ASHRAE Guideline 0-2005

ASHRAE GUIDELINE

The Commissioning Process

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a. interpretation of the contents of this Guideline,
b. participation in the next review of the Guideline,
c. offering constructive criticism for improving the Guideline,
d. permission to reprint portions of the Guideline.

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NOTE

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FOREWORD

The Commissioning Process is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.

The Commissioning Process assumes that owners, programmers, designers, contractors, and operations and maintenance entities are fully accountable for the quality of their work. The Commissioning Team uses methods and tools to verify that the project is achieving the Owner's Project Requirements throughout the delivery of the project. For example, the contractor is responsible for fully constructing, testing, and ensuring that its employees' work has provided the level of quality expected. The Commissioning Authority then randomly samples the contractor's work to verify that it is achieving the Owner's Project Requirements. If systemic issues are identified, then the contractor is expected to recheck all of his/her work and correct any deficiencies. This quality-oriented process is different than when the Commissioning Authority does 100% checking or non-quality-based sampling. Guideline 0 has been developed to present an approach based on these assumptions.

The Commissioning Process begins at project inception (during the Pre-Design Phase) and continues for the life of the facility (through the Occupancy and Operations Phase). Because this Guideline details a process, it can be applied to both new and renovation projects. The Commissioning Process includes specific tasks to be conducted during each phase in order to verify that design, construction, and training meet the Owner's Project Requirements. This Guideline describes the overall Commissioning Process in order to provide a uniform, integrated, and consistent approach for delivering and operating facilities that meet an owner's ongoing requirements.

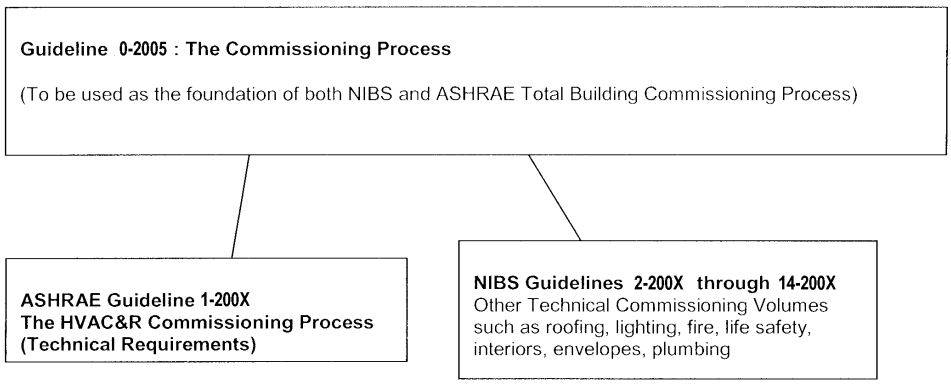
The Commissioning Process is a quality-based method that is adopted by an Owner to achieve successful construction projects. It is not an additional layer of construction or project management. In fact, its purpose is to reduce the cost of delivering construction projects and increase value to owners, occupants, and users. This Guideline has been developed to assist those who are adopting or plan to adopt a better quality-based and cost-effective process.

Development of guidelines for the Commissioning Process began formally in 1982 when the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) formed a committee to document best practices to achieve facilities that performed according to the owner's project requirements. ASHRAE published its original commissioning guideline in 1989 and an updated version in 1996. The Commissioning Process detailed in these guidelines is the result of experience on projects requiring that systems and assemblies worked from the first day the project was turned over to the owner. This Commissioning Process is further based upon experience with projects that met the requirements of owners, occupants, users of processes, and facility operating-maintenance-service organizations at a high level of satisfaction and that reduced the cost to deliver the project.

Guideline 0 is an integral part of the National Institute of Building Sciences (NIBS) total building commissioning guideline series. The relationship of this guideline to other technical commissioning guidelines is shown below.

Guideline 0 presents details on the Commissioning Process without focusing upon specific systems or assemblies. Supplementary technical guidelines are being developed to provide specific and detailed information on how to implement the Commissioning Process for each major building/facility system or assembly. For example, this Guideline details what is required for a high-quality and effective Systems Manual and how and when it is developed, whereas a technical guideline details what specific information for a given system or assembly must be included in the Systems Manual.

The use of a common content organization and the focus upon specific information achieve a closely coordinated set of documents that can be used together or in any combination to accommodate varying owner requirements. This Commissioning Process guideline allows the technical commissioning guidelines to avoid repeating information on the commissioning process, making them more concise and focused relative to their technical requirements.



The fundamental objectives of the Commissioning Process are to:

(a) *Clearly document Owner's Project Requirements;*

(b) *Provide documentation and tools to improve the quality of deliverables;*

(c) *Verify and document that systems and assemblies perform according to the Owner's Project Requirements;*

(d) *Verify that adequate and accurate system and assembly documentation is provided to the owner;*

(e) *Verify that operation and maintenance personnel and occupants are properly trained;*

(f) *Provide a uniform and effective process for delivery of construction projects;*

(g) *Deliver buildings and construction projects that meet the owner's needs, at the time of completion;*

(h) *Utilize quality-based sampling techniques to detect systemic problems, as such sampling provides high value, efficient verification, accurate results, and reduced project costs; and*

(i) *Verify proper coordination among systems and assemblies, and among all contractors, subcontractors, vendors, and manufacturers of furnished equipment and assemblies.*

Due to the integration and interdependency of facility systems, a performance deficiency in one system can result in less than optimal performance by other systems. Implementing the Commissioning Process is intended to reduce the project capital cost through the first year of operation and also reduce the life-cycle cost of the facility. Using this integrated process results in a fully functional, fine-tuned facility, with complete documentation of its systems and assemblies and trained operating and maintenance personnel.

Emphasis is placed on documentation of the Owner's Project Requirements at the inception of the project and the proper transfer of this information from one party to the next. Owners adopt the Commissioning Process to achieve their stated objectives and criteria—starting with the inception of a project instead of after a facility is occupied.

While circumstances may require owners to adopt the Commissioning Process during the Design or Construction Phase of a project, such later implementation must capture the information that would have been developed had the Commissioning Process begun at project inception. Beginning the Commissioning Process at project inception will achieve the maximum benefits.

Annexes to this document have been included to assist in further understanding the Commissioning Process and to aid in the development of the technical guidelines. The Annexes are based on specific project experience, with details on what is current best practice. Annexes illustrate varying applications of the Commissioning Process for all projects. Therefore, Annexes should be viewed as examples of how to develop documents and to define Owner's Project Requirements, Basis of Design, Commissioning Plan, benefits and roles in the Commissioning Process, verification, testing requirements, documentation, and training.

The Commissioning Process has been structured to coincide with the phases of a generic project with Pre-Design, Design, Construction, and Occupancy and Operations phases.

This guideline describes the Commissioning Process; the responsibilities of Commissioning Team participants; the role of the Commissioning Authority; and a model framework for developing a Commissioning Plan, specifications, and reports. This guideline also describes the general requirements for a training program for continued successful system and assembly performance. Documentation necessary to meet the guideline requirements is also described.

1. PURPOSE

1.1 The purpose of this guideline is to describe the Commissioning Process capable of verifying that a facility and its systems meet the Owner's Project Requirements.

2. SCOPE

2.1 The procedures, methods, and documentation requirements in this guideline describe each phase of the project delivery and the associated Commissioning Processes from pre-design through occupancy and operation, without regard to specific elements, assemblies, or systems, and provide the following:

(a) overview of Commissioning Process activities,

(b) description of each phase's processes,

(c) requirements for acceptance of each phase,

(d) requirements for documentation of each phase, and

(e) requirements for training of operation and maintenance personnel.

2.2 These *Commissioning Process* guideline procedures include the Total Building Commissioning Process (TBCxP) as defined by National Institute of Building Sciences (NIBS) in its *Commissioning Process Guideline 0*.

3. UTILIZATION

3.1 The application of this guideline will depend upon the Owner's Project Requirements and how the project will be designed, built, and operated. The process described in this guideline is written for a generic project and must be adapted to each project.

3.2 This guideline describes the Commissioning Process, and is supplemented by companion technical guidelines. A technical guideline describes the specific details to properly implement the Commissioning Process relative to a specific facility system or assembly. Annex A in this guideline provides the required format for developing technical guidelines for the Commissioning Process.

4. DEFINITIONS

Acceptance: A formal action, taken by a person with appropriate authority (which may or may not be contractually defined) to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.

Basis of Design: A document that records the concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

Checklists: Verification checklists that are developed and used during all phases of the commissioning process to verify that the Owner's Project Requirements are being achieved. This includes checklists for general verification, plus testing, training, and other specific requirements.

Commissioning: See *Commissioning Process.*

Commissioning Authority: An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the Commissioning Process.

Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the Commissioning Process.

Commissioning Process: A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements.

Commissioning Process Activities: Components of the Commissioning Process.

Commissioning Process Progress Report: A written document that details activities completed as part of the Commissioning Process and significant findings from those activities, which is continuously updated during the course of a project. Usually incorporated into the Commissioning Plan as an ongoing appendix.

Commissioning Process Report: A document that records the activities and results of the Commissioning Process. Usually developed from the final Commissioning Plan with all of its attached appendices.

Commissioning Team: The individuals who through coordinated actions are responsible for implementing the Commissioning Process.

Construction Checklist: A form used by the contractor to verify that appropriate components are onsite, ready for installation, correctly installed, and functional. Also see *Checklists.*

Construction Documents: These include a wide range of documents that will vary from project to project and with the Owner's needs and with regulations, laws, and countries. Construction documents usually include the project manual (specifications), plans (drawings), and general terms and conditions of the contract.

Continuous Commissioning Process: A continuation of the Commissioning Process well into the Occupancy and Operations Phase to verify that a project continues to meet current and evolving Owner's Project Requirements. Continuous Commissioning Process activities are ongoing for the life of the facility. Also see *Ongoing Commissioning Process*.

Contract Documents: These include a wide range of documents that will vary from project to project and with the Owner's needs and with regulations, laws, and countries. Contract Documents frequently include price agreements, construction management process, subcontractor agreements or requirements, requirements and procedures for submittals, changes, and other construction requirements, timeline for completion, and the Construction Documents.

Coordination Drawings: Drawings showing the work of all trades to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances.

Issues Log: A formal and ongoing record of problems or concerns – and their resolution – that have been raised by members of the Commissioning Team during the course of the Commissioning Process.

Nominal Group Technique: A formal, structured brainstorming process used to obtain the maximum possible ranked input from a variety of viewpoints in a short period of time. The typical approach is a workshop session where a question is presented, the attendees record their responses individually on a piece of paper, the individual responses are recorded on a flip chart without discussion in a round robin fashion, all of the responses are discussed, and then the participants rank their top five responses.

Ongoing Commissioning Process: A continuation of the Commissioning Process well into the Occupancy and Operations Phase to verify that a project continues to meet current and evolving Owner's Project Requirements. Ongoing Commissioning Process activities occur throughout the life of the facility; some of these will be close to continuous in implementation, and others will be either scheduled or unscheduled (as needed). Also see *Continuous Commissioning Process*.

Owner's Project Requirements: A written document that details the functional requirements of a project and the expectations of how it will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. (The term *Project Intent* is used by some owners for their Commissioning Process Owner's Project Requirements.)

Quality Based Sampling: A process for evaluating a subset (sample) of the total population. The sample is based upon a known or estimated probability distribution of expected values; an assumed statistical distribution based upon data from a similar product, assembly, or system; or a random sampling that has scientific statistical basis.[1, 2, 3]

Re-Commissioning: An application of the Commissioning Process requirements to a project that has been delivered using the Commissioning Process. This may be a scheduled re-commissioning developed as part of an *Ongoing Commissioning Process*, or it may be triggered by use change, operations problems, or other needs.

Retro-Commissioning: The Commissioning Process applied to an existing facility that was not previously commissioned. This guideline does not specifically address retro-commissioning. However, the same basic process needs to be followed from Pre-Design through Occupancy and Operations to optimize the benefits of implementing the Commissioning Process philosophy and practice.

Systems Manual: A system-focused composite document that includes the operation manual, maintenance manual, and additional information of use to the Owner during the Occupancy and Operations Phase.

Test Procedure: A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.

Training Plan: A written document that details the expectations, schedule, budget, and deliverables of Commissioning Process activities related to training of project operating and maintenance personnel, users, and occupants.

Verification: The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Owner's Project Requirements.

5. PRE-DESIGN PHASE

5.1 Introduction

5.1.1 Pre-Design is a preparatory phase of the project delivery process in which the Owner's Project Requirements are developed and defined. Information about the project is gathered, including program requirements, community context, codes and regulations, site and climate, facility context and function, facility technology, sustainability, cost, schedule, and the client's (including owner, occupants, operators, and maintenance personnel) needs and capabilities.

5.1.2 This phase is critical to the Commissioning Process because the documented Owner's Project Requirements form the foundation for the design, construction, and occupancy and operation of the facility and are the basis for the Commissioning Plan and schedule. Starting the Commissioning Process during the Pre-Design Phase facilitates project communication by monitoring the Owner's Project Requirements from Pre-Design through Design, Construction, and Occupancy and Operations and by verifying decisions in these phases with the written documents called the Owner's Project Requirements and the Basis of Design.

5.1.3 Pre-Design Phase Commissioning Process objectives include the following:

(a) Developing the Owner's Project Requirements.

(b) Identifying a scope and budget for the Commissioning Process.

(c) Developing the initial Commissioning Plan.

(d) Acceptance of Pre-Design Phase Commissioning Process activities.

(e) Review and use of lessons-learned information from previous projects.

5.2 Pre-Design Phase Commissioning Process Activities

5.2.1 Pre-Design Phase Commissioning Process Responsibilities

5.2.1.1 During the Pre-Design Phase, a Commissioning Team is formed to oversee, implement, and accomplish the Commissioning Process activities detailed in this guideline. Responsibility for leadership of the Commissioning Team should be defined and assigned at the beginning of the Pre-Design Phase. The term used for the person with overall responsibility for the Commissioning Process is "Commissioning Authority." The Commissioning Team members must be available for meetings, have the qualifications to contribute to the development of the Owner's Project Requirements, and have the authority to make decisions binding on the firms/constituencies they represent. Lines of authority and lines of communication in determining Commissioning Team members' responsibilities shall be documented. The Commissioning Team composition must be based upon the scope of the Commissioning Process services established for the project.

5.2.1.2 The Owner must assign (or contract for) appropriate representatives to participate on the Commissioning Team – both from within and external to their organization. Commissioning Team responsibilities should be consistent with the agreements between parties involved in the project – and such agreements must clearly address Commissioning Process responsibilities.

5.2.1.3 Essential team members during the Pre-Design Phase include Owner's representatives, the Commissioning Authority, pre-design and programming professionals, design professionals, and (if known) the construction/program/project managers. The Commissioning Authority can assist the Owner in identifying and selecting these initial Commissioning Team members. Owner's representatives will include the project manager, occupants or users, facility manager, and operation and maintenance personnel. Including operation and maintenance personnel on the Commissioning Team will help ensure that important operation and maintenance issues are included in the Owner's Project Requirements. The Owner will generally need to reconcile conflicting project requirements and provide feedback on decisions to the Commissioning Team. The design team members and Commissioning Authority can assist the Owner in reconciling conflicting technical requirements.

5.2.1.4 The Commissioning Team will evolve as a project progresses. During successive phases, the active membership of the Commissioning Team may shift to meet the unique requirements of each phase. Contractors and vendors, for example, may join the Commissioning Team after they are under contract or after the start of construction.

5.2.1.5 Pre-Design Phase Commissioning Process activities described in this section to be performed by the design team must be included in the scope of services described in the "Owner - Design Professional Service Agreement." These Commissioning Process activities may be more than are normally required in their scope of services. The scope of services in the "Owner - Design Professional Service Agreement" should also include the requirement to cooperate with the

Commissioning Authority during Pre-Design, Design, and Construction phases of the project. This may include testing soils, surveying, or other requirements during Pre-Design.

5.2.1.6 Responsibilities of the Commissioning Team during the Pre-Design Phase include the following:

(a) Assist Owner in preparing requests for project services that outline the roles and responsibilities developed in the Commissioning Plan.

(b) Facilitate development and documentation of the Owner's Project Requirements.

(c) Develop scope and format for project Systems Manual and select/designate entity responsible for developing this manual. Add this entity to the Commissioning Team where appropriate.

(d) Develop scope and budget for project-specific Commissioning Process activities.

(e) Verify that Commissioning Process activities are clearly stated in all project scopes of work.

(f) Integrate the Commissioning Process activities into the project schedule.

(g) Build and maintain cohesiveness and cooperation among the project team.

(h) Coordinate Owner's representative's participation as defined in Section 5.2.1.2.

(i) Conduct and document Commissioning Team meetings.

(j) Identify who will accomplish the Commissioning Process activities.

(k) Review Pre-Design Phase documents for compliance with the Owner's Project Requirements.

(l) Write the initial Commissioning Plan.

(m) Develop the initial format to be used for Issues Logs throughout, and for each phase of, the Commissioning Process.

(n) Track and document issues and deviations relating to the Owner's Project Requirements and document resolutions in the Issues Log.

(o) Write and review Commissioning Process Progress Reports.

5.2.2 Develop Owner's Project Requirements

5.2.2.1 The Owner's Project Requirements form the basis from which all design, construction, acceptance, and operational decisions are made. An effective Commissioning Process depends upon a clear, concise, and comprehensive Owner's Project Requirements document. It includes information to help the project team to properly plan, design, construct, operate, and maintain systems and assemblies.

5.2.2.2 The Commissioning Authority facilitates the development of the Owner's Project Requirements. Input will be gathered from all team members.

5.2.2.3 Each item of the Owner's Project Requirements shall have defined performance and acceptance criteria. Those that can be benchmarked should have the benchmark defined in specific terms and the means of measurement defined.

5.2.2.4 The Owner's Project Requirements should include the following:

(a) Project schedule and budget.

(b) Commissioning Process scope and budget.

(c) Project documentation requirements, including format for submittals, training materials, reports, and the Systems Manual. Consideration should be given to use of electronic format documents and records where appropriate.

(d) Owner directives.

(e) Restrictions and limitations.

(f) User requirements.

(g) Occupancy requirements and schedules.

(h) Training requirements for Owner's personnel.

(i) Warranty requirements.

(j) Benchmarking requirements.

(k) Operation and maintenance criteria for the facility that reflect the Owner's expectations and capabilities and the realities of the facility type.

(l) Equipment and system maintainability expectations, including limitations of operating and maintenance personnel.

(m) Quality requirements for materials and construction.

(n) Allowable tolerance in facility system operations.

(o) Energy efficiency goals.

(p) Environmental and sustainability goals.

(q) Community requirements.

(r) Adaptability for future facility changes and expansion.

(s) Systems integration requirements, especially across disciplines.

(t) Health, hygiene, and indoor environment requirements.

(u) Acoustical requirements.

(v) Vibration requirements.

(w) Seismic requirements.

(x) Accessibility requirements.

(y) Security requirements.

(z) Aesthetics requirements.

(aa) Constructability requirements.

(ab) Communication requirements.

(ac) Applicable codes and standards.

(See Table J-1 in Annex J for an example matrix that can assist in the development of Owner's Project Requirements.)

5.2.2.5 Obtaining the information and criteria for the Owner's Project Requirements document requires input from all key facility users and operators. The method used to obtain the information should allow the different user groups and operators to interact. Nominal Group Technique workshops, interviews, and surveys can be used to obtain this input, with decreasing levels of interaction attained, respectively, for each type. See Annex I for additional guidance.

5.2.2.6 The Owner's Project Requirements become part of the Systems Manual documentation.

5.2.2.7 The Owner's Project Requirements is a document that evolves through each project phase. As decisions are made during the Design, Construction, and Occupancy and Operations Phases, this document will be updated to reflect the current project requirements of the Owner. It is the primary tool for benchmarking success and quality at all phases of the project delivery and throughout the life of the facility.

5.2.2.8 Make reference to the Owner's Project Requirements in the bidding documents as "information available to bidders." It must be noted in the contract documents that the Owner's Project Requirements are issued for information only and that this document shall not define, nor shall it be used to interpret, the requirements of the contract.

5.2.2.9 Use quality-based sampling for verification of each activity or task to determine how well it meets or relates to the Owner's Project Requirements in the Pre-Design Phase. This includes programming documents, defined scope-of-design services, special reports and workshop outcomes, and other activities in the Pre-Design Phase.

5.2.3 Identify the scope and budget for the Commissioning Process

5.2.3.1 The scope of the Commissioning Process will vary from one project to another. The Commissioning Team develops the scope for the Commissioning Process. The experiences of the programming team, users, designers, Commissioning Authority, and the Owner with similar and previous facilities and projects can aid in establishing a scope for the Commissioning Process. Additional insight regarding the scope of the Commissioning Process can be obtained from code officials, regulations, published information on similar facilities, and information in the Technical Commissioning Process Guidelines.

5.2.3.2 A well-defined scope permits the establishment of an appropriate budget allocation for the Commissioning Process. The Commissioning Process budget should be realistic, distributed by phase, activity, and entity (Owner, Commissioning Authority, design professional, and contractors), and not subject to reduction without an express change in the Commissioning Plan. Lack of a properly defined and maintained Commissioning Process budget will adversely affect the Commissioning Process and the success of the facility in meeting the Owner's Project Requirements.

5.2.3.3 Typically the Owner will focus the Commissioning Process efforts on selected systems or assemblies based upon the budget, systems or assemblies where the Owner has experienced previous problems, upon complex systems and assemblies, or upon the criticality of the system or assembly in providing for the Owner's Project Requirements. The Commissioning Process can focus upon:

(a) Substructure: includes basement and foundations.

(b) Shell: includes superstructure, roof, walls, fenestration, and exterior doors.

(c) Interiors: includes interior construction, wall, floor, and ceiling finishes, partitions, interior doors, stairways, hardware, and fitting specialties.

(d) Services: includes controls, HVAC&R systems, electrical systems, fire and life safety systems and assemblies, security systems, communication systems, plumbing systems, conveying systems, and specialty or technology systems.

(e) Equipment and furnishings.

(f) Sitework.

(g) Landscaping.

5.2.4 Develop the Commissioning Plan

5.2.4.1 The Commissioning Plan identifies processes and procedures necessary for a successful Commissioning Process. The Commissioning Plan addresses the Owner's Project Requirements and reflects the defined scope and budget for the Commissioning Process.

5.2.4.2 The Commissioning Plan includes a schedule of Commissioning Process activities, individual responsibilities, documentation requirements, communication and reporting protocols, and evaluation procedures. Evaluation procedures include the review and verification to the Owner's Project Requirements of the design documents, contract documents, construction and test procedures.

