
Logistics Management Institute

Construction Management Excellence

Using ISO 9000 to Improve Quality Systems

CE501MR1

Jeffrey A. Hawkins

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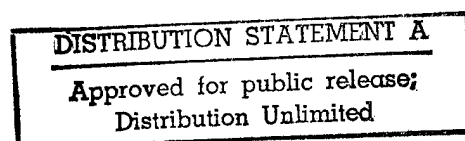
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November 1995

Jeffrey A. Hawkins

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Logistics Management Institute
2000 Corporate Ridge
McLean, VA 22102-7805

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Construction Management Excellence: Using ISO 9000 to Improve Quality Systems

Executive Summary

The U.S. Army Corps of Engineers (USACE) has been effectively managing military and civil works construction projects for many years. In the past, customers were satisfied with the service they received and with the cost of that service. However, the rules are changing. The Corps' customers are demanding more. As they face the realities of smaller staffs, shrinking budgets, and compressed schedules, they are asking the Corps to shoulder some of the burden. They still want their projects to be completed as designed and to meet all environmental, industry, and safety standards; but they also want their projects delivered faster and at a lower cost, and they want to be able to tailor the construction management services they receive for each particular project.

The Corps, too, is faced with downsizing, budget cuts, reengineering, and modernization as well as increasing competition for what used to be exclusive services. To ensure that it remains the public sector's construction organization of choice, the Corps must reevaluate its corporate culture and its business methods. The future success of its Construction Divisions depends on their ability to deliver the total quality product and services their customers are now demanding.

The Corps Construction Divisions have begun to implement a number of total quality management initiatives and have instituted effective quality assurance programs. However, the construction organizations still lack a comprehensive quality management system that encompasses all aspects of the construction management process. One such system that the construction organizations could readily apply is the ISO 9000 quality system developed by the International Organization for Standardization. Specifically, the Corps construction organizations should implement the quality standards in ISO 9002, *Quality Systems — Model for Quality Assurance in Production and Installation*. By obtaining ISO 9002 certification, the Construction Divisions would demonstrate that they have established a fundamental quality system and that they consistently apply that quality system to meet their customers' requirements.

The current quality system practices at USACE Construction Divisions and their resident and area offices already incorporate much of what is needed to comply with the requirements of ISO 9002. However, to bring its quality system into full compliance, a Corps Construction Division must develop a quality manual that outlines its quality system policies and establishes the framework for the quality system, and it must develop more comprehensive documentation of its quality procedures. In addition, it must assign a management representative with sufficient authority and responsibility to manage the quality system,

develop a formal internal quality system audit program, and formalize its corrective and preventive action system.

Any Construction Division wishing to become ISO certified should develop an implementation strategy. If aggressively managed, implementation of an ISO-compliant quality system will take about 11 months; cost about \$120,000 for the necessary training, consulting support, and registration fees; and require between 200 and 300 staff-days. We recommend pursuing registration at no fewer than two Corps construction organizations. From the experience gained from registering those test sites, the Corps will be able to determine the costs and benefits of expanding the ISO registration to all other USACE construction organizations. As more construction organizations gain experience with the implementation process, procedures and documentation can be shared, resulting in a reduction in costs and time.

The goal of every construction organization must be to establish a quality system that consistently meets or exceeds all the customers' requirements; anticipates, prevents, and resolves problems before they occur; is responsive to both the customer and industry specifications; and focuses on continuous quality and productivity improvement. The pursuit of overall operational excellence, or world-class quality, will require executive-level Construction Division leadership, the dedicated involvement of nearly every member of the organization, empowerment of the employees, rapid deployment of changing requirements and processes, management of innovation, customer-focused planning, integration of quality planning into business planning, and a move toward more flexible work environments.

Implementing an ISO 9000-compliant quality system is the essential first step that the Corps must take to make sure its quality objectives are realized. But ISO 9000 registration is not the end of the quest for world-class quality in the Construction Divisions; it merely establishes the fundamentals, which can then serve as the foundation for making further improvements to products, processes, and service.

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CHAPTER 1

Introduction

The Construction Divisions within the U.S. Army Corps of Engineers (USACE) have a long tradition of providing competent construction management, quality assurance, and contract administrative services to its military and civil works customers. The Corps' focus on effectively delivering technically excellent facilities and civil projects has earned the Corps its reputation and has been sufficient to keep its customers satisfied. However, the business climate is changing rapidly. The Corps' customers are faced with shrinking program budgets and reduced staffing. To fulfill their missions under these conditions, they are reengineering processes and procedures and, in that new environment, are recognizing that there is more to quality construction than technically excellent results. Corps' customers are now demanding a higher quality product — not by the Corps' definition of quality, but by theirs. They still want a finished facility that meets the approved design and that satisfies all environmental, safety, and industry codes, but they also want their construction projects delivered faster, on schedule, and at lower cost, and they want to tailor the construction management and contract administrative services they need for each particular project.

Because its customers can choose among other public-sector agencies or even private-sector construction firms, the Corps, to remain competitive, must provide the higher quality service its customers demand. And it must do so in an environment that is similar to that faced by its customers — one of downsizing and reduced budgets. By improving current practices, building new and better customer-responsive systems, institutionalizing total quality practices in its daily operations, and continually demonstrating its commitment to quality, USACE can ensure that it remains a major force in the industry well into the future.

The Corps understands that its future depends on its ability to effectively deliver construction management services to its customers, and it is not taking that challenge lightly. It has begun reevaluating its business culture and processes, and it has established and documented its vision for the future: the Corps will be satisfied with nothing less than overall performance and service excellence and to remain the public-sector's engineering and construction organization of choice. Moreover, the Corps has begun to tackle important quality-related issues in a number of targeted areas. For example, USACE has begun partnering with its customers and contractors, forming cooperative teams at the earliest stages of the design phase, and working with those teams through final construction to avoid confrontations that erode quality and turn customer relations sour.

Because it recognizes the importance of quality to future business success, the Corps has also undertaken a total quality management (TQM) initiative to further improve quality. In a 1993 memorandum, the Chief of Engineers expressed concern about the future of USACE, given the uncertainty under which it would be operating, and recommended adopting a TQM approach called Total Army Quality (TAQ). (The memorandum is provided in Appendix A.) However, even with those efforts underway, USACE has still not satisfactorily addressed the issue of demonstrated commitment to quality and proof to customers that bona fide quality systems are in place. It is not enough that the Corps says it will meet its customers' requirements and exceed their expectations for service; customers want proof that quality systems exist and that those quality systems are working. If properly implemented, an effective quality system will assure Corps' customers of consistent quality products, institute corporate vision and direction, raise productivity, increase efficiency, and promote competitiveness.

Fortunately for the Corps, a fundamental and internationally recognized quality system model already exists. That model — the ISO 9000 quality system standards developed by the International Organization for Standardization — is rapidly becoming the world's preferred model for gauging the acceptability of an organization's quality program and quality management system. The ISO 9000 standards are nothing more than generic guidelines for what constitutes an acceptable quality system. The ISO standards specify the minimum essential elements of that quality system, but they do not tell how to do the job nor do they refer to any specific products. The standards are generic and can be applied to any product or service and to any business or industry, whether in the private or the public sector. As such, the standards are, without a doubt, applicable to USACE and its construction management activities. In fact, managers at USACE headquarters believe that the ISO 9000 quality system standards will provide the model that Corps Districts need to improve quality management, enhance productivity, improve competitiveness, and improve customer relations. ISO 9000 quality system standards will form the foundation that will enable USACE to establish itself as a world-class engineering and construction organization while supporting current and ongoing quality initiatives (see Figure 1-1).

The feasibility of, and justification for, USACE adopting and becoming registered to ISO 9000 have already been documented.¹ Moreover, the Corps has begun adopting the ISO 9000 standards at four selected USACE Districts and is planning to seek ISO certification of the engineering organizations in those Districts.² The Corps now wishes to seek ISO certification for USACE construction organizations, so it tasked the Logistics Management Institute to develop a complementary strategy for implementing an ISO-9000-compliant quality system in the Construction Divisions. (The following section provides

¹LMI Report CE308R1, *Toward a World-Class Engineering Organization — Making ISO 9000 the Foundation to Quality Management*, Jeffrey Hawkins and James L. Hathaway, April 1994.

²The certification process being adopted by USACE engineering organizations is based on an implementation strategy developed by LMI. See LMI Report CE308RD1, *Road to Engineering Excellence: ISO 9000 Blueprint to Success*, Jeffrey A. Hawkins, April 1995.

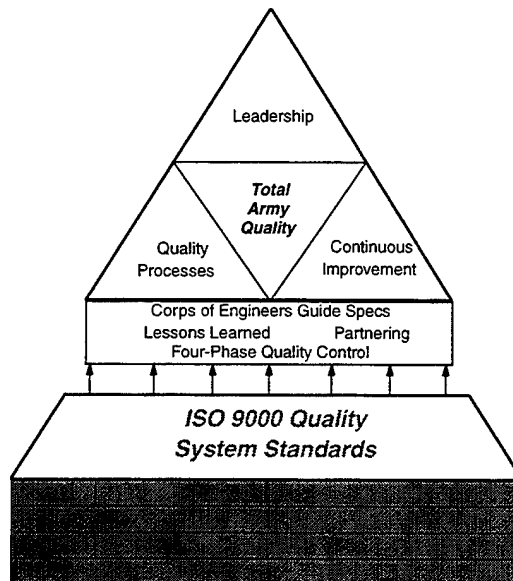


Figure 1-1.
ISO 9000 Quality System Foundation

additional background about the ISO standards and summarizes the registration process.) An ISO 9000-compliant quality management system will provide the USACE Construction Divisions with an internationally recognized quality system framework that will enable them to establish a consistent and stable quality assurance process and quality product delivery system. In addition, a consistent quality system will provide the USACE construction organizations a foundation upon which they can make controlled and continuous improvements. Ultimately, implementation of such a system will result in greater customer satisfaction and will further enhance USACE's image as an industry leader.

BACKGROUND

Based largely on U.S. Military Quality Specifications 9858-A, the ISO 9000 standards were developed by a Geneva-based organization — the International Organization for Standardization — with the help of an international consortium of quality experts. Initially, the standards were developed in response to the formation of the European Economic Community and the need to assure quality across international borders. But today, nearly the entire industrialized world has adopted ISO 9000 standards in one form or another (see Figure 1-2). In the United States, the standards have been implemented under the American National Standards Institute/American Society for Quality Control Q9000-series quality system standards.



Note: Dark regions show countries that have adopted ISO 9000.

Figure 1-2.
Worldwide Acceptance of ISO 9000

Like traditional definitions of quality, which center around fitness for use of a product or service and relate the quality of that product or service to customer specifications, the ISO 9000 standards contend that quality is achieved by eliminating nonconformity to the customer's requirements (or contract specifications). When an organization obtains ISO 9000 certification, it demonstrates to its customers, society, and the rest of the world that it has established a fundamental quality system and that it consistently applies that quality system to continually meet the contractual requirements specified by its customers. Most organizations already registered to the ISO standards (including engineering and construction firms) have found that the ISO 9000 quality system standards are quite easy to interpret and most definitely apply to their specific businesses. Used internally, conformance to the ISO standards indicate that a business has a legitimate and documented quality system that is fully implemented and consistently followed. Used for external quality assurance, conformance to the standards proves that the existence of a quality system has been verified by an outside accredited registrar and that the organization will likely consistently deliver the quality product customers want.

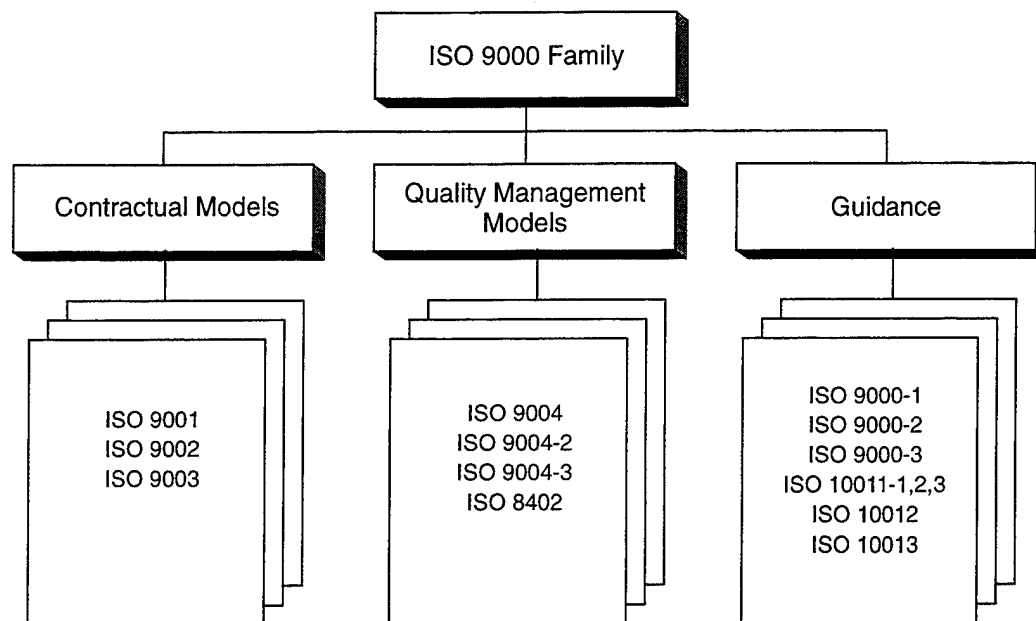
Basically, the ISO standards require an organization to establish a quality management system that does the following:

- ◆ *Documents what the organization does.* Qualified organizations must establish and maintain a documented quality system that describes the processes and procedures it uses to deliver the product or service, demonstrates how quality is ensured, and specifies how customer requirements are consistently met. The required documentation provides the needed evidence (and basis

for quality system audits) that an organization has thoroughly addressed and planned all procedures that affect the quality of its product.

- ◆ *Demonstrates that the organization actually does what is documented.* The organization must prove that the personnel or systems responsible for delivering quality products (or services) are following the system that it has planned and documented. Auditors will collect evidence of system conformance, usually covering three to six months, during on-site compliance audits.
- ◆ *Measures and keeps accurate records of the work that was performed.* Collected evidence must show that the qualified organization has established required quality system records, that those records are legitimate, and that quality has been part of the business over the three- to six-month period. Part of the burden of proof rests with effectively recording elements of the business that affect the quality of the product.
- ◆ *Evaluates and analyzes the results.* The organization must establish a system for checking how well its product performs with respect to these documented procedures and the customer's and contractual requirements.
- ◆ *Corrects system deficiencies and continually improves.* The organization must have a system that ensures current and potential problems are addressed and ultimately resolved. Resolution of problems may require changing existing procedures when it is cost-effective to do so and, when warranted, updating the relevant procedural and quality system documentation. These quality system reviews and corrective and preventive actions are the foundation for the organization's continuous improvement efforts.

When discussing the ISO 9000 quality system standards, we are really talking about a family of individual documents comprising contractual models, quality management models, and guidance (see Figure 1-3). There are three core quality conformance documents (ISO 9001, ISO 9002, and ISO 9003) that external entities use to verify an organization's quality system (e.g., quality assurance). Others provide supporting guidelines. For example, ISO 9004 expands on the contractual models and offers additional voluntary guidance. ISO 9004 can be used for internal evaluation or for implementation of an organization's quality management practices.



ISO 9001 — *Quality Systems — Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.*

ISO 9002 — *Quality Systems — Model for Quality Assurance in Production and Installation.*

ISO 9003 — *Quality Systems — Model for Quality Assurance in Final Inspection and Test.*

ISO 9004 — *Quality Management and Quality System Elements, Guidelines.*

ISO 9004-2 — *Quality Management and Quality System Elements, Part 2: Guidelines for Services.*

ISO 9004-3 — *Quality Management and Quality System Elements, Part 3: Guidelines for Processed Materials.*

ISO 8402 — *Quality Vocabulary.*

ISO 9000-1 — *Quality Management and Quality Assurance Standards: Guidelines for Selection and Use.*

ISO 9000-2 — *Quality Management and Quality Assurance Standards — Part 2: Generic Guidelines for the Application of ISO 9001, ISO 9002, and ISO 9003.*

ISO 9000-3 — *Quality Management and Quality Assurance Standards — Part 3: Guidelines for the Application of ISO 9001 to the Development, Supply, and Maintenance of Software.*

ISO 10011-1 — *Guidelines for Auditing Quality Systems.*

ISO 10011-2 — *Qualification Criteria for Quality System Auditors.*

ISO 10011-3 — *Management of Audit Programs.*

ISO 10012 — *Quality Assurance Requirements for Measuring Equipment — Part 1: Metrological Confirmation System for Measuring Equipment.*

ISO 10013 — *Guidelines for Developing Quality Manuals.*

Figure 1-3.
ISO 9000-Series Architecture

Each of the ISO 9000 contractual models (9001, 9002, or 9003) applies to a specific range of businesses, and none of the models is considered better than another. In selecting which model to adopt, most organizations simply refer to the guidance found in the ISO 9000 standard, which requires systematic consideration of the following six factors:

- ◆ *Design process complexity.* How difficult is the design and/or preliminary development of the product or service?
- ◆ *Design maturity.* Is the product unique or can a previously developed design be used?
- ◆ *Production process complexity.* How complex is the process for developing the product or service?
- ◆ *Product or service characteristics.* How complex is the product or service and how critical are the interrelated characteristics of the product to its performance?
- ◆ *Product or service safety.* How costly are product failures?
- ◆ *Economics.* How costly are the preceding factors relative to the costs of a nonconforming product?

Organizations get registered to the standard best fitting their range and scope of business. For example, ISO 9001 applies to those businesses providing a full range of services, including design and product development, production, installation, and postinstallation servicing. ISO 9002 is nearly identical except it does not include requirements for design and product development. Therefore, an organization that has complete control over product design should register under ISO 9001, while an organization with no more than an ancillary role in product design and development should register under ISO 9002. For example, the primary role of the USACE construction organizations is to provide construction management services. Design is managed by other USACE organizations. Therefore, the ISO quality system model that applies best to USACE construction organizations is ISO 9002, *Quality Systems — Model for Quality Assurance in Production and Installation*.

Becoming registered to the ISO 9000 quality system standards means that an organization has met the minimum requirements and that an outside, independent, and accredited auditor, known as an ISO quality system registrar, has examined the organization's quality system and found that it complies with its interpretation of the ISO standards.³ An examination of the organization's quality system documentation will ensure that all elements of the ISO standards are effectively planned, adequately addressed, and sufficiently documented, and then an on-site compliance audit will ensure that those documented quality

³ Registrars are accredited in the United States through a national central authority called the Registration Accreditation Board, an affiliate of the American Society for Quality Control.

system processes and procedures are consistently implemented and that adequate records are kept. If the organization meets the registrar's expectations, then that company is granted a registration to the ISO standard it selected. Registration does not, however, guarantee the quality of the product; it simply means that quality processes are in place to deliver that product.

A successful organization receives a certificate noting its accomplishment. The registration is published in a register available to the public, and the organization is then permitted to use its registrar's logo in its marketing and to display it in its advertising, stationery, and packaging as evidence that its quality system meets the requirements of the ISO standard. ISO registration is site specific, so organizations with many sites must register each site individually. In USACE, each Construction Division should register as a single site that encompasses its numerous field offices. Once a site becomes registered, its registration is valid indefinitely as long as it continually passes periodic surveillance audits. Organizations that fail any reassessment risk losing their registration and the privileges that go with it. Those organizations may correct those deficiencies and reapply for registration if so desired.

