QUALITY IN THE CONSTRUCTED PROJECT

A GUIDE FOR OWNERS, DESIGNERS, AND CONSTRUCTORS

THIRD EDITION
A manual or report in this series consists of an orderly presentation of facts on a particular subject, supplemented by an analysis of limitations and applications of these facts. It contains information useful to the average engineer in his or her everyday work, rather than findings that may be useful only occasionally or rarely. It is not in any sense a “standard,” however; nor is it so elementary or so conclusive as to provide a “rule of thumb” for nonengineers.

Furthermore, material in this series, in distinction from a paper (which expresses only one person’s observations or opinions), is the work of a committee or group selected to assemble and express information on a specific topic. As often as practicable, the committee is under the direction of one or more of the Technical Divisions and Councils, and the product evolved has been subjected to review by the Executive Committee of the Division or Council. As a step in the process of this review, proposed manuscripts are often brought before the members of the Technical Divisions and Councils for comment, which may serve as the basis for improvement. When published, each work shows the names of the committees by which it was compiled and indicates clearly the several processes through which it has passed in review, in order that its merit may be definitely understood.

In February 1962 (and revised in April 1982) the Board of Direction voted to establish a series entitled “Manuals and Reports on Engineering Practice,” to include the Manuals published and authorized to date, future Manuals of Professional Practice, and Reports on Engineering Practice. All such Manual or Report material of the Society would have been refereed in a manner approved by the Board Committee on Publications and would be bound, with applicable discussion, in books similar to past Manuals. Numbering would be consecutive and would be a continuation of present Manual numbers. In some cases of reports of joint committees, bypassing of Journal publications may be authorized.
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The third edition of this very important ASCE manual is dedicated to James W. Poirot, P.E., President of ASCE in 1994 and principal advocate for the material contained in this manual.

In November 1984, nearly 100 members of the design and construction industry convened for a workshop in Chicago to discuss ways of attaining quality in planning, design, and construction. Those attending agreed on several related points. First, accidents, design flaws, cost overruns, and other similar problems were occurring at a serious rate. The collapse of two suspended walkways in the Kansas City Regency in 1981, killing 114 and injuring 185, was one of the more recent tragic incidents. But not all incidents or problems were as serious or as widely publicized as the Regency. Losses measured in dollars without loss of life were also serious concerns that were addressed.

It was agreed that the American Society of Civil Engineers, the principal sponsor of the Chicago workshop, should develop and publish a comprehensive guide to quality in design and construction (Manual of Professional Practice for Quality in the Constructed Project). James Poirot volunteered to lead the steering committee, which consisted of 40 authors and some 90 reviewers from throughout the industry—a daunting task.

Thanks to Poirot’s determination and leadership the task was successful and led to the initial publication of the preliminary edition for trial use and comment in 1988. His work remains as the very substantial foundation for this third edition.
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The idea for this Guide arose during a series of meetings in 1983–1985 among leaders of the design and construction industry who convened to discuss opportunities to improve quality in constructed projects. The group decided that the American Society of Civil Engineers (ASCE) would develop and publish a guide with information and recommendations geared toward helping people improve the quality of the projects they own, design, and/or construct.

In 1987, ASCE published a Preliminary Review Draft of the Guide that was distributed to more than 1,000 professionals, including owners, design professionals, constructors, agency personnel, legal experts, educators, and others. Their comments were addressed and incorporated into a Trial Use and Comment Edition, published in 1988 and purchased by more than 15,000 people in the construction industry. The Trial Use and Comment Edition yielded approximately 1,500 additional comments, which were addressed in the First Edition, published in 1990. In 1997, ASCE appointed a committee to update the Guide for the Second Edition, which was published in 2000.

The Second Edition carried on the originators’ intent that the Guide be a living document. The Committee to Update Manual 73 worked with authors to produce four new or entirely rewritten chapters that address important industry changes during the period 1990 to 2000:

- “Project Delivery Systems” (Chapter 3);
- “Computers and Project Quality” (Chapter 21);
- “Partnering” (Chapter 24);
- “Value Engineering” (Chapter 25).

In addition, reviewers updated the existing chapters from the First Edition. The new and updated chapters were reviewed by representative groups of owners, design professionals, and constructors. The entire Guide was then reviewed by the appointed committee, 13 professional associations, a forum of legal experts, and a peer review team. Altogether, more than 125 industry professionals participated in producing the Second Edition.

The Second Edition also included new features to increase the day-to-day utility of the Guide, including summaries of project participant activities for each chapter, a page layout format to provide space for notes, more references to relevant publications and Internet resources, and Internet links to the latest editions of standard-form contract documents.
This Third Edition maintains the features of the Second Edition and provides relevant information developed since the publication of the Second Edition. More than 50 industry professionals have participated in producing the Third Edition.

