2018.

4.3.3 ISO 9001:2015—In 2015, the present standard, ISO 9001:2015, was released. Registered organizations have 3 years to update to the new standard. The new standard took a departure from the ISO 9001:2008 in clause numbering sequence and some modification of concepts. The focus remains high level and is based on quality management principles: customer focus, leadership, engagement of people, process approach improvement, evidence-based decision-making, and relationship management.

The changes are as follows:

a. The clause numbering sequence was reorganized to comply with the High Level Structure per Annex SL, Appendix 2, of the ISO/EIC Directives, Part One. The intention is to align the clauses of the new standard with those of other ISO Standards such as **ISO 14001** and **ISO 27001**. The alignment of these clauses facilitates the structuring and monitoring of these respective management systems either in parallel or in combination.

b. There is no longer a requirement to align the clauses of the quality management system with those of the standard, providing the requirements are met. This allows organizations to structure their systems in a manner more familiar to them and more closely aligned with their processes.

c. The use of ISO terminology is no longer mandatory. Organizations can use terms familiar to them and better fit their operations when structuring systems.

d. Risk-based thinking is specifically required as a quality management tool to support and improve the process approach. It is used to replace preventive action as a requirement.

e. Greater emphasis has been placed on leadership.

f. Emphasis is placed on understanding the context of the organization. This can be understood to be the business environment the organization operates within and includes internal and external factors as well as the expectations of interested parties. Internal factors would be how the organization is staffed, who is responsible for what, communication between departments, and integration of processes. External factors would include strategic planning, market development and research, domestic and international economics, and politics. Interested parties are customers, shareholders, partners and suppliers, public agencies, competitors, and society.

4.4—Other systems that may be encountered

It is not within the scope of the guide to list every method of implementing a quality management system. As stated, all systems use common tools. The following are some systems an auditor may encounter in the concrete industry.

4.4.1 Six Sigma—Six Sigma is a statistically-based quality management system that focuses on elimination of defects and removal of waste. It was developed in the 1980s to improve production control. Six Sigma principles operate under the DMAIC (Define, Measure, Analyze, Improve, and Control) cycle. There is no certification for organizations as there is for ISO. Individuals are certified to one of six levels of competency from White Belt up to Black Belt. While there is no sole certification body, several organizations have developed programs for Six Sigma certifications. The criteria for certifications may vary for one certifier to another. The **American Society for Quality** is one of the major certifying bodies and requires a written examination and provision of an affidavit for the required levels of experience.

4.4.2 Nuclear Regulatory Commission (NRC) 10CFR-50—Understandably, more stringent quality management practices are applied to construction of a nuclear power facility. In the United States, licensing is obtained by compliance with 10CFR50:2015, Appendix B, which is composed of quality management requirements listed and expressed in

a manner very similar to those contained in the superseded **ISO 9001:1994**, indicating the continued use of these quality management elements. Following this is **ASME NQA-1** with the same structure.

4.4.3 Total quality management (TQM)—There are a multitude of quality management systems based on the philosophies of various quality theorists, including W. Edwards Deming, Malcolm Baldrige, Philip B. Crosby, Joseph M. Juran, Kaoru Ishikawa, and Walter A. Shewhart.

Juran and Godfrey (1998) introduced Big Q and Little q terminology to distinguish between managing for all aspects of business processes (Big Q) and managing only at a product or process delivery levels (little q). TQM can be considered Big Q.

There is no consensus on the definition of TQM. The TQM approach is customer-focused, process-centered, requires all employees' involvement, has strategic and systematic approaches to achieving the organization's vision, operates in an integrated system, adopts continual improvements, collects and analyzes data to support fact-based decision-making, and requires effective communication. Per the definition of the **American Society for Quality** (2015):

Simply put, it is a management approach to long-term success through customer satisfaction. TQM is based on all members of an organization participating in improving processes, products, services and the culture in which they work.

TQM was popular in the 1970s and 1980s but is now overshadowed by ISO. Examples of leading figures in this philosophy are W. Edwards Deming and Malcolm Baldrige.

4.4.3.1 Deming—W. Edwards Deming was a leading management consultant after WWII during the rebuilding of the Japanese industrial base (Juran and Godfrey 1998). His early teachings dealt mainly with production controls, but expanded into what can be described as TQM. His 14 points of quality management are still one of the foundations of TQM practice today:

1. Create constancy of purpose for improving products and services.
2. Adopt the new philosophy.
3. Cease dependence on inspection to achieve quality.
4. End the practice of awarding business on price alone; instead, minimize total cost by working with a single supplier.
5. Improve constantly and forever every process for planning, production, and service.
6. Institute training on the job.
7. Adopt and institute leadership.
8. Drive out fear.
9. Break down barriers between staff areas.
10. Eliminate slogans, exhortations, and targets for the workforce.
11. Eliminate numerical quotas for the workforce and numerical goals for management.
12. Remove barriers that rob people of pride of workmanship, and eliminate the annual rating or merit system.

13. Institute a vigorous program of education and self-improvement for everyone.

14. Put everybody in the company to work accomplishing the transformation.

4.4.3.2 Baldrige—Malcolm Baldrige was an industrial leader in New England who turned around industries by diversification in changing markets (Juran and Godfrey 1998). He was later appointed as Secretary of Commerce under Ronald Reagan, establishing trade agreements with China, India, and Russia. The Baldrige Excellence Frameworks are published under The National Institute of Standards and Technology (**NIST 2014**). A TQM business approach is the basis for the United States' Baldrige National Quality Program (BNQP) which is viewed as a Big Q approach. Baldrige criteria for performance excellence framework are based on leadership, strategic planning, customer and market focus, measurement, analysis and knowledge management, human resource focus, process management, and business results.

CHAPTER 5—AUDIT PROGRAM CHARACTERISTICS

5.1—Basis for audit: applicable to all quality management systems

The previous section identifies different quality management systems that are employed in construction. Common to all, regardless of the system employed, is the use of audit as a tool to monitor for compliance and identify improvement possibilities.

5.1.1 Audits are typically mandated by the client, owner's representative, or authority that hires or has a stake in the performance of the subordinate organization (auditee). One could ask, "Does the auditee have the capability, training, skill sets, quality management system, and procedures to undertake the work and execute it in compliance to drawings and specifications?"

For pre-award contractor review by owner (or subcontractor review by contractor), a desk audit (documents review) of the auditee's existing quality management system is a reasonable start.

All quality audits, regardless of the quality management system employed, require a basis under which the audit will be conducted. The basis will be the quality management system that is specified by contract (such as **ISO 9001**). If a quality management system has not been specified, the basis may be in accordance with plans, specifications, and the quality management system in use or proposed by the auditee.

If the contract is minimally prescriptive (or totally silent) on quality management performance (as is typical for high-rise construction under construction management), then the desk audit should inquire as to if there is a quality plan in place. If there is not one in place, then the desk audit should inquire as to if an inspection and test plan or a checklist for the trade will be performed.

From desk audit, one can then progress to on-site audit to see the organization, meet the participants, observe facilities or site, and audit to greater detail.

5.2—Creating an environment for successful audit program

5.2.1 Organizational support—A program will not be successful unless there are resources to support it. Support of the organization will be driven by the realization of financial savings, customer satisfaction, and industry reputation. Therefore, audits should not be presented with conformance as the only emphasis. They should be driven by the benefits conformance will bring to the organization. Whenever possible, audit results, whether findings or conformances, should be presented in terms of real savings and losses.

5.2.2 Formal and informal audits—Quality auditing can take different forms, from an informal, unannounced visit to a potential supplier, to a full assessment of the quality management system. Informal audits may have the objective to simply gauge the capability of the organization. Formal audits typically are based on contractual agreements or laws and assess conformance to contract terms and conditions or compliance with regulations, respectively.