REPORT ORGANIZATION

The first step in developing a plan to implement a new quality system is to gain a thorough understanding of the existing quality system. Therefore, in Chapter 2, we present an assessment of existing quality management practices utilized by USACE construction organizations. We compare current practices to those prescribed by ISO 9002, and we identify specific quality system improvement opportunities that will bring the construction quality system into compliance with ISO 9002. In Chapter 3, we present a strategy for obtaining ISO 9002 registration. The strategy includes an implementation plan that specifies required tasks, responsibilities, and a schedule; we also discuss the fiscal and staff resources needed to carry out the plan.

CHAPTER 2

Quality System Evaluation

Before we can develop an effective implementation strategy, we must first fully understand the quality system that USACE construction organizations would like to put in place. We must also evaluate the condition of the existing quality system with respect to the desired system so that we can identify processes and procedures that must be developed or modified to achieve the desired result.

Envisioning the desired quality system — ISO 9002 — is easy. The ISO quality system standards already define the desired end state. Of course, each site seeking registration may need to customize the interpretation of the ISO 9002 quality system to satisfy unique conditions.

Evaluating the condition of the existing quality system employed by Corps construction organizations requires a bit more effort. Understanding where the current quality system is in relation to the desired quality system means performing an assessment or internal audit of all the policies, processes, and procedures that encompass the existing quality initiatives. Called a *gap analysis* within the industry, that internal assessment identifies shortfalls, or nonconformities, with the ISO 9002 standards. That is, the difference between the existing system and the desired one defines the gaps in the quality system that construction organizations must address and bring into compliance before it seeks and is granted registration.

In the first two sections of this chapter, we briefly describe the ISO quality system requirements and summarize the existing elements of the quality system USACE construction organizations have already put in place. In the third section, we present the results of a preliminary gap analysis conducted at two USACE Construction Divisions (including area and resident offices) that were selected to represent typical Corps construction organizations known to have effective TAQ programs underway.

ISO QUALITY SYSTEM

In today's customer-focused environment, service providers are doing whatever is necessary to understand and meet their customers' requirements. The processes and procedures that organizations similar to USACE construction organizations put in place to make sure they meet those requirements is called a *quality management system*. Its purposes are to (1) make sure customers' requirements are fully understood before work begins, (2) provide customers with ongoing feedback during product development, and (3) ensure that the finished

product satisfies the requirements established and agreed to by both parties. In addition to earning satisfied customers, an effective quality management system will improve an organization's productivity, and it will reduce the costs associated with inefficient operations and wasted efforts because the organization will do the right things right, the first time, all the time.

The ISO 9000 quality management system model contains 20 distinct but related elements (see Table 2-1). The most rigorous contractual model — ISO 9001 — requires that an organization comply with all 20 elements before it can become certified. (ISO 9001 is reproduced in its entirety in Appendix B.) ISO 9002 — the contractual model applicable to USACE Construction Divisions — is virtually identical to ISO 9001; the only difference is that one element, 4.4 *Design Control*, does not apply. Thus, an organization wishing to become certified as compliant with ISO 9002 must meet only 19 of the 20 quality system elements.

Table 2-1.
Elements of ISO Quality System

Quality system element	Number
Management responsibility	4.1
Quality system	4.2
Contract review	4.3
Design control	4.4
Document and data control	4.5
Purchasing	4.6
Control of customer-supplied product	4.7
Product identification and traceability	4.8
Process control	4.9
Inspection and testing	4.10
Control of inspection, measuring, and test equipment	4.11
Inspection and test status	4.12
Control of nonconforming product	4.13
Corrective and preventive action	4.14
Handling, storage, packaging, preservation, and delivery	4.15
Control of quality records	4.16
Internal quality audits	4.17
Training	4.18
Servicing	4.19
Statistical techniques	4.20

The 19 elements that USACE Construction Divisions must meet to comply with ISO 9002 affect virtually every aspect of the construction management and contract administration process and require full compliance from the District activities as well as area, resident, and project offices. Appendix C explains the application of the ISO 9002 elements to USACE construction management activities and provides guidance concerning the scope and application of the ISO 9002 standards to USACE construction organizations; Appendix C also provides references to other required ISO and USACE guidance and defines ISO 9000 terms as they relate to typical construction organizations.

The backbone of the quality system described by ISO 9002 is documentation. Any organization applying for ISO 9002 certification must document its entire quality system to show the auditors that it has been sufficiently planned and that each element of the standard has been addressed and sufficiently met — *you must say what you do*. Registrars will take several days to examine the organization's documented quality system to ensure full compliance with the requirements of the standards. If the documentation is insufficient, the registrars will note where documentation needs improvement, but when the documentation is sufficient, the registrar will schedule a conformance audit to ensure the organization practices what is documented. During a two- to four-day on-site audit involving three or four auditors familiar with USACE construction activities, the construction organizations must then demonstrate to the auditors that their practices conform to what they have documented — *you must do what you say*.

Figure 2-1 illustrates the four-level documentation structure suggested by the ISO 9000 standards. At the top of the documentation pyramid is quality policy as documented in a quality manual. The quality manual must describe the organization's policy with respect to each of the 19 ISO 9002 elements and should be about 20 to 30 pages long. Level 2 documentation addresses the quality system procedures and should relate to the policy requirements as stated in the quality manual. While most of USACE's quality procedures are broadly described in directives and regulations, the ISO auditors will be concerned with how those regulations and statutes are implemented at the local level. The description of quality procedures does not need to be lengthy; it is enough to describe simply what is to be accomplished. Keep in mind that documentation can never take the place of training, education, and experience. Where staff members have the required skills and knowledge associated with their education and professional know-how, no supplementing procedures will be required. Level 3, work instructions, deals with how each required procedure is to be accomplished. Those instructions form the bulk of the documentation. Not every procedure needs associated work instructions, but work instructions should be documented for any procedures directly affecting the quality of the product. Level 4 documentation comprises the records, or proof, that the organization has implemented practices in accordance with the stated quality policy and procedures. The ISO 9000 standards dictate what records USACE construction organizations must keep as a minimum.

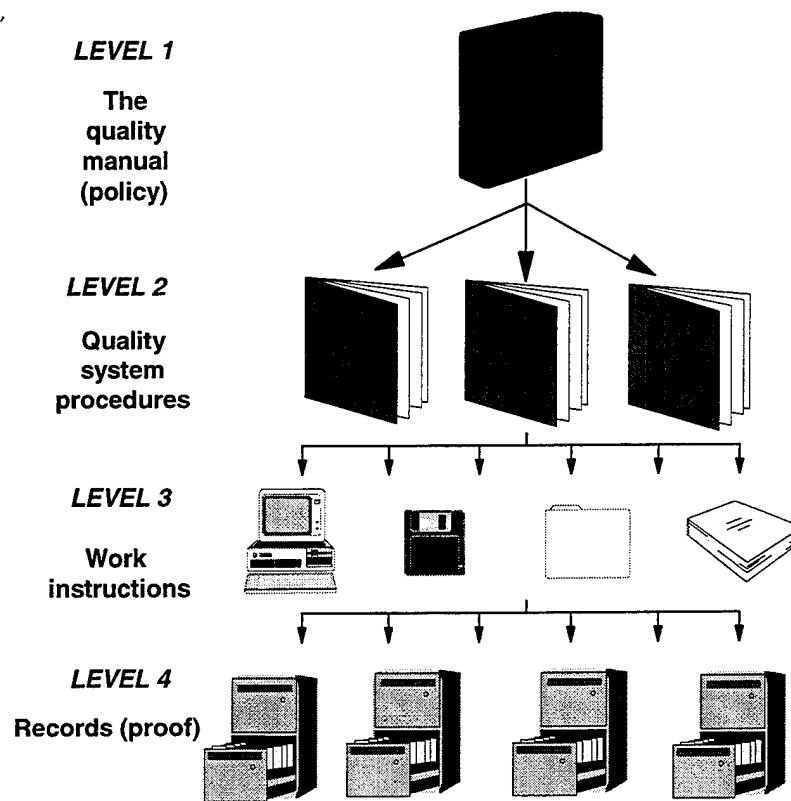


Figure 2-1.
ISO 9000 Documentation Structure

EXISTING CONSTRUCTION QUALITY SYSTEM

In other industries and quality management circles, quality is often defined as "the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs." To USACE's Construction Division customers, that elaborate definition can be stated more simply: *quality is getting projects delivered on schedule, within budget, according to technical specifications and functional requirements, and with excellent service.* Making sure their customers get the quality they are demanding is the burden of the Construction Divisions and their quality assurance processes and procedures — their quality management system.

The Corps construction organizations and the construction contractors hired by USACE both have a role in achieving quality. As the customer's agent and the government's representative, USACE wants to make sure the customer gets the facility it needs on time and within budget but at a cost that is reasonable to the government and the American taxpayer. At the same time, the contractor wants to deliver a satisfactory facility that meets the contract requirements while making a reasonable profit. Clearly, the responsibilities of both parties are complementary. Thus, for the USACE construction quality management system to

be effective, it must succeed in meeting the goals of the customer, the Corps, and the construction contractor.

To satisfy those seemingly conflicting goals, there must be a planned and systematic program of actions and an established line of authority and responsibilities around the quality management system. In the existing quality system, a Corps construction contractor must demonstrate that it understands the contract requirements and can do the work, and it must ensure that the finished construction project meets contract requirements. To provide those assurances, USACE instructs the contractor to prepare a quality control plan. The quality control plan must be developed early and be approved by the Corps before construction work begins. In the plan, the contractor must adequately address the following:

- ◆ Capability of management staff to successfully manage the organization and the project as well as size and training of quality control staff.
- ◆ On- and off-site procedures for the control, inspection, and testing of the construction product as well as qualifications and training of contractor personnel who will perform those activities. The plan must list the tests to be performed and must specify who will be responsible for the results. The plan also must specify who will be responsible for approval of the reports. The report forms must be comprehensive and frequency of report submittals must be indicated.
- ◆ Procedures for processing submittals along with the approval authority.
- ◆ System for tracking deficiencies during the construction process to ensure timely corrective actions.
- ◆ Procedures for maintaining records of quality control activities and for enabling the Corps to review those records.

A member of the Construction Division is assigned quality assurance responsibilities. That person meets with the construction contractor and the Corps' representatives to resolve all issues pertaining to the quality control plan. Construction does not begin until USACE is satisfied with the contractor's quality control plan.

In addition to approving the quality control plan, the USACE construction organizations also

- ◆ establish the technical and functional standards for the construction project,
- ◆ check the adequacy of the construction contractor's quality control system,
- ◆ perform specified tests and inspections as designated by the contract,
- ◆ resolve reported construction deficiencies and modifications,

- ◆ analyze the construction contractor's claims,
- ◆ control construction project costs, and
- ◆ manage the project schedule.

To assure the quality of the construction projects it manages, USACE has instituted procedures for controlling all definable features of the construction project in each of four phases: preparatory phase, initial phase, follow-up phase, and final acceptance phase. In addition, it has developed procedures for controlling all construction materials, fabricated items, and installed equipment; verification testing (all other testing is the contractor's responsibility); conducting final inspection and acceptance for each definable portion of work; and controlling quality-related documentation.

PRELIMINARY QUALITY SYSTEM ASSESSMENT

The quality system used by USACE construction organizations is generally impressive and has enabled USACE to make progress toward achieving some of its total quality goals. Moreover, the existing quality system meets a significant portion of the ISO 9002 quality system requirements and thus can serve as the backbone of an ISO-compliant quality system. However, the existing system falls short of the ISO 9002 quality system in a number of areas. The following are among the major nonconformities we identified during the gap analysis:

- ◆ An overall framework for an ISO 9002-compliant quality system — that is, a tiered documentation structure as illustrated in Figure 2-1 — is not sufficiently established:
 - ▶ We found no evidence of a quality manual (as required by ISO 9002 element 4.2 that outlines the organization's general policies relative to each ISO 9002 requirement and that establishes the framework for the quality system by referencing quality system procedures and work instructions.
 - ▶ Documentation of required quality system procedures is not comprehensive enough. (However, required Level 3 documentation are, for the most part, sufficient to meet the requirements of the standard.)
 - ▶ Except for those unique records required by ISO 9002, the records management system is sufficiently planned, documented, and implemented in accordance with the standard.
- ◆ We found no evidence of a management representative with sufficient authority and responsibility to manage the quality system within each Construction Division.

- ◆ We found no evidence of a formal internal quality system audit program.
- ◆ Although the Construction Divisions take some corrective and preventive actions, we found no evidence of a formal corrective and preventive action system that has been planned and documented in accordance with the standard.
- ◆ The existing document control systems do not comply with ISO standards. However, we found evidence that the Construction Divisions are already working to improve document control procedures.

In the following subsections, we provide specific observations pertaining to how well the quality systems in place at the two Construction Divisions we assessed meet each element of the ISO 9002 standards, and we identify the most notable nonconformities.

Management Responsibility (4.1)¹

The USACE Construction Divisions we examined have already established (during previous TAQ efforts) and documented some quality policies and objectives, and those policies and objectives were approved and distributed as required by ISO 9002. However, we found that those existing policies and quality objectives are not written in a way that can be easily understood by everyone in the organization, nor are they specifically relevant to construction management activities. As a result, it would be virtually impossible to measure progress toward meeting those objectives as is required by ISO 9002. In addition, the Construction Divisions do not have an overall strategy for making sure that their quality policies and objectives are known and understood by everyone in their organizations.

Generally, the construction organizations meet the ISO 9002 requirements for an established organizational infrastructure to manage, perform, and verify work affecting quality. In addition, we found evidence that managers of the Construction Divisions make sure that adequate resources are available to sustain an appropriate level of quality throughout the life of the construction project — project planning, design phase support, quality control and quality assurance activities, four-phase control, etc. — as well as to perform sufficient training within the construction organization.

Neither of the construction organizations we assessed have a management representative — someone with executive responsibility to oversee the establishment and maintenance of the organization's quality system. Any organization seeking ISO 9002 certification is required to have such an individual. Specifically, to comply with ISO 9002, the USACE construction organization must appoint a management representative, grant that individual the authority to establish and maintain the quality system, and inform the rest of the organization of that appointment.

¹ Numbers in parentheses refer to corresponding elements in the ISO 9001 standards.

In addition to lacking management representatives, the construction organizations we assessed do not conduct official, planned, and periodic reviews of the documented and implemented quality system conducted by the executive management. To comply with ISO 9002, the construction organizations must keep records that demonstrate management is conducting reviews and that specify what action is proposed and taken.

Quality System (4.2)

To comply fully with the requirements of ISO 9002, the construction activities must ensure that each element of the standard is adequately established, sufficiently documented, and effectively implemented. We found evidence that a good number of those elements were adequately addressed but others were not. And the system lacks an overall structure, primarily because of the absence of a quality manual that provides the top-down structure needed. The quality manual must be developed that documents the Construction Division's policies with respect to each of the standards and serves to establish the important links between those policies, procedures, and work instructions. And, where quality system procedures and work instruction are absent from the system, they too must be established and documented (those areas are discussed element by element in the following subsections).

Contract Review (4.3)

While the overall responsibility for establishing the construction contract is beyond the authority of the Construction Divisions, making sure they can deliver on their agreements is not. We found that, in some cases, the Construction Division is properly represented at precontract meetings, but in other cases, it is not represented at all or is not represented properly. Moreover, we found no documented procedures that outline the Construction Division's responsibilities during precontract and design phases.

To comply with ISO 9002, the Construction Divisions must be involved in the precontract and design development phases of every project; constructability, biddability, and operability reviews are an integral part of the overall construction project delivery process. Specifically, the Construction Divisions must make sure that the customer's requirements are properly developed, that in-house capabilities are sufficient to meet those requirements, and that the results of the agreements between the customer and the construction organization are documented. Moreover, the procedures for conducting contract reviews also must be documented.

The Construction Divisions must conduct all contract modifications in accordance with guiding regulations — the Federal Acquisition Regulations (FAR), FAR supplements, and local contracting procedures. ISO 9002 requires documentation of only those changes ordered by the customer. Generally, we found sufficient documentation of contract changes that occurred during construction.

In fact, the construction organizations exceed the requirements of ISO 9002 because, typically, they document all forms of changes not just those requested by the customer.

Design Control (4.4)

The requirement for design control is not applicable to USACE construction activities and is not required under ISO 9002. However, when necessary, documented procedures should exist to demonstrate how design changes during construction will be handled, authorized, coordinated, and implemented. We would expect to see that requirement addressed under 4.5.3, *Document and Data Changes*.

Document and Data Control (4.5)

The Construction Divisions adequately control certain documents and data. In particular, we found evidence that the construction organizations control project-specific documents and data in accordance with ISO 9002. However, they do not sufficiently control externally produced documents and data (e.g., regulations, specifications, procedures, and industry codes from USACE headquarters, Army, DoD, and above). In addition, we found no evidence of an overall system for document and data control.

To comply with ISO 9002, the construction organization must develop a master list — including the source, location, responsibility, and current revision status — of all documents and data in its care, and it must establish procedures to control them. Examples of documentation that should be controlled are the quality manual, Army and USACE regulations, local procedures, guide specifications, technical manuals, etc. The control procedures should ensure that only the most current documentation is being used, that obsolete documentation or data retained for any reason is so identified, that changes are correctly recorded and issued where needed, and that outdated documents or data are removed from circulation. Compliance with ISO 9002 also requires that the document and data control system be fully documented.

Purchasing (4.6)

The requirements of this element are not applicable to those construction organizations with little or no influence in selecting subcontractors or purchased materials. However, for those Construction Divisions that do have involvement and some authority, documented procedures must ensure that all purchased materials and services conform to preestablished requirements. They must also make sure that all contractors are selected on their ability to deliver quality products to USACE's customers. Construction Divisions that purchase materials and services utilize the construction contractor appraisal support system (CCASS) to ensure that contractors are selected on the basis of their ability to deliver quality

products to USACE's customers and that purchases conform to preestablished requirements. When properly used, the CCASS meets the requirements of ISO 9002. In addition, the Construction Divisions' responsibilities and procedures with respect to purchasing are sufficiently documented.

Control of Customer-Supplied Product (4.7)

In USACE construction organizations, customer-supplied products may refer to government-furnished equipment, materials, supplies, or fixtures and furnishings procured by the customer for use in the constructed facility. It may also refer to any documents or data furnished by the customer and used by the construction activity for any purpose. In either case, the construction activity must have documented procedures for controlling any customer-supplied materials or data to ensure that materials and data are verified before being used, that those items are appropriately handled and stored, and that any lost or defective items are reported to the customer. Such control is needed to avoid using something from a customer (e.g., engineering test results or as-built drawings) that is not validated and thus possibly inaccurate. In addition, the standard requires that all such materials and data be identified, and recorded, as customer supplied.

For the most part, construction activities do not take possession of government-furnished materials or equipment, so this element may not be applicable. But, when they do or when the Construction Division assumes responsibility for any customer-supplied information or data, the organization must develop documented procedures to make sure that the materials or data are verified before being used, identified as customer supplied, and stored and handled properly.

Product Identification and Traceability (4.8)

The USACE Construction Divisions have a system in place to identify its products by unique project or contract number. However, sometimes the products are difficult to trace to the original engineering projects because the numbering differs between engineering and construction projects. To comply with the traceability requirement of ISO 9002, USACE must develop a cross-referencing scheme.

We found no evidence of the existence of documented procedures for identifying and tracing products. The Construction Divisions must develop that documentation to comply with the standard.

Process Control (4.9)

The USACE construction organizations fully comply with the requirements for process control as stated in ISO 9002. Their system for managing construction throughout the project life cycle is effective, particularly for military construction projects, and is sufficiently documented. The organization has identified steps needed to manage a construction project, ensured that work is carried out in a suitable environment and with adequate resources, developed process control and work instructions, established criteria for acceptable performance of the work, and identified the use of critical equipment (e.g., quality assurance, testing, computer-aided design and development workstations, and various software packages).

