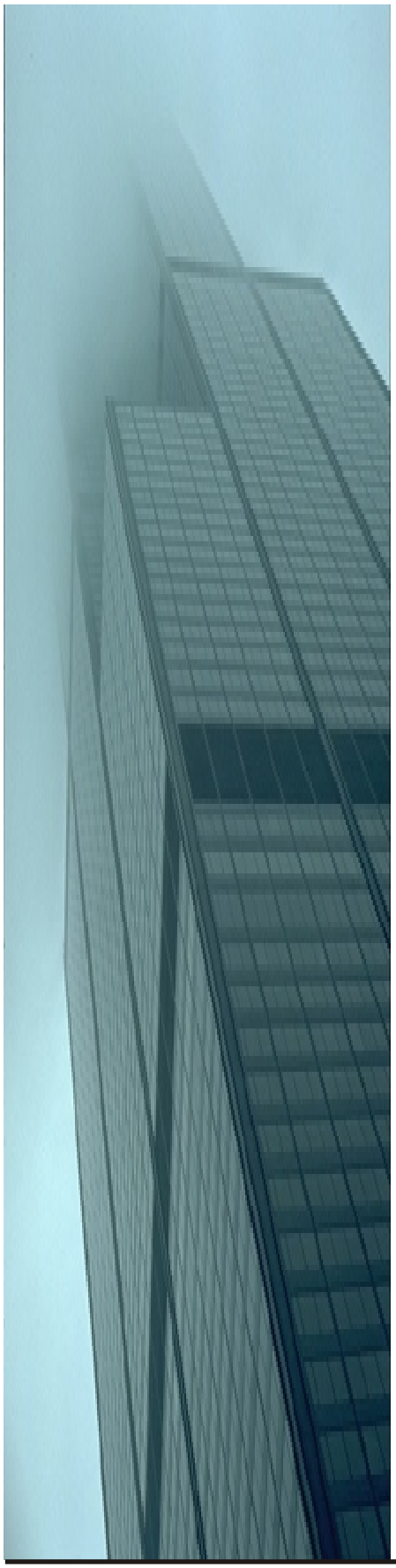

PROCEDURAL STANDARDS FOR WHOLE BUILDING SYSTEMS COMMISSIONING OF NEW CONSTRUCTION

2009 - THIRD EDITION

National Environmental Balancing Bureau
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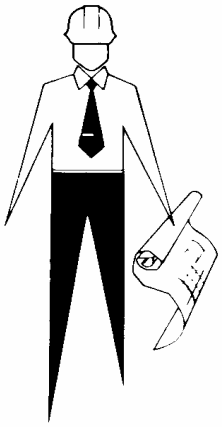

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PROCEDURAL STANDARDS FOR WHOLE BUILDING SYSTEMS COMMISSIONING OF NEW CONSTRUCTION

FIRST EDITION - JANUARY 1993
SECOND EDITION - JANUARY 2000
THIRD EDITION – FEBRUARY 2009

These Procedural Standards were developed using reliable engineering principles and research plus consultation with, and information obtained from, manufacturers, users, testing laboratories and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable. Building Systems Commissioning completed to these standards may not be applicable if the system being commissioned contains features or components that impair the results of these standards. The National Environmental Balancing Bureau assumes no responsibility and has no liability for the application of the principles or techniques contained in these Procedural Standards. Authorities considering adoption of these Procedural Standards should review all Federal, State, local and contract regulations applicable to the specific installation.

FOREWORD

The purpose of the NEBB *Procedural Standards for Whole Building Systems Commissioning for New Construction* is to establish a uniform and systematic set of criteria for the performance of the commissioning of building and environmental systems.

Today's buildings provide highly controlled indoor environments. These conditions could not exist without sophisticated systems, components and assemblies which are incorporated into today's facilities by a team of skilled professionals. A key member of this team is the NEBB Certified Building Systems Commissioning (BSC) Firm.

This Third Edition represents a departure from past editions and is divided into three distinct Parts: *Standards, Process* and *Procedures*. These BSC procedural standards have been developed using language defined by **"*Shall, Should, and May*"** as it relates to the standards and procedures described in this manual. It is important to note these particular words throughout this manual and how they pertain to the NEBB standards and procedures.

Previous editions included the requirements for commissioning of HVAC and Plumbing systems. This 3rd edition details the requirements for Whole Building Systems Commissioning and includes HVAC Systems, Building Envelope, Electrical Systems, Special Electrical Systems, Plumbing Systems and Fire Protection Systems.

This Procedural Standard establishes a minimum level of technical effort to provide value. The NEBB Commissioning program complements the current editions of ASHRAE Guideline 0, *The Commissioning Process* and ASHRAE Guideline 1, *The HVAC Commissioning Process,* from pre-design phase through occupancy and operations phase. These BSC Procedural Standards have been carefully compiled and reviewed by the NEBB Technical Committees.

Part 1 STANDARDS

Part 1, STANDARDS, covers the requirements for Quality Control and Compliance, Instrumentation Requirements, and Reports. Defined requirements for instruments /equipment and reports are identified. The new report requirements allow the NEBB Certified Firm more flexibility in designing their reports by prescribing sets of information that ***"Shall, Should*** and/or ***May"*** be required to complete a BSC Report.

Part 2 PROCESS

Part 2 is devoted to providing a detailed explanation of the commissioning process.

Part 3 PROCEDURES

Part 3, PROCEDURES, covers the technical procedures for commissioning today's building systems.

APPENDICES

The Appendices include the NEBB commissioning process matrix.

This Third Edition of the BSC Procedural Standards, when used by NEBB Certified BSC Firms, will assure the building owner or operator that building systems are properly commissioned within design and installation limitations.

Andrew P. Nolfo, P.E.
NEBB Technical Director

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TABLE OF CONTENTS

PAGE

SECTION 5 Standards for Reports and Forms

PART 2 - PROCESS

SECTION 6 The Commissioning Process

PAGE

PART 3 - PROCEDURES

SECTION 7 Commissioning of HVAC Systems

SECTION 8 Commissioning of Building Envelope Systems

PART 1 - STANDARDS

SECTION 1 DEFINITIONS

These procedural standards have been developed using language defined by "Shall, Should, and May" as it relates to the standards and procedures described in this publication. It is important to note these particular words throughout this publication and how they pertain to NEBB standards and procedures.

These procedural standards have been developed utilizing ASHRAE Guideline 0 as the standard for the basic commissioning process for new buildings to ensure industry continuity but offer expanded procedures that provide a higher technical effort. Many definitions below are similar to ASHRAE definitions but in some cases include expanded technical clarifications.

Acceptance Phase Commissioning: Commissioning tasks executed after the construction has been completed, all Site Observations and Static Tests have been completed and all Pre-Functional Testing has been completed and accepted. The main commissioning activities performed during this phase are verification that the installed systems are functional as verified by conducting Functional Performance tests and Owner Training.

Accuracy: The capability of an instrument to indicate the true value of a measured quantity.

AHJ: The local governing **A**uthority **H**aving **J**urisdiction over the installation.

ASHRAE: The American Society of Heating Refrigerating and Air-Conditioning Engineers

Basis of Design (BOD): The Engineer's Basis of Design is comprised of two components: the Design Criteria and the Design Narrative, these documents record the concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements (OPR) and to satisfy applicable regulatory requirements, standards, and guidelines.

BIM: Building Information Modeling utilizes a 3-dimensional computer-aided design and drafting program to model all aspects of a building which allows discovery of space conflicts, scheduling conflicts and improved design due to improved coordination.

Building Systems Commissioning (BSC): NEBB acronym used to designate its commissioning program.

Calibrate: The act of comparing an instrument of unknown accuracy with a standard of known accuracy to detect, correlate, report, or eliminate by adjustment any variation in the accuracy of the tested instrument.

CCTV: Closed circuit Television. Normally used for security surveillance and alarm detections as part of a special electrical security system.

Checklists: Lists of data or inspections that should be verified to ensure proper system or component installation, operation and function. Verification checklists are developed and used during all phases of the commissioning process to verify that the Owner's Project Requirements (OPR) is being achieved.

Commissionability: Defines a design component or construction process that has the necessary elements that will allow a system or component to be effectively measured, tested, operated and commissioned

Commissioning (Cx-NC): Commissioning process applied to New Construction. See *Commissioning Process*.

Commissioning Authority (CA): The NEBB Certified BSC Professional who administers the Cx process by managing the Cx team. Where CA is used in the standard it means the CA, members of his staff or appointed members of the commissioning team.

Commissioning Plan: A document that outlines the scope and defines responsibilities, processes, schedules, and the 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, components, and assemblies are planned, designed, installed, tested, can be operated, and maintained to meet the Owner's Project Requirements.

Commissioning Report: The final document which presents the commissioning process results for the project. Cx reports include an executive summary, the commissioning plan, issue log, correspondence, and all appropriate check sheets and test forms.

Commissioning Team: Individual team members whose coordinated actions are responsible for implementing the Commissioning Process.

Contract Documents (CD): Contract documents include design and construction contracts, price agreements and procedure agreements. Contract Documents also include all final and complete drawings, specifications and all applicable contract modifications or supplements.

Continuous Commissioning Process: A continuation of the Commissioning Process well into the Occupancy and Operations Phase. This process verifies 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.

Construction Phase Commissioning (CPC): All commissioning efforts executed during the construction process after the design phase and prior to the Acceptance Phase Commissioning.

Coordination Drawings: Drawings showing the work of all trades that are used 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. On mechanical projects, coordination drawings include structural steel, ductwork, major piping and electrical conduit and show the elevations and locations of the above components.

Deferred System Test: Tests that cannot be completed at the end of the acceptance phase due to ambient conditions, schedule issues or other conditions preventing testing during the normal acceptance testing period.

Deficiency: Any condition that adversely affects the commissionability, operability, maintainability or functionality of a system, equipment or component or an issue that does not conform to the project OPR, contract documents or standard industry best practices.

Design Criteria: A listing of the projects design requirements, including its source. These are used during the design process to show the design element meets the OPR.

Design Development (DD): Design Development takes the schematic design (SD) phase and turns these conceptual plans into one-line duct and piping drawings with identifiable zones. Specifications would be in outline form with typical details shown. DD's would contain preliminary equipment data schedules, etc.

Design Intent: The overall term that includes the OPR and the BOD. It is a detailed explanation of the ideas, concepts, and criteria that are defined by the owner to be important. The design intent documents are utilized to provide a written record of these ideas, concepts and criteria.

Design Narrative: A written description of the proposed design solutions that satisfy the requirements of the OPR. The preparation of this document is the responsibility of the Engineer. The narrative should include a description of the systems selected and why they were chosen. It should also include reasons other systems were considered and rejected. Acceptance of the items in the Design Narrative should be the consensus of both the Owner and the Engineer.

Design Phase Commissioning (DPC): All commissioning tasks executed during the design phase of the project.

Design Professional: The architect(s) or engineer(s) of record of the project.

Environmental Systems: Systems that use a combination of mechanical equipment, airflow, water flow and electrical energy to provide heating, ventilating, air conditioning, humidification, and dehumidification for the purpose of human comfort or process control of temperature and humidity.

Executive Summary: A section of the Commissioning report that reviews the general outcome of the project. It also includes any unresolved issues, recommendations for the resolution of unresolved issues and all deferred testing requirements.

Function: For the purposes of this NEBB Standard, *function* refers to the specific type of data measurement specified in Table 4-1 of Section 4, *Standards for Instrumentation and Calibration.*

Functionality: This defines a design component or construction process which will allow a system or component to operate or be constructed in a manner that will produce the required outcome of the OPR.

Functional Performance Test (FPT): Functional performance tests are tests that are intended to prove functionality of the component or system. FPT tests are done after all PFT tests are complete.

Industry Accepted Best Practice: A design component or construction process that has achieved industry consensus for quality performance and functionality. Refer to the current edition of the NEBB *Design Phase Commissioning Handbook* for examples.

Installation Verification: Observations or inspections that confirm the system or component has been installed in accordance with the contract documents and to industry accepted best practices.

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.

May: The term is used to indicate a course of action that is recommended to enhance a commissioning project but is not required for a NEBB certified project.

Maintainability: A design component or construction process that will allow a system or component to be effectively maintained. This includes adequate room for access to adjust and repair the equipment. Maintainability also includes components that have readily obtainable repair parts or service.

NEBB: National Environmental Balance Bureau

NEBB Certified BSC Firm: A firm that has met and maintains all the requirements of the National Environmental Balancing Bureau for firm certification in Building Systems Commissioning and is currently certified by NEBB. A NEBB Certified BSC Firm must employ at least one NEBB Certified BSC Professional in a full time management position.

NEBB Certified BSC Report: The final report of the project commissioning process. The commissioning report includes all testing data results, issue logs, observations and other pertinent data to the commissioning process. NEBB Certification indicates that the commissioning process and the report have been completed and compiled in accordance with the current edition of the NEBB *Procedural Standards for Whole Building Systems Commissioning of New Construction*.

NEBB Certified BSC Professional A full time employee of the firm in a management position who has successfully passed the Certified Professional level examinations and maintains the Certified Professional re-qualification requirements of NEBB.

Owner's Project Requirements (OPR): A written document that details the project requirements and the expectations of how the building and its systems will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

Precision: The ability of an instrument to produce repeatable readings of the same quantity under the same conditions. The precision of an instrument refers to its ability to produce a tightly grouped set of values around the mean value of the measured quantity.

Pre-Design Phase Commissioning: Commissioning tasks performed prior to the commencement of design activities that includes project programming and the development of the commissioning process for the project.

Pre-Functional Test (PFT): An inspection or test that is done before functional testing. PFT's include installation verification and system and component start up tests.

Procedure: A defined approach that outlines the execution of a sequence of work or operations. Procedures are used to produce repeatable and defined results.

Range: The upper and lower limits of an instrument's ability to measure the value of a quantity for which the instrument is calibrated.

RCx: Abbreviation for Retro-Commissioning.

Retro-Commissioning (RCx-EB): The NEBB Retro-Commissioning Certification program. Retro-Commissioning is the process of improving the performance of an existing building. RCx-EB utilizes different procedures; see the NEBB RCx-EB Procedural Standards

Resolution: This word has two meanings in the Cx Process. The first refers to the smallest change in a measured variable that an instrument can detect. The second refers to the implementation of actions that correct a tested or observed deficiency.

Schematic Design (SD): A conceptual image of the projects engineering requirements. Load calculations, preliminary system selection, and flow sheets are developed in this phase of the project. This phase could represent the project at approximately 35% of the design effort.

Shall: The term is used to indicate mandatory requirements that must be followed In order for the project to become a NEBB certified project. Work must conform to these standards and procedures and no deviation is permitted. Note: In the event unique circumstances prevent a required action from being fulfilled, a notation shall be included in the Cx report explaining the reason that the requirement was not completed.

Should: The term is used to indicate that a certain course of action is preferred and recommended to be included to provide a high quality commissioning project but is not required to be implemented in a minimum NEBB certified project.

Site Observation Reports (SO): Reports of site inspections and observations made by the CA. Observation reports are intended to provide early indication of an installation issue which will need correction or analysis.

Special System Inspections: Inspections required by a local code authority prior to occupancy and are not normally a part of the commissioning process.

Standard: A required qualification, action, or result for BSC work.

Static Tests: Tests or inspections that validate a specified static condition such as pressure testing. Static tests may be specification or code initiated.

Start Up Tests: Tests that validate the component or system is ready for automatic operation in accordance with the manufactures requirements.

Sound (S): The NEBB certification program for Sound Testing S is utilized to indicate the level of sound exposure to occupants of a facility.

Systems Manual: A system-focused composite document that includes all information required for the owners operators to operate the systems.

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

Testing: The use of specialized and calibrated instruments to measure parameters such as: temperature, pressure, vapor flow, air flow, fluid flow, rotational speed, electrical characteristics, velocity, and other data in order to determine performance, operation, or function.

Testing, Adjusting, and Balancing (TAB): A systematic process or service applied to heating, ventilating and air-conditioning (HVAC) systems and other environmental systems to achieve and document air and hydronic flow rates. The standards and procedures for providing these services are referred to as *"Testing*, *Adjusting, and Balancing"* and are described in the NEBB *Procedural Standards for the Testing, Adjusting and Balancing of Environmental Systems.*

Thermal Scans: Thermographic pictures taken with an Infrared Thermographic Camera. Thermographic pictures show the relative temperatures of objects and surfaces and are used to identify leaks, thermal bridging, thermal intrusion, electrical overload conditions, moisture containment, and insulation failure.

Training Plan: A written document that details, in outline form the expectations of the operator training. Training agendas should include instruction on how to obtain service, operate, startup, shutdown and maintain all systems and components of the project.

Validation: The process by which work is verified as complete and operating correctly:

1. First party validation occurs when a firm or individual verifying the task is the same firm or individual performing the task.
2. Second party validation occurs when the firm or individual verifying the task is under the control of the firm performing the task or has other possibilities of financial conflicts of interest in the resolution (Architects, Designers, General Contractors and Third Tier Subcontractors or Vendors).
3. Third party validation occurs when the firm verifying the task is not associated with or under control of the firm performing or designing the task.

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.

Vibration (V): The NEBB certification program for Vibration Testing. V is utilized to indicate the level of vibration exposure to occupants of a facility.

Warranty Phase Commissioning: Commissioning efforts executed after a project has been completed and accepted by the Owner. Warranty Phase Commissioning includes follow-up on verification of system performance, measurement and verification tasks and assistance in identifying warranty issues and enforcing warranty provisions of the construction contract.

Warranty Visit: A commissioning meeting and site review where all outstanding warranty issues and deferred testing is reviewed and discussed.

Whole Building Commissioning: Commissioning of all building systems such as Building Envelope, HVAC, Electrical, Special Electrical (Fire Alarm, Security & Communications), Plumbing and Fire Protection.

SECTION 2 NEBB PROGRAM, QUALITY CONTROL AND COMPLIANCE

2.1 NEBB PROGRAMS

The National Environmental Balancing Bureau (NEBB) is a not-for-profit organization founded in 1971 to:

a) Develop standards, procedures and programs for the performance of testing, balancing and commissioning of building systems,
b) Promote advancement of the industry through technical training and development of additional programs to improve the professionalism and technical competency of the testing and commissioning firms, and
c) Operate programs to certify firms and qualify individuals who meet and maintain NEBB standards with integrity.

Additional information on NEBB Programs is available at www.nebb.org.

2.1.1 NEBB DISCIPLINES

NEBB establishes and maintains standards, procedures, and specifications for work in its various disciplines, which include:

a) Testing-Adjusting-Balancing (TAB) -- Air and Hydronic Systems
b) Sound (S) Measurement
c) Vibration (V) Measurement
d) Cleanroom Performance Testing (CPT)
e) Building Systems Commissioning (BSC)
f) Fume Hood Performance Testing (FHT)
g) Retro-Commissioning (RCx-EB)

Each discipline is anchored by a NEBB Procedural Standards manual that provides guidelines for work to be performed. NEBB also has created technical manuals, training materials, programs, and seminars to enhance and support each discipline.

2.1.2 CERTIFICATION OF FIRMS

NEBB certifies firms that meet certain criteria, ensuring strict conformance to its high standards and procedures. Among other requirements, NEBB Certified Firms must document a record of responsible performance, own a complete set of instruments and have a NEBB Certified BSC Professional as a full-time employee.

2.1.3 CERTIFICATION OF PROFESSIONALS

NEBB also establishes professional qualifications for the supervision and performance of work in its various disciplines. NEBB Certified BSC Professionals must have extensive experience, and they must pass appropriate, written examinations that prove technical competence and demonstrate

certain practical working knowledge and proficiency in the use of instruments required for the various disciplines.

2.1.4 RECERTIFICATION REQUIREMENTS

A firm must re-certify every two years. During the recertification process, the firm must verify that its NEBB Certified Professional is still employed on staff, has maintained their qualification and that the firm continues to own a complete set of instruments and equipment that are in current calibration. In addition, the firm's NEBB Certified Professional must maintain his or her qualification. Certified Professionals must keep abreast of developments in their discipline by successfully completing continuing education requirements as outlined by NEBB.

2.2 QUALITY ASSURANCE PROGRAM - CONFORMANCE CERTIFICATION

The credibility of NEBB is built by maintaining integrity through high standards, quality programs, and demonstrated capabilities of its certified firms. As further assurance, NEBB offers a Quality Assurance Program to guarantee that the work will be accomplished in accordance with its standards. NEBB's Quality Assurance Program applies to each project. It assures that the NEBB Certified Firm will perform specified services in conformity with the current applicable NEBB Procedural Standards.

2.2.1 PROGRAM ADVANTAGES

The NEBB Quality Assurance Program affords building owners, architects, engineers and other agents a reliable basis for specifying work within the various disciplines of NEBB. The program promotes proper execution of projects by ensuring compliance with NEBB standards and procedures.

2.2.2 NEBB QUALITY ASSURANCE PROGRAM CERTIFICATE

The NEBB Quality Assurance Program Conformance Certificate is not required, but is available for any project.

2.3 QUALITY CONTROL AND COMPLIANCE

Building owners are entitled to a professional service by every NEBB Certified BSC Firm on every project, whether the job is NEBB-specified or not. It is the responsibility of the NEBB Certified BSC Firm and its NEBB Certified BSC Professional to establish and maintain procedures and practices that will ensure a consistent pattern of high quality work on all projects.

2.3.1 BSC WORK COMPLIANCE

The scope of work shall be as agreed to between the NEBB Certified BSC Firm and the Owner/Buyer. Each relevant or applicable item as identified in the scope of work shall be performed, verified or witnessed by the NEBB BSC Commissioning Authority and recorded in the NEBB BSC Final report. Data presented in a NEBB BSC report shall provide an accurate record of the system tests, measurements, data and information.

a. In all cases, the processes followed, the commissioning activities, the requirements of each phase, and the testing results shall conform to the current edition of the NEBB *Procedural Standards for Whole Building Systems Commissioning of New Construction*.

b. References to desired procedures may include statements such as "the work will be performed in accordance to NEBB Standards." When specifications indicate that the BSC work shall be performed in accordance with NEBB standards, the BSC procedures will conform to the

edition of the NEBB *Procedural Standards of Building Systems Commissioning* that is current at the time of the contract.

c. The NEBB Certified BSC Firm and the NEBB Certified BSC Professional are allowed to sign and stamp a commissioning report as a NEBB Certified Commissioning Report only when the procedures and requirements as identified in these Procedural Standards have been followed.

d. A NEBB Certified Report may consist of any single commissioning phase or any combination of phases as described in these Procedural Standards as required by the owner. To qualify as a NEBB Certified Report, each commissioned phase included in the report must adhere to the ***SHALL*** requirements of the phase being commissioned.

e. If a scope of work of the commissioning contract does not specifically delineate the commissioning processes then the project will be required to meet all ***SHALL*** language for each phase commissioned to be a NEBB Certified Project.

f. If a project scope of work of the commissioning contract requires a different level of commissioning than described by the minimum ***SHALL*** language of this standard, the procedural variance shall be clearly delineated in the project scope of work and listed on the commissioning report certification page to qualify as a NEBB Certified Report.

g. Any project that does not comply with the minimum ***SHALL*** requirements of this standard and does not clearly identify the specific procedural variances required by the commissioning contract on the certification page ***SHALL NOT*** be signed and stamped as a NEBB certified commissioning report. All references to NEBB, including NEBB logos, stamps, certifications, etc ***SHALL*** be removed from the report.

2.4 CERTIFIED BSC PROFESSIONAL RESPONSIBILITIES

It is the responsibility of the NEBB Certified BSC Professional to control the quality of the commissioning work. This means that the NEBB BSC Certified Firm, through its NEBB Certified BSC Professional, must satisfy the contract obligations as defined in the contract documents or as agreed to with the Owner/Buyer.

2.4.1 EXECUTION OF BSC PROCEDURES

The NEBB Certified BSC Professional must have project responsibility, which includes authority to represent the NEBB Certified BSC Firm. Examples of project responsibility may include labor decisions, negotiating change orders, committing to contract interpretations and implementing changes in job schedules.

The NEBB Certified BSC Professional has the responsibility to assure that the systems have been commissioned properly in accordance with these Procedural Standards and the contract documents and to assure the accuracy of all data included in the final Commissioning Report. Factors such as training, instrument use, coordination / supervision, work instructions, and project communication play a critical role in achieving this requirement.

2.4.2 INSTRUMENT USE and MAINTENANCE

NEBB Certified BSC Professional must possess knowledge and skill in the proper use and care of instruments required when performing field measurements. This shall include a thorough

understanding of the operating principles and use of equipment and instruments. Considerations for the delicate nature of many of the instruments typically used, as well as the adverse effects of dirt, shock, jarring movements and exceeding rated capacities, shall be addressed along with the proper methods for storing and transporting the instruments.

2.4.3 COORDINATION / SUPERVISION

The NEBB Certified BSC Professional ***SHALL*** be responsible for directing Commissioning Team members/ technicians in performing the commissioning work.

2.4.4 PROJECT COMMUNICATION

The NEBB Certified BSC Professional ***SHALL*** provide all commissioning communication as outlined in these procedural standards and included in the commissioning scope. These communications shall include:

a. Commissioning Plan
b. Issue Log
c. Commissioning Duration Schedules
d. Observation Reports
e. Kick Off Meetings
f. Commissioning Meetings
g. Commissioning PFT Check Sheets
h. Commissioning FPT Check Sheets
i. Commissioning letters
j. Issue Log Resolution assistance
k. Commissioning Report
l. System Manual

2.4.5 WORK COMPLETION

The NEBB Certified BSC Professional shall determine when the commissioning work has been completed, and when to submit the final Commissioning Report. Generally, the specified BSC work is complete when:

a. All contract documents, constructed systems, components and assemblies are properly commissioned and have been designed, constructed and operate in conformance to the OPR

or

b. All reasonable efforts within the extent of commissioning have been performed in an effort to achieve acceptable system performance. The NEBB Certified BSC Professional has notified the appropriate project personnel of any system deficiencies preventing commissioning completion or any issue requiring additional work before the final Commissioning report is submitted. Any variances, deficiencies, or issues unresolved in the Issues Log ***SHALL*** be noted in the final Commissioning Report Executive Summary. The final report may contain unresolved issues only when the owner/buyer has accepted the unresolved issue and has agreed on its exclusion as a requirement of project completion. If the owner refuses to accept an unresolved issue and its correction is in dispute with the contracting or design team or the owner fails to respond to the issue report after three attempts, such issues shall be identified in the executive summary of the final commissioning report.

2.4.6 COMPILATION AND SUBMISSION OF FINAL COMMISSIONING REPORTS

a. Reports shall include information and data to provide an accurate quantitative record of system measurements and information. Reports also shall include notes and comments, as appropriate, to provide the reviewer with additional details related to the test procedure, system operation and results. Reports shall meet the criteria listed in Section 5.

b. The certification page on a NEBB Certified BSC report ***SHALL*** bear the stamp of the NEBB Certified BSC Professional. The stamp on the certification page shall be signed as evidence that the NEBB Certified BSC Professional has personally reviewed and accepted the report.

c. Issues that are not resolved in a manner consistent with the OPR ***SHALL*** be approved by the Owner. If issues remain unresolved at the end of the project for any reason a certified report can only be issued if the CA has attempted to obtain resolution a minimum of three times and has documented those attempts. An explanation and clarification of any unresolved issues must be included in the final commissioning report executive summary.

SECTION 3 RESPONSIBILITIES

3.1 INTRODUCTION

Many approaches can be taken to deliver a successful commissioning project. Commissioning services should be procured directly by the Owner and the contract for these services should be between the Owner and the commissioning firm. Under this arrangement, the commissioning firm does not have a contractual relationship with any other members of the project delivery team. This procedural standard assumes that the BSC firm is contracted directly to the owner. When other contractual relationships exist special language must be included in the contract to preclude any conflicts of interest and to maintain the proper validation level.

In order to maximize value and benefits from commissioning, it is important to understand that the Owner, the design professionals and the contractors have responsibilities that will affect the outcome of the commissioning process.

3.2 OWNER RESPONSIBILITIES

It is recommended that the Owner:

a. Retains the services of the NEBB Certified BSC Firm and requires that the NEBB Certified BSC Firm be retained early in the commissioning process. This should happen at the beginning of the pre-design phase.
b. Identify the Owners Project Requirements (OPR)
c. Manage all issue log open items to a final resolution
d. Have final responsibility to enforce the contract obligations to correct any deficiencies, or accept any designed / constructed condition even if they do not meet the OPR
e. Have final authority to determine when the project is complete and the OPR has been fulfilled
f. Have final authority to accept the final report

3.3 DESIGN PROFESSIONALS RESPONSIBILITIES

It is recommended that the design professionals:

a. Prepare a Basis of Design document that responds directly to the Owner's Project Requirements
b. Incorporate the Basis of Design into a set of Contract Documents that convey the design intent and conforms to the OPR
c. Provide design development and Contract Documents to the commissioning team for commissioning evaluation and comment
d. Work in concert with the Commissioning Authority (CA) to maximize the functionality, operability, maintainability and commissionability of the project
e. Work in concert with the CA so that the Contract Documents define the level of commissioning effort required by the construction team and equipment vendors
f. Specify that the construction team members provide documentation in accordance with these procedural standards

g. Specify that all technical system suppliers or installers provide access to hardware, software, or onsite technical support required to assist the BSC effort. The hardware, software or the onsite technical support shall be provided to the commissioning team at no cost to the Owner, Testing Subcontractors or the NEBB Certified BSC Firm.
h. Attend periodic commissioning meetings
i. Attend appropriate training for facilities operations presented by the commissioning team

3.4 CONTRACTOR RESPONSIBILITIES

The General Contractor, Subcontractors and their Vendors must provide the following:

a. Copies of contract document change orders, requests for information communications, meeting minutes and contract addenda as they are developed during the construction process
b. All project submittals for systems and components included in the commissioning scope as they are approved or reviewed by the design team
c. A project schedule which incorporates commissioning milestones and schedules provided by the commissioning authority (CA). The schedule must coordinate the work of other disciplines and provide *adequate* time in the construction process to allow successful completion of the Construction Phase of the BSC work.
d. Notify the NEBB Certified BSC Firm of all schedule changes
e. Manage and implement the construction process to ensure that the building and its systems are constructed in accordance with the contract documents and are complete and operational
f. Manage and implement the start up process in accordance with manufacturer's recommendations to ensure that all systems and components of all building systems are installed correctly and operating correctly and are ready for functional testing
g. Manage and implement all system testing and balancing in accordance with the contract documents
h. Require that any special tools, software or programming devices or the instruction on their use that are required for startup, testing, balancing, commissioning or operation of any technical system be provided by the manufacturer or installing contractor to the firm or individual providing those services free of any additional cost or fees.

3.5 NEBB CERTIFIED BSC FIRM RESPONSIBILITIES

The NEBB Certified BSC firm must provide the following:

a. Follow the current NEBB procedural standards when performing the BSC work
b. Chair commissioning meeting with designers and contractors to introduce and direct the commissioning process
c. Review plans, specifications and submittal evaluations for conformance to the OPR and for possible conflicts and deficiencies. Evaluate documents for the ability of systems to be operated, maintained, commissioned, tested, adjusted and balanced, and conforming to industry accepted practices.
d. Create, utilize and manage the commissioning issue log to resolve all design and construction issues discovered during the commissioning process
e. Attend on-site commissioning meetings as required to complete and coordinate the commissioning process
f. Assist CM/GC in developing all commissioning schedules
g. Assist the contractors, if required, in developing and implementing all installation verifications or start up Pre-Functional Tests (PFT) to be performed by the contractor. Pre-Functional tests

SHALL include the installation, checkout or start up of all equipment and systems included in the scope of work.

h. Develop all functional performance tests (FPT) to be performed by the contractors and direct the CA to verify performance for all systems included in the scope of work
i. Make recommendations to the Owner regarding the acceptance of all equipment and system tests
j. Review all final operation and maintenance manuals and all “As Built” documents for use in the Owner training seminar.
k. Coordinate the content of the Owner’s training seminar, including all documentation for future use by the owner
l. Provide the final commissioning report to the Owner
m. Coordinate and schedule any warranty phase commissioning tests required by the scope of work

SECTION 4 STANDARDS FOR EQUIPMENT, INSTRUMENTATION AND CALIBRATION

4.1 MINIMUM INSTRUMENTATION

A NEBB Certified BSC Firm will use a variety of instrumentation in performing the specified BSC procedures on a project. It is the responsibility of the NEBB Certified BSC Firm to use appropriate instrumentation meeting the requirements of Table 4-1 (IP or SI). Instrumentation used on a NEBB project must be in proper operating condition and must be used in accordance with the manufacturer's recommendations.

NEBB requires that NEBB Certified BSC Firms ***SHALL*** own the specified instrumentation. Table 4-1 (US or SI) lists the minimum instrumentation that a NEBB Certified BSC Firm shall own. The NEBB Certified BSC Firms must maintain the instruments and have the instruments calibrated in accordance with the calibration requirements of Table 4-1.

The required instruments and equipment listed in Table 4-1 may be the same equipment and instruments utilized for NEBB TAB, S, V and/or CPT certification. A separate set of instruments is not required.

4.2 RANGE AND ACCURACY

A NEBB Certified BSC Firm ***SHALL*** possess instruments for each function and range listed in Table 4-1. Each instrument must have been specifically designed to meet the criteria (Minimum Accuracy, Range, and Resolution) of the function. Instrumentation with multiple capabilities can be accepted for more than one function when submitting documentation for a firm's certification. However each separate function must meet NEBB requirements. Information and data regarding accuracy of all submitted instrumentation for the stated functions must be available from the manufacturer to show compliance with these requirements.

The accuracy and range as reported by the instrument manufacturer ***SHALL*** be verified by a testing laboratory which uses methods and equipment traceable to the National Institute of Standards and Technology or equivalent institute in countries other than the United States. Calibration requirements for each function are specified and ***SHALL*** be met. Some instruments such as U-tube manometers and inclined manometers may not require calibration. However, if a "mechanical / electrical" device is substituted or employed in place of these types of instruments, the indicated calibration requirements noted shall apply.

All instrumentation shall comply with the calibration requirements of TABLE 4-1 (US or SI). This condition applies whether a firm has one instrument of each type or multiple instruments.

Certified Professionals must understand the importance of using accurate instrumentation in the field, and shall be prepared to show proof of instrumentation calibration for any instrument used in the execution of a NEBB certified commissioning project.

Instruments shall be used in accordance with manufacturer's recommendations. The most suitable instrument, or combination of instruments, should be employed for a particular measurement or reading.

4.3 SPECIAL INSTRUMENTS

A NEBB Certified BSC Professional may be required to utilize special instrumentation that is not included in Table 4-1. Special instrumentation may be provided by the Certified BSC Professional or by the installing Subcontractors or Vendors. This instrumentation shall be in good working condition and will have proof of calibration within the last 12 months.

TABLE 4-1 NEBB REQUIRED INSTRUMENTS (I.P. UNITS)

Function	Minimum Range	Accuracy	Resolution	Calibration Interval
BSC CERTIFICATION AND HVAC QUALIFICATION				
SHALL Instruments Requirements for Basic Commissioning and **HVAC Section 7**				
Digital Camera	24 mm – 72 mm	3 x Zoom	3.1 Mega Pixels	Note 1
Temperature Measurement Air Immersion Contact	 -40° to 240°F -40° to 240°F -40° to 240°F	 ± 1% of reading ± 1% of reading ± 1% of reading	 0.2°F 0.2°F 0.2°F	12 Months
True RMS Electrical Measurement Volts AC Amperes	 0 to 600 VAC 0 to 100 Amps	 ± 2% of reading ± 2% of reading	 1.0 Volt 0.1 Ampere	12 Months
Air Pressure Measurement	0 to 10.00 in.w.g.	± 2% of reading	0.01 in.w.g. ≤1in.w.g. 0.1in.w.g. >1in.w.g.	12 Months
Air Velocity Measurement (Not for Pitot tube traverses)	50 to 2500 fpm	± 5% of reading	20 fpm	12 Months
Humidity Measurement	10 to 90% RH	± 2% RH	1%	12 Months
Hydronic Pressure Measurement	-30" hg. to 60 PSI 0 to 100 PSI 0 to 200 PSI	± 2% of reading ± 2% of reading ± 2% of reading	0.5 PSI 1.0 PSI 2.5 PSI	12 Months
Hydronic Differential Pressure Measurement	0 to 100 in.w.g. 0 to 100 ft.w.g.	± 2% of reading ± 2% of reading	1.0 in.w.g. 1.0 ft.w.g.	12 Months
SHOULD Instruments Requirements for Basic Commissioning and **HVAC Section 7**				
Temperature Data Loggers	-4° to 150°F	± 1% of reading	0.05°F	Note 3
Humidity Data Loggers	10 to 90% RH	± 2% RH	0.05% RH	Note 3
Sound Level Meter and/or Vibration Analyzer	Note 2	Note 2	Note 2	12 Months
MAY Instruments Requirements for Basic Commissioning and **HVAC Section 7**				
TDS Meter	0 – 10,000 µ 0 – 5,000 ppm	± 2% Full Scale	± 1%	Note 1
BSC BUILDING ENVELOPE QUALIFICATION				
SHOULD Instruments Requirements for **Building Envelope Section 8**				
Thermal Image Camera	20 mm		120 x 120	Note 1
Capacitance Moisture Meter	0 – 100%		1.25" Penetration	Note 1
MAY Instruments Requirements for **Building Envelope Section 8**				
Door Pressure Assembly	300 to 6300 cfm	± 5% of reading	0.004 in. w.g.	Note 1

1. Per Instrument Manufacturers recommendations
2. Requirements to conform to Table 4-1, current edition of the *NEBB Procedural Standards for the Measurement of Sound & Vibration*
3. Data logger calibration may be verified from a calibration instrument with an associated calibration form showing calibration readings from both the calibrated instrument and the data logger. If the data logger is out of calibration and cannot be adjusted the logger must be sent back to the factory for re-calibration or replaced.