5.2.4.3 The Commissioning Plan is continually updated during the life of a project to reflect changes in planning, design, construction, and occupancy and operations. During the Pre-Design Phase, the Commissioning Plan focuses upon the scope of the Commissioning Process during the Design Phase. The Construction Phase and Occupancy and Operations Phases are included, but details are usually added during the Design Phase for the Construction and Occupancy and Operations Phases—see Sections 6.2.3 and 7.2.5.

5.2.4.4 The Commissioning Plan contains the following information:

(a) Overview of the Commissioning Process developed specifically for the project.

(b) Roles and responsibilities for the Commissioning Team throughout the project and specifically during the Pre-Design and Design Phases. The roles shall differentiate the areas with which each of the members is involved, and the responsibilities shall detail the specific tasks that are to be completed by the individual members.

(c) Documentation of general communication channels to be used throughout the project. Design Phase procedures should be clearly documented during the Pre-Design Phase.

(d) Detailed description of Commissioning Process activities and a schedule of activities during the Pre-Design and Design Phases. The milestones should include the Commissioning Team meetings, Owner's Project Requirements development, design review periods, and the completion of the Basis of Design and the commissioning specifications.

(e) General description of Commissioning Process activities that will occur during the Construction and Occupancy and Operations Phases.

(f) Guidelines and format that will be used to develop the

Commissioning Process documentation that facilitates communication among the Commissioning Team and all other parties involved in the project.

(g) Commissioning Process forms that will be used during the Pre-Design and Design Phases to communicate and track critical Commissioning Process information.

(h) Project design document verification procedures.

(i) The framework for procedures to follow whenever Commissioning Process verification does not meet the Owner's Project Requirements.

(j) Quality-based sampling procedures for verification of achieving the Owner's Project Requirements during all project phases.

5.2.4.5 If properly developed, the Commissioning Plan forms the core of the Final Commissioning Process Report.

5.2.5 Establish Issues Log Procedures

5.2.5.1 An Issues Log contains detailed descriptions of design, installation, or performance issues that are at variance with the Owner's Project Requirements. Issues are identified and tracked as they are encountered during the design, construction, and operation of a facility. It is recommended that an Issues Log be maintained with the status of all current and resolved issues. The information outlined in 5.2.5.2 and 5.2.5.3 should be documented in the Issues Log as a minimum.

5.2.5.2 Information to be documented at the time an issue is identified includes:

(a) Unique numeric or alphanumeric identifier by which the issue may be tracked.

(b) Short, descriptive title of the issue.

(c) Date and time of the identification of the issue.

(d) Test number of the test being performed at the time of the observation, if applicable, for cross-reference.

(e) Identification of system, equipment, or assembly to which the issue applies.

(f) Location of the issue.

(g) Description of the observed design, installation, or performance issue, including any information that may be helpful in diagnosing or evaluating the issue.

(h) Recommended corrective action, if apparent.

(i) Identification of the Commissioning Team member responsible for resolution of the issue, if apparent.

(j) Expected date of correction.

(k) Name of the person documenting the issue.

5.2.5.3 Information to be documented when an issue is resolved:

(a) Date of completion of resolution.

(b) Description of corrective action taken. Include description of diagnostic steps taken to determine the root cause of the issue and the value of resolving the Commissioning Process issue for the owner, design team, contractor, or occupant.

(c) Identification of changes to the Owner's Project Requirements or Basis of Design that require action (if any).

(d) Statement that the correction was completed and the system or assembly is ready for retest, if applicable.

(e) Name of the person who resolved the issue.

(f) Name of person documenting the issue resolution.

5.2.6 Prepare Issues Report

5.2.6.1 On a periodic basis, at least for each Commissioning Team meeting, a report shall be generated for review of outstanding issues. The following information should be included:

(a) Issue number.

(b) Short, descriptive title of the issue.

(c) Date of the identification of the issue.

(d) Name of the Commissioning Team member assigned responsibility for resolution.

(e) Expected date of correction.

5.2.7 Prepare Commissioning Process Progress Reports

5.2.7.1 Commissioning Process Progress Reports are periodic reports of the status of Commissioning Process activities throughout the project and become part of the Commissioning Process Report. Commissioning Process Progress Reports should cover the following information:

(a) Commissioning Process activities completed since the last report, including the current status of Pre-Design project activities.

(b) Description of changes to the Commissioning Process schedule (e.g., early completion of or delays in work and early or late delivery of items that impact the Commissioning Process activities), Commissioning Plan, and design, along with their effect on the Owner's Project Requirements and Basis of Design.

(c) Include new and outstanding issues and list those that have been resolved since the last Progress Report, including a brief description of actions taken to resolve the issues. Also include planned activities to resolve outstanding issues expeditiously.

(d) Commissioning Process activities anticipated during the period before the next Progress Report.

5.2.7.2 The frequency of Commissioning Process Progress Reports depends upon the amount of work being accomplished and could vary from every two weeks to every six months. A general guide to follow is one progress report for every four Commissioning Team meetings.

5.3 Pre-Design Phase Acceptance Requirements

5.3.1 During the Pre-Design Phase the Commissioning Process should include the formal acceptance by the Owner of the Owner's Project Requirements and the Commissioning Plan.

5.4 Pre-Design Phase Documentation

5.4.1 The Commissioning Process scope and budget, Owner's Project Requirements, the Commissioning Plan, Issues Log and reports, and Commissioning Process Progress Reports are the primary documentation requirements for the Pre-Design Phase Commissioning Process.

5.4.2 The information in the Owner's Project Requirements and the Commissioning Plan is used throughout subsequent project phases (including Occupancy and Operations).

5.5 Pre-Design Phase Training Identification Requirements

5.5.1 Training requirements for facility, system, and assembly operation and maintenance are addressed in the Owner's Project Requirements.

6. DESIGN PHASE

6.1 Introduction

6.1.1 During the Design Phase of the project delivery process, the Owner's Project Requirements are translated into construction documents. A document called the Basis of Design is created that clearly conveys the assumptions made in developing a design solution that fulfills the intent and criteria in the Owner's Project Requirements document. Narrative descriptions of facility systems and assemblies are developed and included in the Basis of Design, and the Commissioning Plan is expanded to include the details of Construction and Occupancy and Operations Phase activities.

6.1.2 Design Phase Commissioning Process objectives include the following:

(a) Verifying the Basis of Design document with the Owner's Project Requirements document.

(b) Updating the Commissioning Plan to include Construction and Occupancy and Operations Phase Commissioning Process activities.

(c) Developing Commissioning Process requirements for inclusion in the Construction Documents.

(d) Developing draft Construction Checklists.

(e) Updating the scope and format of the project Systems Manual.

(f) Defining training requirements.

(g) Performing commissioning-focused design review.

(h) Acceptance of Design Phase Commissioning Process activities.

6.1.3 Design Phase Commissioning Process activities described in this section that are to be performed by the design team and special consultants must be included in the scope of services described in the "Owner - Design Professional Service Agreement." These Commissioning Process activities may be more than are normally required in their scope of services. The scope of services in the "Owner - Design Professional Service Agreement" should also include the requirement to cooperate with the Commissioning Authority during Pre-Design, Design, and Construction phases of the project. This may include testing soils, evaluating or checking existing conditions, surveying, or other requirements during Design.

6.1.4 Use quality-based sampling for verification of each activity or task determined to be related to the Owner's Project Requirements in the Design Phase.

6.1.5 If the Commissioning Process on a particular project starts at the Design Phase, then the Commissioning Process activities described for the Pre-Design Phase must be completed before the following Design Phase activities are begun.

6.2 Design-Phase Commissioning Process Activities

6.2.1 Design-Phase Commissioning Process Responsibilities

6.2.1.1 During the Design Phase, the Commissioning Team works to verify that the Construction Documents meet and properly convey the Owner's Project Requirements.

6.2.1.2 Essential team members during the Design Phase include the Owner's representatives, the Commissioning Authority, design professionals, and construction/program/project managers (if known).

6.2.1.3 Responsibilities of the Commissioning Team during the Design Phase include the following:

(a) Build and maintain cohesiveness and cooperation among the project team.

(b) Assist Owner in preparing requests for project services that outline the Commissioning Process roles and responsibilities developed in the Commissioning Plan.

(c) Verify that Commissioning Process activities are clearly stated in all project scopes of work.

(d) Develop the scope and budget for project-specific Commissioning Process activities.

(e) Identify specialists who will be responsible for accomplishing the Commissioning Process activities for specific systems and assemblies.

(f) Conduct and document Commissioning Team meetings.

(g) Inform all Commissioning Team members of decisions that result in modifications to the Owner's Project Requirements.

(h) Integrate the Commissioning Process activities into the project schedule.

(i) Track and document issues and deviations relating to the Owner's Project Requirements and document resolutions in the Issues Log.

(j) Verify documentation and updating of the Basis of Design.

(k) Develop Construction Checklists.

(l) Develop Construction and Occupancy and Operations Phase test requirements.

(m) Develop training program requirements.

(n) Document Commissioning Process requirements and integrate them into the contract documents.

(o) Update the Commissioning Plan.

(p) Review Design Phase documents for compliance with the Owner's Project Requirements.

(q) Update the Owner's Project Requirements.

(r) Write and review Commissioning Process Progress Reports.

6.2.2 Basis of Design Documentation

6.2.2.1 The Basis of Design, developed and updated throughout the Design Phase, is required with each design submission and should include the following:

(a) System and assembly options.

(b) System and assembly selection reasoning.

(c) Facility, system, and assembly performance assumptions:

(i) Assumptions for calculations/sizing.
(ii) Analytical procedures and tools.
(iii) Environmental conditions.
(iv) Limiting conditions.
(v) Reference make and model.
(vi) Operational assumptions.

(d) Narrative system and assembly descriptions.

(e) Codes, standards, guidelines, regulations, and other references.

(f) Owner guidelines and directives.

(g) Specific descriptions of systems and assemblies.

(h) Consultant, engineering, and architectural guidelines for design developed by the design team or others.

6.2.2.2 The Basis of Design documents how each criterion in the Owner's Project Requirements is implemented in the design. For any criterion that could not be met, documentation detailing what was done, its impact on the Owner's Project Requirements, and how the Owner's Project Requirements was modified shall be included.

6.2.3 Update Commissioning Plan

6.2.3.1 The Commissioning Plan must be updated to reflect changes in the Owner's Project Requirements and include additional information developed during the Design Phase.

6.2.3.2 During the Design Phase, the following is added to or updated in the Commissioning Plan:

(a) Systems and assemblies to be verified and tested.

(b) Schedule of Construction Phase and Occupancy and Operations Phase Commissioning Process activities.

(c) Roles and responsibilities of new Commissioning Team members.

(d) Construction Phase and Occupancy and Operations Phase documentation and reporting requirements, including procedures and formats.

(e) Construction Phase and Occupancy and Operations Phase communication protocols.

(f) Construction Phase and Occupancy and Operations Phase Commissioning Process procedures.

6.2.3.3 The milestones to be incorporated in the schedule should include the pre-bid meeting, pre-construction meeting, Commissioning Team meetings, training sessions, shop drawing submittals, Systems Manual submittal, special tests or code official inspection and acceptance, tests, test periods, substantial completion, occupancy, seasonal testing, initial Commissioning Process Report submittal, warranty review two months prior to end of warranty period, lessons-learned meeting, and final Commissioning Process Report.

6.2.3.4 The Construction Phase and Occupancy and Operations Phase roles and responsibilities of the individual members of the Commissioning Team, including any new members, should be clearly defined based upon the unique experience and knowledge of the team members. Professional and services agreements must be modified to reflect the scope of work.

6.2.3.5 The Commissioning Plan must define the documentation that will be required as part of the Commissioning Process during the Construction Phase and Occupancy and Operations Phase. This includes the specific formats to be used (electronic/paper, software program and version), the information to be included, the frequency of submittal, and the distribution.

6.2.3.6 The communication protocols to be used during the Construction Phase and Occupancy and Operations Phase shall be clearly defined in the Commissioning Plan. This includes how the flow of information among the team members will be coordinated and distributed.

6.2.3.7 The Commissioning Process procedures to be implemented during the Construction Phase and Occupancy and Operations Phase must be clearly documented in the Commissioning Plan. These include:

(a) Review of submittals.

(b) Scheduling and holding of meetings.

(c) Site visit procedures.

(d) Issues identification, documentation, tracking, and resolution.

(e) Construction Phase test preparation, implementation, and follow-up.

(f) The responsibilities of each member of the Commissioning Team.

(g) Who is responsible for costs related to verification and testing—including re-testing or verification activities.

(h) Systems Manual development and review.

(i) Training program.

(j) Occupancy and Operations Phase test preparation, implementation, and follow-up.

6.2.3.8 The test procedure requirements developed during the Design Phase are general in nature, structure, and complexity but must clearly convey the level and amount of testing (see Section 7.2.9) required by manufacturers and contractors.

6.2.4 Commissioning Process Requirements in the Construction Documents

6.2.4.1 The Commissioning Process requires that certain quality-assurance and quality-control procedures, envisioned in the Commissioning Plan, be performed as part of the construction contract.

6.2.4.2 The Owner's Project Requirements should be included in the Contract Documents and labeled as for "Informational Purposes Only" to differentiate it from the contractor's contractual obligations. In addition, as much Basis of Design information should be included in the Contract Documents as possible. This information is included in the Contract Documents to aid the contractors in understanding the design, material requirements, sustainability and energy goals, and the desired use and intent of the facility. Such information aids in the successful implementation of the Commissioning Process but does not relate directly to the contract requirements.

6.2.4.3 Specific Commissioning Process requirements are included in the contract specifications. For this guideline, specification division numbers and section titles consistent with the Construction Specifications Institute MasterFormat® are used. This is done to simplify a lengthy list of specification requirements. Commissioning Process activities that address systems and assemblies need to be included in Division 1 sections and those that address equipment and components need to be included in Divisions 2 through 16.

(a) The obligations to perform Commissioning Process activities must be documented in the contract between the Owner and Contractor.

(b) Detailed scope and responsibilities of the Contractor shall be included in the "Summary of Work" section in Division 1.

(c) The Commissioning Process requirements for documentation, training, and testing facility systems and assemblies are integrated into commissioning sections in Division 1.

(d) Specific equipment and component performance documentation requirements and use of Construction Checklists should be integrated into specification sections in Divisions 2 through 16, with appropriate cross-references.

6.2.4.4 The Commissioning Process activities to be integrated include:

(a) Performance, installation, and operations information requirements as part of shop drawing submittals in Divisions 2 through 16 sections.

(b) Completion of Construction Checklists in Division 1 and references to Division 1 in Divisions 2 through 16 sections.

(c) Contractor involvement in the Commissioning Team in Division 1.

(d) Test requirements in Division 1.

(e) Training program development and implementation requirements in Division 1.

(f) Systems Manual requirements in Division 1.

6.2.4.5 A guide specification section template for general Commissioning Process requirements in Division 1 is included in Annex L.

6.2.5 Construction Checklists

6.2.5.1 Construction Checklists aid the installers by providing specific information on the Owner's Project Requirements for equipment and assemblies for long-term operation. Checklists typically include:

(a) Equipment/assembly verification.

(b) Pre-installation checks.

(c) Installation checks.

(d) Any negative responses.

6.2.5.2 The first section of the Checklist is equipment/assembly verification. This section should include vital information on the equipment or materials being supplied (specific listings of vital information are included in the technical guidelines developed for various facility systems). This section contains information on what equipment/material was specified/submitted and space to document/verify what was actually delivered to the site.

6.2.5.3 The pre-installation section of the Checklist is utilized to verify the condition of the equipment/material at the site immediately prior to its installation.

6.2.5.4 The installation section of the Checklist is utilized to verify proper installation. This section focuses on the ability of the installation to meet the Construction Documents and the Owner's Project Requirements. For equipment, this section focuses on the physical installation and its start-up when applicable. For assemblies, the focus is typically on installation and performance.

6.2.5.5 The negative responses section is a space provided to document the reason for any negative responses and whether any action has been taken to correct the problem or problems that led to the negative responses.

6.2.5.6 Whenever a test data form is required for a specific system or assembly, there should be an item in the associated Construction Checklist for the test data form to be submitted to the Commissioning Authority.

6.2.5.7 Construction Checklists should be kept as short as possible and the questions should be worded clearly so that the correct answer is typically yes.

6.2.5.8 Construction Checklists are used by the Commissioning Team to verify that the installation meets the Owner's Project Requirements. They can also be used by the contractors to track progress of construction against the schedule of values.

6.2.5.9 Annex M contains sample formats for Construction Checklists.

6.2.6 Systems Manual

6.2.6.1 The Systems Manual should provide the information needed to understand, operate, and maintain the systems and assemblies and to inform those not involved in the design and construction process about the systems and assemblies. The Systems Manual should be the repository of information on updates and corrections to systems and assemblies as they occur during the Occupancy and Operations Phase.

6.2.6.2 The Systems Manual expands the scope of the traditional operating and maintenance documentation to include the additional information gathered during the Commissioning Process and to provide a systems-based organization of information.

6.2.6.3 Contractor documentation requirements for the Systems Manual shall be clearly stated in the Construction Documents.

6.2.6.4 The following should be included in the Systems Manual (see Annex O for an example format):

(a) Index of Systems Manual with notation as to content storage location if not in actual manual.

(b) Executive Summary.

(c) Owner's Project Requirements.

(d) Basis of Design documents.

(e) Construction Record Documents, specifications, and approved submittals.

(f) A list of recommended operational record-keeping pro-

cedures, including sample forms, logs, or other means, and a rationale for each.

(g) Ongoing optimization guidance.

(h) Operations and maintenance manuals (includes operating procedures for all normal, abnormal, and emergency modes of operation; maintenance procedures; parts and recommended spare parts list; troubleshooting guide; and systems schematics (one-line diagrams).

(i) Training materials.

(j) Commissioning Process Report.

6.2.7 Training Requirements

6.2.7.1 During the Design Phase, the training requirements of the operations and maintenance personnel and occupants are identified relative to the systems and assemblies to be installed in the facility. It is critical that the operations and maintenance personnel have the knowledge and skills required to operate the facility to meet the Owner's Project Requirements. The occupants need to understand their impact on the use of the facility and its ability to meet the Owner's Project Requirements.

6.2.7.2 These training requirements can be obtained using a Nominal Group Technique workshop, interviews, or surveys. The requirements are obtained after the systems and assemblies have been decided upon, and prior to issuance of the Construction Documents, to ensure that the requirements for training are clearly conveyed in the Construction Documents. The results of the workshop, interviews, or surveys should address the following:

(a) The systems, subsystems, equipment, and assemblies for which training will be required.

(b) The capabilities and knowledge of the occupants and operations and maintenance personnel.

(c) The number and type of training sessions. The training program should be organized into a series of instructional modules, each covering a portion of the facility's systems, equipment, and assemblies.

(d) Measurable learning objectives and teaching outlines should be developed to clearly describe the specific skills and knowledge that the participant is expected to master.

6.2.7.3 The first training session should be general in nature for the operations and maintenance personnel and the occupants, and it should review the Owner's Project Requirements and the Basis of Design. This provides the background on why the facility is being constructed and its limitations.

6.2.7.4 The majority of training should be planned to be accomplished during the Construction Phase and prior to substantial completion.

6.2.7.5 Training during the Occupancy and Operations Phase may be required for certain systems and assemblies to achieve or maintain the Owner's Project Requirements.

6.2.7.6 The Systems Manual has a close functional relationship with personnel training. A meaningful and useful training program typically includes using the operation and maintenance components of the Systems Manual as the basis of development.

6.2.7.7 Review of documentation during training consists of reviewing the content of emergency, operation, and maintenance information in the Systems Manual, project Record Documents, system and equipment identification systems, warranties, and maintenance service agreements contained in the Systems Manual. Training should specifically address:

(a) Emergency instructions and procedures: those required for operating the facility during various emergencies, including step-by-step instructions for each type of emergency.

(b) Operation instructions and procedures: the procedures required for normal operation of the facility, including step-by-step instructions for day-to-day operation.

(c) Adjustment instructions: information for maintaining operational parameters.

(d) Troubleshooting procedures: instructions for diagnosing operating problems and procedures for testing and inspecting.

(e) Maintenance and inspection procedures.

(f) Repair procedures: instructions for diagnosing problems and for disassembly, component removal, replacement, and reassembly.

(g) Upkeep of the Systems Manual and associated maintenance documentation and logs.

6.2.7.8 In the specifications, as a minimum, define the time requirements for each type of system/assembly that requires demonstration and training or include an allowance for demonstration and training capabilities. Also include the expected experience and knowledge of trainer, the number of unique training sessions, the need for repeating the training for multiple shifts, and submittal of Training Plan, handouts, record of the training, and electronic recording of on-site training.

6.2.7.9 Training materials should include or utilize the following items:

(a) Copy of the Training Plan including schedule, syllabus, and agenda.

(b) Systems Manual.

(c) Manufacturers' training manuals.

(d) Electronic media or videotapes of manufacturers' or vendors' training and service materials.

6.2.8 Review of Design Professional Submittals

6.2.8.1 Complete targeted design reviews at strategic times during the Design Phase. All design issues should be resolved prior to continuing with design.

6.2.8.2 A targeted design review is composed of four tasks:

(a) General quality review of the documents, including legibility, consistency, and level of completeness.

(b) Coordination between disciplines.

(c) Discipline-specific review for achieving the Owner's Project Requirements.

(d) Specification applicability and consistency with Owner's Project Requirements and Basis of Design.

6.2.8.3 The general quality of the documents is evaluated by checking for consistent layout and legibility of the Design Professional Submittal and Construction Documents. Compliance with the Owner's Project Requirements along with ease of use and clarity are the major issues to check when looking at the complete package. This review looks for completeness of the drawings and for items of concern identified during previous reviews.

6.2.8.4 Sample areas of the facility, 10-20% of the total area, are reviewed in detail to evaluate the coordination accomplished within and among disciplines. This includes reviewing for constructability and interfaces among disciplines. The intent of this review is to determine if there are systematic errors, not to fully check the drawings. The responsibility for complete checking of the drawings for coordination and accuracy remains with the Design Team.

6.2.8.5 A discipline-specific review involves a review of the Construction Documents along with the Basis of Design, design calculation assumptions, and methods for compliance with the Owner's Project Requirements. A sampling strategy of focusing upon 10-20% of the drawings provides for an in-depth analysis and evaluation of the ability of the documents to meet the Owner's Project Requirements.