Inspection and Testing (4.10)

The Construction Divisions comply with all ISO 9002 inspection and testing requirements. Specifically, the Construction Division has documented procedures for reviewing and approving its construction products. Those procedures include validating all incoming construction materials and assuring that all physical testing and inspections are performed as required by the contract documents. The Construction Divisions also verify that all construction activities are carried out in accordance with the project management plan and the quality assurance plan. In addition, Construction Division personnel ensure that the finished facility satisfies all the requirements established by the completed design (along with in-process changes), the contract agreement, and all industry and regulatory codes and practices. And construction personnel release products at each stage in the process only after the required inspections and tests have been successfully completed. Finally, they keep records of inspections and tests along with approval authorities, as required by ISO 9002.

Control of Inspection, Measuring, and Test Equipment (4.11)

This element of the ISO 9002 standard does not apply to Construction Division offices at the District level because they have no need to control inspection, measuring, and test equipment. However, this element does apply to the field offices. At that level, inspection, measuring, and test equipment is being effectively controlled in some cases, but we found no evidence of an overall control system.

To comply with the requirements of ISO 9002, each construction field office must maintain a list of all equipment that has a direct bearing on the quality of the finished product and indicating whether the equipment requires calibration. All equipment that requires calibration must be identifiable as controlled equipment, and the date of its last calibration must be shown. While not required by ISO 9002, all equipment that is not calibrated also should be identifiable as uncalibrated. In addition to identifying equipment to be controlled, the organization must establish policy and procedures for scheduling and accomplishing the

calibration, and it must provide evidence that the equipment is being calibrated according to plan. Finally, the organization must document the policy and procedures it develops for controlling all such equipment.

Inspection and Test Status (4.12)

The Construction Divisions have procedures for ensuring that the inspection and test status of construction management products is suitably identified. However, we found no evidence that the procedures are documented. To comply with ISO 9002, the construction organizations must document their procedures. The documentation must include identification of the approval authority responsible for releasing the finished or in-process products.

Control of Nonconforming Product (4.13)

The Construction Divisions have a deficiency tracking system to prevent the use of deliverables or materials that do not conform to specified requirements. When properly used, that system satisfies the requirements of this element of ISO 9002. The construction organizations also meet the ISO 9002 requirements for procedural documentation covering the application of the deficiency tracking system.

Corrective and Preventive Action (4.14)

An effective corrective and preventive action system is important to a good quality management system because it serves as the foundation for continuous improvement efforts. Some USACE construction organizations below the Division level have a lessons-learned system in place and, in some cases, use it effectively. However, we found no evidence that USACE construction organizations have a formalized system for taking corrective and preventive actions.

To comply with the requirements of ISO 9002, the Construction Divisions must establish a formal system of corrective and preventive actions. The system should incorporate, for example, lessons-learned programs. The corrective and preventive action system that Construction Divisions put in place must ensure that the causes of a problem are investigated, that the necessary corrective actions are taken, and that procedures are improved so that the identified problem will not recur. The system also should ensure that actions taken are commensurate with the risks involved; corrective actions that cost more than the cost of leaving the problem uncorrected cannot be justified. In addition, the system must verify that corrective or preventive action has been initiated and has solved the problem. The construction organizations must keep records of actions taken, and they must document the policy and procedures for carrying out the corrective and preventive action system.

Handling, Storage, Packaging, Preservation, and Delivery (4.15)

This element does not apply to the Construction Divisions we visited.

Control of Quality Records (4.16)

In general, the Construction Divisions we visited do a relatively impressive job of controlling their quality records, particularly those relating to testing and inspection and to process control. However, the Construction Divisions are not yet compliant with ISO 9002 in some areas of records management, such as management review and internal quality system audits. To comply fully with the requirements of ISO 9002, the construction organizations must establish, document, and maintain procedures for identifying, collecting, indexing, accessing, filing, storing, maintaining, and disposing of all records directly affecting the quality of its products. They must identify what records must be kept and must generate a master list that includes the title, responsibility, retention time, and location of those records. Records must be legible, accurate, and easy to identify and retrieve, and they must be properly disposed of when appropriate.

Internal Quality Audits (4.17)

The USACE construction organizations have no formal program to conduct internal audits of their quality management system. To comply with the requirements of ISO 9002, the organizations must establish and document an internal quality audit program that focuses on quality management system elements of the ISO standard. Audits must be carried out on an established schedule by adequately trained internal auditors, and records of the results must be maintained. The audit program will likely serve as the foundation to the corrective and preventive action program described in ISO element 4.14.

Training (4.18)

The Construction Divisions adequately identify, document, carry out, and record their training needs in accordance with the requirements of ISO 9002. The individual training plans required by USACE regulations are sufficient to satisfy the intent of the standards. However, the Corps could improve its training system if it placed additional emphasis on identifying training needs for new or recently modified procedures and on quality and total quality management.

Servicing (4.19)

The USACE construction organizations have established and are effectively using procedures to resolve problems during the warranty period of recently completed construction projects. However, the construction organizations have

not documented those procedures. The Construction Divisions must develop servicing documentation if they are to comply with ISO 9002.

Statistical Techniques (4.20)

The USACE construction organizations have not formally addressed the use of statistical techniques in evaluating their construction management processes. While it is possible that such techniques are not appropriate for use in their operations, the Construction Divisions must be able to show evidence that they have conducted a formal evaluation of the use of statistical techniques and must document the results. Where statistical techniques are appropriate, the Construction Divisions must establish and document effective procedures to ensure effective implementation of the statistical practices.

CHAPTER 3

Implementation Strategy and Costs

The ISO 9002 quality model is simply a set of fundamental management practices that, taken together, describe a responsible, sensible, and effective means for running construction organizations in a way that will ensure customers get the products they want. To comply with ISO quality standards, organizations must consistently conform to a prescribed set of procedures — procedures that have been properly planned and implemented. As discussed earlier, the basic principle is simple: say what you do, do what you say, record the results, review performance, and make corrections and continuous improvements.

When faithfully and aggressively implemented, the ISO model will create a quality management system that ensures that the organization operates in a stable fashion and gives its customers confidence in a quality outcome. For USACE Construction Divisions, implementation of ISO 9002 standards will result in a consistent construction project delivery process leading to consistent results and to informed, involved, and pleased customers. When the process and products are stabilized, the impact of modifications to that process can be carefully monitored, which will become a basis for continuous improvement. Most organizations that have adopted the ISO standards have achieved that desired process consistency, reduced system redundancies, improved processes and procedures, and enhanced communications both internally and with its customers.

Nearly every organization that applies for ISO 9000 certification is successful. However, not every organization is successful on the first try. And the costs of implementing an ISO-compliant quality system are high. Too often, organizations spend more and take longer than is necessary. The experience of organizations that are similar in size to a typical USACE Construction Division suggests that making the required quality system changes to comply with the ISO 9000 model will cost between \$250,000 and \$350,000, including both internal efforts and outlays for external help. On the other hand, most organizations that go through the effort find that the benefits of an ISO-compliant quality system outweigh the internal and external implementation costs and that those costs can be captured within two years after becoming registered.

To maximize the chance of becoming registered on the first try and to minimize the time and costs, it is important to develop an effective, well-planned implementation strategy. This chapter outlines a prototype implementation plan for a typical USACE Construction Division (including area and resident offices) and provides estimates of implementation costs. USACE construction organizations should use this information as the basis for developing their District-specific plans for becoming ISO certified.¹

PROTOTYPE IMPLEMENTATION PLAN

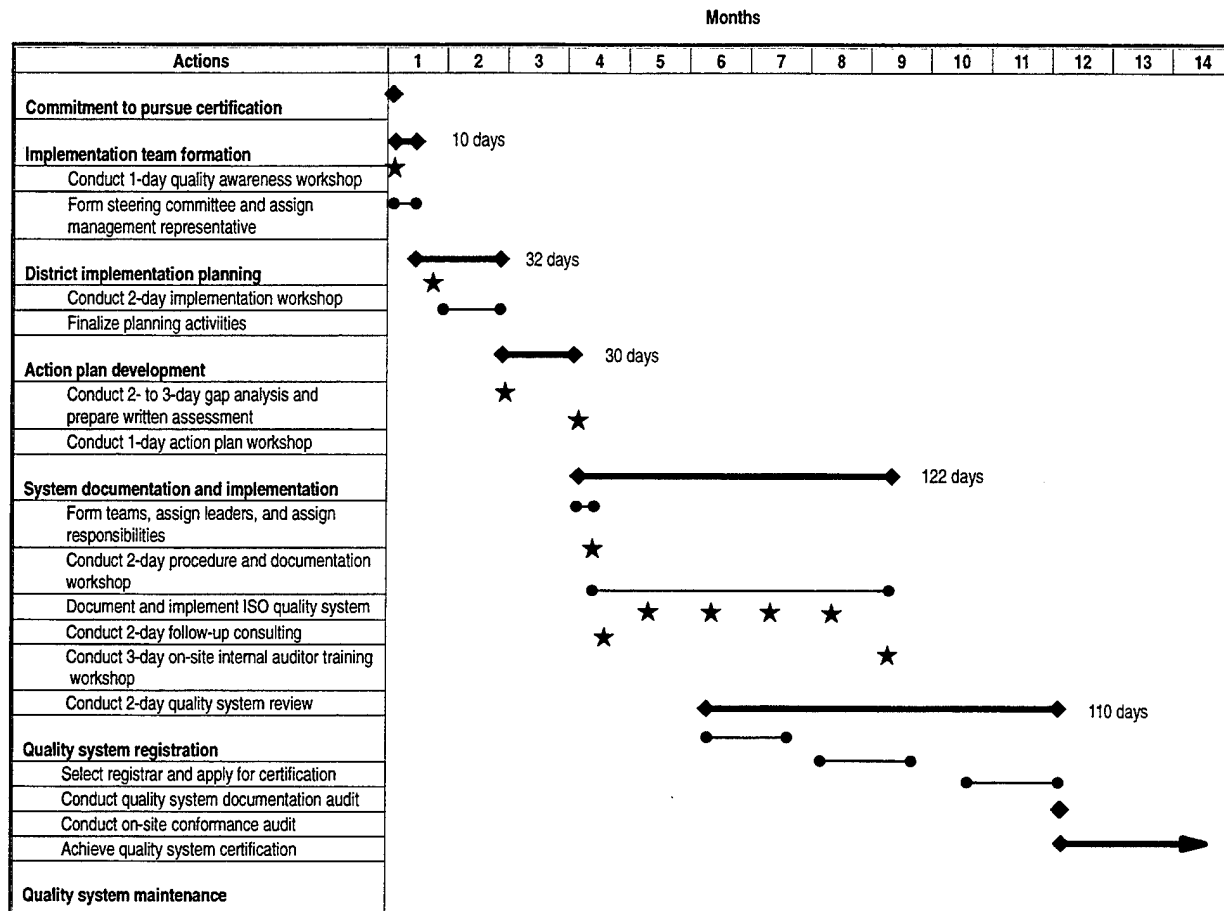
The prototype implementation plan is designed to help those undertaking the challenge to understand the complexity of events that they will face and to establish the major goals that will help keep the implementation process on a reasonable timetable. Once the decision to pursue ISO 9002 certification has been made, the prototype implementation process has five principal steps, as shown in Figure 3-1. A sixth activity — quality system maintenance — occurs after the organization has obtained ISO certification.

The proposed strategy and schedule are ambitious, and their achievement will require the support of District management, the full commitment of Construction Division management, and the continuous efforts of nearly every member of the organization. Without that commitment, the initiative is unlikely to succeed. With that dedication, the process from the time the decision is made to pursue ISO registration to the time registration is obtained can be completed in about 11 months. The time for each particular Construction Division to complete each step in the process will depend on a number of factors, including the complexity of its current construction management processes, the combined size of its military construction and civil works programs, the intended scope of registration, and the current level of documentation of its quality system. A more detailed critical path network of the prototype implementation process is presented in Appendix D, and each of the major implementation activities is explained in more detail in the following subsections.

Implementation Team Formation

The suggested composition of the implementation team is shown in Figure 3-2. Directed by the Construction Division's senior management, the implementation team should be comprised of a steering committee, a management representative, internal auditors, and quality action teams (QATs); in addition, the team will need the support of qualified external consultants.

¹The engineering activities in four selected USACE Districts have already begun conforming to the requirements of ISO 9000 and plan to seek ISO certification. The certification process they are using is based on an implementation strategy developed by LMI. See LMI Report CE308RD1, *Road to Engineering Excellence: ISO 9000 Blueprint to Success*, Jeffrey A. Hawkins, April 1995.



Note: ★ indicates externally supported workshops, training, and consulting.

Figure 3-1.
Implementation Schedule

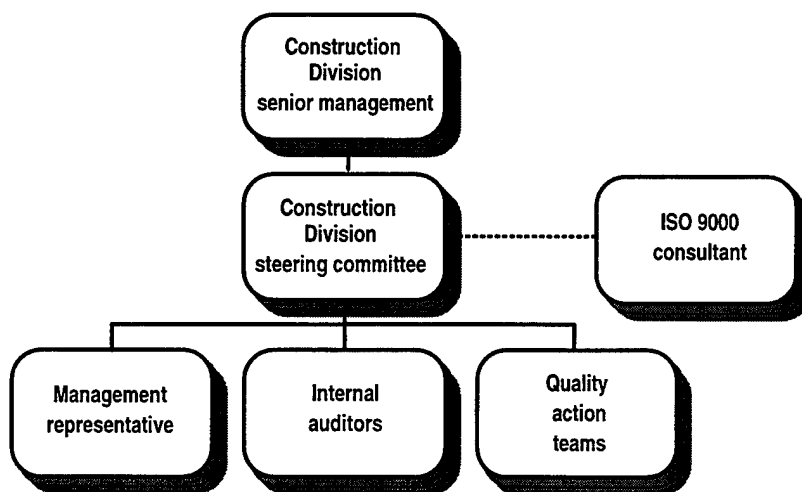


Figure 3-2.
Construction Division's Implementation Team

Team personnel are key to the outcome of the process and therefore should be selected carefully. Identifying the best people and winning their support may take several weeks. After the team has been selected, we suggest that the implementing Construction Division conduct a one-day quality awareness workshop to ensure that the committee and other members of the team comprehend the importance of quality management to the success of the construction organization and the role of the ISO standards in making sure an effective quality system is in place.

Support from the Construction Division's senior management throughout the implementation process is critical, and the time to obtain that commitment is at the earliest stages. Furthermore, senior management involvement is required by the ISO 9002 standard in its first element, *Management Responsibility*. That element says that the organization's executive management must not delegate its quality responsibilities; it must be active in the process and must make ISO registration a top priority. As part of that effort, management must assign and approve steering committee responsibilities, approve the District-specific action plan, and fund the involvement of the staff for quality action team participation. That upfront commitment of money and time will be essential even though it will conflict with other pressing needs for those same limited resources. The Construction Division should expect to commit about 10 staff-days and close to \$6,000 to fund the initial quality awareness workshop.

Auditors will pay close attention to the level of involvement by the Construction Division's senior management, so it is best to be forthright concerning commitment to the effort. Management will be judged by whether sufficient resources are budgeted for quality planning, training, and achieving ISO registration.

STEERING COMMITTEE

Members of the Construction Division's top management (Division-level managers in addition to branch chiefs from each of the major functional activities) and other key members of the organization should be assigned as members of the steering committee. From that group, senior management should assign one individual to serve as the management representative and charge that person with project management authority to ensure that the quality system is implemented successfully. Other members of the team should serve as internal auditors and QAT team leaders. Part of the committee's early planning should focus on assigning those responsibilities.

The implementation team's responsibilities early in the process include modifying this prototype implementation plan to develop a District-specific implementation strategy, organizing the needed resources, and forming and assigning responsibilities to the QATs following the development of the action plan. However, each major element of the engineering activity likely will be required to participate throughout the 11-month implementation process as members of the QATs, so their support also is important.

MANAGEMENT REPRESENTATIVE

A management representative is specifically required by the ISO standards. That person, "irrespective of other responsibilities," ensures that the quality system is effectively implemented and carried out according to the standards. Eventually, that person will serve as the primary interface between the Construction Division and the ISO 9000 registrar. In addition, the ISO 9002 standards require that the management representative have a direct-line relationship with the Construction Division's senior manager (e.g., the Division chief).

We suggest that the Division chief or one of the branch chiefs be selected to serve as the management representative. While not required, each resident and area office should also have an individual assigned as assistant management representative; that individual should be directed by the management representative at the Construction Division office. Since the management representatives will play a critical role in the success of the implementation, executive management should identify and empower those people as early as possible. They must have the total backing of top management, the necessary clout to influence other members of the team and organization, sufficient knowledge of the ISO standards and the Construction Division's processes, and a genuine commitment to the quality management system and ISO 9000. In addition, while it is not required by the standard, it is a good idea to give the management representatives overall project management responsibility for carrying out the implementation plan.

INTERNAL AUDITORS

Internal auditors are required by the standards. Volunteers should be drawn from all areas of the Construction Division since those individuals will serve as main interfaces between executive management and the other elements of the organization. While it is important to identify them early, their training and identification of their responsibilities will occur after the District-specific action plan has been created. Also, the internal auditors make excellent choices for the QAT leaders given their responsibilities and knowledge as internal auditors.

QUALITY ACTION TEAMS

Quality action teams are formed later in the implementation process, but identifying key members of the organization as team leaders should occur as soon as practical. The QATs are responsible for developing and implementing the quality system procedures required by the ISO standard and for developing the required documentation when existing documentation is insufficient to meet the standard. The teams may be organized by department, major construction management process, or ISO 9002 element. Or the construction organization could use existing teams formed for TAQ. Each team should be chaired by a team leader who is sufficiently trained in the development and writing of

ISO-compliant procedures. QATs should report directly to the management representative or to the steering committee.

District Implementation Planning

After executive management has selected and officially notified team members, it should hold a two-day ISO 9000 implementation workshop for all members of the steering committee; including the management representative, internal auditors (if selected), and QAT leaders (if selected). Because it is important that all members of the implementation team be committed to the initiative, any member who demonstrates a lack of commitment to getting the Construction Division registered to ISO 9002 should be replaced immediately. During the workshop, the implementation team must tailor the prototype implementation strategy and schedule presented in this report to fit local circumstances, availability of resources (funding and personnel), and anticipated start time. Ideally, the workshop should be professionally facilitated by external consultants to ensure that all necessary initial tasks are accomplished and issues resolved.

The following are among the initial tasks that the team must accomplish:

- ◆ *Review and finalize interpretation of the ISO 9002 quality system.* Every Construction Division that seeks ISO 9002 certification will need to carefully interpret how the ISO 9002 quality system standards apply to their unique operations and processes. While Appendix C of this report offers a starting point, one of the important first steps will be to modify that interpretation to suit local circumstances. The management representative should take the lead in completing the Construction Division's interpretation of the standards.
- ◆ *Identify and finalize the scope of registration.* The scope of registration can be whatever the team believes is in the organization's best interest. For example, the greatest possible scope, but the most difficult and costly to achieve, would be ISO registration of the entire USACE District — engineering, construction, contracting, and project management activities. On the other hand, the team may decide to register the Construction Division's military construction function only. We suggest that, initially, the Construction Division focus on registering both its military construction and civil works activities and include all resident and area offices. After registration of the Construction Division, it can phase in other District activities over the next couple of years.
- ◆ *Develop a statement of the organization's mission and quality goals.* Some USACE Districts have already developed their vision statement and quality goals and objectives. If the District has not, the team may have to spend up to a full day developing them. It is important that the vision and mission statements coincide with USACE and District visions and that the quality goals and objectives be measurable, meaningful, and obtainable. After developing those statements and measures, the team must then produce a plan

and assign responsibilities to ensure that all members of the Construction Division are familiar with the ISO implementation plan, the stated mission, and the quality objectives. Without that familiarity, the quality message will not be well established in the lower levels of the organization, and the Construction Division will not satisfy an important element of the ISO 9002 standards.