TABLE 4-1 NEBB REQUIRED INSTRUMENTS (I.P. UNITS) (Continued)

Function	Minimum Range	Accuracy	Resolution	Calibration Interval
BSC ELECTRICAL QUALIFICATION				
SHALL Instruments Requirements for **Electrical Section 9**				
Receptacle Circuit Tester	125 VAC			Note 1
Voltage Detector	50 -1000 VAC			Note 1
Light Level Meter	0 – 4000 FC			12 Months
SHOULD Instruments Requirements for **Electrical Section 9**				
Thermal Image Camera	20 mm		120 x 120	Note 1
Light Level Data Logger	0 – 3000 lumens			Note 1
MAY Instruments Requirements for **Electrical Section 9**				
Power Quality Meter Data Logger Volts AC Amperes	 0-600 VAC 0 -500 Amps	 ± 2% of reading ± 2% of reading	 1.0 VAC 0.1 Amp	Note 1
BSC SPECIAL ELECTRICAL QUALIFICATION				
SHOULD Instruments Requirements for **Special Electrical Section 10**				
Voltage Detector	5 – 1000 VAC			Note 1
MAY Instruments Requirements for **Special Electrical Section 10**				
Sound Level Meter and/or Vibration Analyzer	Note 2	Note 2	Note 2	12 Months
BSC PLUMBING QUALIFICATION				
SHOULD Instruments Requirements for **Plumbing Section 11**				
Water Pressure Data Logger	0 – 100 PSI	± 1% of reading	0.1 PSI	Note 3
MAY Instruments Requirements for **Plumbing Section 11**				
TDS / Hardness Meter	0 – 10,000 µ 0 – 5,000 ppm	± 2% Full Scale	± 1%	Note 1
Sound Level Meter and/or Vibration Analyzer	Note 2	Note 2	Note 2	12 Months
BSC FIRE PROTECTION QUALIFICATION				
SHOULD Instruments Requirements for **Fire Protection Section 12**				
Water Pressure Data Logger	0 – 100 PSI	± 1% of reading	0.1 PSI	Note 3
MAY Instruments Requirements for **Fire Protection Section 12**				
Sound Level Meter and/or Vibration Analyzer	Note 2	Note 2	Note 2	12 Months

1. Per Instrument Manufacturers recommendations
2. Requirements to conform to Table 4-1, current edition of the *NEBB Procedural Standards for the Measurement of Sound & Vibration*
3. Data logger calibration may be verified from a calibrated instrument with an associated calibration form showing calibration readings from both the calibrated instrument and the data logger. If a data logger is out of calibration and cannot be adjusted the logger must be sent back to the factory for re-calibration or replaced.

TABLE 4-1 NEBB REQUIRED INSTRUMENTS (S.I. UNITS)

Function	Minimum Range	Accuracy	Resolution	Calibration Interval
BSC CERTIFICATION AND HVAC QUALIFICATION				
SHALL Instruments Requirements for **HVAC Section 7**				
Digital Camera	24 mm – 72 mm	3 x Zoom	3.1 Mega Pixels	Note 1
Temperature Measurement Air Immersion Contact	 -40 to 115°C -40 to 115°C -40 to 115°C	 ± 1% of reading ± 1% of reading ± 1% of reading	 0.1°C 0.1°C 0.1°C	12 Months
True RMS Electrical Measurement Volts AC Amperes	 0 to 600 VAC 0 to 100 Amps	 ± 2% of reading ± 2% of reading	 1.0 Volt 0.1 Ampere	12 Months
Air Pressure Measurement	0 to 2500 Pascals	± 2% of reading	2.5 Pa ≤ 250 Pa 25 Pa > 250 Pa	12 Months
Air Velocity Measurement (Not for Pitot tube traverses)	0.25 to 12.5 m/s	± 5% of reading	0.1 m/s	12 Months
Humidity Measurement	10 to 90% RH	2% RH	1%	12 Months
Hydronic Pressure Measurement	-760 mm hg. to 400 kPa 0 to 700 kPa 0 to 1400 kPa	± 2% of reading ± 2% of reading ± 2% of reading	3.3 kPa 6.7 kPa 16.7 kPa	12 Months
Hydronic Differential Pressure Measurement	0 to 25 kPa 0 to 300 kPa	± 2% of reading ± 2% of reading	250 Pa 3.0 kPa	12 Months
SHOULD Instruments Requirements for **HVAC Section 7**				
Temperature Data Loggers	-20° - 65°C	± 1% of reading	0.10° C	Note 3
Humidity Data Loggers	10 to 90% RH	± 2% RH	0.05% RH	Note 3
Sound Level Meter and/or Vibration Analyzer	Note 2	Note 2	Note 2	12 Months
MAY Instruments Requirements for **HVAC Section 7**				
TDS Meter	0 – 10,000 µ 0 – 5,000 ppm	± 2% Full Scale	± 1%	Note 1
BSC BUILDING ENVELOPE QUALIFICATION				
SHOULD Instruments Requirements for **Building Envelope Section 8**				
Thermal Image Camera	20 mm		120 x 120	Note 1
Capacitance Moisture Meter	0 – 100%		1.25” Penetration	Note 1
MAY Instruments Requirements for **Building Envelope Section 8**				
Door Pressure Assembly	0.14 - 3.0 m³/s	± 5% of Reading	1.0 Pa	Note 1

1. Per Instrument Manufacturers recommendations.
2. Requirements to conform to Table 4-1, current edition of the *NEBB Procedural Standards for the Measurement of Sound & Vibration.*
3. Data logger calibration may be verified from a calibrated instrument with an associated calibration form showing calibration readings from both the calibrated instrument and the data logger. If a data logger is out of calibration and cannot be adjusted the logger must be sent back to the factory for re-calibration or replaced.

TABLE 4-1 NEBB REQUIRED INSTRUMENTS (S.I. UNITS) (Continued)

Function	Minimum Range	Accuracy	Resolution	Calibration Interval
BSC ELECTRICAL QUALIFICATION				
SHALL Instruments Requirements for **Electrical Section 9**				
Receptacle Circuit Tester	125 VAC			Note 1
Voltage Detector	50 -1000 VAC			Note 1
Light Level Meter	0 – 4000 FC			12 Months
SHOULD Instruments Requirements for **Electrical Section 9**				
Thermal Image Camera	20 mm		120 x 120	Note 1
Light Level Data Logger	O – 3000 Lumens			Note 1
MAY Instruments Requirements for **Electrical Section 9**				
Power Quality Meter Data Logger Volts AC Amperes	 0-600 VAC 0 -500 Amps	 ± 2% of reading ± 2% of reading	 1.0 VAC 0.1 Amp	Note 1
BSC SPECIAL ELECTRICAL QUALIFICATION				
SHOULD Instruments Requirements for **Special Electrical Section 10**				
Voltage Detector	5 – 1000 VAC			Note 1
MAY Instruments Requirements for **Special Electrical Section 10**				
Sound Level Meter and/or Vibration Analyzer	*	*	*	12 Months
BSC PLUMBING QUALIFICATION				
SHOULD Instruments Requirements for **Plumbing Section 11**				
Water Pressure Data Logger	0 – 700 kPa	± 1% of reading	0.5 kPa	Note 3
MAY Instruments Requirements for **Plumbing Section 11**				
TDS / Hardness Meter	0 – 10,000 µ 0 – 5,000 ppm	± 2% Full Scale	± 1%	Note 1
Sound Level Meter and/or Vibration Analyzer	*	*	*	12 Months
BSC FIRE PROTECTION QUALIFICATION				
SHOULD Instruments Requirements for **Fire Protection Section 12**				
Water Pressure Data Logger	0 – 700 kPa	± 1% of reading	0.5 kPa	Note 1
MAY Instruments Requirements for **Fire Protection Section 12**				
Sound Level Meter and/or Vibration Analyzer	*	*	*	12 Months

1. Per Instrument Manufacturers recommendations
2. Requirements to conform to Table 4-1, current edition of the *NEBB Procedural Standards for the Measurement of Sound & Vibration*
3. Data logger calibration may be verified from a calibrated instrument with an associated calibration form showing calibration readings from both the calibrated instrument and the data logger. If a data logger is out of calibration and cannot be adjusted the logger must be sent back to the factory for re-calibration or replaced.

Instrumentation with multiple capabilities shall be accepted for more than one function when submitting documentation for a firm's certification, providing that each separate function meets NEBB requirements.

Calibrations of all instrumentation requiring calibration shall be traceable to current NIST Standards for US firms, or equivalent organizations in other countries.

SECTION 5 STANDARDS FOR REPORTS AND FORMS

5.1 COMMISSIONING REPORT

The NEBB *Procedural Standards for Whole Building Systems Commissioning of New Construction* establishes minimum requirements of a NEBB Certified BSC Report. The standards have been developed and written using **"*SHALL, SHOULD, and MAY*"** language. It is important to note these particular words throughout this document and how they pertain to NEBB Procedural Standards.

NEBB BSC Report includes the following information:

1. Report Title Page ***(SHALL)***
2. Report Certification Page ***(SHALL)***
3. Table of Contents Page ***(SHALL)***
4. Executive Summary ***(SHALL)***
5. Project OPR ***(SHOULD)***
6. Commissioning Plan ***(SHALL)***
7. Final Issue Log ***(SHALL)***
8. Completed Pre Functional Test Forms And Check Sheets ***(SHALL)***
9. Completed Functional Performance Test Forms And Check Sheets ***(SHALL)***
10. Observation Reports ***(SHALL)***
11. Training Verification Records ***(SHOULD)***
12. Commissioning Communications ***(SHALL)***
13. Test Instrument Page ***(SHALL)***

5.2 REQUIRED PAGES

The **requirements** for each NEBB Certified BSC Report are listed below:

5.2.1 REPORT TITLE PAGE

SHALL Data: The report title page ***SHALL*** include the following:

a. The heading: "Certified Building Systems Commissioning Report"
b. Project Name / Project Address
c. Owner Name / Address / Contact Numbers
d. NEBB Certified BSC Firm Name / Address / Contact Numbers / Certification Number

SHOULD Data: The report title page ***SHOULD*** include the following:

a. Design Professionals Names / Addresses / Contact Numbers

MAY Data: The report title page ***MAY*** include the following:

a. General Contractor Name / Address / Contact Numbers
b. HVAC Contractor Address / Contact Numbers
c. Plumbing Contractor Name / Address / Contact Numbers
d. Chemical Treatment Contractor Name / Address / Contact Numbers
e. Electrical Contractor Name / Address / Contact Numbers
f. Control Contractor Name / Address / Contact Numbers
g. TAB Contractor Name / Address / Contact Numbers

5.2.2 REPORT CERTIFICATION PAGE

The certification page ***SHALL*** bear the stamp of the NEBB Certified BSC Professional. The stamp on the certification page ***SHALL*** be signed or secure digital signature affixed as evidence that the NEBB Certified Professional has reviewed and accepted the report. ***Signature stamps are specifically prohibited.***

SHALL Data: The report certification page shall include the following:

a. Project Name
b. Certifying NEBB Certified BSC Professional's Name
c. Firm Name; Certification Number; Expiration Date
d. Commissioning Phases performed to NEBB standards
e. Certifying NEBB Certified BSC Professional's NEBB Stamp (signed & dated); and the following exact verbiage:
"THE DATA AND CONCLUSIONS PRESENTED IN THIS REPORT ARE A RECORD OF SYSTEM COMMISSIONING, PERFORMANCE TESTING AND TRAINING VERIFICATION IN ACCORDANCE WITH THE NEBB BUILDING SYSTEMS COMMISSIONING PROCEDURAL STANDARDS AND THE PROJECT REQUIRMENTS"
f. Statement of Scope of Work and variance deviation documentation

SHOULD Data: The report certification page should include the following:

"THE RESULTS SHOWN AND INFORMATION GIVEN IN THIS REPORT ARE CERTIFIED TO BE TRUE AND ACCURATE TO THE EXTENT POSSIBLE DUE TO THE SYSTEMS OPERATING PARAMETERS AT THE TIME THE SYSTEMS WERE TESTED. THE COMMISSIONING AUTHORITY MAKES NO CLAIMS OR WARRANTIES STATED OR IMPLIED CONCERNING THE CONTINUED PERFORMANCE, OPERATION OR SAFETY OF THE FACILITY PAST THE TEST DATE IF CONDITIONS CHANGE OR OPERATING PARAMETERS WERE CHANGED BY OTHERS."

The Report Certification Page ***SHALL*** also include an exact description of the project commissioning scope of work as per the commissioning contract. Any specific required variances from the NEBB required minimum SHALL requirements will be clearly defined.

5.2.3 TABLE OF CONTENTS PAGE

The Table of Contents ***SHALL*** serve as a guide to the organization of the BSC report.

SHOULD Data: The table of contents ***SHOULD*** include the following sections with the associated page numbers:

a. Report Title Page
b. Report Certification Page
c. Table of Contents Page
d. Executive Summary
e. Project OPR
f. Commissioning Plan
g. Final Issue Log
h. Completed Pre Functional Test Forms And Check Sheets
i. Completed Functional Performance Test Forms And Check Sheets
j. Observation Reports
k. Training Verification Records
l. Commissioning Communications Copies
m. Test Instrument Page

5.2.4 EXECUTIVE SUMMARY / REMARKS

A NEBB Certified BSC Report ***SHALL*** include an executive summary.

SHALL Data: The executive summary ***SHALL*** include the following information:

a. Review of the Commissioning Project Processes utilized
    1. Refer to NEBB Procedural Standards for standard processes
    2. Refer to Plan for specific processes
b. Review any deviations used
c. Review of each unresolved issue
d. Review of each issue that was resolved in a manner that may still affect future system performance or creating future liability
e. Review of each deferred system test that is to be performed in the future

5.2.5 PROJECT OPR

A NEBB Certified BSC Report ***SHOULD*** include the Owners Project Requirements (OPR). If such document was not provided by the Owner or insufficient information was provided about the project programming stage, the NEBB CA should create an OPR in outline form for documentation of known project requirements.

SHOULD Data: The OPR ***SHOULD*** include the following information:

a. Project Requirements
b. Building Requirements
c. Site Requirements
d. Budget & Costs
e. Sustainability
f. Energy & Efficiency
g. Accessibility
h. Safety & Security
i. Systems & Components
j. Operation & Maintenance

k. Level of maintenance anticipated per system or component

5.2.6 COMMISSIONING PLAN

A NEBB Certified BSC Report ***SHALL*** include the final project commissioning plan which includes Pre-Design Phase information, Design Phase information, Construction Phase information, Acceptance Phase information and Warranty Phase information for all phases included in the commissioning scope.

SHALL Data: The commissioning plan ***SHALL*** include the following information:

a. Commissioning Scope
b. Commissioning Team
c. Commissioning Team Member Responsibilities
d. Normal channels of communication
e. Commissioning Procedures Utilized
f. Commissioning Check Sheets and Forms Utilized

SHOULD Data: The commissioning plan ***SHOULD*** include the following information:

a. The commissioning schedule
b. List or matrix of commissioning check sheets and forms

5.2.7 FINAL ISSUE LOG

A NEBB Certified BSC Report ***SHALL*** include the final issue log which ***MAY*** include Pre-Design Phase issues, Design Phase issues, Construction Phase issues, Acceptance Phase issues and Warranty Phase issues.

SHALL Data: The commissioning issue log ***SHALL*** include the following information:

a. Project Name
b. Issue Log Date
c. Issue Number
d. Issue statement
e. Date of Issue statement
f. Person making issue statement
g. Issue statement answer
h. Date of Issue statement answer
i. Person making the issue statement answer.

5.2.8 COMPLETED PRE-FUNCTIONAL CHECK SHEETS OR FORMS

A NEBB Certified BSC Report ***SHALL*** include all completed Pre-Functional check sheets and forms utilized on the project.

SHALL Data: Commissioning Pre-Functional check sheets ***SHALL*** include the following information:

a. Project Name
b. System or Component Name or tag number
c. Description of item, condition or process to be verified
d. Design Data for item, condition or process to be verified
e. Observed state of item, condition or process to be verified

f. Date of Observation or Verification
g. Initials or Name of person providing the verification

5.2.9 COMPLETED FUNCTIONAL PERFORMANCE CHECK SHEETS OR FORMS

A NEBB Certified BSC Report ***SHALL*** include all completed Functional check sheets and forms utilized on the project. Includes results of deferred Functional check sheets and reports.

SHALL Data: Commissioning Functional check sheets ***SHALL*** include the following information:

a. Project Name
b. System or Component Name or tag number
c. Functional Test Design Parameters or description of item, condition or process to be verified
d. Design Data for item, condition or process to be verified
e. Approved trend or observed state of item, condition or process to be verified
f. Date of Observation or Verification
g. Initials or Name of person providing the verification

5.2.10 SITE OBSERVATION (SO) REPORTS

A NEBB Certified BSC Report ***SHALL*** include any observation reports produced for the project.

SHALL Data: Observation reports ***SHALL*** include the following information:

a. Project Name
b. Date of Observation
c. Observation statement

SHOULD Data: Observation reports ***SHOULD*** include the following information:

a. Observation statement pictures
b. Observation relevant data or suggestions

5.2.11 TRAINING RECORDS

A NEBB Certified BSC Report ***SHOULD*** include any training verification complete for the project.

SHOULD Data: Training verification reports ***SHOULD*** include the following information:

a. Training Agendas for each training session
b. Training Schedule for all training sessions
c. Training Attendance Records

MAY Data: Training verification reports ***MAY*** include the following information:

a. CD of Video Taping of each training session

5.2.12 COMMISSIONING COMMUNICATIONS

A NEBB Certified BSC Report ***SHALL*** include all pertinent commissioning communications.

SHALL Data: Commissioning communications ***SHALL*** include the following information:

a. Letters between the commissioning team members that are pertinent to the commissioning process performed or not performed for the project
b. Emails or other written documentation covering issues or issues resolution for the project
c. Commissioning Meeting Minutes

5.2.13 TEST INSTRUMENT PAGE

A NEBB Certified BSC Report ***SHALL*** include a Test Instrument page.

SHALL Data: The Test Instrument page ***SHALL*** include the following information:

a. List of NEBB required tools
b. Model number and Serial number of each instrument
c. Certification date of each instrument

SHOULD Data: The Test Instrument page ***SHOULD*** include the following information:

a. List of non NEBB required tools utilized for the project
b. Model number and Serial number of each instrument
c. Certification date of each instrument

5.2.14 ALL REPORT PAGES

All tested items or systems included in the NEBB BSC Report ***SHALL*** be clearly identified with a unique designation. The method of identification may use unique numbers, mechanical plans identification, or an appropriate narrative description.

SHALL Data:

a. All pages ***SHALL*** contain the name of the project
b. All pages ***SHALL*** be identified with a unique page number
c. Each PFT or FPT form ***SHALL*** include the name of the responsible verifier
d. Date of verification

MAY Data: Pages ***MAY*** include a remarks section to record any information pertinent to the data reported on the data sheet.

PART 2 – PROCESS

SECTION 6 THE COMMISSIONING PROCESS

6.1 INTRODUCTION

ASHRAE and other organizations are working with the National Institute of Building Standards (NIBS) to provide a complete set of commissioning requirements entitled Whole Building Commissioning. Commissioning efforts must be focused on the entire facility, not just the mechanical systems. Each component, system, or assembly has an integral relationship with other components, systems and assemblies. As an example, indoor air quality is not just a function of the quality and quantity of ventilation air supplied to the occupants. Indoor air quality is affected by fenestration issues, building enclosure, roofing systems, internal project processes, etc. Because of the important interrelationship between various architectural and other building systems components NEBB's Building Systems Commissioning (BSC) program will add new, technically-focused procedures as they are developed and approved by NEBB.

The purpose of this Section is multifold. It is meant to provide a description and review of the commissioning process phases, and define the responsibilities and activities required during each phase. The NEBB process is similar to the requirements defined in ASHRAE Guideline 0, *The Commissioning Process, 2005.* However, the NEBB procedures include specific technical processes to provide validation of the results of the commissioning process. While the process is similar, there are differences between ASHRAE and the NEBB Building Systems Commissioning (BSC) programs as identified in this Procedural Standard. Both ASHRAE and NEBB programs have the same goal; that a completed project conforms to the Owner's Project Requirements (OPR). The NEBB BSC program accomplishes this goal by validating that the design, installation and performance of the systems, equipment and components incorporated into the project meet the OPR. The Commissioning Authority (CA) must posses the technical competence to evaluate the OPR, the design, the installation, and the performance of a project from the standpoint of commissionability, maintainability, functionality and industry accepted best practices.

This section of the NEBB *Procedural Standard for Whole Building Systems Commissioning of New Construction,* like ASHRAE Guideline 0, is global in content and is generic in defining the commissioning process. This section describes the process and the elements of the process that are necessary to validate and document any of the various building components, systems and assemblies in a facility.

The last issue addresses the use of "sampling" during commissioning. NEBB minimum procedures require that systems be validated and tested with the following minimal requirements:

a. Installed construction ***SHALL*** be validated by first party validation at a minimum
b. System start up ***SHALL*** be validated by first party validation at a minimum
c. Functional testing shall be validated by third party validation at a minimum with sampling strategies allowed only in accordance with each individual section requirements

6.2 COMMISSIONING PHASES

In a perfect world commissioning starts at the owner's project inception and is continuous for the life of the building. However, the design and construction of today's facilities does not exist in a perfect world. Consequently, the concepts and phases discussed in this section and the technical commissioning sections that follow are intentionally segregated into the various phases due to the fact that not all phases are included in all projects. This may require that a task from a previous phase may need to be performed during a subsequent phase. The actual scope of commissioning services to be provided ***SHALL*** be as mutually agreed upon between the Owner and the NEBB Certified BSC Firm.

The phases of commissioning are as follows:

- Pre-Design Phase
- Design Phase
- Construction Phase
- Acceptance Phase
- Warranty Phase

NEBB recommends that all five phases as outlined below be performed on all projects. However, individual phases may be performed at the direction of the Owner. The project commissioning scope may also be limited to a portion of a project by phase. Any separate phase or portion of a project would be required to meet all ***SHALL*** criteria for the performed phases to be a NEBB Certified Project.

a. If a scope of work of the commissioning contract does not specifically delineate the commissioning processes then the project will be required to meet all ***SHALL*** language for each phase commissioned to be a NEBB Certified project.

b. If a project scope of work with an Owner requires a different level of commissioning than described by the minimum ***SHALL*** language it shall be clearly delineated in the project scope of work and listed on the commissioning report certification page to qualify as a NEBB Certified report.

c. Any project that does not comply with the minimum ***SHALL*** requirements of this standard and does not clearly identify the specific procedural variances required by the commissioning contract on the certification page ***SHALL NOT*** be signed and stamped as a NEBB certified commissioning report. All references to NEBB, including NEBB logos, stamps, certifications, etc ***SHALL*** be removed from the report.

6.3 PRE- DESIGN PHASE COMMISSIONING

6.3.1 INTRODUCTION

There are two main purposes of the Pre-Design Phase. The first is to develop and document the Owner's Project Requirements (OPR) and the second is to develop the Commissioning Plan.

6.3.2 PRE-DESIGN PHASE OWNER'S PROJECT REQUIREMENTS (OPR)

The OPR is a compilation of the communication and documentation of the owner's goals, objectives, and expectations for the project. The OPR includes the specific requirements pertaining to this project. This is where the owner states the goals for how the project will be judged as a

success or failure. The OPR is also a communication tool for specific project requirements. While the objectives are high-level goals, the requirements can be specific details for the project and could include such items as building performance, sustainability requirements, commissioning goals, production details, equipment manufacturers, required environmental criteria, anticipated utility/energy usage, maintenance features, etc. The OPR includes information on how the building will be operated, types of tenants, maintenance requirements, indoor air quality objectives, budgetary issues and other objectives of the owner. The objectives should be definable by their performance criteria. Objectives may include flexibility of space arrangements or occupancy, environmental conditions, etc.

The Owner and the project programming team should define and develop the Owner's Project Requirements (OPR). Sophisticated building owners may be able to easily provide their OPR to the Commissioning Authority (CA). The CA must be capable of providing technical competence and expertise to assist and guide the owner in developing this document. The OPR should be focused on measurable "end results".

The OPR is a dynamic instrument that should be updated, refined and expanded at each step in the commissioning process based on Owner accepted changes.

The OPR ***MAY*** contain the following project information:

a. Project Requirements

    1. Design Contract Method & Contract Type
    2. Construction Contract Method & Contract type
    3. Description of project programming methodology
    4. Design deliverables
    5. Construction deliverables
    6. Desired Project Schedule
    7. Project communication & reporting standards
    8. BIM Requirements
    9. Commissioning Requirements

b. Building Requirements

    1. Size & Type
    2. Use & Occupancy
    3. Aesthetics
    4. Historic Preservation
    5. Future Adaptability
    6. Comfort parameters, temperature, sound, vibration, ventilation, light
    7. Control system sophistication and complexity
    8. Measurement and Verification requirements

c. Site Requirements

    1. Zoning, Codes & Standards
    2. Site Master Plan & Future expansion
    3. Coverage Density
    4. Site Access
    5. Utility

6. Parking, Vehicle Traffic & Public Transportation
7. Pedestrian & Bicycle Traffic

d. Budget & Costs

1. Construction Budget & adjustment methodology
2. Life cycle cost utilization
3. Anticipated allowances

e. Sustainability

1. Define Green Building Rating
2. Site
3. Building
4. Utilities
5. Renewable Energy
6. Carbon Footprint
7. Recycled Content of building
8. Occupant recycling requirements
9. Day lighting
10. Natural Ventilation
11. Gray water
12. IAQ

f. Energy & Efficiency

1. Electrical
2. Water
3. Gas
4. Renewable
5. Cogeneration

g. Accessibility

1. Standards (ADA / ABA)
2. Access for physical disabilities, recovering from injury, elderly, or children
3. Level and Location
4. Powered scooters, Segways, etc.

h. Safety & Security

1. Safe from acts of God, wind, fire, flood, earthquake, rain, snow & ice
2. Safe from manmade acts, explosion, vandalism, unauthorized entry, biological & chemical attack and computer cyber attack
3. IAQ, Fumes, Vapors & Mold
4. Disaster response
5. Emergency responder access

i. Systems & Components

1. HVAC

2. Envelope
3. Electrical
4. Plumbing
5. Fire Protection
6. Life Safety
7. Security & Access
8. Data & Wireless infrastructure
9. Communications

j. Operation & Maintenance

1. Anticipated level of Operators technical capability
2. Anticipated level of Operators training requirements

k. Level of maintenance anticipated per system or component

1. Janitorial requirements

6.3.3 PRE-DESIGN PHASE COMMISSIONING PLAN

The Commissioning Plan is the document that:

a. Identifies all of the commissioning activities
b. Identifies the systems to be commissioned
c. Identifies the various Commissioning Team members during each phase
d. Defines the roles and responsibilities of each Commissioning Team member
e. Creates the schedule of all commissioning activities during each phase
f. Establishes documentation requirements
g. Establishes communication and reporting procedures

The Commissioning Plan, like the OPR, is updated at each step in the commissioning process to account for accepted changes. The CA shall create the Preliminary Commissioning Plan and distribute it to all members of the commissioning team.

6.3.4 PRE-DESIGN PHASE RESPONSIBILITIES

6.3.4.1 Commissioning Team Members

During the pre-design phase, the commissioning team ***SHOULD*** be comprised of the Owner/Owner's representative, and the CA. Additionally, if the design professionals, construction manager/general contractor, program manager, or specialty trade contractors are known at the time, a representative from those entities should also be included at appropriate times.

Throughout the commissioning process, the Team Members may change, but the entities and the organizational structure will remain the same during all the phases of project delivery and the associated commissioning phases. For example, during the Pre-Design Phase, the Owner may be represented by the actual building owner or his representative. During the Acceptance Phase Functional Performance testing the Owner may be represented by his on-site maintenance personnel.

6.3.4.2 Commissioning Team Responsibilities

The Owner and the project programming team ***SHOULD*** define and develop the OPR. The CA ***MAY*** need to assist the owner in developing the OPR. The Commissioning Team, the Owner and the CA, are responsible for working in unison to completely define the OPR. The CA shall be

responsible for developing the Preliminary Commissioning Plan and shall also be responsible for documenting commissioning-related communications among the Commissioning Team members during this phase.

6.3.5 PRE-DESIGN PHASE ACTIVITES

6.3.5.1 OPR Definition and Development

As previously stated in Section 6.3.2 and Section 6.3.4.2, the Owner is ultimately responsible for creating the OPR and the CA ***SHALL*** document the creation of the OPR. The ability to determine the success or failure of the commissioning efforts in a project can be directly related to the accurate definition of the OPR. Development of an accurate OPR is the singularly most important aspect in the commissioning effort. The development and definition of accurately stated requirements can directly equate to a successful project.

6.3.5.2 The Preliminary Commissioning Plan

Section 6.3.3 provided an overview of the elements of the Commissioning Plan. It is the benchmark used to identify the various activities within each phase of the project. It also identifies the roles and responsibilities of all the Commissioning Team members during each of those phases. The CA ***SHALL*** prepare the Commissioning Plan.

6.3.5.3 Issues Log

The CA ***SHALL*** create the Issues Log during the Pre-Design Phase. The Issue Log shall record all identified commissioning related issues and the answers, responses, dates and authors of the issues and responses.

6.3.5.4 Commissioning Scope(s) of Work and Budgeting

The NEBB Certified BSC Firm scope of commissioning services ***SHALL*** be as specified or as mutually agreed to between the Owner and the NEBB Certified BSC Firm. In order to be a NEBB certified project, the scope must meet the minimum ***SHALL*** requirements of each phase included in the scope of work, unless a specific requirement is specifically excluded in the scope of work statement and included in the certification page of the commissioning report. The CA may also be required to prepare budget costing for the commissioning scope of services.

6.3.5.5 Commissioning Meetings

The CA ***SHALL*** conduct all Commissioning Team meetings and ***SHALL*** issue meeting minutes as documentation of these meetings.

6.3.5.6 Systems Manual

During the Pre-Design Phase, the CA and the Commissioning Team ***MAY*** determine which documents make up the Systems Manual. The Final Systems Manual ***SHOULD*** include the following:

a. Summary
b. Final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents
f. Record Drawings (As-Built)
g. Final O&M Manuals
h. Final Commissioning Report
i. Operator Training Materials
j. Recommended Standard Operating Procedures (SOP)

k. Testing Reports

6.3.5.7 Update the OPR
The Owner ***SHALL*** update the OPR during Pre-Design Phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications.

6.3.6 PRE-DESIGN PHASE COMPLETION
The Pre-Design Phase is complete when the OPR and the Commissioning Plan have been produced.

6.3.7 PRE-DESIGN PHASE DOCUMENTATION
Documentation Requirements ***SHOULD*** include:

a. The accepted OPR
b. The initial Commissioning Plan
c. The initial Issues Log

6.4 DESIGN PHASE COMMISSIONING

6.4.1 INTRODUCTION
In the Pre-Design Phase the Owner's Project Requirements (OPR) have been identified. The purpose of Design Phase Commissioning is to verify that the design professionals incorporate the OPR into the Contract Documents. The design professionals should prepare a document that is called the Basis of Design (BOD). This document identifies how the design professionals will create a design that conforms to the OPR.

Many entities in the design and construction field utilize the terms Design Intent, Basis of Design, Design Criteria and others interchangeably. The NEBB BSC Program defines meanings for these terms (See Section 1 Definitions).

The Design Intent, as its name implies, contains the design intentions for the project; both the intentions of the Owner and the intentions of the design professionals. Consequently, the Design Intent is comprised of two documents: the OPR and the BOD.

6.4.2 DESIGN PHASE BASIS OF DESIGN (BOD)
The design professionals are responsible for preparing the BOD. The BOD has two components: the Design Narrative and the Design Criteria.

6.4.2.1 Design Narrative
The Design Narrative is a written description that identifies the assumptions made by the design professionals in interpreting the OPR and the proposed design solutions that satisfy the requirements of the OPR. The narrative should include a description of the systems, equipment and components that were selected and why they were chosen. It should also include reasons other systems, equipment and components were considered and rejected. Acceptance of the items in the Design Narrative should be the consensus of both the Owner and the design professionals. The CA ***SHALL*** document this agreement. The Design Narrative documents the design professional's process and decisions made at the early stages of the project. The narrative serves as a scope of work for the Design Team in creating the Design Development documents.

6.4.2.2 Design Criteria
The Design Criteria is a listing of the project design parameters, including its source, and how it meets the OPR during the design of the project. The criteria may include, but is not limited to the following:

a. Project location, special site requirements, and environmental criteria
b. Design parameters and conditions
c. Design assumptions and limitations
d. Accepted safety factors to be used
e. Accepted levels of redundancy
f. Code review requirements, applicable standards, and other governmental agency regulations

These Design Criteria are used to produce the engineering calculations and Contract Documents.

The CA ***SHOULD*** evaluate the design for conformance to the OPR and verify that the components, systems and assemblies in the design, directly relate to the *commissionability, maintainability, functionality and industry accepted best practices*.

Design Phase commissioning is the process of comparing each element of the design to the Owner's Project Requirements (OPR). The NEBB Design Phase commissioning process is not intended to be a peer review of the design professionals work or responsibilities. These remain the responsibility of the design professional and the design team. Design Phase commissioning is the process of reviewing each system and element of the design as it relates to functionality, maintainability and industry accepted best practices. Design Phase commissioning consists of:

a. Assisting the design team in making sure that the Basis of Design created by the design team meets the requirements of the Owner's Project Requirements
b. Reviewing design development documents for items c) and d) below as they relate to systems and system components
c. Systems review. The CA will review each system for its *operability, functionality, maintainability* and compliance to standard industry quality practices.
d. Component review. The CA will review each component for its *operability, functionality, maintainability* and compliance to standard industry quality practices.
e. Verifying that the proposed system can be tested in a manner that provides both valid test results and manageable baseline data for the operators of the systems
f. Design Phase commissioning report. The CA shall maintain a commissioning issue log for the documentation and facilitation of Design Phase issues.

6.4.3 DESIGN PHASE RESPONSIBILITIES

6.4.3.1 Commissioning Team Members
During the design phase, the commissioning team ***SHOULD*** be comprised of the Owner/Owner's representative, design team members comprised of the various design professionals and the CA. Additionally, if the construction manager/general contractor, program manager, or specialty trade contractors are known at the time, a representative from those entities ***SHOULD*** also be included at appropriate times.

6.4.3.2 Commissioning Team Responsibilities
The Commissioning Team ***SHALL*** work to prepare the Contract Documents that are incorporated in the OPR.

6.4.3.3 Commissioning Authority (CA)
Commissioning is a process that works most effectively when done in a *cooperative team atmosphere*. The CA will generally have the primary responsibility to foster this sense of cooperation and focus on a common outcome. Further, the CA will be responsible for: ensuring that communications between Design Team members is a two way process, creating effective methods to deliver comments, and soliciting and documenting responses from Design Team members.

6.4.4 DESIGN PHASE ACTIVITIES

Design Phase commissioning is the process of evaluating each element of the design for conformance to the OPR as it relates to commissionability, maintainability, functionality and industry accepted best practices. Design Phase commissioning activities consist of:

6.4.4.1 Design Phase Kickoff Meeting
The CA ***SHOULD*** conduct an initial Kickoff Meeting with the Design Team and the Owner. The purpose of the meeting will be to establish the purpose and proposed process for commissioning the design and to review the Design Phase Commissioning Plan.

a. Create the agenda
b. Attend and lead the meeting
c. Review the Commissioning Plan with the Team Members
d. Review the various commissioning activities and schedules
e. Review documentation requirements
f. Review communication and reporting procedures
g. Prepare and distribute meeting minutes

6.4.4.2 OPR Definition and Development
If the OPR was not produced during a Pre-Design phase, the OPR ***SHALL*** be defined and developed during this phase. See Section 6.3.5.1 for these requirements.

6.4.4.3 OPR Conformance
The CA ***SHOULD*** assist the design team in documenting that the Basis of Design created by the Design Team meets the requirements of the OPR. This is done by evaluating the Design Narrative and the Design Criteria.

6.4.4.4 Commissioning Activities Scheduled
The CA ***SHALL*** verify that commissioning activities are incorporated into the Design Phase schedule.

6.4.4.5 Commissioning Plan
The Commissioning Plan ***SHOULD*** be prepared during the Pre-Design Phase. If it has not been prepared, the CA ***SHALL*** create the Commissioning Plan during this phase. See Section 6.3.5.2 for these requirements. During the Design Phase, the CA ***SHALL*** update the Commissioning Plan to incorporate any changes to the OPR that would affect the Commissioning Plan. In addition, the Commissioning Plan ***SHALL*** be expanded to detail the commissioning process as the Contract Documents are further defined.

