Quality Management

Guidelines

2017 Edition

CMAA

Advancing Professional Construction and Program Management Worldwide

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The authors have worked to ensure that all information in this book is accurate at the time of publication and consistent with standards of good practice in the construction management industry. As research and practice advance, standards may change. For this reason, it is recommended that readers evaluate the applicability of recommendations in light of particular situations and changing standards.
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Richard Bernardini, PE, CCM, T.N. Ward Co.
Mark E. Cacamis, PE, CCM, CPC, HNTB Corporation
Todd Christopherson, Amcon CM
Darryl Dunn, PE, Construction Dynamics Group, Inc.
William L. Franklin, PE, Tarrant County Hospital District,
Paul Gustafson, Camp Dresser & McKee
James D. Hobbs, Jr., FCMAA, Wright Robinson Osthimer & Tatum
Donald Laford, PE, CCM, AECOM
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Thomas Quaranta, FCMAA, AECOM
Gabe Sasso, Gale & Wentworth
Coy Veach, PE, CCM, Freese & Nichols, Inc.
Preface

These Quality Management Guidelines provide guidance in adoption of standard quality management plans, processes, and procedures for the construction manager (CM) during the execution of construction projects. This guideline supplements the Construction Management Standards of Practice quality management chapter by providing an overview of the typical quality management responsibilities on a typical project from concept to occupancy. Each project may have a set of unique tasks because of project characteristics, such as:

- **Project Type**—Different project types – airports, transit facilities, healthcare facilities, courthouses, bridges – may involve and require different quality applications, measurements, and reporting tasks unique to the project type.

- **Location**—Projects in different geographical areas require applications of different engineering and construction codes and standards, and different administrative requirements will apply. International projects have additional issues, ranging from codes and standards, contractual frameworks, and cultural differences.

- **Renovation versus New Construction**—Projects involving renovation or rehabilitation in and around on-going operations may involve different types of measuring and monitoring applications.

- **Project Delivery Method**—Whether a project is being delivered under a traditional general contract, multiple prime contracts, construction management at-risk contract, design-build contract, etc. will significantly impact the CM’s responsibility for project management and coordination, which in turn will impact and shape the project’s quality management systems.

Further, the CM may only be involved with one phase of the project, e.g. the construction phase. If that is the case, guidance provided in the pre-design and/or design phase sections may need to be applied during the construction phase, if those services are in the CM agreement with the owner. Accordingly, this guide should be read with the understanding that the guidance provided herein must be tailored to fit the needs of a particular project and the CM’s scope of work.
The services performed by the CM may or may not include all the services and tasks discussed in this manual. Nothing in this manual should be construed to define a CM’s scope of services for quality management but rather, guidance in providing these services if quality management is in the CM’s contract agreement.

Other Guidelines published by CMAA address specific guidance in cost management, time management, contract administration, and sustainability.

“Quality is a journey, not a destination.”
Chapter 1: Introduction

1.1 Introduction

These guidelines are intended to assist construction managers in applying the principles of quality management (QM) on their projects. Construction managers are encouraged to consider the information in this document with the objective of improving the quality of the constructed project through construction management services, which is possible by performing management tasks in a manner that meets owner expectations in an efficient, reliable, and consistent manner.

This guide contains quality management principles and practices which are applicable to all project delivery methods, including:

- Agency CM, where the owner is the contracting entity with project contractors and the CM augments the owner’s staff;
- CM-at-Risk, where the CM is providing a guaranteed maximum price to owners;
- Design-Build, Design-Bid-Build, Design-Build-Operate-Maintain;
- Other project delivery methods.

Regardless of the nature of the management services offered, the owner should utilize the expertise of the CM to aid the owner’s organization in all aspects of quality and project development and implementation. Timely reference should be made to these Quality Management Guidelines during all project phases. They outline the basic approach that the project team should utilize to achieve an acceptable level of quality through a process-oriented approach while undertaking the management tasks of the project.
The intention of these Guidelines is to serve the construction management industry through the establishment of an improved and consistent focus on project quality. The Guidelines do not represent any approach towards a Total Quality Management (TQM) process at this time. Further, the Guidelines are not a guide to the ISO 9000 family of standards for quality management. See www.iso.org for more details.

After describing the objectives of quality management and providing important definitions, this section provides an overview of quality management in the context of the other distinct functions of construction management. This guide describes the application of quality management principles and techniques during each phase of the project lifecycle: pre-design, design, procurement, construction and post-construction. For additional information, please refer to the CMAA Construction Management Standards of Practice and specific Guidelines on each topic.

1.2 Quality Management Objectives

“Quality” is the degree to which a project and its components meet the owner’s expectations, objectives, standards, intended purpose, and contract requirements. Quality is determined by measuring conformity of the project to the plans, specifications and standards, and other applicable contract documents. The objective of quality management is to plan, organize, implement, monitor, and document a system of policies and procedures that assign, coordinate, and direct relevant project resources and activities in a manner that will achieve the owner’s objectives and performance requirements for the project.

1.3 Definitions

The following definitions are offered relative to CM and project quality:

**Construction Management (CM)**
Construction Management is a professional service that applies effective management techniques to the planning, design, and construction of a project from inception to completion for the purpose of monitoring safety and managing time, cost, scope, and quality.

**Construction Management Plan (CMP)**
The Construction Management Plan is a written, project-specific plan which outlines the project’s scope, budget, schedule, organizational roles, quality standards, and specific methods and procedures that the CM will undertake to accomplish the various management
tasks for the project. These *Quality Management Guidelines* should be integrated into the various sections of the CMP to maintain a focus on project quality. On certain large projects, it may be appropriate for the CM to prepare a separate Quality Management Plan (QMP) which elaborates upon the quality guidance aspects of the CMP.

**Independent Verification (IV)**
The confirmation or substantiation of a work product’s conformance to the contract documents by a party that is not directly or indirectly responsible for the work product.

**International Organization for Standardization (ISO) Quality Standards**
ISO Quality Standards are an international quality management system standard. Promulgated by ISO, the standards provide a framework around which a quality management system can effectively be based. An independent third party registrar audits an organization’s implementation of its quality management plan and certifies that they are operating in compliance with ISO Quality Standards. Clients, purchasers, and others may then have confidence that the organization’s products or services will conform to the specified requirements.

**Lean Six Sigma**
Lean Six Sigma is a continuous process improvement methodology which utilizes process mapping to identify and eliminate non-added value elements. The basic tool used to analyze data and process is DMAIC: define, measure, analyze, improve, and control. The total Lean Six Sigma process reduces product and process variability and defects thereby continually improving product and service quality.

**Quality**
The degree to which the project and its components meet the owner’s expectations, objectives, standards, and intended purpose; determined by measuring conformity of the project to the plans, specifications, and applicable standards.

**Quality Culture**
Culture represents the collective shared characteristics of an organization which includes the core values, guiding principles, attitudes, and the behaviors of employees which collectively define the organization. It is within the culture that supports and promotes the individual actions, and behaviors which result in quality. Quality is an individual responsibility supported by the culture.

**Quality Management (QM)**
The process of planning, organizing, implementing, monitoring, and documenting a system of policies and procedures that coordinate and direct relevant project resources and activities in a manner that will achieve the desired quality.
Quality Control (QC)
The continuous review, certification, inspection, and testing of project components, including persons, systems, services, materials, documents, techniques, and workmanship to determine whether or not such components conform to the plans, specifications, applicable standards, and project requirements.

Quality Assurance (QA)
The application of planned and systematic reviews which demonstrate that quality control practices are being effectively implemented.

Quality Management Plan (QMP)
A project-specific, written plan prepared for projects which reflect the general methodology to be implemented by the Construction Manager during the course of the project to enhance the owner’s control of quality through a process-oriented approach to the various management tasks for the program. The Quality Management Plan complements the CMP and forms a basis of understanding as to how the project team will interrelate in a manner that promotes quality in all aspects of the program, from the pre-design phase through completion of construction. Its purpose is to emphasize the quality goals of the project team in all issues associated with the work. This pertains not only to the traditional QA/QC of constructing elements of the work, but also addresses the quality needs of management tasks such as performing constructibility reviews during design, checking estimates, making appropriate decisions, updating schedules, and guiding the selection of subcontractors and vendors through quality-oriented criteria.

Total Quality Management (TQM)
Total Quality Management is a structured process for continuous improvement whereby long-range quality goals are established at the highest levels of an organization and the means to reach those goals are defined. The TQM process must be consistently applied through all facets of the organization. It includes process documentation, staff empowerment, and training. Benchmark measurements and periodic audits must be performed to steer the continuous improvement efforts. A primary focus is directed to internal and external client satisfaction.

Sustainability
Sustainability is meeting the needs of present generations without compromising the needs of future generations.
1.4 Project Management

Quality, like cost, schedule, and safety, is a significant goal of project management. Much like quality management, project management involves the application of processes designed to yield orderly outcomes that enable monitoring and control of cost and schedule risks. While quality management and project management are not synonymous, many of the imperatives and tools used to advance quality and project management objectives are identical.

- Understanding and accurately recording the owner’s requirements.
- Developing and implementing management plans that convey the owner’s requirements.
- Recording cost, schedule, and workmanship performance.
- Managing and communicating with an inter-disciplinary project team.
- Coordinating the activities of stakeholders.

The CM’s primary tools to meet scope, schedule, budget, and quality control objectives should be clearly articulated in the project or Construction Management Plan and its component or subordinate elements.

1.5 Cost Management

The CM usually has the responsibility to generate and track all project costs, from the initial conceptual estimate to the final accounting. The detailed project budget, prepared by the CM before design begins, becomes the designer’s guide as the process moves toward the procurement phase. After bids are received, the value of the accepted contractor proposals provides the budget basis. As construction proceeds, contract changes, and allocated expenses are recorded. Every aspect of the project’s cost is estimated as early as possible and substantiated as it occurs.

The intersection of cost and quality management is the scope of work. At every stage of the lifecycle when a project’s budget and schedule performance are reviewed, the construction manager must review the plan’s compliance with the original project goals and objectives of the project. Where cost variances indicate alternatives analysis or require mitigation, quality management tools and processes are applied to assure project objectives are maintained, and to communicate changes in project parameters to all project participants so that mitigation can take place as early as possible in the process without sacrificing project performance.
1.6 Time Management

Time management encompasses all aspects of scheduling during the course of the project. Scheduling integrates the restrictive elements of time and resources from planning through design, construction, and project occupancy. The main contributions of scheduling are to mitigate (or eliminate) time and resource crises and to predict major milestone completions. The time impact of critical quality management processes must be anticipated and incorporated into design and construction schedules.

- Scheduling each step in the quality management system during all project phases and required inspections.
- Development, buy-in, and approval of quality management systems and monitoring plans in the design, procurement, and construction phases.
- Required inspections and documentation processes in construction and post-construction

Proper planning for quality and communication with all project stakeholders throughout the project lifecycle will integrate the demands of quality systems on the construction schedule.

1.7 Contract Administration

The role of the CM is to represent the best interests of the client, typically the owner. These interests include timely completion of the project, within budget, and in conformance with the contract requirements. To accomplish these objectives, the CM establishes systems, policies, and procedures necessary to ensure adequate project controls are in place. Specifically, the CM must understand the basic responsibilities and interrelationships of all team members; i.e., the owner (both project management and user), the designer(s), the contractor(s), and others, such as consultants and the CM.

To the extent that the owner’s requirements are articulated in various contract documents, means and methods of contract administration and quality management systems are indistinguishable: both turn on vigilance and documentation. Whereas the application of sound contract administration principles yields an orderly project in compliance with the operational and administrative provisions of the contracts used on the project, similar and often identical quality systems are leveraged to verify the conformance of the project to the plans, specifications, and applicable standards.
1.8 Safety Management

Quality management and safety monitoring systems are always complementary. The CM should incorporate current local, state, and federal safety laws into the contract documents, the Construction Management Plan, and the Project Procedures Manual.

1.9 Sustainability Management

The most critical step in producing a sustainable project is the owner’s adoption of sustainability as a guiding principle of design. Thereafter, consistent application of quality management systems assures that sustainability, like any other owner requirement, is a documented outcome of the design and construction process.

If the definition of a sustainable project is a project that is delivered and functions in a manner that conserves natural resources, protects the natural environment, and sustains the community, then sustainability objectives are met with the successful implementation of CM best practices, including quality management systems tailored to the project.

1.10 Risk Management

Risk is an inherent component in every design and construction project. Successful CMs assist the owner in identifying and assessing the sources of risk well in advance of critical project decision-making and then assist in risk management throughout the project lifecycle. The objective is not to eliminate or cover up risk, but to manage it proactively, with an understanding of the divergent interests of all the project’s stakeholders.

Contract documents should clearly articulate risk management strategies, which include risk identification, assessment, allocation, minimization, mitigation, monitoring, and control.

Quality management systems in design and construction are critical elements of a risk management system. The quality management system inevitably ties into and supports risk management strategies. Managing risk starts in the pre-design phase of the project. Procedures must be in place to eliminate, or minimize, errors, omissions, and ambiguities in the contract documents. Mitigation focuses on the timely recognition of design and even contract changes and the timely resolution of all changes in design and construction.
1.11 Building Information Modeling (BIM)

BIM is a process by which digital representations of the physical and functional characteristics of a facility are captured, analyzed, documented, and assessed virtually, then revised iteractively through the design and construction process. BIM enables 3D parametric modeling, engineering analysis, clash detection, 4D schedules, quantity take-off, and general information assignment for owner facility management (including specification and product data linkage).

BIM has the potential to significantly improve the effectiveness and efficiency of design and construction processes, and facilitate if not revolutionize, quality management. Because BIM can incorporate accurate modeling information early in the design process, BIM can improve coordination and reduce potential errors associated with assessing sustainability performance. As-built conditions can be incorporated into a project’s BIM to help determine if it is being built within specified design tolerances and will achieve specified credits.

On projects where BIM is used in design, construction, or both, BIM development and deployment processes should be clearly identified in contract documents, and in quality management processes, plans, and procedures.
Chapter 2: Pre-Design Phase

2.1 Introduction

Once the CM is notified of selection for the project, interface with the owner begins. The pre-design phase of a project is the first opportunity for the CM to apply the construction management process and demonstrate its value to the owner.

It is advantageous to select a CM at this point in time, to allow the owner to benefit from the CM’s assistance in completing the planning for the project, initiating overall coordination with various project participants and selecting the design team.

2.2 Clarifying Owner Objectives and Concerns

The owner should consider hiring the CM as early as possible. During initial discussions, it is essential that the CM and owner attain a meeting of the minds as to the role, responsibility, and authority of the CM during the project. The CM should guide the owner toward fully understanding the value that the construction management process can add to a project. Likewise, the CM should gain an understanding of the owner’s expectation of CM services. At this time, the CM and owner must establish open lines of communication, mutual respect, and trust. Overall, it is extremely important that the CM develop a full understanding of the owner’s needs to allow the forthcoming CM services to be applied most efficiently and successfully. The CM should also confirm the status of project funding at this time.

The CM should assist the owner in defining quality requirements as early in the project as possible in order to start right and stay right through all project phases.

The owner should have clear and realistic objectives for the project, and the CM services being procured. The owner decision regarding sustainability should be made early. The CM needs to advise the owner of the benefits of commissioning in the pre-design phase for inclusion in the project documents addressing the roles and responsibilities of the
commissioning agent, the contractor, the owner, and the CM. In the event assistance is needed, the CM should provide the necessary help at this point. In the case where a detailed RFP is developed to solicit the CM’s services, clarifications as to the owner’s intent as well as specific scope issues must be made.

2.3 Scope of Services – The CM Contract

A quality contract includes a clearly defined, comprehensive scope of CM services. It is recommended that the CM utilize the CMAA standard form of contract for this purpose, after introducing certain project-specific changes. The wording of the contract should be as explicit as possible to outline the requirements of both the CM and the owner. Items or information required by the owner should be outlined in the contract. It may be appropriate to include a modified CM proposal in the contract, adjusted to reflect any changes during negotiations, a manpower schedule, and an overall project schedule summary upon which the CM services are based.

The contract will need to include the method in which the CM will obtain compensation for services and should include provisions for overtime, shift work, and extra work which is not a part of the original scope of services.

2.4 Design Team Selection

It is recommended that owners utilize the CM to assist in the formulation of a Request for Prequalification for design services where appropriate. The CM should undertake this task by developing reasonable, brief pre-qualification criteria for the design team that addresses the past experience of the designers on past projects. The Request for Prequalification should include the quality management system in use by the design for review and evaluation by the CM. CMAA recommends a minimum of five past projects be documented by prospective designers on work of a similar nature and that the projects proposed demonstrate experience including a reference for verification. The CM should assist the owner in contacting and verifying the designers’ past project experience information. The information should be summarized and presented to the owner with a recommendation of those design teams to be invited to compete for the project.

After pre-qualification is completed, it is recommended that a preliminary submission in the form of a Letter of Interest be made by all pre-qualified design teams to demonstrate their understanding of the project’s scope, complexity, and their special expertise for review by the owner. The CM should assist the owner in reviewing the submissions and developing a
short list of three to five firms from those that prequalified. The short-listed firms should then receive a Request for Proposal (RFP).