- ◆ *Finalize the implementation schedule and establish responsibilities.* The team must ensure that the overall process has been sufficiently planned to maximize the likelihood of getting registered in a reasonable time frame and as efficiently and cost-effectively as practical.
- ◆ *Schedule the gap analysis.* The gap analysis, discussed in the following subsection, will identify the major nonconformities in the current quality system and specify how they can be corrected.

The expected outcome from this initial phase is a total commitment to the costs and efforts that the registration process will require. This phase will require nearly 30 staff-days of Construction Division management time and up to about \$12,000 to fund the workshop and consultants.

Action Plan Development

Developing a detailed action plan unique to the implementing Construction Division is critical to the success of the implementation process. While all Construction Divisions will go through a similar process, no two will be identical, and only through this stage in the process will the nuances of each location, conditions of current quality system initiatives, and quality of management and staff be worked into the overall process. Following the formation of the teams and preliminary planning and scheduling, the steering committee will be responsible for developing a detailed action plan that shows what must be done, who will do it, how it will be done, how long it should take, and who will be responsible for making sure it gets done on time.

The first step is to conduct a comprehensive assessment of the existing quality system as it compares with the ISO 9000 model. That assessment, or gap analysis, can be performed by internal staff, but we believe that it will be more beneficial to have it performed by an outside consulting firm familiar with conducting gap analyses. Gap analyses at typical Construction Divisions, including several of the field activities, will require three to four people about two to three days. Disruption to daily operations should be minimal, but nearly full-time involvement from the management representative and part-time effort from senior managers should be anticipated.

All nonconformities to the ISO 9002 quality system standards uncovered during the gap analysis should be documented; that information will be the basis for the action plan. When the results of the gap analysis are available, the

Construction Division should conduct another one-day workshop to accomplish the following:

- ◆ Develop a District-specific action plan to correct the nonconformities uncovered during the gap analysis. The action plan must be thorough. It must identify the quality system elements that need to be added to the existing quality system, areas of the current quality system that must be modified, and documentation that needs to be created or modified. The plan should identify specific goals and assign tasks to the QATs along with estimated completion times. If necessary, the plan should also identify needed training and associated costs. Nonconformities concerning policy and procedures may require the immediate and direct attention of the steering committee.
- ◆ To coincide with development of the action plan, form the QATs (or notify if they have already been established); identify team leaders; and assign the appropriate tasks, responsibilities, and deadlines.
- ◆ Update the implementation schedule to reflect any major changes resulting from the more detailed planning activity.

Development of the Division-specific action plan will cost nearly \$30,000 and require about 10 staff-days of management support.

The completion of the action plan is a significant milestone in the implementation process. Until that point, much of the work is done by the Construction Division's management staff and external contractors. But once the action plan is completed, the remaining tasks in the implementation process, which constitute the bulk of the work, become the responsibility of the Construction Division's staff. Since the work outlined in the action plan may require more than a staff-year of effort, the completion of the action plan is a good time for senior leadership to reflect on the challenge ahead and make a final decision whether to proceed. An unwavering commitment will be essential through this forthcoming period of internal changes and turmoil to ensure success.

System Documentation and Implementation

DOCUMENTATION

Documentation of the quality system is mandatory. It provides the auditors objective evidence that the quality system has been properly conceived — that you can say what you do. Generation of the required documentation is an assigned responsibility of the QATs. The QATs should begin generating the documentation while the quality system changes are being implemented.

Most of the required documentation is already present in the Construction Divisions we inspected. However, some documentation will still be required. The QAT leaders must make sure that documentation deficiencies identified in

the gap analysis are corrected. To ensure that the team gets the necessary guidance to satisfy this important requirement, the Construction Division should hold a two-day procedure and documentation workshop for the QAT leaders and the management representative.

As discussed previously, the documentation will follow a four-tiered structure (Figure 2-1). The following subsections describe the documentation requirements for each of the four tiers.

Quality Manual and Policy

One of the first documents that needs to be prepared is the quality manual. Element 4.2 of the ISO standards says the following: "The quality manual shall include or reference the documented procedures that form part of the quality system." ISO 9000 also requires that the manual describe how quality will be managed on all construction projects. Typically a responsibility of the management representative (or the team under his or her control), development of the quality manual should be initiated during the two-day procedure and documentation workshop, but planning and actual work on the document can begin much sooner if the management representative is prepared to begin the task.

The quality manual for a USACE construction organization likely will be 20 to 30 pages long — it need not be an extensive undertaking. It should include a statement specifying the Construction Division's general quality policy, objectives, and commitment to quality that was developed during the initial workshops; details of the organizational structure and interrelationship between the various elements and how quality is assured; a general description of the organization's quality system and its underlying structure (with cross-references to procedures); and a statement specifying what will be done to control quality in the organization with respect to each element of the ISO standard. The quality manual should reference all procedures, work instructions, and records (discussed below) to provide a comprehensive picture of the organization's total documented quality system. After a first draft of the manual is prepared, we suggest that it be reviewed by an external consultant to identify areas in which the manual can be improved.

Quality System Procedures

The ISO standards identify what procedures should be documented. The written procedures must specify what is to be done and who is responsible, allow for the identification of error causes, and ensure that subsequent correction will preclude further similar errors. Developed correctly, written quality system procedures serve an important overall role in the quality of the finished product by providing a reference point for new or junior members of the organization. Also, the documentation is an essential reference source for the auditors and is the evidence that processes have been carefully planned.

The detailed gap analysis will identify whether existing written procedures are acceptable or need to be modified; it also will identify procedures that have yet to be documented. While the documentation need not be exhaustive or redundant, it must reflect current, observed practices. When practices and written documentation about those practices diverge, the Construction Division, through the QATs, must take action — change the practice, documentation, or both — to bring them into conformity.

When the QATs have completed a first draft of the quality system procedures, we recommend that the draft be reviewed by an external consultant to ensure conformity to the standard. The QATs should be able to finalize all system documentation within a month following that review.

Work Instructions

The work instructions, the bulk of the documented quality system, tell how various activities are to be performed. Again, the work instructions need not be lengthy documents, but they must provide enough detail to show how various required procedures will be carried out. No work instructions will be needed to supplement skills and knowledge that are inherent in trained and skilled professional staffs as typically found in USACE Construction Divisions, resident offices, and area offices.

The preliminary system assessment (presented in Chapter 2) showed that work instructions already exist for most areas. The detailed gap analysis will pinpoint those areas requiring further documentation. To ensure that the work instructions are accurate, the QATs should make sure that the people performing the work are involved in documenting the instructions.

Records

Records are the proof that the quality system, as defined by the quality manual, written procedures, and work instructions, is being carried out as planned. One of the QATs should be assigned to generate the required procedural documentation and to expand the records management system to include other records not currently kept within the Construction Division but required by the ISO 9002 standards.

IMPLEMENTATION

Implementing the action plan is largely the responsibility of the QATs but is managed by the steering committee. The two-day procedure and documentation workshop will give the QATs the tools they need to succeed in this critical phase in the ISO registration process since it is the QATs that provide the talent and manpower to carry out the required process changes and generate the required documentation. Following the training, the QATs should be given about one

month to draft a plan for bringing the nonconformities into compliance with the ISO 9002 requirements. We recommend that the plan be evaluated by an external consultant to ensure that it conforms to the requirements of the standard. Following that review, another two months may be required to make the necessary changes, fine-tune the plan, and implement those necessary processes and procedures into the organization's daily operations. An external consultant should then conduct a final, two-day system review — similar in nature to the gap assessment. When that step has been completed, the documented quality system will be ready for a preliminary system audit by the selected registrar's audit team to determine if the Construction Division is prepared for an on-site compliance audit.

While the QATs are addressing quality system deficiencies, the Construction Division's internal auditors should be developing and documenting procedures for conducting internal quality system audits (as required by ISO element 4.17). This critical requirement of the standard must be started as soon after the two-day workshop as possible so that records of internal audits and actions taken can be established. Auditors will look for several months of evidence that internal audits are being conducted and that they are effective. As a first step, we recommend that the Construction Division hold a three-day on-site training workshop exclusively for the internal auditors. The final day of the training workshop should focus on developing an acceptable framework for succeeding in the audit program. (The management representative may also participate in what may serve as an excellent refresher course.) As soon as practical after the training, the internal auditors should finalize their processes and procedural documentation and begin conducting internal audits of the QATs and of their system processes and documentation. It is best to manage as much of this effort as possible using the in-house trained staff.

Early in the implementation phase, executive management should begin conducting its quality system reviews as required by ISO element 4.1.3, *Management Review*. Initially, the reviews should occur whenever the QATs recommend changes to a process. Later, executive management reviews should occur monthly so that corrective and preventive actions triggered by the internal audits (ISO element 4.14) can be scrutinized. As the quality system begins to achieve a steady state, the management reviews should be conducted at least bi-annually to coincide with registration and reassessment audits by the ISO registrar. To comply with ISO standards, the Construction Division must document the executive reviews, including minutes and recommended actions.

Implementation of an ISO-compliant quality system will take about five or six months, will cost more than \$40,000 for external support, and will require more than 200 staff-days of in-house effort — more than half of the anticipated schedule, costs, and internal effort. This part of the implementation plan must be managed carefully to ensure that the process does not get bogged down and that the organization does not attempt to do too much. Too often organizations begin creating quality systems that are above and beyond their current capabilities to implement. We suggest that, initially, the USACE construction organizations focus on making minor changes only and implement the minimum system

that will comply with the ISO 9002 model. Moving beyond the minimum requirements established by ISO 9002 is the purpose of continuous improvement and TAQ principals being adopted at many USACE Districts.

Quality System Registration

About four or five months into the implementation phase, assuming everything goes according to plan, the management representative and steering committee should contact the ISO registrar to apply formally for registration under the selected ISO 9000 standard (ISO 9002). Upon completion of the formal application, the Construction Division will schedule a pre-audit meeting.

The pre-audit meeting will include the registrar's audit team, or at least the lead auditor; the steering committee; and the management representative. At that meeting, which may take an entire day, the registrar's audit team will want to meet the key personnel within the organization, get a better understanding of the business processes, have a tour of the facilities, discuss and agree on the scope of the forthcoming audit, and identify any special logistical issues that may affect their ability to conduct the on-site audit. At the end of the meeting, the audit team will expect to be briefed on the documented quality system and will expect to take the essential documentation with them. The team will review the documentation to ascertain whether the quality system, as documented, complies with ISO 9002 quality system requirements. The audit team will notify the Construction Division if it believes, on the basis of the pre-audit meeting or its documentation review, that the organization will not pass the conformance audit. That notification will enable the construction organization to correct those deficiencies and reschedule the conformance audit.

Again, assuming everything goes according to plan, a conformance audit will be scheduled about one month following the pre-audit meeting. The conformance audit will focus on the organization's compliance with what it has documented to ensure that you do what you say. Thus, it is important to ensure that the quality system documented matches the processes and procedures already in place, not those planned for the future.

The conformance audit takes two to four days and will be a distracting, and perhaps stressful, event, especially for the management representative. It also will be disruptive to some members of the Construction Division because they will be interviewed at random by the registrar's audit team. Therefore, we recommend that, one to two weeks before the conformance audit, everyone in the Construction Division receive several hours of auditee skills training that focuses on what to expect during the conformance audit and on the appropriate conduct by the staff that will minimize the chance of a poor showing.

The conformance audit will be initiated with an in-brief and will be followed by an official one- or two-hour closeout meeting at which the registrar's audit team will present its findings and summarize its conclusions and recommendations. Typically, the audit team likely will recommend registration even if

it finds minor nonconformities, with the proviso that those nonconformities are corrected according to a set schedule. On the other hand, most audit teams will end the audit immediately if they find a major nonconformity, so getting to the closeout meeting is a good sign that the organization will be approved for registration. If the audit team approves the organization's quality system, the registrar will grant registration within several weeks after the on-site audit.

The registration phase will require relatively little of the Construction Division's staff time and perhaps as little as 20 staff-days of the management representative's and senior management's time. The Construction Division should expect to pay about \$25,000 to the registrar for services rendered.

IMPLEMENTATION COSTS

On average, the external costs of obtaining ISO registration (dollars spent for training, consulting support, and registration fees paid to the registrar) will total about \$120,000; the internal costs (the number of in-house staff-hours required to perform the tasks) may range from 200 to 300 staff-days depending on local circumstances. As more USACE Construction Divisions achieve certification, the costs to implement and document the system should decrease. Table 3-1 summarizes the anticipated external and internal costs of each implementation phase for a typical USACE Construction Division.

Table 3-1.

Costs of Implementing an ISO-Compliant Quality System, by Phase

Implementation phase	External costs (\$)	Internal costs (staff-days)
Implementation team formation	6,000	10
District implementation planning	12,000	30
Action plan development	30,000	10
System documentation and implementation	25,000	130 – 230
Quality system registration	25,000	20

The costs to implement the ISO 9002 quality system at a particular activity will depend largely on the condition of its existing quality system. Activities with mature quality systems in place will be able to comply with the ISO 9002 quality system standards easily and at relatively low cost, while those with only a few elements of a quality system in place will find the process more expensive and time-consuming.

Those construction organizations already engaged in TAQ may find it beneficial to shift some of their resources for their ongoing TAQ effort to the ISO implementation effort rather than budgeting additional resources. In addition to the implementation costs, each Construction Division should plan for about

1.5 staff-years of effort annually to maintain its quality system and about \$6,000 in external costs since the registrar will likely visit twice a year for reassessment audits to make sure the quality system continues to comply with the requirements of ISO 9002.

APPENDIX A

Memorandum on Total Army Quality



DEPARTMENT OF THE ARMY

U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CERM-O

22 APR 1993

MEMORANDUM FOR Commanders, USACE Commands

SUBJECT: Total Army Quality in the U. S. Army Corps of Engineers

1. References:

- a. AR 5-1, Army Management Philosophy, 12 June 1992.
- b. Leadership for Total Army Quality (Encl).

2. Despite this time of uncertainty and turbulence the USACE team has demonstrated that our tradition remains strong. We remain strong because of the ability of our people to rise to meet great challenges, to skillfully address our nation's national security and domestic needs, and to identify opportunities for innovation and initiative.

3. Total Army Quality (TAQ) is a means for us to equip our people with the necessary skills to enhance our effectiveness. A number of organizations have already begun to implement the principles of this leadership and management philosophy. We can learn from their experience as we implement TAQ across the command. I encourage you to adopt the TAQ concept and ask you to determine how best to implement it within your organization.

4. As we embark upon this mutual endeavor, we must keep in mind that TAQ is not a program and that implementation is the responsibility of all leaders and managers. I have asked the Director of Resource Management to provide coordination and liaison during the initial phases of implementation. He has established an electronic network to facilitate sharing ideas and lessons-learned. Information about this network will be distributed separately.

5. You have my fullest support in this effort. I look forward to hearing about your successes.

Encl

ARTHUR E. WILLIAMS
Lieutenant General, USA
Commanding

APPENDIX B

ISO 9001 Standards

QUALITY SYSTEMS — MODEL FOR QUALITY ASSURANCE IN DESIGN/DEVELOPMENT, PRODUCTION, INSTALLATION, AND SERVICING

0.0 INTRODUCTION

This Standard is one of a series of three Standards dealing with quality systems that can be used for external quality assurance purposes. The alternative quality assurance models, set out in the three Standards listed below, represent three distinct forms of functional or organizational capability suitable for two-party contractual purposes:

— ANSI/ASQC Q91-1987, *Quality Systems — Model for Quality Assurance in Design/Development, Production, Installation, and Servicing*.

For use when conformance to specified requirements is to be assured by the supplier during several stages which may include design/development, production, installation, and servicing.

— ANSI/ASQC Q92-1987, *Quality Systems — Model for Quality Assurance in Production and Installation*.

For use when conformance to specified requirements is to be assured by the supplier during production and installation.

— ANSI/ASQC Q93-1987, *Quality Systems — Model for Quality Assurance in Final Inspection and Test*.

For use when conformance to specified requirements is to be assured by the supplier solely at final inspection and test.

It is emphasized that the quality system requirements specified in this Standard, Standards Q92 and Q93 are complementary (not alternative) to the technical (product/service) specified requirements. These Standards are technically equivalent to the International Standards ISO 9001, 9002, and 9003 respectively.

It is intended that these Standards will normally be adopted in their present form, but on occasions they may need to be tailored for specific contractual situations. Q90 provides guidance on such tailoring as well as selection of the appropriate quality assurance model, namely Q91, Q92, or Q93.

1.0 SCOPE AND FIELD OF APPLICATION

1.1 Scope

This Standard specifies quality system requirements for use where a contract between two parties requires the demonstration of a supplier's capability to design and supply product.

The requirements specified in this Standard are aimed primarily at preventing nonconformity at all stages from design to servicing.

1.2 Field of Application

This Standard is applicable in contractual situations when:

- a) the contract specifically requires design effort and the product requirements are stated principally in performance terms or they need to be established;
- b) confidence in product conformance can be attained by adequate demonstration of certain supplier's capabilities in design, development, production, installation, and servicing.

2.0 REFERENCES

ANSI/ASQC A3, *Quality Systems Terminology*.

ISO 8402-1986, *Quality — Vocabulary*.

ANSI/ASQC Q90-1987 *Quality Management and Quality Assurance Standards — Guidelines for Selection and Use*.

ISO 9000-1987, *Quality Management and Quality Assurance Standards — Guidelines for Selection and Use*.

3.0 DEFINITIONS

For the purposes of this Standard, the definitions given in ANSI/ASQC A3 apply.

NOTE: For the purposes of this Standard, the term "product" is also used to denote "service," as appropriate.

4.0 QUALITY SYSTEM REQUIREMENTS

4.1 Management Responsibility

4.1.1 Quality Policy

The supplier's management shall define and document its policy and objectives for, and commitment to, quality. The supplier shall ensure that this policy is understood, implemented, and maintained at all levels in the organization.

4.1.2 Organization

4.1.2.1 Responsibility and Authority

The responsibility, authority, and the interrelation of all personnel who manage, perform, and verify work affecting

quality shall be defined; particularly for personnel who need the organizational freedom and authority to:

- a) initiate action to prevent the occurrence of product nonconformity;
- b) identify and record any product quality problems;
- c) initiate, recommend, or provide solutions through designated channels;
- d) verify the implementation of solutions;
- e) control further processing, delivery, or installation of nonconforming product until the deficiency or unsatisfactory condition has been corrected.

4.1.2.2 Verification Resources and Personnel

The supplier shall identify in-house verification requirements, provide adequate resources, and assign trained personnel for verification activities (see 4.18).

Verification activities shall include inspection, test, and monitoring of the design, production, installation, and servicing of the process and/or product; design reviews and audits of the quality system, processes, and/or product shall be carried out by personnel independent of those having direct responsibility for the work being performed.

4.1.2.3 Management Representative

The supplier shall appoint a management representative who, irrespective of other responsibilities, shall have defined authority and responsibility for ensuring that the requirements of this Standard are implemented and maintained.

4.1.3 Management Review

The quality system adopted to satisfy the requirements of this Standard shall be reviewed at appropriate intervals by the supplier's management to ensure its continuing suitability and effectiveness. Records of such reviews shall be maintained (see 4.16).

NOTE: Management reviews normally include assessment of the results of internal quality audits, but are carried out by, or on behalf of, the supplier's management, namely management personnel having direct responsibility for the system (see 4.17).

4.2 Quality System

The supplier shall establish and maintain a documented quality system as a means of ensuring that product conforms to specified requirements. This shall include:

- a) the preparation of documented quality system procedures and instructions in accordance with the requirements of this Standard;

- b) the effective implementation of the documented quality system procedures and instructions.