6.2.8.6 A review of the specifications is performed to determine completeness and applicability to the project. A review of 10-20% of the specification is performed in detail for verification of compliance with the Owner's Project Requirements. Items checked include applicability of the section to the project, Commissioning Process requirements, submittal requirements, applicability of equipment, training requirements, and coordination with other sections.

6.2.8.7 See Annex N for additional guidance on how to accomplish quality-based design reviews.

6.3 Design Phase Acceptance Requirements

6.3.1 The Commissioning Process should include the formal acceptance by the Owner of the Basis of Design and the updated Owner's Project Requirements during the Design Phase, following review and comment by the Commissioning Authority.

6.4 Design Phase Documentation Requirements

6.4.1 Construction Document commissioning requirements, updated Owner's Project Requirements, updated Commissioning Plan, the updated Issues Log, and the Commissioning Process Progress Reports are the primary documentation requirements for the Design Phase Commissioning Process.

6.4.2 The information in these deliverables is used throughout subsequent project phases (including Occupancy and Operations).

6.5 Design Phase Training Identification Requirements

6.5.1 Training requirements for facility, system, and assembly operation and maintenance are addressed during the Design Phase by the completion of a training requirements identification workshop, development of the Construction Phase and Occupancy and Operations Phase training program, and inclusion of the training program requirements in the Commissioning Plan and Construction Documents.

7. CONSTRUCTION PHASE

7.1 Introduction

7.1.1 During the Construction Phase of the project delivery process, systems and assemblies are installed, inspected, tested, and placed into service to meet the Owner's Project Requirements. This phase may also include bidding, negotiation, and contracting activities. The Systems Manual is delivered during this phase and training is provided.

7.1.2 Construction Phase Commissioning Process objectives include the following:

(a) Updating the Owner's Project Requirements.

(b) Updating the Commissioning Plan.

(c) Verifying that submittals meet the Owner's Project Requirements.

(d) Developing detailed test procedures and data forms.

(e) Verifying that systems and assemblies comply with the Owner's Project Requirements.

(f) Delivering the Systems Manual.

(g) Verifying training of the Owner's operation and maintenance personnel and occupants.

(h) Acceptance of Construction Phase Commissioning Process activities.

7.1.3 Construction Phase Commissioning Process activities described in this section that are to be performed by the design team and special consultants must be included in the scope of services described in the "Owner – Design Professional Service Agreement." These Commissioning Process activities may be more than are normally required in their scope of services. The scope of services in the "Owner - Design Professional Service Agreement" should also include the requirement to cooperate with the Commissioning Authority during Pre-Design, Design, and Construction phases of the project. This may include material testing, TAB, performance tests, records, photography, outside training, Owner's furnished equipment vendors, and other requirements during the Construction Phase.

7.1.4 If the Commissioning Process on a particular project starts at the Construction Phase, Commissioning Process activities described for the Pre-Design and Design Phases must be completed before the following Construction Phase activities are begun.

7.2 Construction Phase Commissioning Process Activities

7.2.1 Construction Phase Commissioning Process Responsibilities

7.2.1.1 During the Construction Phase, the Commissioning Team works to verify that systems and assemblies are installed in a manner that will achieve the Owner's Project Requirements.

7.2.1.2 Use quality-based sampling for verification of each task and test determined to be related to the Owner's Project Requirements during the Construction Phase.

7.2.1.3 Conduct and document regularly scheduled Commissioning Team meetings to facilitate coordination and cooperation in delivering a facility that meets the Owner's Project Requirements.

7.2.1.4 Essential team members during the Construction Phase include Owner's representatives, the Commissioning Authority, design professionals, contractors, suppliers/vendors, and construction/program/project managers.

7.2.1.5 Responsibilities of the Commissioning Team during the Construction Phase include the following:

(a) Participate in the pre-bid conference.

(b) Coordinate participation of Owner's representatives.

(c) Identify specialists who will be responsible for accomplishing the Commissioning Process activities for specific systems and assemblies.

(d) Update the Owner's Project Requirements to reflect decisions made during bidding and construction.

(e) Update the Commissioning Plan.

(f) Conduct a pre-construction Commissioning Process meeting.

(g) Review the following submittals for compliance with the Owner's Project Requirements: coordination drawings, shop drawings, product data, preliminary Systems Manual, and training program.

(h) Schedule the Commissioning Process activities and integrate them into the project construction schedule.

(i) Address schedule changes.

(j) Develop and document test procedures and data forms.

(k) Conduct and document ongoing Commissioning Team meetings.

(l) Monitor compliance with the Owner's Project Requirements through periodic site visits.

(m) Verify completion of items indicated in the Construction Checklists.

(n) Witness tests.

(o) Verify tests.

(p) Verify test data reports.

(q) Verify training of operation and maintenance personnel and occupants according to the Owner's Project Requirements.

(r) Identify, diagnose, and track issues and deviations relating to the Owner's Project Requirements and document resolution of same.

(s) Write and review Commissioning Process Progress Reports.

(t) Review construction progress reports.

(u) Verify incorporation of new equipment and systems into the maintenance management program.

(v) Verify updates to the Basis of Design documentation.

(w) Verify updates to the Systems Manual.

(x) All Commissioning Team members are responsible for keeping the Commissioning Team informed of decisions that result in modifications to the Owner's Project Requirements.

(y) Review contract modifications for compliance with Owner's Project Requirements.

7.2.2 Pre-bid Conference

7.2.2.1 Time should be allotted during the pre-bid conference for the Commissioning Team to alert bidders to Commissioning Process requirements with which they may not be familiar.

7.2.3 Coordinate Owner's Representatives Participation

7.2.3.1 Coordinate and schedule participation of Owner's representatives in Commissioning Process activities. Owner representatives may vary from one activity to another, both in number and in the specific individuals. It is important for Owner's representatives to participate in Commissioning Team meetings, review of commissioning process reports, discussions of changes to the Owner's Project Requirements, and staff and occupant training. Other Commissioning Process activities in which Owner's representatives typically participate include reviewing submittals and witnessing testing.

7.2.4 Update Owner's Project Requirements

7.2.4.1 Changes to the Owner's Project Requirements during bidding and the Construction Phase may be initiated as the result of Owner-directed changes to the Owner's Project Requirements or design/construction process-initiated changes to the Construction Documents.

7.2.4.2 When the Owner initiates a change to the Owner's Project Requirements, the design shall be modified and reviewed as necessary to meet the change in the Owner's Project Requirements.

7.2.4.3 When the Owner considers changes initiated through the design/construction process, the Commissioning Team should review the proposed changes to determine if they compromise the Owner's Project Requirements, paying special attention to the functional impacts of value management proposals. If the Owner chooses to initiate a change after reviewing the Commissioning Team's comments, the Owner's Project Requirements must be updated as necessary to match the change.

7.2.5 Update the Commissioning Plan

7.2.5.1 Update the Commissioning Plan to include new or revised descriptions of Commissioning Process activities during the Construction Phase. Incorporate the following:

(a) Test procedures and data forms developed during the Construction Phase.

(b) Refinement and integration of Commissioning Process activities in the construction schedule.

(c) Roles and responsibilities of the Commissioning Team during the Construction Phase, including the identification of new team members.

(d) Identification of specialists responsible for accomplishing Commissioning Process activities for specific systems and assemblies.

(e) Changes to the communication channels and procedures to be used during the Construction Phase.

7.2.6 Conduct Pre-Construction Commissioning Process Meeting

7.2.6.1 Early in the Construction Phase, the Commissioning Authority shall conduct a pre-construction Commissioning Process meeting with the Commissioning Team.

7.2.6.2 During the pre-construction meeting, the Owner's Project Requirements, Basis of Design, and unique contract document requirements are reviewed. In addition, the specific roles and responsibilities of the contractors relative to the Commissioning Process activities are reviewed.

7.2.7 Verify Submittals

7.2.7.1 It is recommended that a sampling strategy of randomly selecting 5% to 10% of the submittal be used to focus upon the quality and ability of the submittal to achieve the Owner's Project Requirements. If deviations are substantial, then review an additional 5% to 10%. If substantial deviations still exist, then reject the submittal and return it with comments.

7.2.7.2 Concurrent with Design Team and Owner review, a designated Commissioning Team member reviews coordination drawings, shop drawings, and project submittals for compliance with the Owner's Project Requirements. Special attention must be paid to substitutions and proposed deviations from the Contract Documents and the Basis of Design that could adversely impact the Owner's Project Requirements.

7.2.7.3 Upon receipt, designated members of the Commissioning Team shall review the Systems Manual for compliance with the Contract Documents and the Owner's Project Requirements.

7.2.7.4 Review training program, materials, and schedule, and monitor delivery of training to verify that it meets the Owner's Project Requirements for the preparation of operations and maintenance personnel.

7.2.7.5 Training records are reviewed by designated members of the Commissioning Team for proper documentation of attendees, material covered, and associated details.

7.2.8 Schedule Commissioning Process Activities

7.2.8.1 The objective of scheduling Commissioning Process activities is to integrate and coordinate them with other Construction Phase activities and to allow all Commissioning Team members to plan their work to achieve the Owner's Project Requirements. Commissioning Process activities should be integrated into the construction schedule. Detailed integration of commissioning work with the construction schedule is critical to maintaining project schedule milestones.

7.2.8.2 The project schedule needs to include the start date, duration, description, and entity responsible for completion.

7.2.8.3 As a minimum, the following should be included in the project schedule:

(a) Commissioning Team meetings.

(b) Start and completion of each construction phase.

(c) Key system and assembly completion and tests.

(d) Training sessions.

(e) Substantial completion.

(f) Warranty start date.

(g) Occupant move-in.

(h) Warranty review two months prior to end of warranty period.

(i) Lessons-learned meeting.

7.2.9 Develop Test Procedures

7.2.9.1 Test Procedures define the means and methods to carry out the tests that are accomplished during the Construction Phase. Test Procedures provide the following:

(a) Participants required for the test, which may include the primary contractor, secondary contractors, design professionals, the Commissioning Authority, operators, the local authority having jurisdiction, and manufacturers associated with the equipment, system, or assembly.

(b) Prerequisites for the test performance in terms of completion of systems and assemblies and acceptable completion of other activities.

(c) Step-by-step instructions to exercise the specific systems and assemblies under test. Instructions include how to configure the system or assembly to start the test and how to restore the system to normal operation at the conclusion of the test.

(d) List of instrumentation, tools, and supplies required for the test. The list should indicate which of the participants is responsible for each of the items listed. The list should be specific as to make, model, range, capacity, accuracy, calibration, and other pertinent performance requirements.

(e) An indication, for each step of the procedure, of what observations or measurements must be recorded and the range of acceptable results.

7.2.9.2 The Commissioning Team will develop a range of test verification procedures. These procedures include:

(a) Component test procedures: Component test procedures verify the performance of components under a full range of actions, responses to inputs, and loads.

(b) System/assembly test procedures: System/assembly test procedures verify the performance of subsystems, systems, and assemblies under a full range of operating conditions (both normal and emergency), responses to inputs, and loads.

(c) Intersystem test procedures: Intersystem test procedures verify the interactions between systems and assemblies.

(d) Owner's Project Requirements test procedures: Owner's Project Requirements test procedures verify that the various systems and assemblies that comprise the facility deliver the intended Owner's Project Requirements at the point of use.

(e) Use quality-based sampling for verification of each test determined to be related to the Owner's Project Requirements.

7.2.9.3 In developing the Test Procedures, special attention must be paid to issues of personnel safety, equipment/assembly protection, and manufacturer's recommendations to protect the validity of the warranty.

7.2.10 Develop Test Data Records

7.2.10.1 Test Data Records capture test data, observations, and measurements. Data may be recorded on photographs, forms, or other means appropriate for the application. The following minimum information should be recorded:

(a) Test number.

(b) Date and time of the test.

(c) Indication of whether the record is for a first test or retest following correction of a problem or issue.

(d) Identification of the system, equipment, or assembly under test. List the location and the construction document designation.

(e) Conditions under which the test was conducted. For example, when testing, fully describe the ambient conditions, setpoints, overrides, and the status and operating condition of devices, systems, and equipment that impact the results of the test.

(f) Expected performance of the systems and assemblies at each step of the test.

(g) Observed performance of the system, equipment, or assembly at each step of the test. When data forms are used, check boxes generally do not adequately describe the system performance and therefore should be avoided in most cases. A blank space in which the observed or measured performance may be described provides more information for diagnostics and a future baseline for performance.

(h) Notation to indicate whether the observed performance at each step meets the expected results.

(i) Other observations about system performance or test procedure.

(j) Issue number, if any, generated as a result of the test.

(k) Dated signatures of the person performing the test and of the witness, if applicable.

7.2.11 Commissioning Team Meetings

7.2.11.1 Consistent, periodic Commissioning Team meetings are essential to maintaining the progress of the project.

7.2.11.2 The schedule of meetings should be documented as early as possible during the Construction Phase and updated as required due to schedule changes. The meeting dates and times should be known a minimum of two weeks in advance and should be coordinated with other meetings to minimize travel time and costs for various attendees.

7.2.11.3 Team members represented at the meeting must be authorized to make commitments and decisions for their respective organizations to facilitate an effective Commissioning Team meeting.

7.2.11.4 Prior to a meeting (usually a minimum of three days) an agenda should be distributed to all invited attendees. The agenda should include:

(a) Meeting location.

(b) Start time.

(c) List of invited attendees.

(d) List of items to cover (previous action items, outstanding issues, schedule review, new issues, and other business) along with defined time allotments for each item.

(e) End time.

(f) Attachments, if applicable.

7.2.11.5 The meeting time and duration should be strictly adhered to. This will set the tone for other Commissioning Process activities.

7.2.11.6 Within a reasonable and established period (frequently, three days) after the meeting, distribute meeting notes or minutes. This should include:

(a) Date, time, and location of the meeting.

(b) List of attendees.

(c) Resolved action items and issues.

(d) Outstanding action items and issues, including clear identification of the responsible party and due dates.

(e) Date, time, and location of the next meeting.

7.2.12 Accomplish Periodic Site Visits to Verify Compliance with the Owner's Project Requirements

7.2.12.1 Site visits are the primary method used during the Construction Phase to verify that the installed systems and assemblies comply with the Owner's Project Requirements.

7.2.12.2 A clear, concise, and consistent procedure must be followed for each site visit to properly identify Construction Phase process problems and issues.

7.2.12.3 The site visit procedure uses statistical sampling techniques for verification of the Construction Checklists and Record Documents. This provides assurance that the verification process is not biased and has reliable consistency. The recommended procedure has the following general steps:

(a) Identify the current state of construction to define the scope of systems and assemblies that can be verified.

(b) Randomly select between 2% and 10% of the systems and assemblies for verification. This can be accomplished by randomly selecting a starting point and selecting every tenth item from a list or by automatically generating a random sample from a computerized database.

(c) Identify Commissioning Team members for the site visit.

(d) Review Owner's Project Requirements.

(e) Accomplish verification. This task is completed by going to the selected system or assembly and comparing the installation to the completed (full or partial) Construction Checklists. Any negative responses should be reviewed in detail.

(f) Any consistent problems with the installation identified (typically more than 10% of the sample has the same issue), including Record Documents, are documented in general terms and provided to the contractor for resolution. The contractor is then responsible for 100% checking of all affected systems or assemblies and making corrections as required.

(g) Any inconsistent problems (one or two occurrences) are sent to the contractor, detailing the specific component, system, or assembly for resolution.

(h) Meet with contractors to discuss any issues identified and the general progress of the project.

(i) Meet with the Owner's representative to review the findings, project schedule, and outstanding issues.

(j) Develop a site visit report and distribute to the Commissioning Team members and other interested parties.

(k) Update the Issues Log.

7.2.13 Test Execution

7.2.13.1 During test execution there can be witnessing of tests, verification of tests, or verification of test data reports. Typically, only one of these is performed by the Commissioning Authority for a specific test or series of tests. However, depending upon the type and complexity of the test, it is possible in some cases to witness a portion of the test, verify the test through a random sampling of components, and verify the test data report through random sampling of the reported results.

7.2.13.2 Completion of tests should comply with the following:

(a) Tests shall be performed according to approved written procedures. Results of test performance shall be recorded on the test data forms and witnessed.

(b) Deviations from the approved procedures, if permitted, should be documented in writing.

(c) Test data should be recorded under steady-state and stable conditions.

(d) If an issue is observed during a test, the test should be terminated, within the scope of the contract. An issue report is created at the time of observation. If the issue cannot be resolved within a reasonable time period, it may be required to run the test immediately, with the understood options to run the test later, after all issues are resolved.

(e) If an issue is discovered during review of the data, the issues shall be resolved or the test repeated in its entirety.

(f) Upon completion of the test, the technician performing the test and the witnesses sign the test data record, attesting to the verity of the recorded observations.

7.2.13.3 Generally, the sequence of testing will be executed in the order of activities listed:

(a) The verification of the Construction Checklists begins with equipment or assembly delivery and continues through start-up and testing.

(b) Tests verifying system and intersystem performance according to the Owner's Project Requirements cannot begin until the Construction Checklists have been verified and accepted by the Commissioning Team.

(c) Other sequencing requirements, depending upon the specific system, may be required to ensure the proper conditions are present or can be created.

(d) A specified test is run according to Contract Documents or to manufacturer's requirements.

7.2.14 Verify Training

7.2.14.1 Within a reasonable period (such as three weeks) of each training program, between 5% and 10% of the trainees shall be randomly selected and tested or informally evaluated on the material covered in the specific program. The intent of this testing is to verify that the trainees were provided with the pertinent information to operate and maintain the facility according to the Owner's Project Requirements.

7.2.14.2 It is not typically expected that the trainees will have memorized everything from the training session but that they know where the information is, can find it, and understand sufficiently to walk through the key steps to troubleshoot a problem and resolve it.

7.2.14.3 Attendee sign-in sheets should be used to verify that training was delivered to the intended people.

7.2.15 Construction Phase Commissioning Process Report

7.2.15.1 The Construction Phase Commissioning Process Report is the documentation of the commissioning work and results accomplished during the Construction Phase. The Construction Phase Commissioning Process Report contains the following:

(a) Identification of any systems or assemblies that do not perform in accordance with the Owner's Project Requirements. For various reasons, the Owner may choose to accept performance that is at variance with the Owner's Project Requirements, either permanently or until schedule and budget constraints allow for correction. The Owner's acceptance of these conditions should be documented along with the environmental, health, safety, comfort, energy, and operating and maintenance cost impacts. The Owner's Project Requirements must be updated to match the revised expectations.

(b) Evaluations of the operating condition of the systems at the time of test completion.

(c) Construction Checklist completion and verification summary.

(d) Results from the Issues Log, including the descriptions of issues and the measures taken to correct them. The description should assess the importance of the issues and estimate the value of their correction in terms of environmental impact, improved health, safety, comfort, energy consumption, operating and maintenance costs, and the ability of the facility to support its mission.

(e) Test procedures and data. This section should incorporate the original test procedures and signed data forms, including additional data such as photos, computerized documentation, and other records of the tests. Data should include the final accepted test, as well as earlier tests that failed to meet the specified criteria. This section should also include a set of blank data forms for future use in the Continuous Commissioning Process and Re-commissioning.

(f) Commissioning Process Progress Reports. Copies of progress reports generated throughout the Commissioning Process.

(g) Deferred Tests. Execution of some tests may be deferred until appropriate natural loads, such as occupancy or design weather conditions, are available. For these deferred tests, the prerequisite conditions and an estimated schedule for their completion should be included.

(h) Lessons Learned. Evaluation of the Commissioning Process used and changes that will improve the delivered project and form the basis for the Final Commissioning Process Report developed during the Occupancy and Operations Phase. This is essential to ensure that issues, benefits, and recommendations are captured in a written document while all team members are available and information is fresh.

7.2.15.2 A draft Construction Phase Commissioning Process Report should be submitted for Owner review. Submittal of the draft Commissioning Process Report to other Commissioning Team members may also be appropriate.

7.2.15.3 The final Construction Phase Commissioning Process Report should incorporate review comments from the Owner and, optionally, from other Commissioning Team members.

7.2.16 Verify Systems Manual Update

7.2.16.1 Verify that the Systems Manual is updated to incorporate materials generated during the Construction Phase. Materials that should be added are:

(a) Test procedures and test data records.

(b) Training plans.

(c) Training records.

(d) Record Drawings.

(e) Submittal review reports.

(f) Updated Owner's Project Requirements.

(g) Updated Basis of Design.

(h) Updated Commissioning Plan.

(i) Updated Issues Log.

(j) Commissioning Process Progress Reports.

7.2.17 Verify Update of the Basis of Design

7.2.17.1 Verify that the Basis of Design is updated to reflect any changes to the design during the Construction Phase. Verify that design changes comply with the Owner's Project Requirements. If necessary, update the Owner's Project Requirements.

7.3 Construction Phase Acceptance Requirements

7.3.1 The Commissioning Process should include the formal acceptance by the Owner of the Systems Manual, verified test reports, and training reports, consistent with the recommendations of the Commissioning Authority and appropriate other Commissioning Team members.

7.4 Construction Phase Documentation Requirements

7.4.1 The primary Commissioning Process requirements for documentation during the Construction Phase include the Construction Phase Commissioning Process Report and commissioning elements of the Systems Manual.

7.4.2 The information in these deliverables is used throughout the Occupancy and Operations Phase.

7.5 Construction Phase Training Requirements

7.5.1 The Commissioning Process training requirements for the Construction Phase are discussed in Section 7.2.14.

8. OCCUPANCY AND OPERATIONS PHASE

8.1 Introduction

8.1.1 The Occupancy and Operations Phase of the Commissioning Process begins at substantial completion. As a minimum, the Commissioning Process activities begun at this point should continue through the end of the contractual warranty/correction period and ideally continue throughout the life of the facility. During the Occupancy and Operations Phase, the ongoing operation, maintenance, and modification of the facility systems and assemblies, and their associated documentation, are verified against the updated Owner's Project Requirements.

8.1.2 The active involvement of the Commissioning Authority and Commissioning Team during the initial portion of the Occupancy and Operations Phase of a project is an integral aspect of the Commissioning Process.

8.1.3 Occupancy and Operations Phase Commissioning Process objectives include the following:

(a) Using the Commissioning Authority's project knowledge and experience to minimize contractor callbacks.

(b) Providing ongoing guidance on operations and maintenance to achieve the Owner's Project Requirements.

(c) Completing seasonal testing of facility systems and assemblies.

(d) Documenting lessons learned from applying the Commissioning Process for application to the next project.

(e) Acceptance of Occupancy and Operations Phase Commissioning Process activities.