Informal audits are typically without a contractual basis, but may be mutually agreed to facilitate future contractual or working relationships. They may simply be an introduction to and an assessment of the capability of the organization being audited. In either case, the basis of the audit should be identified at the onset.

5.2.3 Auditee support

5.2.3.1 External audits—External audits require the support of the auditee. Midlevel production management may often be schedule-driven and shortsighted, viewing an auditor's presence as an obstruction to the supplier's delivery for their operation. Supplier upper management in a mature organization, however, if practicing the principles of customer focus and continual improvement, will have far-reaching objectives and will welcome the opportunity to explore the customer's expectations and their own strengths and weaknesses.

5.2.3.2 Internal audits—Personnel should be made aware of the potential improvement and positive changes that an internal audit can bring. The manner in which audits are conducted, reported, and followed up on are critical in that personnel can become defensive unless they see some benefit for them in the process. Respect for auditees and their work is paramount. Inclusion of the auditees as much as possible in establishing the audit process can help improve buy-in and make the process more successful overall.

Internal audits can clarify the reasons for failures by identifying systemic problems. They can mend interdepartmental process breakdowns. They can encourage training and continual improvement. They can also highlight the work of those who perform efficiently, thereby encouraging others to do the same.

5.3—Audit objectives: compliance, conformance, and improvement

Audit objectives are usually established to increase understanding of an organization so decisions regarding future business relations can be made, conformance with contractual requirements or compliance to regulations can be assessed, and process or product improvements can be made.

5.3.1 External audits: compliance, conformance, and capability—External audits refer to audits conducted on a supplier or occasions when the organization is audited by the customer. Audits may include items of regulatory, statutory, or contractual compliance and conformance to standards, specifications, contract requirements, or stated procedures. They can also include audits for registration and certification, such as **ISO 9001:2015** registration or NRMCA batch plant certification (**NRMCA 2014**), which can be used as a method of supplier assessment to determine strengths and weaknesses.

External audits can include second- and third-party audits. A second-party audit is one performed on a supplier by or on behalf of the customer. A third-party audit is performed by a party that does not act on behalf of the customer or the supplier (for example, an audit performed by the ISO registrar).

External audits are also used for supplier evaluation. They are best conducted either prior to procurement or early in the production process to assess a supplier's capability. They are good tools for evaluating risk to the organization when taking on new suppliers or those with competitive pricing, but uncertain experience, exposure, or transparency.

External audits are mainly focused on conformance more than on improving the audited organization. Exceptions to this would be when the customer and the supplier have developed a long-term relationship and the customer is interested in further developing the supplier's capability, or it is in the interest of the customer to raise the supplier's level of performance.

5.3.2 Internal audits: compliance, conformance, and improvement—Internal audits, also called first-party audits, are performed within an organization with the intent of verifying compliance with regulations or conformance to internal procedures and standards. Internal audits against regulations or established external standards (such as ISO 9001:2015) can be the basis for self-declaration of compliance or conformance, respectively. Additionally, through auditing the performance of the organization, internal audits can bring value and promote continual improvement by exposing weaknesses in a process or its interrelationship with another process.

More mature organizations focus primarily on effectiveness and continual improvement with a shift from conformance to performance (conformance being considered embedded in performance). These audits are considered management tools and drivers to continual improvement. Under these circumstances, auditees and auditors are sharing experiences, identifying more efficient processes, and applying problem-solving skills.

5.3.3 Surveillance audits: continual conformance—Surveillance audits are used for monitoring or observing to verify that the systems presented in previous audits are, in fact, in use and functioning adequately. Surveillance audits typically refer to field audits of physical processes as opposed to desk audits of records. They can be employed as spot checks or random surveys to ensure continued conformance. Unannounced audits can be considered a doorway to good team building in that they can show a lack of consid-

eration for the auditee. Unannounced surveillance audits, however, can be valuable by providing insight into the actual methods in practice and can be appropriate if supplier transparency is minimal.

CHAPTER 6—PERFORMING AN AUDIT

The following is a description of the steps an auditor can take in conducting a formal audit.

Refer to **A.1** of this guide for the ISO Audit Procedure QMP-010 (ISO 9001:2008).

6.1—Notification and scheduling

Audit programs will normally have scheduled intervals for audits. They are sometimes partial audits and focus only on selected processes or elements of the operation so as not to overwhelm the auditee and divert them from their task all at once in the course of a top-to-bottom audit. Organizations with numerous suppliers and subcontractors will normally develop an audit schedule at the beginning of the project. This will ensure the important topics are covered and help to prioritize the audits of suppliers critical to schedule and outcome of the work.

Prior to start of work, it is an effective measure, based on the project schedule, to establish a list of suppliers and identify tasks and significant milestones for each supplier. Following this, an auditor can schedule interim interviews based on the anticipated start date of those tasks. Audits can take the form of timely, brief, focused audits to check the items seen as critical. With the agreement of both parties, the audit can be informal and not need to include all the protocol a formal audit would require.

It is professional practice to notify the auditee of the time, location, objectives, and scope of the audit. Two weeks of initial notification prior to the audit is usually sufficient time for scheduling to occur. At that time, the duration and general scope of the audit should be stated. If additional information is required of the auditee, it should be requested at this time. This initial notification can be followed with more detail in the form of the audit schedule, agenda, and checklist to be employed as the date approaches where 5 working days can be considered adequate. If confidentiality agreements are required, they can be executed at this time.

Refer to **A.2** of this guide for the ISO Audit Schedule QMP-010A (ISO 9001:2008).

6.2—Audit team selection

The size of the audit team will depend on the scope and scale of the audit. The audit team may be composed of one or more individuals and is often led by a lead auditor (who, for team audits, will be referred to as the auditor). Depending on the nature of the audit, technical experts can also be included. Auditors-in-training may also be included, but they should not audit without direction or guidance.

Having determined the scope and scale, assignments should be made for each member of the audit team. A large audit may require splitting up the forces to delegate segments of the audit, which would include the document research and preparation of the audit criteria and checklists.

ISO 19011:2011 provides criteria for evaluating and selecting auditors. Among the requirements are:

- Personal attributes to include ethical behavior, perceptive observation, communication skills, a decisive approach, and open-minded interpretation of data
- Experience in audit principals and methodology
- Knowledge of quality management systems and acceptable practices
- Continuing education and professional development of management and auditing skills
- Experience and technical background in the audit subject.

It is not within the scope of this guide to mandate auditor qualifications, as it would limit its application. However, it is reasonable to expect a lead auditor to have at least 5 years of experience of auditing within the subject discipline.

Technical experts can be included in the audit team; however, technical background alone does not necessarily qualify an individual as an auditor without meeting the aforementioned requirements.

6.3—Document collection and review

Documents to be reviewed should include:

- The submitted quality plan, procedures, and work methods
- Contract requirements in the form of specifications, plans, codes, and accepted industry standards
- Proposals such as statements of qualifications, detailed quotes and bids, and verbal or written commitments for performance in terms of volume or quality
- Previous audit reports and related follow-ups, such as requests for corrective action requests (CARs)
- History of nonconformance, deficiencies, corrective actions and preventive actions, and opportunities for improvement

As part of the preparation for the audit and based on the audit criteria and the audit team expertise, the lead auditor will assign to each auditor documents for review and for preparation of checklists.

6.4—Audit plan preparation

The audit plan should be prepared under the direction of the lead auditor and should include:

- Agenda and schedule
- Date, time, location, and duration
- Audit objectives, including determining conformity to audit criteria, evaluating capacity to meet a certain criterion, and determining areas for improvement
- Scope in terms of which processes and activities to be focused on
- Audit criteria and reference documents, normally selected from those listed previously
- Roles and responsibilities of the audit team and auditees
- Checklists to be employed
- Confidentiality issues
- Audit follow-up actions
- Logistic arrangements

Refer to **A.3** of this guide for the ISO Audit Agenda Form QMP-010B (ISO 9001:2008).