6.4.4.6 Commissioning Requirements Identified in the Contract Documents
The CA ***SHOULD*** assist the design professionals in preparing the commissioning specifications for the contract documents. The CA ***SHALL*** evaluate the contract documents to verify that that the proper

contractual obligations related to the construction phase and the acceptance phase commissioning have been defined for all applicable bid sections of the project. The CA ***SHALL*** verify that the commissioning scope of work for the contractors, vendors, specialty subcontractors, etc. is well defined so contractors and vendors can quantify the commissioning requirements and their associated costs. The CA ***SHALL*** also verify that the documents clearly define the type and method of testing and also define the criteria that will be used to determine compliance/acceptance.

6.4.4.7 Establish Training Requirements
The CA ***SHALL*** work with the Owner and the design professionals in defining the training requirements for the Owner's personnel. The CA ***SHALL*** verify that the training requirements are incorporated into the final Contract Documents.

6.4.4.8 Drawing and Specification Design Phase Commissioning
The CA ***SHALL*** evaluate the contract documents at least once near 100% Construction Document level. The CA ***MAY*** evaluate the drawings and specifications at each milestone; Schematic Design, Design Development, and Contract Documents. The frequency of evaluation ***SHALL*** be as specified or as mutually agreed to between the Owner and the NEBB Certified BSC Firm. The CA ***SHALL*** evaluate drawings and specifications for each system, component, and equipment for its commissionability, maintainability, functionality and best practices.

6.4.4.9 Testing Evaluation
The CA ***SHALL*** verify that the proposed components, systems, and assemblies can be tested in a manner that provides both valid test results and manageable baseline data for the operators of the systems. The CA ***SHALL*** create or assist in the creation of the testing plans and forms for all Pre-Functional Tests and shall create all Functional Performance Tests. Pre-Functional Tests include installation verification and startup tests. Functional Performance Tests are used to verify the appropriate sequential performance of automated system and the stability of these sequences under normal, upset and transitional conditions. See Section 6.1 for validation level.

6.4.4.10 Issues Log
The Issues Log ***SHOULD*** be prepared during the Pre-Design Phase. If it has not been prepared, the CA ***SHALL*** create the Issues Log during this phase. See Section 6.3.5.3 for these requirements. The CA ***SHALL*** maintain the Issues Log for the documentation and facilitation of Design Phase issues and deviations from the OPR.

6.4.4.11 Meetings
The CA ***SHALL*** conduct all commissioning team meetings and shall issue meeting minutes as documentation of these meeting.

6.4.4.12 Updating the OPR
The Owner ***SHALL*** update the OPR during design phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final Contract Documents.

6.4.4.13 Pre-Bid Meeting
The CA ***MAY*** be required to attend and participate in the Pre-Bid meeting to fully explain the commissioning requirements of the Contract Documents. This is a valuable activity when contractors are not familiar with the commissioning process. This is an important meeting that will help the subcontractors better understand the level of involvement in the commissioning process. When contractors understand their involvement in the commissioning process it helps them to avoid over or underestimating the cost of subcontractor involvement in the commissioning process.

6.4.5 DESIGN PHASE COMPLETION

Design Phase Commissioning is complete when the final contract documents are complete.

6.4.6 DESIGN PHASE DOCUMENTATION

Documentation Requirements ***SHOULD*** include:

a. The Contract Documents including the commissioning requirements for construction
b. The updated OPR
c. The updated Issues Log with noted corrections
d. The updated Commissioning Plan
e. The updated BOD from the design professionals

6.5 CONSTRUCTION PHASE COMMISSIONING

6.5.1 INTRODUCTION

The OPR has been identified in the Pre-Design Phase. During the Design Phase, the CA has verified that the design professionals have incorporated the OPR into the Contract Documents. During the Construction Phase, the building shell is erected and the systems, components and equipment are installed. The main focus of the commissioning efforts during the Construction Phase is to:

a. Conduct the Kickoff meeting and all other Commissioning Meetings
b. Perform Site Observations (SO)
c. Verify that the Pre-Functional Tests (PFT) are performed

Site Observations are static inspections of all systems, components and equipment. Pre-Functional Performance Tests include installation verification and startup tests.

6.5.2 CONSTRUCTION PHASE RESPONSIBILITIES

6.5.2.1 Commissioning Team Members

During the Construction Phase, the Commissioning team ***SHOULD*** be comprised of the Owner/Owner's representative, various design professionals, the general contractor, the construction manager, program manager, specialty trade contractors, and the CA.

6.5.2.2 Commissioning Team Responsibilities

The Commissioning Team is responsible for verifying that the installed and operating systems, components and equipment will achieve the OPR.

6.5.2.3 Commissioning Authority (CA)

The commissioning process works most effectively when done in a *cooperative team atmosphere*. This cooperative effort is even more important during the Construction Phase. The CA will generally have the primary responsibility to foster this sense of cooperation and focus on a common outcome. Further, the CA ***SHALL*** be responsible for championing the commissioning process among the Commissioning Team members to ensure conformance to the OPR.

6.5.2.4 Test Procedures

Pre-Functional Tests (PFT) ***SHALL*** be done during the Construction Phase. Functional Performance Tests (FPT) ***SHALL*** be done during the Acceptance Phase. The responsibility for creating, administering, performing, and observing the various activities of the tests ***SHALL*** be as

outlined in Section 6.1 and in the Commissioning Plan. Based on the technical level of the Pre-functional tests, they may be performed by different members of the Commissioning Team.

6.5.3 CONSTRUCTION PHASE ACTIVITES

6.5.3.1 Commissioning Kickoff Meeting

The kickoff meeting should be the initial meeting with all members of the Commissioning Team for the Construction Phase. The CA ***SHALL***:

a. Create the agenda
b. Attend and lead the meeting
c. Review the Commissioning Plan with the Team Members
d. Review the various commissioning activities and schedules
e. Review documentation requirements
f. Review communication and reporting procedures
g. Prepare and distribute meeting minutes

6.5.3.2 Commissioning Meetings

The CA ***SHALL*** conduct periodic commissioning review meetings throughout the construction phase to monitor the progress of the commissioning activities. The CA ***SHALL***:

a. Create the agenda
b. Attend and lead meeting
c. Schedule and review the commissioning activities
d. Coordinate with construction meetings and activities
e. Prepare and distribute meeting minutes

6.5.3.3 Commissioning Activities Scheduled

The CA ***SHOULD*** verify that commissioning activities are incorporated into the Construction schedule.

6.5.3.4 Approved Submittal and Shop Drawings

Submittals and shop drawings are documents provided by the contractors and vendors during the Construction Phase of a project. The submittals and shop drawings ***SHALL*** be reviewed by the responsible design professionals and the CA. The CA ***SHALL*** verify that the submittals conform to the OPR.

6.5.3.5 Site Observation Inspections

Site observations are routine inspections that ***SHALL*** be performed by the CA during the Construction Phase. The purpose of the inspections is to verify that the construction complies with the Contract Documents, the OPR and identify and document any quality issues that may lead to functional issues. Site observations are forwarded to the appropriate team member for their review and corrective action. Any site observation issues that are not automatically accepted and resolved, the issue are added to the Issue Log for resolution.

6.5.3.6 Pre-Functional Tests

As previously stated in Section 6.5.2.4, the responsibility for creating, administering, performing, and observing the various activities during the Pre-Functional Tests are outlined in the Commissioning Plan and can be performed by different members of the Commissioning Team during the Construction Phase based on the type of technical activity of the test. The party responsibility to perform each task is defined in the contract documents and the commissioning plan. The following

activities ***SHALL*** be performed by the Commissioning Team as part of Construction Phase Commissioning:

a. Create and review test forms
b. Review installation verification requirements with members of the Commissioning Team
c. Review startup requirements with members of the Commissioning Team
d. Administer, perform and/or observe all PFT
e. Report deficiencies on the Issues Log
f. Distribute Issues Log to members of the Commissioning Team and manage the issue log for issue resolution

6.5.3.7 Issues Log & Deficiency Resolution
The CA ***SHALL*** report deficiencies from the PFT on the Issues Log and the log ***SHALL*** be distributed to the appropriate members of the Commissioning Team for resolution. The CA *SHALL* work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA shall assist as necessary to complete the issue log. After corrective action, retests ***SHALL*** be performed to verify conformance. When deficiencies are resolved, the issues ***SHALL*** be signed off on the Issues Log by the CA and the appropriate Commissioning Team Member(s). All Issue Log items must be resolved or answered by the appropriate commissioning team member. Issues that are not properly resolved or are resolved but do not meet the requirements of the OPR must be approved by the Owner.

6.5.3.8 Updating the Commissioning Plan, the OPR and the BOD
The Owner must update the OPR during Construction Phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications. The design professionals should update the BOD for all design related issues. The Commissioning Plan ***SHALL*** be updated and further defined to reflect any changes to the OPR, BOD or Contract Documents.

6.5.4 CONSTRUCTION PHASE COMPLETION
Construction Phase Commissioning is complete when all construction and PFT's are complete.

6.5.5 CONSTRUCTION PHASE DOCUMENTATION
Documentation requirements ***SHALL*** include:

a. Commissioning Meeting Minutes
b. Submittal / Shop Drawing Evaluation Comments
c. Site Observation Reports
d. Pre-Functional Test Reports
e. Record Drawings Completed
f. Completed Operations & Maintenance Manuals
g. Updated Issues Log with noted corrections
h. Updated Commissioning Plan
i. Updated OPR
j. Updated BOD from the design professionals

6.6 ACCEPTANCE PHASE COMMISSIONING

6.6.1 INTRODUCTION
In the Pre-Design Phase, the OPR has been identified. During the Design Phase, the CA has

verified that the design professionals have incorporated the OPR into the Contract Documents. During the Construction Phase, the building shell is erected and the systems, components and equipment are installed and Pre-Functional tests are performed to show that construction meets the contract requirements.

During the Acceptance Phase, the building systems are complete and fully functional. The main focus of the commissioning efforts during the Acceptance Phase is to:

a. Verify that the building is functionally complete
b. Coordinate the Owner's Personnel Training

Functional Performance Tests (FPT) verify appropriate sequential performance of automated systems and the stability of these sequences under normal, upset and transitional conditions. FPT are used to verify that the building systems are functionally complete.

6.6.2 ACCEPTANCE PHASE RESPONSIBILITIES

6.6.2.1 Commissioning Duration Schedules

The CA ***SHOULD*** continue to monitor and update the duration schedules for the contractors for the commissioning activities in the Acceptance Phase required by the Commissioning Plan. These duration schedules should track all commissioning activities of the Commissioning Team in this phase.

6.6.2.2 Commissioning Team Members

During the Acceptance Phase, the Commissioning Team ***MAY*** be comprised of the Owner's representative, various design professionals, the construction manager, general contractor, program manager, specialty trade contractors, and the CA.

6.6.2.3 Commissioning Team Responsibilities

The Commissioning Team is responsible for working in unison to verify that the testing of the installed and operating systems, components and equipment will achieve the OPR.

6.6.2.4 Commissioning Authority (CA)

As with all of the phases, the commissioning process works most effectively when done in a *cooperative team atmosphere*. The CA will generally have the primary responsibility to foster this sense of cooperation and focus on a common outcome. Further, the CA and the owner will be responsible for championing the commissioning process among the Commissioning Team members to ensure conformance to the OPR.

6.6.2.5 Test Performance

Functional Performance Tests (FPT) ***SHALL*** be executed during the Acceptance Phase. The CA shall create all FPT and ***SHALL*** have the final responsibility of verifying that the commissioned systems, equipment and components are functional.

6.6.3 ACCEPTANCE PHASE ACTIVITES

6.6.3.1 Commissioning Meetings

The CA ***SHALL*** conduct periodic commissioning review meetings throughout the Acceptance Phase to monitor the progress of the commissioning activities. The CA ***SHALL***:

a. Create the agenda
b. Attend and lead meetings
c. Schedule and review the commissioning activities

d. Coordinate with construction meetings and activities
e. Prepare and distribute meeting minutes

6.6.3.2 Functional Performance Tests
As previously stated in Section 6.6.2.4, the responsibility for creating, administering, performing, and observing the various activities during the Functional Performance Tests are as outlined in the Commissioning Plan and can be performed by different members of the commissioning team during the Acceptance Phase. The following activities ***SHALL*** be performed by the CA as part of Acceptance Phase Commissioning:

a. Create and develop test forms and requirements that appropriately test the automated sequence
b. Review data measurements to be verified
c. Review method of acquiring data measurements
d. Administer, observe, and/or perform all FPT
e. Report deficiencies on the Issues Log
f. Distribute Issues Log to members of the commissioning Team and manage the issue log for issue resolution

6.6.3.3 Deferred Testing
Some testing may be deferred for various reasons. The reasons could include budgetary issues, seasonal requirements, etc. Deferred testing ***SHOULD*** be performed in the Warranty Phase. The CA ***SHALL*** verify and document that these deferred tests are performed by the responsible member of the commissioning team.

6.6.3.4 Issues Log & Deficiency Resolution
The CA ***SHALL*** report deficiencies on the Issues Log and it ***SHALL*** be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the appropriate Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues. After corrective action, retests ***SHALL*** be performed to verify conformance in accordance with the commissioning plan. All issue log items ***SHALL*** be resolved and answered or accepted by the appropriate Commissioning Team member. Issues that are not resolved in a manner consistent with the OPR ***SHALL*** be approved by the Owner. If issues remain unresolved at the end of the project for any reason a certified report can only be issued if the CA has attempted to obtain resolution a minimum of three times and has documented those attempts. An explanation and clarification of any unresolved issues must be included in the final commissioning report executive summary.

6.6.3.5 Record Documents and Operations & Maintenance Information
The Owner, and/or his personnel, ***SHALL*** be thoroughly trained in the operation, maintenance, and function of the project, its equipment, systems and components. In order to accomplish this activity, the contractors ***SHALL*** provide Record Documents (As-Built Drawings) and Operations & Maintenance Manuals (O&Ms) as contractually required. These materials are normally reviewed by the appropriate design professionals before being sent to the Owner. The CA ***SHALL*** evaluate the materials after they have been approved by the design professional (or concurrently) and prior to being sent to the owner. The CA ***SHALL*** evaluate the completeness of the documentation from the standpoint of operator training and instruction for start up, shut down, operation and maintenance information. These documents ***SHALL*** be reviewed by the CA, the Owner and his operating personnel prior to the Owner training sessions as they form an integral component of the training sessions.

6.6.3.6 Owner Training Completion
The Owner's, and/or his personnel, ***SHALL*** be thoroughly trained in the operation, maintenance, and function of the project, its equipment, systems and components.

The CA ***MAY*** coordinate the training activities of the Commissioning Team Members and assist the contractor in scheduling the training sessions. The CA ***SHOULD*** review training agendas and preview training sessions with the trainers. The following activities ***SHOULD*** be performed as part of Owner Training:

a. The CA ***SHOULD*** review training agendas and preview training sessions with the trainers
b. The CA ***MAY*** assist the Owner with staff selection
c. The design professionals should train the Owner on relevant design approaches that were incorporated in the design, especially design issues that relate directly to operating and maintaining the facility
d. The contractors should train the Owner on relevant means, methods and construction techniques that were incorporated into the construction of the project that have impact on the ability to operate and maintain the facility
e. Equipment vendors should train the Owner on proper startup/shutdown procedures of operating equipment and systems. The training sessions should cover normal operational features and routine maintenance requirements of the major items of operating equipment, systems, and components. The sessions should be tailored to the exact equipment, systems and components incorporated into the project and not just a generalized session on typical maintenance items.
f. The CA ***MAY*** verify and document that the training sessions have been performed.

6.6.3.7 Updating the Commissioning Plan, the OPR and the BOD
The Owner must update the OPR during Acceptance Phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications. If any of the issues are design related, the design professionals should update the BOD. The Commissioning Plan ***SHALL*** be updated and further defined to reflect any changes to the OPR, BOD or Contract Documents.

6.6.3.8 Final Commissioning Report
The Final Commissioning Report shall contain all documentation from all of the phases of the commissioning process. The CA ***SHALL*** assemble the data into a final Commissioning Report. The final report will incorporate the final record documents for each system, as appropriate. The Commissioning Report ***SHALL*** include:

a. Title Page
b. Certification Page
c. Table of Contents
d. Executive Summary
e. Commissioning Plan
f. Completed Pre-Functional Commissioning Check Sheets and Forms
g. Verification Data
h. Completed Functional Performance Tests
i. Observation Reports
j. Issues Log
k. All pertinent correspondence
l. Test Instrument Page

6.6.3.9 Systems Manual
At the end of the Acceptance phase the CA ***MAY*** produce the Systems Manual. The purpose of the Systems Manual is to provide the Owner and his operators with a permanent record of all pertinent documents required for future operation, commissioning and validation processes of the facility. The Systems Manual ***SHOULD*** be provided to the Owner in electronic format. At a minimum the final system manual ***SHOULD*** include the following and should be provided in a digital format:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operating and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures
j. Testing Reports

6.6.4 ACCEPTANCE PHASE COMPLETION
Acceptance Phase Commissioning is complete when all FPT are complete and accepted by the CA.

6.6.5 ACCEPTANCE PHASE DOCUMENTATION
Documentation requirements ***SHOULD*** include:

a. Commissioning Meeting Minutes
b. Functional Performance Test Reports
c. Training documentation
d. Updated Issues Log with noted corrections
e. Updated Commissioning Plan
f. Updated OPR
g. Updated BOD from the design professionals
h. The Final Commissioning Report

6.7 WARRANTY PHASE COMMISSIONING

6.7.1 INTRODUCTION
The purpose of the Warranty Phase Commissioning effort is to insure that any warranty issues are resolved, deferred tests are performed and outstanding construction issues are resolved. Any operator issues that may have become apparent with building occupancy should be resolved during the warranty phase.

6.7.2 WARRANTY PHASE RESPONSIBILITIES
6.7.2.1 Commissioning Team Members
During this phase, the Commissioning Team members ***SHOULD*** be comprised of a representative from the Owner, the CA and any team member who is involved with any outstanding issues. The Commissioning Team may also include members from the design professionals and the contractors.

6.7.2.2 Commissioning Team Responsibilities
As with all other phases of the commissioning process, the Commissioning Team is responsible for working in unison to verify that the installed and operating systems, components and equipment will achieve the OPR.

6.7.2.3 Commissioning Authority (CA)
The CA's role will continue to be the champion of the commissioning process.

6.7.3 WARRANTY PHASE ACTIVITES

6.7.3.1 Deferred Testing
Any Acceptance Phase testing that was deferred should be performed during the Warranty Phase. The CA ***SHALL*** verify and document that these deferred tests are performed by the responsible member of the commissioning team in accordance with 6.6.3.2 above.

6.7.3.2 Construction Phase Commissioning Follow-up
The CA ***MAY*** coordinate warranty issues and contractor call-backs. The CA ***MAY*** be required to verify that the warranty issue has been resolved including retesting if required.

6.7.3.3 Warranty Phase Commissioning Review Meeting
The following may take place during the Warranty Phase:

a. Perform operations review with owner and building operators
b. Provide documentation
c. Revise issue log if any deficiencies are found
d. Coordinate retests and verify any items identified as deficient are resolved.

6.7.3.4 Acceptance Phase Commissioning Follow-up
The CA ***MAY*** coordinate any unresolved acceptance phase issues. The CA ***MAY*** be required to verify that the issue has been resolved including retesting if required.

6.7.3.5 Reinforcement Training Verification
The CA ***MAY*** be required to assist O&M staff with questions on O&M procedures. They ***MAY*** also need to identify, coordinate and verify any required seasonal training. Training session ***MAY*** need to be performed for equipment and systems that were not in operation at substantial completion. Additionally, more detailed training ***MAY*** be required for complex systems where initial testing was more of an overview, or subsequent training is warranted. Typically, this ***MAY*** include such items as building controls systems.

6.7.3.6 Lessons Learned Workshop
The CA ***MAY*** conduct a "lessons learned" workshop with the Owner and operators to facilitate improvements to the owner's future building projects and commissioning efforts. The workshop ***SHOULD*** include the following:

a. A review of the results of commissioning for this project, its successes and its failures
b. A review of the functionality of the building
c. A review of the buildings comfort level and its energy utilization
d. Documented suggestions for improvement for inclusion into future projects OPR

6.7.4 WARRANTY PHASE COMPLETION

The Warranty Phase is complete when:

a. All warranty issues are corrected, or accepted by the Owner
b. Final Commissioning Report with the warranty addenda is complete and accepted by the Owner
c. Lessons learned workshop is complete
d. The reinforcement training sessions are complete

6.7.5 WARRANTY PHASE DOCUMENTATION

Documentation Requirements ***SHOULD*** include:

a. Final Commissioning Report Warranty Addenda
b. Updated issue log if appropriate
c. Retest forms with deferred testing results if appropriate
d. Lessons Learned Workshop Report

PART 3 – PROCEDURES

SECTION 7 COMMISSIONING OF HVAC SYSTEMS

7.1 INTRODUCTION

The purpose of Section 7 is to describe the requirements for commissioning a project's HVAC systems, equipment and components. While Section 6 details the elements of the commissioning process in global terms, this section will detail the minimum requirements for a NEBB Certified HVAC Commissioning project. The actual scope of work may differ from these requirements. These minimum requirements are described as ***SHALL*** requirements. ***SHOULD*** requirements are recommended to produce a higher quality project and ***MAY*** requirements could be included to enhance the commissioning project. These minimum requirements take precedence when a scope of work is not defined, or the requirements state words to effect that the "…project ***SHALL*** be commissioned in accordance with the requirements of the NEBB *Procedural Standards for Whole Building Systems Commissioning of New Construction."* To be a NEBB certified report the following must apply:

1. The actual contracted scope of work ***SHALL*** be clearly defined on the certification page of the report as specified in the contract documents or as agreed to between the Owner / Buyer and the NEBB Certified BSC Firm.
2. If the scope of work differs from the NEBB ***SHALL*** language it shall be clearly delineated on the certification page of the report, otherwise all ***SHALL*** language must be adhered to for a NEBB Certified Report.

7.2 PRE-DESIGN PHASE COMMISSIONING

7.2.1 INTRODUCTION

There are two main purposes of the Pre-Design Phase. The first is to develop and document the Owner's Project Requirements (OPR) and the second is to develop the Preliminary Commissioning Plan.

7.2.2 PRE-DESIGN PHASE RESPONSIBILITIES

7.2.2.1 Commissioning Team Members

During the Pre-Design Phase the Owner should assign or contract for the appropriate Commissioning Team members to facilitate the Pre-Design process. The required Commissioning team members for the Pre-Design Phase should be as follows:

a. Owner's Representatives
b. Commissioning Authority (CA)
c. Programming Professionals if applicable
d. Architect if applicable
e. Mechanical & Electrical Engineer if applicable
f. Construction Manager / General Contractor if applicable

7.2.2.2 Commissioning Team Responsibilities
The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member must be responsible for contributing to the commissioning process based on their individual project responsibilities.

7.2.3 PRE-DESIGN PHASE ACTIVITIES

7.2.3.1 OPR Definition and Development
The Owner should produce the Owner's Project Requirements (OPR) to facilitate the design and delivery of the project. The OPR outlines the expectations the Owner has for the HVAC requirements of the project. The HVAC OPR ***SHOULD*** include the following items that relate to the HVAC system:

a. Use and space requirements
b. Anticipated occupancy
c. Mechanical construction budget
d. Indoor and outdoor building environmental requirements
e. Special systems or equipment requirements that may affect cooling and heating loads, ventilation requirements, etc.
f. Specific material or equipment requirements
g. Energy efficiency expectations
h. Sustainability requirements
i. Measurement & Verification Strategies
j. Ongoing Commissioning & Building Rating Requirements
k. Levels of redundancy
l. Building Automation / Controls sophistication
m. Vibration, sound, seismic or wind restraint requirements
n. Operation and maintenance criteria
o. Owner's expectations for operator and occupant training
p. Requirements for future facility adaptation and expansion
q. Owner's expectations of the design team and their produced documents
r. Owner's expectations of the construction team and their document requirements
s. Owner's expectations of the Commissioning Authority and their document requirements

7.2.3.2 Commissioning Plan
The CA ***SHALL*** develop a preliminary HVAC Commissioning Plan that documents the following:

a. The commissioning scope
b. The Commissioning Team
c. Normal channels of communication
d. Design phase commissioning procedures
e. Design phase commissioning duration schedules

7.2.3.3 Issues Log
The CA ***SHALL*** develop the format of the Issues Log to be utilized for the commissioning process. The Issues Log should address the manner that the perceived HVAC deficiencies will be documented by the CA and communicated to the design professionals and the contractors during subsequent commissioning phases of the project development and delivery. The Issues Log should also address the deficiency resolution procedure. The Issues Log should include:

a. Issue Number
b. Issue statement

c. Date of Issue statement
d. Person making issue statement
e. Issue statement response
f. Date of Issue statement response
g. Person making the issue statement response

7.2.3.4 Commissioning Scope(s) of Work and Budgeting
The CA ***SHOULD*** assist the Owner in developing the commissioning scope of the project and its associated costs. Project scope should include:

a. Phase to be commissioned: The Owner must determine which phases will be commissioned for the project such as Pre-Design Phase, Design Phase, Construction Phase, Acceptance Phase and Warranty Phase.
b. Systems to be commissioned: The Owner must determine which systems will be commissioned for the project including special systems and if any areas will be excluded from the commissioning project.
c. The commissioning scope shall be based upon this Procedural Standard and its definition of the commissioning process and its required ***SHALL*** language. If the Owner desires to establish a different level of commissioning activities than those stated in this procedural standard it must be clearly delineated in the scope of work.
d. Level of Owner's participation in the commissioning process: The Owner must establish the level of participation their representatives will provide to the commissioning team during each phase of the commissioning project.

7.2.3.5 Develop System Manual Requirements
During the Pre-Design Phase the Commissioning Team and the CA ***MAY*** develop documents which will make up the system manual and determine what the Owner's Operator training requirements will be. The final system manual ***MAY*** include the following and should be provided in electronic format:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operations and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures
j. TAB Report

7.2.3.6 Commissioning Meetings
The CA ***SHALL*** conduct all Commissioning Team meetings as required to implement the commissioning process and ***SHALL*** issue meeting minutes as documentation of these meetings.

7.2.3.7.Update the OPR
The Owner must update the OPR during Pre-Design Phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications.

7.2.4 PRE-DESIGN PHASE DOCUMENTATION

The following commissioning documents are produced during Pre-Design Phase Commissioning if these activities are included in commissioning scope of work:

a. Owner's Project Requirements ***(SHOULD)***
b. Preliminary Commissioning Plan ***(SHALL)***
c. Issues Log ***(SHALL)***
d. Commissioning Scope and Budgets ***(MAY)***
e. System Manual Index of contents ***(MAY)***

7.3 DESIGN PHASE COMMISSIONING

7.3.1 INTRODUCTION

During the Design Phase, the design professionals create the Contract Documents. The Contract Documents turn the OPR into working design documents. The CA ***SHALL*** evaluate and document that the Contract Documents conform to the OPR. The CA ***SHALL*** evaluate that the HVAC systems, equipment and components incorporated into the Contract Documents to ensure they conform to the OPR from the standpoint of commissionability, maintainability, functionality and best practices.

7.3.2 DESIGN PHASE RESPONSIBILITIES

7.3.2.1 Commissioning Team Members

The required Commissioning Team members for the Design Phase should be:

a. Owner's Representatives
b. Commissioning Authority (CA)
c. Programming Professionals
d. Architect
e. Mechanical Engineer
f. Electrical Engineer
g. Construction Manager / General Contractor if applicable
h. Specialty, or Trade Contractors (Mechanical, Sheet Metal, Controls, TAB, etc.) if applicable

7.3.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member is responsible for contributing to the commissioning processes according to their individual project responsibilities.

7.3.3 DESIGN PHASE ACTIVITES

7.3.3.1 OPR Definition and Development

If the project does not have a Pre-Design Phase, or if the OPR was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 7.2.3.1 for the requirements.

7.3.3.2 Commissioning Plan

If the project does not have a Pre-Design Phase, or if the Commissioning Plan was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 7.2.3.2 for the requirements.

7.3.3.3 Issues Log

If the project does not have a Pre-Design Phase, or if the Issues Log was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 7.2.3.3 for the requirements.

7.3.3.4 Design Kick-Off Meeting
The CA ***SHOULD*** conduct an initial Kickoff Meeting with the Design Team and the Owner. The purpose of the meeting will be to establish the purpose and proposed processes for commissioning the design and to review the Design Phase Commissioning Plan.

7.3.3.5 Commissioning Activities Scheduled
The CA ***SHALL*** verify that commissioning activities are incorporated into the Design Phase schedule.

7.3.3.6 Evaluate Basis of Design Conformance
The design professional will prepare the Basis of Design (BOD) document in response to the OPR. The BOD includes the Design Narrative and the Design Criteria. The CA ***SHOULD*** verify that the BOD conforms to the requirements of the OPR.

The Design Narrative s*hould* include the following:

a. Description of the selected HVAC systems and the reasons they were selected
b. Description of other systems that were analyzed and rejected and the reasons for rejections
c. Preliminary heating, cooling and ventilation load calculation requirements
d. Various systems approaches
e. System energy analysis
f. Sustainability and renewable energy approach
g. Life cycle costing information of each system analyzed
h. Preliminary major component selection
i. Equipment space layout for establishing building space requirements

The Design Criteria *should* include the following:

a. Project location and special mechanical site requirements
b. Design parameters including: weather data and source, space design conditions, space occupancy, outside air requirements, all internal and special equipment energy requirements, filtration requirements, special areas of concern and / or other criteria used that may define the methodology used to complete the mechanical load analysis.
c. Sustainability design parameters including: Renewable Energy, Carbon footprint and total system energy efficiency
d. Design assumptions and limitations
e. Energy management systems sophistication
f. System and controls sophistication of Owner's operating personnel
g. Sizing criteria to be used for duct and piping systems
h. Accepted safety factors incorporated into the design
i. Accepted levels of redundancy
j. Reference to specific equipment selection limitations as to make or model numbers
k. Operation assumptions
l. Codes, standards and guidelines to be utilized for the design

The CA ***SHOULD*** evaluate the BOD for conformance to the OPR from the standpoint of commissionability, maintainability, functionality and industry accepted best practices and produce an evaluation document.

7.3.3.7 Commissioning Specifications
The CA ***SHALL*** review the contract commissioning specifications and verify that they are included in the contract documents. The CA ***SHOULD*** assist in creating commissioning specifications to be included in the contract documents. The commissioning specifications should include the following:

a. Specification describing the basic commissioning process that will be used on the project by the CA, located in the general requirement area of the specification
b. Specification describing the commissioning activities required of the Mechanical, Electrical, Control and TAB contractors, located in each individual discipline specification section
c. Specification describing the commissioning activities required of any Vendor or equipment supplier or specialty subcontractor, located in each individual vendor, supplier or subcontractor specification section

7.3.3.8 Establish Training Requirements
The CA ***SHOULD*** work with the Owner and the design professionals to define the training requirements for the Owner's personnel. Verify that these requirements are incorporated into the project specifications. Training ***SHOULD*** include:

a. Theory of operation presented by the Engineer
b. Sustainability methods and measures presented by the Green Building Accredited Professional or the Engineer
c. Start Up procedures, Shut down procedures, Operating procedures and Maintenance procedures for each type of equipment and system presented by the manufacturer or contractor
d. Control system operations and programming training. Include durations extended over time.
e. Specify classroom instruction duration and field demonstration duration for each training event.
f. O&M manual review for warranty repair or replacement procedures
g. Review of all warranty durations and start dates

7.3.3.9 Schematic Design Document Evaluation
The CA ***MAY*** complete a thorough evaluation of the Schematic Design (SD), or a 35% design review of documents to establish that the HVAC systems, equipment and components are identified and can be installed in compliance with the OPR and the BOD. Schematic Design Document Evaluation ***MAY*** include: engineering calculations, system selection, system selection criteria, flow sheet designs and major component selection.

7.3.3.10 Design Development Document Evaluation
The CA ***SHOULD*** complete a thorough evaluation of the Design Development (DD), or a 65% design review of documents and submitted criteria for continued compliance to the OPR and BOD; Evaluate design documents for commissioning specifications and requirements; Draft preliminary Commissioning Specifications and Supplemental Commissioning Language for other specifications if required. Design Development Document Evaluation ***SHOULD*** include zoning requirements, specifications, typical room layouts, system main layouts, riser layouts, standard details, schedules and coordination requirements.

7.3.3.11 Contract Documents Evaluation
The CA ***SHALL*** evaluate the contract documents at least once near 100% construction document level. The CA ***SHALL*** evaluate drawings and specifications for each system, component, and equipment for its commissionability, maintainability, functionality and best practices.

7.3.3.12 Meetings
The CA ***SHALL*** conduct all commissioning team meetings and shall issue meeting minutes as documentation of these meeting.

7.3.3.13 Update the OPR and the BOD
The Owner must update the OPR and the design professionals must update the BOD during the design phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final Contract Documents.

7.3.3.14 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any additional Commissioning Team members, procedures and schedules or design phase commissioning requirements developed in the Design Commissioning process.

7.3.3.15 Issues Log Management
The Owner must manage the Issues Log as to timely issue answers and resolutions. The Owner has the final authority over issue resolution disagreements or interpretations. The final Issues Log, its statements and its statement answers ***SHALL*** become a permanent record of the commissioning process.

7.3.3.16 Update the Issues Log Documentation
The CA ***SHALL*** create and maintain the Issues log. The Issues Log shall be used throughout the commissioning process, going from a Pre-Design Phase issue log, to a Design Phase issue log, to a Construction Phase issue log, to an Acceptance Phase issue log and finally to a Warranty Phase issue log. The final (complete) issue log shall become a part of the final Commissioning Report.

7.3.3.17 Pre-Bid Meeting
The Owner should conduct a Pre-bid meeting to assist contractors in answering any questions about the systems or the commissioning process. The CA ***SHOULD*** attend the Pre-Bid meeting to fully explain the commissioning requirements of the Contract Documents and allow the contractors to understand their roll in the commissioning process and its associated costs. Provide any assistance required by the Owner in answering written questions (in the form of clarifications or addendum recommendations) during the bidding process.

7.3.4 DESIGN PHASE DOCUMENTATION

The following commissioning documents are produced during the Design phase commissioning if these activities are included in commissioning scope of work.

a. Updated Owner's Project Requirements **(*SHOULD)***
b. Updated Commissioning Plan **(*SHALL)***
c. Basis of Design Evaluation **(*SHOULD)***
d. Contract Document Evaluation **(*SHALL)***
e. Updated Issues Log **(*SHALL)***
f. Pre-Bid Meeting minutes or documentation **(*SHOULD)***

7.4 CONSTRUCTION PHASE COMMISSIONING

7.4.1 INTRODUCTION

During the Construction Phase the commissioning team works to verify the equipment and systems are installed in accordance with the design documents and are operable, maintainable and ready for functional testing.

7.4.2 CONSTRUCTION PHASE RESPONSIBILITES

7.4.2.1 Commissioning Team Members

The commissioning team members for the Construction Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives
d. Construction Manager Representative
e. General Contractor Representatives
f. Mechanical Contractor Representative
g. Electrical Contractor Representative
h. Control Contractor Representative
i. Test & Balance Representative
j. Specialty Contractor Representative (If Required)

7.4.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

7.4.3 CONSTRUCTION PHASE ACTIVITIES

7.4.3.1 Commissioning Plan

If the project does not have a Design Phase, or if the Commissioning Plan was not produced in the Design Phase, it ***SHALL*** be produced at this time by the CA. The commissioning plan should include:

a. Description of the commissioning process utilized for the project
b. Commissioning Team member identification and contact information
c. Team member responsibilities
d. Commissioning check sheet or form index
e. Copies of all typical commissioning check sheets or forms

7.4.3.2 Construction Kick-Off Meeting

The CA ***SHALL*** conduct an initial commissioning meeting with all contractors and Commissioning Team members. The purpose of the meeting will be to review the Construction Phase Commissioning process and activities for the commissioning of the project. During the meeting the CA ***SHOULD*** review the following:

a. The Commissioning Plan
b. The basic commissioning processes to be utilized on the project
c. The individual roles and responsibilities of each participating Commissioning Team member
d. Documentation requirements
e. Communication and reporting procedures
f. The check sheets and forms to be utilized on the project

g. The commissioning duration schedules

The CA ***SHALL*** create the meeting agenda, lead the meeting and prepare and distribute the meeting minutes.

7.4.3.3 Commissioning Duration Schedule
The CA ***SHOULD*** prepare a duration schedules for the contractors for the commissioning activities required by the commissioning plan. These duration schedules ***SHOULD*** be incorporated into the contractor's project schedule to track all commissioning activities of the Commissioning Team.