NOTE: In meeting specified requirements, timely consideration needs to be given to the following activities:

- a) the preparation of quality plans and a quality manual in accordance with the specified requirements;
- b) the identification and acquisition of any controls, processes, inspection equipment, fixtures, total production resources, and skills that may be needed to achieve the required quality;
- c) the updating, as necessary, of quality control, inspection, and testing techniques, including the development of new instrumentation;
- d) the identification of any measurement requirement involving capability that exceeds the known state of the art in sufficient time for the needed capability to be developed;
- e) the clarification of standards of acceptability for all features and requirements, including those which contain a subjective element;
- f) the compatibility of the design, the production process, installation, inspection and test procedures, and the applicable documentation;
- g) the identification and preparation of quality records (see 4.16).

4.3 Contract Review

The supplier shall establish and maintain procedures for contract review and for the coordination of these activities.

Each contract shall be reviewed by the supplier to ensure that:

- a) the requirements are adequately defined and documented;
- b) any requirements differing from those in the tender are resolved;
- c) the supplier has the capability to meet contractual requirements.

Records of such contract reviews shall be maintained (see 4.16).

NOTE: The contract review activities, interfaces, and communication within the supplier's organization should be coordinated with the purchaser's organization, as appropriate.

4.4 Design Control

4.4.1 General

The supplier shall establish and maintain procedures to control and verify the design of the product in order to ensure that the specified requirements are met.

4.4.2 Design and Development Planning

The supplier shall draw up plans that identify the responsibility for each design and development activity. The plans shall describe or reference these activities and shall be updated as the design evolves.

4.4.2.1 Activity Assignment

The design and verification activities shall be planned and assigned to qualified staff equipped with adequate resources.

4.4.2.2 Organizational and Technical Interfaces

Organizational and technical interfaces between different groups shall be identified and the necessary information documented, transmitted, and regularly reviewed.

4.4.3 Design Input

Design input requirements relating to the product shall be identified, documented, and their selection reviewed by the supplier for adequacy.

Incomplete, ambiguous, or conflicting requirements shall be resolved with those responsible for drawing up these requirements.

4.4.4 Design Output

Design output shall be documented and expressed in terms of requirements, calculations, and analyses.

Design output shall:

- a) meet the design input requirements;
- b) contain or reference acceptance criteria;
- c) conform to appropriate regulatory requirements whether or not these have been stated in the input information;
- d) identify those characteristics of the design that are crucial to the safe and proper functioning of the product.

4.4.5 Design Verification

The supplier shall plan, establish, document, and assign to competent personnel functions for verifying the design.

Design verification shall establish that design output meets the design input requirement (see 4.4.4) by means of design control measures such as:

- a) holding and recording design reviews (see 4.16);
- b) undertaking qualification tests and demonstrations;
- c) carrying out alternative calculations;
- d) comparing the new design with a similar proven design, if available.

4.4.6 Design Changes

The supplier shall establish and maintain procedures for the identification, documentation, and appropriate review and approval of all changes and modifications.

4.5 Document Control

4.5.1 Document Approval and Issue

The supplier shall establish and maintain procedures to control all documents and data that relate to the requirements of this Standard. These documents shall be reviewed and approved for adequacy by authorized personnel prior to issue. This control shall ensure that:

- a) the pertinent issues of appropriate documents are available at all locations where operations essential to the effective functioning of the quality system are performed;
- b) obsolete documents are promptly removed from all points of issue or use.

4.5.2 Document Changes/Modifications

Changes to documents shall be reviewed and approved by the same functions/organizations that performed the original review and approval unless specifically designated otherwise. The designated organizations shall have access to pertinent background information upon which to base their review and approval.

Where practicable, the nature of the change shall be identified in the document or the appropriate attachments.

A master list or equivalent document control procedure shall be established to identify the current revision of documents in order to preclude the use of non-applicable documents.

Documents shall be re-issued after a practical number of changes have been made.

4.6 Purchasing

4.6.1 General

The supplier shall ensure that purchased product conforms to specified requirements.

4.6.2 Assessment of Sub-Contractors

The supplier shall select sub-contractors on the basis of their ability to meet sub-contract requirements, including quality requirements. The supplier shall establish and maintain records of acceptable sub-contractors (see 4.16).

The selection of sub-contractors, and the type and extent of control exercised by the supplier, shall be dependent upon

the type of product and, where appropriate, on records of subcontractors' previously demonstrated capability and performance.

The supplier shall ensure that quality system controls are effective.

4.6.3 Purchasing Data

Purchasing documents shall contain data clearly describing the product ordered, including, where applicable:

- a) the type, class, style, grade, or other precise identification;
- b) the title or other positive identification, and applicable issue of specifications, drawings, process requirements, inspection instructions, and other relevant technical data, including requirements for approval or qualification of product, procedures, process equipment and personnel;
- c) the title, number, and issue of the quality system Standard to be applied to the product.

The supplier shall review and approve purchasing documents for adequacy of specified requirements prior to release.

4.6.4 Verification of Purchased Product

Where specified in the contract, the purchaser or the purchaser's representative shall be afforded the right to verify at source or upon receipt that purchased product conforms to specified requirements. Verification by the purchaser shall not absolve the supplier of the responsibility to provide acceptable product nor shall it preclude subsequent rejection.

When the purchaser or the purchaser's representative elects to carry out verification at the sub-contractor's plant, such verification shall not be used by the supplier as evidence of effective control of quality by the sub-contractor.

4.7 Purchaser Supplied Product

The supplier shall establish and maintain procedures for verification, storage, and maintenance of purchaser supplied product provided for incorporation into the supplies. Any such product that is lost, damaged, or is otherwise unsuitable for use shall be recorded and reported to the purchaser (see 4.16).

NOTE: Verification by the supplier does not absolve the purchaser of the responsibility to provide acceptable product.

4.8 Product Identification and Traceability

Where appropriate, the supplier shall establish and maintain procedures for identifying the product from applicable drawings, specifications, or other documents, during all stages of production, delivery, and installation.

Where, and to the extent that, traceability is a specified re-

quirement, individual product or batches shall have a unique identification. This identification shall be recorded (see 4.16).

4.9 Process Control

4.9.1 General

The supplier shall identify and plan the production and, where applicable, installation processes which directly affect quality and shall ensure that these processes are carried out under controlled conditions. Controlled conditions shall include the following:

- a) documented work instructions defining the manner of production and installation, where the absence of such instructions would adversely affect quality, use of suitable production and installation equipment, suitable working environment, compliance with reference standards/codes, and quality plans;
- b) monitoring and control of suitable process and product characteristics during production and installation;
- c) the approval of processes and equipment, as appropriate;
- d) criteria for workmanship which shall be stipulated, to the greatest practicable extent, in written standards or by means of representative samples.

4.9.2 Special Processes

These are processes, the results of which cannot be fully verified by subsequent inspection and testing of the product and where, for example, processing deficiencies may become apparent only after the product is in use. Accordingly, continuous monitoring and/or compliance with documented procedures is required to ensure that the specified requirements are met. These processes shall be qualified and shall also comply with the requirements of 4.9.1.

Records shall be maintained for qualified processes, equipment, and personnel, as appropriate.

4.10 Inspection and Testing

4.10.1 Receiving Inspection and Testing

4.10.1.1 The supplier shall ensure that incoming product is not used or processed (except in the circumstances described in 4.10.1.2) until it has been inspected or otherwise verified as conforming to specified requirements. Verification shall be in accordance with the quality plan or documented procedures.

4.10.1.2 Where incoming product is released for urgent production purposes, it shall be positively identified and recorded

(see 4.16) in order to permit immediate recall and replacement in the event of nonconformance to specified requirements.

NOTE: In determining the amount and nature of receiving inspection, consideration should be given to the control exercised at source and documented evidence of quality conformance provided.

4.10.2 In-Process Inspection and Testing

The supplier shall:

- a) inspect, test, and identify product as required by the quality plan or documented procedures;
- b) establish product conformance to specified requirements by use of process monitoring and control methods;
- c) hold product until the required inspection and tests have been completed or necessary reports have been received and verified except when product is released under positive recall procedures (see 4.10.1). Release under positive recall procedures shall not preclude the activities outlined in 4.10.2 a);
- d) identify nonconforming product.

4.10.3 Final Inspection and Testing

The quality plan or documented procedures for final inspection and testing shall require that all specified inspection and tests, including those specified either on receipt of product or in-process, have been carried out and that the data meets specified requirements.

The supplier shall carry out all final inspection and testing in accordance with the quality plan or documented procedures to complete the evidence of conformance of the finished product to the specified requirements.

No product shall be dispatched until all the activities specified in the quality plan or documented procedures have been satisfactorily completed and the associated data and documentation is available and authorized.

4.10.4 Inspection and Test Records

The supplier shall establish and maintain records which give evidence that the product has passed inspection and/or test with defined acceptance criteria (see 4.16).

4.11 Inspection, Measuring, and Test Equipment

The supplier shall control, calibrate, and maintain inspection, measuring, and test equipment, whether owned by the

supplier, on loan, or provided by the purchaser, to demonstrate the conformance of product to the specified requirements. Equipment shall be used in a manner which ensures that measurement uncertainty is known and is consistent with the required measurement capability.

The supplier shall:

- a) identify the measurements to be made, the accuracy required, and select the appropriate inspection, measuring, and test equipment;
- b) identify, calibrate, and adjust all inspection, measuring and test equipment, and devices that can affect product quality at prescribed intervals, or prior to use, against certified equipment having a known valid relationship to nationally recognized standards — where no such standards exist, the basis used for calibration shall be documented;
- c) establish, document, and maintain calibration procedures, including details of equipment type, identification number, location, frequency of checks, check method, acceptance criteria, and the action to be taken when results are unsatisfactory;
- d) ensure that the inspection, measuring, and test equipment is capable of the accuracy and precision necessary;
- e) identify inspection, measuring, and test equipment with a suitable indicator or approved identification record to show the calibration status;
- f) maintain calibration records for inspection, measuring, and test equipment (see 4.16);
- g) assess and document the validity of previous inspection and test results when inspection, measuring, and test equipment is found to be out of calibration;
- h) ensure that the environmental conditions are suitable for the calibrations, inspections, measurements, and tests being carried out;
- i) ensure that the handling, preservation, and storage of inspection, measuring, and test equipment is such that the accuracy and fitness for use is maintained;
- j) safeguard inspection, measuring, and test facilities, including both test hardware and test software, from adjustments which would invalidate the calibration setting.

Where test hardware (e.g., jigs, fixtures, templates, patterns) or test software is used as suitable forms of inspection, they shall be checked to prove that they are capable of verifying the acceptability of product prior to release for use during production and installation and shall be rechecked at prescribed intervals. The supplier shall establish the extent and frequency of such checks and shall maintain records as evidence of control (see 4.16). Measurement design data shall be made available, when required by the purchaser or his representative, for verification that it is functionally adequate.

4.12 Inspection and Test Status

The inspection and test status of product shall be identified by using markings, authorized stamps, tags, labels, routing cards, inspection records, test software, physical location, or other suitable means, which indicate the conformance or nonconformance of product with regard to inspection and tests performed. The identification of inspection and test status shall be maintained, as necessary, throughout production and installation of the product to ensure that only product that has passed the required inspections and tests is dispatched, used, or installed.

Records shall identify the inspection authority responsible for the release of conforming product (see 4.16).

4.13 Control of Nonconforming Product

The supplier shall establish and maintain procedures to ensure that product that does not conform to specified requirements is prevented from inadvertent use or installation. Control shall provide for identification, documentation, evaluation, segregation when practical, disposition of nonconforming product, and for notification to the functions concerned.

4.13.1 Nonconformity Review and Disposition

The responsibility for review and authority for the disposition of nonconforming product shall be defined.

Nonconforming product shall be reviewed in accordance with documented procedures. It may be:

- a) reworked to meet the specified requirements, or
- b) accepted with or without repair by concession, or
- c) re-graded for alternative applications, or
- d) rejected or scrapped.

Where required by the contract, the proposed use or repair of product (see 4.13.1 b) which does not conform to specified requirements shall be reported for concession to the purchaser or the purchaser's representative. The description of nonconformity that has been accepted, and of repairs, shall be recorded to denote the actual condition (see 4.16).

Repaired and reworked product shall be re-inspected in accordance with documented procedures.

4.14 Corrective Action

The supplier shall establish, document, and maintain procedures for:

- a) investigating the cause of nonconforming product and the corrective action needed to prevent recurrence;
- b) analyzing all processes, work operations, concessions,

quality records, service reports, and customer complaints to detect and eliminate potential causes of nonconforming product;

- c) initiating preventative actions to deal with problems to a level corresponding to the risks encountered;
- d) applying controls to ensure that corrective actions are taken and that they are effective;
- e) implementing and recording changes in procedures resulting from corrective action.

4.15 Handling, Storage, Packaging, and Delivery

4.15.1 General

The supplier shall establish, document, and maintain procedures for handling, storage, packaging, and delivery of product.

4.15.2 Handling

The supplier shall provide methods and means of handling that prevent damage or deterioration.

4.15.3 Storage

The supplier shall provide secure storage areas or stock rooms to prevent damage or deterioration of product, pending use, or delivery. Appropriate methods for authorizing receipt and the dispatch to and from such areas shall be stipulated. In order to detect deterioration, the condition of product in stock shall be assessed at appropriate intervals.

4.15.4 Packaging

The supplier shall control packing, preservation, and marking processes (including materials used) to the extent necessary to ensure conformance to specified requirements and shall identify, preserve, and segregate all product from the time of receipt until the supplier's responsibility ceases.

4.15.5 Delivery

The supplier shall arrange for the protection of the quality of product after final inspection and test. Where contractually specified, this protection shall be extended to include delivery to destination.

4.16 Quality Records

The supplier shall establish and maintain procedures for identification, collection, indexing, filing, storage, maintenance, and disposition of quality records.

Quality records shall be maintained to demonstrate achievement of the required quality and the effective operation of

the quality system. Pertinent sub-contractor quality records shall be an element of these data.

All quality records shall be legible and identifiable to the product involved. Quality records shall be stored and maintained in such a way that they are readily retrievable in facilities that provide a suitable environment to minimize deterioration or damage and to prevent loss. Retention times of quality records shall be established and recorded. Where agreed contractually, quality records shall be made available for evaluation by the purchaser or the purchaser's representative for an agreed period.

4.17 Internal Quality Audits

The supplier shall carry out a comprehensive system of planned and documented internal quality audits to verify whether quality activities comply with planned arrangements and to determine the effectiveness of the quality system.

Audits shall be scheduled on the basis of the status and importance of the activity.

The audits and follow-up actions shall be carried out in accordance with documented procedures.

The results of the audits shall be documented and brought to the attention of the personnel having responsibility in the

area audited. The management personnel responsible for the area shall take timely corrective action on the deficiencies found by the audit (see 4.1.3).

4.18 Training

The supplier shall establish and maintain procedures for identifying the training needs and provide for the training of all personnel performing activities affecting quality. Personnel performing specific assigned tasks shall be qualified on the basis of appropriate education, training, and/or experience, as required. Appropriate records of training shall be maintained (see 4.16).

4.19 Servicing

Where servicing is specified in the contract, the supplier shall establish and maintain procedures for performing and verifying that servicing meets the specified requirements.

4.20 Statistical Techniques

Where appropriate, the supplier shall establish procedures for identifying adequate statistical techniques required for verifying the acceptability of process capability and product characteristics.

APPENDIX C

Guidelines for Conformance with ISO 9002 Standards

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Guidelines for Conformance with ISO 9002 Standards

1.0 INTRODUCTION

This appendix provides the U.S. Army Corps of Engineers (USACE) Construction Divisions with an interpretation of the ISO 9002 quality system standards as they apply specifically to the unique USACE construction environment. It also contains guidance for complying with the requirements of the standards in terms that should be familiar to typical USACE construction personnel. The interpretation and guidance in this appendix should *not* be applied to other USACE District functions such as engineering, project management, contracting, and resource management.

This appendix should be read in conjunction with the ISO 9002-1994 standards.¹ The requirements in ISO 9002-1994 take precedence over the interpretation provided herein.

2.0 REFERENCES

Publications covering the ISO 9000 family of quality system standards and USACE construction quality assurance include the following:

- ◆ ISO 9000-1 — *Quality Management and Quality Assurance Standards: Guidelines for Selection and Use*
- ◆ ISO 9000-2 — *Quality Management and Quality Assurance Standards — Part 2: Generic Guidelines for the Application of ISO 9001, ISO 9002, and ISO 9003*
- ◆ ISO 9002 — *Quality Systems — Model for Quality Assurance in Production and Installation*
- ◆ ISO 9004 — *Quality Management and Quality System Elements, Guidelines*
- ◆ ISO 9004-2 — *Quality Management and Quality System Elements, Part 2: Guidelines for Services*
- ◆ ISO 10011-1 — *Guidelines for Auditing Quality Systems*
- ◆ ISO 10011-2 — *Qualification Criteria for Quality System Auditors*

¹ISO 9000 standards are reproduced in the United States under the American National Standards Institute and the American Society of Quality Control Q9000 series.

- ◆ ISO 10011-3 — *Management of Audit Programs*
- ◆ ISO 10013 — *Guidelines for Developing Quality Manuals*
- ◆ ISO 8402 — *Quality Vocabulary*
- ◆ Engineering Regulation (ER) 1-1-11 — *Administration — Progress, Schedules, and Network Analysis Systems*
- ◆ ER 25-345-1 — *System Operation and Maintenance Documentation*
- ◆ ER 415-1-10 — *Contractor Submittal Procedures*
- ◆ ER 415-1-11 — *Construction — Biddability, Constructibility, Operability*
- ◆ ER 415-1-13 — *Construction — Design and Construction Evaluation (DCE)*
- ◆ ER 415-3-11 — *Engineering and Design Post-Completion Inspection Feedback*
- ◆ ER 415-7-1 — *Construction — Contractor Performance Evaluations*
- ◆ ER 715-1-10 — *Architect Engineers Responsibility Management*
- ◆ ER 1180-1-6 — *Contracts — Construction Quality Management*
- ◆ Engineering Publication (EP) 415-1-260 — *Resident Engineer Management Guide*
- ◆ EP 415-1-266 — *Resident Engineer Management Guide for Hazardous, Toxic, and Radioactive Waste Projects.*

3.0 DEFINITIONS

The ISO 9000 standards carry a specific set of definitions consistently applied throughout the series of contractual and guidance documents. We have adopted the same definitions but have further defined them as they specifically apply to USACE construction activities:

- ◆ *Supplier* — the USACE Construction Division (or, in cases where construction is combined with other District functions, that portion of the organization responsible for construction activities). We refer to the supplier as the Construction Division, the construction organization, or construction.
- ◆ *Product* — the ISO 9000 standards define a product as the result of activities or processes and add that a product may be a service rendered, hardware, processed materials, software, or any combination thereof, and it may be tangible or intangible (e.g., knowledge or concepts). For USACE construction activities, the product is a service — management of a construction

project throughout its life cycle, including construction project scheduling, quality assurance, cost control, contract administration, procurement of materials (where necessary), value engineering, and claims analysis, and warranty services.