6.5—Preparation of checklists and supporting documents

Keys to efficiency of an audit are the checklists, supporting documents, and working documents.

6.5.1 Checklists are guides to the audit process. They are meant to keep the audit on track and direct the discussion to the main issues to be covered, yet are to be flexible enough and broad enough in their questions and topics to allow the auditee the opportunity to describe the process. An auditor has to be well versed in the topic to branch off the checklist topic when faced with an answer that requires further discussion.

Audit questions are best planned by asking the “how” of a process rather than targeting a “yes” or “no” response. The auditee is asked to explain the process and, in so doing, will widen the discussion into further dialog. Questions such as, “Can you walk me through this process?” or “How do you accomplish this?” can prompt the type of information sought. The auditor should expect the auditee to be able to expand on the subject, as they should be the expert on the topic.

Checklists should be assembled using the appropriate terminology considering both technical jargon and regional expressions used in the industry. The level of checklist detail and response compliance is the choice of the auditor and, in the absence of well-defined criteria, such as in a capability evaluation audit, there is no right or wrong answer. The level of expectation should match the scale, criticality, and complexity of the work, as well as the cost and expectations.

It is best to structure the checklist as a matrix to have room for notes and branching off the topic question when necessary. A checklist used by an auditor with an assistant that takes notes is a good system, whereby the auditor can jot down their follow-up questions while the assistant takes notes on the responses.

6.5.2 Supporting documents can include the references and documents from which the audit plan and checklists have been drawn, if it is practical to bring them.

6.5.3 Working documents include sign-in sheets, data sheets, logs, forms, and sampling lists for documents, data, or materials necessary for the evaluation.

Refer to **A.4** of this guide for the ISO Audit Checklist form QMP-010C (ISO 9001:2008).

6.6—Conducting the audit

The on-site audit activities include the initial opening meeting; interviews; collection of information; and the debriefing, sometimes referred to as the closing meeting.

6.6.1 The opening meeting should include the following:

- a. Introduction of the audit team and their assignments
- b. Confirmation of the audit plan and objectives
- c. Confirmation with the auditee of who will be the point of contact, guide for each audit team member, or both
- d. Addressing any confidentiality issues
- e. Addressing safety policies and personal protective equipment, if required for access to the project
- f. Confirmation that during the audit the auditee team will be informed of the progress

g. Method of reporting, including explanation of how deficiencies, nonconformances, and opportunities for improvement are handled

6.6.2 Interviews and collection of information should consider the following:

6.6.2.1 The methods of collecting audit information include interviews with the auditee team, observation of activities, and review of documents. The information should be relevant, verifiable, and recorded on the auditor’s notes. In no instance should conclusions be drawn on assumptions, suspicions, or other nonverifiable information.

6.6.2.2 Interviews and collection of evidence must be done with the auditee’s knowledge of each element gathered and recorded. It is a good practice to confirm with the auditee the audit findings, good or bad, as the information is presented. Information that could have a negative impact on the outcome of the audit should be noted to the auditee as soon as it is discovered, thereby giving the auditee an immediate opportunity to expand on the response, provide more information, or clarify what has been presented. There could be something the auditor missed, misunderstood, or did not request.

6.6.2.3 Branching to a related process or drilling down to specifics is acceptable practice and needs to be expected by the auditee. Auditor consideration to a subject that is not on the checklists, the agenda, or both, should be avoided. The exception is topics discovered while reviewing a checklist or agenda topic. Care should be taken to ensure that the auditee understands why the subject is being considered.

6.6.2.4 The lead auditor should be in constant communication with the audit team members and meet periodically during the course of the audit to review and evaluate information gathered up to that point.

6.6.2.5 Sampling of reports and data should be done in a random fashion. Rather than ask for a sample of a report or item of data, ask for a specific date, location, or product; or follow a trail for a specific object or task chosen at random. Requesting a sample without specifying which one can often result in receiving the best, or only, one in existence.

6.6.2.6 Respect and consideration of the auditee is paramount. Without their cooperation, the audit cannot take place. An auditee usually takes pride in what they do and may resent an outsider who criticizes their work. For informal audits, expressions such as nonconformance, deficiency, or failure should be used with some reserve. Explaining problems by stating the requirement and then comparing it to what has been presented will usually get the point across. For formal audits, however, the correct terms should be used for an accurate record of the findings. The auditee should be encouraged to respond to a finding, propose corrections to fix the physical issue, and provide corrective action to improve the process and prevent recurrence. This can promote buy-in and further motivate the auditee to implement the correction.

6.6.2.7 If relevant to the scope of the audit, a negative finding can be recorded in a corrective action request (CAR) in which the auditor requests the auditee to bring a process or task into conformance with requirements. This is at the option of the auditor, but a CAR is appropriate when the objective of the audit be one of a corrective action evaluation.

ation. For more minor issues, a CAR can also be more delicately presented as an opportunity for improvement to express it with the same intent, but with a different connotation.

6.6.2.8 Prior to the closing meeting, the audit team should gather to discuss, review, and summarize the audit findings; agree on recommendations, observations, and conclusions; and identify items requiring follow-up. As part of the audit conclusion, a statement related to the extent of audit objectives being met can be included.

6.6.3 The debriefing or closing meeting can contain the following:

- a. A show of appreciation for auditees' participation and assistance
- b. A summary of the results of the audit, both negative and positive. If negative results such as nonconformance are found, this audit debriefing meeting is the best venue to discuss and agree on the finding. It is recommended to write out the nonconformances fully in their final form in advance of the debriefing meeting, so that the wording can be addressed, modified, and agreed to if need be.
- c. An open discussion that could possibly lead to some immediate resolution and agreement on issues not found satisfactory
- d. A listing of recommendations; it should be noted that recommendations are not binding upon either party
- e. Issues that will need to be addressed and clear plans for any follow-up audit

Issues can be recorded on a nonconformance or CAR form, in which case a formal response is required, or they can simply be noted in the audit report. Time frames for nonconformance resolutions or corrective actions can also be discussed with the auditee.

The auditor may give a copy of their handwritten checklist notes to the auditee for reference and documentation of the findings and agreements. However, a word of caution is given—informal and trusting communication could later put the auditor in a position of disadvantage should the auditee decide to dispute the findings based on the auditor's notes and verbal agreements.

If the auditor wishes to obtain agreement with the auditee on any contentious issue, nonconformance, CAR, or opportunity for improvement, allow sufficient time on the day of the audit to type the audit report and associated nonconformance report (NCR) findings with descriptions, and review these in the closing meeting so that both parties can agree to the wording.

6.7—Audit report preparation

The report should be the responsibility of the lead auditor. The report should be signed and dated by the lead auditor. It should be issued to the auditee within a brief time frame, generally 1 week or less. Otherwise, the impact of the audit, the information conveyed, and the intent will be diminished. It should be concise to serve as an accurate record. The time required for follow-up should be discussed and agreed to, as some actions may take considerable time, and the auditee's commitment to the time frame is important. The report may contain the following:

- a. Audit scope, criteria, objectives, date, and location
- b. Brief summary of the audit process
- c. The audit team members and auditee's interviewed personnel
- d. Sign-in sheets for the opening and closing meetings and minutes of such meetings, if kept
- e. List of reference documentation, including the drawings, specifications, codes, plans and procedures, and proposal used for criteria development
- f. Completed audit checklists and notes
- g. Observations, recommendations, corrective action requests (CARs), nonconformance reports (NCRs), opportunities for improvement, and any follow-up requirements
- h. Statement related to the confidential nature of the audit report

Audit reports should be treated as quality records and maintained for a period of time determined by either contractual or organizational requirements.