7.4.3.4 Commissioning Team Meetings
The CA ***SHALL*** attend and lead all commissioning meetings as required with the Commissioning Team to review progress of the commissioning effort and reinforce individual responsibilities. Also, review completed work and agree upon the acceptability of the delivered product. The CA ***SHALL***:

a. Create the agenda
b. Attend and lead meeting
c. Schedule and review the commissioning activities
d. Coordinate commissioning meetings with construction meetings and activities
e. Prepare and distribute meeting minutes

7.4.3.5 Submittal and Shop Drawing Review
The CA ***SHALL*** review all pertinent HVAC submittals and shop drawings to support the Commissioning Process. The submittal and shop drawing review should include:

a. The submittal and shop drawing information is utilized to create the appropriate PFT check sheets and forms for the project.
b. The CA ***SHALL*** review the submittals & shop drawings for commissionability, maintainability, functionality, best practices and for conformance to the CD's, OPR and BOD.
c. The CA ***SHALL*** document any found issues on the project Issue Log. The Issues Log ***SHALL*** be forwarded to the appropriate Commissioning Team member for resolution.

7.4.3.6 Site Observations
During the course of construction, the CA ***SHALL*** visit the site to inspect the progress of construction with respect to the HVAC systems, equipment and components being commissioned. The purpose of the inspections is to verify that the construction complies with the Contract Documents, the OPR and identify and document any quality issues that may lead to functional issues. Site observations are forwarded to the appropriate team member for their review and action. If site observations are not automatically accepted and resolved, the observation is added to the Issue Log for resolution.

7.4.3.7 Pre-Functional Tests (PFT)
There are several types of HVAC PFT that ***SHALL*** be performed during the construction phase: installation verification tests, static tests, and equipment startup tests.

7.4.3.7.1 HVAC & Controls Installation Verification Tests
The contractor must verify that all work is installed in accordance with the contract documents and / or the manufacturer's recommendations and provide the associated check sheets verifying such. The contractor must document that all equipment is installed in the correct location and is operable in accordance with the contract documents. The CA ***SHOULD*** provide the installation verification check sheets, if not available from the manufacturers or contractors. The CA ***MAY*** perform the installation

inspections at his discretion. The CA or his staff ***SHALL*** validate the Installation Verification check sheets completed by the contractor by back checking them through site observations. Completion of all installation verification tests signifies that those systems are ready for start up activities. Examples of these tests include:

a. All piping systems and component installations
b. All duct systems and component installations
c. All HVAC equipment installation
d. All Building Automation / Control equipment and component installation

Installation Verification tests ***SHALL*** include the following:

a. Material or Equipment Name or description
b. Model Number
c. Type and Size
d. Serial Number
e. Installation & location to design requirements verification
f. Maintenance access verification
g. Installation complete and ready for start up

7.4.3.7.2 Static Tests
The contractor must perform hydrostatic and pressure tests as described in the Contract Documents. All hydrostatic and pressure tests must be verified by contractor or code authority as required by the Contract Documents or as dictated by the local codes. The CA ***MAY*** provide the static test sheets to the contractor performing the tests. The CA ***MAY*** observe and document these static tests. Completed static test sheets are then provided to the CA. Examples of these tests include:

a. Hydrostatic testing of all piping systems to the appropriate test pressure and duration
b. Pressure testing of all ducts for leakage determination

7.4.3.7.3 HVAC Equipment Startup Tests
The contractor or vendor who has contractual obligation to provide start up services ***SHALL*** start up the systems and equipment in accordance with the Contract Documents and the manufacturer's requirements. Completed start up check sheets are then provided to the CA. The CA ***MAY*** observe and document these start up tests. At a minimum start up tests ***SHOULD*** include the following:

a. Manufacturer's Name
b. Model Number
c. Type and Size
d. Serial Number
e. Actual Settings or Adjustments
f. Actual Electrical Characteristics
g. Actual load
h. Operating data as required by the manufacturer

7.4.3.7.4 Control System Startup Tests
The CA ***SHALL*** provide a 100% point-to-point control system test and sensor calibration as verification of the control system operational status with no sampling strategies allowed. The control point-to-point test shall verify the system operation from the system graphic to the end sensor or control device. The control tests ***SHOULD*** include the following:

a. Controller Manufacturer
b. Controller or System identification
c. Verification of controller communication
d. Pin Address
e. Point ID and name
f. Point type
g. Connected device description
h. Verification of action and polarity
i. Verification of status indication
j. Actual sensor reading, system reading and offset

7.4.3.8 Update the OPR and the BOD

The Owner must update the OPR and the design professionals must update the BOD during construction phase to incorporate any approved HVAC changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final construction.

7.4.3.9 Update the Commissioning Plan

The CA ***SHALL*** update the Commissioning Plan to include any changes to the commissioning team members, their responsibilities, contact information, procedures, schedules or changes to the commissioning requirements as a result of the Construction Phase. The Commissioning Plan shall also be updated to include all revised or added check sheets or forms utilized during the Pre-Functional Tests.

7.4.3.10 Issues Log & Deficiency Resolution

The CA ***SHALL*** report deficiencies from any PFT on the Issues Log and it shall be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA ***SHALL*** assist as necessary to complete the issue log. After corrective action, retests shall be performed to verify conformance. When deficiencies are resolved, the issues shall be signed off on the Issues Log by the appropriate Commissioning Team Member(s). All issue log items must be resolved or answered by the appropriate commissioning team member. Issues that are resolved in a manner not consistent with the OPR must be approved by the Owner.

7.4.4 CONSTRUCTION PHASE DOCUMENTATION

The following commissioning documents are produced during the Construction Phase commissioning, if these activities are included in commissioning scope of work:

a. Kick off team meeting agenda and minutes ***(SHALL)***
b. Agendas and Minutes of all commissioning team meetings ***(SHALL)***
c. Commissioning duration schedules ***(SHOULD)***
d. Submittal & Shop Drawing review documents ***(SHALL)***
e. Site Observation reports ***(SHALL)***
f. Pre-Functional Test report check sheets: Installation Verification Tests, Static Tests and Equipment Startup Tests ***(SHALL)***
g. Updated Owner's Project Requirements ***(SHOULD)***
h. Updated Commissioning Plan ***(SHALL)***
i. Updated Issues Log ***(SHALL)***

7.5 ACCEPTANCE PHASE COMMISSIONING

7.5.1 INTRODUCTION

During the Acceptance Phase the Commissioning Team works to verify the functionality of all equipment, systems and components. The Commissioning Team assures that all systems are functioning in a manner that conforms to the OPR. The Commissioning Team also coordinates the level of Owners Personnel Training.

7.5.2 ACCEPTANCE PHASE RESPONSIBILITIES

7.5.2.1 Commissioning Team Members

The required commissioning team members for the Acceptance Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives (if required)
d. Construction Manager Representative (if required)
e. General Contractor Representatives (if required)
f. Mechanical Contractor Representative (if required)
g. Electrical Contractor Representative (if required)
h. Control Contractor Representative
i. Test & Balance Representative (if required)
j. Specialty Contractor Representative (if required)

7.5.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

7.5.3 ACCEPTANCE PHASE ACTIVITIES

7.5.3.1 Commissioning Duration Schedule

The CA ***SHOULD*** continue to monitor and update the duration schedules for the contractors for the commissioning activities in the Acceptance Phase required by the Commissioning Plan. These duration schedules should track all commissioning activities of the Commissioning Team in this phase.

7.5.3.2 Commissioning Team Meetings

The CA ***SHALL*** continue to attend and lead all commissioning meetings as required with the Commissioning Team to review progress of the commissioning effort and reinforce individual responsibilities.

7.5.3.3 Testing, Adjusting and Balancing Report Verification

The CA ***SHALL*** verify that the completeness and accuracy of the final Testing, Adjusting and Balancing Report. This verification ***SHALL*** include repeatable observations of selected TAB readings. The CA ***SHALL*** pick readings to be repeated at random. If these tests do not show repeatability to the TAB report within specified balance tolerances, the TAB contractor ***SHALL*** be required to re-balance the selected systems until repeatability is proved. The CA ***SHALL*** determine the extent and quantity of repeatability tests to prove the integrity of the balance efforts.

7.5.3.4 Functional Performance Tests (FPT)
Functional Performance Tests ***SHALL*** be designed by the CA and performed by the Commissioning Team. The CA or his staff ***SHALL*** observe and facilitate the FPT for all systems that have operating sequences. The CA ***SHALL*** provide final approval for Functional Performance Test results. FPT ***SHALL*** be performed for all sequences with no sampling strategies allowed except for application specific, factory programmed devices that cannot have the program modified in the field. The FPT tests ***SHALL*** include the following:

a. System description
b. Specific function being tested
c. Functional test design
d. Description of data points tested
e. Description of test duration and test interval times
f. Description of test setpoints and setpoint changes
g. Description of test report documentation requirements
h. Description of test pass/fail criteria

7.5.3.5 Sound & Vibration (S&V) Testing
The CA ***SHALL*** verify that the Sound level tests and Vibration measurements tests have been completed in accordance with the Contract Documents and ***SHALL*** review the final S&V Report for completeness and accuracy.

7.5.3.6 Record Documents / As-Built Drawings and Operations and Maintenance (O&M) Manuals
The Contractors ***SHALL*** create and assemble the Operations and Maintenance Manuals as contractually required. The drawings and manuals are then forwarded to the design professional for review and approval. The CA ***SHOULD*** review all Record Documents and Operations and Maintenance Manuals for accuracy and completeness to the Contract Documents and for conformance to the OPR. The CA ***SHOULD*** review these documents after review and approval by the design professional. The Record Documents and the O&M Manuals ***SHOULD*** include:

a. Final Approved Submittals
b. Final Approved Shop Drawings
c. Record Documents
d. Service Procurement information
e. Operating Manuals specifically tailored to the exact equipment, systems and components installed
f. Maintenance Requirements and Procedures
g. Lubrication lists and instructions
h. Recommended spare parts lists with purchase contact information
i. Warranty information

The CA ***SHOULD*** verify that the Record Documents and O&M Manuals are reviewed, approved and delivered to the Owner prior to operator training.

7.5.3.7 Owner Training
The CA ***SHOULD*** work with the contractor and Owner to schedule and plan training activities so that training occurs in a coordinated and coherent fashion. The CA ***SHOULD*** assist in the development of training schedules and agendas, encourage the use of a combination of “classroom” and field training, and assist the contractors in the development of training agendas for each system, piece of equipment or component installed in the project.

The design professionals, contractors and vendors provide the training instruction and provide training materials. Additional operator skill training ***MAY*** be provided as an additional scope item if desired by the Owner.

The CA ***MAY*** document Owner training events by video taping presentations and demonstrations for future use by the Owner.

7.5.3.8 Update the OPR and BOD
The Owner must update the OPR and the design professionals must update the BOD during Construction Phase to incorporate any approved HVAC changes that may have developed due to changes, additions, deletions, or other modifications incorporated during the Acceptance Phase.

7.5.3.9 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any changes to the Commissioning Team members, their responsibilities, their contact information, procedures, schedules or changes to the commissioning requirements as a result of the Acceptance Phase. The Commissioning Plan shall also be updated to include all revised or added check sheets or forms utilized during the Functional Performance Tests. The Commissioning Plan ***SHOULD*** include:

a. Description of the commissioning process utilized for the project
b. Commissioning Team member identification and contact information
c. Team member responsibilities
d. Commissioning FPT forms index
e. Copies of all typical FPT forms

7.5.3.10 Issues Log & Deficiency Resolution
The Owner must manage the Issue Log as to timely issue answers and resolutions. The Owner shall have final authority over issue resolution disagreements or interpretations. The final Issues Log, its statements and its statement responses, ***SHALL*** become permanent record of the commissioning process.

7.5.3.11 Update the Issues Log
The CA ***SHALL*** report deficiencies from the FPT on the Issues Log and it ***SHALL*** be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA ***SHALL*** assist as necessary to complete the issue log. After corrective action, retests ***SHALL*** be performed to verify conformance. When deficiencies are resolved, the issues ***SHALL*** be signed off on the Issues Log by the CA and the appropriate Commissioning Team Member(s). All issue log items ***SHALL*** be resolved or answered by the appropriate commissioning team member. Issues that are resolved in a manner that are not consistent with the OPR must be approved by the Owner. If after three attempts by the CA to obtain an issue resolution a CA can issue a certified report by clearly describing the unresolved issue in the Commissioning Report executive summary.

7.5.3.12 Final Commissioning Report
Based on the accumulated commissioning work completed as described above, the CA ***SHALL*** assemble the data into a final Commissioning Report. The final report will incorporate the final record documents for each system, as appropriate. The Commissioning Report will include:

a. Report Title Page (***SHALL***)
b. Report Certification Page (***SHALL***)
c. Table of contents Page (***SHALL***)
d. Executive Summary (***SHALL***)
e. Project OPR (***SHOULD***)
f. Commissioning Plan (***SHALL***)
g. Final Issue Log (***SHALL***)
h. Completed Pre Functional Test Forms and Check Sheets (***SHALL***)
i. Completed Functional Performance Test Forms and Check Sheets (***SHALL***)
j. Observation Reports (***SHALL***)
k. Training Verification Records (***SHOULD***)
l. Commissioning Communications (***SHALL***)
m. Test Instrument Page (***SHALL***)

7.5.3.13 Systems Manual

At the end of the Acceptance Phase the CA ***MAY*** produce the Systems Manual. The purpose of the Systems Manual is to provide the Owner and his operators with a permanent record of all pertinent documents required for future operation, commissioning and validation processes of the facility. The Systems Manual ***SHOULD*** be provided to the Owner in electronic format. The final system manual ***SHOULD*** include the following:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operating and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures
j. TAB Report

7.5.4 ACCEPTANCE PHASE DOCUMENTATION

The following commissioning documents are produced during the Acceptance Phase commissioning if these activities are included in commissioning scope of work.

a. Completed TAB Verification Forms ***(SHALL)***
b. Completed Functional Performance Tests Report Forms ***(SHALL)***
c. O&M Review Document ***(SHOULD)***
d. Commissioning Report ***(SHALL)***
e. Systems Manual ***(MAY)***
f. Training Agenda ***(SHOULD)***

7.6 WARRANTY PHASE COMMISSIONING

7.6.1 INTRODUCTION

During the Warranty Phase the Commissioning Team works to verify the installed equipment and systems are meeting the OPR at the end of the warranty period.

7.6.2 WARRANTY PHASE REPSONSIBILITIES

7.6.2.1 Commissioning Team Members

The required Commissioning Team members for the Warranty Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives
d. Construction Manager Representatives
e. General Contractor Representatives
f. Applicable Subcontractors
g. Applicable Vendors

7.6.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

7.6.3 WARRANTY PHASE ACTIVITIES

7.6.3.1 Deferred Systems Tests

The CA and all applicable contractors and vendors ***SHALL*** provide any required deferred system Functional Performance Tests required by the commissioning plan. Functional Performance Tests ***SHALL*** be designed by the CA and performed by the contractors or Owner. The CA ***SHOULD*** observe and facilitate all functional performance tests for all systems that have operating sequences. The CA ***SHALL*** provide final approval for Functional Performance test results.

7.6.3.2 Warranty Visit

The CA ***SHOULD*** inspect the site and interview building operating personnel to identify any outstanding warranty failures and to identify any persistent equipment failure issues that should be handled within the warranty period. This site visit should occur approximately two months prior to the end of the warranty period.

7.6.3.3 Lessons Learned Workshop

The CA ***MAY*** perform a lessons learned workshop with the owner, designers and/or construction team members. The purpose of the lessons learned workshop is to determine how to improve the process for future projects.

7.6.4 WARRANTY PHASE DOCUMENTATION

The following commissioning documents are produced during the Warranty Phase commissioning if these activities are included in commissioning scope of work.

a. Deferred Functional Performance Tests Check Sheets and Forms ***(SHALL)***
b. Warranty visit documentation with associated issues ***(SHALL)***
c. Commissioning Report Addenda with deferred testing results ***(SHALL)***
d. Lessons Learned Workshop report (***MAY***)

NEBB COMMISSIONING REQUIREMENTS - HVAC SYSTEMS			
Item	***SHALL***	***SHOULD***	***MAY***
PRE DESIGN PHASE COMMISSIONING *(If included in commissioning scope)*			
Commissioning Scope defined on Certification page	Owner Establishes	CA Assist	
Create OPR	Owner Perform	CA Assists	CA Perform
Create Preliminary Commissioning Plan	CA Perform		
Create Issues Log	CA Perform		
System Manual Requirements			CA Perform
DESIGN PHASE COMMISSIONING (DPC) *(If included in commissioning scope)*			
Create or Update Commissioning Plan	CA Perform		
Create or Update Issues Log	CA Perform		
Design Kick Off Meeting		CA Perform	
Schematic Design Review			CA Perform
Update OPR	Owner Perform	CA Perform	
Update BOD	Engineer Perform		
Basis of Design Review		CA Perform	
Specification & Drawing Review near 100% CD's	CA Perform		
Define training requirements for Owners personnel	Owner Perform	CA Perform	
Create Commissioning Specifications		CA Perform	
Pre Bid Meeting		CA Assist	
CONSTRUCTION PHASE COMMISSIONING			
Construction Kick Off Meeting	CA Perform		
Create Commissioning Duration Schedules		CA Perform	
Submittal and Shop Drawing Review	CA Perform		
Update Issues Log	CA Perform		
Update Commissioning Plan	CA Perform		
Update OPR and BOD	Owner Perform	CA Perform	
Site Observations for all Systems and Equipment	CA Perform		
Site Observations for all Control Systems and Equipment	CA Perform		
Create HVAC Pre Functional Equipment Installation Check Sheets	Contractor Perform	CA Perform	
Perform HVAC Pre Functional Equipment Installation Check Sheets	Contractor Perform	CA Verify	CA Perform
Create HVAC Pre Functional Test Equipment Start Up Sheets	Mfr. / Vendor Perform		CA Perform
Perform & Doc Pre Functional Equipment Start Up Tests	Contractor Perform		CA Observe
Create Controls Pre Functional Installation Check Sheets	Contractor Perform	CA Perform	
Perform & Doc Controls Pre Functional Installation Check Sheets	Contractor Perform	CA Perform	CA Perform
Perform & Document Static Tests	Contractor Perform		CA Observe
Create Pre Functional Controls Point to Point Check Sheets	CA Perform		
Perform Pre Functional Controls Point to Point Check Sheets	CA Perform		
ACCEPTANCE PHASE COMMISSIONING			
Create Functional Performance Test Check Sheets	CA Perform		
Program, run & Doc Functional Performance Tests	Contractor Perform	CA Observe	Owner or CA Perform
Witness functionality of FPT tests	CA Perform		
Approve Functional Tests results	CA Perform		
Perform TAB verification utilizing sampling strategies	CA Perform		
Review Operating and Maintenance Manuals	Engineer Perform	CA Perform	
Create Training Schedules with Owner	Contractor Perform	CA Assist	CA Perform
Assist contractors in developing Training Agendas		CA Perform	
Update Issues Log	CA Perform		
Update OPR	Owner Perform	CA Perform	
Update BOD	Engineer Perform		
Document Owner Training			CA Perform
Create Final Commissioning Report	CA Perform		
Create Final System Manual			CA Perform
WARRANTY PHASE COMMISSIONING *(If included in commissioning scope)*			
Create Deferred Functional Test Check Sheets	CA Perform		
Perform & Document Deferred Functional Tests	Contractor Perform	CA Observe	Owner or CA Perform
Witness functionality of FPT tests	CA Perform		
Approve Deferred Functional Tests results	CA Perform		
Perform Warranty Visit & Documentation		CA Perform	
Create Commissioning Report Addenda	CA Perform		
Update Issues Log	CA Perform		
Perform a Lessons learned workshop			CA Perform

SECTION 8 COMMISSIONING OF BUILDING ENVELOPE SYSTEMS

8.1 INTRODUCTION

The purpose of Section 8 is to describe the requirements for commissioning a project's Building Envelope systems, equipment and components. While Section 6 details the elements of the commissioning process in global terms, this section will detail the minimum requirements for a NEBB Certified Building Envelope Commissioning project. The actual scope of work may differ from these requirements. These minimum requirements are described as ***SHALL*** requirements. ***SHOULD*** requirements are recommended to produce a higher quality project and ***MAY*** requirements could be included to enhance the commissioning project. These minimum requirements take precedence when a scope of work is not defined, or the requirements state words to effect that the "…project ***SHALL*** be commissioned in accordance with the requirements of the NEBB *Procedural Standards for Whole Building Systems Commissioning of New Construction."* To be a NEBB certified report the following must apply:

1. The actual contracted scope of work ***SHALL*** be clearly defined on the certification page of the report as specified in the contract documents or as agreed to between the Owner / Buyer and the NEBB Certified BSC Firm.
2. If the scope of work differs from the NEBB ***SHALL*** language it shall be clearly delineated on the certification page of the report otherwise all ***SHALL*** language must be adhered to for a NEBB Certified Report.

8.2 PRE-DESIGN PHASE COMMISSIONING

8.2.1 INTRODUCTION

There are two main purposes of the Pre-Design Phase. The first is to develop and document the Owner's Project Requirements (OPR) and the second is to develop the Preliminary Commissioning Plan.

8.2.2 PRE-DESIGN PHASE RESPONSIBILITIES

8.2.2.1 Commissioning Team Members

During the Pre-Design Phase the Owner should assign or contract for the appropriate Commissioning Team members to facilitate the Pre-Design process. The required Commissioning team members for the Pre-Design Phase should be as follows:

a. Owner's Representatives
b. Commissioning Authority (CA)
c. Programming Professionals if applicable
d. Architect
e. Landscape Architect
f. Mechanical & Electrical Engineer if applicable
g. Construction Manager / General Contractor if applicable

8.2.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member must be responsible for contributing to the commissioning process based on their individual project responsibilities.

8.2.3 PRE-DESIGN PHASE ACTIVITIES

8.2.3.1 OPR Definition and Development

The Owner should produce the Owner's Project Requirements (OPR) to facilitate the design and delivery of the project. The OPR outlines the expectations the Owner has for the Building Envelope requirements of the project. The Building Envelope OPR ***SHOULD*** include the following items that relate to the Building Envelope system:

a. Use and space requirements
b. Anticipated occupancy
c. Building Envelope construction budget
d. Building Envelope codes or standards to be utilized
e. Special systems or equipment requirements that may affect Building Envelope calculations and loads
f. Specific material or equipment requirements
g. Energy efficiency expectations
h. Sustainability requirements
i. Ongoing Commissioning & Building Rating Requirements
j. Feature Automation and Controls sophistication
k. Vibration, sound and / or seismic requirements
l. Operation and maintenance criteria
m. Owner's expectations for operator and occupant training
n. Requirements for future facility adaptation and expansion
o. Owner's expectations of the design team and their produced documents
p. Owner's expectations of the construction team and their document requirements
q. Owner's expectations of the Commissioning Authority and their document requirements

8.2.3.2 Commissioning Plan

The CA ***SHALL*** develop a preliminary Building Envelope Commissioning Plan that documents the following:

a. The commissioning scope
b. The Commissioning Team
c. Normal channels of communication
d. Design phase commissioning procedures
e. Design phase commissioning duration schedules

8.2.3.3 Issues Log

The CA ***SHALL*** develop the format of the Issues Log to be utilized for the commissioning process. The Issues Log should address the manner that the perceived Building Envelope deficiencies will be documented by the CA and communicated to the design professionals and the contractors during subsequent commissioning phases of the project development and delivery. The Issues Log should also address the deficiency resolution procedure. The Issues Log should include:

a. Issue Number
b. Issue statement
c. Date of Issue statement

d. Person making issue statement
e. Issue statement response
f. Date of Issue statement response
g. Person making the issue statement response

8.2.3.4 Commissioning Scope(s) of Work and Budgeting
The CA ***SHOULD*** assist the Owner in developing the commissioning scope of the project and its associated costs. Project scope should include:

a. Phase to be commissioned: The Owner must determine which phases will be commissioned for the project such as Pre-Design Phase, Design Phase, Construction Phase, Acceptance Phase and Warranty Phase.
b. Systems to be commissioned: The Owner must determine which systems will be commissioned for the project including special systems and if any areas will be excluded from the commissioning project.
c. The commissioning scope shall be based upon this NEBB BSC Procedural Standard and its definition of the commissioning process and its required ***SHALL*** language. If the Owner desires to establish a different level of commissioning activities than those stated in this procedural standard it must be clearly delineated in the scope of work.
d. Level of Owner's participation in the commissioning process: The Owner must establish the level of participation their representatives will provide to the commissioning team during each phase of the commissioning project.

8.2.3.5 Develop System Manual Requirements
During the Pre-Design Phase the Commissioning Team and the CA ***MAY*** develop documents which will make up the system manual and determine what the Owner's Operator training requirements will be. The final system manual ***MAY*** include the following and should be provided in electronic format:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operating and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures
j. Test Reports

8.2.3.6 Commissioning Meetings
The CA ***SHALL*** conduct all Commissioning Team meetings as required to implement the commissioning process and ***SHALL*** issue meeting minutes as documentation of these meetings.

8.2.3.7 Update the OPR
The Owner must update the OPR during Pre-Design Phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications.

8.2.4 PRE-DESIGN PHASE DOCUMENTATION

The following commissioning documents are produced during Pre-Design Phase Commissioning if these activities are included in the commissioning scope of work:

a. Owner's Project Requirements ***(SHOULD)***
b. Preliminary Commissioning Plan ***(SHALL)***
c. Issues Log ***(SHALL)***
d. Commissioning Scope and Budgets ***(MAY)***
e. System Manual Index of contents ***(MAY)***

8.3 DESIGN PHASE COMMISSIONING

8.3.1 INTRODUCTION

During the Design Phase, the design professionals create the Contract Documents. The Contract Documents turn the OPR into working design documents. The CA ***SHALL*** evaluate and document that the Contract Documents conform to the OPR. The CA ***SHALL*** evaluate that the Building Envelope systems, equipment and components are incorporated into the Contract Documents to ensure they conform to the OPR from the standpoint of commissionability, maintainability, functionality and best practices.

8.3.2 DESIGN PHASE RESPONSIBILITIES

8.3.2.1 Commissioning Team Members

The required Commissioning Team members for the Design Phase should be:

a. Owner's Representatives
b. Commissioning Authority (CA)
c. Programming Professionals
d. Architect
e. Landscape Architect
f. Mechanical & Electrical Engineer if applicable
g. Construction Manager / General Contractor if applicable
h. Specialty, or Trade Contractors if applicable

8.3.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member is responsible for contributing to the commissioning processes according to their individual project responsibilities.

8.3.3 DESIGN PHASE ACTIVITES

8.3.3.1 OPR Definition and Development

If the project does not have a Pre-Design Phase, or if the OPR was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 8.2.3.1 for the requirements.

8.3.3.2 Commissioning Plan

If the project does not have a Pre-Design Phase, or if the Commissioning Plan was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 8.2.3.2 for the requirements.

8.3.3.3 Issues Log

If the project does not have a Pre-Design Phase, or if the Issues Log was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 8.2.3.3 for the requirements.

8.3.3.4 Design Kick-Off Meeting

The CA ***SHOULD*** conduct an initial Kickoff Meeting with the Design Team and the Owner. The purpose of the meeting will be to establish the purpose and proposed processes for commissioning the design and to review the Design Phase Commissioning Plan.

8.3.3.5 Commissioning Activities Scheduled
The CA ***SHALL*** verify that commissioning activities are incorporated into the Design Phase schedule.

8.3.3.6 Evaluate Basis of Design Conformance
The design professional should prepare the Basis of Design (BOD) document in response to the OPR. The BOD includes the Design Narrative and the Design Criteria. The CA ***SHOULD*** verify that the BOD conforms to the requirements of the OPR.

The Design Narrative s*hould* include the following:

a. Description of the selected Building Envelope components and the reasons they were selected
b. Description of other components that were analyzed and rejected and the reasons for rejections
c. Preliminary Building Envelope calculation requirements
d. Various systems approaches
e. Sustainability approach
f. Life cycle costing information of each system analyzed
g. Preliminary major component selection

The Design Criteria *should* at a minimum include the following:

a. Project location and special Building Envelope site requirements
b. Design parameters including: space occupancy, utility requirements, all special equipment requirements, special areas of concern and / or other criteria used that may define the methodology used to complete the Building Envelope design.
c. Sustainability design parameters including: daylighting, shading, renewable energy and envelope energy efficiency
d. Design assumptions and limitations
e. Accepted safety factors incorporated into the design
f. Reference to specific envelope component selection limitations for owner standardization
g. Operation assumptions
h. Codes, standards and guidelines to be utilized for the design

The CA ***SHOULD*** evaluate the BOD for conformance to the OPR from the standpoint of commissionability, maintainability, functionality and industry accepted best practices and produce an evaluation document.

8.3.3.7 Commissioning Specifications
The CA ***SHALL*** review the contract commissioning specifications and verify that they are included in the contract documents. The CA ***SHOULD*** assist in creating commissioning specifications to be included in the contract documents. The commissioning specifications should include the following:

a. Specification describing the basic commissioning process that will be used on the project by the CA, located in the general requirement area of the specification
b. Specification describing the commissioning activities required of any Vendor or material supplier or specialty subcontractor, located in each individual vendor, supplier or subcontractor specification section.

8.3.3.8 Establish Training Requirements

The CA ***SHOULD*** work with the Owner and the design professionals to define the training requirements for the Owner's personnel. Verify that these requirements are incorporated into the project specifications. Training ***SHOULD*** include:

a. Sustainability methods and measures presented by the Green Building Accredited Professional or the Architect
b. Operating procedures and Maintenance procedures for each type of equipment and system presented by the manufacture or contractor
c. Control system operations and programming training. Include durations extended over time.
d. Specify classroom instruction duration and field demonstration duration for each training event
e. O&M manual review for warranty repair or replacement procedures
f. Review of all warranty durations and start dates

8.3.3.9 Schematic Design Document Evaluation

The CA ***MAY*** complete a thorough evaluation of the Schematic Design (SD), or a 35% design review of documents to establish that the Building Envelope systems, materials and components are identified and can be installed in compliance with the OPR and the BOD. Schematic Design Document Evaluation ***MAY*** include: site design, architectural designs, engineering calculations, component selection, and component selection criteria.

8.3.3.10 Design Development Document Evaluation

The CA ***SHOULD*** complete a thorough evaluation of the Design Development (DD), or a 65% design review of documents and submitted criteria for continued compliance to the OPR and BOD; Evaluate design documents for commissioning specifications and requirements; Draft preliminary Commissioning Specifications and Supplemental Commissioning Language for other specifications if required. Design Document Evaluation ***SHOULD*** include specifications, typical layouts, standard details, schedules and coordination requirements.

8.3.3.11 Contract Documents Evaluation

The CA ***SHALL*** evaluate the contract documents at least once near 100% construction document level. The CA ***SHALL*** evaluate drawings and specifications for each system, component, and equipment for its commissionability, maintainability, functionality and best practices.

8.3.3.12 Meetings

The CA ***SHALL*** conduct all commissioning team meetings and shall issue meeting minutes as documentation of these meetings.

8.3.3.13 Update the OPR and the BOD

The Owner must update the OPR and the design professionals must update the BOD during design phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final Contract Documents.

8.3.3.14 Update the Commissioning Plan

The CA ***SHALL*** update the Commissioning Plan to include any additional Commissioning Team members, procedures and schedules or design phase commissioning requirements developed in the Design Commissioning process.

8.3.3.15 Issues Log Management
The Owner must manage the Issues Log as to timely issue answers and resolutions. The Owner has the final authority over issue resolution disagreements or interpretations. The final Issues Log, its statements and its statement answers ***SHALL*** become a permanent record of the commissioning process.

8.3.3.16 Update the Issues Log Documentation
The CA ***SHALL*** create and maintain the Issues log. The Issues Log shall be used throughout the commissioning process, going from a Design Phase issue log to a Construction Phase issue log, to an Acceptance Phase issue log and finally to a Warranty Phase issue log. The final (complete) issue log shall become a part of the final Commissioning Report.

8.3.3.17 Pre-Bid Meeting
The Owner should conduct a Pre-bid meeting to assist contractors in answering any questions about the systems or the commissioning process. The CA ***SHOULD*** attend the Pre-Bid meeting to fully explain the commissioning requirements of the Contract Documents and allow the contractors to understand their role in the commissioning process and its associated costs. The CA should provide any assistance required by the Owner in answering written questions (in the form of clarifications or addendum recommendations) during the bidding process.

8.3.4 DESIGN PHASE DOCUMENTATION
The following commissioning documents are produced during the Design Phase commissioning, if these activities are included in commissioning scope of work.

a. Updated Owner's Project Requirements **(*SHOULD)***
b. Updated Commissioning Plan **(*SHALL)***
c. Basis of Design Evaluation **(*SHOULD)***
d. Contract Document Evaluation **(*SHALL)***
e. Updated Issues Log **(*SHALL)***
f. Pre Bid Meeting minutes or documentation **(*SHOULD)***

8.4 CONSTRUCTION PHASE COMMISSIONING

8.4.1 INTRODUCTION
During the Construction Phase the commissioning team works to verify the installed components are installed in accordance with the design documents and are operable, maintainable and ready for functional testing.

8.4.2 CONSTRUCTION PHASE RESPONSIBILITES
8.4.2.1 Commissioning Team Members
The commissioning team members for the Construction Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives
d. Construction Manager Representatives
e. General Contractor Representatives
f. Specialty Control Contractor Representatives (If Required)
g. Specialty Contractor Representatives (If Required)

8.4.2.2 Commissioning Team Responsibilities
The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

8.4.3 CONSTRUCTION PHASE ACTIVITIES

8.4.3.1 Commissioning Plan
If the project does not have a Design Phase, or if the Commissioning Plan was not produced in the Design Phase, it ***SHALL*** be produced at this time by the CA. The commissioning plan should include:

a. Description of the commissioning scope and process utilized for the project
b. Commissioning Team member identification and contact information
c. Team member responsibilities
d. Commissioning check sheet or form index
e. Copies of all typical commissioning check sheets or forms

8.4.3.2 Construction Kick-Off Meeting
The CA ***SHALL*** conduct an initial commissioning meeting with all contractors and Commissioning Team members. The purpose of the meeting will be to review the Construction Phase Commissioning process and activities for the commissioning of the project. During the meeting the CA ***SHOULD*** review the following:

a. The Commissioning Plan
b. The basic commissioning processes to be utilized on the project
c. The individual roles and responsibilities of each participating Commissioning Team member
d. Documentation requirements
e. Communication and reporting procedures
f. The check sheets and forms to be utilized on the project
g. The commissioning duration schedules

The CA ***SHALL*** create the meeting agenda, lead the meeting and prepare and distribute the meeting minutes.

8.4.3.3 Commissioning Duration Schedule
The CA ***SHOULD*** prepare a duration schedules for the contractors for the commissioning activities required by the commissioning plan. These duration schedules ***SHOULD*** be incorporated into the contractor's project schedule to track all commissioning activities of the Commissioning Team.

8.4.3.4 Commissioning Team Meetings
The CA ***SHALL*** attend and lead all commissioning meetings as required with the Commissioning Team to review progress of the commissioning effort and reinforce individual responsibilities. Also, review completed work and agree upon the acceptability of the delivered product. The CA ***SHALL***:

a. Create the agenda
b. Attend and lead meeting
c. Schedule and review the commissioning activities
d. Coordinate commissioning meetings with construction meetings and activities
e. Prepare and distribute meeting minutes

8.4.3.5 Submittal and Shop Drawing Review

The CA ***SHALL*** review all pertinent submittals and shop drawings to support the Commissioning Process. The submittal and shop drawing review should include:

a. The submittal and shop drawing information is utilized to create the appropriate PFT check sheets and forms for the project.
b. The CA ***SHALL*** review the submittals & shop drawings for commissionability, maintainability, functionality, best practices and for conformance to the CD's, OPR and BOD.
c. The CA ***SHALL*** document any found issues on the project Issue Log. The Issues Log ***SHALL*** be forwarded to the appropriate Commissioning Team member for resolution.

8.4.3.6 Site Observations

During the course of construction, the CA ***SHALL*** visit the site to inspect the progress of construction with respect to the Building Envelope systems, materials and components being commissioned. The purpose of the inspections is to verify that the construction complies with the Contract Documents, the OPR and identify and document any quality issues that may lead to functional issues. Site observations are forwarded to the appropriate team member for their review and action. If site observation issues are not automatically accepted and resolved the observation is added to the issue Log for resolution.

8.4.3.7 Pre-Functional Tests (PFT)

There are three types of Building Envelope PFT that ***SHALL*** be performed during the construction phase: static tests, thermal scans and special systems startup tests.