- ◆ *Customer* — anyone or any organization that receives a product from the USACE Construction Division. Customers can be either internal or external to the USACE District. Internal customers may include the District's project management, engineering, or operations activities, while external customers may include Army installations, Air Force installations, or other Federal or state governmental agencies.
- ◆ *Contract* — any contract instrument or medium (written or oral) used to establish agreed-upon requirements between the supplier (Construction Division) and the customer (internal or external). The contract may be a memorandum of agreement (MOA), a memorandum of understanding (MOU), a delivery order, work order, action required under the project management plan, or traditional contract vehicle.
- ◆ *Tender* — offer made by the construction organization in response to any invitation by a customer for the provision of a product.
- ◆ *Prime contractor* — general construction contractor hired by USACE to execute the construction contract (referred to as subcontractor in the ISO standard).
- ◆ *Subcontractors* — trade and other service providers hired by the prime contractor to construct the facility.
- ◆ *Contractors* — other service providers, such as testing or delivery contractors, that are hired by the USACE Construction Division as needed to deliver the product.
- ◆ *Government-furnished equipment (GFE)* — all materials either purchased by the District's contracting activity or by the customer for inclusion in the contracted facility. Examples include fixtures, furnishings, and specialized equipment that a customer may provide under another contract that will be delivered to the site for placement or installation in the contracted facility.

4.0 QUALITY SYSTEM REQUIREMENTS

The following structure of clause and subclause numbering coincides exactly with the ISO 9002 standards.

4.1 Management Responsibility

4.1.1 QUALITY POLICY

Requirement

To meet quality policy requirements, the Construction Division's senior management (typically, the chief or a committee comprising branch chiefs) must ensure that

- ◆ the quality policy and quality objectives are well defined, approved, auditable, measurable, and sufficiently documented;
- ◆ the policy cites commitment to developing the highest quality products, to meeting customers' expectations for quality products, and to satisfying the needs of construction organization personnel;
- ◆ everyone in the organization (including District, area, resident, and project offices) understands, embraces, and practices what is represented by the policy; and
- ◆ the quality policy is consistent with Army and USACE command directives, internal District and Construction Division policy, organizational quality goals, and the expectations and needs of construction customers.

Note: Quality policy is defined by ISO 8402 as "the overall intentions and direction of an organization with regard to quality, as formally expressed by top management."

Guidance

The quality policy and quality objectives developed by the Construction Division and promulgated throughout the organization should be consistent with quality policies and goals and with vision and mission statements already in place in the District. Moreover, the quality policy and quality objectives required by ISO 9002 should be

- ◆ measurable and ambitious, yet achievable, and
- ◆ easy and relevant for everyone in the Construction Division to understand.

For example, it may not be enough simply to say that the Construction Division will reduce supervision and administration (S&A) costs; instead, construction should specify, for example, that it will reduce those costs by 10 percent in the coming year. While local quality objectives will vary at each construction or-

ganization, the following are examples of quality objectives that are relevant, measurable, and achievable:

- ◆ Projects will be completed on schedule 95 percent of the time (on time means beneficial occupancy within two months of agreed time).
- ◆ Projects will be completed within budget 95 percent of the time (within budget means not exceeding programmed amount by 10 percent).
- ◆ Projects will never exceed 120 percent of the programmed amount.
- ◆ Controlled cost growth will not exceed 2 percent.
- ◆ Uncontrollable cost growth will not exceed 5 percent.
- ◆ All contract actions will be closed out within six months of the owner occupancy.
- ◆ Progress payments will be made within 14 days of invoice acceptance

In addition, while not required specifically by ISO 9002, the Construction Division's senior management should do the following:

- ◆ Define the key elements of quality, such as fitness for use; responsiveness to customers; effectiveness of cost control; and compliance with the organization's internal policy and regulations, guide specifications, and relevant codes.
- ◆ Consider the ramifications and costs if its quality objectives are not met.
- ◆ Provide sufficient resources to develop relevant, measurable, and achievable quality policy and objectives.
- ◆ Determine the competence, experience, and training required to achieve those goals.
- ◆ Ensure that the policy and objectives are written simply and clearly.

4.1.2 ORGANIZATION

4.1.2.1 *Responsibility and Authority*

Requirement

The construction organization must define the responsibilities, authorities, and interrelationships of all personnel affecting the quality of its construction management services. In other words, the Construction Division must have a documented and current organization chart along with functional descriptions

for the branches, sections, and field offices under its authority. The documentation must specify the personnel responsible for identifying, correcting, and preventing nonconformities in the construction product, procedures, or quality system.

Guidance

Members at all levels of the construction organization should

- ◆ be aware of the scope, responsibility, and authority of their job functions;
- ◆ be aware of their impact on product quality;
- ◆ have adequate authority to carry out their responsibilities in relation to quality; and
- ◆ accept responsibility (and be held accountable) for achieving quality objectives.

4.1.2.2 Resources

Requirement

Construction Division executive management must make sure that sufficient resources are available for all quality assurance activities on every project so that the finished project conforms to stated requirements. In addition, the organization must make sure that personnel assigned to each project are adequately trained and possess adequate experience or skills to carry out their job assignments effectively (on-the-job training is permissible). See element 4.18, *Training*. At a minimum, quality assurance and quality control activities must include

- ◆ inspection and verification of work performed by the contractor or test labs,
- ◆ reviews of quality control plans submitted by construction contractors,
- ◆ in-process reviews and verification of contractor quality control plans,
- ◆ contract administrative activities,
- ◆ internal quality system audits, and
- ◆ verification of construction materials or equipment produced at a subcontractor's facility.

Guidance

Effective verification of the construction organization's products requires cooperation and objectivity among those involved. Resources required can include the following elements:

- ◆ Awareness of the ISO standards and the organization's quality system
- ◆ Adequate training to perform the assigned duties
- ◆ Realistic quality plans that allow ample resources for biddability, constructability, operability, and environmental (BCOE) reviews; supervision; inspections; and tests
- ◆ Adequate and proper equipment [e.g., computer/computer-aided design development, testing, Resource Management System (RMS)] and other resources to perform any quality system assignment.

When training budgets are set by District-level activities and are thus beyond the control of the construction organization, the Construction Division should be able to demonstrate that training requirements are prioritized and that the organization's highest priorities are funded. Also, it may be able to redirect other Division funding toward meeting its training priorities.

4.1.2.3 Management Representative

Requirement

The Construction Division chief (executive management) must appoint a management representative who has the responsibility and authority for establishing and maintaining the quality system and reporting on that system to senior management so that it can review system performance and identify opportunities for improvement. The appointed management representative must be a member of the Construction Division's management team, must be officially recognized, and must be recorded in the quality manual or similar documentation.

Guidance

Anyone in the construction organization could be selected as the management representative: the chief, one of the branch chiefs (preferably from the Quality Assurance Branch or the Contract Administration Branch), or an individual from the Construction Division. Whoever is selected as the management representative must be given the required authority and organizational line of control to the Division chief. (A member of the Construction Division's management team will already have the needed authority to carry out the responsibilities.) The management representative should also have representation, either by

direct line of authority or through the appointment of agents, at each area and resident office.

In addition to having the authority to carry out his or her responsibilities, the management representative should

- ◆ be knowledgeable about the Corps' or the Construction Division's traditional quality assurance techniques,
- ◆ have a thorough understanding of the ISO 9000 quality system standards,
- ◆ be committed to the importance of ISO 9000 to the construction organization,
- ◆ be well respected within the organization, and
- ◆ have excellent communication skills.

If the selected individual does not have the required quality system knowledge, proper training will be necessary.

If the management representative has other responsibilities in addition to quality system oversight, no conflict of interest should exist between the duties and the role of management representative should be at least as important as the other duties.

4.1.3 MANAGEMENT REVIEW

Requirement

At defined and regular intervals, executive management must conduct a quality system review meeting to ensure the continued suitability of the quality system and to resolve any outstanding issues relating to the stated quality policy, goals, and objectives. Meeting minutes must be recorded and maintained.

Guidance

The frequency of internal reviews is not specified in the standard and will depend on local circumstances. However, auditors would typically expect to see records of progress since the last audit. Since audits occur at least annually (for any particular element), it is widely held that management reviews should be scheduled at least as often as the registrar's ongoing assessments. In terms of

follow-up, problems should be documented, analyzed, and resolved in a timely manner. The quality system reviews should address the following questions:

- ◆ Is the system (still) working effectively?
- ◆ How is quality being measured and are those metrics within proscribed levels?
- ◆ Is the construction organization meeting its stated quality policy and objectives?
- ◆ Are written procedures current and consistent with the way they are applied by construction staff?

While the scope of its reviews is up to the Construction Division's executive management, management should, at a minimum, review the following:

- ◆ Results of internal quality system audits (see 4.17, *Internal Quality Audits*)
- ◆ Summary of system nonconformities and deficiencies and of corrective and preventive actions taken (see 4.14, *Corrective and Preventive Action*)
- ◆ Indicators of quality system implementation and attainment of established policies and objectives (quality system elements, organizational structure, and quality policies and objectives may need to be modified)
- ◆ Effectiveness of current training
- ◆ Achieved and perceived (based on customer feedback) quality of the construction products.

4.2 Quality System

4.2.1 GENERAL

Requirement

The construction organization must establish, document, and maintain its quality system. That documented quality system must include a quality manual (see guidance below) that addresses the relevant elements of the ISO 9002 standard as well as Army, USACE, District, and Construction Division policies with respect to those ISO elements. The quality manual must also reference quality system procedures and outline the structure of the quality system. Typically, that structure includes the quality system procedures; work instructions; other required quality system documentation; project quality assurance plans; and relevant Federal legislation, Army and engineering regulations, technical manuals, and guide specifications. The quality manual must also describe how the construction organization will ensure the quality of every project it undertakes.

Note: The Construction Division must document all local policies and practices that deviate from Army and USACE regulations.

Guidance

The quality system applies to all activities related to the delivery of a quality construction project. These activities can range from initial project development and design through construction and servicing, if necessary.

The framework of the documented quality system typically follows a tiered structure, with each tier becoming increasingly detailed. At the top tier, the quality manual should explain the whys and whats of the construction organization's quality system policies. On the second and third tiers, the manual should discuss the who, when, and where of the quality system procedures and provide work instructions. Quality system records form the fourth tier.

ISO 9004 stresses that the goal of the quality system is to provide confidence that

- ◆ the system is understood by everyone in the organization and is carried out effectively,
- ◆ the construction organization's product — construction project management — satisfies customer and industry requirements and customer expectations,
- ◆ the needs of both society and the environment have been addressed, and
- ◆ the emphasis is on problem prevention rather than detection and correction after occurrence.

The quality manual may include the following elements:

- ◆ Signature of the Construction Division chief (or designee)
- ◆ Name and location of the District and Construction Division
- ◆ Organization's quality policy, goals, and measurable objectives
- ◆ Current organization charts and functional statements
- ◆ Designated quality responsibilities and name of the management representative
- ◆ Accepted management review system
- ◆ Approved methods for revising and updating the manual
- ◆ Complete coverage of all ISO 9002 quality system elements.

4.2.2 QUALITY SYSTEM PROCEDURES

Requirement

Documented quality system procedures that address the relevant requirements of the ISO 9002 standards and Construction Division's quality policy, goals, and objectives must be effectively implemented. Those procedures must show the quality control points at which quality will be verified.

Guidance

Above all else, the quality system procedures need to be kept simple; two to four pages per procedure should be sufficient under most conditions. The construction organization may select whatever format it wants for its procedures: flow or process charts, models, narrative, or a combination of formats. The level of detail in the documented procedures should be inverse to the level of training, experience, and qualifications of the Construction Division's staff. In other words, relatively little documentation is required when the level of education, experience, and qualifications of the staff is relatively high. Conversely, for a staff with less education, experience, and qualifications, the processes and procedures should be documented in detail.

4.2.3 QUALITY PLANNING

Requirement

As appropriate, the construction organization must develop an overall organizational quality management plan that shows how it will consistently deliver quality products and meet its stated quality policy and objectives. Construction must also develop an effective quality assurance plan for every construction project. That plan must show how the technical, schedule, industry, and cost requirements for the project will be met. Quality management and quality assurance plans must be developed in accordance with USACE regulations, Construction Division policy, and project-specific requirements outlined in the project management plan (see element 4.9, *Process Control*). The Construction Division also must develop guidance that explains how projects are selected.

Guidance

The quality assurance plan developed by field activities for each project should define how the requirements for that project will be met. The development of a quality assurance plan is especially important for identifying and defining customer requirements, requirements associated with industry practices, and requirements to satisfy safety and environmental concerns when each project is unique and particularly when those requirements are conflicting.

4.3 Contract Review

4.3.1 GENERAL

Requirement

The construction organization must have a documented contract review system that

- ◆ ensures that the requirements of the organization's customers are adequately defined, documented, and understood before the contract is signed (e.g., a properly developed statement of work);
- ◆ effectively resolves misunderstandings with customer requirements when they arise;
- ◆ ensures that, before the organization enters into a contract agreement for construction management or contract administration, it is capable of meeting the requirements with in-house personnel or through subcontracted support; and
- ◆ keeps records of all above-related discussions and agreements reached (see 4.16, *Control of Quality Records*).

Note: "Contract Review" refers to any contractual arrangement between the construction organization and its customers (internal or external), including MOAs, MOUs, DD1391s, delivery orders, and other customer contracts.

Guidance

At most USACE Districts, responsibility for contract review rests with the Project Management and Engineering divisions. But if it is to deliver a quality product, the Construction Division must thoroughly understand what its customers want, need, and expect before it accepts and starts any work. And it is the construction organization's responsibility to ensure that those requirements and expectations are effectively communicated.

4.3.2 REVIEW

Requirement

The following are the basic requirements of the contract review process:

- ◆ Requirements must be adequately defined, agreed to by both parties, and documented.

- ◆ Any requirements that differ from those in the proposal or tender must be resolved.
- ◆ The construction organization must understand the requirements of the contract and know its capabilities in meeting those requirements.

Guidance

Establishing and reviewing contracts with external customers is beyond the Construction Division's authority, but making sure it is capable of delivering the work promised is not. The construction organization should participate in any meetings between outside customers and the District's Contracting or Project Management divisions to ensure its views are represented and to sign off on any agreements reached.

The constructability review (part of the BCOE review) during the design development process is an opportunity for the construction organization to thoroughly review what will eventually become the basic requirements of the construction contract. The construction organization must actively participate in this or other similar reviews if it is to meet the requirements of this quality system element. The constructability reviews must be identified in the project management plan and carried out according to that plan.

The contract review procedures should have the following features:

- ◆ Provision ensuring that all parties have an opportunity to review the contract
- ◆ Verification checklist
- ◆ Method for questioning the contract requirements and resolving problem areas
- ◆ Provision for changing the contract.

For each project, the construction organization should include the finalized and agreed-upon statement of work in the quality assurance plan to serve as on-going reference.

4.3.3 AMENDMENT TO CONTRACT

Requirement

All contract modifications under the control of Construction Division personnel and authorized by the contracting officer (e.g., usually for changes costing less than \$100,000) must be conducted in accordance with documented procedures, the Federal Acquisition Regulations (FAR), and FAR supplements.

At a minimum, procedures must include a review, notification to affected functions, and records of the contract agreements reached.

Guidance

Only those contract modifications dealing with the customer's changes to the initially agreed-upon requirements need to be addressed. Other modifications concerning design changes or differing site conditions are addressed under ISO element 4.10.3, *In-Process Inspection and Testing*. Modifications exceeding the administrative contracting officer's authority must be coordinated with the contracting officer at the District office or above.

4.3.4 RECORDS

The construction organization must establish records of all contract reviews and identify the personnel performing those reviews (see 4.16, *Control of Quality Records*).

4.4 Design Control

Design control is not applicable to quality system requirements of USACE construction activities and is not an element under ISO 9002 registration. However, on some projects, changes to facility designs may be necessary. For those cases, construction must document how it will handle such changes. The documentation should include an explanation of how the changes are authorized and how they get implemented. Element 4.5.3, *Document and Data Changes*, contains further guidance.

4.5 Document and Data Control

4.5.1 GENERAL

Requirement

The Construction Division must have documented procedures for creating, controlling, reviewing, approving, and publishing internally and externally generated documents and data that relate to any applicable element of this standard or to any specific construction project. The construction activity must identify which documents/data it will control.

Note: Data and documents can be of any medium, including hard copy or electronic.

Guidance

Document control may apply to all documents and data pertinent to construction project planning, required purchasing activities, construction management responsibilities, the ISO 9002 quality system standards, inspections and verification, product testing, and internal written procedures. The document control procedures should describe

- ◆ what documents and data are to be controlled,
- ◆ how documentation and data are to be controlled,
- ◆ who is responsible for document control (more than one person may be responsible and different documents may be controlled by different persons), and
- ◆ where and when it is to be controlled.

The following are examples of documents and data that the Construction Division may wish to control:

- ◆ Applicable Federal statutes
- ◆ All Army and USACE regulations, pamphlets, circulars, and technical notes
- ◆ ISO quality manual and operating procedures
- ◆ Corps of Engineers guide specifications
- ◆ Training materials
- ◆ Project specifics (e.g., construction contract plans and specifications)
- ◆ Work instructions
- ◆ Any other ISO-related quality documentation.

4.5.2 DOCUMENT AND DATA APPROVAL AND ISSUE

The Construction Division must prepare a master list of documents and data it intends to control. The list should include documents and data required by the customer. Authorized personnel must approve the master list before it is issued.

To avoid using invalid or obsolete documents, construction must identify the current revision status of the controlled documents and data and must ensure that current and appropriate documents and data are available at all relevant locations where needed. It must remove invalid or obsolete documents or

otherwise handle them to ensure against unintended use, and it must identify any obsolete documents retained for legal or knowledge-preservation purposes.

4.5.3 DOCUMENT AND DATA CHANGES

Requirement

When changes to controlled documents or data are necessary, cognizant construction activities or persons must identify and approve the changes. The review and approval process must be performed by the same activities or people that performed the original review (unless specifically designated otherwise); those activities or people must have access to appropriate information upon which to base their decisions. The organization must consider whether the changes should be identified, either within the documents that have been changed or in appropriate change notifications.

Guidance

This element applies to all internally and externally controlled documents and data. Construction should consider the effect that changes in one area may have on other parts of the organization and should plan the circulation of a change proposal to avoid disruption as well as time the implementation to minimize disruption.

4.6 Purchasing

4.6.1 GENERAL

Requirement

This element does not apply to construction organizations that do not need to purchase goods or services in order to deliver their product or that have little or no influence over the selection of the general construction contractors.

For those Construction Divisions that purchase goods or services, this element requires that all purchased supplies, materials, and services conform to preestablished requirements and that the acquisition process satisfy the provisions of the FAR and FAR supplements. To do so, all contractors must be selected on the basis of their ability to meet contract (customer) requirements as established in the project management plan and quality assurance plan. Also, the Construction Division must establish and maintain records of successful and unsuccessful contractors.

In addition, customers must be able to verify that their requirements can be met by those services contracted to outside firms.

Note: In the event of a declared national emergency, USACE can exercise extensive procurement authority under public law.

Guidance

Planned and adequately controlled purchasing procedures ensure that sub-contracted products and services conform to the specified requirements. Construction should establish effective working relationships and feedback systems with all of its subcontractors and test laboratories.

A quality procurement program should include the following elements:

- ◆ Selection of acceptable subcontractors
- ◆ Agreement on quality assurance
- ◆ Agreement on test and verification methods
- ◆ Provisions for settling disputes
- ◆ Plan for inspecting and controlling products and services when received
- ◆ Quality records related to purchasing.

4.6.2 EVALUATION OF SUBCONTRACTORS

Requirement

During execution of the construction contract, personnel in the Construction Division must monitor each contractor's performance against that contract and provide the necessary feedback to the contracting authorities so that poor performance can be considered for subsequent contracts.

Guidance

The construction contractor appraisal support system satisfies the requirements of this quality system element if properly implemented by the Construction Division activities. By law, procurement of the construction contractors is the responsibility of the District's contracting officer. However, when requested, the construction organization must evaluate those contractors and provide feedback on their abilities to meet the contract and the customer's requirements.

4.6.3 PURCHASING DATA

For all services, materials, and supplies purchased by the construction organization, the required contracting documents must clearly identify what is being purchased. Where applicable, the Construction Division must support the contracting officer in developing the required statements of work for products or services they need.