Many public funded project procurement regulations for professional services do not allow for pre-qualification of design services. Under these conditions, the CM will assist the agency to prepare an RFP that will solicit proposals from design firms. The RFP should specifically detail the agency selection criteria for the project. The RFP must also include instructions to the proposers and agency mandated forms.

Design firms responding to the RFP should document, in detail, their approach to the project, addressing all appropriate items of time, project cost, quality control, and quality assurance processes. Upon submission of the technical proposals to the owner, technically qualified professionals on the CM staff assist the owner in reviewing the submissions and ranking the candidates considering the quality of their past services and the quality expected based on a review of their technical proposal. Depending on the size and complexity of the project, oral interviews and presentations may be warranted and factored into the selection rating procedure.

If the scope of work calls for LEED design and construction, LEED experience should be considered for key individuals on the design team. This may include architects, engineers, and LEED accredited professionals. Owners of infrastructure projects may promote the use of Envision from the Institute for Sustainable Infrastructure (http://sustainableinfrastructure.org/) to increase the awareness and value of sustainability.

After selection of the highest rated candidate, the owner, with the assistance of the CM, should negotiate a fair price for the professional services. Should negotiations fail with the top selected consultant, the owner should initiate negotiations with the second highest rated design team at that time and follow this procedure until a selection is made.

2.5 Project Implementation Tools

The CM has certain tools available to implement the project from conception through completion of construction. These tools are represented by various plans, procedures, and approaches which may be undertaken by the CM to successfully complete the activities in the scope of services.

The CM must select the right “tools” for the project implementation phase of CM services. The complexity and size of any plan or procedure developed must be appropriate for the need. Benefits of the owner’s having their CM use these Guidelines will be the efficient and effective use of the CM’s staff by conducting itself in a manner that achieves quality of
practice and is consistent with the overall Standards of Practice of CMAA. Some of these implementation tools are as follows:

2.5.1 Construction Management Plan

Upon initiating services on the project, the CM should develop a written Construction Management Plan (CMP) that reflects the components outlined in these guidelines to the extent they are applicable. This forms a basis for the owner, CM, design team, and other project participants to understand the interface, responsibilities, and practice goals of the construction manager. Conformance to the CMP is a measure of quality CM delivery.

It is noted that the exact scope and complexity of various CM plans and procedures may vary widely from project to project. Some projects may require a CMP be developed to cover virtually every aspect of CM practice, such as on a large multi-contract power plant valued at over $100 million. Some large projects may have a 100+ page CMP and serve as practice guidance for ten, twenty, or more site CM representatives and inspectors. Other projects may be served by having a CMP that is only two or three pages long, which outlines the daily tasks of a single CM on a site where a small industrial building is being constructed.

The CM should circulate a draft of the CMP to the owner for review and comment. Suggested revisions should be reviewed and, when agreed upon, a final document is submitted to the owner for record purposes. The design team and other major project participants receive copies without budget information. This will allow clarity on the CM’s role in achieving quality in the constructed project as well as to form a basis of understanding of the CM’s day-to-day function.

The CM should update and maintain the CMP throughout the course of the project. A procedure for modifying the CMP should be included in the document to facilitate further revisions as they become necessary.

The development of a project-specific CMP allows the CM and other team members to recognize the quality responsibilities and objectives of the team throughout each phase of the project. Quality management requires a “Quality Attitude.” This attitude must be directed toward the various processes guiding how things are accomplished, how activities are executed, how information is handled, and how assurances are provided with a goal of achieving quality in the outcome. These issues are addressed in a systematic application of basic management initiatives and actions that are described in these Guidelines.

The CM may assume the role of quality assurance agent for the owner, with the designer providing quality control for their design and the contractor providing the quality control for the constructed project components.
The following are examples of some components that would be included in a CMP:

- Acceptance procedures
- Master schedule with milestones
- Bid packaging and contracting strategy
- Periodic construction executive reports
- Explanation of roles, responsibilities, and authority of team members
- Project budget/work breakdown structure
- Permitting
- Daily field reports
- Project description
- Document control
- Applicable codes/standards
- Project organization chart and manpower schedule
- Emergencies
- Public relations
- Claims avoidance
- Quality management approach
- Communications protocol
- Progress payment procedures
- Reference to project documents
- Environmental/archeological considerations
- Reference to project procedures manual
- Constructibility reviews
- Safety considerations
- Management Information System (MIS)
- Site mobilization and utilization phase
- Change order control
- Testing guidelines
- Project commissioning
- Sustainability requirements, including certification requirements
• High-performance Building
• Environmental preferred products
• Final acceptance
• Sustainability
• Retro Commissioning (RCX)
• Energy Star
• Renewable Energy Credits (REC)
• The name of the quality manager

2.5.2 Quality Management Plan

Owners, for certain projects, require that the CM prepare a separate Quality Management Plan (QMP). In these cases, the QMP is a project-specific plan that reflects the approach of the CM towards achieving quality in the constructed project. It is developed with heavy reliance on many of the sections included in these guidelines, and fully supports the CMP. When a separate QMP is prepared, most of the quality-oriented issues and discussion of processes, check lists, audits, etc., are contained in the QMP rather than the CMP. The CMP then addresses the day-to-day performance of the various functions and outlines the methods by which the construction manager’s forces will perform their services.

The QMP typically will include some of the following:

• Overall project organization
• Project QA/QC organization
• QA/QC representatives of design team and contractors
• Management decision flow chart
• Formats for various elements of the CM services (i.e., formats for job meeting minutes, progress payment applications, field observation reports, shop drawing logs, notice of proposal change order, etc.)
• Detailed check lists or audit plans to provide for quality in the practice of CM functions (i.e., check lists for approving contractor’s schedules, approving revisions to schedules, reviewing change order costs, obtaining approval within the owner organization for changes, approval to start foundation construction, approval to start concrete pour, approval to start steel erection, preliminary and final acceptance, etc.)
• Project quality audit forms
The CM will prepare quality management narratives for the use of his/her staff for each of the check lists and quality procedures contained in the QMP to provide for an acceptable level of quality at all levels of CM practice.

2.5.3 Project Procedures Manual

Due to the size and complexity of certain large projects, a separate Project Procedures Manual may be developed to complement items in the CMP that refer to practice procedures. The following are examples of some of the issues that may be addressed in the manual:

- Project monthly cost estimates (methodology to develop and approve monthly progress payments and to provide a regular update of anticipated project cost)
- Quality assurance program (establishes the type and frequency of tests or field audits required to assess the viability of the contractor’s quality control program)
- Project schedule (development, approval process, revisions, and updating)
- Change order control (covers method of soliciting change orders, approval process, negotiations, and schedule relationships)
- Correspondence control (provides flow diagrams and sample format for correspondence generated on project, including shop drawings and other submissions)
- Safety program (clarifies owner, CM, and contractor roles, and provides forms for monitoring if applicable)
- Documentation for sustainability (if the project is seeking LEED certification, a cooperative effort across all project disciplines must occur to plan for, prepare, and secure various forms of paperwork documenting the LEED credits for which the project is seeking. Refer to the appropriate LEED reference guide and preferably a project LEED AP for further information)
- Sustainability requirements
- Document control
- Project Management Information Systems

The Project Procedures Manual also should include any necessary check lists which are intended to be used by the CM, as well as an appendix of blank forms and sample forms that may be required for any aspect of the CM’s duties on the project. The need for a separate Project Procedures Manual is considered before the initiation of services by the CM.
2.5.4 Pre-Design Project Conference

The CM, together with the owner, should plan, conduct, and document a pre-design project conference that addresses the overall scope of services and Construction Management Plan with respect to the design phase. The general purpose of the conference is to provide introductions and establish a commitment and understanding of the project goals, the project approach, and procedures to be utilized by the owner, the design team, all key project participants, and the CM. It will serve to make all parties aware of the quality of services expected by the various stakeholders in the project start right and stay right.

2.5.5 Management Information Systems (MIS)

The CM has the responsibility for establishing a MIS that will keep the team informed as to the overall status of the project. As in the case of the project procedures manual, the need for a separate document outlining the scope of the MIS to be used by the CM is dependent upon the CM’s scope of services and the size and complexity of the project. For many projects, the MIS approach can be readily outlined in the CMP. However, many other projects require a separate reference document that outlines various aspects of information management on a project. Projects of this nature tend to be large multi-contract projects with multiple contractors, design teams, outside agencies, and a complex owner organization.

Providing factual, accurate, timely information is critical to quality processes necessary for a quality project. The MIS which is developed should address team information needs, data sources, and control elements for time and cost control functions, output measures, and information relative to how the system is to be organized, implemented, and maintained. The system should provide a sound basis for managing the project information including sustainability documentation when applicable. Distribution, frequency of reports, and policy for record retention should also be established in the MIS.

A comprehensive account of project activities, in a manner that is documented and facilitates timely review by project executives is an important aspect of the MIS. Job level as well as executive level reporting of project activities is a primary function of this system on any project. Information databases may be routinely developed to complement any aspect of the CMP or policy and procedures manual as applicable. It is imperative that the CM establish the correct level of project guidelines, manuals, etc. to suit the needs of the project given the scope of service, complexity, and size of the project.

The MIS also deals with the reporting of financial status, current and projected, and must be designed to enable both the owner and the CM to plan, monitor, and effectively control the application of available funds to the project. The format of reports should accommodate a continuing input of data. The resultant information should serve as a budgeting and cost control tool on a contract phase and total project basis. Financial reporting should cover
budgeted, authorized, and committed funds, expenditures to date, cost to complete, invoices, payments and retention, change orders, projected total costs, and projected cash flow.

The CM should consult the owner and the design professional’s staff personnel and determine the type, format, and frequency of information and reports required by the team members. As a minimum, information should include schedule and progress reporting, drawing schedules, budget versus cost of services, and change requests (approved and pending) for design and CM services. The first reports should be issued during the design phase and thereafter, on an agreed frequency. The CM’s team should also closely check the contents and the information reported in a manner that provides for consistent quality of job documentation associated with any MIS.

2.5.6 Pre-Design Data

The CM should review the data provided to the design team to assure that it is as complete as possible at this stage of the project. Unique project specific issues should be identified for the design team to evaluate. This data includes the owner’s expectations for quality.
Chapter 3: Design Phase

3.1 Introduction

The design phase requires continual review and consultation among the team members on all issues. The team goal during the design phase is to complete a set of documents defining a cost-effective project which can be bid in the current local market within the owner’s established budget, performance requirements, deliverables, and time requirements without jeopardizing any of the owner’s quality goals.

Design professionals are responsible for their performance. The CM’s role is primarily coordination and guidance of the other team members. The CM makes recommendations regarding constructibility, quality management, cost, phasing, and sequencing of construction, construction duration, impact of alternative construction methods, and determination of contract packages.

3.2 Initial Design Meeting

The CM should arrange for and conduct an initial design meeting with the design team and the owner’s representatives for the project. The agenda for the meeting should focus on the design team members and their organization, the schedule of performance, and the designer’s approach to quality. Other items of interest to the designer should be addressed to confirm that there is an efficient initiation of design services. It is also important that open and honest dialogue occur so that clear directions are furnished and open questions are answered, resulting in the effective and efficient transfer of information in clear, concise terms.

During this meeting, it is important that the CM request the designer make a special presentation on their internal quality management system, which should contain their specific efforts associated with quality control and quality assurance. Importantly, the
designer should address this topic for any sub-consultants he may rely on to provide services as well. Observations about any adjustments to the consultant’s quality management system should be discussed and resolved at this time to eliminate any misunderstandings or loss of efficiency during the design process.

The designer should be prepared to present information associated with his/her professional fee to the owner utilizing the assistance of the CM when appropriate. Regular updates on the expenditure of the design fee vs. actual progress should be agreed to in advance between the designer and the owner with CM assistance. Clear understanding should be raised at this point relative to the designer’s obligation to highlight and document the need for any additional compensation associated with changed conditions in the performance of his/her services.

Following this meeting, the designer should have an agreed-upon time-frame upon which to submit his/her performance schedule for approval of the CM and the owner. The CM should review this schedule when submitted, in the context of the overall project goals, and make specific recommendations to the owner and coordinate a response to the design team as approved by the owner. The CM should assist the designer in developing a computerized CPM schedule and use this to monitor the work thereafter, making revisions as required.

### 3.3 Partnering

The design process is a blending of many parties that contribute input into a single entity, the owner’s project. The various parties include the owner’s representative, the design professionals, the CM, and many others (utilities, environmental agencies, governmental agencies, etc.) who have a stake in the project. The assimilation of the individual self-interests into a team working for a successful project is best accomplished by an independent facilitator and a structured partnering process initiated by a one- or two-day partnering workshop at a location away from the job.

The owner or CM should guide the selection of the facilitator for a partnering program. A program must be established that will foster the building of trust and respect among the team members. Attendance at the partnering session must be comprehensive and include all project stakeholders to be effective. The goals and objectives of the project are established in the workshop and the working relationships of the team are identified. Issues to be identified may include roles, expectations, factors for success, mission statement, and key processes. The spirit of partnering should continue throughout the life of the project. The goal of partnering is the creation of a non-adversarial team with a vision of a claim-free successful project. Within this positive atmosphere, the project participants exercise an effective decision-making process to avoid any issue being delayed at one decision point longer than
necessary. Basic agreement is reached that decisions are made at the lowest level, and when that is not possible, they are advanced to the next higher level without animosity.

The by-product of a partnering workshop is a mission statement which all parties should sign to attest their endorsement of the project’s goals and key issues. It is developed in a joint manner by all participants in the workshop. After the workshop is completed, it is recommended that quarterly meetings, at a minimum, be held with the executive staff of the project to review and discuss how well the goals agreed upon at the partnering workshop are being achieved, and to take necessary action where required.

### 3.4 Design Procedures

In order to properly coordinate the duties and responsibilities of all team members, the CM must obtain copies of all design professional contracts. It is vital that the owner’s contract with the designer be coordinated with the separate contracts of the CM, contractor(s), and others. The CM will then be aware of the roles and commitments of the designer to the owner as well as the owner’s duties as defined within that contract. Particular attention should be paid to the contractual quality requirements. It may be expected that the CM contract is distributed to others as well.

The various phases of the project are defined by the contract in most cases or by specific reference. During each of the following phases, the performance of the design professional will be defined by deliverables or documents that are the work product of their professional service:

- Conceptual
- Schematic
- Design development
- Construction documents
- Support during construction
- Post-construction

Review/acceptance of the work product of each phase must be coordinated by the CM and include the entire project team. This process includes a formal sign-off and acceptance by each responsible party. At the end of each phase the design objective, budget, and schedule are to be confirmed for compliance with the original goals and objectives of the project. Comparison with the project objectives will reveal variances. In order to maintain the project
objectives, alternatives may be required to meet the owner’s criteria for design, cost, and schedule.

The CM must exercise project leadership, as the delivery of the project mainly rests within his/her charge. During this period, the project’s quality expectations must be maintained to be certain the final design product is consistent with the owner’s goals.

### 3.5 Document Control

The CM is the clearinghouse for all project communications. Communication that is factual, accurate, and timely is critical for quality delivery. This task requires a comprehensive system for the control and access of the many letters, transmittals, plans, sketches, etc. of a typical project. This computer-based control system, whether it is a proprietary system or self-designed, is a basic component of the MIS to be utilized by the CM. Any document control system would be guided by a formal MIS should one be developed for the project. Investigation of internet project linked web pages, intranet, and extranet services is recommended.

The project communication and distribution of information can best be executed by the creation of a matrix of the project team. The matrix will establish all the types of documents, need for communication, and the originators and recipients of the documents. This matrix is to be distributed to the entire project team for acceptance and use. The establishment of agreed time limits for review/response for each document is to be defined with the matrix. The media of deliverables should be established and coordinated with all of the project team members, including electronic data format.

### 3.6 Design Submittal Review

The CM must review the design team’s effort at regular intervals through a series of submissions. It is recommended that the design team members making submissions accompany each submission with appropriate indication that their internal quality assurance and quality control checking has been undertaken to the degree necessary as reflected in their quality management system, and in conformance with contractual requirements. An integral part of the development of the design is the proper coordination of various submissions with various parties having input or being affected by the project. Accordingly, the CM should work with the design team to develop a checklist of those individuals who require status updates of the design progress.
Those parties not directly involved in design development but having a potential significant contribution should be made aware of all progress on the project and requested to furnish their input. This is important throughout the project and as a minimum; the parties should have an opportunity to review the project at the 30%, 60%, 90%, and final product phases. Input from utility companies, railroads, special equipment suppliers, adjacent construction programs, maintenance forces, facility users, etc., may need to be coordinated by the design team prior to the issuance of bid documents. In some situations, the CM, and, possibly the owner, may request that certain associated parties to the contract actually sign-off on progress documents and the final submission of the design to limit any chance that full coordination has not been accomplished.