8.1.4 Occupancy and Operations Phase Commissioning Process activities described in this section that are to be performed by the design team and special consultants that must be included in the scope of services described in the "Owner – Design Professional Service Agreement." These Commissioning Process activities may be more than are normally required in their scope of services. The scope of services in the "Owner - Design Professional Service Agreement" should also include the requirement to cooperate with the Commissioning Authority during Pre-Design, Design, and Construction Phases of the project. This may include training, seasonal tests, problem resolution, design evaluation, site visits, updating drawings and specifications, or other requirements performed during the occupancy and initial operations period defined for the project.

8.1.5 If the Owner adopts the Commissioning Process on a project at the Occupancy and Operations Phase, then this process is termed "Retro-Commissioning" and, while it accomplishes some Commissioning Process Activities described herein, it is sufficiently different from the Commissioning Process that it is not within the scope of this guideline.

8.1.6 It is often desirable for the Owner to maintain the benefits of the Commissioning Process well into the life of the facility.

8.2 Occupancy and Operations Phase Commissioning Process Activities

8.2.1 Occupancy and Operations Phase Commissioning Process Responsibilities

8.2.1.1 During the Occupancy and Operations Phase, the Commissioning Team works to verify the ongoing compliance with the Owner's Project Requirements.

8.2.1.2 Essential team members during the Occupancy and Operations Phase include Owner's representatives, the Commissioning Authority, design professionals, contractors, and construction/program/project managers.

8.2.1.3 Responsibilities of the Commissioning Team during the Occupancy and Operations Phase include the following:

(a) Coordinate contractor callbacks.

(b) Verify seasonal testing of facility systems and assemblies.

(c) Verify continuing operation and maintenance personnel training.

(d) Verify system and assembly operations meet updated Owner's Project Requirements.

(e) Verify continual updating of the Systems Manual.

(f) Conduct and verify periodic performance evaluations of facility systems and assemblies.

(g) Convene lessons-learned workshop.

(h) Complete the final Commissioning Process Report for the project.

8.2.2 The Commissioning Authority should aid in the coordination of the callback of contractors during the Occupancy and Operations Phase. Since the Commissioning Authority has been involved since the Pre-Design Phase, he/she has the ability to identify which contractors should be contacted to resolve an issue.

8.2.3 Verification of the performance of all systems and assemblies being commissioned should be completed during the Construction Phase. However, certain weather conditions, load conditions, or occupant interactions are required to complete some verification activities. Such deferred performance verification shall be conducted at an appropriate time, and under appropriate conditions, as early as possible after occupancy.

8.2.4 Training of the Owner's operation and maintenance personnel on the fundamentals of facility and system/assembly operations and the occupants on facility usage will ideally occur primarily during the Construction Phase of a project. Some training, however, is likely to be best deferred until the Owner has assumed responsibility for his/her facility. Such training will be defined in the Commissioning Plan and Contract Documents.

8.2.4.1 Ongoing training is an integral part of a Continuous Commissioning Process. The Owner's operation and maintenance personnel and the occupants will be critical members of the Commissioning Team responsible for these periodic efforts.

8.2.5 The final project Commissioning Process Report will be completed during this phase. The requirements for a successful Commissioning Process Report are described in Section 7. Content not available or incomplete at the end of the Construction Phase will be added during this phase.

8.2.5.1 Should the Owner choose to implement the Continuous Commissioning Process for his/her facility, periodic Commissioning Process Reports will be created throughout the Occupancy and Operations Phase to reflect the Commissioning Process activities undertaken.

8.2.6 The final project Systems Manual will be completed during this phase. The requirements for a successful Systems Manual are described in Section 7. Content not available or incomplete at the end of the Construction Phase will be added during this phase.

8.2.6.1 The Systems Manual needs to be updated as changes are made to the facility throughout the entire Occupancy and Operations Phase. This includes updating the Owner's Project Requirements to reflect current conditions and needs and updating the Basis of Design to reflect changes to systems and assemblies.

8.2.7 Dynamic systems and equipment, as well as static systems, assemblies, and components, will tend to migrate from their as-installed conditions over time. In addition, the needs and demands of facility users and processes typically change as a facility is used. To attain optimal performance of facility systems, periodic verification of system, assembly, and component condition and operation is essential. The Systems Manual provides the tools and documented benchmarks for evaluation of ongoing performance. Such periodic verification is often best done in the context of a Continuous Commissioning Process.

8.2.8 The Continuous Commissioning Process has the following key activities:

(a) Maintaining the Owner's Project Requirements to reflect changes in use and operation of the facility.

(b) Maintaining the Basis of Design to reflect changes in systems and assemblies due to renovations or in response to changes in the Owner's Project Requirements.

(c) Periodic evaluation of achieving the current Owner's Project Requirements and against previous benchmarks by appropriate tests.

(d) Maintaining the Systems Manual to reflect changes in Owner's Project Requirements, Basis of Design, and systems/assemblies.

(e) Ongoing training of operations and maintenance personnel and occupants on current Owner's Project Requirements and Basis of Design and changes in systems and assemblies.

8.3 Occupancy and Operations Phase Acceptance Requirements

8.3.1 The Commissioning Process should include the formal acceptance by the Commissioning Authority and the Owner of any deferred training, the final project Systems Manual, and the Final Commissioning Process Report during the Occupancy and Operations Phase.

8.4 Occupancy and Operations Phase Documentation Requirements

8.4.1 The final project Commissioning Process Report and final project Systems Manual are the primary documen-

tation requirements for the Occupancy and Operations Phase Commissioning Process. The information in these deliverables is used throughout the life of the facility.

8.4.2 If periodic performance verification is conducted for the Owner, a Continuous Commissioning Process Report and updates (as necessary) to training and the Systems Manual should be provided as deliverables.

8.5 Occupancy and Operations Phase Training Requirements

8.5.1 The Commissioning Process training requirements for the Occupancy and Operations Phase are discussed in Section 8.2.4.

9. REFERENCES

1. DeVor, R., T. Chang, and J. Sutherland. 1992. *Statistical Quality Control: Contemporary Concepts and Methods*, Macmillan Publishing Company, New York, Chapter 7.
2. Gitlow, H. and S. Gitlow. 1987. *The Deming Guide to Quality and Competitive Position*, Prentice-Hall, Englewood Cliffs, NJ, Chapter 3.
3. Juran, J.M. (Ed.). 1995. *A History of Managing for Quality: The Evolution, Trends, and Future Directions of Managing for Quality*, ASQC Quality Press, Milwaukee, WI.

(This is a normative annex and is part of this guideline.)

NORMATIVE ANNEX A
GUIDE FOR DEVELOPING SUPPLEMENTARY TECHNICAL GUIDELINES FOR THE COMMISSIONING PROCESS

The purpose of this annex is to provide the recommended format and content for Total Building Commissioning Process supporting technical guidelines. The objective is to use the same format for all Commissioning Process guidelines. The National Institute of Building Sciences is facilitating the development of a number of technical topic guidelines to support the effective implementation of the Total Building Commissioning Process. These guidelines will be developed by various professional, technical, and trade organizations. For example, the technical guideline for heating, ventilating, air-conditioning, and refrigeration (HVAC&R) will be developed by ASHRAE. The technical guidelines are developed to assist the Commissioning Team in successfully using the Commissioning Process for various systems and assemblies. The goal is to use the process as defined and provided in Guideline 0, "The Commissioning Process." Further, it is desired that each different system or assembly involved in the construction, addition to, or rehab of buildings, structures, campuses, or utilities use the Commissioning Process from Guideline 0-2005 and not redefine it within the respective (topic) technical guideline.

The objective of both Guideline 0-2005 and the technical guidelines is to provide information on implementing the Commissioning Process. The technical guidelines are not intended to be a detailed user's guide or provide guide specifications, full commissioning plans, development of owner's project requirements, construction checklists, statistical or other quality tools, or other detailed requirements for implementing the Commissioning Process.

The format of the technical guidelines should follow the same format used in Guideline 0-2005. The following is the general organization to be used in the development of the technical guidelines.

FOREWORD

The Foreword should provide key information on what has led to success on previous projects, the role of the specific technology in a successful building or construction project, and closely related supplementary technical guidelines or topics.

SECTION 1, PURPOSE

The following should be used as the general purpose for each technical guideline:

"The purpose of this guideline is to describe the technical requirements for the application of the Commissioning Process described in ASHRAE Guideline 0-2005 that will verify that the [*insert topic, for example, fire systems or envelope assembly*] achieves the Owner's Project Requirements."

SECTION 2, SCOPE

The following text should be used as the general scope for each technical guideline:

"The procedures, methods, and documentation requirements in this guideline describe the application of the Commissioning Process for each project delivery phase from Pre-design through Owner Occupancy and Operation for [*insert topic*] to support the Commissioning Process activities described in ASHRAE *Guideline 0-2005, The Commissioning Process* (also published by NIBS as Guideline 0, *The Total Building Commissioning Process*). This includes requirements for:

(a) [*insert topic*] to fully support the Total Building Commissioning Process activities,
(b) verification during each phase of the Commissioning Process,
(c) acceptance at each phase,
(d) documentation during each phase,
(e) Systems Manual, and
(f) training for operations and maintenance personnel and occupants."

SECTION 3, UTILIZATION

The following paragraphs should be included as the Utilization section:

3.1 The application of this guideline will depend upon the Owner's Project Requirements and how the project will be designed, built, and operated. This guideline is supplemental to the Commissioning Process detailed in ASHRAE Guideline 0-2005.

3.2 This guideline describes specific details required to properly implement the Commissioning Process relative to

[*insert topic*]. This includes documentation, test procedures, and checklists.

SECTION 4, DEFINITIONS

Include definitions that are unique to the technical guideline. Do not redefine or repeat those in ASHRAE Guideline 0; instead, include a statement referring to the definitions in Section 4 of Guideline 0.

SECTION 5, PRE-DESIGN PHASE

The following needs to be included in the Pre-Design Phase section for [*insert topic*]:

1. List of Commissioning Team members.
2. List and description of criteria and items to be included in the Owner's Project Requirements document.
3. List of milestones.
4. List of specialists required for implementing the Commissioning Process.
5. List of items to focus upon during the design reviews.
6. List of items to be included in the Commissioning Plan.
7. List of items to be included as part of the Issues Log.
8. List of items required for acceptance of Pre-Design Phase commissioning.
9. Develop needs for tests and list tests that need to be performed.
10. Develop training requirements.
11. Develop requirements for the Systems Manual, such as parts lists, troubleshooting needs, operations and maintenance requirements, system description, level at which each set of material needs to be written for clear understanding.

SECTION 6, DESIGN PHASE

The following needs to be included in the Design Phase section for (*topic*). This will be the basis for Construction Phase documents for contractors, vendors, and equipment/assembly manufacturers:

1. List of items required for the Basis of Design.
2. Revision review procedure for Commissioning Team members and Owner's Project Requirements.
3. List of coordination requirements and items provided by others.
4. Key milestones that need to be reviewed.
5. Update lists of specialists required to implement the Commissioning Process based upon the actual design and interrelationship with other systems and assemblies.
6. List of items to be included in the construction documents.
7. Develop lists of priority items and relate whenever possible to safety, health, energy, environmental impact, aesthetics, operations and maintenance, in addition to Owner's Project Requirements.
8. List of Construction Checklists to be used by the contractor.
9. Samples of Construction Checklists. Examples of construction checklists are included in Annex M to this guideline and in other annexes in other supplementary technical guidelines (such as ASHRAE Guideline 1-200x, HVAC&R Technical Requirements for the Commissioning Process).
10. List of items to be included in the Systems Manual, such as parts lists, troubleshooting needs, operations and maintenance requirements, system description, level at which each set of material needs to be written for clear understanding.
11. List of training requirements, timing, learning outcomes.
12. Develop needs for tests and tests that need to be performed.
13. List of items required for acceptance of Design Phase commissioning.

SECTION 7, CONSTRUCTION PHASE

The following needs to be included in the Construction Phase section for [*insert topic*]:

1. List of test procedures and data forms to verify achievement of Owner's Project Requirements and Basis of Design.
2. Samples of test procedures and data forms. Examples of these are included in Annex U to other supplementary technical guidelines (such as ASHRAE Guideline 1-200X, HVAC&R Technical Requirements for the Commissioning Process).
3. List of coordination requirements and items provided by others.
4. List of specific items for the site visit procedures.
5. Tests needs and schedule.
6. Commissioning Team meetings.
7. Issues Logs.
8. Input into the final Commissioning Process Report.
9. Lessons-learned workshop schedule during Occupancy and Operations Phase.
10. List of items required for acceptance of Construction Phase commissioning.

SECTION 8, OCCUPANCY AND OPERATIONS PHASE

The following needs to be included in the Occupancy and Operations Phase section for [*insert topic*]:

1. List of training items to be accomplished during the first year of operation.
2. List of warranty items to be checked during the first year of operation.
3. List test requirements during occupancy, including periodic re-testing for a successful continuous operation of the facility.
4. List who should attend the lessons-learned workshop.
5. List of criteria to be included in the final Commissioning Process Report.
6. List of items required for acceptance of Occupancy and Operations Phase commissioning.

SECTION 9, REFERENCES

Include industry-specific references that support recommendations for benchmarking, testing, and other supporting guidance in the development of the Owner's Project Requirements, Basis of Design, tests, and other Commissioning Process documents.

ANNEXES

Annexes are to be used to provide additional information, examples of documentation, examples of specifications, acceptance procedure details, and other items that are not required to achieve compliance with the technical guideline but will assist in implementing the Commissioning Process for the specific technical system or assembly. This is the place to illustrate best practices and to provide information on how to achieve best practice and economy in design. Annex Q, References, should provide current articles, guides, and other information on implementing the Commissioning Process for the specific supporting technical requirements guidelines.

The desired goal is to have all Commissioning Process guidelines use the same annex designation. They should use the same annex letters as Guideline 0-2005. If an annex is not required, it should specifically be so noted in each technical guideline—suggested wording: "This annex is intentionally left blank" or "There is no supplemental information required for [*insert assembly or system*] technology." Annex A will be empty in all supplemental guidelines. Annex B is specific to Guideline 0 and should not be changed in supplemental guidelines. Annexes C through E may require no modification for most supplemental guidelines.

NOTE: The list and numbering of annexes, to be in compliance with Guideline 0-2005, must be as follows:

- Annex A – Guide for Developing Supplementary Technical Guidelines for the Commissioning Process (used only in Guideline 0)
- Annex B – Commissioning Process Flowchart (used only in Guideline 0)
- Annex C – Cost and Benefits of the Commissioning Process (typically only in Guideline 0)
- Annex D – Commissioning Process Documentation Matrix (typically only in Guideline 0)
- Annex E – Commissioning Process Request for Qualifications (typically only in Guideline 0)
- Annex F – Roles and Responsibilities
- Annex G – Commissioning Plan
- Annex H – Acceptance Plan
- Annex I – Owner's Project Requirements Workshop Guidance
- Annex J – Owner's Project Requirements
- Annex K – Basis of Design
- Annex L – Specifications
- Annex M – Construction Checklists
- Annex N – Quality-Based Sampling Examples
- Annex O – Systems Manual
- Annex P – Training Manual and Training Needs
- Annexes Q through X – In addition to the annexes (above) that are included in Guideline 0-2005, *The Commissioning Process,* all supplemental technical guidelines should include the following annexes with specific technical topic guidance or requirements, as appropriate. It is the intent to have all technical guidelines use the same reference letter for each topic. That is, all examples of Checklists would always be included in Annex M. The technical Commissioning Process guidelines should include annexes that provide examples and guidance on the following topics or should include notes such as "Not used," or "This annex is intentionally left blank," or "There is no supplemental information required."
- Annex Q – Publications, Articles, References, Codes, Regulations, and Standards
- Annex R – Integration Requirements
- Annex S – Interference and Coordination with Other Systems and Assemblies
- Annex T – Communications: What, When, and Who
- Annex U – Test Procedures and Data Forms
- Annex V – Pre-Design Phase Commissioning Process Specific Needs
- Annex W – Design Phase Commissioning Process Specific Needs
- Annex X – Construction Phase Commissioning Process Specific Needs
- Annex Y – Occupancy and Operations Phase Commissioning Process Specific Needs
- Annex Z (and, if needed, Annex AA and beyond) can be used as required for other topics that are determined to be useful for a specific assembly or system.

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX B
COMMISSIONING PROCESS FLOW CHART

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

The flow chart shown in Figure B.1 depicts an example for an owner who has adopted the Commissioning Process from project inception. If the owner adopts the Commissioning Process after project inception, then the tasks shown are still accomplished in whatever phase the Commissioning Process commences. The Continuous Commissioning Process is shown in the flow chart as ongoing tasks during the Occupancy and Operations Phase after the last acceptance block.

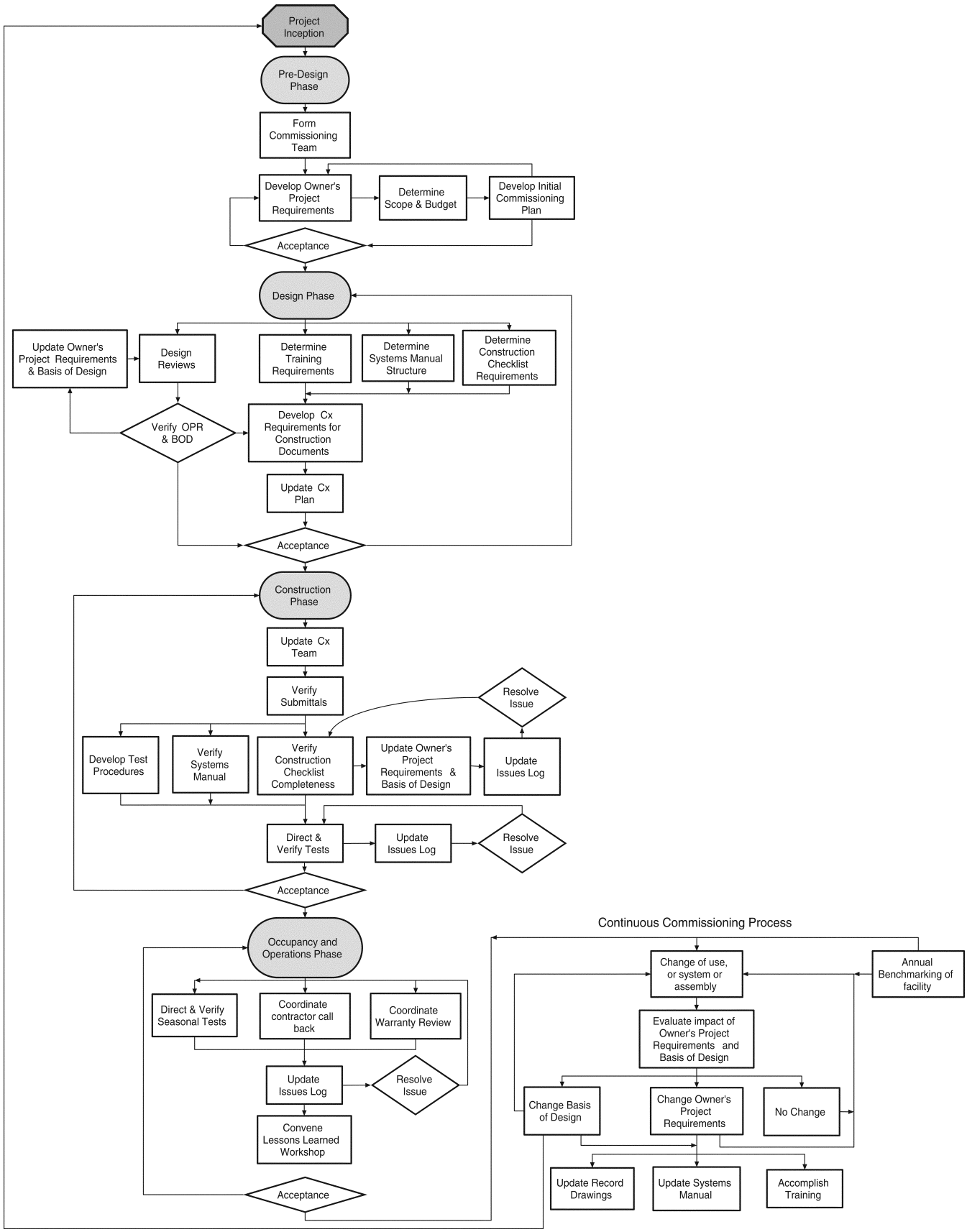


Figure B.1 Commissioning process flow chart.

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX C
COST AND BENEFITS OF THE COMMISSIONING PROCESS

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

OVERVIEW

The Commissioning Process focuses on producing a quality-based system that achieves the Owner's Project Requirements.

This annex discusses the potential benefits and where they accrue and quantifies these benefits by providing evidence of potential costs and savings.

DISCUSSION OF NEW COST ITEMS

Ultimately, the owner of the facility will determine the extent of the Commissioning Process activities and who will be responsible for each phase of work. The intent here is to outline the scope of work that represents new cost items rather than to assign responsibilities for each task. The cost of the Commissioning Process should be considered as a part of the project budget.

Design Professional

In addition to the design professional's typical scope of work, including the preparation of design drawings and specifications, the Commissioning Process often requires that the design professional work with the Commissioning Authority to integrate the Commissioning Process activities into the project specifications. These activities typically include:

1. Test requirements and documentation.
2. Operational, maintenance, and troubleshooting documentation requirements.
3. Construction Checklists.
4. Systems Manual.
5. Comprehensive training program for operation and maintenance personnel and users.

The design professional may also be responsible for reviewing the Commissioning Plan at the various phases of the process and for delivering the Basis of Design in a format specific for the owner.

Commissioning Authority

The activities accomplished by the Commissioning Authority as defined in this guideline require that additional funds be allocated during the Pre-Design, Design, and Construction Phases. These funds are allocated from the savings obtained through fewer change orders and requests for information and through reduced problems during start-up of the systems and occupancy of the facility.

Contractors

The completion of some detailed tests is unique to the Commissioning Process. The contractor will have additional work and costs associated with completing these tests.

DISCUSSION OF BENEFITS

For convenience and clarity, benefits will be discussed as they relate to major participants in the Commissioning Process: the Design Professional, the Contractor, and the Owner.

Benefits to the Design Professional

Potential benefits include:

- Facility will achieve the of Owner's Project Requirements.
- Reduced risk exposure.
- Improved knowledge base for use in future designs and installation.
- Benefit of other participants' input, leading to the most cost-effective design and operation.
- Reduced number of interference drawings during construction due to improved communication and coordination throughout the project.