Refer to [A.5](#) of this guide for the ISO Audit Report form QMP-010D, [A.6](#) for the Opportunity for Improvement (OFI) form QMP 010E, and [A.7](#) for the Nonconformance Report form QMP 010F ([ISO 9001:2008](#)).

6.8—Audit procedure templates and forms

This guide provides template forms and procedures for conducting audits. See the following attachments:

- a. QMP 010-Audit Procedure ([A.1](#))
- b. QMP 010A-Audit Schedule ([A.2](#))
- c. QMP 010B-Audit Agenda Form ([A.3](#))
- d. QMP 010C-Audit Checklist Form ([A.4](#))
- e. QMP 010D-Audit Report Form ([A.5](#))
- f. QMP 010E-Opportunity for Improvement Form ([A.6](#))
- g. QMP 010F-Nonconformance Report ([A.7](#))

CHAPTER 7—QUALITY MANAGEMENT COMMON ELEMENTS AND PROCESSES

There are common elements and processes that are the essential building blocks for quality management systems. They have been categorized, ordered, and discussed with consideration for their application within the concrete industry. As this guide is intended to be nonmandatory, it is not meant to align itself with any standard, but draws from the applicability and benefits of [ISO 9001:1994](#), [ISO 9001:2000](#), [ISO 9001:2008](#), and [ISO 9001:2015](#), and is arranged accordingly.

Documented procedures can be required by project specifications that are formatted in the same manner as the ISO 9001:1994 standards. With respect to ISO 9001:2015, however, a documented procedure for every process is not required by that standard. The auditee should only provide evidence that a process and its interrelated processes function adequately.

The following are presented as quality management system elements and processes common to all industries. For discussion of quality management processes specific to disciplines within the concrete construction industry, please refer to [Chapters 8 and 9](#).

7.1—Quality management system

7.1.1 Elements—The elements of a quality management system can be as follows:

(a) The quality policy is normally written by top management and serves as the mission statement for the organization. It briefly states the intent and objectives and is further defined by the quality plan (stated objectives) and the procedures. Input from all levels of staff in developing the policy can be helpful for increasing buy-in and help motivate compliance overall.

(b) The quality plan states the objectives and commitments of the quality management system. It can be brief and refer to the procedures as a second tier of the system or have the procedures nested within it, at the option of the organization.

(c) Procedures are normally documented in the quality plan or apart from it as a second tier. They can be further supported by work methods as a third tier if deemed necessary. Procedures are not always required by quality management systems, but are good practice in that they provide for standardization, clarity, and ease of training of new personnel. It is further noted as good practice to index procedures and work methods with a numbering system and post revisions to be included, or at least referenced, in the quality manual.

(d) Organization is the people that operate the system. Quality plans will often include organization charts and descriptions of roles to show reporting structure and responsibilities. Within the organization can be a designated management/quality representative appointed by management to lead the effort as well as supporting personnel in other disciplines, such as production, but with responsibilities for quality activities.

Refer to Fig. 7.1.1.

7.1.2 Quality manual—The quality manual often contains the scope, objectives, and documented tools for the quality management system and states any exceptions it takes to the standard if it is written to one. It can be issued as controlled copies or uncontrolled copies. Owners of controlled copies will be listed and receive all revisions. Uncontrolled copies are meant to be used only as references and not official documents.

The quality manual may contain the following:

- (a) Quality policy signed by members of upper management and the management/quality representative
- (b) The quality plan (objectives, commitments, or intent)
- (c) Procedures, descriptions of procedures, or a list of the procedures
- (d) Organization chart and descriptions to include the organization's reporting structure and definition of roles, responsibilities, and authorities for each position
- (e) List, description, or mapping of processes and their interrelationships

Refer to B.1 for sample audit questions.

7.2—Management responsibility: leadership

7.2.1 Quality policy and communication—Management are those with the authority to direct the organization and set priorities and objectives. Management should develop the quality policy. It is best that it be a written policy so



Fig. 7.1.1—Quality management system hierarchy.

it can be included in the quality manual and posted in the facility. As an option, the quality policy can be nested within the mission statement along with safety, production, and customer satisfaction objectives. Management can also be responsible to communicate the quality policy in the form of training. All personnel can be, at a minimum, trained in the objectives and the general means to reach them. Supervisors can be trained in the implementation and operation of the quality management system.

7.2.2 Management commitment

7.2.2.1 Responsibility and authority are to be defined and delegated by management. A management/quality representative may be designated. In the interest of independence and objectivity, persons having quality assurance duties such as audits and records review are normally not under the supervision or authority of production. The authority may include the right to stop work, reject products and raw materials, or direct changes to a process.

Authority to conduct quality control activities can be delegated to production personnel if it is in the interest of production control. This would be subject to audit by the management/quality representative to ensure conformance. Final acceptances of civil and structural works contracts, however, are usually mandated by code to be performed by independent third-party inspection or the owner's representative.

7.2.2.2 Resources to be provided by management for the quality management system are as follows:

- (a) Personnel to operate the system with staffing levels reviewed for adequacy at set intervals
- (b) Infrastructure and facilities to include measuring, testing, and inspection equipment; expendables; access to the work; notification of schedules; construction documents; reference materials; office space; computers; and any other items necessary to perform duties

7.2.3 Contract review and customer focus—It is the responsibility of management in the interest of both the client and the organization to review contracts for risk and organizational capability prior to acceptance. The following should be considered:

(a) Can the organization perform this work for the bid price and be confident the customer will return with more work?

(b) Is the organization familiar with this work, and can it anticipate pitfalls?

(c) Is this a familiar team of the owner and other entities in a familiar location?

(d) Can it be accomplished with the present level of manpower, equipment, material supply, and expertise?

(e) Are the design, specification, and product requirements well defined? Will there be many delays due to questions and issues with these topics?

(f) Does the design violate any local codes or ordinances?

(g) Have we asked all the questions and taken the necessary exclusions?

(h) Are there requirements that are not readily apparent in the documentation? For example, have issues such as appearance of surfaces without use of special form liners, accommodation of drainage issues either during construction or after, and minimization of disruption to tenants and neighbors been addressed?

It is best to be methodical in evaluation of contracts and to document decisions and the answers to these questions so that a successful project can be repeated with a satisfied customer and an unsuccessful one can be avoided in the future.

7.2.4 Quality planning—Though not always specifically required by all standards, a written procedure for quality planning can be an effective tool for a new process. The steps in planning a new process would be as follows:

(a) Determining the process sequence and the interrelated processes that impact it

(b) Determining what controls and metrics (methods of measurement for process evaluation) are necessary to make the process effective

(c) Determining the availability of resources in terms of personnel and equipment

(d) Writing process procedures to include the scope, objectives, process steps, criteria for acceptance, responsibilities, documentation requirements, and requirements for review of data

(e) Training of personnel

(f) Methods to monitor performance data and make improvements

7.2.5 Management review—Upper management needs to review the performance of the quality management system as well as the organization as a whole. There can be a procedure put in place for this that would include a periodic report by the management/quality representative and other department managers to outline the metrics of performance such as schedule realization, cost and production controls, accounts and categorization of nonconforming items of work, action items for corrective and preventive actions, customer complaints and evaluations, processes in need of adjustment, audit results, and opportunities for improvement. It is helpful to develop a report template and requirements for responses and any necessary action on the part of management within a set time frame.

Refer to **B.2** for sample audit questions.