The CM should routinely review the design submissions furnished by the designers. This review should be directed to plans, specifications, and estimates that have been developed during the course of the program. Necessarily, the CM, the design team, and the owner at various points should hold a field visit during the design development to the extent necessary to confirm that there is no misunderstanding or misrepresentation regarding existing conditions and how they are to be addressed in the design documents.

The CM should develop a detailed checklist for plans, specifications, and estimates (should estimates be developed by the designer) to confirm that the various areas of review and concern are accomplished by the CM team to promote the required high level of quality in the development of the design.

If included in the designer’s scope of work, the CM should establish a procedure that assures contractor submittals are reviewed by the designer. This review is to assure that the contractor supplied material/equipment meets the technical requirements of the contract specifications. Typical designer review status is “Accept with No Comments,” “Revise and Resubmit,” or “Reject.” The CM’s procedure should track designer submittal status.

### 3.7 Changes in Design, Scope, or Criteria

The design of a project is an evolutionary process. During the course of the project, change is inevitable. The CM must monitor the changes and advise the owner of the impact of the changes to scope, schedule, and budget. Notification by the designer together with the review of the progress documents will identify variances with the previously agreed-upon design.

All design changes and their impacts must be communicated to the project team. The efficiency of the team can be affected by these changes. The lack of information received by any one member of the team will eventually create problems. This may have significant
impact on the operations of the project in the design and/or the construction phases and may jeopardize the overall quality of the project.

The cost of the project must be carefully tracked and monitored for every change in the design. A system for identifying the source, authorization, funding, and execution of the changes must be established by the CM. The cost of project enhancements must be made clear to the owner, who will give final authorization for the change.

The schedule impact of the design change can be as critical as the cost. The owner and the project team must be advised of the impact of their initiated changes to the project. Input of the information regarding changes to the project CPM schedule to determine the end dates and effects on the master schedule is required to convey the change’s impact.

The method by which the project is to be constructed is another factor that must be considered in the analysis of the design change. For example, fast-track construction is by its’ very nature subject to many changes. The project team must be organized to accept and execute changes very quickly and efficiently on any type of project. Conventional design/bid/build projects have different priorities depending on the owner, i.e. public versus private and funding requirements. It may be extremely critical to an owner to remain within funding limits and/or occupancy dates. The project’s requirements for material deliveries and their integration into the work are equally important to consider, especially where owner provided items or items provided by third parties are involved.

The life safety implications of the design change must be reviewed for conformity to any approved life safety plan for the project as well as the safe intended use of the facility to be constructed. The various systems of the project must be coordinated for their functionality with respect to the changes proposed to the design. Constructibility, maintainability, and inspectability of the systems must also be considered as each change is initiated.

When sustainability goals (LEED, high-performance buildings, retro commissioning) are specified, the CM should assure the appropriate requirements are included in the design documents.

### 3.8 Permits

The CM should assure that a list of project required permits is developed. The list must include applicable federal, state, and local permits and indicate the responsibility for obtaining the permit. The quality of the permit application with respect to comprehensively providing all required information is critical to timely approval. The CM should assure that the following activities are implemented:
• Appropriate firm/staff is assigned to obtain each permit.
• Lead time is established and is adequate to support the project schedule.
• Agency review time as scheduled is reasonable.
• Permit applications are submitted as scheduled.
• Track agency review comments and responses for schedule impact.
• Permits are issued before work covered by the permit starts.

3.9 Quality Management System (QMS)

During the design phase of work, the CM should ascertain the specific approach to achieving quality in the design documentation with each consultant on the design team.

This can be as simple as dealing with one prime design consultant on a project, or it may involve many prime design consultants and their sub-consultants. Whatever the case, it is imperative that the CM, on behalf of the owner assure that the QMS of consultant’s and sub-consultant’s meet the minimum requirements of the owners QMS, or the approved project specific QMS to confirm that an appropriate level of design quality management activities is taking place addressing quality control and quality assurance.

A typical design consultant Quality Management System would include documentation of some of the following items:

• Mission statement regarding the firm’s specific approach to achieving quality
• The design team’s organization
• Project management control systems
• Computer operations
• Contract administration
• QA/QC systems
• Interdisciplinary coordination (services and documents)
• Drawing control and record retention
• Shop drawing and submission acceptance format and process
• Change documentation
• Design schedule development and maintenance
• Progress meetings
• Construction support activities
• Preparation of record drawings

After a review of the design team’s QMS documentation, the CM should offer constructive comments in any areas needing improvement resulting in a robust QMS meeting the owner’s requirements.

It is recommended that early in the project, each design firm initiating services is requested to make a submission to the CM outlining what their QMS or other specific approach is to achieving quality in their designs. Thereafter, the CM should include an agenda topic in all design team meetings relative to the implementation of quality systems during the course of the project.

3.9.1 Quality Control

Quality control is carried out by the representatives of the design team on a day-to-day basis by implementing a system of performing the design in a manner that relies upon a reliable procedure(s) that affirms that the design is developing correctly, both in the development of plans, details, specifications, and estimates. This is achieved by using a system of detailed checks and reviews between members of the design team, performing measurements and surveys as may be necessary to confirm the viability of the design and design assumptions. It includes a system whereby all plans, specifications, and calculations developed are confirmed by a rigorous system of checking to eliminate errors and omissions.

The designer should implement this quality control effort during all design stages that culminate in a detailed final checking of the plans and retention of a record “check set” of plans and specifications. The checking system should include either a form or a stamp which can be affixed to design documents indicating the nature of the quality control review, who performed it, and the date, along with any comments which may be pertinent for the designer to consider for further design development and documentation.

Many projects have a number of designers performing services during this phase. It is imperative that the CM monitor that the design team is performing their quality control efforts in a manner that allows full coordination between design professionals developing the project. Coordination is of paramount importance in that many design deficiencies, which are noted during the construction phase, are generated by lack of adequate coordination between design disciplines prior to construction. For multi-disciplinary projects, it is recommended that a coordination sheet be signed off by a representative of each design consultant involved as various stages of the design are completed.
3.9.2 Quality Assurance

The CM’s involvement with the design phase of the project is itself an important tool of the owner for quality assurance (QA). The CM provides an independent construction perspective to the design process in addition to the design professional’s effort towards quality control. The design professionals should have their own in-house procedure for quality assurance. This program should be made available to the CM for monitoring purposes. The design professional should prepare and issue a report of their internal review of the project documents and the results of the QA review at the end of each design phase.

The quality assurance activities of the design professionals deal with the planned and systematic efforts which are undertaken by the designer’s forces to confirm that quality control activities are, in fact, taking place. These efforts by members of a design team should be taking place at various points in the design development. It is common that reviews take place, at a minimum, at the 30%, 60%, and 90% stages. More frequent reviews, of some or all of the design, may be required. The CM should monitor, on behalf of the owner, the documentation of quality assurance activities by the design team members at whatever phases are agreed upon for submissions. The quality assurance efforts of the designer should include documentation that detailed checks have been made of the QC activities at the various submission points as well as regular spot checks on a regular basis during the course of the design and between submission milestones.

A QA file should be maintained by each prime design consultant and should be made available for the CM’s review. It is recommended that the CM periodically review the QA file at least on the basis of the submission increments that are required by the QMP. The CM should monitor the design team members’ conformance to their quality assurance approach by periodically reviewing their documents associated with performing QC checks, and also the designer’s identification of the need for corrective actions that were developed during QA reviews. In addition to the prime design consultants, it is imperative that documented efforts at assuring quality take place by the sub-consultants as well. The prime design consultants should ascertain how well this is accomplished and this should be discussed with the CM during periodic meetings. Ultimately, when final plans, specifications, and estimates are submitted, evidence that quality assurance activities have been applied to the documents should accompany the final package.

For specially designed systems without reliable track records, the CM should recommend performance testing, bench studies, pilot studies, or simulations to verify the manufacturers’ claims of material and/or equipment performance which is an important exercise to be performed during the design phase. In this way, the owner will be able to confirm the level of quality and avoid potential failures or disappointments in the functionality of the item’s intended uses. The establishment of quality expectations by the owner for all of the project
team members is an important communication tool, which must be created during the initial stages of the project.

The utilization of 3D CAD, mock-ups, Building Information Modeling (BIM), and samples for critical project components or systems can be extremely useful in the early determination of the applicability of the project’s important features and should be recommended by the CM. This will aid in the elimination of costly removals and replacements of project components by the owner and contractors. This also allows the designers to explore innovative technological components of the project without significant investments on behalf of the owners to confirm the anticipated level of quality that can be expected in certain areas. BIM modeling, if required, should also include appropriate data for the owner to manage the facility during its lifetime.

The creation of a contractor feedback plan, which allows the project construction team to provide information to the owner and design team of problems that were encountered during the project, may provide invaluable information to the entire team. Project coordination and progress meetings are an excellent forum for conveying this information.

3.10 Project Estimates

The responsibility for the preparation and maintenance of the project cost estimates should belong to the CM. Cost estimates of the project should be updated at project milestones to verify that project funding will remain adequate to complete the project in accordance with the scoping documents.

After the estimate is prepared, it should be checked by an individual who is not responsible for its preparation, and that the estimate document itself show evidence of having been checked. It is recommended that the CM and design professional reconcile project scope for accuracy. Further to the checking effort, the CM should monitor that there is a reasonable level of quality in the development of pricing information. The estimate file should contain detailed information of where each aspect of price information was obtained, whether it is from simple experience, the owner’s past bidding information, or reliance on one of the many estimating documents or software systems which exist in the marketplace. Due consideration to the pricing effort should be made to allow clarity as to whether or not the funds indicated in the estimate are intended to represent current dollars or the cost to the owner at some future point in time, thus requiring an escalation factor.

Estimates that are developed for projects should be maintained on as confidential a level as possible during the design phase to limit the likelihood that any costing information be transmitted to potential vendors or bidders for the work.
3.11 Owner Authorization and Approvals

A procedure to identify and acquire the authorization of the owner to maintain progress and proceed with the project must be established. The CM should review that these authorizations and approvals are provided for in the development of the project. By accomplishing this, the level of quality of management of the project will improve through a higher level of understanding of these critical elements. The various acceptances, approvals, and authorizations required by the owner may include such item as:

- **Changes** - Deviations from the originally conceived and currently approved program established by the owner and project team.

- **Authorized Contract Officer** - Identification of key individuals from each team organization empowered to commit the organization to performance criteria.

- **Limits of Authority of team members** - Establishment in connection with the Contract Officer assignments, of secondary levels of responsibilities of the team.

- **Notice to Proceed** - The formal authorization by the owner to proceed with the project design or various design components in accordance with the contract should be scheduled and identified as a milestone(s) of the project.

- **Budget** - The anticipated cost constraints of the owner must be identified and a system established to maintain control of the design process to stay within budget.

- **Schedule** - The milestones of the entire project design process and end occupancy dates must be identified and agreed upon. Project milestones related to sustainable design and/or sustainable construction should be included in the schedule.

3.12 Constructibility Reviews

As an extension of the owner, the CM’s role in the review of the design documents for constructibility, or reasonableness and efficiency in construction, is a major value-added contribution. The goal is to maximize the ease with which labor, equipment, and materials can be brought together by a builder to complete the project in a timely and economic manner. It is always easier to “build” the project virtually by computer model or on paper first, than to redesign the project through substitutions during the construction process. The review of the design, bid, and contract documents for constructibility should include the following:
• Availability of materials
• Appropriate use of sustainable materials
• Energy conservation measures
• Retro-commissioning
• Long lead items
• Alternative studies of construction technology
• Site access
• Limited work spaces
• Suitability for use
• Construction materials
• Design intent
• Clarity/completeness of the documents
• Effect on contractor’s ability to implement their “means and methods”
• Feasibility of the schedule
• Trade labor availability
• Subsurface concerns
• Utility conflicts
• Accurate representation of existing conditions

Scheduled activities for review and assessment should be defined within the project schedule, so that a regular and formal review of the documents is performed. An independent team, preferably the CM and not the design team, should perform this review.

It is recommended that constructibility reviews take place periodically throughout the design performance period. Ideally, reviews should take place at the scoping, pre-design, 30%, 60%, and 90% stages, along with a final pre-bid review after completion of design. The CM should utilize checklists for reviews of plans and specifications to review whether various items of the constructibility review may have been overlooked. The reviews should include a visit to the site to spot-check conditions which may not be indicated on the plan. The CM should prepare this checklist early in the design, and review it with the owner and the designer.
3.13 Value Engineering

Value Engineering (VE) is the systematic application of recognized techniques by multi-disciplined team(s) which identifies the function of a product or service; establishes a worth for that function; generates alternatives through the use of creative thinking; and provides the needed functions, reliably, at the lowest lifecycle cost.

Value Engineering is founded on the following three (3) basic precepts:

- **An organized review** to improve value by using multi-disciplined teams of specialists knowing various aspects of the problem being studied.

- **A function oriented approach** to identify the essential functions of the system, product, or service being studied and the costs associated with those functions.

- **Creative thinking** that uses recognized techniques to explore alternate ways of performing the functions at a lower cost or to improve the design, service, or product.

The Value Engineering process includes:

- **Lifecycle Cost Analysis** - An evaluation of the various project systems, materials and equipment with respect to first cost, long term cost, anticipated life of the component and all other time related factors of the item.

- **Maintenance** - An evaluation of the anticipated cost for the owner to maintain the operational efficiency of the item, as compared to alternate considerations.

- **Operation** - An evaluation of the anticipated energy and other costs for the operation of the item.

- **Compliance Standards** - An evaluation of regulatory and code requirements of each item.

Ultimately, the owner will achieve, through the value engineering exercise, a balance of first cost, ease of maintenance, low cost operation of the project in compliance with all applicable codes and regulations. Value engineering is not intended to be an exercise in cost cutting and obtaining the lowest initial cost of the project, but the best overall value for the life of the project and its intended uses. It is recommended to organize a VE review at the 30% completion of design with follow-up sessions dependent on the size and complexity of the project.
Individuals certified by the Society of American Value Engineers often lead value engineering studies. These Certified Value Specialists (CVS) may be on the CM staff or be a sub-consultant by the CM or owner and should organize and undertake the job-specific approach to value engineering as may be approved by the owner. Many CM and owner organizations often perform value engineering using their own in-house committees similar to the system used by CVS. Value engineering techniques are an important and cost-effective initiative in any program.

### 3.14 Risk Management

Risk management processes should be applied throughout all project phases. The risk management process can mitigate potential loss through taking pre-emptive measures once a problem arises on a project. The CM may need to involve third party experts in statistical analysis and/or data collection to aid in the process. Risk management is very useful to evaluate and develop strategies to limit cost and scope creep and have been typically used on large projects.

The first step in the risk management process is to identify all of the potential problems that could be encountered, which would affect the quality, scope, cost, or schedule of the project. A complete list of potential risks is tabulated in a Risk Register. These can include funding issues, weather conditions, or community resistance. When identifying these potential problems, it is important to assess their impact and probability. If an occurrence is virtually unlikely, going through the trouble identifying the probability and impact may cost more than the associated risk. Accordingly, the effort should be primarily focused on risks that can be reasonably expected to occur or if they occur, the impact is catastrophic.

After all possible problems have been identified; the CM must determine the probability of occurrence and impact associated with each one. If statistical information is available for similar types of past problems, the probability of occurrence can be determined through data collection and statistical analysis. In cases where there is not data available, the CM is forced to rely on the process of probability encoding by subject matter experts.

Impact is measured in terms of the amount of time, cost, and quality lost per occurrence of a risk event. If harsh weather conditions delay a job, the cost of the associated delay is its impact on the project. The impact of each problem must be multiplied by the probability of that problem to obtain the risk it poses to the project.

Project risk can be defined as the potential of losses/problems resulting from an uncertain exposure to a hazard or as the result of unforeseen events. Risk management attempts to identify and quantify the potential outcome from certain sets of events. In other words:
• What can go wrong? Risk identification identifies a single event or a sequence of events that can lead to an undesirable consequence called scenarios. The event or scenario can be viewed as a cause that if it occurs, results in an adverse consequence or some degree of severity. An example could be lack of skilled welders needed to perform a critical path task on a project. How likely is it? This assesses the probability of each scenario. This can range from extremely unlikely to likely. In the above example, the availability of the skilled welder can be determined by evaluating the need for this type of skilled welder on other projects in the area and surrounding areas and the country.

• What are the outcomes or consequences if it occurs? The impact of the scenario can range from “none” to “catastrophic.” The welder shortage is an event that could lead to consequences for the project such as higher costs, schedule delay, or reduction in quality.

• What mitigation measures can be implemented should certain risks occur during the life of the project?

A typical scenario-based analysis and quality management methodology can have the following primary steps:

• Define the objectives of the assessment, including the consequence measures of importance to the decisions
• Project definition and formalization based on its criteria for success
• Identification of risks and potential events in a risk register
• Identification and mitigation measures for each risk
• Modeling and identification of the scenarios
• Evaluation of the failure of each event in the scenarios
• Conducting qualitative and quantitative risk assessment
• Managing project risk through the application of controls, countermeasures, failure prevention, and consequence mitigation using risk-based decision-making.