Benefits to the Contractor

Potential benefits include:

- Improved planning and coordination through the implementation of the Commissioning Plan.
- Improved coordination between different trades and reduced likelihood of site interference drawings required of contractors throughout the project. Reduced number of deficiencies at substantial completion. Reduced number of callbacks.
- Reduced number of calls for operational guidance due to participation in training programs for operations and maintenance personnel.

Benefits to the Owner

Potential benefits include:

- Improved operator knowledge of how to optimize the facility operation and maintenance due to the early inclusion of operators in the Commissioning Process.
- Reduced training requirements due to continuously updated documentation of how systems should operate and be maintained; personnel will only need to be trained with regard to changes.
- Facility performance is in accordance with the Owner's Project Requirements.
- Systems Manual provides an easy reference document for system and assembly operation and maintenance.
- Reduced downtime due to better diagnosis of failures.
- Improved ability to provide accurate information to occupants on facility operation and maintenance.
- Lower operating costs due to improved operational techniques.
- Benefits to building occupants, including greater worker productivity, reduced complaints, and reduced incidence of absenteeism.

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX D COMMISSIONING PROCESS DOCUMENTATION MATRIX

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

The following table summarizes the documents that are produced during the implementation of the Commissioning Process on a project.

TABLE D-1 Documentation Matrix

Phase	Document	Input By	Provided By	Reviewed/ Approved By	Used By	Notes
Pre-Design	Owner's Project Requirements	O&M, Users, Capital Projects, Design Team (?)	CA or Designer	Owner	CA, Design Team	Design Team may not be hired yet.
	Commissioning Plan	Owner, Design Team (?), CA	CA	Owner	CA, Owner, Design Team	Design Team may not be hired yet.
	Systems Manual Outline	O&M, CA	Owner or CA	Owner	Design Team	May be included in OPR
	Training Requirements Outline	O&M, Users, CA, Design Team	Owner or CA	Owner	Design Team	May be included in OPR
	Issues Log	CA	CA	N/A	CA, Design Team	May be only format at this phase
	Issues Report	CA	CA	Owner	Design Team, Owner	
	Pre-Design Phase Commissioning Process Report	CA	CA	Owner	Owner	Close of Phase report
Design	Owner's Project Requirements Update	O&M, Users, Capital Projects, Design Team	CA or Designer	Owner	CA, Design Team	
	Basis Of Design	Design Team	Design Team	Owner, CA	Design Team, CA	
	Construction Specifications for Commissioning	Design Team, CA, Owner	Design Team or CA	Owner	Contractors, CA, Design Team	May also be provided by Project Manager/ Owner's Rep.
	Systems Manual Outline-Expanded	Design Team, CA, O&M, Contractor (?)	Design Team or CA	Owner, CA	Design Team, Contractor	Contractor may not be hired yet.
	Training Requirements In Specifications	O&M, Users, CA, Design Team	Owner or CA	Owner	Design Team	Contractor may not be hired yet
	Design Review Comments	CA	CA	Owner	Design Team	
	Issues Log	CA	CA	N/A	CA, Design Team	
	Issues Report	CA	CA	Owner	Design Team, Owner	
	Design Phase Commissioning Process Report	CA	CA	Owner	Owner	Close of Phase report
Construction	Owner's Project Requirements Update	O&M, Users, Capital Projects, Design Team	CA or Designer	Owner	CA, Design Team, Contractors	
	Basis of Design Update	Design Team	Design Team	CA, Owner	Design Team, CA	
	Commissioning Plan Update	Design Team, CA, Owner, Contractor	CA	CA, Owner, Design Team, Contractor	CA, Owner, Design Team, Contractors	
	Submittal Review Comments	CA	Design Team	Design Team	Contractor	

Notes:
1. The term "contractor" is understood to refer to any of several entities that provide construction services. Depending upon the project, this could include, among others, the owner's representative, construction manager, contractors, and subcontractors.
2. Abbreviations: CA: Commissioning Authority; O&M: operations and maintenance personnel; OPR: Owner's Project Requirements.

TABLE D-1 (Continued) Documentation Matrix

Phase	Document	Input By	Provided By	Reviewed/ Approved By	Used By	Notes
	System Coordination Plans	Contractor, Design Team	Contractor	CA, Design Team	Contractor, CA	
	Inspection Checklists	CA, Contractor, Design Team	CA	CA, Design Team	Contractor	
	Inspection Reports	Contractor	CA	CA, Owner	Contractor	
	Test Procedures	CA, Contractor, Design Team	CA	CA, Design Team	Contractor	
	Test Data Reports	Contractor	CA	CA, Owner	Contractor	
	Commissioning Meeting Agendas and Minutes	CA	CA	All	All	
	Training Plans	Design Team, CA, O&M, Contractor	Contractor or CA	Owner, CA	O&M, Users, Contractor	
	Systems Manual	Design Team, CA, O&M, Contractor	Contractor	Owner, CA	O&M, Users	
	Issues Log	CA	CA	N/A	CA, Design Team, Contractor	
	Issues Report	CA	CA	Owner, Design Team	Design Team, Owner, Contractor	
	Preliminary Construction Commissioning Process Report	CA	CA	Owner	Owner	Prior to Occupancy
	Final Construction Phase Commissioning Process Report	CA	CA	Owner	Owner	Close of Phase report
Occupancy and Operations	Owner's Project Requirements Update	O&M, Users, Design Team	CA or Designer	Owner	CA, Design Team, Contractors	
	Basis of Design Update	Design Team	Design Team	CA, Owner	Design Team, CA	
	Maintenance Program	O&M, Contractor, CA	Owner or CA	Owner, CA	O&M, Users	
	Test Procedures	Contractor, CA, O&M, Design Team	CA	Design Team, CA	Contractor	
	Test Data Reports	Contractor	CA	CA, Owner	Contractor, O&M	
	Issues Log	CA	CA	N/A	CA, Design Team, Owner, Contractors	
	Issues Report	CA	CA	Owner	Design Team, Owner, Contractors	
	Commissioning Process Report	CA	CA	Owner	Owner	Final report
	Re-Commissioning Plan	O&M, Users, CA	CA or Owner	Owner	Owner	

Notes:
1. The term "contractor" is understood to refer to any of several entities that provide construction services. Depending upon the project, this could include, among others, the owner's representative, construction manager, contractors, and subcontractors.
2. Abbreviations: CA: Commissioning Authority; O&M: operations and maintenance personnel; OPR: Owner's Project Requirements.

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX E
COMMISSIONING PROCESS REQUEST FOR QUALIFICATIONS

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

BACKGROUND

_____ (Owner) is seeking the services of a qualified Commissioning Authority for _____. The project is a _____ gross ft^2, ___ story, Class ___ [*type*] _____ building in [*city & state*] _____, _____, with a project budget of $_____ million. The facility is expected to be composed of ____% [*space type*], ____% [*space type*], and _____% [*space type*].

The project is currently in the early pre-design phase. The expected schedule is to start design by _____, start construction by _____, and occupy by _____.

The management structure is traditional design/bid/build with full design documents and specifications being developed by an architectural/engineering firm. The construction documents will be let out to bid and a general contractor will be hired to complete the construction. The Owner's primary construction representative on site will be provided by the separately contracted services of a construction manager. The Commissioning Authority will be hired by and report directly to the Owner.

SCOPE OF WORK

The Owner has adopted the Commissioning Process as his/her quality process to plan, design, construct, and operate this facility. As with any quality process, the Commissioning Process provides tools to enable everyone involved in the construction of the facility to verify that the final facility meets the Owner's Project Requirements.

The following is a summary of the Commissioning Process that the Owner intends to implement on this project. The proposer is free to suggest changes and improvements to this process. However, for this proposal the following process will be assumed.

Commissioning Process During the Pre-Design Phase

The Commissioning Process activities completed by the Commissioning Authority during the Pre-Design Phase include:

- Developing and documenting the Owner's Project Requirements.
- Identifying a scope and budget for the Commissioning Process.
- Developing the initial Commissioning Plan.
- Acceptance of Pre-Design Phase Commissioning Process activities.

Commissioning Process During the Design Phase

The Commissioning Process activities completed by the Commissioning Authority during the Design Phase include:

- Works with the Commissioning Team to document the Owner's Project Requirements for the facility.
- Works with the design professionals in documenting the Basis of Design.
- Verifies the Basis of Design with regard to the Owner's Project Requirements.
- Develops a Commissioning Plan encompassing the Design, Construction, Occupancy and Operations Phases.
- Determines the commissioning requirements and activities to include in the Construction Documents, with review by the design team, for integration into the project's construction specifications.
- Reviews the in-depth design documentation developed by the design professionals.
- Performs statistically based quality design review at 35%, 50%, 95%, and 100% completion of the drawings and specifications.

Commissioning Process During the Construction Phase

The Commissioning Process activities accomplished by the Commissioning Authority during the Construction Phase include:

- Organizes the Commissioning Process components and conducts a pre-bid and pre-construction meeting where the Commissioning Process requirements are reviewed with the Commissioning Team.
- Organizes and conducts periodic Commissioning Team meetings necessary to plan, develop the scope of, coordinate, and schedule activities and resolve problems.
- Reviews submittals concurrent with the design professional's review.
- Works with Contractors in completing Construction Checklists and tracking of Checklist completion.
- Statistically samples completion of Construction Checklists on a periodic basis to verify that Contractor's quality process is achieving the Owner's Project Requirements.
- Develops specific test procedures. The Contractors review the procedures.
- Directs the execution of the tests by the Contractors.
- Documents the results of the tests.
- Documents the correction and retesting of noncompliance items by the Contractor.
- Reviews the Systems Manual for achieving the Owner's Project Requirements.
- Reviews, pre-approves, and verifies the training provided by the Contractors.
- Verifies delivery of the Systems Manual.

Commissioning Process During the Occupancy and Operations Phase

The Commissioning Process activities accomplished by the Commissioning Authority during the Occupancy and Operations Phase include:

- Schedules and verifies deferred and seasonal testing by the Contractor.
- Verifies continuing training.
- Accomplishes a review of warranties with the operations and maintenance staff two months prior to expiration of warranty.
- Schedules, organizes, and attends a lessons-learned workshop. The workshop is facilitated by an independent member of the Commissioning Authority's firm.
- Completes the Final Commissioning Process Report.

LIMIT OF RESPONSIBILITIES

The Commissioning Authority is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The Commissioning Authority may assist with problem-solving or resolving nonconformance or deficiencies, but ultimately that responsibility resides with the general contractor and design professionals.

FOCUS OF THE COMMISSIONING PROCESS

The following systems and assemblies are the focus of the Commissioning Process:

- [*Insert list of systems and assemblies*]

DESIRED QUALIFICATIONS

It is desired that the person designated as the Commissioning Authority satisfy as many of the following requirements as possible:

1. Has acted as the principal Commissioning Authority for at least three projects during the past year. [Note that the size of the project should be accounted for. Whereas one proposer may have done ten projects all small in size, another proposer that accomplished one large and complex project may have equal credentials].
2. Experienced in quality processes.
3. Knowledgeable in building operation and maintenance training.
4. Excellent verbal and written communication skills. Highly organized and able to work with both management and trade contractors.
5. A bachelor's degree in [*insert discipline*] is strongly preferred and [*insert type*] certification or professional license is desired.
6. The Commissioning Authority's firm will demonstrate depth of experienced personnel and capability to sustain loss of assigned personnel without compromising quality and timeliness of performance.
7. The Commissioning Authority will be an independent contractor and not an employee or subcontractor of the General Contractor or any other subcontractor on this project, including the design professionals.
8. [*Insert any qualifications or special requirements for a specific system or assembly*].

INSTRUCTIONS TO PROPOSERS

A proposer must propose to execute all phases of the Commissioning Process in a single proposal. The proposal must be signed by an officer of your firm with the authority to commit the firm.

1. List the key individual who will be the Commissioning Authority for this contract and describe his or her relevant qualifications and experience. This information is required in addition to any detailed resumes the proposer submits. The contract will require that this individual be committed to the project for its duration.
2. Provide project and professional references and experience for three to five commissioning projects for which the proposer was the principal Commissioning Authority in the last three years. Include a description of the projects, identify when the proposer came into the projects, and describe the involvement of each individual on the proposer's team in the projects. For each project, attach a sheet that includes the name and telephone number of the Owner's project manager, construction manager, facility administrator of the building, the design professionals, and the contractors.
3. Describe any experience of the proposer's team in the following areas. List each party's involvement.
   (a) Quality process experience.
   (b) Operation and maintenance experience.
   (c) Design experience.
   (d) Life-cycle costing.
   (e) [*Insert other system or assembly specific experience requirements*].
4. Describe your proposed approach to managing the project expertly and efficiently, including your team participation. Describe what approach you will take to integrate the Commissioning Process into the normal design and construction process in order to make it "business as usual."
5. Describe what you will do to foster teamwork and cooperation from contractors and designers and what you will do to minimize adversarial relationships.
6. Describe how your work will facilitate the use of your product as a prototype that may be subsequently used by the Owner in future projects, including access to the electronic versions of all documents and forms.
7. As an attachment, provide the following work products that members of the proposer's team wrote.
   (a) Commissioning Plan that was executed.
   (b) Integrated commissioning specifications.
   (c) Electronic Issues Log.
   (d) Construction Checklists.
   (e) Test procedure that was executed.
8. [*Insert any other desired instructions*].

SELECTION CRITERIA

The submitted proposals will be reviewed and ranked according to the following (items from the above numbered list):

1.	Key individual experience	20 points
2.	Staff experience	15 points
3.	Similar project experience	20 points
4.	Team experience in related skill areas	15 points
5.	Management approach	20 points
6.	Work examples	10 points
		100 points

Reference checks will not be scored individually but may be used to supplement all categories. The Owner reserves the right to eliminate or change the weight of extremely high or extremely low fee proposals.

SUBMISSION AND SELECTION

Consultants will submit [*quantity*_____] copies of the written proposal, to be received in the Owner's office at [*address*_____] by [*date and time*_____]. Late proposals will not be accepted.

Review and selection process.....

Requirement of personal interview for finalists.....

LIMITATIONS AND PROVISIONS

[*Insert wording on right to reject, to seek clarifications, to negotiate a final contract; cost of proposal preparation not reimbursable; primary contact for questions; other necessary legal language, etc.*]

MINIMUM REQUIREMENTS FOR CONTRACT EXECUTION

General Conditions

Miscellaneous as required.....

Insurance

The Commissioning Authority's firm shall obtain, at the firm's expense, and keep in effect during the term of the project, $[*list required insurance*].

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX F
ROLES AND RESPONSIBILITIES

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

Understanding and defining the role of each participant is vital to the success of the Commissioning Process. This annex provides an example of the responsibilities of each participant in a comprehensive Commissioning Process. These responsibilities shall be documented in the contracts between the owner and the contractor(s) and the owner and the design professionals. The responsibilities of each participant should be included in the contract documents.

The responsibilities of the owner, Commissioning Authority, design professionals, construction manager, contractors, and manufacturers are detailed below.

OWNER

1. Include a statement regarding design professional commissioning responsibilities and scope in the request for design services.
2. Develop and commit to the Owner's Project Requirements for the facility and its use.
3. Assign operations and maintenance personnel and schedule them to participate in the various meetings, training sessions, and observations/inspections as follows:
   (a) Design Phase coordination meetings.
   (b) Construction Phase coordination meetings.
   (c) Initial owner-training session at initial placement of major equipment.
   (d) Maintenance orientation and inspection.
   (e) System testing verification meetings.
   (f) Procedures meeting for testing systems.
   (g) Owner's training session.
   (h) Verification demonstrations.
   (i) Systems and assemblies tests.
   (j) Final review at acceptance meeting.
4. Review and approve any changes made to Owner's Project Requirements.
5. Review and approve the Construction Documents.
6. Provide qualified personnel for videotaping and editing of training sessions.
7. Videotape construction progress.
8. Review and comment on the Commissioning Authority's Commissioning Process Progress Reports.
9. Review and comment on the Commissioning Authority's verification reports.
10. Review and accept the Commissioning Authority's Commissioning Process Report.

COMMISSIONING AUTHORITY

1. Organize and lead the Commissioning Team.
2. Facilitate and document the Owner's Project Requirements.
3. Verify that the Commissioning Process activities are clearly stated in all scopes of work.
4. Integrate the Commissioning Process activities into the project schedule.

5. Prepare a Commissioning Plan that describes the extent of the Commissioning Process to accomplish the Owner's Project Requirements. Update the Commissioning Plan during each phase of the project to incorporate changes and additional information.
6. Review and comment on the ability of the design documents to achieve the Owner's Project Requirements for the commissioned systems and assemblies.
7. Prepare the Commissioning Process activities to be included as part of the project specification. Include a list of all individual trade contractor responsibilities for all the Commissioning Process activities (list contractors by name, firm, and trade specialty if known).
8. Execute the Commissioning Process through the writing and review of Commissioning Process Reports, organization of all Commissioning Team meetings, tests, demonstrations, and training events described in the Contract Documents and approved Commissioning Plan. Organizational responsibilities include preparation of agendas, attendance lists, arrangements for facilities, and timely notification to participants for each Commissioning Process activity. The Commissioning Authority shall act as chair at all commissioning events and ensure execution of all agenda items. The Commissioning Authority shall prepare minutes of every Commissioning Process activity and send copies to all Commissioning Team members and attendees within five workdays of the event.
9. Review the plans and specifications (during the Pre-Design and Design Phases) with respect to their completeness in all areas relating to the Commissioning Process. This includes verifying that the Owner's Project Requirements have been achieved, and that there are adequate devices included in the design to properly test the systems and assemblies and to document the performance of each piece of equipment, system, or assembly.
10. Schedule all document review coordination meetings.
11. Attend the project's pre-bid meeting to detail the design professional or contractor Commissioning Process requirements.
12. Schedule the pre-design and pre-construction Commissioning Process meeting within 60 days of the award of the contract at some convenient location and at a time suitable to the attendees. This meeting will be for the purpose of reviewing the complete Commissioning Process and establishing tentative schedules for the Design Phase and Construction Phase commissioning activities.
13. Develop the initial format to be used for Issues Logs throughout and for each phase of the Commissioning Process.
14. Schedule the initial owner training session so that it will be held immediately before the contractor training. This session will be attended by the owner's O&M personnel, the design professionals, the contractor, and the Commissioning Authority. The Commissioning Authority will review the Owner's Project Requirements and the design professional(s) will review the Basis of Design.
15. Review proposed contractor-provided training program to verify that the Owner's Project Requirements are achieved.
16. Attend a portion of the contractor-provided training sessions to verify that the Owner's Project Requirements are achieved.
17. Receive and review the Systems Manual as submitted by the contractor. Verify that it achieves the Owner's Project Requirements. Insert systems descriptions as provided by the design professional(s) in the Systems Manual.
18. Witness system and assembly testing. Verify the results and include a summary of deficiencies.
19. Supervise the Commissioning Team members in completion of tests. The test data will be part of the Commissioning Process Report.
20. Periodically review Record Drawings for accuracy with respect to the installed systems. Request revisions to achieve accuracy.
21. Verify that the Systems Manual and all other design and construction records have been updated to include all modifications made during the Construction Phase.
22. Repeat implementing of tests to accommodate seasonal tests or to correct any performance deficiencies. Revise and resubmit the Commissioning Process Report.
23. Prepare the final Commissioning Process Report.
24. Assemble the final documentation, which includes the Commissioning Process Report, the Systems Manual, and all record documents. Submit this documentation to the owner for review and acceptance.
25. Recommend acceptance of the individual systems and assemblies to the owner (in accord with the defined project requirements).

DESIGN PROFESSIONAL

1. Participate and assist in the documentation of the initial Owner's Project Requirements.
2. Document revisions to the Owner's Project Requirements and obtain approval from the owner.
3. Document the Basis of Design
4. Prepare Contract Documents, including the integration of the Commissioning Process requirements and activities provided by the Commissioning Authority.
5. Prepare Contract Documents that coordinate required interfaces between systems and assemblies.
6. Attend the Pre-Design and Design Phase coordination and review meetings.
7. Respond to Commissioning Team design submission review comments and other issues in a timely manner.
8. Attend the pre-bid and pre-construction meetings as scheduled by the Commissioning Authority.
9. Specify and verify that the operation and maintenance of the systems and assemblies has been adequately detailed in the Construction Documents.
10. Review and incorporate as appropriate the Commissioning Authority's comments from submittal reviews.

11. Participate in the initial operation and maintenance personnel and occupant training session by presenting the project Basis of Design.
12. Participate in other training as detailed in the training program.
13. Review test procedures submitted by the contractor.
14. Review and comment on the Commissioning Authority's periodic Commissioning Process Progress Reports and Issues Log reports.
15. Review and accept record documents as required by Contract Documents.
16. Review and comment on the final Commissioning Process Report.
17. Recommend final acceptance of the systems to the owner.

CONSTRUCTION MANAGER

1. Include costs for Commissioning Process activities in the contract price.
2. Include Commissioning Process requirements and activities in all contractors' contracts.
3. Provide adequate accessibility as required to properly operate and maintain the facility.
4. Provide acceptable representation with the means and authority to prepare and coordinate implementation of the Commissioning Process as detailed in the Contract Documents.
5. Issue a statement certifying that all work has been completed and that the facility is operational, in accordance with Contract Documents.
6. Issue the appropriate final reports to the design professionals for review and acceptance.
7. Remedy deficiencies identified by the Commissioning Authority during verification of the installation or testing.
8. Review and comment on the final Commissioning Process Report.

CONTRACTOR

1. Include costs for Commissioning Process activities in the contract price.
2. Include Commissioning Process requirements and activities in each purchase order or subcontract written.
3. Obtain cooperation and participation of all subcontractors and manufacturers.
4. Attend the pre-construction and Commissioning Team meetings.
5. Include Commissioning Process milestones in the project schedule.
6. Implement the training program as detailed in the Contract Documents.
7. Provide submittals to the owner, design professionals, and the Commissioning Authority.
8. Notify the Commissioning Authority when systems and assemblies are ready for testing.
9. Demonstrate the performance of assemblies and/or operation of systems to the Commissioning Authority.
10. Complete the Construction Checklists as the work is accomplished. Provide the completed Construction Checklists to the Commissioning Authority.
11. Continuously maintain the Record Drawings and submit as detailed in the Contract Documents.

MANUFACTURERS

1. Provide all information required for the operation and maintenance of the system or assembly as part of the initial submittal.
2. Provide the requirements to maintain the warranty as part of the initial submittal.
3. Coordinate and accomplish factory tests as detailed in the Contract Documents.
4. Provide training as detailed in the training program contained in the Contract Documents.
5. Demonstrate operation and performance of the system or assembly as detailed in the Contract Documents.