7.3—Design control

The extent of design control will depend on the scale and complexity of the design effort. One would not expect a formalized design development structure for a small project or development of a new type of precast product where brainstorming sessions, field trials, and meetings are more in order. The extent to which the auditor should look for documentation should bear on the applicability of it. For more on design and development, refer to **Chapter 8**.

The following presents the sequence of events for design of a large-scale design project executed using common quality management techniques along with the related documentation:

(a) Planning would include determining and documenting the scope; objectives; organization in terms of staff, consultants, and field personnel; schedule and milestones; division of the project into design units or packages; and the key activities such as sequence and stages of interim design reviews.

(b) Definition and documentation of design inputs to include information regarding customer requirements, design criteria and methodology, codes, statutes, and regulatory requirements. Sometimes this is documented and summarized in a design memo or confirmation memo for review and acceptance by the customer and used as reference for all involved in the task.

(c) In-progress development would include quality control checks of calculations, specifications, and drawings by peers or independents using well-developed quality control methods such as color coding and signing off on calculation sheets and drawings, all with complete traceability so it can be determined who developed and who checked each element. Checks within each of these elements of design development would be for conformance (with the design criteria), accuracy, and style (presentation and format).

(d) Design output is confirmed in a process referred to as verification and validation. Verification is the assurance that all the requirements are met. Validation is the process of assuring that the design meets the customer's needs. These are accomplished by a set of reviews at predetermined intervals along the path to completion, sometimes set at 40, 80, and 100 percent of design completion.

(e) Design reviews can include the following types:

- i. Discipline coordination reviews within the design firm are intended to provide assurance that the design outputs are fully aligned, conflicts addressed, and objectives are consistent.
- ii. Fitness-for-purpose/adequacy reviews within the design firm are also intended to provide validation of the design.
- iii. Constructability reviews assess the feasibility of the design, its sequences, and opportunities for improvement.
- iv. Client reviews are conducted for their own assurance that their requirements are being met.
- v. Documentation of design reviews and resolution of comments and issues.

spreadsheets to track them and serve as a quality record for the design development.

(f) Changes to design and the process for making those changes should be documented.

Design and development activities are not the sole domain of the designer or engineer of record. Activities by prime construction contractors or suppliers can involve design responsibilities for tasks such as temporary shoring, formwork, and support of excavation; development of products such as proprietary precast items and concrete mixtures; assembly of reinforcing steel and embed placement drawings; construction joint location drawings for placement sequencing; and proposals for alternative designs. In some jurisdictions and contracts, the contractor is required to provide an engineering seal for these items and, even though they are usually submitted to the owner's engineer for review, there should be a system in place to ensure they are accurate. A system of checks, sign-offs, and documentation should be in place for this and be commensurate with the gravity and complexity of the task.

Refer to **B.3** for sample audit questions.

7.4—Document and data control

Document and data control is a keystone to any effective management system, not just quality alone. It is one of only six mandatory procedures required by **ISO 9001:2008** as a minimum for a quality management system. Having a written procedure for document and data control promotes uniformity across the organization and facilitates training, versatility of assignment for personnel, and the opportunity to improve upon the methods. Of greatest significance, it saves time looking for information.

7.4.1 Items subject to document control—Accurate recording and tracking of the following is necessary:

- (a) Design criteria and changes
- (b) Design drawings and specifications released for construction
- (c) As-built drawings, record drawings, or both
- (d) Submittals to include shop drawings, catalog cuts, proposals, and quality records
- (e) Correspondence to include notice of claim
- (f) Requests for information
- (g) Directives
- (h) Change orders
- (i) Quality records (7.5)
- (j) Design development documents (7.3)
- (k) Plans, procedures, and work methods
- (l) All revisions to the aforementioned list items

Where applicable, the aforementioned list items should be logged in master lists, filed, and labeled as to revision and status of acceptance. Retention of these records is at the option of the entity that archives them but is best established in the procedure. Quality records (7.5) are often required by contract to be retained for a certain length of time.

7.4.2 Submittals review and cover sheets—Submittals should be turned in only after review by the submitting party. This should be indicated on the submittal by a stamp and signature attesting that the submitted items are

in conformance with the contract. This expedites the review process by minimizing errors and inaccuracies in submittals. Submittals should be accompanied by a transmittal cover sheet to identify the items, the reason for submitting them, and the contact person.

Design changes should not be initiated by the contracting agency or designer in the submittal review process. If the submittal intentionally contains items for review that deviate from the contract requirements, these items should be clearly identified as substitutions or deviations from the specified work. Alternately, such a submittal should be preempted by filing a formalized request for design change. Refer to **8.5.3** regarding design changes.

7.4.3 Implementation of document and data control system—This can be facilitated by application of various construction management software programs. They have greater applications on larger projects where personnel are trained in their use. Simpler methods using spreadsheets can be used for smaller projects and have the advantage of simplicity and ease of use. There can be a designated person for documents and data control. Free-for-all submittal systems with no central control will lack consistency and can be difficult to search.

7.4.4 Prevention of inadvertent use of superseded documents—Revision control prevents the inadvertent use of out-of-date documents. There are a number of methods used in combination with one another for ensuring the correct revisions are in use. They include the following:

- (a) Communication of the issue of revisions to all document holders
- (b) Issuing revised documents to owners of controlled document sets, pulling the superseded documents, and allowing only controlled document sets to be used
- (c) Clearly marking all superseded documents to prevent use; plans marked up by field personnel can be left in place for reference rather than necessitating transcription of all markings, but the superseded documents need to be clearly marked.
- (d) Conducting audits to determine if documented sets are up to date; this can be done shortly after critical revisions are issued

(e) Periodic issuance of conformed project drawings updated with all issued directions to proceed, design changes, and responses to RFIs. Issuing updates can be done cheaply and easily if based on an electronic format

7.4.5 Internal audits—Regular internal audits are recommended considering the dependence on the efficiency of document control systems.

Refer to **B.4** for sample audit questions.

7.5—Quality records

Quality records are considered their own category of documents that may or may not be carried in the document control system. They are intended to provide evidence that the quality was achieved. They also serve to provide a source of data for control of processes and a history of the work. They include the following:

- (a) Policies, plans, procedures, and work methods

- (b) Design records such as design input documents, calculations, drawings, design review records, customer comments, and resolutions
- (c) Inspection and testing reports
- (d) Checklists for activities that may include hold points and witness points
- (e) Audit reports and related documents such as checklist and samples
- (f) Record of contract review
- (g) Records to confirm traceability of products and other components
- (h) Training records, qualification, and certifications of personnel and companies
- (i) Calibration records
- (j) Nonconformance reports, corrective and preventive action requests, and proposals
- (k) Statistical records
- (l) Receiving inspection, reports of damage or shortage, and inventory storage condition audits

Often one of the best sources of information on the job history is quality records. If the contract specifies maintaining quality records after project closure, a specific time frame will be indicated. Also indicated will be the entity responsible for this. This may be dictated by local regulations designating the party responsible for defects and the length of this term. To minimize exposure, good practice would dictate that a responsible party would maintain such records, regardless of regulations or contract requirements.

Refer to **B.5** for sample audit questions.

7.6—Purchasing/management of subs and suppliers

7.6.1 Evaluation of suppliers—A procedure, not just a policy, can be put in place for the evaluation of suppliers. The level of assessment would depend on the value and risk of the services or materials procured and the history and relationship with the suppliers being considered. Elements to be considered in writing such a procedure would include:

- (a) Information drawn from a formalized company system of supplier evaluation, if one exists
- (b) Quality of workmanship based on external audits and tracking of nonconforming items of work
- (c) Schedule conformance on previous work
- (d) Performance for previous clients
- (e) Survey of the supplier's facility
- (f) Registration or certification by professional agencies such as ISO, NRMCA, and ACI
- (g) Dispute resolution history
- (h) Management structure to include quality and safety as well as production; this would include the level of detail, applicability, and execution of the quality plans provided

(i) History of any failure to perform

(j) Supplier or supplier safety performance records

Maintaining an approved suppliers list based on a formalized end-of-project evaluation system is beneficial to an organization in making these selections.