The risks can be modeled using statistical analysis and Monte-Carlo programs which are beyond the scope of this guideline. Probability encoding is a common method used which is the assessment of risks based on the collective rating of subject matter experts. For large projects, it is recommended that a formal risk analysis be performed.
Based on the risk analysis, the CM and project team should develop an appropriate mitigation plan for risks that occur during the life of the project. In the case of the skilled welder example, the mitigation plan could include paying premium wages and/or overtime to attract the desired skilled welders as well as training programs to develop welders specifically for the project. Each mitigation plan needs to be reviewed with the owner to assure it understands the risk and the potential cost/schedule/quality impact of the risk.

During the project, the CM should periodically review the risks identified at the start of the project and should ascertain whether any new risks have been encountered. Effective mitigation measures may be considered and applied to all events that generate undesirable risk to the project outcome. The process is continuous until the completion of this project.

Once the risk management processes have been performed, the CM should meet with the owner to discuss the results. Risk management will assist in cost estimation and scheduling. The monitoring of risks and continual risk evaluation may require additional risk mitigation planning necessary to minimize the effect that risks may have on a project.

### 3.15 Establishing Construction Duration and Scheduling

The CM, with input from the designer when necessary, should jointly accomplish careful development of the duration of a project. It is recommended that this be accomplished by developing a pre-bid CPM schedule to the level necessary to document reasonable construction duration for the project resulting in a final completion date to be included in the contract. Quality can be affected by short durations, night work, or long shifts. The quality of the pre-bid schedule should be attained by using professionals with scheduling expertise. They should develop the CPM network, including a review of construction durations of each work task, documenting all task durations and assumptions.

The pre-bid schedule serves as a base of record information from which the overall construction time is estimated. Special assumptions made regarding shift work or extended hours should be indicated on the Pre-Bid Schedule Plan.

During the design phase, the CM should work with the designer to establish what acceptable scheduling software should be specified. Since the CM will be responsible for monitoring the contractor’s schedule during the construction phase, the CM should develop the project scheduling specification. In the specification, the CM should indicate the various aspects of contractor interface with the schedule, including a format for schedule development, acceptance updates, revisions, and notice of delays. It is also recommended that the contractor be required to submit his CPM schedule for acceptance within 30 days of
receiving a Notice to Proceed. A summary logic network and a 30 day look-ahead should be submitted at the time of the pre-construction conference. The schedule specifications should also clearly outline how changes may be introduced in the event unforeseen conditions are encountered. Necessarily, the CM should clarify in the schedule specification the basis upon which the contractor may be entitled to a time extension. The CM must also verify that there is clarity on the achievement of any milestones, time allowance for sustainability product delivery and commissioning. Special attention should be directed to any provisions for liquidated damages or penalty/bonus provisions, substantial completion or beneficial occupancy, final acceptance, and any warranty milestones to the extent they are related to the contractor’s impact on the schedule.

3.16 Construction Inspection and Testing Requirements

Most agency owners have rigid construction testing and inspection requirements. When not provided by the owner, it is appropriate during the design phase to develop an inspection and testing program for the project. Either the design professionals or the CM can develop the program but the total design team should review and concur in the reasonableness and practicality of the program. Clear and concise requirements for inspection and testing introduced into the contract documents will emphasize to the contractors that the owner’s team has a significant interest in achieving quality in the constructed project. Inspection procedures for all required project components should be defined. It must also be clear which materials or components will be accepted based on supplier certifications of quality. Reporting of the testing results should be conveyed via the project documents. Failure, retest, and remediation procedures should be defined by the project documents as well.

3.17 Sustainability Certification & Commissioning Requirements

Early during the design phase, a project seeking a sustainability rating should perform an “eco-charrette” to determine the appropriate rating system, targeted certification level, specific credits that will be sought. The eco-charrette should include the project owner, architect, project engineers from all disciplines, and the construction, and project managers, if possible.

Once the rating system, such as LEED, Green Globes, Envision, Collaborative for High Performance Schools (CHPS), or ENERGY STAR, has been selected, the CM should facilitate a special workshop with the assistance of the commissioning agent (CxA), LEED
AP, or Green Building Facilitator (GBF) to determine procedures for attaining the selected certification and the responsibilities of each project participant. The input of the CxA and/or GBF should be considered and incorporated into quality management documents and procedures.

3.17.1 Sustainable Products and Materials

When sustainable products and materials are to be utilized, the CM should review to assure the criteria is well defined in the construction documents and includes coordination with the commissioning for the project.

3.17.2 Commissioning

Commissioning is a recommended practice. If commissioning is part of the project, the CM must review the project specifications to assure that commissioning requirements and responsibilities are clearly presented. The specifications need to establish the contractor’s responsibilities for commissioning and the commissioning agent’s role in this process.

3.18 Quality Management Specifications

The CM should assist the design team in developing specifications that clearly set forth the contractor’s responsibility for quality assurance and quality control during construction. It should also deal with the quality of various management tasks that may be expected of the contractors’ organizations during construction.

The QA/QC requirements should clearly indicate that the contractor is responsible for delivering the project in accordance with the contract documents. It should also note that the contractor has primary responsibility for quality control on the project, and it should be clear what the owner’s expectations are regarding the quality control activities of the contractor. Should the CM propose, with the owner’s approval, that the contractor have a quality assurance officer separate from other quality control inspectors, indicate this now. It should be clear if the contractor should prepare and submit for acceptance any written quality QA/QC plan for his organization or for any vendor or supplier.

The method in which the contractor will control the acceptance of materials on the site for introduction into the work should be specified. In addition to this, a procedure should be outlined as to how the contractor should identify construction, which is not in accordance with specifications, and provide corrective action or otherwise replace the unacceptable elements. These Quality Management procedures should also state the CM’s authority to
reject nonconforming work and either order replacement or allow it to remain on a reduced-cost basis if in the best interests of the owner.

The quality management specifications should also include information regarding what the procedure is regarding acceptance of various elements of the work that may occur prior to final acceptance. It should rely heavily on the use of checklists and the formal sign-off of hold-and-witness points to be used jointly by the contractor and CM in progressing certain elements of work. In this manner, an acceptable level of quality should be achieved in the final product.

### 3.19 Design Support during Construction

The CM should check that procedures and budget are established for the design team to provide design support during construction. Procedures include Request for Information, nonconformance reporting/resolution process and procedures, shop drawing review, test report review, and periodic field visits.

### 3.20 Public Relations

A focus on achieving a high level of quality has a very beneficial effect on the public and the users of the facility. Many owners are sensitive to the public perception of their facility investments. It is important to confer with the owner and establish a procedure for the dissemination of public information regarding the project. Any articles and published information should be reviewed and approved by the owner prior to publication.

### 3.21 User Review

During the course of design development, it is imperative that those who will actually use the facility have an opportunity to review the design. A design charrette provides an opportunity for all stakeholders to offer input that may be appropriate relative to the construction, maintenance, and operations of the facility. The quality of a project is often enhanced by allowing all those who will ultimately use the completed project facility an opportunity to offer input into the process. This specific quality management recommendation may be easily accomplished by having special meetings with the appropriate user group(s) and documenting the recommendations that are offered, or
otherwise simply documenting the fact that those who will ultimately be using the facility had an opportunity to offer valued comments.

### 3.22 Public Funding

The CM should maintain a high “quality image” of how the project is being managed during the design phase to representatives of any public funding agency. This can be accomplished through with regular meetings and also by furnishing copies of key job documentation to the public financing agency representative for their awareness.

The requirements of publicly funded projects are usually very specific, governed by law, and require special attention. The CM should request that the owner provide all information regarding compliance with the public funding agency requirements. Carefully review and prepare an abstract of the requirements as they relate to, but not limited to, the following: contract payments, labor rates, labor utilization, buy America requirements, applicable minority requirements, subcontracting, payment procedures, processes, performance and payment bonds, insurance, other federal and state requirements, etc. Strict compliance with these requirements is necessary to assure funding. The CM may assist the owner in preparing compliance reports on these issues when requested.

### 3.23 Project Review Meetings

The CM should establish a leadership position within the project team by scheduling and chairing review meetings at regular intervals in accordance with the pace of the project. A meeting agenda should be prepared and distributed in advance. The agenda will identify the purpose and objectives of the meeting so as to prepare the participants for their anticipated contributions to the meeting. The CM should chair each meeting and discuss the project schedule, referring to the design CPM schedule. After discussing the schedule, review major categories of performance such as design issues, submission status, agency coordination, owner reviews, sub-consultant performance, project estimate, and status of QA/QC. In this manner, all those associated with the project will understand how well they are meeting the schedule goals as well as foster a clear understanding of the ramifications to other parties when schedule goals are or are not being achieved. This will allow prompt discussion on any necessary remedial action to recover lost time.

The project review meetings should be used to confirm anticipated activities for each phase of the project. These activities include safety, schedule, cost, QA/QC reviews, and issue identification and status. The meetings during the design phase of the project should include
all prime design consultants and sub-consultants appropriate for discussions of the project at the time of the meeting. The CM should accurately record the discussions and any decisions made at the meeting. It should be clear in the minutes as to which party has an action for each topic covered. Complete and accurate project records are vital for accountability and continued control of the project processes. The CM should forward copies of all job meeting minutes to those who were in attendance, together with a representative of each sub-consultant involved in the project. Also, key members of the owner’s staff should receive copies as well as key outside organizations such as utility companies, railroads, etc., who have a stake in the project.

These meetings continue into the construction phase with major emphasis on field issues and design support. They can be held on a periodic basis, normally monthly, to confirm that the owners, CM, and designer maintain an acceptable level of quality communication.

3.24 Reports

The professional preparation of project reports is vital to the effective management and communication of the status of the project. The reports must be regularly prepared and issued in accordance with the agreed time limits established by the project team. Review of reports prior to submission should be addressed in the QMP. It is recommended that the CM author a monthly or quarterly “Construction Executive Report” which is submitted to the owner and any key representatives of the owner’s organization or funding sponsor. This report should succinctly discuss the key aspects of the project schedule, costs, and overall achievement of quality goals beginning with the design consultant at this phase and continuing through construction. The contents of the Construction Executive Report should be proposed by the CM early in the program and meet with the owner’s approval as it deals with such items as overall project scope, design development status, construction status, key project action items, program costs, changes in scope, and project safety program.

3.25 Nonconforming and Corrective Work

As part of the CM’s quality management procedures, standard forms should be developed for reporting of design work that does not conform to standards, agreements, or decisions made and any necessary corrective action, which is required. These forms would typically be generated during quality audits at any time during the design phase when any actions or inactions by the design professionals are observed which are not consistent with the owner’s goals.
The documentation of nonconforming and corrective work that is necessary is a typical part of any quality management system. It is the responsibility of the CM to educate both the owner and the design professionals in this regard. A thorough understanding of quality-related practices can prevent adversarial situations from developing.

3.26 Close-out and Warranty Management Planning

The completion of the project remains the most recent memory of the owner after the project is complete and the team is gone. The CM should assist the design team to plan for the effective management of the closeout phase of the project.

The contract document should include provisions for construction close-out documents including, as appropriate:

- Warranties/guarantees
- Punchlist preparation
- Release of retainage for punchlist completion
- Early acceptance items
- Maintenance bonds
- Certified payrolls if applicable
- Special acceptance procedures
- Record drawings
- Sustainability certification when required (LEED, Green Globes, etc.)
- Sustainable products when required
- Commissioning when required
- owner's maintenance and operation manuals
- Certificate of Occupancy and regulatory approvals
- Consent of surety, if applicable
- Final release
If the project is to be under a warranty from the contractor for a period of time, a list of the contractor’s emergency numbers must be provided. Also required is a procedure for a final inspection prior to the expiration of the warranty.

### 3.27 Quality Audits

Periodically during the design phase, the CM should perform quality audits of the designer’s QA/QC efforts. A senior member of the CM staff charged with the duty to monitor designer performance should conduct these audits. An appropriate check list of issues to be reviewed should be developed at the beginning of the program, with copies furnished to the designers so that they are aware of the issues that will be reviewed as they perform their design services.

It is recommended that, at the completion of the design phase, the CM hold a meeting with the designers who have been involved in the auditing process to review and discuss various ways that problems were identified and overcome. Discussions should be promoted on a “lessons learned” basis to improve the interface between design representatives and the CM as the project begins to lead into construction.
Chapter 4: Procurement Phase

4.1 Introduction

The Construction Management Plan that was developed by the team during the pre-design phase of the project should clearly outline the systems, methods, and procedures to be followed during the procurement phase. The quality of the procurement processes is critical to delivering fair and legal opportunities for all prospective bidders. Quality procurement processes mitigate project delays due to bid protests. This section of the Quality Management Guidelines provides guidelines for procurement planning, preparation of clear and concise instructions, source evaluation, and objective evidence of the capability to meet requirements of the contract document including required level of quality. The emphasis is placed on those planned and systematic actions required to meet the owner’s expectations, industry standards, and intended purpose.

4.2 Definitions

Bid
The act of offering to perform a scope of services or item for a specific price or other consideration(s).

Offeror
The organization that submits a proposal in response to an advertisement or solicitation.

Proposal
The act of offering to perform a scope of service or item for consideration including price and other factors.

Source
An organization that has the potential to supply the materials, equipment, or service required by the owner or CM.
4.3 Procurement Planning

Many government agencies require the pre-qualification of contractors and the pre-approval of materials and suppliers. These pre-qualifications and pre-approvals are not project specific, although most agencies pre-qualify for types of construction and magnitude of the work. Similar processes are of value on all CM assignments.

Procurement planning by the CM and owner can promote meeting project needs in the most effective and efficient manner. The detail and formality of the planning process varies with the cost and complexity of the objective. Some benefits of procurement planning include:

- Locating sources and alternatives to provide for adequate competition
- Identifying the lead time required for obtaining various materials or services
- Establishing review and approval levels
- Work load leveling
- Identifying potential problems
- Scheduling procurements for overall economy or cash flow considerations
- Improving the accuracy of cost estimates
- Identifying availability of sustainable products and materials
- Environmental preferable products

The CM procurement planning process must involve all affected parts of the owner’s organization including those responsible for establishing the requirements, the purchasing group, the end users, and those individuals who are affected by the procurement activity.

The planning may include many of the following as appropriate:

- An analysis of similar procurements
- Research to establish the availability of products and sources. This research might include an evaluation of available technology, sustainability of products, environmentally preferable products, the success of application for similar uses, the observations of others and or testing
- An analysis of constraints such as schedule, cost, performance, environmental concerns, and incompatibility with other project features
- Identification of risks and plans to reduce risks
- Estimated cost and the availability of funds
• Delivery or performance requirements
• Evaluation criteria
• Identification of potential conflicts of interest
• QA/QC program
• Reporting criteria
• Warranties or guaranties
• Pre-qualification of vendors and contractors
• Solicitation requirements
• Contract type and special clauses
• Contract performance
• Liquidated damages
• Bid bond
• Payment and performance bond

4.4 Advertising & Solicitation of Bids

The purpose of proposal advertising is to alert qualified sources to the owner’s need for material, equipment, or services. Government agencies usually have a prescribed method for contacting vendors and contractors. All legal requirements must be adhered to. The CM must develop a program to attract the appropriate qualified sources when the method of advertising the proposal is not dictated by the owner. Recommended actions include1:

• Define the sources of expertise that will provide the product or services to be procured, including vendors and contractors with experience or proven knowledge of sustainable procurement strategies, when applicable.
• Select the display media to effectively reach the target audience.
• Typical advertising placement:
  o Local newspapers

1 Note: In the event the product or service is complicated, the advertisement might not establish sufficient level of detail to determine interest, provide additional details by a separate solicitation package. When utilizing this process, schedule additional time for mailing and proposal preparation.
• Area journals of commerce
• Commerce Business Daily (CBD)
• Plan center postings
• Trade association and agency news letters
• Trade magazines
• Mailing lists
• Telephone solicitation
• Fax messages
• Internet

• Include the following basic information in the advertisement:
  • Title of product or service (i.e. vertical fire pumps, excavation contractor, wet-lands survey)
  • Product description or scope of service to be furnished in sufficient detail for the reader to determine if the source has the potential qualifications
  • When applicable, sustainability certification level, high-performance building criteria, and sustainable products
  • Evaluation criteria
  • Type of contract
  • When, where, and to whom the proposal is to be delivered and the conditions if it is late
  • Advise if proposals will be publicly opened and read aloud
  • Contact for additional information (i.e. name and telephone number, Fax, or e-mail)
  • When applicable, time, date, location for a pre-proposal conference and/or site visit and if attendance is mandatory
  • Minority participation requirements, if applicable
  • Instructions on where and how to obtain plans, specifications, or other solicitation materials. In the event fees are to be charged for the documents, indicate the amount. If documents are available at plan centers, indicate location
  • Specify bonding requirements
  • Indicated rules for withdrawal of proposals
  • Indicate the duration the proposals will be firm
State the rights to reject any or all proposals and to waive any informalities or irregularities in the proposals received at no cost to the owner, as allowed by applicable laws

Note that a contractor quality control program or other project specific programs such as safety will be required for the project

The solicitation should address each of the applicable items noted above in full detail. When issued, solicitations should be made available to qualified sources on inquiry. Distribution to others such as plan centers, trade associations, information services, publishers, and others is optional. An accurate record of distribution should be maintained by the CM in the event addenda or other notices are required. If the solicitation is voluminous, it is common practice to establish a fee for the solicitation package. The fee generally reflects the reproduction cost of the solicitation. Cost can be minimized by distribution of CDs or emails of the solicitation package.