This Guide is written primarily for the three principal project participants in a traditional design-bid-build (DBB) project—the owner, design professional, and constructor. It is also intended to be valuable to other project participants, including regulatory agency staff, subcontractors, subconsultants, and suppliers, as well as educators and students. Topics are organized in approximate project chronology, beginning with the owner’s role and the selection of a project delivery system, the selection of other team members, design, construction, start-up, and operations and maintenance.

This Guide also highlights areas in which alternate forms of project delivery, such as design-build, may shift project responsibilities and risks to different participants. In cases where the Guide describes functions that would typically be performed by many people on larger projects, the reader may infer that these functions may be carried out by one person or a few people on smaller projects.

This Guide is not a substitute for the exercise of good judgment by the owner, designer, and constructor, nor should the procedures suggested in any way affect the specific contractual provisions governing a particular project. Users of this Guide are advised to consult knowledgeable and experienced legal counsel concerning the subjects addressed herein.

ASCE will continue to revise this Guide at appropriate intervals; comments are welcome at any time. Please address comments in writing to the Construction Institute, ASCE, 1801 Alexander Bell Drive, Reston, VA 20191, or via the Internet at ci@asce.org.
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EXECUTIVE SUMMARY

This Guide discusses principles and procedures that, in the experience of the authors and reviewers, are effective in achieving quality in constructed projects. It is written for project owners, design professionals, and constructors. Other project participants, such as regulatory agency personnel, subcontractors, subconsultants, and suppliers, may also find this guide useful. The material focuses on the typical requirements, responsibilities, roles, relationships, and limits of authority of the principal participants in constructed projects.

In this Guide, the principal members of the project team are the owner, design professional, and constructor. Topics are generally approached from the perspective of traditional design-bid-build (DBB) project delivery, the widely used form of contracting under which the design professional and the constructor are individually bound to the owner and their respective responsibilities specified by separate contractual agreements.

On some projects, alternate forms of project delivery, such as design-build (wherein a single entity performs both design and construction) can enhance overall quality. Therefore, while this Guide usually discusses project activities from the DBB perspective, it also notes instances under alternate forms of project delivery in which team members may be responsible for tasks other than, or in addition to, those described.

Given its broad intended use, this Guide is an “aspirational” document with the goal of educating users and stimulating them to identify areas where they may raise the quality level of their involvement in the design and construction process. This Guide is not a technical standard, nor a compilation of standard industry practices.

Quality is defined as the delivery of products and services in a manner that meets the reasonable requirements and expectations of the owner, design professional, and constructor, including conformance with contract requirements, prevailing industry standards, and applicable codes, laws, and licensing requirements.

Responsibilities refer to the tasks that a participant is expected to perform to accomplish the project objectives as specified by contractual agreement and applicable laws, codes, standards, and regulatory guidelines.

Requirements are what each team members expects to achieve or needs to receive during and after their participation in a project.
This definition of quality hinges on the degree to which the requirements of project participants are met. Therefore, this Guide focuses on practices and procedures that encourage participants to express their requirements with clarity.

**PROJECT ORGANIZATION**

A successful project begins with the owner. As the first member of the project team, the owner identifies the need for a project, establishes the main goals, selects the other team members, defines the basic allocation of risk among project participants, and communicates the project goals to the other team members. The owner also secures funding and pays for the services of the other participants.

In the early stages of project development, the owner is responsible for a fundamental decision: the selection of an appropriate project delivery system. While DBB remains the predominant system for organizing a project team, other forms of project delivery may better meet the owner’s needs, including the following:

- **Owner-provided.** The owner performs all design activities and acts as a general contractor, hiring construction subcontractors as needed.
- **Program manager.** The owner hires a single entity to extend owner capabilities in planning, design, and/or construction management to complete the project.
- **Design-build.** The owner hires a single entity to complete both design and construction.
- **Construction manager at risk.** The owner retains a contractor to provide pre-construction services during the project design period and to act as a general contractor to construct the project after the design is completed, or as the design progresses to completion.
- **Design-build variations.** The owner hires a design-builder who may also share the project’s financial risk and/or operate the constructed project for a specified period before turning the facility over to the owner.

Fast-tracking is not a form of project delivery. Rather, it is a management strategy that can be utilized within the delivery systems listed above in which the construction of underlying elements begins before design is complete for elements that are to be built later. Fast-tracking is most commonly undertaken on design-build projects (see 3.6 “Fast-Tracking: A Distinction”).

