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QUALITY in the CONSTRUCTED PROJECT

A Guide for Owners, Designers, and Constructors

Second Edition



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MANUALS AND REPORTS ON ENGINEERING PRACTICE NO. 73

QUALITY IN THE CONSTRUCTED PROJECT

A GUIDE FOR OWNERS, DESIGNERS, AND CONSTRUCTORS

SECOND EDITION

ASCE

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Abstract

This Second Edition of *Quality in the Constructed Project: A Guide for Owners, Designers, and Constructors* (ASCE Manual No. 73) provides information and recommendations on principles and procedures that are effective in enhancing the quality of constructed projects. This Guide discusses the roles, responsibilities, requirements, and limits of authority of participants in the design and construction process, highlighting concepts and practices that are valuable to each in achieving project goals and objectives. This Guide presents several key themes, including the value of clearly defining and assigning responsibilities, the importance of teamwork, the need for clear contractual provisions, strategies for good communication, the owner's selection process for other team members, the potential benefits associated with various project delivery systems, and procedures for managing design and construction.

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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 everyday work. It is not in any sense a "standard," nor is it so elementary or conclusive as to provide a "rule of thumb" for non-engineers.

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In February 1962 (and revised in April 1982) the Board of Direction voted to establish:

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87	Urban Runoff Quality Manual
88	Management of Water Treatment Plant Residuals
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PREFACE TO THE SECOND EDITION

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, to be published in 2000.

This Second Edition carries 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 last decade:

- "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 have participated in producing the Second Edition that is before you.

This Second Edition also includes 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 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 Professional Practices Division, ASCE, 1801 Alexander Bell Drive, Reston, VA 20191, or via the Internet at www.asce.org. ❑

ACKNOWLEDGMENTS

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Legal Review Forum

Robert Rubin, Chair, Postner & Rubin
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ASCE Staff

Gretchen Hyde, Manual 73 Administrator

Editor

David Elvin, Elvin Strategic Writing, Inc.

Contributing Authors

John Belvedere, P.E., CH2M Hill, Inc.
Sue Dyer, Orgmetrics
Paul H. Gilbert, P.E., N.A.E., Parsons Brinckerhoff International, Inc.
Howard B. Greenfield, P.E., CVS, Lewis & Zimmerman Associates, Inc.
John F. Hill, AIA, Systems Management Consultants
Charles Hodge, Boyle Engineering Corporation
Michael P. Ingardia, P.E., Systems Management Consultants, Inc.
Muthiah Kasi, Alfred Benesch & Company
Roger Lang, AIA, Turner Construction
Richard McKim Preston, Seyfarth, Shaw, Fairweather & Geraldson
Eric G. Mion, Lewis & Zimmerman Associates, Inc.
Brian L. Ray, P.E., Kittelson & Associates, Inc.
Norman Scott, Consulting Engineering Group
Robert Smith, Wickwire Gavin, P.C.
Jennifer Starrman, Barton Malow Company
Stephen G. Walker, Esq., P.E., Bechtel Corporation
Bruce Wiggins, Orgmetrics