8.4.3.7.1 Static Tests

The contractor must perform static tests as described in the Contract Documents. All static tests must be verified by the architect, contractor or CA as required by the Contract Documents. The CA ***MAY*** provide the static test sheets to the testing contractor. The CA ***MAY*** observe and document these static tests. Completed static test sheets are then provided to the CA. The CA ***MAY*** perform these static tests with his own forces if so desired. Examples of these tests include:

a. Whole building pressure tests
b. Room or component pressure tests
c. Rain Intrusion component test
d. Field thermal conductance component test
e. Field vapor transmittance component test
f. Moisture test
g. Blast resistance or other extraordinary events testing

8.4.3.7.2 Building Envelope Special Systems Startup Tests

The contractor or vendor who has contractual obligation to provide start up services ***SHALL***, create startup check sheets, start up the systems and equipment in accordance with the Contract Documents and the manufacturer's requirements. Completed start up check sheets are then provided to the CA. The CA ***MAY*** observe and document these start up tests. At a minimum start up tests ***SHOULD*** include the following:

a. Manufacturer's Name
b. Model Number
c. Type and Size
d. Serial Number
e. Actual Settings or Adjustments

f. Actual Electrical Characteristics
g. Operating data as required by the manufacturer

8.4.3.7.3 Typical Building Envelope Special Systems
Typical Building Envelope special systems are:

a. Automated Doors
b. Automated Windows
c. Automated Blinds and Shades
d. Other Automated systems that are not a part of Mechanical, Fire Protection, Electrical or Special Electrical systems

8.4.3.7.4 Special Systems Automated Control System Startup Tests
The CA ***SHALL*** provide a 100% point-to-point control system test and sensor calibration as verification of the control system operational status with no sampling strategies allowed. The control point-to-point test shall verify the system operation from the system graphic, if applicable, to the end sensor or control device. The control tests ***SHOULD*** include the following:

a. Controller Manufacturer
b. Controller or System identification
c. Verification of controller communication
d. Pin Address
e. Point ID and name
f. Point type
g. Connected device description
h. Verification of action and polarity
i. Verification of status indication
j. Actual sensor reading, system reading and offset

8.4.3.8 Update the OPR and the BOD
The Owner must update the OPR and the design professionals must update the BOD during construction phase to incorporate any approved Building Envelope changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final construction.

8.4.3.9 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any changes to the commissioning team members, their responsibilities, contact information, procedures, schedules or changes to the commissioning requirements as a result of the Construction Phase. The Commissioning Plan shall also be updated to include all revised or added check sheets or forms utilized during the Pre-Functional Tests.

8.4.3.10 Issues Log & Deficiency Resolution
The CA ***SHALL*** report deficiencies from any PFT on the Issues Log and it shall be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA ***SHALL*** assist as necessary to complete the issue log. After corrective action, retests shall be performed to verify conformance. When deficiencies are resolved, the issues shall be signed off on the Issues Log by the appropriate Commissioning Team Member(s). All issue log items must be resolved or answered by the

appropriate commissioning team member. Issues that are resolved in a manner not consistent with the OPR must be approved by the Owner.

8.4.4 CONSTRUCTION PHASE DOCUMENTATION

The following commissioning documents are produced during the Construction Phase commissioning if these activities are included in commissioning scope of work:

a. Kick off team meeting agenda and minutes ***(SHALL)***
b. Agendas and Minutes of all commissioning team meetings ***(SHALL)***
c. Commissioning duration schedules ***(SHOULD)***
d. Submittal & Shop Drawing review documents ***(SHALL)***
e. Site Observation reports ***(SHALL)***
f. Pre-Functional Test report check sheets: Installation Verification Tests, Static Tests and System Startup Tests ***(SHALL)***
g. Updated Owner's Project Requirements ***(SHOULD)***
h. Updated Commissioning Plan ***(SHALL)***
i. Updated Issues Log ***(SHALL)***

8.5 ACCEPTANCE PHASE COMMISSIONING

8.5.1 INTRODUCTION

During the Acceptance Phase the Commissioning Team works to verify the functionality of all systems, equipment, systems and components. The Commissioning Team assures that all systems are functioning in a manner that conforms to the OPR. The Commissioning Team also coordinates the level of Owners Personnel Training.

8.5.2 ACCEPTANCE PHASE RESPONSIBILITIES

8.5.2.1 Commissioning Team Members

The required commissioning team members for the Acceptance Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives (if required)
d. Construction Manager Representatives (if required)
e. General Contractor Representatives (if required)
f. Specialty Control Contractor Representatives (if required)
g. Specialty Contractor Representatives (if required)

8.5.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

8.5.3 ACCEPTANCE PHASE ACTIVITIES

8.5.3.1 Commissioning Duration Schedule

The CA ***SHOULD*** continue to monitor and update the duration schedules for the contractors for the commissioning activities in the Acceptance Phase required by the Commissioning Plan. These duration schedules should track all commissioning activities of the Commissioning Team in this phase.

8.5.3.2 Commissioning Team Meetings
The CA ***SHALL*** continue to attend and lead all commissioning meetings as required with the Commissioning Team to review progress of the commissioning effort and reinforce individual responsibilities.

8.5.3.3 Functional Performance Tests (FPT)
Functional Performance Tests ***SHALL*** be designed by the CA and performed by the Commissioning Team. The CA ***SHALL*** observe and facilitate the FPT. The FPT tests ***SHALL*** include the following:

a. System or component description
b. Specific item or function being tested
c. Functional test procedure
d. Description of test report documentation requirements
e. Description of test pass/fail criteria

8.5.3.4 Functional Performance Tests (FPT)
Typical FPT tests for Building Envelope ***SHOULD*** include the following:

a. Thermal Scans for Temperature migration
b. Thermal Scans or moisture meter readings for moisture detection
c. FPT tests for Building Envelope Special Systems Control Functionality

8.5.3.5 Sound & Vibration (S&V) Testing
The CA ***SHALL*** verify that the Sound level tests and Vibration measurements tests have been completed in accordance with the Contract Documents and ***SHALL*** review the final S&V Report for completeness and accuracy.

8.5.3.6 Record Documents / As-Built Drawings and Operations and Maintenance (O&M) Manuals
The Contractors ***SHALL*** create and assemble the Operating and Maintenance Manuals as contractually required. The drawings and manuals are then forwarded to the design professional for review and approval. The CA ***SHOULD*** review all Record Documents and Operating and Maintenance Manuals for accuracy and completeness to the Contract Documents and for conformance to the OPR. The CA ***SHOULD*** review of these documents after review and approval by the design professional. The Record Documents and the O&M Manuals ***SHOULD*** include:

a. Final Approved Submittals
b. Final Approved Shop Drawings
c. Record Documents
d. Service Procurement information
e. Operating Manuals specifically tailored to the exact equipment, systems and components installed
f. Maintenance Requirements and Procedures
g. Lubrication lists and instructions
h. Recommended spare parts lists with purchase contact information
i. Warranty information

The CA ***SHOULD*** verify that the Record Documents and O&M Manuals are reviewed, approved and delivered to the Owner prior to operator training.

8.5.3.7 Owner Training

The CA ***SHOULD*** work with the contractor and Owner to schedule and plan training activities so that training occurs in a coordinated and coherent fashion. The CA ***SHOULD*** assist in the development of training schedules and agendas, encourage the use of a combination of "classroom" and field training, and assist the contractors in the development of training agendas for each system, piece of equipment or component installed in the project.

The design professionals, contractors and vendors provide the training instruction and provide training materials. Additional operator skill training ***MAY*** be provided as an additional scope item if desired by the Owner.

The CA ***MAY*** document Owner training events by video taping presentations and demonstrations for future use by the Owner.

8.5.3.8 Update the OPR and BOD

The Owner must update the OPR and the design professionals must update the BOD during Construction Phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications incorporated during the Acceptance Phase.

8.5.3.9 Update the Commissioning Plan

The CA ***SHALL*** update the Commissioning Plan to include any changes to the Commissioning Team members, their responsibilities, their contact information, procedures, schedules or changes to the commissioning requirements as a result of the Acceptance Phase. The Commissioning Plan shall also be updated to include all revised or added check sheets or forms utilized during the Functional Performance Tests. The Commissioning Plan ***SHOULD*** include:

a. Description of the commissioning process utilized for the project
b. Commissioning Team member identification and contact information
c. Team member responsibilities
d. Commissioning FPT forms index
e. Copies of all typical FPT forms

8.5.3.10 Issues Log & Deficiency Resolution

The Owner must manage the Issue Log as to timely issue answers and resolutions. The Owner shall have final authority over issue resolution disagreements or interpretations. The final Issues Log, its statements and its statement responses, ***SHALL*** become permanent record of the commissioning process.

8.5.3.11 Update the Issues Log

The CA ***SHALL*** report deficiencies from the FPT on the Issues Log and it ***SHALL*** be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA ***SHALL*** assist as necessary to complete the issue log. After corrective action, retests ***SHALL*** be performed to verify conformance. When deficiencies are resolved, the issues ***SHALL*** be signed off on the Issues Log by the CA and the appropriate Commissioning Team Member(s). All issue log items ***SHALL*** be resolved or answered by the appropriate commissioning team member. Issues that are resolved in a manner that are not consistent with the OPR must be approved by the Owner. If after three attempts by the CA to obtain an issue resolution a CA can issue a certified report by clearly describing the unresolved issue in the Commissioning Report executive summary.

8.5.3.12 Final Commissioning Report

Based on the accumulated commissioning work completed as described above, the CA ***SHALL*** assemble the data into a final Commissioning Report. The final report will incorporate the final record documents for each system, as appropriate. The Commissioning Report ***SHALL*** include:

a. Report Title Page ***(SHALL)***
b. Report Certification Page ***(SHALL)***
c. Table of Contents Page ***(SHALL)***
d. Executive Summary ***(SHALL)***
e. Project OPR ***(SHOULD)***
f. Commissioning Plan ***(SHALL)***
g. Final Issue Log ***(SHALL)***
h. Completed Pre Functional Test Forms and Check Sheets ***(SHALL)***
i. Completed Functional Performance Test Forms and Check Sheets ***(SHALL)***
j. Observation Reports ***(SHALL)***
k. Training Verification Records ***(SHOULD)***
l. Commissioning Communications ***(SHALL)***
m. Test Instrument Page ***(SHALL)***

8.5.3.13 Systems Manual

At the end of the Acceptance Phase the CA ***MAY*** produce the Systems Manual. The purpose of the Systems Manual is to provide the Owner and his operators with a permanent record of all pertinent documents required for future operation, commissioning and validation processes of the facility. The Systems Manual ***SHOULD*** be provided to the Owner in electronic format. The final system manual ***SHOULD*** include the following:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operating and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures

8.5.4 ACCEPTANCE PHASE DOCUMENTATION

The following commissioning documents are produced during the Acceptance Phase commissioning if these activities are included in commissioning scope of work.

a. Completed Functional Performance Tests Report ***(SHALL)***
b. O&M Review Document ***(SHOULD)***
c. Commissioning Report ***(SHALL)***
d. Systems Manual ***(MAY)***
e. Training Agenda ***(SHOULD)***

8.6 WARRANTY PHASE COMMISSIONING

8.6.1 INTRODUCTION

During the Warranty Phase the Commissioning Team works to verify the installed equipment and systems are meeting the OPR at the end of the warranty period.

8.6.2 WARRANTY PHASE RESPONSIBILITIES

8.6.2.1 Commissioning Team Members

The required Commissioning Team members for the Warranty Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives
d. Construction Manager Representatives
e. General Contractor Representatives
f. Applicable Subcontractors
g. Applicable Vendors

8.6.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

8.6.3 WARRANTY PHASE ACTIVITIES

8.6.3.1 Deferred Systems Tests

The CA and all applicable contractors and vendors ***SHALL*** provide any required deferred system Functional Performance Tests as required by the commissioning plan. Functional Performance Test's ***SHALL*** be designed by the CA and performed by the contractors or Owner. The CA ***SHOULD*** observe and facilitate all functional performance tests. The CA ***SHALL*** provide final approval for Functional Performance test results.

8.6.3.2 Warranty Visit

The CA ***SHOULD*** inspect the site and interview building operating personnel to identify any outstanding warranty failures and to identify any persistent equipment failure issues that should be handled within the warranty period. This site visit should occur approximately two months prior to the end of the warranty period.

8.6.4 WARRANTY PHASE DOCUMENTATION

The following commissioning documents are produced during the Warranty Phase commissioning if these activities are included in commissioning scope of work.

a. Deferred Functional Performance Tests Check Sheets and Forms ***(SHALL)***
b. Warranty visit documentation with associated issues ***(SHALL)***
c. Commissioning Report Addenda with deferred testing results ***(SHALL)***
d. Lessons Learned Workshop Report ***(MAY)***

NEBB COMMISSIONING REQUIREMENTS - BUILDING ENVELOPE SYSTEMS			
Item	***SHALL***	***SHOULD***	***MAY***
PRE DESIGN PHASE COMMISSIONING *(If included in commissioning scope)*			
Commissioning Scope defined on Certification page	Owner Establishes	CA Assist	
Create OPR	Owner Perform	CA Assists	CA Perform
Create Preliminary Commissioning Plan	CA Perform		
Create Issues Log	CA Perform		
System Manual Requirements			CA Perform
DESIGN PHASE COMMISSIONING (DPC) *(If included in commissioning scope)*			
Create or Update Commissioning Plan	CA Perform		
Create or Update Issues Log	CA Perform		
Design Kick Off Meeting		CA Perform	
Schematic Design Review			CA Perform
Update OPR	Owner Perform	CA Perform	
Update BOD	Engineer Perform		
Basis of Design Review		CA Perform	
Specification & Drawing Review near 100% CD's	CA Perform		
Define training requirements for Owners personnel	Owner Perform	CA Perform	
Create Commissioning Specifications		CA Perform	
Pre Bid Meeting		CA Assist	
CONSTRUCTION PHASE COMMISSIONING			
Construction Kick Off Meeting	CA Perform		
Create Commissioning Duration Schedules		CA Perform	
Submittal and Shop Drawing Review	CA Perform		
Update Issues Log	CA Perform		
Update Commissioning Plan	CA Perform		
Update OPR and BOD	Owner Perform	CA Perform	
Site Observations during construction	CA Perform		
Create Pre Functional Check Sheets	Contractor Perform	CA Perform	
Perform Pre Functional Check Sheets	Contractor Perform	CA Verify	CA Perform
Create Pre Functional Test Automated Systems Start Up Sheets	Mfr / Vendor Perform		CA Perform
Perform & Doc Pre Functional Auto Systems Start Up Tests	Contractor Perform		CA Observe
Create Controls Pre Functional Installation Check Sheets	Contractor Perform	CA Perform	
Perform & Doc Controls Pre Functional Installation Check Sheets	Contractor Perform	CA Perform	CA Perform
Perform & Document Envelope Static Tests	Contractor Perform	CA Observe	
Create Pre Functional Controls Point to Point Check Sheets	CA Perform		
Perform Pre Functional Controls Point to Point Check Sheets	CA Perform		
ACCEPTANCE PHASE COMMISSIONING			
Create Functional Performance Test Procedures & Check Sheets	CA Perform		
Perform Thermal & Moisture FPT	CA Perform		
Program, run & Doc Special Systems FPT Tests	Contractor Perform	CA Observe	Owner or CA Perform
Witness functionality of Special Systems FPT tests	CA Perform		
Approve Special Systems Functional Tests results	CA Perform		
Review Operating and Maintenance Manuals	Engineer Perform	CA Perform	
Create Training Schedules with Owner	Contractor Perform	CA Assist	CA Perform
Assist contractors in developing Training Agendas		CA Perform	
Update Issues Log	CA Perform		
Update OPR	Owner Perform	CA Perform	
Update BOD	Engineer Perform		
Document Owner Training			CA Perform
Create Final Commissioning Report	CA Perform		
Create Final System Manual			CA Perform
WARRANTY PHASE COMMISSIONING *(If included in commissioning scope)*			
Create Deferred Functional Test Check Sheets	CA Perform		
Perform & Document Deferred Functional Tests	Contractor Perform	CA Observe	Owner or CA Perform
Witness functionality of FPT tests	CA Perform		
Approve Deferred Functional Tests results	CA Perform		
Perform Warranty Visit & Documentation		CA Perform	
Create Commissioning Report Addenda	CA Perform		
Update Issues Log	CA Perform		
Perform a Lessons learned workshop			CA Perform

SECTION 9 COMMISSIONING OF ELECTRICAL SYSTEMS

9.1 INTRODUCTION

The purpose of Section 9 is to describe the requirements for commissioning a project's Electrical systems, equipment and components. While Section 6 details the elements of the commissioning process in global terms, this section will detail the minimum requirements for a NEBB Certified Electrical Commissioning project. The actual scope of work may differ from these requirements. These minimum requirements are described as ***SHALL*** requirements. ***SHOULD*** requirements are recommended to produce a higher quality project and ***MAY*** requirements could be included to enhance the commissioning project. These minimum requirements take precedence when a scope of work is not defined, or the requirements state words to effect that the "…project ***SHALL*** be commissioned in accordance with the requirements of the NEBB *Procedural Standards for Whole Building Systems Commissioning of New Construction."* To be a NEBB certified report the following must apply:

1. The actual contracted scope of work ***SHALL*** be clearly defined on the certification page of the report as specified in the contract documents or as agreed to between the Owner / Buyer and the NEBB Certified BSC Firm.
2. If the scope of work differs from the NEBB ***SHALL*** language it shall be clearly delineated on the certification page of the report otherwise all ***SHALL*** language must be adhered to for a NEBB Certified Report.

9.2 PRE-DESIGN PHASE COMMISSIONING

9.2.1 INTRODUCTION

There are two main purposes of the Pre-Design Phase. The first is to develop and document the Owner's Project Requirements (OPR) and the second is to develop the Preliminary Commissioning Plan.

9.2.2 PRE-DESIGN PHASE RESPONSIBILITIES

9.2.2.1 Commissioning Team Members

During the Pre-Design Phase the Owner should assign or contract for the appropriate Commissioning Team members to facilitate the Pre-Design process. The required Commissioning team members for the Pre-Design Phase should be as follows:

a. Owner's Representatives
b. Commissioning Authority (CA)
c. Programming Professionals if applicable
d. Architect if applicable
e. Electrical & Mechanical Engineer if applicable
f. Construction Manager / General Contractor if applicable

9.2.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member must be responsible for contributing to the commissioning process based on their individual project responsibilities.

9.2.3 PRE-DESIGN PHASE ACTIVITIES

9.2.3.1 OPR Definition and Development

The Owner should produce the Owner's Project Requirements (OPR) to facilitate the design and delivery of the project. The OPR outlines the expectations the Owner has for the Electrical requirements of the project. The Electrical OPR ***SHOULD*** include the following items that relate to the HVAC system:

a. Use and space requirements
b. Anticipated occupancy
c. Electrical construction budget
d. Electrical codes or standards to be utilized
e. Special systems or equipment requirements that may affect Electrical calculations and loads.
f. Specific material or equipment requirements
g. Energy efficiency expectations
h. Lighting systems and components
i. Sustainability requirements
j. Electrical Testing requirements
k. Measurement & Verification Strategies
l. Ongoing Commissioning & Building Rating Requirements
m. Levels of redundancy
n. Electrical Automation / Controls sophistication
o. Vibration, sound and / or seismic requirements
p. Operation and maintenance criteria
q. Owner's expectations for operator and occupant training
r. Requirements for future facility adaptation and expansion
s. Owner's expectations of the design team and their produced documents
t. Owner's expectations of the construction team and their document requirements
u. Owner's expectations of the Commissioning Authority and their document requirements

9.2.3.2 Commissioning Plan

The CA ***SHALL*** develop a preliminary Electrical Commissioning Plan that documents the following:

a. The commissioning scope
b. The Commissioning Team
c. Normal channels of communication
d. Design phase commissioning procedures
e. Design phase commissioning duration schedules

9.2.3.3 Issues Log

The CA ***SHALL*** develop the format of the Issues Log to be utilized for the commissioning process. The Issues Log should address the manner that the perceived Electrical deficiencies will be documented by the CA and communicated to the design professionals and the contractors during subsequent commissioning phases of the project development and delivery. The Issues Log should also address the deficiency resolution procedure. The Issues Log should include:

a. Issue Number
b. Issue statement
c. Date of Issue statement
d. Person making issue statement
e. Issue statement response
f. Date of Issue statement response
g. Person making the issue statement response

9.2.3.4 Commissioning Scope(s) of Work and Budgeting
The CA ***SHOULD*** assist the Owner in developing the commissioning scope of the project and its associated costs. Project scope should include:

a. Phase to be commissioned: The Owner must determine which phases will be commissioned for the project such as Pre-Design Phase, Design Phase, Construction Phase, Acceptance Phase and Warranty Phase.
b. Systems to be commissioned: The Owner must determine which systems will be commissioned for the project including special systems and if any areas will be excluded from the commissioning project.
c. The commissioning scope shall be based upon this NEBB BSC Procedural Standard and its definition of the commissioning process and its required ***SHALL*** language. If the Owner desires to establish a different level of commissioning activities than those stated in this procedural standard it must be clearly delineated in the scope of work.
d. Level of Owner's participation in the commissioning process: The Owner must establish the level of participation their representatives will provide to the commissioning team during each phase of the commissioning project.

9.2.3.5 Develop System Manual Requirements
During the Pre-Design phase, the Commissioning Team and the CA ***MAY*** develop documents which will make up the systems manual and determine what the Owner's Operator training requirements will be. The final system manual ***MAY*** include the following and should be provided in electronic format:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operating and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures
j. Test Reports

9.2.3.6 Commissioning Meetings
The CA ***SHALL*** conduct all Commissioning Team meetings as required to implement the commissioning process and ***SHALL*** issue meeting minutes as documentation of these meetings.

9.2.3.7 Update the OPR
The Owner must update the OPR during Pre-Design Phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications.

9.2.4 PRE-DESIGN PHASE DOCUMENTATION

The following commissioning documents are produced during Pre-Design Phase Commissioning if these activities are included in commissioning scope of work:

a. Owner's Project Requirements ***(SHOULD)***
b. Preliminary Commissioning Plan ***(SHALL)***
c. Issues Log ***(SHALL)***
d. Commissioning Scope and Budgets ***(MAY)***
e. System Manual Index of contents ***(MAY)***

9.3 DESIGN PHASE COMMISSIONING

9.3.1 INTRODUCTION

During the Design Phase, the design professionals create the Contract Documents. The Contract Documents turn the OPR into working design documents. The CA ***SHALL*** evaluate and document that the Contract Documents conform to the OPR. The CA ***SHALL*** evaluate that the Electrical systems, equipment and components are incorporated into the Contract Documents to ensure they conform to the OPR from the standpoint of commissionability, maintainability, functionality and best practices.

9.3.2 DESIGN PHASE RESPONSIBILITIES

9.3.2.1 Commissioning Team Members

The required Commissioning Team members for the Design Phase should be:

a. Owner's Representatives
b. Commissioning Authority (CA)
c. Programming Professionals
d. Architect
e. Landscape Architect
f. Electrical Engineer
g. Lighting Consultant if applicable
h. Mechanical Engineer
i. Construction Manager / General Contractor if applicable
j. Specialty, or Trade Contractors if applicable

9.3.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member is responsible for contributing to the commissioning processes according to their individual project responsibilities.

9.3.3 DESIGN PHASE ACTIVITES

9.3.3.1 OPR Definition and Development

If the project does not have a Pre-Design Phase, or if the OPR was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 9.2.3.1 for the requirements.

9.3.3.2 Commissioning Plan

If the project does not have a Pre-Design Phase, or if the Commissioning Plan was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 9.2.3.2 for the requirements.

9.3.3.3 Issues Log

If the project does not have a Pre-Design Phase, or if the Issues Log was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 9.2.3.3 for the requirements.

9.3.3.4 Design Kick-Off Meeting

The CA ***SHOULD*** conduct an initial Kickoff Meeting with the Design Team and the Owner. The purpose of the meeting will be to establish the purpose and proposed processes for commissioning the design and to review the Design Phase Commissioning Plan.

9.3.3.5 Commissioning Activities Scheduled

The CA ***SHALL*** verify that commissioning activities are incorporated into the Design Phase schedule.

9.3.3.6 Evaluate Basis of Design Conformance

The design professional should prepare the Basis of Design (BOD) document in response to the OPR. The BOD includes the Design Narrative and the Design Criteria. The CA ***SHOULD*** verify that the BOD conforms to the requirements of the OPR.

The Design Narrative ***SHOULD*** include the following:

a. Description of the selected Electrical systems, and components and Lighting systems and components and the reasons they were selected
b. Description of other systems and components that were analyzed and rejected and the reasons for rejections
c. Preliminary Electrical calculation requirements
d. Preliminary Lighting calculations requirements
e. Various systems approaches
f. Electrical usage analysis
g. Sustainability, energy conservation approach
h. Life cycle costing information of each system analyzed
i. Preliminary major component selection
j. Equipment space layout for establishing building space requirements

The Design Criteria ***SHOULD*** include the following:

a. Project location and special Electrical site requirements
b. Design parameters including: space occupancy, utility requirements, all special equipment requirements, special areas of concern and / or other criteria used that may define the methodology used to complete the Electrical design
c. Sustainability design parameters including: Electrical efficiency, Lighting and Day lighting Controls, and Renewable Energy
d. Design assumptions and limitations
e. Electrical control systems sophistication
f. Sizing criteria to be used for wiring and safety devices
g. Accepted safety factors incorporated into the design
h. Accepted levels of redundancy
i. Reference to specific equipment selection limitations as to make or model numbers
j. Operation assumptions
k. Codes, standards and guidelines to be utilized for the design

The CA ***SHOULD*** evaluate the BOD for conformance to the OPR from the standpoint of commissionability, maintainability, functionality and industry accepted best practices and produce an evaluation document.

9.3.3.7 Commissioning Specifications

The CA ***SHALL*** review the contract commissioning specifications and verify that they are included in the contract documents. The CA ***SHOULD*** assist in creating commissioning specifications to be included in the contract documents. The commissioning specifications should include the following:

a. Specification describing the basic commissioning process that will be used on the project by the CA, located in the general requirement area of the specification
b. Specification describing the commissioning activities required of the Electrical, and Control contractors, located in each individual discipline specification

c. Specification describing the commissioning activities required of any Vendor or equipment supplier or specialty subcontractor, located in each individual vendor, supplier or subcontractor specification section

9.3.3.8 Electrical Testing Specifications

The CA ***SHALL*** review the contract electrical testing specifications and verify that they are included in the contract documents. The CA ***SHOULD*** assist in creating or verifying testing specifications that meet International Electrical Testing Association (NETA) requirements. The electrical testing specifications should include the following:

a. Specification describing the basic electrical testing requirements of the electrical contractor and how they are documented. Normally includes bolted connections, torque settings and resistive tests and high potential testing of connections and conductors.
b. Specification describing the electrical testing requirements for the project conducted by an electrical testing firm. Normally includes sequence operation testing, safety device testing, ground testing, and full load thermal imaging of all bolted connections and current carrying devices. (On less complex projects all testing may be done by the Electrical Contractor).
c. Specification describing generator testing requirements of the electrical contractor or vendor and whether NFPA testing is required

9.3.3.9 Establish Training Requirements

The CA ***SHOULD*** work with the Owner and the design professionals to define the training requirements for the Owner's personnel. Verify that these requirements are incorporated into the project specifications. Training ***SHOULD*** include:

a. Theory of operation presented by the Engineer
b. Sustainability methods and measures presented by the Green Building Accredited Professional or the Engineer
c. Start Up procedures, Shut down procedures, Operating procedures and Maintenance procedures and safety procedures for each type of equipment and system presented by the manufacturer or contractor
d. Control system operations and programming training. Include durations extended over time.
e. Specify classroom instruction duration and field demonstration duration for each training event.
f. O&M manual review for warranty repair or replacement procedures
g. Review of all warranty durations and start dates

9.3.3.10 Schematic Design Document Evaluation

The CA ***MAY*** complete a thorough evaluation of the Schematic Design (SD), or a 35% design review of documents to establish that the Electrical systems, equipment and components are identified and can be installed in compliance with the OPR and the BOD. Schematic Design Document Evaluation ***MAY*** include: engineering calculations, system selection, system selection criteria, flow sheet designs and major component selection.

9.3.3.11 Design Development Document Evaluation

The CA ***SHOULD*** complete a thorough evaluation of the Design Development (DD), or a 65% design review of documents and submitted criteria for continued compliance to the OPR and BOD; Evaluate design documents for commissioning specifications and requirements; Draft preliminary Commissioning Specifications and Supplemental Commissioning Language for other specifications if required. Design Development Document Evaluation ***SHOULD*** include one line requirements,

specifications, typical room layouts, system main layouts, riser layouts, standard details, schedules and coordination requirements.

9.3.3.12 Contract Documents Evaluation
The CA ***SHALL*** evaluate the contract documents at least once near 100% construction document level. The CA ***SHALL*** evaluate drawings and specifications for each system, component, and equipment for its commissionability, maintainability, functionality and best practices.

9.3.3.13 Meetings
The CA ***SHALL*** conduct all commissioning team meetings and shall issue meeting minutes as documentation of these meeting

9.3.3.14 Update the OPR and the BOD
The Owner must update the OPR and the design professionals must update the BOD during design phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final Contract Documents.

9.3.3.15 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any additional Commissioning Team members, procedures and schedules or design phase commissioning requirements developed in the Design Commissioning process.

9.3.3.16 Issues Log Management
The Owner must manage the Issues Log as to timely issue answers and resolutions. The Owner has the final authority over issue resolution disagreements or interpretations. The final Issues Log, its statements and its statement answers ***SHALL*** become a permanent record of the commissioning process.

9.3.3.17 Update the Issues Log Documentation
The CA ***SHALL*** create and maintain the Issues Log. The Issues Log shall be used throughout the commissioning process, going from a Design Phase issue log to a Construction Phase issue log, to an Acceptance Phase issue log and finally to a Warranty Phase issue log. The final (complete) issue log shall become a part of the final Commissioning Report.

9.3.3.18 Pre-Bid Meeting
The Owner should conduct a Pre-bid meeting to assist contractors in answering any questions about the systems or the commissioning process. The CA ***SHOULD*** attend the Pre-Bid meeting to fully explain the commissioning requirements of the Contract Documents and allow the contractors to understand their roll in the commissioning process and its associated costs. The CA should provide any assistance required by the Owner in answering written questions (in the form of clarifications or addendum recommendations) during the bidding process.

9.3.4 DESIGN PHASE DOCUMENTATION

The following commissioning documents are produced during the Design phase commissioning if these activities are included in commissioning scope of work.

a. Updated Owner's Project Requirements **(*SHOULD)***
b. Updated Commissioning Plan **(*SHALL)***
c. Basis of Design Evaluation **(*SHOULD)***
d. Contract Document Evaluation **(*SHALL)***
e. Updated Issues Log **(*SHALL)***
f. Pre Bid Meeting minutes or documentation **(*SHOULD)***

9.4 CONSTRUCTION PHASE COMMISSIONING

9.4.1 INTRODUCTION

During the Construction Phase the commissioning team works to verify the equipment and systems are installed in accordance with the design documents and are operable, maintainable and ready for functional testing.

9.4.2 CONSTRUCTION PHASE RESPONSIBILITES

9.4.2.1 Commissioning Team Members

The commissioning team members for the Construction Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives
d. Construction Manager Representative
e. General Contractor Representatives
f. Mechanical Contractor Representatives
g. Electrical Contractor Representatives
h. Control Contractor Representatives (If Required)
i. Specialty Contractor Representatives (If Required)

9.4.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

9.4.3 CONSTRUCTION PHASE ACTIVITIES

9.4.3.1 Commissioning Plan

If the project does not have a Design Phase, or if the Commissioning Plan was not produced in the Design Phase, it ***SHALL*** be produced at this time by the CA. The commissioning plan should include:

a. Description of the commissioning scope and process utilized for the project
b. Commissioning Team member identification and contact information
c. Team member responsibilities
d. Commissioning check sheet or form index
e. Copies of all typical commissioning check sheets or forms

9.4.3.2 Construction Kick-Off Meeting

The CA ***SHALL*** conduct an initial commissioning meeting with all contractors and Commissioning Team members. The purpose of the meeting will be to review the Construction Phase Commissioning process and activities for the commissioning of the project. During the meeting the CA ***SHOULD*** review the following:

a. The Commissioning Plan
b. The basic commissioning processes to be utilized on the project
c. The individual roles and responsibilities of each participating Commissioning Team member
d. Documentation requirements
e. Communication and reporting procedures
f. The check sheets and forms to be utilized on the project
g. The commissioning duration schedules

The CA ***SHALL*** create the meeting agenda, lead the meeting and prepare and distribute the meeting minutes.

9.4.3.3 Commissioning Duration Schedule
The CA ***SHOULD*** prepare a duration schedules for the contractors for the commissioning activities required by the commissioning plan. These duration schedules ***SHOULD*** be incorporated into the contractor's project schedule to track all commissioning activities of the Commissioning Team.

9.4.3.4 Commissioning Team Meetings
The CA ***SHALL*** attend and lead all commissioning meetings as required with the Commissioning Team to review progress of the commissioning effort and reinforce individual responsibilities. Also, review completed work and agree upon the acceptability of the delivered product. The CA ***SHALL***:

a. Create the agenda
b. Attend and lead meeting
c. Schedule and review the commissioning activities
d. Coordinate commissioning meetings with construction meetings and activities
e. Prepare and distribute meeting minutes

9.4.3.5 Submittal and Shop Drawing Review
The CA ***SHALL*** review all pertinent Electrical submittals and shop drawings to support the Commissioning Process. The submittal and shop drawing review should include:

a. The submittal and shop drawing information is utilized to create the appropriate PFT check sheets and forms for the project.
b. The CA ***SHALL*** review the submittals and shop drawings for commissionability, maintainability, functionality and for conformance to the CD's, OPR and BOD.
c. The CA ***SHALL*** document any found issues on the project Issue Log. The Issues Log ***SHALL*** be forwarded to the appropriate Commissioning Team member for resolution.

9.4.3.6 Site Observations
During the course of construction, the CA ***SHALL*** visit the site to inspect the progress of construction with respect to the Electrical systems, equipment and components being commissioned. The purpose of the inspections is to verify that the construction complies with the Contract Documents, the OPR and identify and document any quality issues that may lead to functional issues. Site observations are forwarded to the appropriate team member for their review and action. If site observation issues are not automatically accepted and resolved the observation is added to the issue Log for resolution.

9.4.3.7 Pre-Functional Tests (PFT)
There are several types of Electrical PFT that ***SHALL*** be performed during the construction phase: installation verification tests, static tests, and equipment startup tests.

9.4.3.7.1 Electrical Equipment & Electrical Controls Installation Verification Tests
The contractor must verify that all work is installed in accordance with the contract documents and / or the manufacturer's recommendations and provide the associated check sheets verifying such. The contractor must document that all equipment is installed in the correct location and is operable in accordance with the contract documents. The CA ***MAY*** provide the installation verification check sheets if not available from the manufacturers or contractors. The CA or his staff ***SHALL*** validate the Installation Verification check sheets completed by the contractor by back checking them through site observations. Completion of all installation verification tests signifies that those systems are ready for start up activities. Examples of these tests include:

a. All conductor and raceway installations
b. All Electrical equipment and Lighting fixture installation
c. All Electrical Control equipment and component installation

Installation Verification tests ***SHALL*** include the following:

a. Material or Equipment Name or description
b. Model Number
c. Type and Size
d. Serial Number (If applicable)
e. Installation and location to design requirements verification
f. Maintenance access verification
g. Installation complete

9.4.3.7.2 Static Tests

The contractor must perform resistance and torque tests as described in the Contract Documents. All tests must be verified and documented by contractor or code authority as required by the Contract Documents or as dictated by the local codes. The CA ***MAY*** provide the static test sheets to the contractor performing the tests. The CA ***MAY*** observe and document these tests. Completed static test sheets are then provided to the CA. Examples of these tests include:

a. Conductor resistive tests
b. Bolted Connections Torque settings and resistive tests
c. System High Potential Tests

9.4.3.7.3 Special Systems Inspections

Code authorities require special system inspections be performed by the Electrical Engineer of Record prior to energizing a systems. Each code authority may require special system inspections on different pieces of electrical equipment. Normally special systems inspections are required for:

a. Conductors from Utility Transformer to entrance section
b. Entrance section and main switch gear
c. Generators and transfer switches

9.4.3.7.4 Electrical Equipment Startup Tests

The contractor, vendor or testing agency that has contractual obligation to provide start up services and ***SHALL*** start up the systems and equipment in accordance with the Contract Documents and the manufacturer's requirements. Completed start up check sheets are then provided to the CA. The CA ***MAY*** observe and document these start up tests. Start up tests ***SHOULD*** include the following:

a. Manufacturer's Name
b. Model Number
c. Type and Size
d. Serial Number
e. Actual Settings or Adjustments
f. Actual Electrical Characteristics
g. Actual voltages and loads
h. Operating data as required by the manufacturer

Start Up Tests Include:

a. Sequence operation testing ***(SHALL)***
b. Safety device testing ***(SHOULD)***
c. Ground system testing ***(SHOULD)***
d. Circuit location and connected device verification ***(MAY)***

9.4.3.7.5 Electrical Control System Startup Tests
The CA ***SHALL*** provide a 100% point-to-point control system test and sensor calibration as verification of the control system operational status with no sampling strategies allowed. The control point-to-point test shall verify the system operation from the system graphic, if applicable, to the end sensor or control device. The control tests ***SHOULD*** include the following:

a. Controller Manufacturer
b. Controller or System identification
c. Verification of controller communication
d. Pin Address
e. Point ID and name
f. Point type
g. Connected device description
h. Verification of action and polarity
i. Verification of status indication
j. Actual sensor reading, system reading and offset

9.4.3.8 Update the OPR and the BOD
The Owner must update the OPR and the design professionals must update the BOD during construction phase to incorporate any approved Electrical changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final construction.

9.4.3.9 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any changes to the commissioning team members, their responsibilities, contact information, procedures, schedules or changes to the commissioning requirements as a result of the Construction Phase. The Commissioning Plan shall also be updated to include all revised or added check sheets or forms utilized during the Pre-Functional Tests.