The coordination of project activities under any method of delivery is essential to project quality. Coordination depends on the ability of participants to tailor their communications to the project delivery system being used.

To help improve the quality of decisions during the early stages of a project, the owner may engage the design professional before specific objectives have been developed to acquire additional planning expertise in project conceptualization, design, and construction. The owner may further enhance the effectiveness of early project decision making by seeking advice on legal, insurance, financial, real estate, land use, and other matters, in addition to procuring design and construction services.
SELECTING THE DESIGN PROFESSIONAL

The owner’s criteria and process for selecting the design professional (or design-builder) have a major impact on project quality. A professional services agreement (PSA), negotiated by an owner and a design professional and reached through qualifications-based selection (QBS) procedures, provides the most flexibility in exploring solutions to design problems. This ultimately helps control project cost and improve quality. Under the QBS process, the owner:

- Establishes a procedure for requesting and evaluating the qualifications of interested design professionals;
- Receives and evaluates the qualifications of design professionals and develops a short list of candidates to design the project;
- Solicits proposals from short-listed design professionals and selects the design professional submitting the proposal that is most responsive to the selection criteria;
- Confers with the selected design professional to determine the scope of the work;
- Negotiates the owner–design professional agreement with the selected design professional, based on the mutually developed scope of work.

The PSA defines the roles and responsibilities of each party, the project objectives, the scope of services that the design professional is to provide, compensation, project budget and schedule, risk allocation, and other contractual matters. It is in the interest of each party to express their understandings and requirements in the agreement, as it governs the activities of those who sign it, as well as others who will provide the design services. Standard-form professional service agreements often provide a good initial framework for individual agreements. A legal review of the contract terms and language is in the best interest of all parties.

In some cases (typically public-sector projects), owners may use competitive low bidding or a two-envelope selection system to procure design services. These systems offer less flexibility in addressing design issues as a project evolves and neglect life-cycle cost analysis.

DEVELOPING THE PROJECT DESIGN

After signing the PSA, the owner and design professional develop a conceptual design that meets the owner’s project goals. Sometimes known as alternative investigation (or pre-design), this phase of the project includes:

- Amplifying and refining the previously stated project goals;
- Developing specific objectives to meet those goals;
- Formulating and studying conceptual alternatives to meet the objectives;
- Selecting the most favorable alternative;
- Completing project conceptualization;
- Developing preliminary facility layouts and other design criteria;
- Developing preliminary cost estimates;
- Documenting these activities to guide the design effort.

➤ Chapter 6, “Selecting the Design Professional”

➤ Chapter 7, “Agreement for Professional Services”

➤ Chapter 8, “Alternative Studies and Project Impacts”
The design professional is typically responsible for studies, project planning, reports, and other activities, as specified by the agreement and directed by the owner. Technical specialists may be engaged for particular tasks, such as geotechnical exploration, noise and air quality analysis, water quality studies, and other activities. The owner is responsible for reviewing and approving the design professional’s end product, usually known as a preliminary design report.

**DESIGN ACTIVITIES**

In DBB contracting, the design professional, acting under the terms of the PSA, is usually responsible for producing the completed design for the owner’s approval. The services to be provided by the design professional are documented in the project plans and project specifications, cost estimates, and other construction contract documents used in the selection of the constructor and procurement of construction services. The design professional presents the completed documents to the owner and the owner’s legal advisers for review and approval.

The design professional follows the preliminary design report approved by the owner for the planning and execution of the design effort and is primarily responsible for design phase activities, which typically include:

• Planning and managing the design;
• Maintaining coordination and communication among design discipline leaders and other team members during design;
• Monitoring and controlling design costs and schedule;
• Developing estimated construction costs;
• Developing the anticipated construction schedule;
• Providing qualified staff;
• Performing design-related quality control functions;
• Arranging for appropriate design reviews, constructability reviews, operability and maintainability reviews, and peer reviews.

The design professional is responsible for providing services in a manner that complies with local, state, and federal laws and applicable codes of ethics. In addition, the design professional can make a substantial contribution to project quality by addressing sustainable development concerns and incorporating features to reduce impacts on natural resources, the environment, and future users.

**PLANNING FOR CONSTRUCTION**

The key aspects of pre-construction planning include the assessment of the owner’s capabilities, the evaluation of resources available for construction, compliance with regulatory laws and guidelines, the completion of necessary site preparation, and the review of construction alternatives and contractual arrangements. These planning activities aid the owner in setting up an effective field organization.
SELECTING THE CONSTRUCTOR

As the pre-construction and design phases conclude, the central project activity (under DBB) becomes the selection of the constructor. The design professional may assist the owner in evaluating constructor bids, but the owner is responsible for choosing the constructor. Procedures for selecting the constructor range from structured public bidding, to priced or best value proposals, to selection based on constructor qualification or on favorable past performance and/or relationships with the owner.