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX G
COMMISSIONING PLAN

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

The following is an example outline for a Commissioning Plan. The basic structure of this example is such that each phase of the plan has its own section detailing what activities will be accomplished and guidance on who accomplishes them and how they are completed. The results from each activity are then included in an appendix. The intent of this format is for the Commissioning Plan to become the Final Commissioning Process Report at the end of the project by filling in the results as the project progresses.

Depending upon the size and scope of the Commissioning Process activities, it may be beneficial to have three Commissioning Plans: one for the Pre-Design Phase, one for the Design Phase, and one for the Construction Phase. If separate Commissioning Plans are used, then care must be taken to inform those that are involved in only a portion of the process of the previous material.

SAMPLE TABLE OF CONTENTS

Develop Initial Commissioning Plan
Commissioning Process Issues
Step 1 - Identify and Record Issues
Step 2 - Calculate Avoided Costs
Step 3 - Evaluate Range of Avoided Costs
DESIGN PHASE
Review and Modify Project Specifications
Verify Basis of Design
Update Commissioning Plan
Accomplish Design Reviews
Develop Commissioning Process Contract Document Requirements
Pre-Bid Meeting
CONSTRUCTION PHASE
Conduct Pre-Construction Meeting
Contractor Submittal Review
Construction Checklists
Delivery Book
Pre-Installation Checks
Installation and Start-Up Checks
Training
Testing
OCCUPANCY AND OPERATIONS PHASE
Final Commissioning Process Report
Seasonal Testing
Ongoing Training
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CONTACT INFORMATION
SCHEDULE REQUIREMENTS
APPENDIX A - OWNER'S PROJECT REQUIREMENTS
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APPENDIX C - PROJECT SPECIFICATIONS
APPENDIX D - COMMUNICATION STRUCTURES
APPENDIX E - ROLES AND RESPONSIBILITIES
APPENDIX F - COMMISSIONED SYSTEMS [listing of systems and assemblies]
APPENDIX G - COMMISSIONING PROCESS SCHEDULE
APPENDIX H - PRE-BID MEETING
APPENDIX I - PRE-CONSTRUCTION MEETING
APPENDIX J - SUBMITTAL REVIEW
APPENDIX K - COMMISSIONING PROCESS ISSUES
APPENDIX L - CONSTRUCTION CHECKLISTS
APPENDIX M - TESTS
APPENDIX N - TRAINING
APPENDIX O - SYSTEMS MANUAL
APPENDIX P - MEETING MINUTES
APPENDIX Q - CORRESPONDENCE
APPENDIX R - WARRANTY REVIEW
APPENDIX S - LESSONS LEARNED

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX H
ACCEPTANCE PLAN

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

Developing and documenting the acceptance procedures in an acceptance plan is an important task for the successful implementation of the Commissioning Process. The acceptance plan details the key Commissioning Process activities that must be accomplished at the end of each phase in a project in order to move on to the next phase.

The following provides a description of the details that should be included in the acceptance plan and demonstrates a format that could be used.

PRE-DESIGN PHASE

The Owner's Project Requirements and the Commissioning Plan are formally accepted by the Owner during the Pre-Design Phase, after review and comment by the Commissioning Authority. The general process for accepting these documents is:

1. The Commissioning Authority develops a draft of each document and provides it to the Commissioning Team.
2. The Commissioning Team provides comments on the draft documents.
3. The Commissioning Authority works with the Commissioning Team to resolve any issues.
4. The Commissioning Authority recommends acceptance of the documents to the Owner and provides copies for review.
5. The Owner reviews the modified documents and accepts.

DESIGN PHASE

Updated Owner's Project Requirements, updated Commissioning Plan, Basis of Design, and Contract Documents are formally accepted by the Owner during the Design Phase. The Owner's Project Requirements and the Commissioning Plan follow the same process as detailed in the Pre-Design Phase.

The general process for accepting the Basis of Design is:

1. The Commissioning Authority provides a list of information required and the format for the Basis of Design to the design professionals prior to the start of design.
2. The design professionals gather and organize the information during the creation of the design.
3. The design professionals submit the Basis of Design to the Owner and Commissioning Authority for review and comment with each design submittal.

4. Upon correction and resubmittal, the Owner accepts the Basis of Design based upon the recommendation of the Commissioning Authority.

The general process for accepting the Contract Documents is:

1. The design professionals submit the final package to the Owner and Commissioning Authority for review.
2. The Commissioning Authority evaluates the Contract Documents using random sampling to determine their ability to achieve the Owner's Project Requirements.
3. The Commissioning Authority meets with the design professionals to discuss and resolve comments.
4. Upon resolution of comments, the Commissioning Authority recommends to the Owner acceptance of the documents.
5. Owner reviews the comments, their resolution, and accepts the Contract Documents.

CONSTRUCTION PHASE

Updated Owner's Project Requirements, updated Commissioning Plan, updated Basis of Design, Systems Manual, training program, and a preliminary and a final Construction Phase Commissioning Process Report are formally accepted by the Owner during the Construction Phase. The Owner's Project Requirements, Commissioning Plan, and Basis of Design follow the same process as previously detailed.

The general process for accepting the Systems Manual is:

1. The Commissioning Authority tracks the Contractor submittals for the required documentation.
2. Within XX days of submittal acceptance for a system or assembly, the Contractor submits a draft Systems Manual to the Owner, Commissioning Authority, and design professionals.
3. The Commissioning Authority consolidates the reviews and meets with the design professionals to discuss and resolve.
4. The Contractor submits to the Commissioning Authority changes to the accepted submittals throughout construction.
5. XX days prior to the first training session, the Contractor submits the final Systems Manual to the Owner, Commissioning Authority, and design professionals.
6. The Owner accepts the final Systems Manual based upon the recommendation of the Commissioning Authority.

The general process for accepting the training program is:

1. The Commissioning Authority provides the training agendas to the Contractor.
2. The Contractor develops the training program, including identifying the trainer, the schedule of sessions, and the material to be developed. This information is submitted to the Owner, Commissioning Authority, and design professionals for review and comment.
3. Based upon the recommendation of the Commissioning Authority, the Owner accepts the training program.
4. The Contractor then develops the training material and submits it to the Owner, Commissioning Authority, and design professionals for review and comment XX days prior to the first training session.
5. Based upon the recommendation of the Commissioning Authority, the Owner accepts the training materials.
6. The Contractor implements the training program.
7. The Commissioning Authority randomly quizzes the trainees two weeks after the completion of a session.
8. The Contractor submits copies of all training materials and edited videotapes of the sessions.
9. The Commissioning Authority recommends acceptance of the completed training program to the Owner.

The general process for accepting the facility is:

1. Throughout construction the Commissioning Authority randomly samples the completion of the Construction Checklists for achieving the Owner's Project Requirements.
2. The Commissioning Authority directs the completion of system and assembly testing by the Contractor and documents the results.
3. The Commissioning Authority works with the Contractor in resolving any issues identified during testing.
4. The Commissioning Authority verifies that all system documentation is received from the Contractor.
5. The Commissioning Authority presents a preliminary Construction Phase Commissioning Process Report prior to occupancy that provides an evaluation of achieving each element of the Owner's Project Requirements, including recommendations to the Owner for acceptance/rejection of the facility.
6. The Commissioning Authority provides a final Construction Phase Commissioning Process Report with details on the Commissioning Process Activities completed during the Construction Phase.

OCCUPANCY AND OPERATIONS PHASE

Updated Owner's Project Requirements, updated Basis of Design, updated Systems Manual, seasonal test results, and Commissioning Process Report are formally accepted by the Owner during the Occupancy and Operations Phase. The Owner's Project Requirements, Basis of Design, and Systems Manual follow the same process as previously detailed.

The general process for accepting the seasonal test results is:

1. The Commissioning Authority directs the completion of seasonal system and assembly testing by the Contractor and documents the results.
2. The Commissioning Authority works with the Contractor in resolving any issues identified during testing.
3. The Commissioning Authority verifies that all updated system documentation is received from the Contractor.
4. The Commissioning Authority recommends to the Owner acceptance of the seasonal testing results.

The general process for accepting the Commissioning Process Report is:

1. The Commissioning Authority provides the Commissioning Process Report to the Owner, design professionals, and Contractor for review and comment.
2. The Commissioning Authority incorporates comments and provides a final copy to the Commissioning Team members.
3. The Owner accepts the Commissioning Process Report, ending the Commissioning Authority's responsibilities.

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX I
OWNER'S PROJECT REQUIREMENTS WORKSHOP GUIDANCE

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

The Owner's Project Requirements are considered the heart and soul of the Commissioning Process. When the Owner's Project Requirements are not developed, the owner, designer, contractors, and operation and maintenance (O&M) personnel each interpret the building requirements, including their individual responsibilities, from the standpoint of their own specific needs. This often creates a range of diverse views of the constructed project's needs. Unfortunately, while critical for a successful project, the Owner's Project Requirements are rarely developed. Developing Owner's Project Requirements that reflect the actual needs of the owner, the users or occupants, service and operating units, and sometimes the community is one of the, if not the, most important aspects for successful implementation of the Commissioning Process.

The following sections detail an example format to follow in developing the Owner's Project Requirements and a discussion of how to obtain the required information. Note that historically the Owner's Project Requirements have often been referred to as "design intent" or "project intent."

FORMAT

While there have been many formats used for presenting criteria for the Owner's Project Requirements, the Owner's Project Requirements workshop is one that has been well received by owners, designers, contractors, and O&M personnel. The workshop initially addresses general needs/requirements and progresses to specific requirements (i.e., moves from project needs to system/equipment/control needs). It is organized around and focuses upon assemblies and systems that have been identified as targets of the Commissioning Process. The workshop needs to be well organized, and it is very desirable to have the results formatted for immediate input into a computer analysis program for rapid feedback on consensus of the group.

Information from the workshop is only one of various resources from which the Owner's Project Requirements document is developed. Following is a description of some of the information that can be included in an Owner's Project Requirements document.

Key sections of the Owner's Project Requirements document are:

- Background – A narrative description to provide context about the project.
- Objectives – For any project there are goals that must be achieved for the project to be successful. Goals can range from first cost, to time schedule, to number of change orders, or to life-cycle cost. Regardless of which goals are identified, they must be summarized up front to ensure everyone is on the same page.
- Green building concepts – This is an optional section for owners who wish to focus upon the sustainability aspects of their building.
- Functional uses and requirements – In addition to general documentation produced by the architect on functional uses of the building (office, storage, kitchen, etc.), the specific requirements for each functional area must be documented. This can include such items as security, safety, comfort, energy, maintainability, and indoor air quality.
- Lifespan, cost, and quality – It is important to clearly document the owner's expectations for lifespan of materials, cost of construction, and the level of quality desired. By providing this information, unrealistic expectations are identified and eliminated.
- Performance criteria – Often the most difficult to define, performance criteria detail minimum acceptable performance benchmarks for various aspects of the facility.
- Maintenance requirements – The maintenance requirements are a mixture of the level of knowledge of the current O&M staff (what can they maintain) and the expected complexity of the proposed systems (what they can learn). If there is a significant gap between the two, no matter how well the building is constructed, it will not be maintained or operated properly.

The following are examples of Owner's Project Requirements elements that are common to most of the Technical Commissioning Process Guideline topics;

- Benchmarks for performance – Specific criteria for the functional use of each space, assembly, and system must be defined. These include temperature, humidity, airflow, light, noise, durability, aesthetics (materials and colors), service life, reliability, redundancy, and the like. Typically, upper and lower limits are provided for general spaces, with exceptions noted as required.
- Problems to avoid – Since occupant/user/operator complaints are common, it is important to identify and document those problems that have caused complaints in the past. If these problems are not documented and the situation recurs, the occupants often consider the entire project as a failure.

- Specific occupant requirements – Specific items that are deemed important to the various occupants in a building must be identified and documented. In speculatively built buildings, this section would detail the limits to which occupants can make use of their spaces. For example, a chemical laboratory cannot be put in a space designed and constructed for general office use without significant changes to the systems and possibly to the building as a whole.

OBTAINING THE INFORMATION

While it may be easy to obtain the information related to development of the Owner's Project Requirements, it is difficult to obtain quality information that the owner, O&M staff, service contractors, customers (i.e., students, patients, retail customers, renters), visitors, subtenants, occupants, and the community all agree upon. In quality-based processes, it is critical that input be obtained from all the users (the various user groups) and that the consensus of and differences between the groups be documented. There usually are requirements for which users do not all agree. These must be documented as unresolved items. Normally, the owner will make final decisions on what the priority order of Owner's Project Requirements will be. However, the owner and the rest of the Commissioning Team must be aware of all requirements so that the final product will include as many individual group requirements as are deemed appropriate and within the budget.

A simple three-step process is recommended for developing the Owner's Project Requirements:

1. Owner's Project Requirements workshop.
2. Owner's Project Requirements documentation (report).
3. Project team approval of the Owner's Project Requirements.

Owner's Project Requirements Workshop

The Owner's Project Requirements workshop is typically facilitated by the Commissioning Authority (CxA), who elicits the primary concerns of the project team. The workshop is organized to encourage identification of all requirements, to encourage interaction and discussion among all team members, and to arrive at group consensus of priorities for the Owner's Project Requirements. This is accomplished through the presentation of multiple questions in an ordered structure. A typical process uses a modified Nominal Group Technique workshop format. This is a formal means of gathering the highest level of consensus that approaches the real needs of the group. The procedure consists of the following steps:

- Provide each question or open concept to each individual participating in the workshop.
- Allow three to five minutes of quiet writing time for each individual to respond with as many answers and ideas as he/she can.
- Record individual responses in a round-robin fashion – no discussion at this point, just record the responses on a visual flipchart, overhead, chalkboard, or multi-computer link to all participants.
- Review all responses, consolidate similar ones, and clarify so all in the group have the same understanding of all responses.
- Have individuals rank the responses for importance (1 through 5).
- Determine a group ranking from individual rankings.
- A re-discussion of the top 10 items—and any responses ranked most important—is desired, followed by a second round of individual and group combined rating/ranking.

The questions asked during this workshop must be broad in nature, elicit discussion, result in a variety of viewpoints, and must not leave the workshop. The questions should not focus on such items as "at what temperature are you comfortable?" but should be broader, such as "how do you define comfort?" or "how will you measure the cost success of this project?" (versus a broader question, such as "how will you determine if this was a successful project?").

Owner's Project Requirements Documentation

The Owner's Project Requirements workshop will identify key items and priorities important to the project team, the owner, users, and the Commissioning Team. However, it does not provide specific values. For example, the number one Owner's Project Requirement may be good air circulation in the rooms. It is the responsibility of the Commissioning Authority to take the individual requirements developed by the project team and translate them into physical properties that can be measured, designed, and documented.

This transformation of the Owner's Project Requirements often requires input from a variety of sources, including the design team, contractors, specialists, standards, and guidelines. Typically, the Commissioning Authority has sufficient experience in the planning, design, construction, and operation of facilities to provide the oversight of such a task. If not, then experts should be retained to aid in the development of the Owner's Project Requirements.

Project Team Approval of the Owner's Project Requirements

After several iterations and reviews of the Owner's Project Requirements by the project and design teams, the requirements must be approved to provide the design team adequate direction for their design. It is important to distinguish development of the Owner's Project Requirements from the traditional role of the architect in the planning or programming process. The Owner's Project Requirements define the criteria required for success, whereas the architect's document may only address specific space size and occupant flow requirements. Where the Owner's Project Requirements may state that the functional use of the facility is X, Y, and Z, the architect's document may specify the locations of, the size of, and the flow of people through X, Y, and Z.

SUMMARY

The Owner's Project Requirements workshop is one means to provide consistency in the implementation of the Commissioning Process from project to project. It should be a topic addressed in the lessons-learned workshop during the

Occupancy and Operations Phase of the Commissioning Process. Other techniques for developing the Owner's Project Requirements, such as interviews and surveys, do not allow interaction between the user groups. Further, it has been shown that the results or answers are biased by the beliefs of the expert who develops the questions for the interviews or surveys. Frequently, using such techniques the questions can be analyzed and the conclusions pre-determined whether the interviews or surveys are completed or not.

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX J
OWNER'S PROJECT REQUIREMENTS

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

A general format for an Owner's Project Requirements document is presented in this annex. The structure provided is intended to encompass the facility requirements and enable the addition of sections depending upon the systems and assemblies to be constructed.

Introduction – Includes an overview of the project and the general reasons why the project is being undertaken. A description of the owner's processes (Commissioning Process) is typically contained in this section.

Key Owner's Project Requirements – Includes a listing of the key Owner's Project Requirements that the Commissioning Process will focus upon and that the owner (Commissioning Team) has determined are critical to the success of the project.

General Project Description - The size and scope of the project are included in this section.

Objectives – The objectives for accomplishing this project are detailed in this section.

Functional Uses – The expected functional uses (spaces) for the facility are detailed in this section. A short description of each functional use is included to provide the context in which it was detailed.

Occupancy Requirements – Includes the number of occupants (users and visitors) and the schedule of occupancy, including all special conditions.

Budget Considerations and Limitations – The expected budgetary restrictions and considerations are contained in this section.

Performance Criteria – The performance criteria upon which the project will be evaluated by the Commissioning Team are included in this section. Each performance criterion should be measurable and verifiable. Include subsections as appropriate to organize and explain the criteria:

- General
- Economic
- User Requirements
- Construction Process
- Operations
- Systems
- Assemblies

Owner's Project Requirements Version History – Includes a summary of the changes made throughout the Pre-Design, Design, Construction, and Occupancy and Operations Phases. This information is critical to understand and document the trade-offs made over time and the resulting impact on the project.

The following table will assist in the development of the Owner's Project Requirements document in accordance with Section 5.2.2.4 using the format presented in this annex. The table is also applicable for those developing Technical Supporting Guidelines as described in Annex A. Inclusion of specific criteria (such as the entries in this example matrix) will depend upon the project and the owner's needs. The Key Owner's Project Requirements Section should emphasize those OPR that are essential to the success of the project.

TABLE J-1 Example Matrix for Developing Owner's Project Requirements

	Guideline 0-2005 Subclause 5.2.2.4 Criteria	OPR Document Section							
		Introduction	Key Owner's Project Requirements	General Project Description	Objectives	Functional Uses	Occupancy Requirements	Budget Considerations and Limitations	
		1	2	3	4	5	6	7	
(a)	Project schedule and budget			Schedule				Budget	
(b)	Commissioning Process scope and budget	Scope						Budget	
(c)	Project documentation requirements, including format for submittals, training materials, reports, and the Systems Manual. Consideration should be given to use of electronic format documents and records where appropriate		X						
(d)	Owner directives		X						
(e)	Restrictions and limitations			X					
(f)	User requirements		X						
(g)	Occupancy requirements and schedules					X	X		
(h)	Training requirements for Owner's personnel		X						
(i)	Warranty requirements		X						
(j)	Benchmarking requirements		X						
(k)	Operation and maintenance criteria for the facility that reflect the Owner's expectations and capabilities and the realities of the facility type		X						
(l)	Equipment and system maintainability expectations, including limitations of operating and maintenance personnel		X		X				
(m)	Quality requirements for materials and construction		X						
(n)	Allowable tolerance in facility system operations				X				
(o)	Energy efficiency goals		X		X				
(p)	Environmental and sustainability goals		X		X				
(q)	Community requirements		X						
(r)	Adaptability for future facility changes and expansion		X		X	X			
(s)	Systems integration requirements, especially across disciplines					X			
(t)	Health, hygiene, and indoor environment requirements		X				X		
(u)	Acoustical requirements		X						
(v)	Vibration requirements		X						
(w)	Seismic requirements		X						
(x)	Accessibility requirements		X						
(y)	Security requirements		X						
(z)	Aesthetics requirements		X						
(aa)	Constructability requirements		X						
(bb)	Communication requirements		X						
(cc)	Applicable codes and standards			X					

TABLE J-1 (Continued) Example Matrix for Developing Owner's Project Requirements

		OPR Document Section							
		Performance Criteria							OPR Version History
		General	Economic	User Requirements	Construction Process	Operations	Systems	Assemblies	
	Guideline 0 Body	8	9	10	11	12	13	14	15
(a)	Project schedule and budget								
(b)	Commissioning Process scope and budget								
(c)	Project documentation requirements, including format for submittals, training materials, reports, and the Systems Manual. Consideration should be given to use of electronic format documents and records where appropriate								
(d)	Owner directives								
(e)	Restrictions and limitations								
(f)	User requirements			X					
(g)	Occupancy requirements and schedules								
(h)	Training requirements for Owner's personnel				X	X			
(i)	Warranty requirements					X			
(j)	Benchmarking requirements		X		X	X	X		
(k)	Operation and maintenance criteria for the facility that reflect the Owner's expectations and capabilities and the realities of the facility type					X	X	X	
(l)	Equipment and system maintainability expectations, including limitations of operating and maintenance personnel				X	X	X		
(m)	Quality requirements for materials and construction	X			X		X	X	
(n)	Allowable tolerance in facility system operations					X	X		
(o)	Energy efficiency goals		X			X	X	X	
(p)	Environmental and sustainability goals	X							
(q)	Community requirements	X							
(r)	Adaptability for future facility changes and expansion				X	X	X	X	
(s)	Systems integration requirements, especially across disciplines	X			X				
(t)	Health, hygiene, and indoor environment requirements			X					
(u)	Acoustical requirements	X		X	X				
(v)	Vibration requirements	X			X				
(w)	Seismic requirements	X			X				
(x)	Accessibility requirements	X		X	X	X			
(y)	Security requirements	X		X	X				
(z)	Aesthetics requirements	X		X	X				
(aa)	Constructability requirements	X			X				
(bb)	Communication requirements	X		X	X				
(cc)	Applicable codes and standards								

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX K
BASIS OF DESIGN

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

The Basis of Design document records the major thought processes and assumptions behind design decisions made to meet the Owner's Project Requirements. The Owner's Project Requirements are intended to capture "what" the owner needs and expects from a project. The Construction Documents detail "how" the Owner's Project Requirements will be physically achieved. The Basis of Design captures important information linking the "what" and "how."

Basis of Design documentation is distinct from the Construction Documents, is seldom included in drawings and specifications, and is generally not needed by the Contractor to meet his/her obligations. It is exceptionally valuable to the Commissioning Team, however, when evaluating the ability of a design and its components to met the Owner's Project Requirements.

The objective of specifically documenting Basis of Design information is to provide the parties involved with a project, at each phase in the process, an understanding of the underlying thinking that led to the selection of specific components, assemblies, systems, and system integrations. A design narrative that provides an overview of assemblies and systems in verbal format is usually an integral element of the Basis of Design.