9.4.3.10 Issues Log & Deficiency Resolution
The CA ***SHALL*** report deficiencies from any PFT on the Issues Log and it shall be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA ***SHALL*** assist as necessary to complete the issue log. After corrective action, retests shall be performed to verify conformance. When deficiencies are resolved, the issues shall be signed off on the Issues Log by the appropriate Commissioning Team Member(s). All issue log items must be resolved or answered by the appropriate commissioning team member. Issues that are resolved in a manner not consistent with the OPR must be approved by the Owner.

9.4.4 CONSTRUCTION PHASE DOCUMENTATION

The following commissioning documents are produced during the Construction Phase commissioning if these activities are included in commissioning scope of work:

a. Kick off team meeting agenda and minutes ***(SHALL)***
b. Agendas and Minutes of all commissioning team meetings ***(SHALL)***
c. Commissioning duration schedules ***(SHOULD)***
d. Submittal and Shop Drawing review documents ***(SHALL)***
e. Site Observation reports ***(SHALL)***
f. Pre-Functional Test report check sheets: Installation Verification Tests, Static Tests and Equipment Startup Tests ***(SHALL)***
g. Updated Owner's Project Requirements ***(SHOULD)***
h. Updated Commissioning Plan ***(SHALL)***
i. Updated Issues Log ***(SHALL)***

9.5 ACCEPTANCE PHASE COMMISSIONING

9.5.1 INTRODUCTION

During the Acceptance Phase the Commissioning Team works to verify the functionality of all systems, equipment, systems and components. The Commissioning Team assures that all systems are functioning in a manner that conforms to the OPR. The Commissioning Team also coordinates the level of Owners Personnel Training.

9.5.2 ACCEPTANCE PHASE RESPONSIBILITIES

9.5.2.1 Commissioning Team Members

The required commissioning team members for the Acceptance Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives (if required)
d. Construction Manager Representative (if required)
e. General Contractor Representatives (if required)
f. Electrical Engineer (if required)
g. Electrical Contractor Representative
h. Electrical Testing Contractor (if required)
i. Control Contractor Representative (If required)
j. Specialty Contractor Representative (if required)

9.5.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

9.5.3 ACCEPTANCE PHASE ACTIVITIES

9.5.3.1 Commissioning Duration Schedule

The CA ***SHOULD*** continue to monitor and update the duration schedules for the contractors for the commissioning activities in the Acceptance Phase required by the Commissioning Plan. These duration schedules should track all commissioning activities of the Commissioning Team in this phase.

9.5.3.2 Commissioning Team Meetings

The CA ***SHALL*** continue to attend and lead all commissioning meetings as required with the Commissioning Team to review progress of the commissioning effort and reinforce individual responsibilities.

9.5.3.3 Functional Performance Tests (FPT)
Functional Performance Tests ***SHALL*** be designed by the CA and performed by the Commissioning Team. The CA ***SHALL*** observe and facilitate the FPT for all systems that have operating sequences. The CA ***SHALL*** provide final approval for Functional Performance Test results. The FPT tests ***SHALL*** include the following:

a. System description
b. Specific function being tested
c. Functional test design
d. Description of testing procedure
e. Description of test duration
f. Description of test report documentation requirements
g. Description of test pass/fail criteria

Electrical Functional Performance Tests ***SHOULD*** include the following:

a. Thermal imaging of all bolted connections and current carrying devices at full load
b. 72 Hour power quality test
c. Electrical control sequences Functional Testing such as generator load shedding or other items that have automated sequence of control

9.5.3.4 Sound & Vibration (S&V) Testing
The CA ***SHALL*** verify that the Sound level tests and Vibration measurements tests have been completed in accordance with the Contract Documents and ***SHALL*** review the final S&V Report for completeness and accuracy.

9.5.3.5 Record Documents / As-Built Drawings and Operations and Maintenance (O&M) Manuals
The Contractors ***SHALL*** create and assemble the Operating and Maintenance Manuals as contractually required. The drawings and manuals are then forwarded to the design professional for review and approval. The CA ***SHOULD*** review all Record Documents and Operating and Maintenance Manuals for accuracy and completeness to the Contract Documents and for conformance to the OPR. The CA ***SHOULD*** review these documents after review and approval by the design professional. The Record Documents and the O&M Manuals ***SHOULD*** include:

a. Final Approved Submittals
b. Final Approved Shop Drawings
c. Record Documents
d. Service Procurement information
e. Operating Manuals specifically tailored to the exact equipment, systems and components installed
f. Maintenance Requirements and Procedures
g. Cleaning and Lubrication lists and instructions
h. Recommended spare parts lists with purchase contact information
i. Warranty information

The CA ***SHOULD*** verify that the Record Documents and O&M Manuals are reviewed, approved and delivered to the Owner prior to operator training.

9.5.3.6 Owner Training
The CA ***SHOULD*** work with the contractor and Owner to schedule and plan training activities so that training occurs in a coordinated and coherent fashion. The CA ***SHOULD*** assist in the development of

training schedules and agendas, encourage the use of a combination of "classroom" and field training, and assist the contractors in the development of training agendas for each system, piece of equipment or component installed in the project.

The design professionals, contractors and vendors provide the training instruction and provide training materials. Additional operator skill training ***MAY*** be provided as an additional scope item if desired by the Owner.

The CA ***MAY*** document Owner training events by video taping presentations and demonstrations for future use by the Owner.

9.5.3.7 Update the OPR and BOD

The Owner must update the OPR and the design professionals ***SHALL*** update the BOD during Construction Phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications incorporated during the Acceptance Phase.

9.5.3.8 Update the Commissioning Plan

The CA ***SHALL*** update the Commissioning Plan to include any changes to the Commissioning Team members, their responsibilities, their contact information, procedures, schedules or changes to the commissioning requirements as a result of the Acceptance Phase. The Commissioning Plan shall also be updated to include all revised or added check sheets or forms utilized during the Functional Performance Tests. The Commissioning Plan ***SHOULD*** include:

a. Description of the commissioning process utilized for the project
b. Commissioning Team member identification and contact information
c. Team member responsibilities
d. Commissioning FPT forms index
e. Copies of all typical FPT forms

9.5.3.9 Issues Log & Deficiency Resolution

The Owner must manage the Issue Log as to timely issue answers and resolutions. The Owner shall have final authority over issue resolution disagreements or interpretations. The final Issues Log, its statements and its statement responses ***SHALL*** become permanent record of the commissioning process.

9.5.3.10 Update the Issues Log

The CA ***SHALL*** report deficiencies from the FPT on the Issues Log and it ***SHALL*** be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA ***SHALL*** assist as necessary to complete the issue log. After corrective action, retests ***SHALL*** be performed to verify conformance. When deficiencies are resolved, the issues ***SHALL*** be signed off on the Issues Log by the CA and the appropriate Commissioning Team Member(s). All issue log items ***SHALL*** be resolved or answered by the appropriate commissioning team member. Issues that are resolved in a manner that are not consistent with the OPR must be approved by the Owner. If after three attempts by the CA to obtain an issue resolution a CA can issue a certified report by clearly describing the unresolved issue in the Commissioning Report executive summary.

9.5.3.11 Final Commissioning Report

Based on the accumulated commissioning work completed as described above, the CA ***SHALL*** assemble the data into a final Commissioning Report. The final report will incorporate the final record documents for each system, as appropriate. The Commissioning Report ***SHALL*** include:

a. Report Title Page ***(SHALL)***
b. Report Certification Page ***(SHALL)***
c. Table of Content Page ***(SHALL)***
d. Executive Summary ***(SHALL)***
e. Project OPR ***(SHOULD)***
f. Commissioning Plan ***(SHALL)***
g. Final Issue Log ***(SHALL)***
h. Completed Pre Functional Test Forms and Check Sheets ***(SHALL)***
i. Completed Functional Performance Test Forms and Check Sheets ***(SHALL)***
j. Observation Reports ***(SHALL)***
k. Training Verification Records ***(SHOULD)***
l. Commissioning Communications ***(SHALL)***
m. Test Instrument Page ***(SHALL)***

9.5.3.12 Systems Manual

At the end of the Acceptance Phase the CA ***MAY*** produce the Systems Manual. The purpose of the Systems Manual is to provide the Owner and his operators with a permanent record of all pertinent documents required for future operation, commissioning and validation processes of the facility. The Systems Manual ***SHOULD*** be provided to the Owner in electronic format. At a minimum the final system manual ***SHOULD*** include the following:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operating and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures

9.5.4 ACCEPTANCE PHASE DOCUMENTATION

The following commissioning documents are produced during the Acceptance Phase commissioning if these activities are included in the commissioning scope of work.

a. Completed Functional Performance Tests Report Forms ***(SHALL)***
b. O&M Review Document ***(SHOULD)***
c. Commissioning Report ***(SHALL)***
d. Systems Manual ***(MAY)***
e. Training Agenda ***(SHOULD)***

9.6 WARRANTY PHASE COMMISSIONING

9.6.1 INTRODUCTION

During the Warranty Phase the Commissioning Team works to verify the installed equipment and systems are meeting the OPR at the end of the warranty period.

9.6.2 WARRANTY PHASE RESPONSIBILITIES

9.6.2.1 Commissioning Team Members

The required Commissioning Team members for the Warranty Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives
d. Construction Manager Representatives
e. General Contractor Representatives
f. Applicable Subcontractors
g. Applicable Vendors

9.6.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

9.6.3 WARRANTY PHASE ACTIVITIES

9.6.3.1 Deferred Systems Tests

The CA and all applicable contractors and vendors ***SHALL*** provide any required deferred system Functional Performance Tests required by the commissioning plan. Functional Performance Test's ***SHALL*** be designed by the CA and performed by the contractors or Owner. The CA ***SHOULD*** observe and facilitate all functional performance tests for all systems that have operating sequences. The CA ***SHALL*** provide final approval for Functional Performance test results.

9.6.3.2 Warranty Visit

The CA ***SHOULD*** inspect the site and interview building operating personnel to identify any outstanding warranty failures and to identify any persistent equipment failure issues that should be handled within the warranty period. This site visit should occur approximately two months prior to the end of the warranty period.

9.6.3.3 Lessons Learned Workshop

The CA ***MAY*** perform a lessons learned workshop with the new owner, designers and/or construction team members. The purpose of the lessons learned workshop is to determine how to improve the process for future projects.

9.6.4 WARRANTY PHASE DOCUMENTATION

The following commissioning documents are produced during the Warranty Phase commissioning if these activities are included in commissioning scope of work.

a. Deferred Functional Performance Tests Check Sheets and Forms ***(SHALL)***
b. Warranty visit documentation with associated issues ***(SHALL)***
c. Commissioning Report Addenda with deferred testing results ***(SHALL)***
d. Lessons Learned Workshop Report ***(MAY)***

NEBB COMMISSIONING REQUIREMENTS - ELECTRICAL SYSTEMS			
Item	***SHALL***	***SHOULD***	***MAY***
PRE DESIGN PHASE COMMISSIONING *(If included in commissioning scope)*			
Commissioning Scope defined on Certification page	Owner Establishes	CA Assist	
Create OPR	Owner Perform	CA Assists	CA Perform
Create Preliminary Commissioning Plan	CA Perform		
Create Issues Log	CA Perform		
System Manual Requirements			CA Perform
DESIGN PHASE COMMISSIONING (DPC) *(If included in commissioning scope)*			
Create or Update Commissioning Plan	CA Perform		
Create or Update Issues Log	CA Perform		
Design Kick Off Meeting		CA Perform	
Schematic Design Review			CA Perform
Update OPR	Owner Perform	CA Perform	
Update BOD	Engineer Perform		
Basis of Design Review		CA Perform	
Specification & Drawing Review near 100% CD's	CA Perform		
Define training requirements for Owners personnel	Owner Perform	CA Perform	
Create Commissioning Specifications		CA Perform	
Pre Bid Meeting		Owner Perform	CA Assist
CONSTRUCTION PHASE COMMISSIONING			
Construction Kick Off Meeting	CA Perform		
Create Commissioning Duration Schedules		CA Perform	
Submittal and Shop Drawing Review	CA Perform		
Update Issues Log	CA Perform		
Update Commissioning Plan	CA Perform		
Update OPR and BOD	Owner Perform	CA Perform	
Site Observations for all Electrical Systems and Equipment	CA Perform		
Site Observations for all Lighting Systems and Controls	CA Perform		
Create Pre Functional Equip & System Installation Check Sheets	Contractor Perform	Test Agency Prfrm	CA Perform
Perform Pre Functional Equip & System Installation Check Sheets	Contractor Perform	Test Agency Prfrm	CA Verify
Perform & Document Static Tests	Contractor Perform	Test Agency Prfrm	CA Verify
Perform special systems inspections	Engineer Perform		
Create Elec Controls Pre Functional Installation Check Sheets	Contractor Perform	CA Perform	
Perform & Doc Elec Controls Pre Functional Installation Chk Sheets	Contractor Perform	CA Verfiy	CA Perform
Create Pre Functional Controls Point to Point Check Sheets	CA Perform		
Perform Pre Functional Controls Point to Point Check Sheets	CA Perform		
ACCEPTANCE PHASE COMMISSIONING			
Create Elec Testing Functional Performance Test Check Sheets	Contractor Perform	Test Agency Prfrm	CA Perform
Perform Elec Testing Functional Performance Tests	Contractor Perform	Test Agency Prfrm	Owner or CA Perform
Create Elec Controls Functional Performance Tests	CA Perform		
Program, run & Doc Elec Controls Functional Performance Tests	Contractor Perform	CA Observe	CA Perform
Approve Functional Tests results	CA Perform		
Review Operating and Maintenance Manuals	Engineer Perform	CA Perform	
Create Training Schedules with Owner	Contractor Perform	CA Assist	CA Perform
Assist contractors in developing Training Agendas		CA Perform	
Update Issues Log	CA Perform		
Update OPR	Owner Perform	CA Perform	
Update BOD	Engineer Perform		
Document Owner Training			CA Perform
Create Final Commissioning Report	CA Perform		
Create Final System Manual			CA Perform
WARRANTY PHASE COMMISSIONING *(If included in commissioning scope)*			
Create Deferred Functional Test Check Sheets	CA Perform		
Perform & Document Deferred Functional Tests	Contractor Perform	CA Observe	Owner or CA Perform
Witness functionality of FPT tests	CA Perform		
Approve Deferred Functional Tests results	CA Perform		
Perform Warranty Visit & Documentation		CA Perform	
Create Commissioning Report Addenda	CA Perform		
Update Issues Log	CA Perform		
Perform a Lessons learned workshop			CA Perform

SECTION 10 COMMISSIONING OF SPECIAL ELECTRICAL SYSTEMS

10.1 INTRODUCTION

The purpose of Section 10 is to describe the requirements for commissioning a project's Special Electrical Systems, equipment and components. While Section 6 details the elements of the commissioning process in global terms, this section will detail the minimum requirements for a NEBB Certified Special Electrical Systems Commissioning project. The actual scope of work may differ from these requirements. These minimum requirements are described as ***SHALL*** requirements. ***SHOULD*** requirements are recommended to produce a higher quality project and ***MAY*** requirements could be included to enhance the commissioning project. These minimum requirements take precedence when a scope of work is not defined, or the requirements state words to effect that the "…project ***SHALL*** be commissioned in accordance with the requirements of the NEBB *Procedural Standards for Whole Building Systems Commissioning of New Construction."* To be a NEBB certified report the following must apply:

1. The actual contracted scope of work ***SHALL*** be clearly defined on the certification page of the report as specified in the contract documents or as agreed to between the Owner / Buyer and the NEBB Certified BSC Firm.
2. If the scope of work differs from the NEBB ***SHALL*** language it shall be clearly delineated on the certification page of the report otherwise all ***SHALL*** language must be adhered to for a NEBB Certified Report.

10.2 SPECIAL ELECTRICAL SYSTEMS

Special Electrical Systems consist of the following systems:

a. Fire Alarm Systems
b. Security Systems
c. CCTV Systems
d. Telephone Systems
e. Paging and Intercom Systems
f. Music and White Noise Systems
g. Nurse Call Systems
h. Network Data Systems

10.3 PRE-DESIGN PHASE COMMISSIONING

10.3.1 INTRODUCTION

There are two main purposes of the Pre-Design Phase. The first is to develop and document the Owner's Project Requirements (OPR) and the second is to develop the Preliminary Commissioning Plan

10.3.2 PRE-DESIGN PHASE RESPONSIBILITIES

10.3.2.1 Commissioning Team Members

During the Pre-Design Phase the Owner should assign or contract for the appropriate Commissioning Team members to facilitate the Pre-Design process. The required Commissioning team members for the Pre-Design Phase should be as follows:

a. Owner's Representatives
b. Commissioning Authority (CA)
c. Programming Professionals if applicable
d. Architect if applicable
e. Electrical Engineer if applicable
f. Selected Vendor if applicable
g. Construction Manager / General Contractor if applicable

10.3.2.2 Commissioning Team Responsibilities
The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member must be responsible for contributing to the commissioning process based on their individual project responsibilities.

10.3.3 PRE-DESIGN PHASE ACTIVITIES

10.3.3.1 OPR Definition and Development
The Owner should produce the Owner's Project Requirements (OPR) to facilitate the design and delivery of the project. The OPR outlines the expectations the Owner has for the Special Electrical Systems requirements of the project The Special Electrical Systems OPR ***SHOULD*** include the following items that relate to the HVAC system:

a. Use and space requirements
b. Anticipated occupancy
c. Selection of Special Electrical Systems to be included in the project
d. Special Electrical Systems construction budget
e. Special Electrical Systems codes or standards to be utilized
f. Special systems or equipment requirements that may affect Special Electrical Systems sizing requirements
g. Specific material or equipment requirements
h. Special Electrical Systems Testing requirements
i. Ongoing Commissioning & Building Rating Requirements
j. Levels of redundancy
k. Special Electrical Systems Automation / Controls sophistication
l. Operation and maintenance criteria
m. Owner's expectations for operator and occupant training
n. Requirements for future facility adaptation and expansion
o. Owner's expectations of the design team and their produced documents
p. Owner's expectations of the construction team and their document requirements
q. Owner's expectations of the Commissioning Authority and their document requirements

10.3.3.2 Commissioning Plan
The CA ***SHALL*** develop a preliminary Special Electrical Systems Commissioning Plan that documents the following:

a. The commissioning scope
b. The Commissioning Team
c. Normal channels of communication
d. Design phase commissioning procedures
e. Design phase commissioning duration schedules

10.3.3.3 Issues Log

The CA ***SHALL*** develop the format of the Issues Log to be utilized for the commissioning process. The Issues Log should address the manner that the perceived Special Electrical Systems deficiencies will be documented by the CA and communicated to the design professionals and the contractors during subsequent commissioning phases of the project development and delivery. The Issues Log should also address the deficiency resolution procedure. The Issues Log should include:

a. Issue Number
b. Issue statement
c. Date of Issue statement
d. Person making issue statement
e. Issue statement response
f. Date of Issue statement response
g. Person making the issue statement response

10.3.3.4 Commissioning Scope(s) of Work and Budgeting

The CA ***SHOULD*** assist the Owner in developing the commissioning scope of the project and its associated costs. Project scope should include:

a. Phase to be commissioned: The Owner must determine which phases will be commissioned for the project such as Pre-Design Phase, Design Phase, Construction Phase, Acceptance Phase and Warranty Phase.
b. Systems to be commissioned: The Owner must determine which systems will be commissioned for the project including special systems and if any areas will be excluded from the commissioning project.
c. The commissioning scope shall be based upon this NEBB BSC Procedural Standard and its definition of the commissioning process and its required ***SHALL*** language. If the Owner desires to establish a different level of commissioning activities than those stated in this procedural standard it must be clearly delineated in the scope of work.
d. Level of Owner's participation in the commissioning process: The Owner must establish the level of participation their representatives will provide to the commissioning team during each phase of the commissioning project.

10.3.3.5 Develop System Manual Requirements

During the Pre Design phase the Commissioning Team and the CA ***MAY*** develop documents which will make up the systems manual and determine what the Owner's Operator training requirements will be. The final system manual ***MAY*** include the following and should be provided in electronic format:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operating and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures
j. Test Reports

10.3.3.6 Commissioning Meetings

The CA ***SHALL*** conduct all Commissioning Team meetings as required to implement the commissioning process and ***SHALL*** issue meeting minutes as documentation of these meetings.

10.3.3.7 Update the OPR
The Owner must update the OPR during Pre-Design Phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications.

10.3.4 PRE-DESIGN PHASE DOCUMENTATION
The following commissioning documents are produced during Pre-Design Phase Commissioning if these activities are included in commissioning scope of work:

a. Owner's Project Requirements ***(SHOULD)***
b. Preliminary Commissioning Plan ***(SHALL)***
c. Issues Log ***(SHALL)***
d. Commissioning Scope and Budgets ***(MAY)***
e. System Manual Index of contents ***(MAY)***

10.4 DESIGN PHASE COMMISSIONING

10.4.1 INTRODUCTION
During the Design Phase, the design professionals create the Contract Documents. The Contract Documents turn the OPR into working design documents. The CA ***SHALL*** evaluate and document that the Contract Documents conform to the OPR. The CA ***SHALL*** evaluate that the Special Electrical Systems, equipment and components incorporated into the Contract Documents to ensure that they conform to the OPR from the standpoint of commissionability, maintainability, functionality and best practices.

10.4.2 DESIGN PHASE RESPONSIBILITIES
10.4.2.1 Commissioning Team Members
The required Commissioning Team members for the Design Phase should be:

a. Owner's Representatives
b. Commissioning Authority (CA)
c. Programming Professionals
d. Architect
e. Electrical Engineer
f. Selected Vendor if applicable
g. Construction Manager / General Contractor if applicable
h. Specialty, or Trade Contractors if applicable

10.4.2.2 Commissioning Team Responsibilities
The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member is responsible for contributing to the commissioning processes according to their individual project responsibilities.

10.4.3 DESIGN PHASE ACTIVITES
10.4.3.1 OPR Definition and Development
If the project does not have a Pre-Design Phase, or if the OPR was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time.

10.4.3.2 Commissioning Plan
If the project does not have a Pre-Design Phase, or if the Commissioning Plan was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time.

10.4.3.3 Issues Log
If the project does not have a Pre-Design Phase, or if the Issues Log was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time.

10.4.3.4 Design Kick-Off Meeting
The CA ***SHOULD*** conduct an initial Kickoff Meeting with the Design Team and the Owner. The purpose of the meeting will be to establish the purpose and proposed processes for commissioning the design and to review the Design Phase Commissioning Plan.

10.4.3.5 Commissioning Activities Scheduled
The CA ***SHALL*** verify that commissioning activities are incorporated into the Design Phase schedule.

10.4.3.6 Evaluate Basis of Design Conformance
The design professional should prepare the Basis of Design (BOD) document in response to the OPR. The BOD includes the Design Narrative and the Design Criteria. The CA ***SHOULD*** verify that the BOD conforms to the requirements of the OPR.

The Design Narrative ***SHOULD*** include the following:

a. Description of the selected Special Electrical Systems, equipment and components and the reasons they were selected
b. Description of other systems and components that were analyzed and rejected and the reasons for rejections
c. Preliminary Special Electrical Systems and descriptive information on how they meet code compliance
d. Special Electrical Systems usage analysis
e. Life cycle costing information of each system analyzed
f. Preliminary major component selection
g. Equipment space layout for establishing building space requirements

The Design Criteria ***SHOULD*** include the following:

a. Project location and special Electrical Systems site requirements
b. Design parameters including: Special equipment requirements, special areas of concern and / or other criteria used that may define the methodology used to complete the Special Electrical Systems design
c. Design assumptions and limitations
d. Special Electrical Systems control systems sophistication
e. Sizing criteria to be used for wiring & safety devices
f. Accepted safety factors incorporated into the design
g. Accepted levels of redundancy
h. Reference to specific equipment selection limitations as to make or model numbers
i. Operation assumptions
j. Codes, standards and guidelines to be utilized for the design

The CA ***SHOULD*** evaluate the BOD for conformance to the OPR from the standpoint of commissionability, maintainability, functionality and industry accepted best practices and produce an evaluation document.

10.4.3.7 Commissioning Specifications
The CA ***SHALL*** review the contract commissioning specifications and verify that they are included in the contract documents. The CA ***SHOULD*** assist in creating commissioning specifications to be included in the contract documents. The commissioning specifications should include the following:

a. Specification describing the basic commissioning process that will be used on the project by the CA, located in the general requirement area of the specification
b. Specification describing the commissioning activities required of the Special Electrical Systems and Control contractors, located in each individual discipline specification
c. Specification describing the commissioning activities required of any Vendor or equipment supplier or specialty subcontractor, located in each individual vendor, supplier or subcontractor specification section

10.4.3.8 Establish Training Requirements
The CA ***SHALL*** work with the Owner and the design professionals to define the training requirements for the Owner's personnel. Verify that these requirements are incorporated into the project specifications. Training ***SHOULD*** include:

a. Theory of operation presented by the Engineer
b. Control system operations and programming training. Include durations extended over time.
c. Specify classroom instruction duration and field demonstration duration for each training event
d. O&M manual review for warranty repair or replacement procedures
e. Review of all warranty durations and start dates

10.4.3.9 Schematic Design Document Evaluation
The CA ***SHOULD*** complete a thorough evaluation of the Schematic Design (SD), or a 35% design review of documents to establish that the Special Electrical Systems, equipment and components are identified and can be installed in compliance with the OPR and the BOD. Schematic Design Document Evaluation ***MAY*** include: System selection, system selection criteria, Design layouts of system wiring and major component selection.

10.4.3.10 Design Development Document Evaluation
The CA ***SHOULD*** complete a thorough evaluation of the Design Development (DD), or a 65% design review of documents and submitted criteria for continued compliance to the OPR and BOD; Evaluate design documents for commissioning specifications and requirements; Draft preliminary Commissioning Specifications and Supplemental Commissioning Language for other specifications if required. Design Development Document Evaluation ***SHOULD*** include one line requirements, specifications, typical room layouts, system main layouts, riser layouts, standard details, schedules and coordination requirements.

10.4.3.11 Contract Documents Evaluation
The CA ***SHALL*** evaluate the contract documents at least once near 100% construction document level. The CA ***SHALL*** evaluate drawings and specifications for each system, component, and equipment for its commissionability, maintainability, functionality and best practices.

10.4.3.12 Meetings
The CA ***SHALL*** conduct all commissioning team meetings and shall issue meeting minutes as documentation of these meeting.

10.4.3.13 Update the OPR and the BOD
The Owner must update the OPR and the design professionals must update the BOD during design phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final Contract Documents.

10.4.3.14 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any additional Commissioning Team members, procedures and schedules or design phase commissioning requirements developed in the Design Commissioning process.

10.4.3.15 Issues Log Management
The Owner must manage the Issues Log as to timely issue answers and resolutions. The Owner has the final authority over issue resolution disagreements or interpretations. The final Issues Log, its statements and its statement answers ***SHALL*** become a permanent record of the commissioning process.

10.4.3.16 Update the Issues Log Documentation
The CA ***SHALL*** create and maintain the Issues Log. The Issues Log shall be used throughout the commissioning process, going from a Design Phase issue log to a Construction Phase issue log, to an Acceptance Phase issue log and finally to a Warranty Phase issue log. The final (complete) issue log shall become a part of the final Commissioning Report.

10.4.3.17 Pre-Bid Meeting
The Owner should conduct a Pre-bid meeting to assist contractors in answering any questions about the systems or the commissioning process. The CA ***SHOULD*** attend the Pre-Bid meeting to fully explain the commissioning requirements of the Contract Documents and allow the contractors to understand their roll in the commissioning process and its associated costs. The CA should provide any assistance required by the Owner in answering written questions (in the form of clarifications or addendum recommendations) during the bidding process.

10.4.4 DESIGN PHASE DOCUMENTATION
The following commissioning documents are produced during the Design phase commissioning if these activities are included in commissioning scope of work.

a. Updated Owner's Project Requirements **(*SHOULD)***
b. Updated Commissioning Plan **(*SHALL)***
c. Basis of Design Evaluation **(*SHOULD)***
d. Contract Document Evaluation **(*SHALL)***
e. Updated Issues Log **(*SHALL)***
f. Pre Bid Meeting minutes or documentation **(*SHOULD)***

10.5 CONSTRUCTION PHASE COMMISSIONING

10.5.1 INTRODUCTION
During the Construction Phase the commissioning team works to verify the equipment and systems are installed in accordance with the design documents and are operable, maintainable and ready for functional testing.

10.5.2 CONSTRUCTION PHASE RESPONSIBILITES
10.5.2.1 Commissioning Team Members
The commissioning team members for the Construction Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives
d. Construction Manager Representative
e. General Contractor Representatives

f. Electrical Contractor Representative
g. Special Electrical Systems Contractor Representative
h. Control Contractor Representative (If Required)
i. Specialty Contractor Representative (If Required)

10.5.2.2 Commissioning Team Responsibilities
The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

10.5.3 CONSTRUCTION PHASE ACTIVITIES

10.5.3.1 Commissioning Plan
If the project does not have a Design Phase, or if the Commissioning Plan was not produced in the Design Phase, it ***SHALL*** be produced at this time by the CA. The commissioning plan should include:

a. Description of the commissioning scope and process utilized for the project
b. Commissioning Team member identification and contact information
c. Team member responsibilities
d. Commissioning check sheet or form index
e. Copies of all typical commissioning check sheets or forms

10.5.3.2 Construction Kick-Off Meeting
The CA ***SHALL*** conduct an initial commissioning meeting with all contractors and Commissioning Team members. The purpose of the meeting will be to review the Construction Phase Commissioning process and activities for the commissioning of the project. During the meeting the CA ***SHOULD*** review the following:

a. The Commissioning Plan
b. The basic commissioning processes to be utilized on the project
c. The individual roles and responsibilities of each participating Commissioning Team member
d. Documentation requirements
e. Communication and reporting procedures
f. The check sheets and forms to be utilized on the project
g. The commissioning duration schedules

The CA ***SHALL*** create the meeting agenda, lead the meeting and prepare and distribute the meeting minutes.

10.5.3.3 Commissioning Duration Schedule
The CA ***SHOULD*** prepare a duration schedules for the contractors for the commissioning activities required by the commissioning plan. These duration schedules ***SHOULD*** be incorporated into the contractor's project schedule to track all commissioning activities of the Commissioning Team.

10.5.3.4 Commissioning Team Meetings
The CA ***SHALL*** attend and lead all commissioning meetings as required with the Commissioning Team to review progress of the commissioning effort and reinforce individual responsibilities. Also, review completed work and agree upon the acceptability of the delivered product. The CA ***SHALL***:

a. Create the agenda
b. Attend and lead meeting
c. Schedule and review the commissioning activities

d. Coordinate commissioning meetings with construction meetings and activities
e. Prepare and distribute meeting minutes

10.5.3.5 Submittal and Shop Drawing Review
The CA ***SHALL*** review all pertinent Special Electrical Systems submittals and shop drawings to support the Commissioning Process. The submittal and shop drawing review should include:

a. The submittal and shop drawing information is utilized to create the appropriate PFT check sheets and forms for the project
b. The CA ***SHALL*** review the submittals and shop drawings for commissionability, maintainability, functionality and for conformance to the CD's, OPR and BOD
c. The CA ***SHALL*** document any found issues on the project Issue Log. The Issues Log ***SHALL*** be forwarded to the appropriate Commissioning Team member for resolution.

10.5.3.6 Site Observations
During the course of construction, the CA ***SHALL*** visit the site to inspect the progress of construction with respect to the Special Electrical Systems, equipment and components being commissioned. The purpose of the inspections is to verify that the construction complies with the Contract Documents, the OPR and identify and document any quality issues that may lead to functional issues. Site observations are forwarded to the appropriate team member for their review and action. If site observation issues are not automatically accepted and resolved the observation is added to the issue Log for resolution.

10.5.3.7 Pre-Functional Tests (PFT)
There are several types of Special Electrical Systems PFT that ***SHALL*** be performed during the construction phase: installation verification tests, static tests, and system startup tests.

10.5.3.7.1 Special Electrical Systems Equipment & Controls Installation Verification Tests
The contractor must verify that all work is installed in accordance with the contract documents and / or the manufacturer's recommendations and provide the associated check sheets verifying such. The contractor must document that all equipment is installed in the correct location and is operable in accordance with the contract documents. The CA ***MAY*** provide the installation verification check sheets if not available from the manufacturers or contractors. The CA or his staff ***SHALL*** validate the Installation Verification check sheets completed by the contractor by back checking them through site observations. Completion of all installation verification tests signifies that those systems are ready for start up activities. Examples of these tests include:

a. All conductor and raceway installations
b. All Special Electrical Systems equipment installation
c. All Special Electrical Systems Control equipment and component installation

Installation Verification tests ***SHALL*** include the following:

a. Material or Equipment Name or description
b. Model Number
c. Type and Size
d. Serial Number (If applicable)
e. Installation and location to design requirements verification
f. Maintenance access verification
g. Installation complete

10.5.3.7.2 Static Tests

The contractor must perform resistance and torque tests as described in the Contract Documents. All tests must be verified and documented by contractor or code authority as required by the Contract Documents or as dictated by the local codes. The CA ***MAY*** provide the static test sheets to the contractor performing the tests. The CA ***MAY*** observe and document these tests. Completed static test sheets are then provided to the CA. Examples of these tests include:

a. Conductor polarity tests
b. Supervised wiring resistance measurement for Fire Alarm systems

10.5.3.7.3 Special Systems Inspections

Some Code authorities require special system inspections be performed by the Special Systems Inspector and may also require the Engineer of Record stamp the special systems inspection report prior to accepting the system. Each code authority may require special system inspections on different pieces of Special Electrical Systems equipment. Normally special systems inspections are required for:

a. Fire alarm systems
b. Smoke detectors
c. Fire dampers
d. Smoke/fire dampers

10.5.3.7.4 Special Electrical Systems Equipment Startup Tests

The contractor, vendor or testing agency that has contractual obligation to provide start up services ***SHALL*** start up the systems and equipment in accordance with the Contract Documents and the manufacturer's requirements. Completed start up check sheets are then provided to the CA. The CA ***MAY*** observe and document these start up tests. Start up tests ***SHOULD*** include the following:

a. Manufacturer's Name
b. Model Number
c. Type and Size
d. Serial Number
e. Actual Settings or Adjustments
f. Actual Special Electrical Systems Characteristics
g. Operating data as required by the manufacturer

10.5.3.7.5 Special Electrical Systems Specific Startup Tests

The CA ***SHALL*** provide a 100% point-to-point system test as verification of the special electrical system operational status with no sampling strategies allowed. The control point-to-point test shall verify the system operation from the system main communication device clear to the end device. The control tests ***SHOULD*** include the following:

a. Fire Alarm
    i. Point-to-point test of all connected devices
    ii. Response testing of all zone and device alarms
    iii. Response testing of all horns, speakers, phones, strobes and alarm devices
    iv. Smoke control system testing
b. Security Systems
    i. Point-to-point test of all connected devices
    ii. Response testing of all input and control devices
    iii. Response testing of all alarms

c. CCTV Systems
    i. Point-to-point test of all connected devices
    ii. Response testing of all zone and device alarms
    iii. Response testing of all cameras, camera controls and recorders
d. Telephone Systems
    i. Point-to-point test of all connected devices
    ii. Response testing of all phone sets and consoles
    iii. Response testing of all connected lines
e. Paging and Intercom Systems
    i. Point-to-point test of all connected devices
    ii. Response testing of all speakers and consoles
f. Music and White Noise Systems
    i. Point-to-point test of all connected speakers and devices
    ii. Response testing of all zones
g. Nurses Call Systems
    i. Point-to-point test of all connected devices
    ii. Response testing of all call devices
    iii. Response testing of all consoles
h. Network Data Systems
    i. Wire continuity testing to verify jacks are connected and active
    ii. Signal Strength Testing

Start Up check sheets and forms ***SHOULD*** include the following:

a. Product Manufacturer
b. Component identification
c. Verification of component communication
d. Verification of action and polarity
e. Verification of status indication
f. Verify functionality described above

10.5.3.8 Update the OPR and the BOD

The Owner must update the OPR and the design professionals must update the BOD during construction phase to incorporate any approved Special Electrical Systems changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final construction.

10.5.3.9 Update the Commissioning Plan

The CA ***SHALL*** update the Commissioning Plan to include any changes to the commissioning team members, their responsibilities, contact information, procedures, schedules or changes to the commissioning requirements as a result of the Construction Phase. The Commissioning Plan shall also be updated to include all revised or added check sheets or forms utilized during the Pre-Functional Tests.

10.5.3.10 Issues Log & Deficiency Resolution

The CA ***SHALL*** report deficiencies from any PFT on the Issues Log and it shall be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA ***SHALL*** assist as necessary to complete the issue log. After corrective action, retests shall be performed to verify conformance.

When deficiencies are resolved, the issues shall be signed off on the Issues Log by the appropriate Commissioning Team Member(s). All issue log items must be resolved or answered by the appropriate commissioning team member. Issues that are resolved in a manner not consistent with the OPR must be approved by the Owner.