7.6.2 Bid data and contracts review—It is important to ensure that all required information is sent to suppliers and

documentation of what was transmitted is maintained so that there is always a record of what was purchased for the price quoted. Items of concern are the specific drawings transmitted, the specifications covered, process requirements, inspection and acceptance criteria, personnel qualifications, and schedule requirements. Any modifications to the base agreement would follow the same pattern. Having a method of ensuring accurate take-offs and keeping a record set of bid packages will serve to minimize surprises and disputes.

A methodical review of the contracts and proposals needs to consider the ability of the subcontractor or supplier to perform work and not delay the schedule with supply or quality issues. Is there more risk assigned to the supplier than to the general contractor? Default will harm all parties, owner included.

7.6.3 Supplier quality requirements—The requirements for quality management should be well defined in the contract language to include submission of a plan, qualifications and acceptance of quality personnel, references and supporting documents, customer's rights to audit, and access to facilities. The prime contractor can take the opportunity to pass along any contract quality requirements to the supplier. It can be arranged so that the supplier signs on to the requirements of the prime contractor's plan or system, but still should provide the supplemental documentation such as organization chart, roles and responsibilities, and procedures specific to the supplier's work.

7.6.4 Source inspection—The customer, which would be the prime contractor if work is by a supplier, can have the right to visit off-site facilities and inspect materials or fabrications prior to shipment. Verification inspections, surveys of production, and formal external audits can be made to provide confidence that the quality requirements have been met. Source inspections and shop release requirements should be defined in the contract if necessary to ensure delivery of an adequate product.

7.6.5 External audits of suppliers—External audits should take place using the protocol described in **Chapter 6**. They should be evaluated against the plan submitted and the supplier agreement requirements. For off-site audits, they can also be coupled with production status surveys to save management the cost of sending someone from purchasing to provide similar information. They should be reported to the management in a timely manner and followed-up on if findings are not in alignment with requirements.

Audits need to be practical and of value with emphasis placed on product realization rather than being confined solely to review of documents. They should be prioritized based on the criticality of the work and its impact on the schedule. They are best conducted either ahead of or in the initial stages of the work to confirm practices.

7.6.6 Receiving inspections—Inspection at delivery should be documented. The advantage of receiving inspection is in that the material can be verified as having arrived in good order with the correct quantity so as not to raise shipping damage disputes or incur delay due to repairs or replacements losses. Receiving inspections are a best practice collection and checking of required documentation such

as certifications of conformance, materials test reports, or inspection records and shop releases (refer to 7.11 for further discussion).

Refer to **B.6** for sample audit questions.

7.7—Process control

A process can be defined as a set of interrelated resources and activities that transforms inputs into outputs. More simply put, it is the combination of all the planning, materials, and labor that make the product. If not carried out with controls, processes can be inefficient and produce unsatisfactory results.

7.7.1 General—It is best to carry out processes under a set of procedures to define the considerations for adequate control. These procedures should include the following:

(a) The manner and sequence in which the work is carried out. This can be in the form of narrative for simple operations or with flowcharts for more complex operations. Critical path method scheduling is a type of flowchart that shows the interrelationship of events to accomplish a task.

(b) The steps in the process need to be defined as events and be subject to the following:

- i. Acceptances of designs, working drawings, materials, and special processes
- ii. Manners of communication that would include preplanning meetings, look-ahead schedules, and daily notifications of work
- iii. Specific measurements and inspections with defined acceptance criteria
- iv. Hold points for acceptance, rejection, or rework
- v. Designation of the entity with authority for acceptance or rejection

(c) Scheduling for adequate coordination for materials, manpower, engineering, acceptances, logistics, weather, and demand for completed product

(d) Equipment and equipment maintenance requirements

(e) Environmental conditions such as hot and cold weather work and rainy season flatwork

Of special concern are characteristics of the product that cannot be determined until a later date. For example, because the strength and durability of concrete is determined typically 28 days after placement, it should be inspected, accepted, and documented as the process proceeds. Typical batching inspection and field acceptance testing fill this requirement as process control in that the tests conducted give an indication of future product quality.

7.7.2 Process approach—A typically employed process control system is the four-phase approach and is shown in the following:

1. The preparatory phase can include drawings and specifications review; examination of the work area and site conditions; inspection of materials; preplanning (kick-off) meetings; acceptance of working drawings, materials, samples, mockups, and proposals for alternate methods; verification of worker and inspection qualifications; identification of hold points; definition of inspection methods and acceptance criteria; procurement of testing and inspection labs; and assembly of a look-ahead schedule. Audit questions make

good topics for a pre-activity meeting agenda and checklists. If asked before an activity takes place, the questions can establish a proactive approach that is beyond their use for just an after-the-fact evaluation.

2. The initial phase concerns the checking of the startup work to verify conformance, confirm acceptable levels of workmanship, and resolve discrepancies. In manufacturing, it is often referred to as “first article inspection” and is used to verify planning assumptions and production capabilities.

3. The in-process phase is the implementation of the normal testing, inspection, and process control to ensure requirements continue to be met, craft is performing as planned, and required witnessing and hold points are satisfied. Results of tests and inspection should be reviewed for trends.

4. The closeout phase is consistent with substantial completion of any given construction item. Some owners will prefer to concur with substantial completion status on a project basis and not by activity. It is an advantage to all to begin the close-out phase early, activity by activity, while personnel that performed the activities are still present and the records documenting completion are readily available to resolve any outstanding concerns.

Refer to **B.7** for sample audit questions.

7.8—Procedures

Procedures are considered the second tier of a quality management system, the first tier being the quality manual or plan. The third tier would be work methods, which provide another level of detail if necessary. It is at the discretion of the organization to further detail the procedures by the use of work methods or simply incorporate this detail into the procedures themselves.

ISO 9001:2008 requires only six procedures be documented. They are as follows:

1. Control of documents
2. Control of records
3. Internal audit
4. Control of nonconforming product
5. Corrective action
6. Preventive action

It is good practice to document procedures. Beyond contractual requirements, the organization has the option of documenting any procedures it cares to. Documented procedures provide the advantage of standardization and facilitate training personnel. Again, there is no single way to conduct business. Some organizations find it acceptable to verbally communicate procedures and make adjustments as they go, so all team members understand the process. Provided there are no contract requirements to have written procedures, no legal consequences of their absence, or no continual misunderstandings, this manner of doing business can function.

Notice should be taken of situations where written procedures are required, but the documented process appears unrealistic or of little benefit. Reporting forms that do not appear to have any value or spaces to enter information that requires detail are also causes for concern. Attention should be drawn to this and objective evidence of documents obtained to assure that the process is authentic.

Procedures can be written in a standard format to ensure all requirements are covered. A suggested format follows:

- (a) Purpose
- (b) Scope—what the procedure covers
- (c) References to specifications, codes, standards, or other procedures
- (d) Process execution details should include: operations, equipment, pretesting or mockups, personnel, reviews, reports, hold points, inspections required, and witness points
- (e) Work methods when appropriate to give specific detailed steps in the process or processes
- (f) Acceptance criteria—definition of requirements and evaluation methods for acceptance; included in this section is the verification of the worker qualifications (this can include welders, cable grouters, designers, drafters, testing and inspection technicians, and others)
- (g) Qualifications of the personnel design checkers, reviewers, inspectors, and technicians if applicable
- (h) Responsibilities and authorities—defines who does what; who has control over the process and to what extent; who performs the tests or inspections; who records the data; and who provides the access, equipment, and documentation
- (i) Documentation requirements—listing and description of the forms, reports, and any other documentation required; this can include inspection and testing reports, notifications, schedules, and checklists

Although it is not required to index, number, and mark revisions on procedures and work methods, it is good practice to do so for the benefit of the organization, control of documents, and assurance that the most current revision is in use.