Another alternative for voluminous solicitations is to issue a synopsis. The synopsis should identify a location where the solicitation package can be examined and the fee to be paid to obtain a copy.

In the event clarifications or corrections are required after the solicitation is issued, addenda can be issued to all solicitation holders. Addenda should be in writing and issued with sufficient time to allow the bidders time to reflect the changes/clarifications in their proposal.

Generally, solicitations are not canceled. However, circumstances may justify this action. All solicitation holders should be notified of the cancellation.

4.5 Select Bidders List

The owner and CM may wish to limit solicitations for equipment, materials, and/or services to a specific group of sources that have demonstrated reliable quality and performance on past projects. Many government agencies pre-qualify contractors and pre-approve equipment and materials. A select bidders list can fulfill this need on non-government contracts. Limiting the sources may be prudent to obtain service, equipment, or materials that are compatible with existing conditions. The risk of limited sources is reduced competition, which can result in higher costs. A wide variety of listings by product type and services are available to use when developing a source list. Some of the more common listings can be obtained from the following:
• Thomas Register
• Sweets Architectural Catalog
• Blue Book Contractors Register
• Trade associations
• Company approved source lists
• Manufacturers’ associations
• Manufacturers’ representatives
• Professional societies
• State professional registration roster
• Internet searches

4.6 Instructions to Bidders

The advertisement and/or solicitation should contain clear and concise instructions to the offeror on how to prepare and submit the proposal. The preparation of well thought out instructions to bidders can save the owner and CM a significant amount of time and expense during proposal evaluation through uniformity of proposal data presentation. Some items to consider when preparing instructions to bidders are as follows:

• Define terms
• State basis for selection (i.e., lowest cost, cost and schedule, experience, assigned personnel, quality control program, safety record, etc.)
• How to obtain copies of proposal documents
• Minimum qualifications of bidders. Include sustainability certification or high performance-building performance if applicable
• Where and when contract documents and/or site can be examined or obtained
• How to obtain interpretations and issue of addenda
• Proposal security requirements
• Contract time
• Liquidated damages
• Substitutions or equal items
• Identification of subcontractors, supplies, and others
• Proposal form
• Submission of proposal (i.e. time, location to deliver the proposal)
• Modifications and withdrawal of proposal
• Opening of proposal, time and location
• Time period for acceptance
• Award of contract procedures
• Contract security
• Signing of the contract
• Minority requirements
• Pre-proposal conference
• Sales and use taxes
• Retainage
• Identification of the proposal (i.e. title, number, etc.)
• Packaging of the proposal (such as separate envelope for technical proposal evaluated first) and separate envelope for price proposal (evaluated second only if technical proposal meets the solicitation technical requirements)
• Attachments to the proposal such as:
  o Proposal/Bid Bond
  o Annual financial report
  o Insurance certificates
  o Unit prices
  o Alternates
  o Non-collusion affidavit
  o References
  o List of similar projects/products
  o Technical or other questionnaires
  o List of subcontractors
  o Minority or small business participants
  o Acknowledge of addenda
4.7 Pre-Bid Conference

The pre-bid conference is an important element of the project’s quality management strategy. The prospective bidders must understand the complete quality responsibilities and objectives of the project team that they will be seeking to join. This conference will provide project orientation and clarify any issues for the bidders including sustainability certification or high-performance building criteria when part of the project. In many instances, a site visit is conducted as part of the pre-bid conference.

The notice of the pre-bid conference should be given in the advertisement and solicitation. Prospective bidders should be instructed to submit written questions in advance, so that prepared answers can be distributed at the conference. Any questions that arise during the conference must be included with answers in the meeting minutes. Answers that alter the bid documents should be issued as an addendum.

The conference should be conducted by the CM for the owner. Design personnel should also attend. Sufficient personnel should be available from the project team to address any technical, contractual, or administration issues that might arise. Minutes of the conference should be prepared by the CM for job record purposes and copied to all attendees for review. The CM should clarify at the meeting that only items that are issued in a forthcoming addendum will be deemed to be the basis of changing any part of the advertised bid documents. Subsequent to the meeting, the CM should work with the owner and design team to prepare any necessary addendum and issue it in a timely manner to allow the formal bid submission to take place. To amplify the quality of the contractor’s bid, every effort should be made to allow a reasonable time between the issuance of any addendum and the bid opening date to avoid last-minute errors that may be generated by not having enough time to fully understand the issues associated with the changes in the addendum.

4.8 Proposal Document Protocol and Bid Opening

Most public agencies and many major corporations have specific procedures concerning proposal document protocol and bid openings. The CM must understand these procedures and instruct the project team accordingly.

Before solicitation, information concerning proposed purchases must not be released before the advertisement/solicitation is issued. Exceptions are public announcements, briefings, or notices. Generally, solicitation information should be restricted in-house to those having a need to know.
After solicitation, only the designated owner, CM representative, and/or others specifically authorized should communicate or transmit information pertaining to the solicitation. Any information provided to a prospective bidder must be provided to all prospective bidders in the form of an addendum when the information is needed for the preparation of proposals. When it becomes apparent that an ambiguity must be clarified or an error corrected, the solicitation must be modified by addendum.

After receipt of proposals, the contents and the identity of bidders may be publicly read. In the case of a private bid, the information should not be disclosed outside the firm and should be limited to persons with the need to know. Disclosures of one bidder’s information with another bidder are not permitted.

To achieve a quality-oriented approach, a detailed check list of proposal contents should be read at bid opening to review that necessary information has been fully submitted to determine responsiveness.

In general, late proposals are considered to be non-responsive. Some owners will consider late proposals when there is no impact to the evaluation process and the proposal offers a significant cost, quality, or technical benefit. Policy on late submissions should be clearly established in the solicitation, and must be consistent with applicable state or federal law.

Addendums, when issued, must be specifically acknowledged in the proposal. Proposals lacking significant solicitation requirements are generally considered non-responsive unless the solicitation permits negotiation and discussion with the bidder to clarify cost, quality, or delivery.

### 4.9 Pre-Award Conference

The owner and CM should conduct a pre-award conference with the apparent successful bidder. Prior to the pre-award conference the CM should assure the quality of the selection process by verifying any and all required licenses, that the contract meets all pre-qualification requirements, bonds and insurance are in accordance with the specifications, there are no irregularities, and verify proposal calculations. The purpose of the conference is to review the scope of service and pricing to make sure there is a clear understanding by both parties of what is to be delivered, the schedule and the level of quality. This is the time (i.e. before the contract is signed) to explore and make sure both parties fully understand their responsibilities and commitments. The conference provides an opportunity resolve potential problems, explore proposal alternatives, and clarify any minor proposal errors and to identify insurance, labor subcontracting, safety, accounting, permits, quality, and any other special contract terms. Meeting notes should be prepared and signed by both parties. Any items
which are to be added or revised should be incorporated into the contract prior to signature/acceptance.

### 4.10 Contract Award

Most public agencies and many major corporations have well-defined procedures for formally notifying the successful bidder that they have been selected for award. The CM must understand and execute these procedures. In general, the owner or CM should formally notify the successful bidder by letter that they have been selected for award. The prerequisites for actual award are normally part of the solicitation. Depending on specification requirements, and in addition to normal pre-award submissions by the contractor, a submission of the contractor’s quality control plan addressing his/her approach to quality assurance and quality control may be required at this time as a condition of award. Otherwise, some of the common prerequisites for the contractor to provide are as follows:

- Performance bond
- Payment bond
- Insurance certificates/policies
- Health and safety plan
- Other special requirements

The selected contractor should be instructed to deliver the appropriate number of signed contract documents to the owner who in turn will sign and transmit the appropriate number of the contract documents, including drawings and specifications, to the contractor.

The CM or owner should issue a notice to proceed when owner approval is received and after the construction contract is executed.

The CM or owner should notify the unsuccessful bidders by letter that they were not successful. If requested, the CM may hold conferences with the unsuccessful bidders to advise them in general terms why their proposal was not accepted. Care should be exercised to avoid formal bid protest during this process. This practice helps the unsuccessful bidders improve the quality of future proposals.
Chapter 5: Construction Phase

5.1 Introduction

The project’s Construction Management Plan and contract documents address the level of quality required throughout the course of the project. It is the contractor’s responsibility to attain the quality as defined by these contract documents and referenced specifications, standards and codes, with the CM monitoring compliance. The CM utilizes quality management techniques through the performance of required services.

5.2 Contractor Quality Assurance/Quality Control (QA/QC)

The contractor should achieve construction quality requirements by utilizing the specified materials, competent craft persons to install the materials and implementation of a formal construction quality control program. The program should be a written document, which includes procedures or instructions and is normally called a quality control (QC) manual. The CM should review the contractor QA/QC topics in the QC manual to be certain the procedures adequately address the type of work required by the contract document. In this manner, the CM will monitor that sufficient clarity is achieved in the expectations of the contractor’s quality control requirements that are consistent with these Quality Management Guidelines and the contract document. If not required to be submitted as a condition of award, any contractor QC program should be specified to be submitted for acceptance before physical work is started.

It is the CM’s responsibility to monitor the effectiveness of the contractor’s QA/QC program in achieving the level of quality specified by the contract. The CM should perform and document regular quality audits on the contractor’s program to ascertain that the program is working and effective. The CM must also promote the resolution of quality-related problems in a manner that achieves compliance with the specification requirements.
5.3 Pre-Construction Conference

The project specifications should require a Pre-Construction Conference, attended by the contractor, owner, CM, affected utilities and local agencies, and design professionals, to review and discuss the overall project. This meeting should take place as soon as possible after a contract is signed and be chaired by the CM, who will also prepare and distribute minutes. The contractor should present a formal description of the firm’s organization structure, usually an organization chart. The organization chart should identify key positions and the formal reporting relationship. The duties, responsibilities, and authority, including quality, for each position on the organization chart needs to be established in writing. During this meeting, the contractor should also submit a summary level schedule and 30 day look-ahead of his/her activities. This will serve as the project schedule for the CM to monitor until acceptance of the official schedule.

The contractor’s organization structure should identify the project level person that is responsible for quality control. This person should be independent from direct project budget and schedule responsibilities and must be given sufficient organization independence to identify, report, and verify correction of quality issues. Typically, this person for quality related matters, reports directly to an officer of the construction firm.

The CM should develop an emergency response plan which should include a contact list of normal and emergency telephone numbers, email, and physical addresses, for the key persons involved in the project including contractor personnel, federal, state, and local agencies, design representatives, owner’s representatives, and the CM’s project staff. The project organization and contact list must be kept current throughout the construction phase of the project.

5.4 Partnering

It is recommended that the construction phase of the project be initiated with a formal partnering session of all project stakeholders; the session should be provided for in the contract document. All of the entities that were included in the design phase partnering should be represented along with representatives of the contractor, major sub-contractors and major materials suppliers. The facilitator that was used in the design phase partnering might conduct this session also. Once again, to maintain focus on quality goals, quarterly executive partnering sessions are recommended during construction. Review of the LEED/Green Globe score sheet at the first partnering meeting and the progress at each subsequent meeting to keep everyone informed on the sustainability efforts and the success in reaching the certification goals.
### 5.5 Construction Planning and Scheduling

The contract documents typically allocate a specific number of working days, calendar days, or a fixed calendar date for the completion of the work. The contractor must submit a realistic work plan and CPM schedule that conforms to the contract’s requirements. The schedule duration must include sufficient time to produce quality work and include time for submission, acceptance, testing, inspection, and verification. The CM should review and recommend acceptance of the contractor’s schedule to the owner. The CM should also coordinate with the owner and designer to make them aware of areas where they have performance duties to support the project schedule. The CM should recognize that sustainability requirements may add time to some functions, especially procurement, submittal and delivery activities. Proactive planning for such conditions is critical.

The review by the CM should be as comprehensive as necessary to ascertain whether the major components of the design and systems to be constructed are adequately addressed and represented in a reasonable manner as far as the general planning logic as well as the durations shown. A quality-oriented checklist should be used to limit overlooking certain schedule issues. The CM’s effort in this regard should be to review the schedule to the level of detail necessary to observe that no major errors exist in the schedule and that the basic logic, sequencing, and flow of work reasonably conform to both the contract requirements and general industry practice. The CM should also satisfy himself that the schedule is sufficiently free of errors which would cause later evaluations of changes to be impossible, since it may not have correctly addressed the contractor’s real planning desires. When applicable, time should be allowed for sustainability and commissioning activities.

The plan and schedule are dynamic and must be periodically modified to reflect changing conditions and the actual production versus planned. It is the contractor’s responsibility to revise the schedule when required and provide the resources necessary to meet the contract requirements on quality and time. The CM should review and recommend acceptance of all schedule revisions. While it is the contractor’s responsibility to revise the schedule, it is the CM’s responsibility to monitor the schedule to protect the owner’s interests and be in a position to help mitigate any delays or disruptions which may occur. It is also the CM’s responsibility to promote a request for a revised schedule when he ascertains that the contractor is either falling significantly behind an operation or working in a manner that is materially different from his/her approved schedule logic.

Schedule updates should be performed jointly with the contractor on, at least, a monthly basis. Immediately prior to progress meetings is ideal and will increase the quality of the schedule report.
5.6 Inspection and Testing

Most government agencies and many major corporations have detailed procedures designating the inspections and tests required for their projects. As a minimum, the contractor’s QA/QC program must include provisions to confirm that specified inspections and tests occur at the appropriate times during the construction process. These procedures assure that the specified materials have been put in the right way, at the right time, in the right quantity, and in the right place. Additionally, procedures for measurement and payment should be addressed as well as procedures for documenting all of the above. The CM should confirm that the inspections and tests are in accordance with the contract specifications, including any sustainability submittal requirements.

The inspection and testing program will be project specific. This program must be fully defined in the contract documents and the CM must monitor the contractor’s compliance to the contract. The CM must verify that the contractor’s QC program adequately addresses the requirement to insure that products submitted and approved are the products utilized on the site. Attention to detail is paramount as products sometimes viewed as the least critical are the most important. Such products include but are not limited to PVC glues, construction adhesives, primers/sealers, glues for finish installation and paints/coatings, and products with volatile organic compounds (VOC) limits.

5.7 Control of Testing and Measuring Equipment

The contractor’s quality control program should include procedures to confirm that only correct and calibrated equipment are used for critical measurements and acceptance testing. The measurements and items requiring control should be identified in the contract documents. Craft steel measuring tapes do not require calibration or inspection, but items such as pressure test gauges, torque wrenches, and digital style electrical meters may require control and calibration depending on the application. For example, the acceptance pressure test of a pipeline at 300-psi using a gauge that has not been calibrated is a significant risk.

The major elements of the test and measuring equipment control program are assignment of unique identification test and measurement equipment, establishment of the frequency of calibration, documentary evidence of use and calibration, and a standard corrective action process if an item previously used for critical measurements or acceptance testing is found to be out of calibration.
The CM should review the contract documents for indications that appropriate test and measurement devices are identified. The CM should also review contractor’s procedures by auditing to observe that the QA/QC program is satisfactory, and is being implemented.

The CM should ask for verification of testing instruments used by the commissioning agent and/or other testing consultants/contractors doing International Accreditation Service (IAS) accredited testing and monitoring to insure they are properly qualified.

### 5.8 Reports and Record Keeping

The CM is the comprehensive repository for project records for the owner. The CM will maintain thorough documentation of daily inspection efforts, tests, and results. In addition, records are maintained of all pertinent project data and correspondence, progress photos, and photos of existing conditions prior to the construction notice to proceed. Correspondence would include all submissions by the contractor, approvals by the owner, shop drawings, change orders, logs, certifications, guaranties, or warranties, etc.

In many instances, the contract documents require the contractor to provide records that document the QA/QC program and to provide as-built drawings for the project. The CM should audit these records to determine if they are being maintained in compliance with the contract. All records must be well labeled and kept neatly and orderly for retrieval and securely stored.

Sustainable projects require extensive documentation to demonstrate compliance during design and construction. The CM should oversee the preparation of the LEED/sustainability documentation and assure timely submittal for certification.

Commissioning also requires records to demonstrative compliance with operating criteria. The CM should assure such documentation is developed per the commissioning plan for the project.

The CM should continually insure that the sustainability consultant, often LEED AP, is receiving timely and necessary information to document the construction efforts in such detail as is required for the certification sought. Any lack of adequate information, record keeping, or effort on the part of any party must be brought to the attention of the owner and rectified as soon as it is known.
5.9 Changes in Work

The contract documents set forth the specific requirements to document and obtain approval by the owner of any changes in the work. The contractor’s QA/QC program should outline the procedures his/her staff must follow when changes occur. The CM is routinely charged with the responsibility to evaluate any changes, deletions, or additions to the work under the contract as to its effect on construction time, cost, and quality. The CM should also propose an acceptable change order administration process to the owner.