The Basis of Design document will typically be developed incrementally as work on a project moves from Pre-Design, to Design, and into the Construction Phase. Changes to the Basis of Design that often occur as a design evolves must be documented.

Content of the Basis of Design document will vary from project to project and system to system, but in general it should address the following:

- Specific codes, standards, and guidelines considered during design of the facility and designer interpretations of such requirements.
- Information regarding ambient conditions (climatic, geologic, structural, existing construction) used during design.
- Assumptions regarding usage of the facility.
- Expectations regarding system operation and maintenance.
- Performance criteria that the system was designed to meet – linked to the Owner's Project Requirements.
- Specific design methods, techniques, software used in design.
- A narrative statement of design – that verbally describes how the designer intends to meet the Owner's Project Requirements.
- A narrative statement of operation – that verbally details how the facility is expected to operate under various situations (such as normal operation, extreme event, emergency).
- A listing of specific manufacturer makes and models used as the basis for drawings and specifications.

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX L
SPECIFICATIONS

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

1. SPECIFICATIONS FOR THE COMMISSIONING PROCESS

1.1 This annex provides guidance on writing specifications for Commissioning Process activities to be performed by construction contractors. A guide specification is included with the assumption that the construction contractor is involved only during the construction phase and for the correction and warranty period.

1.2 Commissioning is a quality-oriented process for achieving, verifying, and documenting that the performance of facility systems and assemblies meets defined objectives and criteria. The Commissioning Process begins at project inception during the Pre-Design Phase and continues for the life of the facility through the Occupancy and Operations Phase. During the Pre-Design Phase, the Owner's Project Requirements (OPR) are determined and documented by the Commissioning Team, which includes the Owner, Commissioning Authority (CxA), design professionals, operation and maintenance personnel, occupants, and users. Throughout each phase of the project, deliverables (drawings, specifications, submittals, construction, training, documentation, etc.) are verified against the OPR.

1.3 An important document created during the Commissioning Process is the Basis of Design document or report (BoD). The design professionals create this document or report during the design phase. The BoD records the concepts, calculations, decisions, and product selections to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. It can include energy, environmental, sustainability, and other certification criteria, both formal and informal. The BoD includes both narrative descriptions and lists of individual items that support the design process.

1.4 ASHRAE or NIBS Guideline 0 provides guidance on content and basic format. While the OPR are Owner-developed criteria, few Owners have the resources to develop the

OPR. Owners without these resources depend on the Commissioning Team (see a definition and discussion of the term *Commissioning Team* in this guideline) to assist them in developing the OPR.

1.5 The OPR and BoD must be included or referenced in the construction Contract Documents for informational purposes only.

1.6 The construction contractor's obligation is to construct the building and its systems and assemblies according to the requirements prescribed in the Contract Documents. There normally are no performance requirements relating to the OPR stated in the Contract Documents. The exceptions to this include situations where contractors are required to provide designs for systems or assemblies to be signed and sealed by licensed professionals.

2. THE COMMISSIONING AUTHORITY (CxA)

2.1 The primary role of the CxA is to verify achievement of the OPR throughout the project, from Pre-Design Phase through Occupancy and Operations Phase. The Owner should perform this role.

2.2 When the Owner cannot perform the CxA duties with qualified personnel, then the CxA should have a separate professional services agreement with the Owner, as this avoids conflicts of interest and provides independence from the other parties (the Owner's project manager, designers of record, construction managers, suppliers, and construction contractors). This professional services agreement defines the duties, rights, and responsibilities of the CxA for each phase of the project. This separate relationship allows the CxA to act independently as director of Commissioning Process activities, to focus on achieving the OPR, and to communicate directly with the Owner.

2.3 The CxA is a group of personnel with expertise and experience in the design, construction, and operations of the various systems and assemblies included in the project. These personnel are led by an individual who has expertise and experience in successfully implementing the Commissioning Process.

2.4 If the CxA is an employee, associate, or partner of the same organization as the designer of record or construction management firm, there is a conflict of interest. While not a recommended approach, in these instances the CxA must have a separate professional services agreement, be organizationally separate from the design team or construction management team, and define and manage the conflicts of interest to provide the Owner with the independence required for the Commissioning Process to be successful.

2.5 The CxA does not perform testing; it directs the process and directs the recording of the results. The CxA plans, schedules, and supervises Commissioning Process activities to verify achievement of the OPR. The Contractor completes construction checklists, performs tests, and accomplishes other Commissioning Process activities.

3. ORGANIZATIONAL STRATEGY FOR INCLUSION OF COMMISSIONING ACTIVITIES IN THE SPECIFICATIONS

3.1 Specifications (as a part of the construction Contract Documents) should include only the Commissioning Process activities the contractors perform during the life of the construction contract, including the work required during the correction period and for warranties.

3.2 *Supplementary Conditions*: Modify the General Conditions of the Contract for Construction in a document titled "Supplementary Conditions." Among other provisions, define the CxA and include the CxA's duties, rights, responsibilities, and limits of authority and additional requirements for substantial completion. AIA Document A511, "Guide for Supplementary Conditions," provides guidance about how to write Supplementary Conditions.

3.3 *General Requirements for the Commissioning Process*: Specifications in Division 1 include the general requirements for contractors relating to Commissioning Process activities. The "Summary" Section describes, in general, how the Contractors, separate Contractors (if there is more than one Prime Contractor), or the Construction Manager must interact with the CxA. Administrative procedures for the Commissioning Process are specified in the Division 1 Section "Commissioning."

3.3.1 The remainder of the specification language, with the exception of Division 1 sections for temporary facilities and controls, should be mute on the subject of who must perform the work.

3.3.2 Other Division 1 Commissioning Sections should describe the testing requirements for systems and assemblies.

3.3.2.1 References in Table L-1 are to MASTERSPEC® section numbers and titles existing at the time this annex was written. Refer to the current MASTERSPEC consolidated table of contents because section numbers and titles may have changed.

TABLE L-1 Description of Specification Sections

SEC NO.	DOCUMENT/SECTION	LIST OF CONTENTS	SCOPE OF CONTENTS
01100	SUMMARY	Work covered by Contract Documents Identification of separate prime contractors	Describe Commissioning Process activities as a part of the project. Alert the Contractor that the Owner has contracted for commissioning with a separate Commissioning Authority. Delineate scope of Commissioning Process.
01290	PAYMENT PROCEDURES		No special Commissioning Process requirements.
01310	PROJECT MANAGEMENT AND COORDINATION	Provisions about coordination of Commissioning Process activities among contractors and subcontractors; project meetings.	Add requirements to include CxA in coordination meetings (particularly "Pre-Construction Meeting"). Coordination of meetings and conferences.
01330	SUBMITTAL PROCEDURES	Procedures for submittals	Submittal requirements for Commissioning Process activity reports and schedules should be specified in Sections 01811 to 01819. Add requirements here for additional copies from Contractor to CxA and for approved submittals to be distributed to CxA.
01400	QUALITY REQUIREMENTS		Coordinate with Commissioning Process activities, witnessing of tests, and test reports.
01500	TEMPORARY FACILITIES AND CONTROLS		Include office space for CxA and utility services for Commissioning Process activities.
01600	PRODUCT REQUIREMENTS		No special Commissioning Process requirements.
01731	CUTTING AND PATCHING		No special Commissioning Process requirements.
01770	CLOSEOUT PROCEDURES		Include key Commissioning Process milestones to achieve substantial completion and closeout.
01782	OPERATION AND MAINTENANCE DATA		Include requirements for CxA to review and recommend approval of Systems Manual. Same procedures as described for Section 01330—Submittals.
01810	GENERAL COMMISSIONING REQUIREMENTS		General administrative and procedural requirements without regard to specific systems and assemblies.
01811	BUILDING ASSEMBLY COMMISSIONING REQUIREMENTS	Substructure Superstructure Building Shell Exterior Wall Assemblies Roof Assemblies Building Interior Separations Paths of Egress	Lists of Construction Checklists Prerequisites to Testing System or Assembly Test Requirements Test Reports
01812	CONVEYING SYSTEM COMMISSIONING REQUIREMENTS	Elevators and Lifts Escalators and Moving Walks	Lists of Construction Checklists Prerequisites To Testing System or Assembly Test Requirements Test Reports
01813	PROTECTIVE SYSTEM COMMISSIONING REQUIREMENTS	Fire Suppression (including pumps, sprinkler and standpipe piping, and terminal devices) Detection and Alarms (including fire, smoke, gas, and leak) Lightning Protection (this is not part of electrical distribution) Cathodic Protection (this is not part of electrical distribution)	Lists of Construction Checklists Prerequisites to Testing System or Assembly Test Requirements Test Reports

TABLE L-1 (Continued) Description of Specification Sections

SEC NO.	DOCUMENT/SECTION	LIST OF CONTENTS	SCOPE OF CONTENTS
01814	PLUMBING SYSTEM COMMISSIONING REQUIREMENTS	Water Distribution Sanitary Waste Storm Drainage Other Plumbing Systems	Lists of Construction Checklists Prerequisites to Testing System or Assembly Test Requirements Test Reports
01815	HVAC&R SYSTEM COMMISSIONING REQUIREMENTS	Heat Generation (including central equipment, distribution systems, and terminal devices) Refrigeration (including central equipment, distribution systems, and terminal devices) Ventilation (including central equipment, distribution systems, and terminal devices) HVAC Control Systems (including central equipment, distribution systems, and terminal devices)	Lists of Construction Checklists Prerequisites to Testing System or Assembly Test Requirements Test Reports
01816	ELECTRICAL SYSTEM COMMISSIONING REQUIREMENTS	Power Distribution (including central equipment, distribution circuits, and terminal devices) Lighting (includes fixtures and controls)	Lists of Construction Checklists Prerequisites to Testing System or Assembly Test Requirements Test Reports
01817	COMMUNICATIONS SYSTEMS COMMISSIONING REQUIREMENTS	Voice and Data Sound and Video	Lists of Construction Checklists Prerequisites to Testing System or Assembly Test Requirements Test Reports
01818	ELECTRONIC SAFETY AND SECURITY SYSTEMS COMMISSIONING REQUIREMENTS	Security Access, Perimeter Security, Intrusion Detection, Alarm and Detection Systems (including fire and smoke and leak detection)	Lists of Construction Checklists Prerequisites to Testing System or Assembly Test Requirements Test Reports
01820	DEMONSTRATION		Coordination requirements with the CxA
	INDIVIDUAL SECTIONS IN DIVISIONS 2 THROUGH 16	Field Quality Control Tests Adjusting and Balancing Cleaning Demonstration	A statement requiring system, subsystem, or equipment to be commissioned as a part of its parent system. A statement requiring Contractor to complete construction checklists and perform tests.

3.3.3 *Extent of Testing*: The contractor's involvement in Commissioning Process tests must be clearly defined. The extent of this testing is determined by the Commissioning Team during the Design Phase based upon the OPR.

3.4 *Component Commissioning Process Specifications*: Sections in Divisions 2 through 16 should specify testing and reporting requirements for products and equipment that are part of a system or assembly and then be referenced to the appropriate Commissioning Process sections in Division 1 for the overall system or assembly requirements.

3.4.1 During construction the CxA verifies that contractor activities, such as installation and start-up; testing; demonstration and training of the Owner's operator and maintenance personnel; and Systems Manual, achieve the OPR. Coordinating activities by the contractor in support of the CxA should be specified within the section where the component is specified (i.e., in individual sections in Divisions 2 through 16) if special requirements are necessary. The following are examples of requirements to include in individual sections in Divisions 2 through 16:

3.4.1.1 *Installation and Start-up*: Include requirements for involvement of factory-authorized service representative in individual sections and for the completion of construction checklists.

3.4.1.2 *Testing*: Include requirements to support the CxA in verifying test results, ranging from coordinating testing, to witnessing the test, to utilizing contractor personnel and test equipment to verify the test report.

3.4.1.3 *Demonstration and Training*: Include special requirements unique to the component within its own section.

3.4.1.4 *Operation and Maintenance Data*: Include unique requirements for the type of information required (e.g., particular requirements about parts lists, service schedules, preventive maintenance lists, and emergency operations) for long-term maintenance of the OPR.

3.4.2 In each section include an article under "General" that refers to Division 1 for Commissioning Process activities for system or assembly requirements. An example is as follows:

1.XX Commissioning Process Activities

A. The roofing materials specified in this Section are included in the Commissioning Process as a part of the building envelope system and roofing subsystem and integrated with flashing, coping, and insulation.

B. Complete the construction checklists and perform tests specified in the Division 1 Section "Building Assemblies Commissioning Requirements."

4. INTRODUCTION TO GUIDE SPECIFICATIONS

This Specification Section was written in cooperation with Architectural Computer Services, Inc. (ARCOM), who are the exclusive publishers and distributors of MASTERSPEC, a product of the American Institute of Architects. MASTERSPEC Section 01 9113—General Commissioning Requirements—is included in Guideline 0 by special agreement between ASHRAE and ARCOM.

4.1 The section includes boxed notes that are instructions to guide specifiers during editing of the specifications for a project.

4.2 The section includes optional text in boldface font and square brackets (e.g., [**optional text**]). These optional text items include text that often occurs and provides an easy way to include these requirements in the master for consideration for each project.

4.3 The section includes insert instructions in boldface font and angle brackets (e.g., <**Insert instructions**>). These instructions are placed where text must be inserted and provide some guidance about the nature of the text that must be inserted. Insert instructions are used when there are an infinite number of options that could occur making the use of [**Optional text**] impractical.

SECTION 01 9113 - GENERAL COMMISSIONING REQUIREMENTS

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Throughout the Section, the optional text "[**each**]" is included with the term "Contractor." Retain "each" for projects that include multiple prime contractors; delete for projects that have a single prime contractor.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

Documents referenced in paragraph below should be prepared during schematic design phase or earlier and updated as design progresses. They should be provided to Contractor when the commissioning process is implemented on Project.

B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.

B. Related Sections include the following:

List below only requirements that the reader might expect to find in this Section but are specified elsewhere. The first four and the last three subparagraphs are not yet available in MASTERSPEC but should be written and included if total building commissioning is implemented.

1. Division 01 Section "Facility Substructure Commissioning" for commissioning process activities for foundations and basement systems and assemblies.
2. Division 01 Section "Facility Shell Commissioning" for commissioning process activities for superstructure, exterior enclosure, and roofing systems and assemblies.
3. Division 01 Section "Interiors Commissioning" for commissioning process activities for interior construction, stairways, and interior finishes systems and assemblies.
4. Division 14 Section "Commissioning of Conveying Equipment" for commissioning process activities for dumbwaiters, elevators, escalators and moving walks, lifts, turntables, and scaffolding systems, assemblies, equipment, and components.
5. Division 21 Section "Commissioning of Fire Suppression" for commissioning process activities for fire suppression systems, assemblies, equipment, and components.
6. Division 22 Section "Commissioning of Plumbing" for commissioning process activities for plumbing systems, assemblies, equipment, and components.
7. Division 23 Section "Commissioning of HVAC&R" for commissioning process activities for commissioning heating, ventilating, air-conditioning, and refrigeration systems, assemblies, equipment and components.
8. Division 25 Section "Commissioning of Integrated Automation" for commissioning process activities for commissioning integrated automation systems, assemblies, equipment and components.
9. Division 26 Section "Commissioning of Electrical" for commissioning process activities for electrical systems, assemblies, equipment, and components.
10. Division 27 Section "Commissioning of Communications" for commissioning process activities for communication systems, assemblies, equipment, and components.
11. Division 28 Section "Commissioning of Electronic Safety and Security" for commissioning process activities for electronic safety and security systems, assemblies, equipment, and components.
12. Division 33 Section "Commissioning of Utilities" for commissioning process activities for water, wells, sanitary sewerage, storm drainage, fuel distribution, hydronic and steam energy, electrical, and communications utilities systems, assemblies, equipment, and components.

1.3 DEFINITIONS

Retain acronyms, abbreviations, and terms below that remain after this Section has been edited.

A. BoD: Basis of Design. A document, prepared by Architect, that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
B. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
C. CxA: Commissioning Authority.
D. OPR: Owner's Project Requirements. A document, prepared by Owner, that details the functional requirements of Project and expectations of how it will be used and operated. This document includes Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
E. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.

1.4 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of [**each**]Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
B. Members Appointed by Owner:
   1. CxA: An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
   2. Representatives of the facility user and operation and maintenance personnel.
   3. Architect and engineering design professionals.

1.5 OWNER'S RESPONSIBILITIES

A. Provide the OPR documentation to the CxA and [**each**]Contractor for information and use.
B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

Coordinate activities specified in paragraph below with Owner-Architect and Architect-Consultant agreements.

C. Provide the BoD documents, prepared by Architect and approved by Owner, to the CxA and [**each**]Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.6 [EACH]CONTRACTOR'S RESPONSIBILITIES

Coordinate this Article with requirements specified in Division 01 Section “Summary of Multiple Contracts” for Project Coordinator's responsibilities.

A. [**Each**]Contractor and their subcontractors shall assign representatives with expertise and authority to act on their behalf and schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
2. Cooperate with the CxA for resolution of issues recorded in "Issues Log."
3. Attend and participate in commissioning team meetings held [**weekly**] [**biweekly**] [**monthly**] [**variable**] <**Insert frequency**>.
4. Integrate and coordinate commissioning process activities with construction schedule.
5. Review and accept construction checklists provided by the commissioning authority.
6. Complete [**paper**] [**electronic**] construction checklists as Work is completed and provide to the commissioning authority on a [**daily**] [**weekly**],<**Insert frequency**>. basis.
7. Review and accept commissioning process test procedures provided by the commissioning authority.
8. Accomplish commissioning process test procedures.

1.7 CxA'S RESPONSIBILITIES

Include CxA responsibilities in this Article that have impact on Contractor activities and responsibilities.

A. Organize and lead the commissioning team.
B. Provide commissioning plan.
C. Convene commissioning team meetings.
D. Provide Project-specific construction checklists and commissioning process test procedures.
E. Verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, CxA will report the failure in the "Issues Log."
F. Prepare and maintain issues log.
G. Prepare and maintain completed construction checklist log.
H. Witness systems, assemblies, equipment, and component startup.
I. Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning process report.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 01 9113

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX M
CONSTRUCTION CHECKLISTS

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

OVERVIEW

Construction Checklists consist of two types:

Component/Equipment Based: These Construction Checklists are utilized for components and pieces of equipment that are delivered, installed, and started up during construction. There is an individual checklist for each individual component or piece of equipment.

System/Assembly Based: These Construction Checklists are utilized for systems and assemblies where separate checklists cannot be applied to subcomponents of the system or assembly. There is a single checklist for the entire system.

The following provides a generic structure to follow for the development of Construction Checklists for any equipment, component, system, or assembly.

[INSERT EQUIPMENT/COMPONENT NAME] CHECKLIST

TAG ID:_____

GENERAL INSTRUCTIONS:

1. This form is to be completed as the work is completed on [insert equipment/component name].
2. Complete Section 1 – Model verification upon delivery of equipment/component to either the job site or storage location.
3. Complete Section 2 – Pre-installation checks just prior to initial installation.
4. Complete Section 3 – Installation as installation progresses.
5. Fill in data, circle item, and initial as indicated.

1. [INSERT EQUIPMENT/COMPONENT NAME] MODEL VERIFICATION

	Specified	Submitted	Installed
[list items to check, such as make, model, and size]			

2. PRE-INSTALLATION CHECKS

The following must be completed upon delivery of equipment/component to the work site.

		Contractor	Initial	CxA
2A	**Physical Checks**			
	[insert physical checks to be verified prior to installation, such as "free of damage" and cleanliness]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		
2B	**Component Verification**			
	[insert component checks to be verified prior to installation, such as location and type of components]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		

3. INSTALLATION

The following items need to be verified during installation. Fill in blanks with check, specific information, or circle "yes" or "no." For any negative responses, complete Section 4.

		Contractor	Initials	CxA
3A	**[insert title of major installation step]**			
	[insert items to verify as installation step is accomplished]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		
3B	**[insert title of major installation step]**			
	[insert items to verify as installation step is accomplished]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		
3C	**[insert title of major installation step]**			
	[insert items to verify as installation step is accomplished]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		
3D	**[insert title of major installation step]**			
	[insert items to verify as installation step is accomplished]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		
3E	**[insert title of major installation step]**			
	[insert items to verify as installation step is accomplished]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		

4. NEGATIVE RESPONSES (ATTACH SHEETS AS NECESSARY)

Item	Reason for negative response	Resolution

[INSERT SYSTEM/ASSEMBLY NAME] INSTALLATION CHECKLIST

GENERAL INSTRUCTIONS

1. This form is to be completed daily by each [insert system/assembly name] work crew at the end of its shift.
2. Date and describe work completed in the appropriate section (1 for pre-installation and 2 for installation).
3. Verify achievement of quality requirements by circling "Yes" or "No." For negative responses, complete Section 3.
4. Initial.

1. [INSERT SYSTEM/ASSEMBLY NAME] PRE-INSTALLATION CHECKS

Date	Description of Work Performed	Items (see descriptions below)					Percent Complete	Initial
		[insert title A]	[insert title B]	[insert title C]	[insert title D]	[insert title E]		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		

[INSERT TITLE A]: [INSERT DESCRIPTION OF TITLE A]

[INSERT TITLE B]: [INSERT DESCRIPTION OF TITLE B]

[INSERT TITLE C]: [INSERT DESCRIPTION OF TITLE C]

[INSERT TITLE D]: [INSERT DESCRIPTION OF TITLE D]

[INSERT TITLE E]: [INSERT DESCRIPTION OF TITLE E]

2. [INSERT SYSTEM/ASSEMBLY NAME] INSTALLATION CHECKS

Date	Description of Work Performed	Items (see descriptions below)				Drawings Updated?	Percent Complete	Initial
		[insert title F]	[insert title G]	[insert title H]	[insert title I]			
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		

[INSERT TITLE F]: [INSERT DESCRIPTION OF TITLE F]

[INSERT TITLE G]: [INSERT DESCRIPTION OF TITLE G]

[INSERT TITLE H]: [INSERT DESCRIPTION OF TITLE H]

[INSERT TITLE I]: [INSERT DESCRIPTION OF TITLE I]

DRAWINGS UPDATED: THE INSTALLED SYSTEM IS SHOWN ON THE RECORD DRAWINGS.