4.6.4 VERIFICATION OF PURCHASED PRODUCT

Requirement

Verification of a purchased product encompasses the following two situations:

- ◆ The construction organization verifies the purchased product at the contractor's or subcontractor's premises.
- ◆ The construction organization or the customer verifies the product at the point of installation.

Guidance

In the first situation, construction must "specify verification arrangements and the method of product release in the purchasing documents." For example, a resident engineer or a member of the Quality Assurance Branch with verification authority may visit a test laboratory to witness that tests are being performed in accordance with the requirements established in the quality assurance plan or contract. Or those personnel may visit a manufacturer's plant to verify that purchased building equipment will meet specified requirements.

In the second situation, the ISO standard adds two caveats:

- ◆ The Construction Division cannot use such verifications as a means of effective quality control over that subcontractor.
- ◆ Even though the customer takes responsibility for verifying the subcontracted product, the Construction Division is still responsible for ensuring the quality of that purchased product, and the customer may still reject the product upon delivery.

4.7 Control of Customer-Supplied Product

REQUIREMENT

When it takes possession of GFE, the construction organization must have documented procedures and must keep records on all products supplied by the customer and, where necessary, stored by the construction organization. Any lost, damaged, or unsuitable products supplied by USACE's customers must be recorded and reported to the customer. Government procedures for the control of GFE apply.

GUIDANCE

Customer-supplied products may be any government-furnished materials procured by the customer for use in a constructed facility. They may also be any materials procured by the District contracting activity to use at the construction site. Finally, customer-supplied products may be specifications, legal documentation, product brochures, blueprints, computer equipment, software, procedure manuals, or any other items that are owned by customers and furnished to the construction organization for use in meeting the contract requirements. Construction is fully responsible for customer-supplied products while they are in its possession.

4.8 Product Identification and Traceability

REQUIREMENT

The construction organization must establish and document a system to ensure that all its documentation and records (or other information) are uniquely identifiable to the appropriate project and traceable to the relevant stage of the construction project. If errors in the finished product are discovered, the process must be identified adequately enough at various stages to enable an effective audit of the causes of the problems. Elements 4.5, *Document and Data Control*, and 4.16, *Control of Quality Records*, also apply.

GUIDANCE

Many identification methods exist, but at a minimum, all construction organization products should be numbered according to a preestablished system. The identifier should be unique to the project. To ensure traceability, construction may need to identify specific personnel involved in phases of the process. One way that personnel can be identified is through signatures on serially numbered documents.

4.9 Process Control

REQUIREMENT

In delivering its product — construction project management — the construction organization must identify, plan, and document its processes and activities that directly affect quality. In addition, those processes and activities must be controlled. To ensure sufficient control, the construction organization should

- ◆ know and comply with applicable Federal statutes, industry codes, environmental regulations, safety codes, and Army and USACE regulations;
- ◆ monitor the progress of projects against the project management and quality plans and resolve problems that arise (design errors, differing site conditions, etc.);
- ◆ manage qualifications of the contractors for its people, processes, and equipment;
- ◆ document construction management and contract administration procedures, specify suitable equipment, and indicate suitable work environments; and
- ◆ develop criteria for determining acceptable construction management performance.

GUIDANCE

Preventing problems by controlling processes is better than discovering problems after the project has been completed. To control processes, construction should consider

- ◆ conducting process capability studies (activity modeling or process simulation, for example) to evaluate the effectiveness of its processes and
- ◆ developing work instructions that “describe the criteria for determining satisfactory work completion and conformity to specification and standards of good workmanship.” Documented work instructions may specify, for example,
 - ▶ methods of accomplishing the work,
 - ▶ tools and equipment needed to perform the tasks,
 - ▶ sequences of activities,

- ▶ necessary review and approval requirements, and
- ▶ statistical sampling requirements, where appropriate.

4.10 Inspection and Testing

4.10.1 GENERAL

The construction organization must establish and maintain documented inspection and testing procedures for ensuring that the finished construction project conforms to the project management plan and to the project quality assurance plan.

4.10.2 RECEIVING INSPECTION AND TESTING

The Construction Division must make sure that the prime construction contractor validates all construction materials in accordance with the project management plan and quality assurance plan. (For civil works projects, the Construction Division may inspect, test, and approve incoming materials.) The validations may be physical tests or inspections or they may be process checks of documentation. Construction should ensure that no building materials are used until the validations defined in the project management plan or quality control plan are successfully completed. The construction organization may vary the nature and extent of validation according to the provisions of the quality assurance plan or the contractor's history.

Construction personnel must verify that off-site testing is being performed in accordance with the quality assurance plan or with the contractor's quality control plan and industry guidelines and must ensure that the test samples apply to the product to be supplied.

For building equipment or materials inspected off site, verification must be performed per element 4.6.4, *Verification of Purchased Product*. When the equipment or material is delivered, construction must validate that it is the same equipment or material examined and approved off site.

When construction uses materials before they are validated, it must document where they were used. For example, if it pours concrete before it receives compression test results, construction should document the location of that pour.

4.10.3 IN-PROCESS INSPECTION AND TESTING

Requirement

The construction organization must ensure that in-process facility testing and inspection are performed as required by the project management plan,

quality assurance plan, or the contractor's quality control plan; it should not permit the work to advance until the required testing and inspections have been completed and approved. For example, local inspections of electrical work may be necessary before walls can be closed. The exception is when work is released under positive recall procedures. The release under positive recall procedures, however, would not preclude the test and inspection steps required above.

Nonconforming work must be handled according to 4.13, *Control of Nonconforming Product*, and contract modifications for design errors or differing site conditions must be handled according to the construction contract, FAR, and FAR supplements.

Guidance

In-process inspection and testing applies to all forms of products. It allows nonconformities to be found early and resolved before finished facilities are released to the customer. Statistical control techniques can be used to identify process trends that are out of control and to prevent future problems (see 4.20, *Statistical Techniques*).

4.10.4 FINAL INSPECTION AND TESTING

When the construction contractor claims the facility is complete, the cognizant Construction Division personnel must carry out final test and inspection of the facility in accordance with documented procedures and with the project management and quality assurance plans. The customer and facility users also may conduct a final inspection. The final inspection and testing may include verifying that all earlier inspections and tests were performed in accordance with the plans and that the customer's originally stated contractual requirements have been satisfied.

4.10.5 INSPECTION AND TEST RECORDS

Requirement

Construction must establish and maintain records that indicate whether the construction product or facility component has passed in-process and final inspections and tests in accordance with the project management plan and the quality assurance plan. The records must identify the inspection authority responsible for releasing product. The records also may include the punch lists, local building and trade inspections, building certification forms, transfer deeds, and inspection logs.

Guidance

Records must be kept in accordance with element 4.16, *Control of Quality Records*. They will facilitate future assessments, including regulatory compliance and possible liability issues.

4.11 Control of Inspection, Measuring, and Test Equipment

4.11.1 GENERAL

Any Construction Division that uses in-house or field inspection and testing equipment must have documented procedures for controlling that equipment. Specifically, the construction organization should

- ◆ identify which measuring and test equipment must be controlled and calibrated;
- ◆ establish and maintain documented procedures to control, calibrate, and maintain any equipment used for inspecting, measuring, or testing construction elements that demonstrate conformance to established requirements;
- ◆ use any such equipment in a manner that ensures that measurement uncertainty is known and is consistent with the required measurement capability;
- ◆ check and recheck the capability of any test software or hardware used; and
- ◆ make technical data for any needed equipment available if required by the customer.

In addition, the construction organization must have documented procedures in place for the control of test laboratories used in house, by the general contractor, or by the subcontractors.

4.11.2 CONTROL PROCEDURE

Requirement

Any Construction Division that uses inspection and test equipment must identify necessary measurements; the accuracy required; the appropriate inspection, measuring, and test equipment needed; and test models to be used during inspection and validation processes. In addition, the construction organization must

- ◆ identify, calibrate, and adjust all equipment in accordance with the quality assurance plan, relevant American Society for Testing and Materials

(ASTM) standards, relevant military standards, and test equipment manufacturers' instructions;

- ◆ establish, document, and maintain calibration procedures;
- ◆ ensure that the equipment used is capable of the required accuracy and precision;
- ◆ be able to identify all test and measuring equipment as to its calibration status;
- ◆ assess the validity of previous results when equipment is out of calibration;
- ◆ ensure suitable conditions for calibration, inspection, measurement, and testing;
- ◆ ensure accuracy and fitness for use when handling, preserving, and storing equipment;
- ◆ safeguard inspection, measuring, and test facilities; and
- ◆ maintain calibration records.

Guidance

Guidance for the management of measuring equipment is provided in ISO 10012-1, *Quality Assurance Requirements for Measuring Equipment — Part 1: Management of Measuring Equipment*. However, that guidance does not add to or otherwise change the requirements in ISO 9002, except where conformance to ISO 10012-1 is required.

4.12 Inspection and Test Status

REQUIREMENT

The construction organization must have documented procedures for ensuring that the inspection and test status of each construction product is identified. In addition, the documentation must specify the persons responsible for verifying the product.

GUIDANCE

The status of a product may be categorized as follows:

- ◆ Not been reviewed

- ◆ Been reviewed and accepted
- ◆ Been reviewed and is on hold awaiting decision
- ◆ Been reviewed and rejected.

The status of each product should be identified using a computer data base or using such means as stamps, tags, notations, or review records that accompany the product. The most certain method of ensuring that the inspection and test status is quickly discernible, and to prevent inaccurate disposition, is to separate the products physically according to status category.

4.13 Control of Nonconforming Product

4.13.1 GENERAL

Requirement

Inadvertent use of a nonconforming product in any construction project must be minimized. The Construction Division must have documented procedures to ensure that deliverables or materials that do not conform to specified requirements are identified clearly so that they will not be used unintentionally. Where practical, the nonconforming construction deliverables or materials must be physically segregated.

When negotiated settlements are necessary, the responsible construction organization must involve the administrative contracting officer or contracting officer in accordance with the FAR.

All reworked products must be reinspected in accordance with the quality assurance plan.

Guidance

A nonconforming product, whether from the Construction Division or one of its contractors, is one that fails to meet the established or agreed-upon requirements or specifications. Use of the USACE deficiency tracking system will make meeting this requirement easier.

The procedure for controlling a nonconforming product should include the following steps:

- ◆ Identify the nonconforming product.
- ◆ Document the nonconformity.

- ◆ Evaluate the nonconformity.
- ◆ Consider alternatives for disposing of the nonconforming product.
- ◆ Physically control the movement, storage, and processing of the nonconforming product.
- ◆ Notify all activities that may be affected by the nonconformity.

4.13.2 REVIEW AND DISPOSITION OF NONCONFORMING PRODUCT

Requirement

Construction must define who is responsible for reviewing and authorizing the disposal of nonconforming products and must document its disposition.

Nonconforming construction products may be reworked, accepted without being reworked by concession of the customer, or rejected.

Guidance

As soon as indications occur that a product — whether materials, components, or a completed project — does not or may not meet the specified requirements, the Construction Division must review the nonconforming product to determine its disposition. The people who review nonconforming items should be competent to evaluate the effects of the decision of interchangeability, further processing, performance, reliability, safety, and aesthetics. A decision to accept a product should be documented, together with the reason for doing so, in authorized waivers, with appropriate precautions.

4.14 Corrective and Preventive Action

4.14.1 GENERAL

Requirement

Construction must establish and maintain documented procedures for implementing corrective and preventive actions that are appropriate to “the magnitude of problems and commensurate to the risks encountered.” Records must be kept of any changes to documented procedures that result from taking corrective or preventive action.

Note: Corrective action is directed toward eliminating the causes of existing nonconformities. Preventive action is directed toward eliminating the causes of potential nonconformities.

Guidance

This element explains what the Construction Division must do when things go wrong. Corrective and preventive actions are intended to enable the construction organization to eliminate the cause of any actual or potential nonconformity. Nonconformities can be analyzed by assessing records of inspection and testing, monitoring the process, and observing audits, among other available feedback methods. Corrective and preventive action procedures should include the following steps:

- ◆ Establish responsibility for taking corrective or preventive action
- ◆ Define how the action will be carried out
- ◆ Verify the effectiveness of the actions taken.

Corrective and preventive actions should address nonconformities with respect to the product, process, and system. Actions taken may require changes to the quality management system or to any of the processes or procedures used to manage a construction project.

4.14.2 CORRECTIVE ACTION

When corrective action is required, the construction organization must

- ◆ effectively handle USACE customer complaints and nonconformity reports,
- ◆ investigate and analyze the problem and record the results (nonconformities may be prioritized to determine which should be investigated further),
- ◆ determine the effective corrective action, and
- ◆ ensure that corrective actions are taken effectively.

Construction also must establish records of corrective actions taken (see 4.16, *Control of Quality Records*).

Note: The local level should evaluate quality assurance inspections and feedback from the deficiency tracking system; proper reporting and feedback will be necessary.

4.14.3 PREVENTIVE ACTION

When preventive action is required, the construction organization must

- ◆ use all available information, such as work processes, internal audit results, quality records, and customer complaints to detect, analyze, and eliminate potential causes of nonconformities;
- ◆ determine a method for preventive action;
- ◆ initiate preventive action and ensure that it is effective; and
- ◆ submit any relevant information on actions taken for management review (see 4.1.3, *Management Review*).

The construction organization also must establish records of preventive action taken (see 4.16, *Control of Quality Records*).

4.15 Handling, Storage, Packaging, Preservation, and Delivery

When projects require GFE or customer-supplied products, the Construction Division must have documented procedures that define the proper handling, storage, packaging, preservation, and delivery of those products under the construction organization's control. Typically, the procedures should address technical and ASTM specifications and GFE regulations. Storage requirements must address the maintenance of test samples. Preservation requirements for long-term storage should be identified from relevant technical specifications.

The requirements of this element are not applicable to those Construction Divisions that do not use GFE or customer-supplied products.

4.16 Control of Quality Records

REQUIREMENT

The construction organization must have documented procedures for creating, maintaining, distributing, using, and disposing of all quality system records. Those records may be in the form of paper, electronic media, or photographs. All quality records must be legible and identifiable to the project involved. The procedures must specify the people responsible for the records management system, types of records to be maintained, system security, retrieval procedures, retention intervals, means of disposal, and a system for making quality records available to customers and auditors. Records management must be in accordance with the Modern Army Record Keeping System (MARKS).

GUIDANCE

Quality records should, at a minimum, consist of

- ◆ all project-specific documents and outputs,
- ◆ project management and quality assurance plans,
- ◆ contract review agreements,
- ◆ construction contract claims,
- ◆ inspection and test results,
- ◆ internal quality system audits and management review results,
- ◆ measuring and test equipment calibration results,
- ◆ personnel training records, and
- ◆ records of corrective and preventive actions taken.

The need for quality records is referred to throughout ISO 9002. The purpose of having quality records is to demonstrate required quality and the effectiveness of the quality system. Effective quality records contain evidence to demonstrate whether the construction organization's product meets the established requirements. The records may be stored in any suitable form as long as they are readily accessible, either as hard copy or on electronic media, and should be kept as specified by contract or regulation.

Sometimes customers may require the Construction Division to store and maintain selected records that attest to the quality of products for a specified part of the operating lifetime. Construction must be able to provide such documents to the customer, as required.

4.17 Internal Quality Audits

REQUIREMENT

The construction organization must establish and maintain documented procedures for comprehensive and systematic (planning, performing, reporting, and follow-up) quality system audits. The audits must be carried out by properly trained and authorized personnel whose regular responsibilities are outside of the area being audited. The audits must be effectively scheduled according to the status and importance of the activity, and records of the findings and follow-up actions must be maintained. The procedures for quality audits must make sure that responsible personnel are notified of any deficiencies so that they can

take timely corrective action. The results of that corrective action must be recorded, and its effectiveness noted in follow-up internal audits.

GUIDANCE

Internal quality audits are the mainstay of quality system conformance and a powerful tool that will enable continuous improvement. The purpose of internal audits is to ensure that the construction organization's quality system is working according to its documented plan to meet customer requirements, to comply with regulatory requirements, and to provide opportunities for improvement.

Normally every area should be audited at least annually; areas consistently having problems should be audited more often. A full audit plan should be developed and documented; the plan should include details for the corrective and preventive systems. Within the construction organization, members of one branch may audit another, and members of a project team may audit another project team. Under no circumstances should a branch chief audit any area under his or her responsibility, nor should a project engineer audit a project under his or her control.

4.18 Training

REQUIREMENT

The construction organization must have documented procedures to identify training needs for every member of its staff. Construction must make sure that all of its personnel are effectively trained to carry out their responsibilities in a way that is consistent with the documented quality system. The documented training program should teach quality and quality management issues to all personnel directly affecting the quality of products, reconcile needed skills with skills possessed by every member of the organization, be adequately funded, evaluate the effectiveness of the training, and conduct posttraining assessments. Records of employee training and training status must be kept.

GUIDANCE

Training is essential to achieving quality results. The construction organization should utilize the training system already established by the Army's Individual Training Program (IDP) and follow the broad career development guidance established by USACE headquarters. Within that program, training within the construction organization should encompass the use of, and underlying rationale for, the quality management approach of the organization. In the training process, the construction organization should

- ◆ evaluate the education and experience of all personnel;

- ◆ identify individual training needs by job function;
- ◆ provide the appropriate needed training, either in-house or externally;
- ◆ record training progress and keep records up to date to identify training needs;
- ◆ encourage development and maintenance of industry-specific expertise, particularly when that expertise is critical to ongoing project work; and
- ◆ encourage professional registration and certifications.

Construction should consider training people at all organizational levels performing activities affecting quality. The training should include newly recruited personnel and personnel transferred to new assignments. Executives and managers also require training in the understanding of the quality system and the tools and techniques needed to operate the system.

4.19 Servicing

Where specifically required by a project management plan or quality assurance plan, the Construction Division must establish documented procedures addressing the requirement for postconstruction servicing (e.g., maintenance, warranty, financial, and legal services).

4.20 Statistical Techniques

4.20.1 IDENTIFICATION OF NEED

Requirement

The construction organization must determine the need for statistical techniques in the various parts of the construction project management life cycle.

Guidance

Statistical techniques can be useful for nearly every aspect of an organization's operation. Among the statistical techniques that may be appropriate in the construction organization are the following:

- ◆ Sampling inspection of materials
- ◆ Graphical methods to help diagnose problems
- ◆ Histograms and Pareto analysis to establish priorities for nonconforming investigations

- ◆ Regression analysis to provide quantitative models for a process
- ◆ Measurement of quality system goals and objectives
- ◆ Network analysis of claims for effectively negotiating impact of time delays.