The most important steps in the selection process are the constructor’s presentation of qualifications to demonstrate an ability to perform under the conditions of the contract and the evaluation of these qualifications by the owner and design professional. Constructor competition based on qualification may lead to a negotiated contract with the owner; it may place the constructor on a short list of invited bidders; or it may pre-qualify the constructor to bid on one or more public projects.

One of the key tasks of the design professional during the selection of the constructor is the preparation of the bidding package for the owner’s approval. The package contains both the contract documents that define the project and the procedures for submitting competitive bids or proposals. The design professional may also assist the owner in administering the bidding process, evaluating bids or proposals received, and preparing the contracts.

THE CONSTRUCTION CONTRACT

After the constructor is selected, the construction contract documents become the basis of understanding between the owner and constructor. The contract package usually includes the owner-constructor contract, general and supplementary conditions, project drawings and project specifications, addenda issued before bid closing, the constructor’s bid, notice of award, performance and payment bonds, insurance certificates, and contract change orders issued as construction proceeds. The constructor is responsible for performing in accordance with the terms of the contract and for constructing the project as described in the documents.

MANAGING CONSTRUCTION, SUBMITTALS, AND CONTRACT ADMINISTRATION

The constructor takes on a major role as construction begins. The constructor’s activities include determining the means, methods, and sequencing of construction; managing and paying subcontractors and suppliers; initiating and maintaining quality control for construction activities; and meeting applicable codes, permit requirements, and other public agency regulations. The owner takes an active role in promoting site safety by assigning overall project safety responsibility and authority to a specific organization or individual (often the constructor) that is qualified in construction safety principles, rules, and practices appropriate for the particular project (see ASCE Policy Statement 350, “Construction Site Safety”).

Chapter 13, “The Construction Team”

Chapter 14, “Procedures for Selecting the Constructor”

Chapter 15, “The Construction Contract”

Chapter 16, “Planning and Managing Construction”
The constructor ultimately depends on the owner for the review and approval of completed construction. The owner, in turn, may delegate certain construction-period administrative responsibilities to the design professional. Though under traditional DBB contracting the design professional has no contractual relationship with the constructor, the design professional is often actively involved in construction administration activities under the terms of the owner–design professional agreement. These activities typically include providing technical services, clarifying contract documents, and reviewing change orders and submittals, as well as reviewing and approving completed construction on behalf of the owner.

The constructor is usually required to submit information for review and approval by the owner and the design professional (if so designated by the owner). Known as submittals, this information may include:

• Contract compliance documentation;
• Schedules;
• Quality control plans;
• Cash-flow estimates;
• Health and safety plan;
• Structure of lump-sum bid items;
• Structural component shop drawings;
• Equipment shop drawings;
• Mechanical and electrical component shop drawings;
• Performance data for equipment assemblies;
• Drawings for temporary construction;
• Vendor and material submittals;
• Results of independent testing.

The preparation and initial approval of submittals is the responsibility of the constructor, assisted by supporting suppliers, equipment manufacturers, and subcontractors, including detailers and fabricators. The owner, often with the aid of the design professional, is responsible for reviewing and approving the constructor’s submittals for the limited purposes stated in the contract documents. The design professional and constructor may assign responsibilities to their respective subconsultants or subcontractors and agree on procedures and communication to facilitate the smooth flow of submittals.

In administering the construction contract, the owner is responsible for fulfilling contractual obligations to the constructor and focusing on issues that directly affect project quality, particularly those related to the quality of materials, craftsmanship, and safety. The owner may assign selected contract administration responsibilities to the design professional. However, construction contract administration does not extend to actually managing the construction, which is the responsibility of the constructor.

**OPERATIONS AND MAINTENANCE**

The successful operation and maintenance (O&M) of a completed project are derived from and closely associated with the level of quality in the design and construction process. Even if design and construction proceed smoothly, overall quality may suffer if the project is costly or cumbersome to operate and maintain. O&M characteristics affect a project’s service reliability, durability, efficiency, and life-cycle costs, as well as the environment, public health, user safety, and other external aspects of the completed project.
OTHER ASPECTS OF PROJECT QUALITY

In addition to the activities above, this Guide provides information on several topics that do not fit neatly into a chronological discussion of constructed project activities, yet are crucial to project quality. These are described below.