10.5.4 CONSTRUCTION PHASE DOCUMENTATION

The following commissioning documents are produced during the Construction Phase commissioning if these activities are included in commissioning scope of work:

a. Kick off team meeting agenda and minutes ***(SHALL)***
b. Agendas and Minutes of all commissioning team meetings ***(SHALL)***
c. Commissioning duration schedules ***(SHOULD)***
d. Submittal & Shop Drawing review documents ***(SHALL)***
e. Site Observation reports ***(SHALL)***
f. Pre-Functional Test report check sheets: Installation Verification Tests, Static Tests and System Startup Tests ***(SHALL)***
g. Updated Owner's Project Requirements ***(SHOULD)***
h. Updated Commissioning Plan ***(SHALL)***
i. Updated Issues Log ***(SHALL)***

10.6 ACCEPTANCE PHASE COMMISSIONING

10.6.1 INTRODUCTION

During the Acceptance Phase the Commissioning Team works to verify the functionality of all systems, equipment, systems and components. The Commissioning Team assures that all systems are functioning in a manner that conforms to the OPR. The Commissioning Team also coordinates the level of Owners Personnel Training.

10.6.2 ACCEPTANCE PHASE RESPONSIBILITIES

10.6.2.1 Commissioning Team Members

The required commissioning team members for the Acceptance Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives (if required)
d. Construction Manager Representative (if required)
e. General Contractor Representatives (if required)
f. Electrical Engineer (if required)
g. Special Electrical Systems Contractor Representative
h. Control Contractor Representative (If required)
i. Specialty Vendor or Contractor Representative (if required)

10.6.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

10.6.3 ACCEPTANCE PHASE ACTIVITIES

10.6.3.1 Commissioning Duration Schedule

The CA ***SHOULD*** continue to monitor and update the duration schedules for the contractors for the commissioning activities in the Acceptance Phase required by the Commissioning Plan. These

duration schedules should track all commissioning activities of the Commissioning Team in this phase.

10.6.3.2 Commissioning Team Meetings
The CA ***SHALL*** continue to attend and lead all commissioning meetings as required with the Commissioning Team to review progress of the commissioning effort and reinforce individual responsibilities.

10.6.3.3 Functional Performance Tests (FPT)
Functional Performance Tests ***SHALL*** be designed by the CA and performed by the Commissioning Team. The CA or his staff ***SHALL*** observe and facilitate the FPT for all systems that have operating sequences. The CA ***SHALL*** provide final approval for Functional Performance Test results. The FPT tests ***SHALL*** include the following:

a. System description
b. Specific function being tested
c. Functional test design
d. Description of testing procedure
e. Description of test duration
f. Description of test report documentation requirements
g. Description of test pass/fail criteria

Special Electrical Systems Functional Performance Tests ***SHOULD*** include:

a. Fire Alarm
    i. All points report without any alarms or trouble indicated on supervised cables
b. Security Systems
    i. Reports indicating specified tracking activity
c. CCTV Systems
    i. Observe functionality of alarms and indicators
    ii. Observe functionality of alarm reports
    iii. Observe functionality of archive functions
d. Telephone Systems
    i. Observe functionality of reports
e. Paging and Intercom Systems
    i. No Functional test requirements
f. Music and White Noise Systems
    i. No Functional test requirements
g. Nurses Call Systems
    i. No Functional test requirements
h. Network Data Systems
    i. No Functional test requirements

10.6.3.4 Record Documents / As-Built Drawings and Operations and Maintenance (O&M) Manuals
The Contractors ***SHALL*** create and assemble the Operating and Maintenance Manuals as contractually required. The drawings and manuals are then forwarded to the design professional for review and approval. The CA ***SHOULD*** review all Record Documents and Operating and Maintenance Manuals for accuracy and completeness to the Contract Documents and for conformance to the OPR. The CA ***SHOULD*** review these documents after review and approval by the design professional. The Record Documents and the O&M Manuals ***SHOULD*** include:

a. Final Approved Submittals
b. Final Approved Shop Drawings
c. Record Documents
d. Service Procurement information
e. Operating Manuals specifically tailored to the exact equipment, systems and components installed
f. Maintenance Requirements and Procedures
g. Recommended spare parts lists with purchase contact information
h. Warranty information

The CA ***SHOULD*** verify that the Record Documents and O&M Manuals are reviewed, approved and delivered to the Owner prior to operator training.

10.6.3.5 Owner Training
The CA ***SHOULD*** work with the contractor and Owner to schedule and plan training activities so that training occurs in a coordinated and coherent fashion. The CA ***SHOULD*** assist in the development of training schedules and agendas, encourage the use of a combination of "classroom" and field training, and assist the contractors in the development of training agendas for each system, piece of equipment or component installed in the project.

The design professionals, contractors and vendors provide the training instruction and provide training materials. Additional operator skill training ***MAY*** be provided as an additional scope item if desired by the Owner.

The CA ***MAY*** document Owner training events by video taping presentations and demonstrations for future use by the Owner.

10.6.3.6 Update the OPR and BOD
The Owner must update the OPR and the design professionals ***SHALL*** update the BOD during Construction Phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications incorporated during the Acceptance Phase.

10.6.3.7 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any changes to the Commissioning Team members, their responsibilities, their contact information, procedures, schedules or changes to the commissioning requirements as a result of the Acceptance Phase. The Commissioning Plan shall also be updated to include all revised or added check sheets or forms utilized during the Functional Performance Tests. The Commissioning Plan ***SHOULD*** include:

a. Description of the commissioning process utilized for the project
b. Commissioning Team member identification and contact information
c. Team member responsibilities
d. Commissioning FPT forms index
e. Copies of all typical FPT forms

10.6.3.8 Issues Log and Deficiency Resolution
The Owner must manage the Issue Log as to timely issue answers and resolutions. The Owner shall have final authority over issue resolution disagreements or interpretations. The final Issues Log, its statements and its statement responses, ***SHALL*** become a permanent record of the commissioning process.

10.6.3.9 Update the Issues Log

The CA ***SHALL*** report deficiencies from the FPT on the Issues Log and it ***SHALL*** be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA ***SHALL*** assist as necessary to complete the issue log. After corrective action, retests ***SHALL*** be performed to verify conformance. When deficiencies are resolved, the issues ***SHALL*** be signed off on the Issues Log by the CA and the appropriate Commissioning Team Member(s). All issue log items ***SHALL*** be resolved or answered by the appropriate commissioning team member. Issues that are resolved in a manner that are not consistent with the OPR must be approved by the Owner. If after three attempts by the CA to obtain an issue resolution a CA can issue a certified report by clearly describing the unresolved issue in the Commissioning Report executive summary.

10.6.3.10 Final Commissioning Report

Based on the accumulated commissioning work completed as described above, the CA ***SHALL*** assemble the data into a final Commissioning Report. The final report will incorporate the final record documents for each system, as appropriate. The Commissioning Report ***SHALL*** include:

a. Report Title Page ***(SHALL)***
b. Report Certification Page ***(SHALL)***
c. Table of Contents Page ***(SHALL)***
d. Executive Summary ***(SHALL)***
e. Project OPR ***(SHOULD)***
f. Commissioning Plan ***(SHALL)***
g. Final Issue Log ***(SHALL)***
h. Completed Pre Functional Test Forms and Check Sheets ***(SHALL)***
i. Completed Functional Performance Test Forms and Check Sheets ***(SHALL)***
j. Observation Reports ***(SHALL)***
k. Training Verification Records ***(SHOULD)***
l. Commissioning Communications ***(SHALL)***
m. Test Instrument Page ***(SHALL)***

10.6.3.11 Systems Manual

At the end of the Acceptance Phase the CA ***MAY*** produce the Systems Manual. The purpose of the Systems Manual is to provide the Owner and his operators with a permanent record of all pertinent documents required for future operation, commissioning and validation processes of the facility. The Systems Manual ***SHOULD*** be provided to the Owner in electronic format. At a minimum the final system manual ***SHOULD*** include the following:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operating and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures

10.6.4 ACCEPTANCE PHASE DOCUMENTATION

The following commissioning documents are produced during the Acceptance Phase commissioning if these activities are included in commissioning scope of work.

a. Completed Functional Performance Tests Report Forms ***(SHALL)***
b. O&M Review Document ***(SHOULD)***
c. Commissioning Report ***(SHALL)***
d. Systems Manual ***(MAY)***
e. Training Agenda ***(SHOULD)***

10.7 WARRANTY PHASE COMMISSIONING

10.7.1 INTRODUCTION

During the Warranty Phase the Commissioning Team works to verify the installed equipment and systems are meeting the OPR at the end of the warranty period.

10.7.2 WARRANTY PHASE RESPONSIBILITIES

10.7.2.1 Commissioning Team Members

The required Commissioning Team members for the Warranty Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives
d. Construction Manager Representatives
e. General Contractor Representatives
f. Applicable Subcontractors
g. Applicable Vendors

10.7.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

10.7.3 WARRANTY PHASE ACTIVITIES

10.7.3.1 Deferred Systems Tests

The CA and all applicable contractors and vendors ***SHALL*** provide any required deferred system Functional Performance Tests required by the commissioning plan. Functional Performance Test's ***SHALL*** be designed by the CA and performed by the contractors or Owner. The CA ***SHOULD*** observe and facilitate all functional performance tests for all systems that have operating sequences. The CA ***SHALL*** provide final approval for Functional Performance test results.

10.7.3.2 Warranty Visit

The CA ***SHOULD*** inspect the site and interview building operating personnel to identify any outstanding warranty failures and to identify any persistent equipment failure issues that should be handled within the warranty period. This site visit should occur approximately two months prior to the end of the warranty period.

10.7.3.3 Lessons learned Workshop

The CA MAY perform a lessons learned workshop with the owner, designers and/or construction team members. The purpose of the lessons learned workshop is to determine how to improve the process for future projects.

10.7.4 WARRANTY PHASE DOCUMENTATION

The following commissioning documents are produced during the Warranty Phase commissioning if these activities are included in commissioning scope of work.

a. Deferred Functional Performance Tests Check Sheets and Forms ***(SHALL)***
b. Warranty visit documentation with associated issues ***(SHALL)***
c. Commissioning Report Addenda with deferred testing results ***(SHALL)***
d. Lessons Learned Workshop Report ***(MAY)***

NEBB COMMISSIONING REQUIREMENTS - SPECIAL ELECTRICAL SYSTEMS			
Item	***SHALL***	***SHOULD***	***MAY***
PRE DESIGN PHASE COMMISSIONING *(If included in commissioning scope)*			
Commissioning Scope defined on Certification page	Owner Establishes	CA Assist	
Create OPR	Owner Perform	CA Assists	CA Perform
Create Preliminary Commissioning Plan	CA Perform		
Create Issues Log	CA Perform		
System Manual Requirements			CA Perform
DESIGN PHASE COMMISSIONING (DPC) *(If included in commissioning scope)*			
Create or Update Commissioning Plan	CA Perform		
Create or Update Issues Log	CA Perform		
Design Kick Off Meeting		CA Perform	
Schematic Design Review			CA Perform
Update OPR	Owner Perform	CA Perform	
Update BOD	Engineer Perform		
Basis of Design Review		CA Perform	
Specification & Drawing Review near 100% CD's	CA Perform		
Define training requirements for Owners personnel	Owner Perform	CA Perform	
Create Commissioning Specifications		CA Perform	
Pre Bid Meeting		Owner Perform	CA Assist
CONSTRUCTION PHASE COMMISSIONING			
Construction Kick Off Meeting	CA Perform		
Create Commissioning Duration Schedules		CA Perform	
Submittal and Shop Drawing Review	CA Perform		
Update Issues Log	CA Perform		
Update Commissioning Plan	CA Perform		
Update OPR and BOD	Owner Perform	CA Perform	
Site Observations for all Special Electrical Systems	CA Perform		
Create Pre Functional Equip & System Installation Check Sheets	Contractor Perform	Test Agency Prfrm	CA Perform
Perform Pre Functional Equip & System Installation Check Sheets	Contractor Perform	Test Agency Prfrm	CA Verify
Perform & Document Static Tests	Contractor Perform	Test Agency Prfrm	CA Verify
Perform special systems inspections	Special Inspector Prfrm		
Create Elec Controls Pre Functional Installation Check Sheets	Contractor Perform	CA Perform	
Perform & Doc Elec Controls Pre Functional Installation Chk Sheets	Contractor Perform	CA Verfiy	CA Perform
Create Pre Functional Controls Point to Point Check Sheets	CA Perform		
Perform Pre Functional Controls Point to Point Check Sheets	CA Perform		
ACCEPTANCE PHASE COMMISSIONING			
Create Elec Functional Performance Test Check Sheets	Contractor Perform	Test Agency Prfrm	CA Perform
Perform Elec Functional Performance Tests	Contractor Perform	Test Agency Prfrm	Owner or CA Perform
Approve Functional Tests results	CA Perform		
Review Operating and Maintenance Manuals	Engineer Perform	CA Perform	
Create Training Schedules with Owner	Contractor Perform	CA Assist	CA Perform
Assist contractors in developing Training Agendas		CA Perform	
Update Issues Log	CA Perform		
Update OPR	Owner Perform	CA Perform	
Update BOD	Engineer Perform		
Document Owner Training			CA Perform
Create Final Commissioning Report	CA Perform		
Create Final System Manual			CA Perform
WARRANTY PHASE COMMISSIONING *(If included in commissioning scope)*			
Create Deferred Functional Test Check Sheets	CA Perform		
Perform & Document Deferred Functional Tests	Contractor Perform	CA Observe	Owner or CA Perform
Witness functionality of FPT tests	CA Perform		
Approve Deferred Functional Tests results	CA Perform		
Perform Warranty Visit & Documentation		CA Perform	
Create Commissioning Report Addenda	CA Perform		
Update Issues Log	CA Perform		
Perform a Lessons learned workshop			CA Perform

SECTION 11 COMMISSIONING OF PLUMBING SYSTEMS

11.1 INTRODUCTION

The purpose of Section 11 is to describe the requirements for commissioning a project's Plumbing systems, equipment and components. While Section 6 details the elements of the commissioning process in global terms, this section will detail the minimum requirements for a NEBB Certified Plumbing Commissioning project. The actual scope of work may differ from these requirements. These minimum requirements are described as ***SHALL*** requirements. ***SHOULD*** requirements are recommended to produce a higher quality project and ***MAY*** requirements could be included to enhance the commissioning project. These minimum requirements take precedence when a scope of work is not defined, or the requirements state words to effect that the "…project ***SHALL*** be commissioned in accordance with the requirements of the NEBB *Procedural Standards for Whole Building Systems Commissioning of New Construction."* To be a NEBB certified report the following must apply:

1. The actual contracted scope of work ***SHALL*** be clearly defined on the certification page of the report as specified in the contract documents or as agreed to between the Owner / Buyer and the NEBB Certified BSC Firm.
2. If the scope of work differs from the NEBB ***SHALL*** language it shall be clearly delineated on the certification page of the report, otherwise all ***SHALL*** language must be adhered to for a NEBB Certified Report.

11.2 PRE-DESIGN PHASE COMMISSIONING

11.2.1 INTRODUCTION

There are two main purposes of the Pre-Design Phase. The first is to develop and document the Owner's Project Requirements (OPR) and the second is to develop the Preliminary Commissioning Plan.

11.2.2 PRE-DESIGN PHASE RESPONSIBILITIES

11.2.2.1 Commissioning Team Members

During the Pre-Design Phase the Owner should assign or contract for the appropriate Commissioning Team members to facilitate the Pre-Design process. The required Commissioning team members for the Pre-Design Phase should be as follows:

a. Owner's Representatives
b. Commissioning Authority (CA)
c. Programming Professionals if applicable
d. Architect if applicable
e. Plumbing, Mechanical and Electrical Engineer if applicable
f. Construction Manager / General Contractor if applicable

11.2.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member must be responsible for contributing to the commissioning process based on their individual project responsibilities.

11.2.3 PRE-DESIGN PHASE ACTIVITIES

11.2.3.1 OPR Definition and Development

The Owner should produce the Owner's Project Requirements (OPR) to facilitate the design and delivery of the project. The OPR outlines the expectations the Owner has for the Plumbing requirements of the project. The Plumbing OPR ***SHOULD*** include the following items that relate to the HVAC system:

a. Use and space requirements
b. Anticipated occupancy
c. Plumbing construction budget
d. Plumbing codes or standards to be utilized
e. Special systems or equipment requirements that may affect plumbing calculations and loads
f. Specific material or equipment requirements
g. Energy and water efficiency expectations
h. Sustainability requirements
i. Measurement and Verification Strategies
j. Ongoing Commissioning and Building Rating Requirements
k. Levels of redundancy
l. Building Automation / Controls sophistication
m. Vibration, sound and / or seismic requirements
n. Operation and maintenance criteria
o. Owner's expectations for operator and occupant training
p. Requirements for future facility adaptation and expansion
q. Owner's expectations of the design team and their produced documents
r. Owner's expectations of the construction team and their document requirements
s. Owner's expectations of the Commissioning Authority and their document requirements

11.2.3.2 Commissioning Plan

The CA ***SHALL*** develop a preliminary Plumbing Commissioning Plan that documents the following:

a. The commissioning scope
b. The Commissioning Team
c. Normal channels of communication
d. Design phase commissioning procedures
e. Design phase commissioning duration schedules

11.2.3.3 Issues Log

The CA ***SHALL*** develop the format of the Issues Log to be utilized for the commissioning process. The Issues Log should address the manner that the perceived Plumbing deficiencies will be documented by the CA and communicated to the design professionals and the contractors during subsequent commissioning phases of the project development and delivery. The Issues Log should also address the deficiency resolution procedure. The Issues Log should include:

a. Issue Number
b. Issue statement
c. Date of Issue statement
d. Person making issue statement
e. Issue statement response
f. Date of Issue statement response
g. Person making the issue statement response

11.2.3.4 Commissioning Scope(s) of Work and Budgeting
The CA ***SHOULD*** assist the Owner in developing the commissioning scope of the project and its associated costs. Project scope should include:

a. Phase to be commissioned: The Owner must determine which phases will be commissioned for the project such as Pre-Design Phase, Design Phase, Construction Phase, Acceptance Phase and Warranty Phase.
b. Systems to be commissioned: The Owner must determine which systems will be commissioned for the project including special systems and if any areas will be excluded from the commissioning project.
c. The commissioning scope shall be based upon this NEBB BSC Procedural Standard and its definition of the commissioning process and its required ***SHALL*** language. If the Owner desires to establish a different level of commissioning activities than those stated in this procedural standard it must be clearly delineated in the scope of work.
d. Level of Owner's participation in the commissioning process: The Owner must establish the level of participation their representatives will provide to the commissioning team during each phase of the commissioning project.

11.2.3.5 Develop System Manual Requirements
During the Pre Design phase the Commissioning Team and the CA ***MAY*** develop documents which will make up the systems manual and determine what the Owner's Operator training requirements will be. The final system manual ***MAY*** include the following and should be provided in electronic format:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operating and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures
j. Test Reports

11.2.3.6 Commissioning Meetings
The CA ***SHALL*** conduct all Commissioning Team meetings as required to implement the commissioning process and ***SHALL*** issue meeting minutes as documentation of these meetings.

11.2.3.7 Update the OPR
The Owner must update the OPR during Pre-Design Phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications.

11.2.4 PRE-DESIGN PHASE DOCUMENTATION

The following commissioning documents are produced during Pre-Design Phase Commissioning if these activities are included in commissioning scope of work:

a. Owner's Project Requirements ***(SHOULD)***
b. Preliminary Commissioning Plan ***(SHALL)***
c. Issues Log ***(SHALL)***
d. Commissioning Scope and Budgets ***(MAY)***
e. System Manual Index of contents ***(MAY)***

11.3 DESIGN PHASE COMMISSIONING

11.3.1 INTRODUCTION

During the Design Phase, the design professionals create the Contract Documents. The Contract Documents turn the OPR into working design documents. The CA ***SHALL*** evaluate and document that the Contract Documents conform to the OPR. The CA ***SHALL*** evaluate that the Plumbing systems, equipment and components incorporated into the Contract Documents to ensure they conform to the OPR from the standpoint of commissionability, maintainability, functionality and best practices.

11.3.2 DESIGN PHASE RESPONSIBILITIES

11.3.2.1Commissioning Team Members

The required Commissioning Team members for the Design Phase should be:

a. Owner's Representatives
b. Commissioning Authority (CA)
c. Programming Professionals
d. Architect
e. Landscape Architect
f. Plumbing Engineer
g. Mechanical Engineer
h. Electrical Engineer
i. Construction Manager / General Contractor if applicable
j. Specialty, or Trade Contractors if applicable

11.3.2.2Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member is responsible for contributing to the commissioning processes according to their individual project responsibilities.

11.3.3 DESIGN PHASE ACTIVITES

11.3.3.1OPR Definition and Development

If the project does not have a Pre-Design Phase, or if the OPR was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 11.2.3.1 for the requirements.

11.3.3.2Commissioning Plan

If the project does not have a Pre-Design Phase, or if the Commissioning Plan was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 11.2.3.2 for the requirements.

11.3.3.3Issues Log

If the project does not have a Pre-Design Phase, or if the Issues Log was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 11.2.3.3 for the requirements.

11.3.3.4 Design Kick-Off Meeting

The CA ***SHOULD*** conduct an initial Kickoff Meeting with the Design Team and the Owner. The purpose of the meeting will be to establish the purpose and proposed processes for commissioning the design and to review the Design Phase Commissioning Plan.

11.3.3.5 Commissioning Activities Scheduled

The CA ***SHALL*** verify that commissioning activities are incorporated into the Design Phase schedule.

11.3.3.6 Evaluate Basis of Design Conformance
The design professional will prepare the Basis of Design (BOD) document in response to the OPR. The BOD includes the Design Narrative and the Design Criteria. The CA ***SHOULD*** verify that the BOD conforms to the requirements of the OPR.

The Design Narrative ***SHOULD*** include the following:

a. Description of the selected Plumbing systems and the reasons they were selected
b. Description of other systems that were analyzed and rejected and the reasons for rejections
c. Preliminary Plumbing calculation requirements
d. Various systems approaches
e. Water usage analysis
f. Sustainability, water and wastewater conservation approach
g. Life cycle costing information of each system analyzed
h. Preliminary major component selection
i. Equipment space layout for establishing building space requirements

The Design Criteria ***SHOULD*** include the following:

a. Project location and special plumbing site requirements
b. Design parameters including: space occupancy, utility requirements, all special equipment requirements, filtration requirements, special areas of concern and / or other criteria used that may define the methodology used to complete the plumbing design
c. Sustainability design parameters including: Water usage, grey water systems, reclaimed water systems, wastewater treatment and system energy efficiency
d. Design assumptions and limitations
e. Control systems sophistication
f. Sizing criteria to be used for piping systems
g. Accepted safety factors incorporated into the design
h. Accepted levels of redundancy
i. Reference to specific equipment selection limitations as to make or model numbers
j. Operation assumptions
k. Codes, standards and guidelines to be utilized for the design

The CA ***SHOULD*** evaluate the BOD for conformance to the OPR from the standpoint of commissionability, maintainability, functionality and industry accepted best practices and produce an evaluation document.

11.3.3.7 Commissioning Specifications
The CA ***SHALL*** review the contract commissioning specifications and verify that they are included in the contract documents. The CA ***SHOULD*** assist in creating commissioning specifications to be included in the contract documents. The commissioning specifications should include the following:

a. Specification describing the basic commissioning process that will be used on the project by the CA, located in the general requirement area of the specification
b. Specification describing the commissioning activities required of the Plumbing, Electrical, and Control contractors, located in each individual discipline specification
c. Specification describing the commissioning activities required of any Vendor or equipment supplier or specialty subcontractor, located in each individual vendor, supplier or subcontractor specification section

11.3.3.8 Establish Training Requirements
The CA ***SHOULD*** work with the Owner and the design professionals to define the training requirements for the Owner's personnel. Verify that these requirements are incorporated into the project specifications. Training ***SHOULD*** include:

a. Theory of operation presented by the Engineer
b. Sustainability methods and measures presented by the Green Building Accredited Professional or the Engineer
c. Start Up procedures, Shut down procedures, Operating procedures and Maintenance procedures for each type of equipment and system presented by the manufacture or contractor
d. Control system operations and programming training. Include durations extended over time.
e. Specify classroom instruction duration and field demonstration duration for each training event.
f. O&M manual review for warranty repair or replacement procedures
g. Review of all warranty durations and start dates

11.3.3.9 Schematic Design Document Evaluation
The CA ***MAY*** complete a thorough evaluation of the Schematic Design (SD), or a 35% design review of documents to establish that the Plumbing systems, equipment and components are identified and can be installed in compliance with the OPR and the BOD. Schematic Design Document Evaluation ***MAY*** include: engineering calculations, system selection, system selection criteria, flow sheet designs and major component selection.

11.3.3.10 Design Development Document Evaluation
The CA ***SHOULD*** complete a thorough evaluation of the Design Development (DD), or a 65% design review of documents and submitted criteria for continued compliance to the OPR and BOD; Evaluate design documents for commissioning specifications and requirements; Draft preliminary Commissioning Specifications and Supplemental Commissioning Language for other specifications if required. Design Development Document Evaluation ***SHOULD*** include zoning requirements, specifications, typical room layouts, system main layouts, riser layouts, standard details, schedules and coordination requirements.

11.3.3.11 Contract Documents Evaluation
The CA ***SHALL*** evaluate the contract documents at least once near 100% construction document level. The CA ***SHALL*** evaluate drawings and specifications for each system, component, and equipment for its commissionability, maintainability, functionality and best practices.

11.3.3.12 Meetings
The CA ***SHALL*** conduct all commissioning team meetings and shall issue meeting minutes as documentation of these meeting.

11.3.3.13 Update the OPR and the BOD
The Owner must update the OPR and the design professionals must update the BOD during design phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final Contract Documents.

11.3.3.14 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any additional Commissioning Team members, procedures and schedules or design phase commissioning requirements developed in the Design Commissioning process.

11.3.3.15 Issues Log Management
The Owner must manage the Issues Log as to timely issue answers and resolutions. The Owner has the final authority over issue resolution disagreements or interpretations. The final Issues Log, its statements and its statement answers ***SHALL*** become a permanent record of the commissioning process.

11.3.3.16 Update the Issues Log Documentation
The CA ***SHALL*** create and maintain the Issues Log. The Issues Log shall be used throughout the commissioning process, going from a Design Phase issue log to a Construction Phase issue log, to an Acceptance Phase issue log and finally to a Warranty Phase issue log. The final (complete) issue log shall become a part of the final Commissioning Report.

11.3.3.17 Pre-Bid Meeting
The Owner ***SHOULD*** conduct a Pre-bid meeting to assist contractors in answering any questions about the systems or the commissioning process. The CA ***SHOULD*** attend the Pre-Bid meeting to fully explain the commissioning requirements of the Contract Documents and allow the contractors to understand their roll in the commissioning process and its associated costs. Provide any assistance required by the Owner in answering written questions (in the form of clarifications or addendum recommendations) during the bidding process.

11.3.4 DESIGN PHASE DOCUMENTATION
The following commissioning documents are produced during the Design phase commissioning if these activities are included in commissioning scope of work.

a. Updated Owner's Project Requirements **(*SHOULD)***
b. Updated Commissioning Plan **(*SHALL)***
c. Basis of Design Evaluation **(*SHOULD)***
d. Contract Document Evaluation **(*SHALL)***
e. Updated Issues Log **(*SHALL)***
f. Pre Bid Meeting minutes or documentation **(*SHOULD)***

11.4 CONSTRUCTION PHASE COMMISSIONING

11.4.1 INTRODUCTION
During the Construction Phase the commissioning team works to verify the equipment and systems are installed in accordance with the design documents and are operable, maintainable and ready for functional testing.

11.4.2 CONSTRUCTION PHASE RESPONSIBILITES
11.4.2.1 Commissioning Team Members
The commissioning team members for the Construction Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives
d. Construction Manager Representative
e. General Contractor Representatives
f. Mechanical Contractor Representative
g. Electrical Contractor Representative
h. Control Contractor Representative (If Required)
i. Specialty Contractor Representative (If Required)

11.4.2.2 Commissioning Team Responsibilities
The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

11.4.3 CONSTRUCTION PHASE ACTIVITIES

11.4.3.1 Commissioning Plan
If the project does not have a Design Phase, or if the Commissioning Plan was not produced in the Design Phase, it ***SHALL*** be produced at this time by the CA. The commissioning plan should include:

a. Description of the commissioning process utilized for the project
b. Commissioning Team member identification and contact information
c. Team member responsibilities
d. Commissioning check sheet or form index
e. Copies of all typical commissioning check sheets or forms

11.4.3.2 Construction Kick-Off Meeting
The CA ***SHALL*** conduct an initial commissioning meeting with all contractors and Commissioning Team members. The purpose of the meeting will be to review the Construction Phase Commissioning process and activities for the commissioning of the project. During the meeting the CA should review the following:

a. The Commissioning Plan
b. The basic commissioning processes to be utilized on the project
c. The individual roles and responsibilities of each participating Commissioning Team member
d. Documentation requirements
e. Communication and reporting procedures
f. The check sheets and forms to be utilized on the project

11.4.3.3 Commissioning Duration Schedule
The CA ***SHOULD*** prepare a duration schedules for the contractors for the commissioning activities required by the commissioning plan. These duration schedules ***SHOULD*** be incorporated into the contractor's project schedule to track all commissioning activities of the Commissioning Team.

11.4.3.4 Commissioning Team Meetings
The CA ***SHALL*** attend and lead all commissioning meetings as required with the Commissioning Team to review progress of the commissioning effort and reinforce individual responsibilities. Review completed work and agree upon the acceptability of the delivered product. The CA ***SHALL***:

a. Create the agenda
b. Attend and lead meeting
c. Schedule and review the commissioning activities
d. Coordinate commissioning meetings with construction meetings and activities
e. Prepare and distribute meeting minutes

11.4.3.5 Submittal and Shop Drawing Review
The CA ***SHALL*** review all pertinent HVAC submittals and shop drawings to support the Commissioning Process. The submittal and shop drawing review should include:

a. The submittal and shop drawing information is utilized to create the appropriate PFT check sheets and forms for the project.

b. The CA ***SHALL*** review the submittals and shop drawings for commissionability, maintainability, functionality and for conformance to the CD's, OPR and BOD.
c. The CA ***SHALL*** document any found issues on the project Issue Log. The Issues Log ***SHALL*** be forwarded to the appropriate Commissioning Team member for resolution.

11.4.3.6 Site Observations

During the course of construction, the CA ***SHALL*** visit the site to inspect the progress of construction with respect to the Plumbing systems, equipment and components being commissioned. The purpose of the inspections is to verify that the construction complies with the Contract Documents, the OPR and identify and document any quality issues that may lead to functional issues. Site observations are forwarded to the appropriate team member for their review and action. If site observation issues are not automatically accepted and resolved the observation is added to the issue Log for resolution.

11.4.3.7 Pre-Functional Tests (PFT)

There are several types of Plumbing PFT that ***SHALL*** be performed during the construction phase: installation verification tests, static tests, and equipment startup tests.

11.4.3.7.1Plumbing & Controls Installation Verification Tests

The contractor must verify that all work is installed in accordance with the contract documents and / or the manufacturer's recommendations and provide the associated check sheets verifying such. The contractor must document that all equipment is installed in the correct location and is operable in accordance with the contract documents. The CA ***SHOULD*** provide the installation verification check sheets if not available from the manufacturers or contractors. The CA or his staff ***SHALL*** validate the Installation Verification check sheets completed by the contractor by back checking them through site observations. Completion of all installation verification tests signifies that those systems are ready for start up activities. Examples of these tests include:

a. All piping systems, and component installations
b. All Plumbing equipment and fixture installation
c. All Plumbing Control equipment and component installation

Installation Verification tests ***SHALL*** include the following:

a. Material or Equipment Name or description
b. Model Number
c. Type and Size
d. Serial Number (If applicable)
e. Installation and location to design requirements verification
f. Maintenance access verification
g. Installation complete

11.4.3.7.2 Static Tests

The contractor must perform hydrostatic and pressure tests as described in the Contract Documents. All hydrostatic and pressure tests must be verified by contractor or code authority as required by the Contract Documents or as dictated by the local codes. The CA ***MAY*** provide the static test sheets to the contractor performing the tests. The CA ***MAY*** observe and document these start up tests. Completed static test sheets are then provided to the CA. Examples of these tests include:

a. Hydrostatic testing of all piping systems to the appropriate test pressure and duration
b. Slope verification tests

11.4.3.7.3 Plumbing Equipment Startup Tests
The contractor or vendor who has contractual obligation to provide start up services ***SHALL*** start up the systems and equipment in accordance with the Contract Documents and the manufacturer's requirements. Completed start up check sheets are then provided to the CA. The CA ***MAY*** observe and document these start up tests. At a minimum start up tests ***SHOULD*** include the following:

a. Manufacturer's Name
b. Model Number
c. Type and Size
d. Serial Number
e. Actual Settings or Adjustments
f. Actual Electrical Characteristics
g. Actual load
h. Operating data as required by the manufacturer

11.4.3.7.4 Control System Startup Tests
The CA ***SHALL*** provide a 100% point-to-point control system test and sensor calibration as verification of the control system operational status with no sampling strategies allowed. The control point-to-point test shall verify the system operation from the system graphic to the end sensor or control device. The control tests ***SHOULD*** include the following:

a. Controller Manufacturer
b. Controller or System identification
c. Verification of controller communication
d. Pin Address
e. Point ID and name
f. Point type
g. Connected device description
h. Verification of action and polarity
i. Verification of status indication
j. Actual sensor reading, system reading and offset

11.4.3.8 Update the OPR and the BOD
The Owner must update the OPR and the design professionals must update the BOD during construction phase to incorporate any approved Plumbing changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final construction.

11.4.3.9 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any changes to the commissioning team members, their responsibilities, contact information, procedures, schedules or changes to the commissioning requirements as a result of the Construction Phase. The Commissioning Plan shall also be updated to include all revised or added check sheets or forms utilized during the Pre-Functional Tests.

11.4.3.10 Issues Log & Deficiency Resolution
The CA ***SHALL*** report deficiencies from any PFT on the Issues Log and it shall be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA ***SHALL*** assist as necessary

to complete the issue log. After corrective action, retests shall be performed to verify conformance. When deficiencies are resolved, the issues shall be signed off on the Issues Log by the appropriate Commissioning Team Member(s). All issue log items must be resolved or answered by the appropriate commissioning team member. Issues that are resolved in a manner not consistent with the OPR must be approved by the Owner.

11.4.4 CONSTRUCTION PHASE DOCUMENTATION

The following commissioning documents are produced during the Construction Phase commissioning if these activities are included in commissioning scope of work:

a. Kick off team meeting agenda and minutes ***(SHALL)***
b. Agendas and Minutes of all commissioning team meetings ***(SHALL)***
c. Commissioning duration schedules ***(SHOULD)***
d. Submittal & Shop Drawing review documents ***(SHALL)***
e. Site Observation reports ***(SHALL)***
f. Pre-Functional Test report check sheets: Installation Verification Tests, Static Tests and Equipment Startup Tests ***(SHALL)***
g. Updated Owner's Project Requirements ***(SHOULD)***
h. Updated Commissioning Plan ***(SHALL)***
i. Updated Issues Log ***(SHALL)***

11.5 ACCEPTANCE PHASE COMMISSIONING

11.5.1 INTRODUCTION

During the Acceptance Phase the Commissioning Team works to verify the functionality of all systems, equipment, systems and components. The Commissioning Team assures that all systems are functioning in a manner that conforms to the OPR. The Commissioning Team also coordinates the level of Owners Personnel Training.

11.5.2 ACCEPTANCE PHASE RESPONSIBILITIES

11.5.2.1 Commissioning Team Members

The required commissioning team members for the Acceptance Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives (if required)
d. Construction Manager Representative (if required)
e. General Contractor Representatives (if required)
f. Plumbing Contractor Representative
g. Electrical Contractor Representative (if required)
h. Control Contractor Representative (If required)
i. Specialty Contractor Representative (if required)

11.5.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

11.5.3 ACCEPTANCE PHASE ACTIVITIES

11.5.3.1 Commissioning Duration Schedule

The CA ***SHOULD*** continue to monitor and update the duration schedules for the contractors for the commissioning activities in the Acceptance Phase required by the Commissioning Plan. These

duration schedules should track all commissioning activities of the Commissioning Team in this phase.

11.5.3.2 Commissioning Team Meetings
The CA ***SHALL*** continue to attend and lead all commissioning meetings as required with the Commissioning Team to review progress of the commissioning effort and reinforce individual responsibilities.

11.5.3.3 System Chlorinization Verification
The CA ***SHALL*** verify that all potable water system have been cleaned and chlorinated and flushed in accordance with the specifications and local code requirements. This verification ***SHOULD*** include witnessing chlorinization tests. The CA ***SHALL*** include copies of all chlorinization test results in the final commissioning report.

11.5.3.4 Functional Performance Tests (FPT)
Functional Performance Tests ***SHALL*** be designed by the CA and performed by the Commissioning Team. The CA or his staff ***SHALL*** observe and facilitate the FPT for all systems that have operating sequences. The CA ***SHALL*** provide final approval for Functional Performance Test results. FPT ***SHALL*** be performed for all sequences with no sampling strategies allowed except for application specific, factory programmed devices that cannot have the program modified in the field. The FPT tests ***SHALL*** include the following:

a. System description
b. Specific function being tested
c. Functional test design
d. Description of data points tested
e. Description of test duration and test interval times
f. Description of test setpoints and setpoint changes
g. Description of test report documentation requirements
h. Description of test pass/fail criteria

11.5.3.5 Sound & Vibration (S&V) Testing
The CA ***SHALL*** verify that the Sound level tests and Vibration measurements tests have been completed in accordance with the Contract Documents and ***SHALL*** review the final S&V Report for completeness and accuracy.