Refer to **B.8** for sample audit questions.

7.9—Inspection and testing

7.9.1 Responsibilities—In construction or manufacturing, the primary responsibility for inspection should be the producer's. In some agreements, such as awards based on lowest responsible bid, the inspection and testing become the responsibility of the owner or the owner's representative. In this situation, the owner is conducting both the quality control (production control) and the quality assurance (acceptance control) testing. Some owners may restrict the scope of quality assurance tests more than appropriate to prevent their use as a replacement for contractor's quality control. Further, owners may restrict the contractor's reliance on the owner's quality assurance testing results to defend the product when the contractor's quality control testing results have indicated failure. A contractor, therefore, may not request that the owner accept the product when the owner's QA testing has shown it as acceptable, but the contractor's QC testing has indicated otherwise.

7.9.1.1 Producer quality control—A more mature organization interested in growth and improvement can conduct their own testing and inspection as quality control measures. This would include in-process testing of materials, inspection of incoming product and supplies, source inspection at manufacturing facilities, and the associated documentation such as reports and checklists. The intent of this type

of inspection is to keep the project on track and maximize performance through monitoring.

7.9.1.2 Owner quality assurance (acceptance)—Most building codes require inspection and testing conducted by a licensed professional or the building department. Based on the reports and acceptances by these agents, building officials will authorize the occupancy of the structure. The exception is public agencies such as departments of transportation that will conduct their own inspections or have them executed by consultants under their supervision. Construction managers will sometimes be given the responsibility to hire and manage an independent professional inspection and testing firm whose reports and affidavits of acceptance will be submitted to the building officials for authorization to accompany the structure.

In some instances, specific quality-control testing and inspection requirements will be assigned to the contractor as part of his agreement, in which case, the contractor may be required to hire an independent third party with no affiliation or financial interest in the project. This will still be followed by the owner's quality assurance testing and inspection to confirm the reliability for final acceptance of the same as conducted by the contractor's independent third-party consultant.

Third-party independent inspection and testing agencies should have accreditations from national accreditation bodies. These accreditations are granted on a per-task basis. Therefore, accreditation covers only those specific tests the agency has been accredited to. Where required by local regulations, agencies should also have municipal licensing. All personnel conducting tests and inspections should have the relevant certifications. Reports submitted for acceptance should be stamped by a professional engineer.

Federally-funded projects allow contractors to subcontract quality control to an independent third-party agency in place of the owner's testing and inspection, but a system of independent assurance that employs verification testing should be taken where a certain percentage of the work is tested in parallel and inspected by an unbiased, independent entity hired by the owner. Results of testing and inspecting are compared and addressed systematically should variations in results exist. **23 CFR Part 637:2014** explains these methods for federally-funded projects.

7.9.2 Inspection procedures—As explained in 7.8, it is best to issue written procedures for testing and inspection to define the criteria, process, duties, and documentation. Documentation should include reports with the signatures of the inspector and preferably the countersignature of production supervision.

7.9.3 Notifications/in-process inspections—Notifications include daily look-aheads, 2- to 6-week look-aheads, and project schedules. Notifications afford everyone the opportunity to schedule witness and hold points, as well as to ensure that adequate resources such as staff and equipment are available for upcoming work. If not a code or contract requirement, notifications should be included in the process as a manner of professional courtesy and as a means of notification of testing and inspection.

7.9.4 Hold points and witness points—Hold points are points in the process where the process cannot continue until certain tests, inspections, confirmations, and acceptances are made. They can be part of the contract and require the acceptance of the owner's representative prior to proceeding. A hold point can be a line on the checklist or testing report with provision for signature by the owner or owner's representative. Acceptance of reinforcing bar placement prior to concrete placement is an example.

Witness points are locations in a process wherein a specific position/role/inspector needs to be given adequate notice of the scheduled inspection or test. Witnessing of concrete testing or the stressing of a post-tensioning element may be a requirement of the contract and would serve as an example of a witness point.

7.9.5 Receiving inspection—Receiving inspection is covered under 7.11.

7.9.6 Final inspection—Final inspection includes the field review of the work, generating and closing of all punch list items and NCRs, checking and archiving of inspection and testing reports and checklists, and ensuring that all inspections and tests required have been completed. It can also include startup and commissioning to verify performance of the end product.

7.9.7 Inspection and test status—At any point in the process, any person should be able to identify the status of a material or product with respect to its acceptance. This can be done by labeling, marking, or keeping records. There is a practice to use green, red, and amber labels on equipment or materials indicating accepted, rejected, or on hold, respectively. There are also less sophisticated methods, such as those by which rejected materials are sprayed with orange or any other visibly contrasting paint. As previously stated, there is no right or wrong method if there are no mandated quality management methods. This is functional, as long as everyone understands the designation for "DO NOT USE".

7.9.8 Recordkeeping—Inspection and testing records are not always part of the document control system and are addressed in 7.5.

Refer to **B.9** for sample audit questions.

7.10—Control of inspection, measuring, and testing equipment

An organization using equipment for measurements should have assurance that measurements are accurate, especially when equipment is subject to wear and breakdown. Calibrations (control of measuring and testing equipment) can include readouts of data such as gauges on a pressure gauge or a compression testing machine, or they can include simple ruler measurements to check deformation as is done on a worn slump cone or set of aggregate gradation screens. They can also include visual verification for signs of wear or contamination due to inadequate care and cleaning. These calibrations should be logged, the documentation collected and filed, and the equipment clearly marked with the calibration date and calibrating entity. Logs should also show the next calibration date. Calibration intervals are usually established by manufacturers of the equipment, contract

requirements, commerce regulations, or published industry standards such as ASTM.

Typical calibration intervals are as follows

Air meters	3 months (or per organization policy)
Torque wrenches for reinforcing bar couplers	12 months
Scales	3 months
Thermometers	12 months
Compression testing machines	12 months
Survey equipment	12 months

The calibration of equipment is the responsibility of the user of the measuring equipment. Calibration should follow written standards. Although this can sometimes be beyond the user's technical capability, they are still responsible for procuring the service from an entity that is qualified for the calibrations.

It is necessary that calibrations and measurement checks are traceable to a known source of reliability. Some field equipment, such as thermometers and pressure gauges, can be calibrated from masters that have been calibrated off site from traceable measurements. Often, contracts will require traceability to the National Institute of Standards and Technology (NIST), which calibrates devices to be used as measurement standards. Lab equipment is usually calibrated off these standards, because accuracy and traceability is important. Pressure-type air entrainment meters can be field-calibrated with the measuring equipment supplied with the accessories. Torque wrenches should be sent out to a calibration lab. If verification of tapes and rulers is done, they are typically verified against master tapes and rulers that are traceable to an established source. They are verified but not calibrated, as they have no provisions for adjustment. Measurements of lengths greater than those made with pocket rules (typically 25 ft [8 m]), if made with survey tapes, need to be adjusted for temperature and tension. Most survey work, however, is now done with electronic survey equipment that provides greater accuracy over longer lengths. Equipment overdue for calibration, damaged, or otherwise not meeting the requirements for the equipment should be removed from service.

Equipment found to be out of calibration and giving incorrect readings subjects all previous measurement data to doubt. Therefore, a procedure can either be in place or specifically developed to investigate the uncertainty of the data. Such a procedure could include methodically remeasuring representative samples or rejecting the entire production run.