3. CONFLICTS (ATTACH SHEETS AS NECESSARY)

Date	Description of Conflict	Suggested Resolution	Resolved?
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX N
QUALITY-BASED SAMPLING EXAMPLES

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

DESIGN PHASE SUBMISSIONS

A critical step in the Commissioning Process is the review of the design submissions from the design professionals. It is important to remember that the role of the Commissioning Authority is to verify that the Owner's Project Requirements are met and that the system is designed in a quality manner. There are three distinct reviews that are completed on a drawing set – general, coordination, and field specific. A review of the specifications is also required. The general steps of completing a drawing review are as follows:

GENERAL REVIEW

1. *Review the Owner's Project Requirements*: Since the drawing review is to verify that the Owner's Project Requirements were met, prior to the review, the Owner's Project Requirements should be reviewed to familiarize the reviewer with the key criteria of the facility.
2. *Document the General Review Criteria*: The criteria from which to accomplish the general review of the submission must be documented. The criteria should be based on general quality characteristics and specific Owner's Project Requirements criteria. The general quality characteristics should include items such as:

- Continuation of items (ductwork, pipes, etc.) from page to page
- Labeling, including correct room numbering
- Details corresponding to actual components
- Schedules including basis of design information
- All information legible (not hidden by crossing lines or text)
- Owner's Project Requirements information is included on drawings

3. *Accomplish Quick General Review*: The general review is intended to familiarize the reviewer with the submission. If during this review significant items are identified as of poor quality, then the review process should be stopped and the design professionals contacted to discuss the quality concerns. If the general quality is good, move on to the Coordination Review.

COORDINATION REVIEW

1. *Determine Sampling Areas*: For each floor plan area (i.e., if there are five sheets for each floor, then there are five floor plan areas for each floor) select a single 10" by 10" square randomly. A simple way to do this is to divide the drawing sheet into 15 squares (5 by 3) and select square number 3 on the first sheet (area) and then 5, 7, etc., for each remaining area. This selection is accomplished typically using the architectural sheets.
2. *Select Review Samples on Drawings*: Using the sampling strategy chosen in Step 1, mark the sample areas to be reviewed in each area. This should be accomplished for each trade (landscaping, architectural, structural, plumbing, mechanical, electrical, etc.).
3. *Accomplish Coordination Review*: For each area, compare the squares between each discipline. The intent of this review is to identify coordination problems with the placement and installation of components. Items of specific interest include:

- Placement of multiple pieces of equipment/components in the same location
- Accessibility to equipment/components for maintenance/replacement
- Use of consistent terminology (e.g., room numbers,)
- Elevations provided where multiple systems are placed in the same area
- Other trade duties clearly identified (e.g., electric wiring for HVAC equipment, holes for sinks)

If significant coordination problems are identified, stop the review and contact the design professionals to discuss. If the coordination is good, continue on with the Field Specific Review.

FIELD SPECIFIC REVIEW

1. *Determine the Review Sampling Procedure*: Use random sampling that selects every x^{th} square on the drawings to be verified. Squares that are completely blank (no walls, equipment, etc.) are not included in the counting. For example, if there are 10 pages of drawings and each drawing is split into 15 grids (5 × 3), there will be 150 potential grids to review. If a 20% sample rate is desired, then 30 grids would be reviewed, or every 5 grids. The starting grid should be chosen using a random selection process (die, 1-6 in a hat, etc.).
2. *Document Review Criteria*: The criteria from which to review the drawings should be based on specific Owner's Project Requirements criteria. This typically includes items such as accessibility, maintainability, meeting sustainability goals, comfort conditions, documentation of Owner's Project Requirements and Basis of Design, and operating details.
3. *Select Review Samples on Drawings*: Using the sampling strategy chosen in Step 1, mark the sample areas to be reviewed.
4. *Accomplish Detailed Statistical Review*: Using the review criteria from Step 2 and the selections from Step 3, accomplish a detailed review of the drawings. This includes verifying that the specifications match those shown on the drawings (see below for specification review details). For

example, if a VAV box is in the selected square, the steps in accomplishing the detailed review might include:

(a) Review design calculation inputs for matching architectural assumptions and the Owner's Project Requirements.

(b) Compare calculation results with the total airflow of the diffusers downstream of the VAV box and with the VAV box schedule.

(c) Compare location of VAV box with maintenance requirements of the selected make and model (Basis of Design).

(d) Compare VAV box location on drawings with requirements in the specifications.

(e) Review the Owner's Project Requirements for other issues that the VAV box could impact.

5. *Document Concerns*: During the review of the drawings keep detailed notes of problems found or concerns with certain items. Also, at the end of the review, a general summary of the quality of the drawings should be developed. A letter detailing the quality of the drawings should then be sent to the design professionals and the owner with specific recommendations and directions given.
6. *Review the Drawing Review Procedure*: After the drawing review is completed, this document should be reviewed and modified to improve the process for the next time.

SPECIFICATION REVIEW

1. *Determine the Review Sampling Procedure*: The purpose of this review is to determine the general quality of the specifications. During the Field Specific Review the actual details are checked. The sampling procedure should check approximately 10% of the specifications. The easiest way of doing this is to check every x^{th} page of the specifications (i.e., if there are 100 pages, check every 10^{th} page).
2. *Accomplish General Review*: The review should focus on the quality of the specification, specifically:

- Are there extraneous sections that do not pertain to the project (i.e., medical gas in an office building, 15 types of valves when only 2 used, etc.)?
- If a manufacturer has been listed, has the engineer checked to verify that the Owner's Project Requirements are met?
- Are there any "or as equals"? ("As equal" should always be defined)
- Are the directions clear and concise?

3. *Develop Summary of Review* – Develop a summary of the review. If there are problems with the specifications, contact the design professionals and discuss.

DESIGN PROFESSIONAL ACTIONS

Comments provided by the Commissioning Authority need to be formally replied to by the design professionals. If systemic issues are identified during the Commissioning Authority's review, the design process should be stopped and the issues resolved. It is expected at the next submission that the Commissioning Authority will again use random sampling that will result in a review of different areas on the drawings and the specifications and that will identify whether the systemic issue has been resolved. Back-checking of the specific items may be appropriate, but not as the sole means of verifying resolution of the issue.

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX O
SYSTEMS MANUAL

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

Developing the Systems Manual encompasses gathering all of the information related to the systems, assemblies, and the Commissioning Process and incorporating it into a usable information resource with indexes and cross-references. This resource shall include the final Owner's Project Requirements, Basis of Design, the final Commissioning Plan, Commissioning Process Report, manufacturer installation manuals, manufacturer operations and maintenance manuals, system schematics, verified Record Drawings, and test results. This information is edited and organized to focus upon the key systems (roofing, walls, fire alarm, chilled water, hot water, etc.) in the building. Coordination with operations and maintenance personnel in developing standard formats and divisions (shops) is accomplished to simplify future Systems Manual development.

Also included in the Systems Manual is the development of periodic maintenance and information for insertion into a computer maintenance management system (CMMS), including equipment make and model information, checking requirements, maintenance requirements, and troubleshooting items.

The Commissioning Authority shall be responsible for verifying the development of the Systems Manual.

The entity responsible for developing the Systems Manual shall include all items involved in the project and capture the system and assembly data in either an electronic or printed version. In addition, printed operations, service, maintenance, spare parts list, and repair manuals may be provided. This entity (owner, contractor, design professional, other) shall have the skills of design, construction, and operations required to develop a cohesive Systems Manual.

The required details for a full Systems Manual are enhanced in each of the technical Commissioning Process Guidelines. The Systems Manual will have multiple sections depending upon the number of systems focused upon during the Commissioning Process. The Systems Manual will include a detailed table of contents with a notation as to resource storage location if not in the actual manual. The following outline is a recommended format:

1. General.

(a) Executive Summary (facility level).

This section includes an overall description of the building and its systems, including a listing of major capabilities and limitations imposed by the design or building code. The description should include type of facility, general description (number of floors, gross area, net area, type of occupancy, etc.), and general system descriptions. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information should be included in this section.

(b) Owner's Project Requirements (facility level).

A copy of the final Owner's Project Requirements for the facility is included in this section. This document was initially developed during the Pre-Design Phase and was updated throughout the project by the Owner, Commissioning Authority, or design professionals.

(c) Basis of Design (facility level).

This section includes the final Basis of Design document at a facility level. This document is written by the design professionals during the Design Phase and is updated by them to include any changes during the Construction Phase.

(d) Construction Record documents and specifications (not included in specific systems sections).

This section includes elements of the record set of Construction Documents (including specifications) that are not covered under specific systems—updated to reflect the final installation.

(e) Approved submittals (not included in specific system sections).

This section includes a copy of the approved submittals (not included under specific systems) with all field modifications and accessories clearly marked. In addition, the comments from original submittals shall be included.

(f) Facility operating procedures for all normal, abnormal, and emergency modes of operation (facility level).

This section includes detailed operating procedures for the facility during normal, abnormal, and emergency modes of operation. This is not intended to be automatic control sequences, but general operating procedures. This would include items such as building access during various situations (normal operation, after-hours operation, fire alarm, civil disturbance operation, emergency power operations, etc.).

(g) A list of recommended operational record keeping procedures at the facility level, including sample forms, trend logs, or others, and a rationale for each.

This section includes direction to the operation and maintenance personnel as to what information needs to be documented and kept on the operation of the facility and why these records are important or will benefit the Owner or operations and maintenance personnel in the future.

(h) Maintenance procedures, schedules, and recommendations (facility level).

This section includes the manufacturer's recommendations for maintenance procedures and when maintenance should be performed on systems not included in specific system sections.

(i) Ongoing Optimization (facility level).

This section includes guidance for the ongoing optimization of the facility. Included in the section are schedules of periodic benchmarking using checklists and tests developed for the original construction, procedures for maintaining the Owner's Project Requirements and Basis of Design documents, and guidance on what to do when the Owner's Project Requirements are not achieved.

(j) Attachments:

Commissioning documents listing and storage location.

[*The following section is completed for each system or assembly requiring operation and maintenance*.]

2. xxx System/Assembly.

(a) Executive Summary (xxx System/Assembly).

This section includes a description of the systems/assemblies covered in this section, including a listing of capabilities and limitations imposed by the design or building code. The description should include type of system/assembly, general description, and schematics. A list of contractors, subcontractors, suppliers, and design professionals involved with this system along with their contact information should be included.

(b) Owner's Project Requirements (xxx System/Assembly level).

A copy of the final Owner's Project Requirements dealing with this system/assembly is included in this section. This document was initially developed during the Pre-Design Phase and was updated throughout the project by the Owner, Commissioning Authority, or design professionals.

(c) Basis of Design (xxx System/Assembly level).

This section includes the final Basis of Design document (including the design intent) as related to the specific systems included in this section. This document is typically written by the design professionals during the Design Phase and is updated by them to include any changes during the Construction Phase.

(d) Construction Record documents and specifications (xxx System/Assembly).

This section includes the record set of Construction Documents (including specifications) that has been updated to reflect the final installation of the specific system/assembly included in this section.

(e) Approved submittals (xxx System/Assembly).

This section includes a copy of the approved submittals for the components associated with the system/assembly with all field modifications and accessories clearly marked. In addition, the comments from original submittals shall be included.

(f) Operating procedures for all normal, abnormal, and emergency modes of operation (xxx System/Assembly).

This section includes detailed operating procedures for xxx systems/assemblies during normal, abnormal, and emergency modes of operation. This is not intended to be automatic control sequences, but general operating procedures.

(g) A list of recommended operational record-keeping procedures, including sample forms, trend logs, or others, and a rationale for each (xxx System/Assembly).

This section includes direction to the operations and maintenance personnel as to what information needs to be documented and kept on the operation of the systems and why these records are important or will benefit the Owner or operations and maintenance personnel in the future.

(h) Maintenance procedures, schedules, and recommendations (xxx System/Assembly).

This section includes the manufacturer's recommendations for maintenance procedures and when maintenance should be performed.

(i) Ongoing optimization (xxx System/Assembly).

This section includes guidance for the ongoing optimization of the system/assembly. Included in the section are schedules of periodic benchmarking using checklists and tests developed for the original construction, procedures for maintaining the Owner's Project Requirements and Basis of Design documents, and guidance on what to do when the Owner's Project Requirements are not achieved.

(j) Operations and maintenance manuals (xxx System/Assembly).

This section includes the manufacturer's printed operations and maintenance manuals for the specific equipment/components provided for the xxx system/assembly. Also included is a parts and recommended spare parts list, a troubleshooting guide for common situations, and one-line diagrams for each applicable system.

(k) Training records (xxx System/Assembly).

This section includes information on training provided and attendees. In addition, information on ongoing training shall be provided.

(l) Commissioning Process Report for xxx System/Assembly.

This section includes the Final Commissioning Process Report for the xxx system/assembly, including all test procedures, test results, and blank test forms.

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE ANNEX P
TRAINING MANUAL AND TRAINING NEEDS

This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.

This annex is a collection of various requirements for training and identifies needs for the Training Manual. The Training Manual includes the Training Plan, which is composed of the Training Syllabus and Training Agenda that are provided to the contractor by the Owner with help from the CxA. The Training Manual also contains the results of training, including the Training Material and Training Evaluations completed by the Contractor. It is an example to provide direction, in that training needs vary substantially for each construction project or new building. The following is an example of a Training Manual outline or syllabus for the Training Manual with a focus on electrical and mechanical systems.

TRAINING SYLLABUS

Overview

This syllabus describes the objectives of the various sessions, lectures, and demonstrations that form a part of the training program developed for the Do-It-Right Building.

Sessions

There are two main sessions on the electrical systems and two main sessions on the mechanical systems that will provide training to the OK Service personnel. The first session will be conducted at the time of start-up and check-out and the second session will be about two months later. Sessions will be a minimum of two days duration for the basics in each system and be conducted as specified below. The sessions will be conducted at the site.

All training sessions will be visually recorded using either videotape (VHS format) or standard compact disk (CD) in PC format. The CD format is desired for longevity and keyword searching. The sessions can be recorded on videotape and then transferred to CDs.

A training agenda in the format enclosed will be provided for each session. This will be submitted three weeks prior to the scheduled training session. All listed owner's representatives will sign this prior to proceeding with the training.

A list of training topics that are appropriate for consideration are listed in the attached Training Agenda Topics list.

The Commissioning Authority will be notified of the scheduled training time and provided with a copy of the training material fifteen days prior to each training session. The Commissioning Authority will review the material and share

comments with the Owner and the design professionals. If any aspects do not meet the requirements of the specifications, this will be communicated through the design professionals. The Commissioning Authority will attend 25% or more of the training sessions.

A receipt acknowledging completion of each item of instruction will be secured.

The training will be evaluated based upon the criteria in the attached evaluation form.

Electrical Systems

The training shall include:

- General familiarization and operating procedures for the entire electrical installation.
- Routine maintenance procedures for equipment.
- Specific operating and maintenance procedures for:
  - Switchboards
  - Emergency power supply system
  - Fire alarm system

Factory-trained technicians will provide operating and maintenance instructions on the following:

System/Equipment	Minimum Session Duration, hours
Emergency power supply system	x
Fire alarm system	x
Lighting control systems	x
Switchboards	x
Medium voltage pad-mounted switchgear	x

Mechanical Systems

The training shall include:

- General familiarization with and operating procedures for the entire plumbing, laboratory gas, pure water, compressed air, fuel, HVAC&R, and fire protection systems installation.
- Routine maintenance procedures for equipment.
- Specific operating and maintenance procedures for:
  - Hot water system consisting of boilers, pumps, controls, and hydronic specialties.
  - Chilled water systems consisting of chillers, cooling towers, pumps, controls, and hydronic specialties.
  - Automatic temperature control system consisting of all associated hardware, software, and program logic; this is to be arranged by systems.
  - Laboratory air-side control system consisting of supply, hood, and general exhaust valves, reheat coils, and room control panel.
  - Clean agent fire suppression systems, including emergency procedures, abort functions, and safety requirements.
  - Laboratory hood exhaust air system.

Factory-trained technicians will give instruction on the following specialty systems and equipment:

System/Equipment	Minimum Session Duration, hours
Variable speed drives	x
Chillers	x
Automatic temperature controls	x
Water treatment systems	x
Laboratory control systems	x

DDC System

There will be two formal training sessions on the DDC system. Each of the sessions will be conducted by factory-trained personnel for a minimum duration of xx 8-hour days. Materials and training will be provided for up to xx operators per session (selected by the Owner).

There will be a separate training course provided on the DDC system for supervisory personnel. This training will briefly cover the material of the operator training session but will be focused on the more advanced features of the system with emphasis on the energy conservation strategies and reporting capabilities of the system and how to implement them. The training session will be conducted by factory-trained personnel for a minimum duration of xx 8-hour days, for a total of xx training hours. Materials and training will be provided for up to xx persons selected by the Owner.

TRAINING AGENDA

Project:	Do-It-Right—Wonderful Sky Building
Training Material:	Systems Manual; Evaluation Forms; Record Forms; Specification Sections, Miscellaneous Manufacturer's Documentation, Field Equipment (for demonstrations)

SECTION 1. AUDIENCE AND GENERAL SCOPE

Intended audience type: ☑ O&M Staff, ☑ Supervisory Personnel
☑ Laboratory Users ☑ _____

General scope of training: ☐ A. Overview ☑ B. Intermediate ☑ C. Detailed

SECTION 2. INSTRUCTORS

ID	Instructor (Factory Trained)	Company
1)	_____	_____
2)	_____	_____
3)	_____	_____
4)	_____	_____
5)	_____	_____

SECTION 3. AGENDA

SESSION A – ELECTRICAL AND FIRE PROTECTION SYSTEMS

	Lectures/Demonstrations	Dates	Location	Duration (hr x freq*)	Instructor ID(s)
A1	Emergency power supply system	_____	_____	8 × 2	_____
A2	Fire alarm system	_____	_____	8 × 2	_____
A3	Lighting control	_____	_____	4 × 2	_____
A4	Switchboards	_____	_____	4 × 2	_____
A5	Medium voltage pad-mounted switchgear	_____	_____	4 x 2	_____
A6	O&M procedures for clean agent fire suppression systems, including emergency procedures, abort functions, and safety requirements	_____	_____	4 x 2	_____

Total duration of training (h) ----------> 64

SESSION B – MECHANICAL AND PLUMBING SYSTEMS

	Lectures/Demonstrations	Dates	Location	Duration (hr x freq*)	Instructor ID(s)
B1	Variable speed drives	_____	_____	4 × 2	_____
B2	Chillers	_____	_____	4 × 2	_____
B3	General familiarization and operating procedures for plumbing equipment	_____	_____	3 × 2	_____
B4	Water treatment systems	_____	_____	2 × 2	_____

Total duration of training (h) ----------> 26

SESSION C – CONTROL SYSTEM

	Lectures/Demonstrations	Dates	Location	Duration (hr x freq)	Instructor ID(s)
C1	Laboratory control systems	_____	_____	8 × 2*	_____
C2	Automatic temperature controls	_____	_____	10 × 2*	_____
C3	DDC system operations (for up to xx operators)	_____	_____	32 × 2*	_____
C4	DDC system emphasis on advanced features of system, energy conservation strategies, and reporting capabilities and how to implement them (for up to xx supervisors)	_____	_____	16 × 1	_____

Total duration of training (h) ----------> 116

* Frequency is 2 formal training sessions as per spec. sections 15900, pg. 16, Part 2.1, and 16800, pg. 5, Part 7.3. The first session shall be conducted at the time of start-up and check-out and the second session shall be approximately 2 months later.

SECTION 4. APPROVALS

This Training Program has been approved by the following individuals, subject to any additions and clarifications noted. (This is not an approval of training completion.)

_____ _____

Do-It-Right, Inc. Representative Date

_____ _____

Commissioning Authority Date

TRAINING AGENDA TOPICS

(Suggested General Topics to Be Included)

	Suggested List of Subjects	Requested by D-I-R, Inc. (✓)	Desired Duration (h)
1.	Overview and description of the purposes of the system		
2.	System troubleshooting: description of diagnostic step-by-step procedures for determining the source of problems on the system level; review technical service manual in detail		
3.	Component maintenance: instruction of required procedures for weekly, monthly, and annual preventive checks and timely repairs to preserve system integrity		
4.	Component troubleshooting: description of diagnostic procedures for determining the source of problems on the component level		
5.	Review of control drawings and schematics (have copies for attendees)		
6.	Startup, loading, normal operation, unloading, shutdown, unoccupied operation, seasonal changeover, etc., as applicable		
7.	Integral controls (packaged): programming, troubleshooting, alarms, manual operation		
8.	Building automation system (BAS) controls: programming, troubleshooting, alarms, manual operation, interface with integral controls		
9.	Interactions with other systems, operation during power outage and fire		
10.	Relevant health and safety issues and concerns and special safety features		
11.	Energy-conserving operation and strategies		
12.	Any special issues to maintain warranty		
13.	Common troubleshooting issues and methods, control system warnings and error messages, including using the control system for diagnostics		
14.	Special requirements of tenants for this equipment's function		
15.	Service, maintenance, and preventive maintenance (sources, spare parts inventory, special tools, etc.)		
16.	Question and Answer Period		
	Total hours requested		
	Total hours required by specifications		

Training Evaluation

Session: _____

Date: _____ **Location: _____**

Purpose: This form is used to evaluate each training session. Based upon this evaluation, later sessions can be improved. This form will be completed by the Commissioning Authority and one D-I-R employee in the training session after each session.

Every attendee fills out one copy of this form. Mark questions that are not applicable with N/A.

		1 = very well to 5 = not at all					
1.	How were the objectives of this training session met?	1	2	3	4	5	N/A
2.	Do you know where the components/systems are located?	1	2	3	4	5	N/A
3.	Do you know what area the components/systems are serving?	1	2	3	4	5	N/A
4.	Do you understand the various types and purpose of these components/systems?	1	2	3	4	5	N/A
5.	Do you understand/know how to systematically troubleshoot common problems with these components/systems?	1	2	3	4	5	N/A
6.	Do you know how the components/systems operate under all normal modes?	1	2	3	4	5	N/A
7.	How well do you understand the importance of meeting the design intent for the systems covered?	1	2	3	4	5	N/A
8.	Are you able to efficiently find the relevant information in the Systems Manual to operate and maintain the systems/components you were trained for in this session?	1	2	3	4	5	N/A
9.	Do you know how to perform the needed maintenance on the equipment and/or do you know to get the information you need?	1	2	3	4	5	N/A
10.	Do you know how to get updated technical service information for the components/systems?	1	2	3	4	5	N/A

Explain why any questions got very low or very high ratings from you:

What topics would you desire to be covered that were absent from this training session?

You may provide other comments concerning anything about this training session (e.g., information prior to training, content):

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.