Quality Assurance and Quality Control (QA/QC)

Project quality is the result of aggressive and systematic quality assurance activities by the owner and quality control efforts by the designer and constructor. QA/QC measures include the following:

- **The Owner** may supply project-specific quality standards to the design professional and constructor or require that each adapt their typical QA/QC procedures to the project;
- **The Design Professional** implements a project QC plan addressing staff needs, communication, design procedures, reviews, the use of specialty advisors, and other concerns;
- **The Constructor** implements a project QC plan addressing personnel, materials, communication, scheduling, cost control, reviews, project environment, safety, and other concerns.

Computers

Computers improve productivity by automating office and design tasks and improving coordination capabilities for the entire team. Powerful desktop and portable computers, networks, e-mail, and the Internet have transformed the way construction industry professionals can work together. Among their many functions, computers aid the owner in managing project activities and operating the completed project, provide the design professional with computer-aided design and drafting capabilities, and offer the constructor greater flexibility in calculating quantities of materials, scheduling, and overall project management.

Peer Review

The peer review is an independent critique of a project conducted by a team of seasoned engineering or construction professionals with the goal of offering a fresh, unbiased look at the functioning of an organization or a clearly specified area of a particular project’s design. While peer reviews do not focus exclusively on costs, they often generate savings by identifying ways to reduce schedule requirements and/or improve the quality of project elements.

Risk, Liability, and Handling Conflict

All constructed projects involve risks. These risks may be grouped in four general categories: safety, financial, professional, and legal. Participants benefit from identifying potential risks and liabilities, developing a clear and fair plan to allocate and manage them, and securing insurance (where appropriate) before making commitments to other parties. While disagreements are natural in work situations, the selection of mature team members, the alignment of common interests, and the fair allocation of risk can help minimize the adverse impacts of conflict.
Partnering

Partnering can enhance project quality by improving relationships among team members. It emphasizes mutually beneficial problem solving, improves risk management, helps reduce claims and cost overruns, increases general job satisfaction, and reduces litigation. Partnering helps develop good working relationships by creating an atmosphere of respect and trust. Partnering is sometimes known as “dispute avoidance.”

Value Engineering

Value engineering (VE) is a structured, utilitarian methodology for reviewing and enhancing project design. VE involves a unique and detailed process, known as function analysis, that gauges the value of individual project elements. The goal of the VE process is to identify alternatives that will maximize the relationship of function, performance, and quality to cost.

SUMMARY

Quality in the constructed project is achieved when the project team works together to fulfill their responsibilities to complete the project objectives in a manner that satisfies the requirements of each participant.

The agreement between the owner and design professional, and the contract between the owner and constructor, are the cornerstones of project quality. The process of developing these documents provides a structured forum for participants to express their requirements and align their interests. As a project proceeds, these documents are a key source of understanding for project objectives and the responsibilities of each team member. The level of project quality is directly related to the clarity with which the team members understand and express their requirements.

This Guide benefits from the experience and input of hundreds of industry professionals from a wide range of owners, designers, and constructors. The information and recommendations presented here are intended to aid users in developing an approach to their work and practice that meets their individual needs, as well as the objectives of particular projects in which they may be involved.
The purpose of this Guide is to provide project owners, design professionals, and constructors with information and recommendations on opportunities to enhance the quality of constructed projects.

While written for these three traditional project participants, this Guide is also intended to be useful to others who are involved in project design and construction, including subcontractors, vendors, operations and maintenance personnel, inspectors, and project users. Additionally, the information in this Guide may be of value to government officials, educators, students, legal professionals, and general readers with an interest in design and construction.

Given its broad intended use, this Guide is an “aspirational” document with the goals of educating and stimulating users to identify areas where they may raise the quality level of their practice. This document is not a technical standard, nor a compilation of standard industry practices.

Users should not infer that simply following the practices discussed herein will automatically result in improved project quality. Many other factors, some beyond the control of the project team, can affect project outcomes. Project participants are therefore encouraged to modify or vary the processes described in this Guide to achieve the desired quality results for specific projects.

1.1 THE MEMBERS OF THE PROJECT TEAM

Under traditional design-bid-build (DBB) project delivery, the project team consists of three principal participants: the owner, design professional, and constructor. Under alternate forms of contracting, the team may include a design-build contractor (performing the roles of both the design professional and constructor), a construction manager, a consulting design professional, a private developer, and/or other participants. While this Guide is written primarily from the DBB perspective, the authors and reviewers have addressed considerations related to other forms of project delivery, such as design-build or owner-provided, where appropriate.

The choice of the word “team” to describe the project participants highlights the desirability of cooperative relationships. Individually and collectively, participants control quality and benefit from its being achieved.