The CM or sustainability consultant should confirm what impact any proposed change orders on the project have on the targeted sustainability requirements for the project. Any impact should be proactively communicated in writing to the project team in order to find an alternative solution that does not negatively affect the targeted sustainability certification level, keeping in mind the project budget and schedule. All executed change orders, and backup documentation that affect the targeted sustainability certification level should be compiled by the CM or sustainability consultant throughout the project for submission to the accrediting agency.

5.10 Document Control and Distribution

The CM establishes procedures for document control and distribution of approved contract plans and specifications. The CM should assure document control is working and current releases for construction, revised drawings, and all other pertinent documents are being used. A log must be maintained of all current documents.

The contractor must establish a program to control the contract documents used to construct the project for subs and his/her forces and distribute them accordingly. The basic design documents requiring control include drawings, specifications, and modifications to them. The control system should confirm that design documents are available for the work to be performed and that only the current applicable design documents are used to construct the project.

The program must recognize that only the designated design agency/organization has the authority to perform design or change previously approved and issued design documents. When designs are found to be incomplete or cannot be built due to field or other conditions, changes and revisions to the design must be approved by the responsible charge engineer/architect or engineer/architect of record. When the contractor performs work without using the current applicable design, the contractor is at risk for the work’s not being accepted.
The CM should set up logs or other collaborative systems to assure that request for information are responded to and submittals are processed in a timely manner. The CM should check to assure that the RFI and submittal systems are responsive to the project’s needs.

The CM should review the contract document control section of the contractor’s QA/QC manual to determine if the program is set up and working. The audit should include a check of document holders at the construction site to determine that they have and are using the latest drawings, specifications and other appropriate information. The USGBC documentation requirements for LEED certification are strict, which makes proper documentation control and distribution important. The firm responsible for the LEED certification, along with all team members, must receive all current documents in a timely manner. The document control and distribution procedure should include requirements regarding distribution to the firm responsible for the LEED certification.

5.11 Nonconforming and Corrective Work

The contract specifications should clearly state the specific requirements for contractor quality control and quality assurance for the project. The contractor should systematically review quality control efforts by his/her forces, including the results of all inspections and tests. Items may be identified which are not in conformance with the contract specifications. These items should be reviewed for technical acceptability by the engineer/architect of record. A log must be maintained by the contractor, with copies to the CM, of all such items and their correction as a result of an acceptable action by the contractor.

Non-conforming and corrective work has the potential to negatively affect the targeted sustainability certification level. The project team, including the CM, has the responsibility to assure that non-conforming work is corrected and any deviations from the contract documents should be properly documented. This documentation should be included in the sustainability certification submission package where required.

5.12 Quality Audits

The quality audit is a periodic review of the contractor’s quality control program conducted under the direction of the manager of the contractor’s quality department or other entity independent of the construction project team to determine the extent to which the quality system fulfills contractually imposed quality requirements. The audit plan is a formal check list of items prepared by the CM in advance of the audit which outlines requirements and
The audit report should include recommendations for corrective action of the program to avoid recurrence of quality problems identified. The auditor may use technically qualified personnel from other sources to assist in the audit process and resolution of findings. A written audit report is required.

The CM should ascertain whether the audits are conducted on a reasonable schedule and the appropriate corrective actions are implemented for the project. The CM may also perform independent QA audits when requested or approved by the owner. Such actions by the CM do not limit any contractor responsibility for full compliance with the QA/QC requirements of the contract documents and the full and acceptable completion of contract work.
5.13 Job Meetings

The CM should conduct these meetings on a regular basis appropriate to the scale, complexity, and risks of the project as outlined in the CMP. They should be chaired by the CM who will enhance the quality of communications and coordination value of the meetings by having a consistent agenda of job topics. Attendees should include the CM, contractor, key representatives from subcontractors, an owner’s representative, key representatives from the firm or persons responsible for obtaining sustainability certification, and a designer representative when required. This meeting agenda should be developed when the CMP is written and cover the general topics that must be covered routinely during each meeting. The actual agenda used for each meeting should be distributed beforehand and be customized to the degree necessary to cover contemporaneous job events. However, this should be accomplished within general job topic parameters. In this manner, there is a limited potential that certain issues are not discussed or overlooked and not documented. Some of the general topics for the agenda are:

- Project schedule status
- General work issues (old business and new business)
- Status of change orders
- Submittal status
- Sustainability documentation when appropriate
- Safety
- Labor and equipment status
- Project cost status
- Non-conformance and corrective action status
- Risk identification
- Commissioning
- Request for Information log
- Change order log
- Issues log

5.14 Progress Payments

The CM should propose an acceptable contractor progress payment process to the owner, unless one exists within the owner’s present plan of operations. The progress process should
include a schedule of values mutually agreeable to the contractor and the owner. Progress payments are based on items prefabricated, materials received and physical construction completed. The degree of completion must take into account the level of quality for the materials received and construction completed. In the event rework is anticipated, sufficient funds should be withheld from the progress payment to cover the corrective action. The CM should only approve requests for payment for accepted materials/items or completed and accepted construction as defined in the contract documents.

The progress payment process should include any sustainability or LEED certification requirements. The contractor should include in their schedule of values a line item for these requirements and should be paid a percentage as progress is made.

5.15 Final Reviews, Documentation, and Punchlist Work

As the project approaches beneficial occupancy/substantial completion, the construction quality program should include reviews of incomplete work, corrective actions to remedy nonconformance and other quality requirements including documentation. The reviews should also include any sustainability certification requirements. Punchlists of incomplete work and corrective actions should be reviewed for completeness by the CM. The punchlist should assign clear responsibility for remedial measures of the items with target dates for their completion. It is recommended that the punchlist be developed by the CM and reviewed by the contractor and jointly signed off. In this manner, confusion and outdated punchlist issues will be avoided. The owner’s operations and maintenance representative(s) should participate in these efforts and be invited to all punchlist inspections. The contractor and CM must monitor this work to determine that all punchlist items are satisfactorily completed.

5.16 Public Relations

While all project owners are concerned with their public images, most public agencies and major corporations have public relations professionals with primary responsibilities in this area. Typically, these professionals are seeking to show that the project is essential, cost effective and of the appropriate quality and seeking to achieve a level of sustainability certification. They want to portray the owner as a good neighbor, concerned with quality of life of the community.
It is the CM’s responsibility to work with these public relations professionals to help them to generally understand the technical aspects of the project and the Construction Management Plan that is being utilized and the sustainability certification goals for the project. All requests for information must be addressed through the owner’s PR professionals. Any news releases or similar public information efforts should utilize the owner’s staff.

If this expertise is not available within the owner’s organization, the partnering sessions should identify a project spokesperson. The CM or a representative of the owner is a logical candidate for this assignment. All public relations/information should funnel through this specific person.

5.17 Special Operations Control

The CM must be aware of various elements in the project requiring special operations control including sustainability elements particularly if the project is identified to be considered under the LEED certification process or similar. These elements may be related to heavy construction field activities as well as those associated with manufacturing facilities, treatment plants, operations control centers, and other facilities dealing with instrumentation and control systems or other as required by contract. To provide for an acceptable level of quality in the project for these facilities, the CM should review the specification requirements for the work with the contractor to confirm that the contractor and its suppliers are focused on quality and the specific requirements as noted by contract. Attention should be paid to the impact on the environment and any requirements related to sustainable construction approaches or processes. They should recognize the need to install these elements in the completed project in a manner that allows them to be utilized for their intended purpose.

5.18 Commissioning

Commissioning is the process for achieving, verifying, and documenting the performance of mechanical, electrical, controls, communications, and other systems to confirm that they function together properly to comply with the performance requirements in a composite manner that achieves the design intent and owner’s operational needs. Proper commissioning will achieve acceptable quality control by eliminating reporting errors, checking correct system installation, enabling verification of systems operation before turn
over, and mandating proper operations and maintenance documentation. It is recommended the construction manager manage the commissioning process².

5.18.1 The Commissioning Plan

The purpose of the commissioning plan is to:

• Outline the organization, scheduling, documentation, etc. pertaining to the overall commissioning process.

• Provide direction for the commissioning process during construction and acceptance, particularly providing resolution for issues and providing details that cannot be, or were not, fully developed during design, such as scheduling, participation of various parties related to the specific project, actual lines of reporting, approval, and coordination.

5.18.2 Commissioning Plan Scope

The commissioning plan should include the requirements that each party involved in the commissioning process will have to accomplish, define the responsibilities of each participant including sequencing, scheduling, documentation requirements, verification procedures, etc. The Commissioning Plan should include the following:

• Detailed procedures for the test to be performed by each party participant in the commissioning process.

• Detailed checklist lists for pre-commissioning inspections and tests. (A list of items to inspect and elementary component tests to conduct to verify proper installation of equipment. The checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation. However, some checklist items entail simple testing of the function of a component or

²References and sources for more information:
Building Commissioning Association: http://www.bxcxA.org; resources include:
BCA Commissioning Training Courses, Downloads, The Checklist Newsletter, Member List.
equipment or system. The checklist augments and is combined with the manufacture’s start-up checklist.)

- Detailed checklist lists for functional performance testing. (The full range of checks and tests carried out to determine if all components, sub-systems, systems, and interfaces between systems function in accordance with the contract documents. In this context, “function” includes all modes and sequences of control operation, all interlocks and conditional control responses, and all specified responses to abnormal emergency conditions.)
- Report forms that will be issued to submit record test data and results.
- A list of test equipment to be used and equipment calibration requirements.
- Sequence and schedule of procedures.
- Definition of acceptable performance and tolerance for each component or system to meet specified design parameters under actual load.
- Other items as may be specified in contract documents.

5.18.3 Roles and Responsibilities

The commissioning plan should define the roles, responsibilities, and levels of authority of the personnel and firms involved in the commissioning process. Typical participants are as follows:

- Construction Manager (provides management expertise, administration, resolve disputes/claims, dispute resolution, scheduling, coordination, cost estimating, quality assurance, and technical expertise)
- Commissioning agent (prepares commissioning plan, monitors commissioning, reviews documentation. Note: The construction manager or contractor may perform some or all of these functions.)
- Owners maintenance staff (witnesses and participate as part of training)
- Owners operations staff (witnesses and participate as part of training)
- Design engineer (provides performance requirements, set points, etc. and resolves controls issues)
- Contractor test engineer (prepares pre-commissioning checklist lists and performance test plans, witness tests, collects data and prepares reports)
- Contractor quality control (assures compliance with procedures and corrections of nonconformance)
• Manufacturer’s representative (defines technical requirements of equipment, provides start-up instructions and assistance to resolve problems)

5.18.4 Procedures for Pre-Commissioning Checklists

The procedures should include as appropriate, but are not limited to the following items performed by the commissioning agent or contractor:

• Verification that specified construction phase inspection/testing is complete. (i.e. items such as completion of installation checklists list complete, resolution of construction nonconformance resolved, hydrostatic testing of piping, continuity testing of cables before termination, etc.)
• Visual inspection of the component or equipment for damage, area cleanliness, access, and readiness for pre-commissioning activities.
• Manufacturer’s start-up checklist.
• Contract document requirements prior to start-up.
• Procedures for performance tests
• The procedures should include as appropriate, but are not limited to the following items for the commissioning agent or contractor:
  • Monitoring of the performance of subsystems consisting of combinations of equipment.
  • Verification Monitoring of the performance of automatic controls, and automatic system features, and automatic system functions. Checks include seasonal modes, day/night or time period operations, and preprogrammed events.
  • Verification Monitoring of the performance of each piece of equipment.
  • Verification Monitoring of the performance of all life safety devices and systems and the interface with other life safety functions and other systems.
  • Monitoring that distributed processing, distributed command, or distributed control system communicate with the system head-end and field hardware or other system equipment as required by the system design of operation.
  • Verification monitoring of the performance and correct operation of interfaces between systems.
  • Verification monitoring to assure that the system operates as a complete operational, whole system.
  • Appropriate documentation of performance such as test reports, data collected and/or charts.
5.18.5 Commissioning Process
This section outlines the suggested sequence of events to implement a Commissioning Plan:

- **Kick-off Meeting:** A commissioning kick-off meeting should be scheduled early in the construction schedule, generally around 20 to 30% complete. The purpose of the meeting is to familiarize the owner, designer, contractor, the commissioning agent (as applicable), and construction manager with the commissioning process, to present the initial draft plan for commissioning for review, and to define the roles and responsibilities the construction manager, owner, contractor and manufactures representative throughout the process. The agenda is typically prepared by the commissioning agent who will also prepare and distribute the kick-off meeting notes.

- **Scoping Meetings:** Scoping meetings involve all parties that will be involved in the process. Typically, these parties are the construction manager, owner’s maintenance and operations representative, the design engineer, the test engineer, the quality control manager, the quality assurance manager, the general contractor, appropriate subcontractors, and the commissioning agent. The commissioning process and lines of reporting are finalized. The flow of documents and types of submittal data is presented and finalized. A schedule is established and integrated with the construction schedule.

- **Final Commissioning Plan:** The commissioning agent finalizes drafts the plan and obtains comments from the participants and issues the final plan for implementation. Meetings are held as required to develop the pre-commissioning checklists and functional performance test plans for each system.

- **Site Observation/Installation Verification:** The construction manager has the responsibility to coordinate the scheduling of construction, the installation verification by the commissioning agent and completion of the pre-commissioning checklist by the appropriate contractor for specific pieces of equipment. When the pre-commissioning checklist is complete and reviewed, functional performance testing can proceed. No sampling strategies are used for the pre-commissioning checklist.

- **Start-Up:** Using the function performance test plan, safeguards, control, interlocks, set points, etc. are activated and determined to operate correctly. When these prerequisites are found to be acceptable by the commissioning agent and then, per the test plan, the equipment and system can be started up. Initial operation is visually observed and parameters verified to conform to the test plan before the equipment is allowed to operate unattended.

- **Deficiencies and Nonconformance:** Deficiencies discovered during the process are documented and appropriate corrective actions are determined for
correction of nonconformance. Nonconformance reports become a part of the commissioning documentation. When required, the corrective action may require re-testing.

- **Sampling:** Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using sampling strategies. These strategies, if used, must be established in the commissioning plan.

- **Training and Orientation:** The owner’s operations and maintenance personnel should, as a minimum, observe and whenever possible, participate in the functional testing and start-up. It is advisable that prior to hands on involvement, the owner’s operations and maintenance personnel be given classroom presentations on the equipment and controls. They should become familiar with the equipment operations and maintenance manuals. Attendance at training should be documented and examinations may be appropriate for complex items and systems.

- **Documentation/Records:** The commissioning agent will review all pre-commissioning checklists and all function performance test reports. The agent will assure observe that the equipment/system performance met the contract document requirements. Deficiencies will be reviewed, corrected, or accepted by the design engineer and/or owner. The documentation/records should be compiled, organized, and indexed for easy retrieval.

- **Summary Report:** The commissioning agent should provide a final summary narrative report to the owner. The report should include an executive summary, list of participants and roles, brief systems/building description, overview of commissioning and testing scope and a general description of testing and verification monitoring methods. Appendices to the report will contain the pre-commissioning checklists, functional performance test reports, meeting minutes, progress reports, deficiency lists, findings, unresolved issues, communications, etc.

### 5.19 Disputes Avoidance and Resolution

The formal partnering session will set up or identify the dispute resolution process for the project using techniques that seek decisions at the lowest possible level and as quickly as possible. This process resulting from the partnering session should be included in the CMP, and consider the relationships defined in the general conditions of the contract. The CM should make every effort to resolve issues before they progress to disputes, then claims, then costly litigation. Negotiation and reasonable understanding of all party positions are keys to making this happen. Whenever resolution cannot be attained within a specified time at each
level, the CM must move the dispute to the next level in accordance with the established project process in a timely manner until a satisfactory resolution is attained. Should job level efforts fail at resolving a dispute, the contractor or owner may utilize the formal process outlined in the contract documents.

5.20 Project Documentation

The CM has a responsibility to document the contractor’s progress on the project. This may be accomplished by utilizing field inspector diaries (FID’s) for the CM’s staff, together with either a resident engineer’s or project manager’s daily report or contractors reports which summarizes all general activities on the project and reflects a compilation of the activities reviewed by individual inspectors on the CM team.

The Construction Management Plan for the project will dictate the methodology to be utilized for project documentation including reports, quality measurements, records, job correspondence, and other types of documentation. During the performance of the CM’s services during the construction phase, it is imperative that the CM be well aware that effective documentation of job occurrences is mandatory. Proper documentation will serve the owner well to assess past events on a project as well as form the basis to approve or deny any contractor request for additional compensation which may be submitted after the completion of construction.