Audit questions would be specific to the type of work being investigated along with its measuring equipment. The principles of calibration, however, are basic to almost all measuring and testing equipment.

Refer to **B.10** for sample audit questions.

7.11—Inventory control

7.11.1 Receiving inspection, reporting, labeling, and acceptance documentation—It is important to establish

a list of critical and long-lead-time materials that should be inspected on receipt, and to determine if the material received satisfies the construction documents, has arrived in useable condition, and is what was expected in terms of quantity and type. In its simplest form, receiving inspection takes place when material is delivered to a site, received by site personnel, the delivery ticket signed, and a copy sent to the office. In a more controlled environment, materials and equipment coming into a production area are inspected upon arrival and entered onto a receiving inspection report. This offers the following benefits:

- (a) Accountability to ensure that material has arrived without damage or shortage, thereby minimizing disputes and facilitating investigation should it be discovered at a later date to be damaged or short in count
- (b) Assurance that it will be ready for use and not cause delay due to damage or shortage
- (c) Consideration for proper storage and handling to prevent deterioration or expiration. This information can be gathered at the point of receipt or found in the manufacturer's literature or contract documents
- (d) Assurance of proper labeling as to description, origin, and other identification
- (e) Labeling for acceptance on the basis of the receiving inspection
- (f) Opportunity to collect the material acceptance documentation such as shop release authorizations, material test reports, certificates of conformance, manufacturers' certifications, safety data sheets, and warranties
- (g) Provision of reports to indicate arrival in acceptable condition or the issue of a report indicating damage; overage; shortage; or failure to provide acceptance, storage, or handling documentation. This is normally done in an over, short, or damaged report issued by the recipient

7.11.2 Product identification and traceability—Products are, when appropriate, given a unique number. Examples are precast units, concrete placements, embeds, and design drawings. Each identified unit should be traceable in terms of its constituents, be it cement and aggregate or design codes and calculations. Items drawn from stock, such as reinforcing bar not precut, should still be traceable, meaning that one should be able to determine what heat, production run, or lot it came from.

7.11.3 Inspection and test status—Inspection and test status is covered in 7.9.7.

7.11.4 Inventory audits—To assure the inventory control is effective, internal audits should take place periodically. They would include a check of documentation as well as a physical inspection of the storage facility.

Refer to **B.11** for sample audit questions.

7.12—Human resources/training

A system should be in place to ensure that personnel are trained and qualified, not only in their tasks but also in the policies of the organization. The first step is to determine the training, competence, and qualification requirements for each position. The program should include training and qualification records of personnel or logs indicating

the status or training, qualification, or competence of staff. Education, certifications, licenses, and other qualifications should be verified and documented. Refer to 7.5 regarding quality records.

As mentioned previously, preactivity meetings are good opportunities to train personnel in procedures and work methods for upcoming operations on a just-in-time basis to aid in retention. This can be done in conjunction with safety training and tool box talks. The sign-in sheet can serve as documentation of training.

7.12.1 For all staff—Training for staff is key in communication of the quality policy and the plan to implement it. For the office management staff, it can often be found in a training category that has become commonplace in large organizations and can include programs such as safety, behavior in the workplace, ethics, protocol for dealing with subcontractors, and company-specific administrative practice. This may not be found in smaller organizations that do not have the same resources or requirements.

7.12.2 For jobsite management personnel—In the interest of effective communication, it is appropriate to train jobsite production managers in the objectives of a site-specific quality program, especially if they will be expected to participate in inspecting either their own work or that of their peers. This training can be simple and may include self-explanatory checklists along with clarifying responsibilities. In the interest of good retention, training for specialized new procedures can be accomplished within a short time frame prior to startup and is known as just-in-time training. This can be considered part of the process control initial phase (refer to 7.7).

7.12.3 For craft—Industry standards do not cover every aspect of the work and unions usually have training and apprenticeship programs to train and qualify personnel. There are, however, specialized training and certification programs offered by trade and professional organizations and state departments of transportation for certain skills, many of which are required by specification. Refer to Table 7.12.3 for a guide to some of those currently available.

7.12.4 For organizations—Trade and professional organizations have programs for companies. They are usually awarded on the basis of satisfying quality management requirements, competency in the performance of specific tasks, and confirmed by audit on a regular basis. They also are referenced in Table 7.12.3. Some of these company certifications and accreditations are required by specifications.

7.12.5 For inspection staff—ACI, PCI, PTI, NICET, WACEL, and ICC offer certification programs for inspection and testing staff. These certifications are also often required by specification and are referenced in Table 7.12.3 for guidance.

7.12.6 For design engineering staff—Professional registration is required for certain positions. Beyond this, training in specialized design techniques and use of design software is good practice. Again, records should be maintained for each person's training and qualifications.

Refer to **B.12** for sample audit questions.

Table 7.12.3—Industry certifications and accreditation summary

Organization	For craft	For organizations (certifications, accreditations, and inspections)	For inspection and testing personnel
ACI	Flatwork Finisher Adhesive Anchor Installer Shotcrete Nozzleman Tilt Up Supervisor		ACI 1 Field Testing Tech Concrete Strength Testing Tech Concrete Lab Testing Tech I & II Aggregate Testing Tech I & II Concrete Construction Special Inspector Concrete Transportation Construction Inspector
ACI (CSA-based)			ACI 1 Field Testing Tech Concrete Construction Special Inspector
ASBI	Certified Grouting Technician		
WACEL		Lab accreditations under ISO IES 17028 and AASHTO R18	Concrete Field Technician Levels I and II Concrete Masonry Strength Technician Concrete Laboratory Technician Structural Concrete Technician
NRMCA	Numerous certifications for batch operators, batch plant manager, concrete technologist, fleet manager, and sustainability professional	Batch plants	NRMCA Concrete Field Testing Technician Grade II
NICET			NICET Levels I, II, III, and IV for asphalt, concrete, and soils
PCI/CPCI		Precast plants Certified precast erector	Quality Control Technician/Inspector Certified Field Auditor Certified Company Auditor
PTI	Iron Worker Field Installation Slab on Ground Stressor	Plant Certification	Inspector Field Specialist
AWS, CWB	Sanctioned programs through authorized facilities		Certified Welding Inspector
ICC		National Standard Building Contractor A, B, or C	Reinforced Concrete Special Inspector Precast Concrete Special Inspector
CRSI		Epoxy coating plant	
State departments of transportation		Batch plants	
AMRL, NAVLAP, A2LA, CCIL, WACEL, L-A-B, CCRL		Testing lab accreditations, inspections, or certification to ASTM E329, C1077, CSA A283-06, ISO/IES17023, AASHTO R18	

Notes:

A2LA: American Association for Laboratory Accreditation
 AASHTO: American Association of State Highway and Transportation Officials
 ACI: American Concrete Institute
 AMRL: AASHTO Materials Reference Laboratory
 ASBI: American Segmental Bridge Institute
 AWS: American Welding Society
 CCIL: Canadian Council of Independent Laboratories
 CCRL: Cement and Concrete Reference Laboratory
 CPCI: Canadian Precast Prestressed Concrete Institute
 CRSI: Concrete Reinforcing Steel Institute
 CSA: Canadian Standards Association
 CWB: Canadian Welding Bureau
 ICC: International Code Council
 L-A-B: Laboratory Accreditation Bureau
 NAVLAP: National Voluntary Laboratory Accreditation Program
 NICET: National Institute for Certification in Engineering Technologies
 NRMCA: National Ready Mixed Concrete Association
 PCI: Precast/Prestressed Concrete Institute
 PTI: Post-Tensioning Institute
 WACEL: Washington Area Council of Engineering Laboratories

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