Chapter Reviewers

Steve Anderson, Anderson Perry & Associates, Inc.
Tore Arnesen, Arnesen & Associates
Richard Berry, Rembco Geotechnical Contractors, Inc.
Ida B. Brooker, Boeing Company
James Brown, Malcolm Pirnie, Inc.
Jerry D. Brown, P.E., East Bay Municipal Utility District
Richard Bryan, H.B. Zachry Company
Gerard P. Cavaluzzi, Esq., Malcolm Pirnie, Inc.
Laura E. Champion, P.E., Gibble Norden Champion Consulting Engineers, Inc.
Stephen W. Cole, P.E., S.W. Cole Engineering, Inc.
Ray Darvish, P.E., CH2M Hill, Inc.
Ronald Daye, OWP&P Architects, Inc.
Gregory DiLoretto, Tualatin Valley Water District
Eric T. Dodge, P.E., Malcolm Pirnie, Inc.
Robert Douglas, Maryland Department of Transportation
Joseph W. Eberle, P.E., Ruekert & Mielke, Inc.
Moon A. Fahel, P.E., H.B. Zachry Company
Edward R. Fisk, P.E., LS, E.R. Fisk Consulting Engineer
Bennett Greenberg, Seyfarth, Shaw, Fairweather & Geraldson
Christopher Liakakos, OWP&P Architects, Inc.
Russell Louderback, Kite Development
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Richard Patton, Turner Construction
Rodney Plourde, McMahon & Associates
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David H. Grieves, P.E., Chavez-Grieves, Consulting Engineers, Inc.
William Gurry, Gurry Associates
George D. Gustafson, P.E., Earth Tech, Inc.
David P. Gustafson, Ph.D., P.E., S.E., Concrete Reinforcing Steel Institute
Paul Haglund, Greeley and Hansen
Norman T. Heinig, CIPE, Heinig Consulting Engineers, Co.
Kenneth W. Henderson, P.E., Malcolm Pirnie, Inc.
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Les Wiersen, CH2M Hill, Inc.
J. Alan Wilson, P.E., Black & Veatch Corporation
J. Anthony Wintz, III, P.E., Esq., ASCE

Organizational Reviewers

American Consulting Engineers Council
  Leo Peters, P.E.
American Institute of Steel Construction
  Charles Carter, P.E.
American Public Works Association
  Ramankutty Kannankutty, P.E.
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TABLE OF CONTENTS

EXECUTIVE SUMMARY xv

CHAPTER 1: INTRODUCTION

1.1 The Members of the Project Team 1
1.2 Team Member Requirements 2
1.3 Team Member Responsibilities 3
1.4 Defining Key Terms 4
1.5 Balancing Team Member Requirements 6
1.6 The Obligations of Team Members 6
1.7 Principal Themes of This Guide 7

CHAPTER 2: THE OWNER'S ROLE AND REQUIREMENTS

2.1 The Owner's Role 9
2.2 Project Goals 10
2.3 Achieving Project Goals 10
2.4 Establishing Project Objectives 10
2.5 Team Member Requirements 12
2.6 Timing and Duration of Participation 12

CHAPTER 3: PROJECT DELIVERY SYSTEMS

3.1 Owner-Provided Delivery 16
3.2 Traditional Design-Bid-Build 17
3.3 Construction Management 18
3.4 Design-Build 19
3.5 Design-Build Variations 21
3.6 Fast-Tracking: A Distinction 23

CHAPTER 4: THE PROJECT TEAM

4.1 Traditional Team Organization and Variations 25
4.2 The Owner's Team 26
4.3 The Design Professional's Team 29
4.4 The Constructor's Team 30
4.5 Common Interests 31

CHAPTER 5: COORDINATION AND COMMUNICATION

5.1 Key Team Members 33
5.2 Developing Coordination Processes 34
5.3 Team Member Relationships 34
5.4 Characteristics of Good Communication 36
5.5 Timing and Critical Moments 40
5.6 Frequency of Communication 41
5.7 Conflict and Disagreement 41

Previous Page
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CHAPTER 6: SELECTING THE DESIGN PROFESSIONAL

6.1	Project Goals and the Design Professional's Scope of Services	43
6.2	Qualifications-Based Selection (QBS)	44
6.3	Competitive Bidding	48
6.4	Two-Envelope Selection	49

CHAPTER 7: AGREEMENT FOR PROFESSIONAL SERVICES

7.1	Purpose of the Professional Services Agreement	54
7.2	Elements of the Agreement	54
7.3	Standard-Form Agreements	59
7.4	Short-Form Agreements	60
7.5	Other Design Contracts	61
7.6	Cautions Concerning Non-Traditional Contracting Relationships	63

CHAPTER 8: ALTERNATIVE STUDIES AND PROJECT IMPACTS

8.1	Project Conceptualization	68
8.2	Existing Conditions and Future Needs Analysis	68
8.3	A Framework for Developing Conceptual Alternatives	69
8.4	Investigating and Selecting Conceptual Alternatives	70
8.5	Environmental Documentation and Permitting	75
8.6	Public Involvement	77