5.21 Beneficial Occupancy

This term, if used on the project, should be defined in the contract documents. Generally, it represents the time that a particular facility, structure, or area is determined to be fit for use by the owner for its intended purpose. This is also the time the contractor’s insurance generally ends and the owner’s coverage requirements begin upon using a facility when responsibilities for insurance, utilities, maintenance, and warranties are either changed or begun. Many municipalities require a formal “Certificate of Occupancy” to be issued prior to allowing an owner to fully utilize a facility. It may also be issued as a “Temporary Certificate of Occupancy” depending on the owner’s needs.

The CM should not recommend beneficial occupancy to the owner until the project punchlist is prepared by the contractor, accepted by the CM and owner, and all specific areas identified are available for use. The punchlist documents the work items the contractor still needs to complete. During beneficial occupancy, items of damage/rework, which may have
been caused by the owner’s use of any system or space, should be identified and a negotiated change order issued to repair any damaged areas.

5.22 Substantial Completion

The contract documents should define what level of completion is required to meet this milestone. The CM should review the contract and completed work to record that the contractor has attained this milestone as defined by the contract and make appropriate recommendations to the owner. The owner and design professional should concur that the milestone has been reached. Minor punchlist work not affecting the use of the facility by the owner may remain incomplete with the approval of the owner and CM for substantial completion. All such incomplete punchlist work should have an agreed upon time frame for completion together with an acceptable withholding of costs for such work.

5.23 Sustainability Rating/Certification

When the project requires a specific sustainability rating or certification (LEED, Green Globes, etc.) the CM should take the lead on pulling together the information needed to meet the certification level desired and assure that the submittal is accomplished in a timely manner and all questions are addressed.

5.24 Final Acceptance

Upon completion of the work, the contractor will provide written notice that the work is ready for final inspection. The final inspection should be a formal site tour with the CM, owner, contractor, and designer with minutes prepared by the CM documenting the inspection and noting relative comments that may result in final punchlist items. The CM should confirm that all outstanding punchlist work is complete and acceptable and then recommend final acceptance to the owner. Final acceptance includes acceptance of the physical work, including submission of contract close-out items. Typical contract close-out items include:

- Affidavits that payrolls, bills for materials and equipment, and other indebtedness connected with the work have been paid and satisfied.
- A certificate indicating that insurance will remain in force after final payment in accordance with the time and value established in the contract.
- Consent of surety to final payment if required by contract.
- Other data if specified in the contract establishing payment or satisfaction of obligations such as receipts, releases and waivers of liens, claims, security interests or other encumbrances.
- A bond to indemnify the owner against liens when required by the contract.
- Acceptance from the USGBC that all submittals meet or exceed requirements for LEED certification.
- Submission of operation and maintenance manuals and training protocol.
- Material certifications.
- Certified payrolls, if applicable.
- Guarantees and warranties.
- Final certificate of payment.
- Final release of claims.
- As-built plans and specifications.
- Record drawings.
- Sustainability certification and commissioning when applicable.
Chapter 6: Post-Construction Phase

6.1 Introduction

The achievement of quality during the project will limit problems and difficulties in the post-construction phase of any program. The careful development of the quality management plan will create the mechanism for timely close-out of the project in a comprehensive manner with a primary focus on quality. The QMP should document requirements that the CM meet with the owner after final acceptance of the construction project to review and discuss the acceptable completion of CM services. During this time, action associated with archiving the documentation of the project should be undertaken in the form of a final checklist, prepared by the CM for the ultimate review by the owner.

The post-construction phase checklist should include all aspects of the project which require submission to the owner for record purposes. Items on the checklist should include:

- Operation and maintenance manuals.
- CM project correspondence files.
- Shop drawing logs and related drawings.
- Project photographs.
- Job cost records.
- Schedule development, revisions, and monitoring data.
- Certification of any required minority participation.
- Project diaries and quantity books.
- Record field set of drawings.
- Comprehensive list of job participants, including design representatives, CM team members, utility company representatives, owner representatives, etc. (Include names, organization, and specific role in the project.)
- Disposition of any outstanding items.
- Certification of materials.
6.2 Quality Management Assessment with Owner

After the construction is completed and final acceptance has been issued, the CM should meet with the owner’s representative to review and discuss the overall quality management (QM) of the project. A detailed checklist should be utilized as an agenda for this meeting, represented by the section titles noted in the project’s quality management plan. The CM should also conduct a specific discussion regarding each quality management initiative noted in the QMP and discuss the acceptability of the CM’s service on each topic.

Conducting the post-construction phase QM assessment will allow all parties to build upon the experiences encountered during the course of the project in a manner that will enhance the quality of forthcoming work programs.

6.3 Final Report and Recommendations

Based on information obtained during the QM assessment with the owner, together with the actual occurrences which were experienced on the project, prepare a final report with recommendations for future practice for transmittal to the owner and other members of the project team, as the owner deems appropriate. This report should be comprehensive and capture all pertinent aspects of the project, including but not limited to, the following:

- Key project dates (award, NTP, binding milestone dates, contract completion date, actual completion date).
- Project costs (base bid, number of change orders, change order costs, etc.).
- General description of work.
- Schedule development, monitoring, and completion.
- Project participants (including organization listings and individual names).
- Summary of final quantities.
- Discussion of significant issues during design and construction.
- Sustainability certification when appropriate.
- Commissioning when specified.
- Lessons learned.
- Conclusions and recommendations
Recommendations should be developed by the CM and furnished to the owner in the final report based on actual occurrences and “lessons learned” by the team during the implementation of the program.

6.4 Warranty Management

The CM should develop a comprehensive checklist of all constructed items having a warranty requirement by the contractor. This checklist should list the item number, item, location in the work, and the date of acceptance by the owner. It should also list the date of warranty expiration and the date of warranty inspection, which should take place 30 days prior to the expiration date.

It is recommended that the CM perform the warranty inspection of the items in the constructed project 30 days prior to the expiration date. The costs of these services, resultant documentation, and management needs be included in the CM contract and compensated by the owner.
Chapter 7: Quality Culture

7.1 Introduction

Culture represents the collective shared characteristics of an organization which includes the core values, guiding principles, attitudes, and behaviors of employees which collectively define the organization. It is within the culture that supports and promotes the individual actions and behaviors that result in quality. Quality is an individual responsibility supported by the culture.

Quality is executing the processes that result in meeting the owner’s expectations, objectives, standards, and intended purpose. Those processes are part of design or construction production systems.

For quality, the goal is zero defects and the motivation is the recognition to the individual of a job well done. The intent of this section is to outline methods to incorporate this CULTURE into project delivery as part of the Quality Management Plan.

7.2 Culture of Quality - Employee Empowerment

The individual involved in the project during all phases from concept to commissioning is the key to attaining satisfactory quality. These individuals thrive in a quality culture. They have an appreciation for excellence in the work itself. That climate is created when quality is a key component of an organization’s mission, vision, and strategic plan. Then these components are linked to the organizations, and individual’s performance. The individual looks to the organization to provide the quality system, tools, criteria, training, and data reporting to measure quality performance. These elements of an organization must be supplemented by the human climate, which motivates the individual to quality production. This motivation must be supplied through organizational culture and must start at the top of
the organization. It is the responsibility of top management to lead by example with respect to quality, motivating the entire organization. Top management’s commitment to quality must be genuine. Top management demonstrates this commitment through actions such as periodic meetings to communicate a quality vision, discussing quality issues, having a quality policy for the firm and project, and giving meaningful feedback with continuous improvement actions. A commitment to quality should be a standard item on project agendas. The Japanese concept of kaizen focuses on making small continuous process improvements before problems arise to avoid having to correct quality problems after the fact. A quality culture enables others to act. Following these actions, a root cause analysis can be used to define, measure, analyze, improve, and control the process leading to improved levels of quality.

The key figure in any quality culture campaign is the individual supported by culture. This includes the technical lead during the design phase, the contracts manager during the procurement phase, the program/construction manager, the principals of all the firms involved in the process, as well as the tradesman and trade foreman during the construction phase. At the grass roots level, the design task lead engineer during the design phase and the foremen during the construction phase are the quality leaders, monitoring the process in accordance with the projects quality requirements, and most importantly making quality a team priority.

A culture of quality is supported by:

- Articles in firm newsletters;
- Posters in the work area (submitted by the individuals);
- Posting quality statistics and reports on corporate and team web sites;
- Meaningful individual employee suggestion programs;
- Awards such as lunches and free family activities to acknowledge quality improvement.

### 7.3 Participative Quality Cultures - Teamwork & Collaboration

The knowledge and skills of individual employees is the key resource in any organization. Engaging employees directly in quality discussions and processes provides personal recognition of their expertise. Work becomes more interesting and challenging for the individual as their knowledge and skills are improved by their influence on decisions.
affecting their job. Only individuals get results and engaged motivated employees provide successful projects, leading to successful programs, leading to successful organizations.

Direct employee participation programs include employee roundtables or similar structures where individuals can provide feedback focused on quality improvement. These programs need to move the individuals thinking beyond their immediate task to a holistic understanding of all the processes that result in a successful project.

The following are principles for developing successful direct participation programs:

1. Successful individual involvement programs require genuine, substantive involvement at all levels of management.
2. Individual contribution and ideas must receive serious consideration and be adopted whenever the recommendations are sound, relevant, and add value.
3. Long term continuity in contributing to firm and project success. The firms involved in a project must carry the programs forward to future endeavors.
4. The involvement needs to include all individuals involved in the project from clerks and craftsmen to principals in charge.
5. Keep the program organization clear and simple.
6. Successful involvement programs require very careful initial preparation and continuous review. Emphasis should be placed on voluntary participation.
7. To be effective, involvement sessions must add value to the individuals who are making a time commitment and foregoing other activities.
8. The substance of the involvement sessions must be relevant to current issues and up to date.
9. Leadership of specific involvement sessions should be individual workers, not support staff or principals in charge.
10. Firm quality control programs should be audited on a regular basis to determine if they are working as intended or need modification/changes to make the program work better.

7.4 Participative Quality Programs: Continuous Process Improvement

Participative programs have multiple titles such as quality circles, quality of working life, quality councils, zero defects approach, employee suggestion programs, management by objective, quality goal setting etc. Most of these programs share the similar outlines as quality
circles that have been in use in manufacturing for over 40 years. These principles are transferable to design and construction sectors.

### 7.4.1 Quality Teams

The concept of quality teams is an evolution of quality circles. Quality is a foundational element of the key business drivers: safety, cost, schedule, productivity, and innovation, that work together to successfully deliver the completed project.

Quality teams are a group of individuals usually from a specific area of the firm or project. The group is generally small (8 to 12 volunteers) who meet periodically on a regular schedule to examine, analyze and solve problems related to process, productivity, safety, working relationships, costs, housekeeping and all other collective activities which impact quality. The quality team also provides a line of communication from the workers to management. One member is selected as a leader and frequently serves as the facilitator. Special training is given the facilitator to help get the group started and to help circle members in developing problem solving techniques. The firm also usually has a steering committee comprised of top managers to provide the all the groups with objectives, encouraging team activity, providing resources, funding, authorizing team actions, as well as establishing policy and guidelines, suggesting areas for suitable circle attention, and other guidance, but not direction on specific quality issues. A firm may have only one quality team, but it is recommended that multiple quality teams be established in differing segments of the firm.

Quality team leaders should be trained so they are knowledgeable in the use of quality tools such as root cause analysis, process mapping, flow charts, various charting techniques, data analysis, and the use of checklists. All useful in identifying quality problems requiring attention and how this attention can be effective along with establishing measurements to evaluate results. The value of quality teams is far less dependent on the organizational structure than the membership’s motivation, behavior, problem oriented attention, and desire to resolve quality issues. The key to success has been the implementation of a participative approach and that the program of employee involvement most genuinely meets the needs and conditions of a specific project and with the understanding that there is no-one best solution to achieving quality mindedness/culture. Consistent with the concepts of kaizen it has been documented that multiple small improvements result in large productivity gains and quality improvements over time.

Quality management has evolved over the decades into the comprehensive improvement approach which brings together the hard inputs and outputs of systems, tools, techniques, profits, and the soft skills of motivating people, building teams, and providing recognition and rewards.
7.5 Quality Control - Turning Culture into Practice

Most firms today have quality control management systems that address quality requirements for each discrete project task. For example, designers have peer-to-peer checking of designs and calculations, inter-disciplinary reviews, subject matter expert technical reviews, and quality assurance processes. Purchase orders and subcontracts use flow-down clauses to communicate the importance of quality requirements to suppliers, subcontractors, and sub-consultants. The prime consultant or prime contractor then performs quality assurance reviews of sub-consultants and sub-contractors to document compliance. During construction, extensive quality control procedures should be in place such as inspections and sign offs at incremental points in the construction process to assure quality work. These include the certification of welders and nondestructive testing of completed critical welds, calibration of test and measurement equipment, as well as document control programs. Personnel need to be made aware of and trained in this procedure to help develop quality mindedness/culture. The training should:

- Focus on fundamentals, centered on real project issues. Concentrate on practical, meaningful, quality issues related to the project and case studies.

- Involve the individual/workers who will be using the quality control procedures to the fullest extent possible. Get their input on the level and details of the training, creating ownership of the implementation of the procedures. This involvement enhances quality mindedness/culture.

- Quality issues are dynamic and are always changing due to specific project conditions. Just like the safety job task analysis, the specific conditions for implementing a quality control procedure need to be constantly reviewed and training modified as needed. Refresher training is a method to accomplish these conditions.

- The training should include all levels of the organization from principle in charge to construction workers and owners. The training needs to be tailored to fit the participants and to promote quality mindedness/culture and to obtain worker buy-in to processes.

- Training needs to be directly relevant to the individual. Well trained craftsmen understand quality workmanship. Foreman need orientation in the construction contractor’s specific quality control procedures, such as the use of concrete pour cards signed off by responsible craft foreman that the area is complete and ready for concrete placement. The independent inspector should not be relied on for this, but considered to be quality assurance that the concrete quality control program is working as intended.
It is the responsibility of the firm’s management to assure that proper and timely training is provided. Owners must recognize that attaining quality is not free and the project budget needs to include funds to allow for training, be it a direct line item or included in overhead.
Appendix

The following checklists are included as a guide. The user must review the checklist attributes against the specific project specifications and drawings for applicability to the project.

1. Reinforced Concrete
2. Post-Tensioned Concrete Inspection at the Jobsite
3. Concrete Batch Plant Inspection
4. ACI Concrete Field Testing Technician
5. Precast Concrete Plant
6. Pile Driving
7. Drilled-In-Anchors
8. Structural Masonry
9. Spray Applied Fireproofing
10. Structural Steel Welding
11. High Strength Bolting
12. Structural Steel Shop Fabrication
13. Soils Technician/Grading Inspector
14. Asphalt Paving
15. Asphalt Batch Plant
Reinforced Concrete Inspection Checklist

CONCRETE MIX VERIFICATION

- Verify that concrete is batched based on approved mix design with correct water/cement ratio, cement type, aggregates and admixtures.
- Verify that the batch weights are recorded on the trip ticket.
- Determine that mixer truck trip ticket specifies mix in truck is the approved mix.
- Verify that the total water added to the mix does not exceed that allowed by the approved mix design and is of acceptable quality.
- Verify that concrete mixing and placing equipment at the site is adequate.
- Verify that the quality of the concrete is indicative of adequate mixing time, consistency, and relevant time limits.

REINFORCING STEEL

- Verify the mill certificates are provided and show the correct grades.
- Verify grade and visual conformity of rebar with approved plans/specs.
- Verify that rebar is free of oil, dirt, excessive rust, and handling damage.
- Verify that rebar is adequately tied, chained, and supported to prevent displacement during concrete placement.
- Verify minimum and maximum clear distances between bars and minimum concrete cover.
- Verify minimum concrete cover is maintained between rebar and the surface of the concrete.
- Verify size and spacing of rebar.
- Verify bar laps for proper length and stagger, bar bends for minimum diameter slope and length.
- Verify that welding of rebar, if any, is approved and properly inspected.
CONCRETE FORMWORK AND EMBEDDED ITEMS

- Verify proper preparation of construction joint surfaces prior to placing.
- Verify that the formwork is tight to prevent leakage and will result in a final structure with correct shape and member size.
- Verify that embedded items are properly sized and placed.
- Ask for shop drawings for embed placement.
- Ensure the Electrical and Mechanical sign off in the pour.

CONCRETE PREPARATION AND PLACEMENT

- Verify acceptable general condition of the concrete base prior to placement.
- Verify that the concrete base is properly wetted and standing water is removed before concrete is placed.
- Verify that concrete conveyance and depositing avoids segregation due to handling or flowing.
- Verify that concrete is properly consolidated.