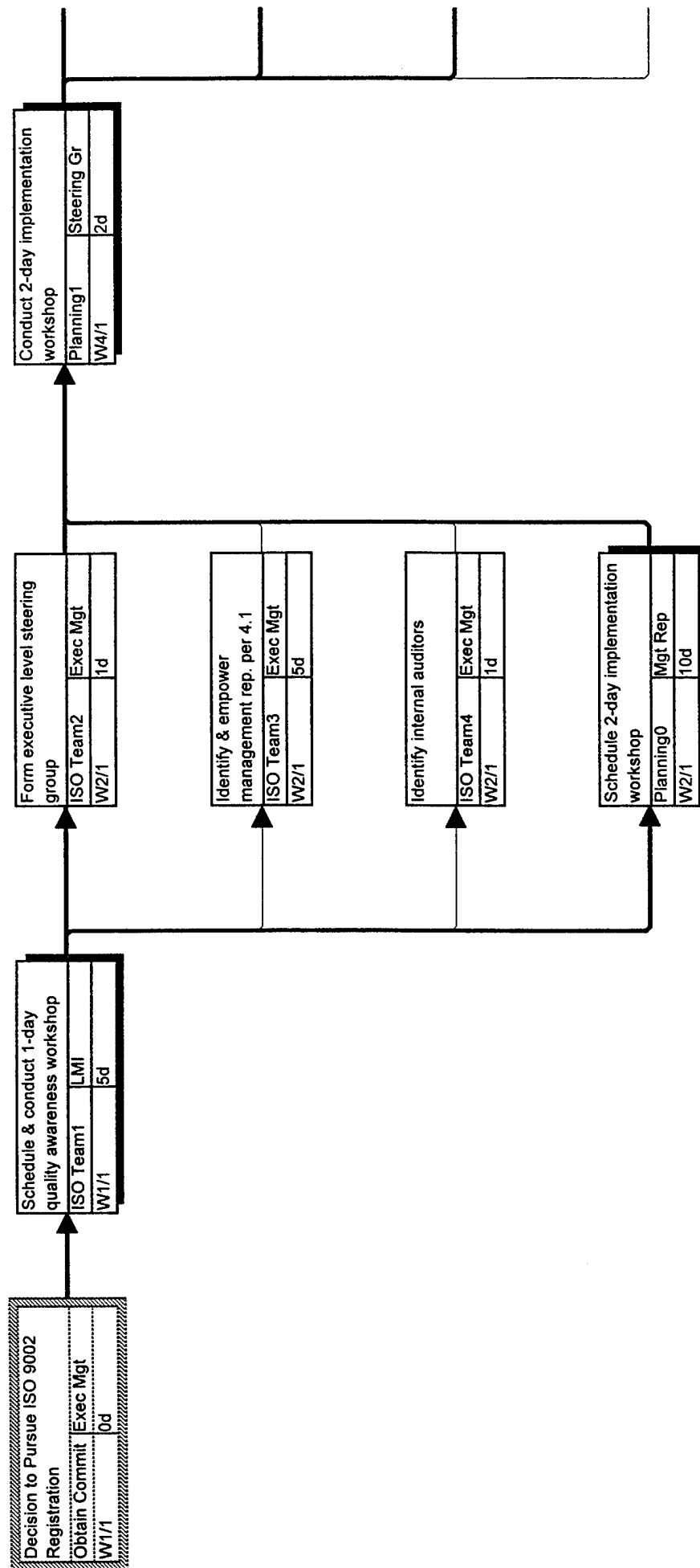
4.20.2 PROCEDURES

The Construction Division must have documented procedures for implementing needed statistical techniques. The documentation may include references to the quality assurance plans.

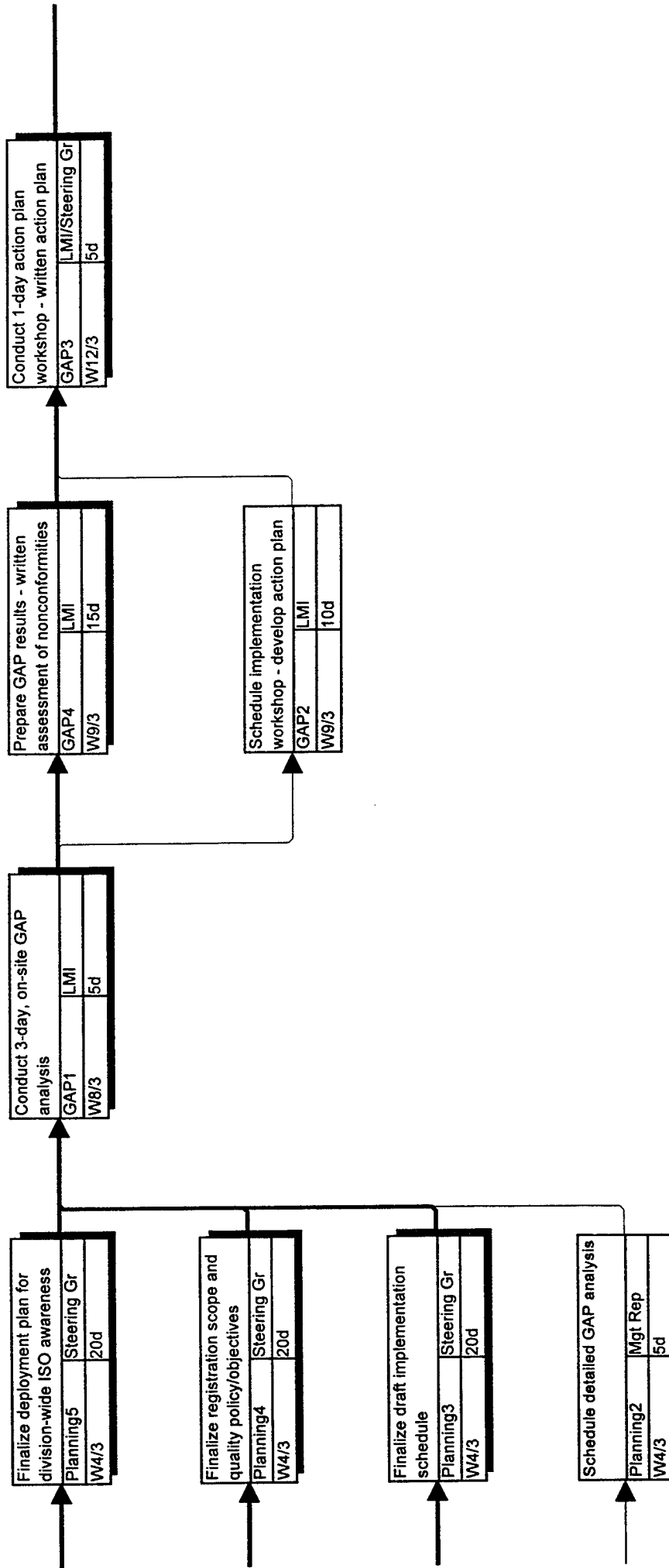
APPENDIX D

Critical Path Network of ISO 9002 Implementation Process

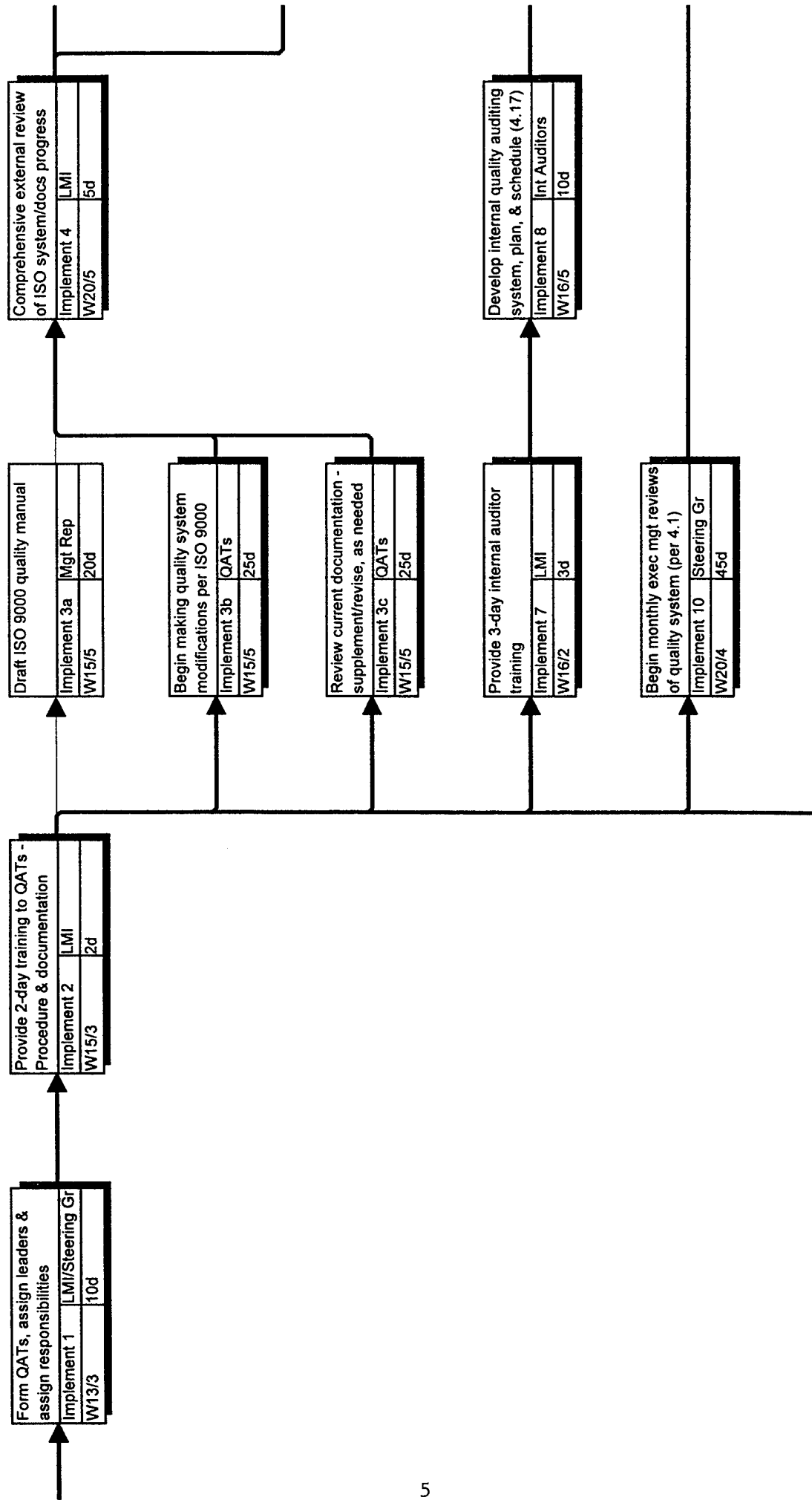
ISO 9002 Implementation Schedule - USACE Construction Divisions



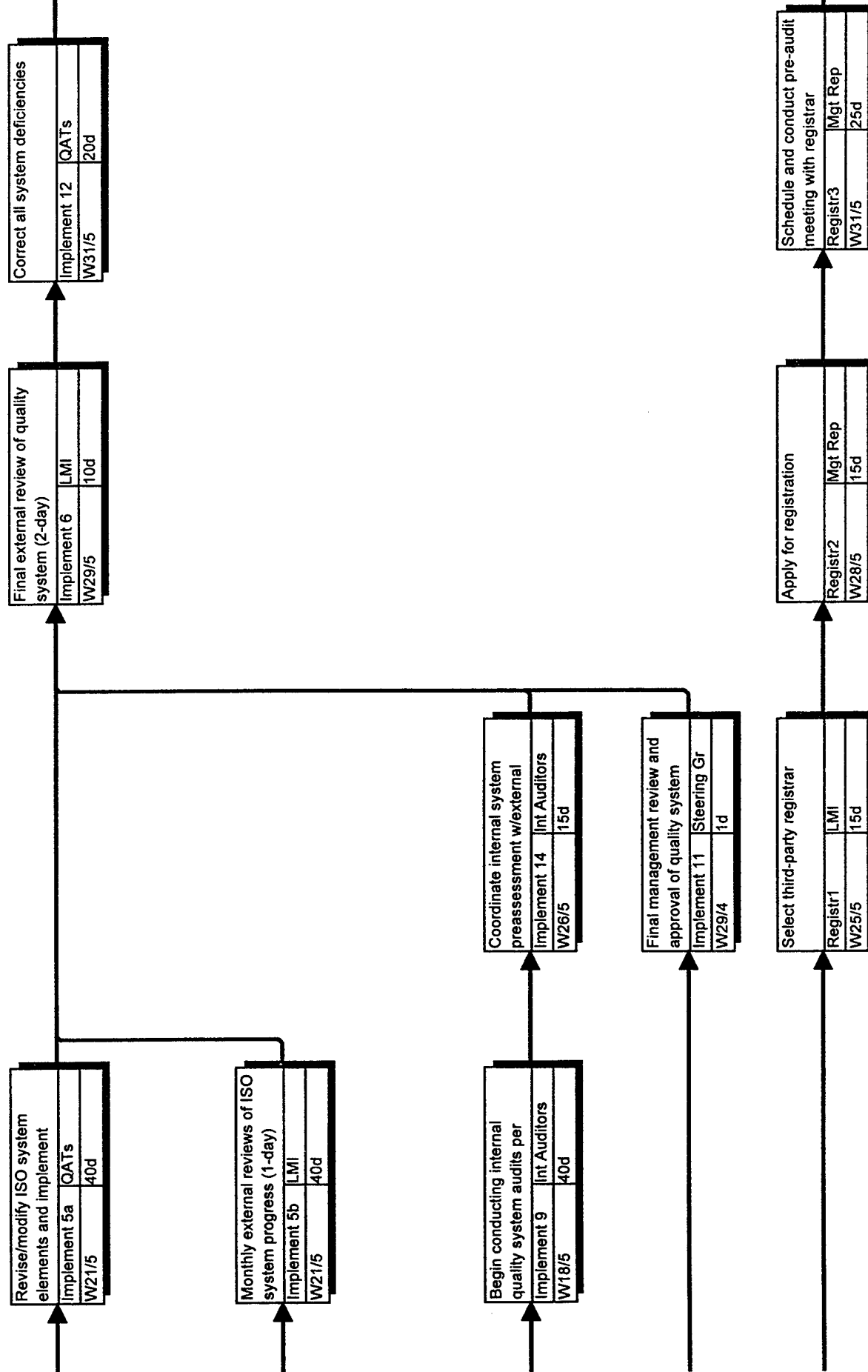
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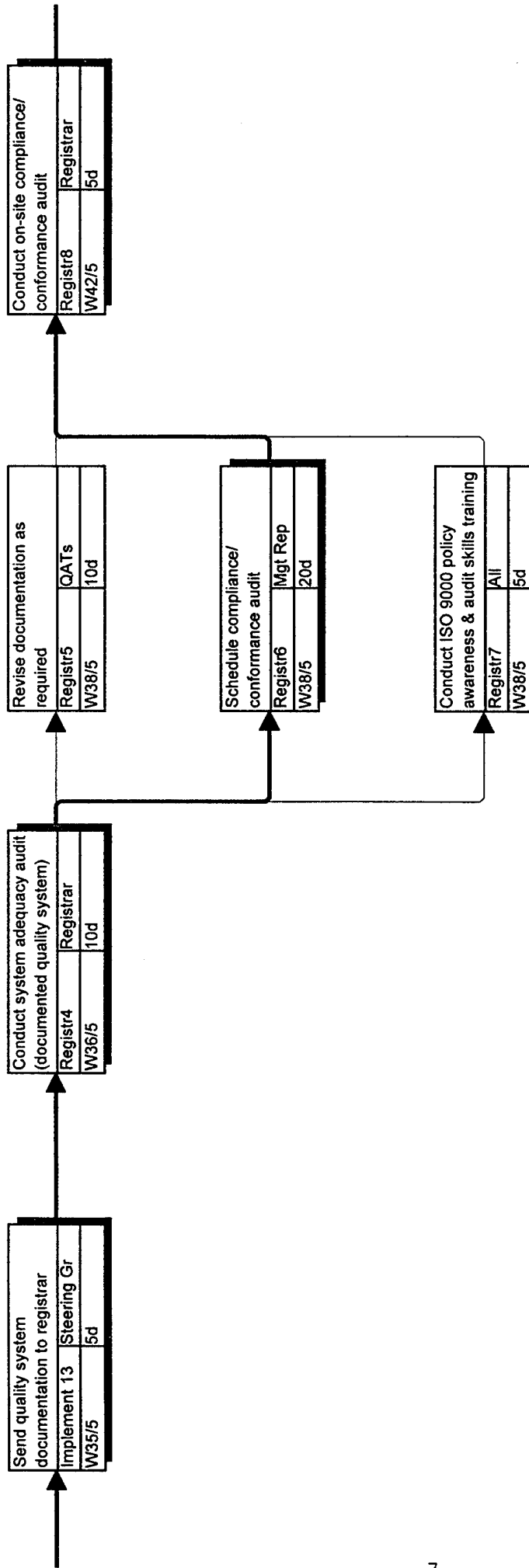
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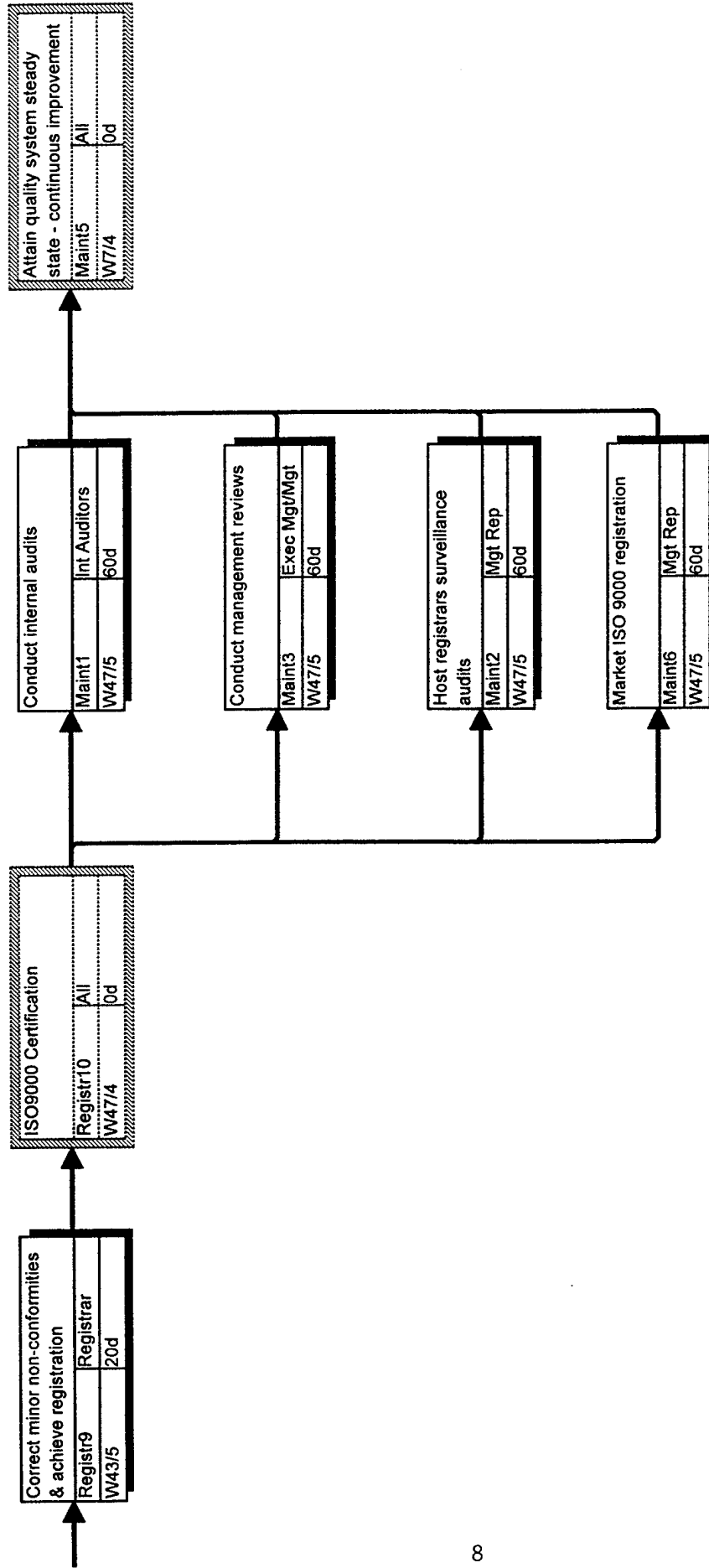
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Project:
Date: 10/30/95

Text1	
Name	Text2
Start	Duration

Critical

Noncritical

Summary

Subproject

Marked

Critical Milestone

Noncritical Milestone

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