CHAPTER 9: PLANNING AND MANAGING DESIGN

9.1	Organizing for Design	79
9.2	The Design Team	81
9.3	Project Design Guidelines	83
9.4	Coordination and Communication During Design	83
9.5	Monitoring and Controlling Design Cost and Schedule	84

CHAPTER 10: DESIGN DISCIPLINE COORDINATION

10.1	Levels of Design Discipline Organization	87
10.2	Design Disciplines and Project Objectives	88
10.3	General Design Team Coordination Considerations	91
10.4	Role of the Professional Discipline Leader During Design	92
10.5	Role of the Design Professional During Construction	93

CHAPTER 11: GUIDELINES FOR DESIGN

11.1	Office Operation	95
11.2	Design Procedures	97
11.3	Design Activities and Responsibilities	98
11.4	Compliance with Codes and Standards	102
11.5	Regulatory Permits and Approvals	103
11.6	Public Funding	103
11.7	Design Responsibility	103

CHAPTER 12: PRE-CONTRACT PLANNING FOR CONSTRUCTION

12.1	Assessing the Owner's Capabilities	107
12.2	Resources for Quality Construction	108
12.3	Regulatory Requirements	111
12.4	Site Development	111
12.5	Reviewing Design and Construction Alternatives	112
12.6	Construction Contract Arrangements	113

CHAPTER 13: THE CONSTRUCTION TEAM

13.1 Assembling the Construction Team 115
13.2 Contracting Strategies and Team Organization 116
13.3 On-site Construction Team Representatives 117
13.4 Construction Specialty Advisers 121

CHAPTER 14: PROCEDURES FOR SELECTING THE CONSTRUCTOR

14.1 Selection Procedures and Qualifications 123
14.2 Constructor Qualifications 124
14.3 Selection By Competitive Bidding 125
14.4 Selection Procedures for Competitive Negotiated Contracts 128
14.5 Selection Procedures for Noncompetitive Negotiated Contracts 129

CHAPTER 15: THE CONSTRUCTION CONTRACT

15.1 Functions of the Construction Contract Relating to Quality 131
15.2 Role of the Design Professional in the Construction Contract 132
15.3 Defining and Preparing the Construction Contract Documents 132
15.4 Industry Standard Construction Contract Documents 133
15.5 International Construction Contracts 133

CHAPTER 16: PLANNING AND MANAGING CONSTRUCTION

16.1 Organizing for Construction 137
16.2 Pre-Construction Meetings 139
16.3 Construction Activities 141
16.4 Coordination and Communication 145

CHAPTER 17: CONSTRUCTION CONTRACT DOCUMENTATION AND SUBMITTALS

17.1 Roles and Coordination 149
17.2 Contract Documentation 153
17.3 Technical Submittals 154

CHAPTER 18: CONSTRUCTION CONTRACT ADMINISTRATION

18.1 Resident Project Representative (RPR) 163
18.2 Quality Objectives 164
18.3 Job Site Safety 166
18.4 Payment 166
18.5 Constructor Submittals 171
18.6 Change Orders 171
18.7 Coordination of Activities 172
18.8 Documentation 172

CHAPTER 19: OPERATION AND MAINTENANCE

19.1 Achieving Quality in O&M 177
19.2 O&M During Planning and Design 178
19.3 O&M During Construction 179
19.4 O&M During Start-Up 180
19.5 Operation 182

CHAPTER 20: QUALITY ASSURANCE AND QUALITY CONTROL

20.1 The Owner's Role 185
20.2 The Design Professional's QA/QC Process 186
20.3 The Constructor's QA/QC Process 189

CHAPTER 21: COMPUTERS AND PROJECT QUALITY

21.1 Common Computer Uses 193
21.2 Computers and the Owner 195
21.3 Computers and the Design Professional 196
21.4 Computers and the Constructor 198
21.5 Internet Resources 200

CHAPTER 22: PEER REVIEW

22.1 General Features 203
22.2 Types and Benefits of Peer Review 204
22.3 Procedural Elements of Peer Review 206
22.4 Responsibility 210
22.5 Peer Review Programs and Resources 210