SAMPLES AND TESTS

- Determine the frequency of test cylinder fabrication from the approved plans and specifications (e.g. every 100 Cubic Yards of placement).
- Sample concrete, and then perform slump tests and temperature tests every time a set of cylinders is fabricated.
- Perform these tests per the latest ASTM Standards.
- ASTM C172 Sampling Freshly Mixed Concrete, ASTM C143 Slump, ASTM C1064 Temperature, air content for air entrained voids per ASTM C231 or C173, and ASTM C31 Making and Curing Test Specimens in the Field.
- Properly handle and store specimens in the correct environment (Cure Box) for initial curing (60-80 °F).
- Arrange for transporting specimens to the test lab (at least 8 hours after final set but before 48 hours).
Post-Tensioned Concrete Inspection at the Jobsite Inspection Checklist

- Review the approved plans, specifications and approved placing and tensioning shop drawings submitted by the post-tensioning contractor.
- As required by the Project specifications, sample and have the following items tested:
  - tensioning strands, rods or wire
  - reinforcing steel
  - steel used for structural inserts
- Verify the general layout, size and spacing of reinforcing steel and post-tensioning steel.
- Verify the profile of tendons.
- Verify installation, location, type of anchorages, inserts embedded items, block outs, etc.
- Calibrate or review current calibration data on proposed stressing equipment.
- Verify that the concrete compressive strength meets the minimum required strength prior to post-tensioning.
- Verify the stressing sequence and verify the required jacking and anchor forces.
- Measure the elongations and record values for each tendon on a “Stressing Record Form.”
- Report to the Engineer of Record any out of tolerance discrepancies in force-elongation relationships, spilled concrete, broken tendons, anchorage slippage, etc.
Concrete Batch Plant Inspection Checklist

- Confirm that scales, metering devices for admixtures and other batching equipment have current calibration certifications.
- Check that scales start and return to zero.
- Confirm that moisture metering device (at least for washed concrete sand) is furnished and operable.
- Verify that aggregate is stored in separate bins (stockpiles) to ensure no intermixing.
- Verify that cement and pozzolan silos are properly sealed to prevent dusting.
- Verify condition of ready-mix trucks by checking condition of fins, charging openings and revolutions counter. Also, verify no wash water remains from previous load.
- At the batching console, fill out a Batch Plant Inspection Ticket for each load. On each ticket calculate free moisture in aggregates (at least for washed concrete sand) and make adjustments to allowable amount of water to be added.
- Check deviations from allowable tolerances in ASTM C94 for batched quantities of aggregate, cement, pozzolan, and water. Immediately report deviations to the batch plant operator, contractor, and Lead Inspector.
- Verify the delivery ticket contains the proper information pertaining to the mix ordered, load and truck number, time batched and batch quantities.
- Provide a copy of the Batch Plant Inspection ticket to the truck driver to deliver to the site with the load.
ACI Concrete Field Testing Technician Inspection Checklist

- Sample concrete from a revolving drum mixer (Ready Mix Truck) in accordance with ASTM C172 and transport samples to place of testing. Normally this is accomplished with a wheel barrow and shovel (to re-mix before testing).
- Perform the temperature test immediately per ASTM C1064 and record results. If temperature exceeds 90°F, inform the contractor and lead inspector.
- Perform slump test per ASTM C143 within 5 minutes after obtaining sample and record results. If slump result is out of tolerance, immediately inform contractor and lead inspector.
- If a density test is specified, perform per ASTM C138. Record results.
- Perform air content test per ASTM C231 for hard rock (dense aggregate) mixes and record results. If air content is out of tolerance, immediately inform contractor and lead inspector.
- For lightweight concrete mixes, perform air content test per ASTM C173 and record results. If air content is out of tolerance, immediately inform contractor and lead inspector.
- Fabricate cylinder strength test samples per ASTM C31. Start molding specimens within 15 minutes after obtaining sample from mixer.
- Mark each cylinder mold on the side with its unique ID number.
- Store strength specimens on a level surface at temperatures 60°F - 80°F (68°F - 78°F if f'c specified is 6,000 psi or greater). Use a cure box if necessary to control temperature.
- Arrange to have the strength test samples (cylinders) picked up and taken to the Test Lab of Record. Usually, this is the next day, but at least 8 hours AFTER final set.
Precast Concrete Plant Inspection Checklist

- Perform Batch Plant Inspection.
- Witness, observe or conduct fresh concrete tests as required by the Project Specifications:
  - slump
  - air content
  - temperature
  - unit weight
  - fabricate concrete test cylinders
- Verify curing procedures, temperatures, and curing cycles.
- Verify compressive strength test results for specified release strength.
- Witness stress transfer.
- Verify member is identified by component and date cast.
Pile Driving Inspection Checklist

- Check general conditions in the area where piles are to be driven (or drilled) – Clearing, grubbing, removals completed? Existing improvements and utilities protected? Excavations or embankment to plan subgrade completed prior to driving piling?
- Check for correct type and length of pile. Other pile requirements? Butt and tip diameter?
- Check the piles for damage and defects.
- Locations of piles on ground staked by survey?
- Check for hazards and provisions for safety. Review the Site Safety Plan. Will overhead power lines be sufficiently clear of crane boom or pile driver leads?
- Check soil borings for expected driving or drilling conditions. Ground water elevation?
- Obtain pile driver specifications and operating data and compare with approved Submittal. (Type, weight and stroke of ram, etc.)
- Is the operation of the pile driver satisfactory? Continuous driving until penetration is attained? Check that ram is operating at full stroke, rated speed and fully recommended operating pressure. Check for and record slowing of hammer.
- Check for proper lifting and handling of pile in the leads. Typically, 2 or 3 “Pick” points are specified on the Pile Shop Drawings.
- Check for proper alignment during driving, plumb, or batter
- Check for sequence of driving or drilling (inside piles in group usually driven first – refer to Geotechnical Report).
- For H-Beam piles: are welded splices permitted? Approved welding procedure, should a certified welder used? Arrange for welding DI. Check for bends in flanges.
- For step taper piles, check for treatment or sealing of joints in ground water. Water and soil removed before placing concrete? Inspected with mirror or light and checked for collapsing after driving? Reinforcing steel centered and concrete placed slowly to prevent voids? Arrange for Reinforced Concrete DI.
- Watch for proper handling of precast, pre-stressed concrete piles. Are proper cushion blocks used?
- Check for overdriving during driving (sound and vibration, bouncing of hammer). High driving resistance in upper portion may require pilot drilling or jetting (review with Design Engineer).
- Recheck low driving resistance in cohesive soils by driving next day.
- Maintain record of driving as required. Record of blow count/foot, pile number, butt and tip elevation; notes regarding delays during driving, extent of jetting if permitted or required. Records kept current throughout operations?
Drilled-In-Anchors Inspection Checklist

Note: This checklist covers epoxy (Adhesive) anchors, expansion (Red Head) anchors, and vinylester glass capsule (Hammer Capsule) anchors. Use “N/A” as appropriate instead of check marks.

- Manufacturer’s installation instructions and/or ICC ES (Evaluation Service) reports available on job site.
- Verify hole size and depth for the type of anchor being used.
- Verify the drilled hole is blown out with oil-free compressed air for a minimum of 4 seconds and then cleaned with a nylon brush for a minimum of 4 cycles.
- For two part epoxy adhesive, dispense adhesive to the side until a uniform colored stream of compound comes out.
- Start filling epoxy from the bottom of the hole to prevent air pockets.
- Fill the hole to about 2/3 of the depth with epoxy.
- Insert the anchor with a turning motion (do not drive it).
- For vinylester glass capsule applications, drive the anchor to the bottom of the hole with a hammer.
- For anchors with screens (mostly used in brickwork), fill the screen with epoxy outside the hole and then insert the screen into the hole.
- The wedge anchors are driven into the hole until the nut and washer are tight against the surface. Then tighten to the required torque.
Structural Masonry Inspection Checklist

MATERIALS
- Check the size, type, and grade of CMU used.
- Check the quality, cleanliness, and soundness of CMU.
- Check for testing requirements, i.e. Unit strength test or Prism test.
- Check the reinforcement for size, grade, & sampling tags.
- Check the joint reinforcement for size and grade, if any.
- Check the ingredients for mortar mix.
- Check for approved fabricator for pre blended mortar.
- Check the approved mix design for grout.
- Check the storage of materials.
- Verify that potable water is available.

WORKMANSHP
- Verify the location and spacing of dowels.
- Check the cleanliness of foundation.
- Verify proportions of the mortar mix and time of mixing.
- Check that the joint thickness of starter course is within limits.
- Verify that head and bed joints are of proper size and completely filled.
- Verify that retempering of mortar is limited.
- Verify the tooling of joints is performed properly.

CONSTRUCTION
- Verify the required spacing of horizontal and vertical reinforcement.
- Verify the location and length of lap splices.
- Verify the trim bars around openings, at intersections and for lintels.
- Check that all mortar fins are cleaned within tolerances.
- Verify the clean outs are provided as required.
- Check the cleaning of cells at clean outs before sealing.
- Check the reinforcement is secured properly before grouting.
- Verify the proper clearance of reinforcement.
- Verify the size and location of anchor bolts and other embedded items before grouting.
- Check for proper clearance around anchor bolts for grout.
- Verify the installation of slab dowels, if any.
Verifying the rules of low lift or high lift grouting are followed as applicable.
Verify the consolidation of grout via mechanical means for complete filling of cell areas.
Remind the contractor of waterproofing of walls, if any.

**SAMPLING AND TESTING**
- Check if Unit Strength method or Prism Testing is required.
- Verify that the prisms, if required are made of the same CMU as to be used in actual construction.
- Verify that the grout used for prisms conforms to same mix design.
- Follow the appropriate ASTM standards for sampling and testing.
Spray Applied Fireproofing Inspection Checklist

- Verify steel substrate is clean, free of contaminants and not blocked by obstructions such as ductwork.
- Verify fireproofing is applied after concrete placement on metal decking.
- Verify the bonding material, if required, is applied per manufacturer's instructions.
- Before mixing, verify the fireproofing material is dry and in unopened packages.
- Verify fireproofing material is mixed with a conventional type plaster mixer using potable water.
- Verify the installation is per manufacturer's instructions and that temperatures are above 40° F.
- Coordinate the test lab for thickness and density testing as well as adhesion tests if required by the job specs.
- Perform a final inspection and witness patching repairs as necessary.
Structural Steel Welding Inspection Checklist

- Verify the surfaces to be welded are smooth, uniform, free of discontinuities (tears, cracks, etc.) and free of scale, slag, rust, moisture, grease or other foreign material.
- Verify that the steel base material is the correct ASTM and traceable to the Mill Certs.
- Verify qualifications of welders.
- Verify that approved WPS's (Welding Procedure Specifications) are on the jobsite.
- Verify welding equipment and filler materials are per the WPS.
- Verify filler materials are stored per the current AWS D1.1.
- Verify the joint fit up complies with tolerances in the current AWS D1.1.
- Verify pre-heat temperatures (if required).
- Verify all elements of the WPS are followed during welding:
  - Voltage
  - Current
  - Wire feed speed
  - Travel speed
  - Interpass temperatures
  - Size of interpass weld
- In multiple pass welding, inspect each pass before allowing the next pass to be laid.
- Verify the final weld is clean of slag, inspect visually for profile/size/length.
- Inspect final weld for discontinuities such as:
  - Cracks
  - Porosity
  - Undercut
  - Weld/base fusion
  - Crater
- Verify any out of tolerance discontinuities are repaired before final acceptance.
- In complete joint penetration (CJP) welds arrange for NDT (Non-Destructive Testing).
- Verify that weld tabs and back-up bars are removed, if used.
High Strength Bolting Inspection Checklist

- Verify the bolts are accompanied by manufacturer’s certifications in conformance with approved plans and specifications.
- Verify bolts are readily identifiable and have proper markings (i.e. A325).
- Verify galvanized bolts and nuts are provided as a set, with galvanized nuts being lubricated.
- Continuously observe the fit up of structural steel members receiving fastener assemblies and verify that the joint plies are in firm contact.
- Verify that faying surfaces and adjacent surfaces are free of dirt and foreign material.
- Verify the surfaces of slip-critical joints are free of coatings and galvanizing (unless approved by the Engineer).
- For High Strength (HS) bolts requiring pre-tensioning, verify the calibration of the tension calibrator (Skidmore-Wilhelm) is current.
- For installation of HS bolts requiring pre-tensioning, verify wrenches are calibrated daily, when the lot of any component of the fastener assembly is changed or when any major component of the fastener assembly or wrench assembly changes.
Structural Steel Shop Fabrication Inspection Checklist

- At the fabrication plant, conduct a prefabrication meeting with the QC Manager of the Fab Shop, the inspector, the steel erection contractor and the general contractor.
- The agenda for the prefabrication meeting should include:
  - Review of fabricator’s current certification (COLA, AISC, etc.)
  - Review of fabricator’s QC program
  - Review of current certifications of welding personnel
  - Verify approved welding procedure specifications (WPS)
  - Confirm shop has a copy of approved set of drawings
  - Review NDT (nondestructive testing) requirements, if any
  - Tour the Fab Shop
- Verify that all elements of the WPS are followed:
  - Voltage
  - Current
  - Wire feed
  - Speed
  - Stick out
  - Size of interpass weld
- Verify the storage of filler materials and shielding gas conform to AWS D1.1.
- Verify the fit up tolerance of the joints are followed per AWS D1.1.
- Verify and record pre-heat temperatures and interpass temperatures.
- For multi-pass welding, inspect each pass to the standards of the final weld.
- Verify an NDT Technician performs testing as required by approved plans and specifications.
- Verify dimensions of the final weld (profile, size, and length).
- Inspect the weld for discontinuities (crack, crater, undercut, porosity, etc.) per AWS and inspect repairs, if required.
- Verify each piece is numbered per approved shop drawings, each weld is initialed by welder, and UT accepted pieces are signed with permanent metal marker.
Soils Technician/Grading Inspector Inspection Checklist

- Verify that appropriate Grading Permits have been obtained.
- Verify that soils report, approved plans, specifications, and submittals are available at the project site.
- Review boring logs and soils report to determine type of soil layers, water table, and recommendations for grading.
- Verify that Dig Alert has been called out prior to start of any excavation work.
- For excavations, verify the slope of cut surfaces is maintained no steeper than 2:1, materials are stockpiled appropriately, that excavations extend to proper depth and have reached proper material as outlined in the soils report.
- For backfill work, verify the subgrade is appropriate and scarified properly (if required), check for uniformity of compaction efforts (equipment used, coverage and number of passes), watch for changes in fill material, test each compacted layer for acceptable density before placement of next layer.
- Confirm maximum density test lab sample material represents material used for fill.
- Complete a Daily Report for all areas inspected and use non-compliance reports as necessary for non-compliant areas.
Asphalt Paving Inspection Checklist

- Hold pre-paving meeting to discuss continuity and sequence of operations, numbers of pavers/trucks/rollers needed, possible reasons for rejection of mix, weather and temperature requirements, truck staging, and traffic control.
- Verify the subgrade and CMB are compacted, firm, dry, smooth, stable, and unyielding.
- Verify the appropriate survey team has confirmed final CMB grades are acceptable.
- Verify equipment to be used per the approved submittals and the specification.
- Verify the tack coat is applied properly.
- Verify the load tickets for correct mix design and binder grade (collect load tickets from each truck).
- Verify temperature of asphalt directly behind the paving machine (270° - 320° F).
- Is operation of spreader providing the correct thickness of mat, lane width, and overlap?
- Does the mat have uniformity of texture or is there evidence of segregation or poor mixing?
- Check mat for irregularities and obtain correction immediately after breakdown rolling.
- Verify that intermediate rolling follows breakdown rolling closely to assure maximum density.
- Verify finish rolling is done while mat is sufficiently workable to remove roller marks and leave a smooth pavement surface (compaction should be completed before the mix cools below 185° F).
- Confirm compaction either by using a Field Technician with a Nuclear Gauge or by coring samples to be taken to the Materials Testing Lab.
- Verify longitudinal elevation variance does not exceed 1/8” in 10 feet and transverse less than ¼” in 10 feet.
- Verify seal coat is applied if called for.
Asphalt Batch Plant Inspection Checklist

- Verify that the stockpiled aggregates are appropriate for the specified mix design.
- Verify that supplemental fine aggregates are stored separately and kept thoroughly dry.
- Verify that the scales and meters are calibrated or tested.
- Verify that the screens are free of large holes.
- Verify that the plant has a temperature indicating device on the drier.
- Verify that the plant is equipped with a functional dust collection system.
- Check asphalt storage tanks and verify the temperature on the meters.
- Review recent aggregate test results for compliance.
- Check the hot bins for tight partitions, free from holes and high enough to prevent intermingling of aggregates.
- Monitor plant proportioning and observe production to assure that a homogeneous uniformly coated mixture is being produced.
- Receive the copies of all asphalt binder loads.
- Monitor and record the temperature of the liquid asphalt.
- Monitor the temperature of heated aggregate as it constitutes 90 to 95% of the mix.
- Verify that the mineral filler is protected from moisture.
- Monitor temperatures to assure that asphalt binder does not exceed limits.
- Observe the storage and charging of all materials to ensure that segregation is prevented.
- Examine truck beds prior to loading to ensure no petroleum products; such as diesel fuel or kerosene are present (non-petroleum release agent should be used to prevent material from sticking).
- Check the load temperature randomly to ensure compliance.
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