CHAPTER 23: RISK, LIABILITY, AND AVOIDING CONFLICT

23.1 Project Risks 213
23.2 Managing Risk 214
23.3 Risk Management Tools 218
23.4 Liability 220
23.5 Avoiding Conflict 220
23.6 Conflict Resolution 221
23.7 Litigation 222

CHAPTER 24: PARTNERING

24.1 Benefits of Partnering 225
24.2 Principles of Partnering 228
24.3 Elements of Partnering 229
24.4 Special Applications of Partnering 234

CHAPTER 25: VALUE ENGINEERING

25.1 The Concept of Value 239
25.2 The Benefits of VE 239
25.3 The Timing of VE Studies 240
25.4 VE Team Composition and Qualifications 243
25.5 Stages of VE Study 244
25.6 Additional VE Considerations 250

GLOSSARY 253

ACRONYMS 262

INDEX 264

EXECUTIVE SUMMARY

This Guide discusses principles and procedures that, in the experience of the authors and reviewers, are effective in achieving quality in constructed facilities. 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.

Quality in the Constructed Project *is an "aspirational" guide.*

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 readership, this Guide is an "aspirational" document with the goal of educating readers 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 fulfillment of project responsibilities in the delivery of products and services in a manner that meets or exceeds the stated requirements and expectations of the owner, design professional, and constructor. 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 a team member expects or needs to receive during and after his or her participation in a project.

➢ Chapter 1, "Introduction"

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

➢ Chapter 2, "The Owner's Role and Requirements"
➢ Chapter 4, "The Project Team"

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.

➢ Chapter 3, "Project Delivery Systems"

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:

- **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 his or her 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.
- **Design-build variations.** The owner hires a design-builder who may also share the project's financial risk and/or operate the facility 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").

➢ Chapter 5, "Coordination and Communication"

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

➢ Chapter 6, "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 negotiated owner-design professional services agreement 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 agreement for professional services between the owner and design professional 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.

➢ Chapter 7, "Agreement for Professional Services"

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 agreement for professional services, 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:

➢ Chapter 8, "Alternative Studies and Project Impacts"

- 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, costs, and other design criteria;
- Documenting these activities to guide the design effort.

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 contractual agreement with the owner, 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 plans and 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:

➢ Chapter 9, "Planning and Managing Design"

➢ Chapter 10, "Design Discipline Coordination"

- 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, and developing estimated construction costs and 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.

➢ Chapter 11, "Guidelines for Design "

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

➢ Chapter 12, "Pre-Contract 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 any 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

➢ Chapter 13, "The Construction Team"

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 con-

structor 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 his or her 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.

➢ Chapter 14, "Procedures for Selecting the Constructor"

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, plans and 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.

➢ Chapter 15, "The Construction Contract"

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 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, reviewing change orders and submittals, as well as reviewing and approving completed construction on behalf of the owner.

➢ Chapter 17, "Construction Contract Documentation and Submittals"

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;
- 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.

➢ Chapter 18, "Construction Contract Administration"

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, tradecraft, 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

➢ Chapter 19, "Operation 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 and quality control efforts by each participant. QA/QC measures include:

➢ Chapter 20, "Quality Assurance and Quality Control"

- **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 plan addressing staff needs, communication, design procedures, reviews, the use of specialty advisors, and other concerns.
- **The Constructor** implements a QA/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 facility, 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.

➢ Chapter 21, "Computers and Project Quality"

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.

➢ Chapter 22, "Peer Review"

Risk, Liability, and Avoiding 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

➢ Chapter 23, "Risk, Liability, and Avoiding Conflict"

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

➢ Chapter 24, "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

➢ Chapter 25, "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 virtually every area of design and construction. The information and recommendations presented here are intended to aid readers 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. ❑

CHAPTER 1

INTRODUCTION

In this chapter

1.1 The Members of the Project Team
1.2 Team Member Requirements
1.3 Team Member Responsibilities
1.4 Defining Key Terms
1.5 Balancing Team Member Requirements
1.6 The Obligations of Team Members
1.7 Principal Themes of This Guide

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 readership, this Guide is an "aspirational" document with the goals of educating and stimulating readers 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.

Quality in the Constructed Project *is an "aspirational" guide.*

Readers 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.