11.5.3.6 Record Documents / As-Built Drawings and Operations and Maintenance (O&M) Manuals.
The Contractors ***SHALL*** create and assemble the Operating and Maintenance Manuals as contractually required. The drawings and manuals are then forwarded to the design professional for review and approval. The CA ***SHOULD*** review all Record Documents and Operating and Maintenance Manuals for accuracy and completeness to the Contract Documents and for conformance to the OPR. The CA ***SHOULD*** review these documents after review and approval by the design professional. The Record Documents and the O&M Manuals ***SHOULD*** include:

a. Final Approved Submittals
b. Final Approved Shop Drawings
c. Record Documents
d. Service Procurement information
e. Operating Manuals specifically tailored to the exact equipment, systems and components installed
f. Maintenance Requirements and Procedures

g. Lubrication lists and instructions
h. Recommended spare parts lists with purchase contact information
i. Warranty information

The CA ***SHOULD*** verify that the Record Documents and O&M Manuals are reviewed, approved and delivered to the Owner prior to operator training.

11.5.3.7 Owner Training
The CA ***SHOULD*** work with the contractor and Owner to schedule and plan training activities so that training occurs in a coordinated and coherent fashion. The CA ***SHOULD*** assist in the development of training schedules and agendas, encourage the use of a combination of "classroom" and field training, and assist the contractors in the development of training agendas for each system, piece of equipment or component installed in the project.

The design professionals, contractors and vendors provide the training instruction and provide training materials. Additional operator skill training ***MAY*** be provided as an additional scope item if desired by the Owner.

The CA ***MAY*** document Owner training events by video taping presentations and demonstrations for future use by the Owner.

11.5.3.8 Update the OPR and BOD
The Owner must update the OPR and the design professionals must update the BOD during Construction Phase to incorporate any approved HVAC changes that may have developed due to changes, additions, deletions, or other modifications incorporated during the Acceptance Phase.

11.5.3.9 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any changes to the Commissioning Team members, their responsibilities, their contact information, procedures, schedules or changes to the commissioning requirements as a result of the acceptance Phase. The Commissioning Plan shall also be updated to include all revised or added check sheets or forms utilized during the Functional Performance Tests. The Commissioning Plan ***SHOULD*** include:

a. Description of the commissioning process utilized for the project
b. Commissioning Team member identification and contact information
c. Team member responsibilities
d. Commissioning FPT forms index
e. Copies of all typical FPT forms

11.5.3.10 Issues Log & Deficiency Resolution
The Owner must manage the Issue Log as to timely issue answers and resolutions. The Owner shall have final authority over issue resolution disagreements or interpretations. The final Issues Log, its statements and its statement responses ***SHALL*** become permanent record of the commissioning process.

11.5.3.11 Update the Issues Log
The CA ***SHALL*** report deficiencies from the FPT on the Issues Log and it ***SHALL*** be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA ***SHALL*** assist as necessary

to complete the issue log. After corrective action, retests ***SHALL*** be performed to verify conformance. When deficiencies are resolved, the issues ***SHALL*** be signed off on the Issues Log by the CA and the appropriate Commissioning Team Member(s). All issue log items ***SHALL*** be resolved or answered by the appropriate commissioning team member. Issues that are resolved in a manner that are not consistent with the OPR must be approved by the Owner. If after three attempts by the CA to obtain an issue resolution a CA can issue a certified report by clearly describing the unresolved issue in the Commissioning Report executive summary.

11.5.3.12 Final Commissioning Report
Based on the accumulated commissioning work completed as described above, the CA ***SHALL*** assemble the data into a final Commissioning Report. The final report will incorporate the final record documents for each system, as appropriate. The Commissioning Report ***SHALL*** include:

a. Report Title Page ***(SHALL)*** Report Certification Page ***(SHALL)***
b. Report Certification Page ***(SHALL)***
c. Table of Contents Page ***(SHALL)***
d. Executive Summary ***(SHALL)***
e. Project OPR ***(SHOULD)***
f. Commissioning Plan ***(SHALL)***
g. Final Issue Log ***(SHALL)***
h. Completed Pre Functional Test Forms and Check Sheets ***(SHALL)***
i. Completed Functional Performance Test Forms and Check Sheets ***(SHALL)***
j. Observation Reports ***(SHALL)***
k. Training Verification Records ***(SHOULD)***
l. Commissioning Communications ***(SHALL)***
m. Test Instrument Page ***(SHALL)***

11.5.3.13 Systems Manual
At the end of the Acceptance Phase the CA ***MAY*** produce the Systems Manual. The purpose of the Systems Manual is to provide the Owner and his operators with a permanent record of all pertinent documents required for future operation, commissioning and validation processes of the facility. The Systems Manual ***SHOULD*** be provided to the Owner in electronic format. At a minimum the final system manual ***SHOULD*** include the following:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operating and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures

11.5.4 ACCEPTANCE PHASE DOCUMENTATION

The following commissioning documents are produced during the Acceptance Phase commissioning if these activities are included in commissioning scope of work.

a. Completed Functional Performance Tests Report Forms ***(SHALL)***
b. O&M Review Document ***(SHOULD)***
c. Commissioning Report ***(SHALL)***
d. Systems Manual ***(MAY)***

e. Training Agenda ***(SHOULD)***

11.6 WARRANTY PHASE COMMISSIONING

11.6.1 INTRODUCTION

During the Warranty Phase the Commissioning Team works to verify the installed equipment and systems are meeting the OPR at the end of the warranty period.

11.6.2 WARRANTY PHASE RESPONSIBILITIES

11.6.2.1 Commissioning Team Members

The required Commissioning Team members for the Warranty Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives
d. Construction Manager Representatives
e. General Contractor Representatives
f. Applicable Subcontractors
g. Applicable Vendors

11.6.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

11.6.3 WARRANTY PHASE ACTIVITIES

11.6.3.1 Deferred Systems Tests

The CA and all applicable contractors and vendors ***SHALL*** provide any required deferred system Functional Performance Tests required by the commissioning plan. Functional Performance Test's ***SHALL*** be designed by the CA and performed by the contractors or Owner. The CA ***SHOULD*** observe and facilitate all functional performance tests for all systems that have operating sequences. The CA ***SHALL*** provide final approval for Functional Performance test results.

11.6.3.2 Warranty Visit

The CA ***SHOULD*** inspect the site and interview building operating personnel to identify any outstanding warranty failures and to identify any persistent equipment failure issues that should be handled within the warranty period. This site visit should occur approximately two months prior to the end of the warranty period.

11.6.3.3 Lessons Learned Workshop

The CA ***May*** perform a lessons learned workshop with the owner, designers and/or construction team members. The purpose of the lessons learned workshop is to determine how to improve the process in the future.

11.6.4 WARRANTY PHASE DOCUMENTATION

The following commissioning documents are produced during the Warranty Phase commissioning if these activities are included in commissioning scope of work.

a. Deferred Functional Performance Tests Check Sheets and Forms ***(SHALL)***
b. Warranty visit documentation with associated issues ***(SHALL)***
c. Commissioning Report Addenda with deferred testing results ***(SHALL)***
d. Lessons Learned Workshop Report ***(MAY)***

NEBB COMMISSIONING REQUIREMENTS - PLUMBING SYSTEMS			
Item	***SHALL***	***SHOULD***	***MAY***
PRE DESIGN PHASE COMMISSIONING *(If included in commissioning scope)*			
Commissioning Scope defined on Certification page	Owner Establishes	CA Assist	
Create OPR	Owner Perform	CA Assists	CA Perform
Create Preliminary Commissioning Plan	CA Perform		
Create Issues Log	CA Perform		
System Manual Requirements			CA Perform
DESIGN PHASE COMMISSIONING (DPC) *(If included in commissioning scope)*			
Create or Update Commissioning Plan	CA Perform		
Create or Update Issues Log	CA Perform		
Design Kick Off Meeting		CA Perform	
Schematic Design Review			CA Perform
Update OPR	Owner Perform	CA Perform	
Update BOD	Engineer Perform		
Basis of Design Review		CA Perform	
Specification & Drawing Review near 100% CD's	CA Perform		
Define training requirements for Owners personnel	Owner Perform	CA Perform	
Create Commissioning Specifications		CA Perform	
Pre Bid Meeting		Owner Perform	CA Assist
CONSTRUCTION PHASE COMMISSIONING			
Construction Kick Off Meeting	CA Perform		
Create Commissioning Duration Schedules		CA Perform	
Submittal and Shop Drawing Review	CA Perform		
Update Issues Log	CA Perform		
Update Commissioning Plan	CA Perform		
Update OPR and BOD	Owner Perform	CA Perform	
Site Observations for all Systems and Equipment	CA Perform		
Site Observations for all Control Systems and Equipment	CA Perform		
Create Pre Functional Equipment Installation Check Sheets	Contractor Perform	CA Perform	
Perform Pre Functional Equipment Installation Check Sheets	Contractor Perform	CA Verify	CA Perform
Create Pre Functional Test Equipment Start Up Sheets	Mfr. / Vendor Perform		CA Perform
Perform & Doc Pre Functional Equipment Start Up Tests	Contractor Perform		CA Observe
Create Controls Pre Functional Installation Check Sheets	Contractor Perform	CA Perform	
Perform & Doc Controls Pre Functional Installation Check Sheets	Contractor Perform	CA Perform	CA Perform
Perform & Document Static Tests	Contractor Perform		CA Observe
Create Pre Functional Controls Point to Point Check Sheets	CA Perform		
Perform Pre Functional Controls Point to Point Check Sheets	CA Perform		
ACCEPTANCE PHASE COMMISSIONING			
Create Functional Performance Test Check Sheets	CA Perform		
Program, run & Doc Functional Performance Tests	Contractor Perform	CA Observe	Owner or CA Perform
Witness functionality of FPT tests	CA Perform		
Approve Functional Tests results	CA Perform		
Verify Chlorinization Tests	Contractor Perform	CA Observe	
Review Operating and Maintenance Manuals	Engineer Perform	CA Perform	
Create Training Schedules with Owner	Contractor Perform	CA Assist	CA Perform
Assist contractors in developing Training Agendas		CA Perform	
Update Issues Log	CA Perform		
Update OPR	Owner Perform	CA Perform	
Update BOD	Engineer Perform		
Document Owner Training			CA Perform
Create Final Commissioning Report	CA Perform		
Create Final System Manual			CA Perform
WARRANTY PHASE COMMISSIONING *(If included in commissioning scope)*			
Create Deferred Functional Test Check Sheets	CA Perform		
Perform & Document Deferred Functional Tests	Contractor Perform	CA Observe	Owner or CA Perform
Witness functionality of FPT tests	CA Perform		
Approve Deferred Functional Tests results	CA Perform		
Perform Warranty Visit & Documentation		CA Perform	
Create Commissioning Report Addenda	CA Perform		
Update Issues Log	CA Perform		
Perform a Lessons learned workshop			CA Perform

SECTION 12 COMMISSIONING OF FIRE PROTECTION SYSTEMS

12.1 INTRODUCTION

The purpose of Section 12 is to describe the requirements for commissioning a project's Fire Protection systems, equipment and components. While Section 6 details the elements of the commissioning process in global terms, this section will detail the minimum requirements for a NEBB Certified Fire Protection Commissioning project. The actual scope of work may differ from these requirements. These minimum requirements are described as ***SHALL*** requirements. ***SHOULD*** requirements are recommended to produce a higher quality project and ***MAY*** requirements could be included to enhance the commissioning project. These minimum requirements take precedence when a scope of work is not defined, or the requirements state words to effect that the "…project ***SHALL*** be commissioned in accordance with the requirements of the NEBB *Procedural Standards for Whole Building Systems Commissioning of New Construction."* To be a NEBB certified report the following must apply:

1. The actual contracted scope of work ***SHALL*** be clearly defined on the certification page of the report as specified in the contract documents or as agreed to between the Owner / Buyer and the NEBB Certified BSC Firm.
2. If the scope of work differs from the NEBB ***SHALL*** language it shall be clearly delineated on the certification page of the report, otherwise all ***SHALL*** language must be adhered to for a NEBB Certified Report.

12.2 PRE-DESIGN PHASE COMMISSIONING

12.2.1 INTRODUCTION

There are two main purposes of the Pre-Design Phase. The first is to develop and document the Owner's Project Requirements (OPR) and the second is to develop the Preliminary Commissioning Plan.

12.2.2 PRE-DESIGN PHASE RESPONSIBILITIES

12.2.2.1 Commissioning Team Members

During the Pre-Design Phase the Owner should assign or contract for the appropriate Commissioning Team members to facilitate the Pre-Design process. The required Commissioning team members for the Pre-Design Phase should be as follows:

a. Owner's Representatives
b. Commissioning Authority (CA)
c. Programming Professionals if applicable
d. Architect if applicable
e. Fire Protection, Mechanical and Electrical Engineer if applicable
f. Construction Manager / General Contractor if applicable

12.2.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member must be responsible for contributing to the commissioning process based on their individual project responsibilities.

12.2.3 PRE-DESIGN PHASE ACTIVITIES

12.2.3.1 OPR Definition and Development

The Owner should produce the Owner's Project Requirements (OPR) to facilitate the design and delivery of the project. The OPR outlines the expectations the Owner has for the Fire Protection requirements of the project The Fire Protection OPR ***SHOULD*** include the following items that relate to the Fire Protection system:

a. Use and space requirements
b. Anticipated occupancy types by area
c. Fire Protection construction budget
d. Fire Protection codes and design standards to be utilized
e. Special systems or equipment requirements that may affect Fire Protection calculations and loads.
f. Specific material or equipment requirements
g. Energy and water efficiency expectations
h. Levels of redundancy
i. Vibration, sound and / or seismic requirements
j. Operation and maintenance criteria
k. Owner's expectations for operator and occupant training
l. Requirements for future facility adaptation and expansion
m. Owner's expectations of the design team and their produced documents
n. Owner's expectations of the construction team and their document requirements
o. Owner's expectations of the Commissioning Authority and their document requirements

12.2.3.2 Commissioning Plan

The CA ***SHALL*** develop a preliminary Fire Protection Commissioning Plan that documents the following:

a. The commissioning scope
b. The Commissioning Team
c. Normal channels of communication
d. Design phase commissioning procedures
e. Design phase commissioning duration schedules

12.2.3.3 Issues Log

The CA ***SHALL*** develop the format of the Issues Log to be utilized for the commissioning process. The Issues Log should address the manner that the perceived Fire Protection deficiencies will be documented by the CA and communicated to the design professionals and the contractors during subsequent commissioning phases of the project development and delivery. The Issues Log should also address the deficiency resolution procedure. The Issues Log should include:

a. Issue Number
b. Issue statement
c. Date of Issue statement
d. Person making issue statement
e. Issue statement response

f. Date of Issue statement response
g. Person making the issue statement response

12.2.3.4 Commissioning Scope(s) of Work and Budgeting
The CA ***SHOULD*** assist the Owner in developing the commissioning scope of the project and its associated costs. Project scope should include:

a. Phase to be commissioned: The Owner must determine which phases will be commissioned for the project such as Pre-Design Phase, Design Phase, Construction Phase, Acceptance Phase and Warranty Phase.
b. Systems to be commissioned: The Owner must determine which systems will be commissioned for the project including special systems and if any areas will be excluded from the commissioning project.
c. The commissioning scope shall be based upon this NEBB BSC Procedural Standard and its definition of the commissioning process and its required ***SHALL*** language. If the Owner desires to establish a different level of commissioning activities than those stated in this procedural standard it must be clearly delineated in the scope of work.
d. Level of Owner's participation in the commissioning process: The Owner must establish the level of participation their representatives will provide to the commissioning team during each phase of the commissioning project.

12.2.3.5 Develop System Manual Requirements
During the Pre Design phase the Commissioning Team and the CA ***MAY*** develop documents which will make up the systems manual and determine what the Owner's Operator training requirements will be. The final system manual ***MAY*** include the following and should be provided in electronic format:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operating and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures
j. Test Reports

12.2.3.6 Commissioning Meetings
The CA ***SHALL*** conduct all Commissioning Team meetings as required to implement the commissioning process and ***SHALL*** issue meeting minutes as documentation of these meetings.

12.2.3.7 Update the OPR
The Owner must update the OPR during Pre-Design Phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications.

12.2.4 PRE-DESIGN PHASE DOCUMENTATION

The following commissioning documents are produced during Pre-Design Phase Commissioning if these activities are included in commissioning scope of work:

a. Owner's Project Requirements ***(SHOULD)***
b. Preliminary Commissioning Plan ***(SHALL)***

c. Issues Log ***(SHALL)***
d. Commissioning Scope and Budgets ***(MAY)***
e. System Manual Index of contents ***(MAY)***

12.3 DESIGN PHASE COMMISSIONING

12.3.1 INTRODUCTION

During the Design Phase, the design professionals create the Contract Documents. The Contract Documents turn the OPR into working design documents. The CA ***SHALL*** evaluate and document that the Contract Documents conform to the OPR. The CA ***SHALL*** evaluate the Fire Protection systems, equipment and components incorporated into the Contract Documents to ensure they conform to the OPR from the standpoint of commissionability, maintainability, functionality and best practices.

12.3.2 DESIGN PHASE RESPONSIBILITIES

12.3.2.1 Commissioning Team Members

The required Commissioning Team members for the Design Phase should be:

a. Owner's Representatives
b. Commissioning Authority (CA)
c. Programming Professionals
d. Architect
e. Landscape Architect
f. Fire Protection Engineer
g. Mechanical Engineer
h. Electrical Engineer
i. Construction Manager / General Contractor if applicable
j. Specialty, or Trade Contractors if applicable

12.3.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member is responsible for contributing to the commissioning processes according to their individual project responsibilities.

12.3.3 DESIGN PHASE ACTIVITES

12.3.3.1 OPR Definition and Development

If the project does not have a Pre-Design Phase, or if the OPR was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 11.2.3.1 for the requirements.

12.3.3.2 Commissioning Plan

If the project does not have a Pre-Design Phase, or if the Commissioning Plan was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 11.2.3.2 for the requirements.

12.3.3.3 Issues Log

If the project does not have a Pre-Design Phase, or if the Issues Log was not produced in the Pre-Design Phase, it ***SHALL*** be produced at this time. See Section 11.2.3.3 for the requirements.

12.3.3.4 Design Kick-Off Meeting

The CA ***SHOULD*** conduct an initial Kickoff Meeting with the Design Team and the Owner. The purpose of the meeting will be to establish the purpose and proposed processes for commissioning the design and to review the Design Phase Commissioning Plan.

12.3.3.5 Commissioning Activities Scheduled
The CA ***SHALL*** verify that commissioning activities are incorporated into the Design Phase schedule.

12.3.3.6 Evaluate Basis of Design Conformance
The design professional will prepare the Basis of Design (BOD) document in response to the OPR. The BOD includes the Design Narrative and the Design Criteria. The CA ***SHOULD*** verify that the BOD conforms to the requirements of the OPR.

The Design Narrative ***SHOULD*** include the following:

a. Description of the selected Fire Protection systems for each area and the reasons they were selected
b. Documentation of the design methodology utilized
c. Documentation of design parameters such as; density, hose demand, pressure, residual pressure, flow rate and flow test results
d. Preliminary Fire Protection calculation requirements
e. Water usage analysis and storage requirements
f. Life cycle costing information of each system analyzed
g. Preliminary major component selection
h. Equipment and main piping space layout for establishing building space requirements

The Design Criteria ***SHOULD*** include the following:

a. Project location and special Fire Protection site requirements
b. Design parameters including: space occupancy, utility requirements, all special equipment requirements, filtration requirements, special areas of concern and / or other criteria used that may define the methodology used to complete the Fire Protection design.
c. Design assumptions and limitations
d. Control systems sophistication
e. Sizing criteria to be used for piping systems
f. Accepted safety factors incorporated into the design
g. Accepted levels of redundancy
h. Reference to specific equipment selection limitations as to make or model numbers
i. Operation assumptions
j. Codes, standards and guidelines to be utilized for the design

The CA ***SHOULD*** evaluate the BOD for conformance to the OPR from the standpoint of commissionability, maintainability, functionality and industry accepted best practices and produce an evaluation document.

12.3.3.7 Commissioning Specifications
The CA ***SHALL*** review the contract commissioning specifications and verify that they are included in the contract documents. The CA ***SHOULD*** assist in creating commissioning specifications to be included in the contract documents. The commissioning specifications should include the following:

a. Specification describing the basic commissioning process that will be used on the project by the CA, located in the general requirement area of the specification
b. Specification describing the commissioning activities required of the Fire Protection, Electrical, and Control contractors, located in each individual discipline specification section

c. Specification describing the commissioning activities required of any Vendor or equipment supplier or specialty subcontractor, located in each individual vendor, supplier or subcontractor specification section

12.3.3.8 Establish Training Requirements
The CA ***SHOULD*** work with the Owner and the design professionals to define the training requirements for the Owner's personnel. Verify that these requirements are incorporated into the project specifications. Training ***SHOULD*** include:

a. Theory of operation presented by the Engineer
b. Sustainability methods and measures presented by the Green Building Accredited Professional or the Engineer
c. Start Up procedures, Shut down procedures, Operating procedures and Maintenance procedures for each type of equipment and system presented by the manufacture or contractor
d. Control system operations and programming training. Include durations extended over time.
e. Specify classroom instruction duration and field demonstration duration for each training event
f. O&M manual review for warranty repair or replacement procedures
g. Review of all warranty durations and start dates

12.3.3.9 Schematic Design Document Evaluation
The CA ***MAY*** complete a thorough evaluation of the Schematic Design (SD), or a 35% design review of documents to establish that the Fire Protection systems, equipment and components are identified and can be installed in compliance with the OPR and the BOD. Schematic Design Document Evaluation ***MAY*** include: engineering calculations, system selection, system selection criteria, flow sheet designs and major component selection.

12.3.3.10 Design Development Document Evaluation
The CA ***SHOULD*** complete a thorough evaluation of the Design Development (DD), or a 65% design review of documents and submitted criteria for continued compliance to the OPR and BOD; Evaluate design documents for commissioning specifications and requirements; Draft preliminary Commissioning Specifications and Supplemental Commissioning Language for other specifications if required. Design Development Document Evaluation ***SHOULD*** include zoning requirements, specifications, typical room layouts, system main layouts, riser layouts, standard details, schedules and coordination requirements.

12.3.3.11 Contract Documents Evaluation
The CA ***SHALL*** evaluate the contract documents at least once near 100% construction document level. The CA ***SHALL*** evaluate drawings and specifications for each system, component, and equipment for its commissionability, maintainability, functionality and best practices.

12.3.3.12 Meetings
The CA ***SHALL*** conduct all commissioning team meetings and shall issue meeting minutes as documentation of these meeting.

12.3.3.13 Update the OPR and the BOD
The Owner must update the OPR and the design professionals must update the BOD during design phase to incorporate any approved changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final Contract Documents.

12.3.3.14 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any additional Commissioning Team members, procedures and schedules or design phase commissioning requirements developed in the Design Commissioning process.

12.3.3.15 Issues Log Management
The Owner must manage the Issues Log as to timely issue answers and resolutions. The Owner has the final authority over issue resolution disagreements or interpretations. The final Issues Log, its statements and its statement answers, ***SHALL*** become a permanent record of the commissioning process.

12.3.3.16 Update the Issues Log Documentation
The CA ***SHALL*** create and maintain the Issues Log throughout the commissioning process. The Issues Log shall be used throughout the commissioning process, going from a Design Phase issue log to a Construction Phase issue log, to an Acceptance Phase issue log and finally to a Warranty Phase issue log. The final (complete) issue log shall become a part of the final Commissioning Report.

12.3.3.17 Pre-Bid Meeting
The Owner ***SHOULD*** conduct a Pre-bid meeting to assist contractors in answering any questions about the systems or the commissioning process. The CA ***SHOULD*** attend the Pre-Bid meeting to fully explain the commissioning requirements of the Contract Documents and allow the contractors to understand their roll in the commissioning process and its associated costs. The CA should provide any assistance required by the Owner in answering written questions (in the form of clarifications or addendum recommendations) during the bidding process.

12.3.4 DESIGN PHASE DOCUMENTATION
The following commissioning documents are produced during the Design Phase commissioning if these activities are included in commissioning scope of work.

a. Updated Owner's Project Requirements **(*SHOULD)***
b. Updated Commissioning Plan **(*SHALL)***
c. Basis of Design Evaluation **(*SHOULD)***
d. Contract Document Evaluation **(*SHALL)***
e. Updated Issues Log **(*SHALL)***
f. Pre Bid Meeting minutes or documentation **(*SHOULD)***

12.4 CONSTRUCTION PHASE COMMISSIONING

12.4.1 INTRODUCTION
During the Construction Phase the commissioning team works to verify the equipment and systems are installed in accordance with the design documents and are operable, maintainable and ready for functional testing.

12.4.2 CONSTRUCTION PHASE RESPONSIBILITES
12.4.2.1 Commissioning Team Members
The commissioning team members for the Construction Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives

d. Construction Manager Representative
e. General Contractor Representatives
f. Fire Protection Contractor
g. Mechanical Contractor Representative
h. Electrical Contractor Representative
i. Fire Alarm Control Contractor Representative (If Required)
j. Specialty Contractor Representative (If Required)

12.4.2.2 Commissioning Team Responsibilities
The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

12.4.3 CONSTRUCTION PHASE ACTIVITIES

12.4.3.1 Commissioning Plan
If the project does not have a Design Phase, or if the Commissioning Plan was not produced in the Design Phase, it ***SHALL*** be produced at this time by the CA. The commissioning plan should include:

a. Description of the commissioning process utilized for the project
b. Commissioning Team member identification and contact information
c. Team member responsibilities
d. Commissioning check sheet or form index
e. Copies of all typical commissioning check sheets or forms

12.4.3.2 Construction Kick-Off Meeting
The CA ***SHALL*** conduct an initial commissioning meeting with all contractors and Commissioning Team members. The purpose of the meeting will be to review the Construction Phase Commissioning process and activities for the commissioning of the project. During the meeting the CA should review the following:

a. The Commissioning Plan
b. The basic commissioning processes to be utilized on the project
c. The individual roles and responsibilities of each participating Commissioning Team member
d. Documentation requirements
e. Communication and reporting procedures
f. The check sheets and forms to be utilized on the project
g. The commissioning duration schedules

The CA ***SHALL*** create the meeting agenda, lead the meeting and prepare and distribute the meeting minutes.

12.4.3.3 Commissioning Duration Schedule
The CA ***SHOULD*** prepare a duration schedules for the contractors for the commissioning activities required by the commissioning plan. These duration schedules ***SHOULD*** be incorporated into the contractor's project schedule to track all commissioning activities of the Commissioning Team.

12.4.3.4 Commissioning Team Meetings
The CA ***SHALL*** attend and lead all commissioning meetings as required with the Commissioning Team to review progress of the commissioning effort and reinforce individual responsibilities. Review completed work and agree upon the acceptability of the delivered product. The CA ***SHALL***:

a. Create the agenda
b. Attend and lead meeting
c. Schedule and review the commissioning activities
d. Coordinate commissioning meetings with construction meetings and activities
e. Prepare and distribute meeting minutes

12.4.3.5 Submittal and Shop Drawing Review
The CA ***SHALL*** review all pertinent Fire Protection submittals and shop drawings to support the Commissioning Process. The submittal and shop drawing review should include:

a. The submittal and shop drawing information is utilized to create the appropriate PFT check sheets and forms for the project.
b. The CA ***SHALL*** review the submittals and shop drawings for commissionability, maintainability, functionality, best practices and for conformance to the CD's, OPR and BOD.
c. The CA ***SHALL*** document any found issues on the project Issue Log. The Issues Log ***SHALL*** be forwarded to the appropriate Commissioning Team member for resolution.

12.4.3.6 Site Observations
During the course of construction, the CA ***SHALL*** visit the site to inspect the progress of construction with respect to the Fire Protection systems, equipment and components being commissioned. The purpose of the inspections is to verify that the construction complies with the Contract Documents, the OPR and identify and document any quality issues that may lead to functional issues. Site observations are forwarded to the appropriate team member for their review and action. If site observation issues are not automatically accepted and resolved the observation is added to the issue Log for resolution.

12.4.3.7 Pre-Functional Tests (PFT)
There are several types of Fire Protection PFT that ***SHALL*** be performed during the construction phase: installation verification tests, static tests, and equipment startup tests.

12.4.3.7.1 Fire Protection and Controls Installation Verification Tests
The contractor must verify that all work is installed in accordance with the contract documents and / or the manufacturer's recommendations and provide the associated check sheets verifying such. The contractor must document that all equipment is installed in the correct location and is operable in accordance with the contract documents. The CA ***SHOULD*** provide the installation verification check sheets if not available from the manufacturers or contractors. The CA or his staff ***SHALL*** validate the Installation Verification check sheets completed by the contractor by back checking them through site observations. Completion of all installation verification tests signifies that those systems are ready for start up activities. Examples of these tests include:

a. All piping systems, and components installations
b. All Fire Protection equipment installations

Installation Verification tests ***SHALL*** include the following:

a. Material or Equipment Name or description
b. Model Number
c. Type and Size
d. Serial Number (If applicable)
e. Installation and location to design requirements verification
f. Maintenance access verification
g. Installation complete

12.4.3.7.2 Static Tests

The contractor must perform hydrostatic and pressure tests as described in the Contract Documents. All hydrostatic and pressure tests must be verified by contractor or code authority as required by the Contract Documents or as dictated by the local codes. The CA ***MAY*** provide the static test sheets to the contractor performing the tests. The CA ***MAY*** observe and document these static tests. Completed static test sheets are then provided to the CA. Examples of these tests include:

a. Hydrostatic testing of all piping systems to the appropriate test pressure and duration
b. Slope verification tests

12.4.3.7.3 Fire Protection Equipment Startup Tests

The contractor or vendor who has contractual obligation to provide start up services ***SHALL*** start up the systems and equipment in accordance with the Contract Documents and the manufacturer's requirements. Completed start up check sheets are then provided to the CA. The CA ***MAY*** observe and document these start up tests. Start up tests ***SHOULD*** include the following:

a. Manufacturer's Name
b. Model Number
c. Type and Size
d. Serial Number
e. Actual Settings or Adjustments
f. Actual Electrical Characteristics
g. Actual load
h. Operating data as required by the manufacturer

Start up tests may include the following:

a. Fire Pumps
b. Antifreeze concentration tests
c. Air compressors
d. Riser components and systems
e. Storage heating systems

12.4.3.7.4 Control System Startup Tests

The CA ***SHALL*** provide a 100% point-to-point control system test as verification of the control system operational status with no sampling strategies allowed. The control point-to-point test shall verify the system operation from the system graphic to the end sensor or control device. The control tests ***SHOULD*** include the following:

a. Controller Manufacturer
b. Controller or System identification
c. Verification of controller communication
d. Pin Address
e. Point ID and name
f. Point type
g. Connected device description
h. Verification of action and polarity
i. Verification of status indication
j. Actual sensor reading, system reading and offset

Control start up tests ***MAY*** include the following:

a. Fire Pumps automatic controls
b. Fire Alarm interlock systems
c. Air compressor automatic controls
d. Riser component system controls
e. Storage heating system controls

12.4.3.8 Update the OPR and the BOD
The Owner must update the OPR and the design professionals must update the BOD during construction phase to incorporate any approved Fire Protection changes that may have developed due to changes, additions, deletions, or other modifications incorporated into the final construction.

12.4.3.9 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any changes to the commissioning team members, their responsibilities, contact information, procedures, schedules or changes to the commissioning requirements as a result of the Construction Phase. The Commissioning Plan shall also be updated to include all revised or added check sheets or forms utilized during the Pre-Functional Tests.

12.4.3.10 Issues Log & Deficiency Resolution
The CA ***SHALL*** report deficiencies from any PFT on the Issues Log and it shall be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA ***SHALL*** assist as necessary to complete the issue log. After corrective action, retests shall be performed to verify conformance. When deficiencies are resolved, the issues shall be signed off on the Issues Log by the appropriate Commissioning Team Member(s). All issue log items must be resolved or answered by the appropriate commissioning team member. Issues that are resolved in a manner not consistent with the OPR must be approved by the Owner.

12.4.4 CONSTRUCTION PHASE DOCUMENTATION

The following commissioning documents are produced during the Construction Phase commissioning if these activities are included in commissioning scope of work:

a. Kick off team meeting agenda and minutes ***(SHALL)***
b. Agendas and Minutes of all commissioning team meetings ***(SHALL)***
c. Commissioning duration schedules ***(SHOULD)***
d. Submittal and Shop Drawing review documents ***(SHALL)***
e. Site Observation reports ***(SHALL)***
f. Pre-Functional Test report check sheets: Installation Verification Tests, Static Tests and Equipment Startup Tests ***(SHALL)***
g. Updated Owner's Project Requirements ***(SHOULD)***
h. Updated Commissioning Plan ***(SHALL)***
i. Updated Issues Log ***(SHALL)***

12.5 ACCEPTANCE PHASE COMMISSIONING

12.5.1 INTRODUCTION

During the Acceptance Phase the Commissioning Team works to verify the functionality of all systems, equipment, systems and components. The Commissioning Team assures that all systems are functioning in a manner that conforms to the OPR. The Commissioning Team also coordinates the level of Owners Personnel Training.

12.5.2 ACCEPTANCE PHASE RESPONSIBILITIES

12.5.2.1 Commissioning Team Members

The required commissioning team members for the Acceptance Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives (if required)
d. Construction Manager Representative (if required)
e. General Contractor Representatives (if required)
f. Fire Protection Contractor Representative
g. Electrical Contractor Representative (if required)
h. Fire Alarm Control Contractor Representative (If required)
i. Specialty Contractor Representative (if required)

12.5.2.2 Commissioning Team Responsibilities

The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

12.5.3 ACCEPTANCE PHASE ACTIVITIES

12.5.3.1 Commissioning Duration Schedule

The CA ***SHOULD*** continue to monitor and update the duration schedules for the contractors for the commissioning activities in the Acceptance Phase required by the Commissioning Plan. These duration schedules should track all commissioning activities of the Commissioning Team in this phase.

12.5.3.2 Commissioning Team Meetings

The CA ***SHALL*** continue to attend and lead all commissioning meetings as required with the Commissioning Team to review progress of the commissioning effort and reinforce individual responsibilities.

12.5.3.3 System Chemical Treatment Verification

The CA ***SHALL*** verify that the piping has been cleaned and passivated with chemicals in accordance with the specifications and local code requirements. This verification ***SHOULD*** include witnessing chemical tests. The CA ***SHALL*** include copies of all chemical test results in the final commissioning report.

12.5.3.4 Functional Performance Tests (FPT)

Functional Performance Tests ***SHALL*** be designed by the CA and performed by the Commissioning Team. The CA or his staff ***SHALL*** observe and facilitate the FPT for all systems that have operating sequences. The CA ***SHALL*** provide final approval for Functional Performance Test results. FPT ***SHALL*** be performed for all sequences with no sampling strategies allowed except for application

specific, factory programmed devices that cannot have the program modified in the field. The FPT tests ***SHALL*** include the following:

a. System description
b. Specific function being tested
c. Functional test design
d. Description of data points tested
e. Description of test duration and test interval times
f. Description of test setpoints and setpoint changes
g. Description of test report documentation requirements
h. Description of test pass/fail criteria

Functional Performance Tests ***MAY*** include the following:

a. Fire Pump control sequence
b. Fire Alarm interlocked systems

12.5.3.5 Sound & Vibration (S&V) Testing
The CA ***SHALL*** verify that the Sound level tests and Vibration measurements tests have been completed in accordance with the Contract Documents and ***SHALL*** review the final S&V Report for completeness and accuracy.

12.5.3.6 Record Documents / As-Built Drawings and Operations and Maintenance (O&M) Manuals.
The Contractors ***SHALL*** create and assemble the Operating and Maintenance Manuals as contractually required. The drawings and manuals are then forwarded to the design professional for review and approval. The CA ***SHOULD*** review all Record Documents and Operating and Maintenance Manuals for accuracy and completeness to the Contract Documents and for conformance to the OPR. The CA ***SHOULD*** review these documents after review and approval by the design professional. The Record Documents and the O&M Manuals ***SHOULD*** include:

a. Final Approved Submittals
b. Final Approved Shop Drawings
c. Record Documents
d. Service Procurement information
e. Operating Manuals specifically tailored to the exact equipment, systems and components installed
f. Maintenance Requirements and Procedures
g. Lubrication lists and instructions
h. Recommended spare parts lists with purchase contact information
i. Warranty information

The CA ***SHOULD*** verify that the Record Documents and O&M Manuals are reviewed, approved and delivered to the Owner prior to operator training.

12.5.3.7 Owner Training
The CA ***SHOULD*** work with the contractor and Owner to schedule and plan training activities so that training occurs in a coordinated and coherent fashion. The CA ***SHOULD*** assist in the development of training schedules and agendas, encourage the use of a combination of “classroom” and field training, and assist the contractors in the development of training agendas for each system, piece of equipment or component installed in the project. The design professionals, contractors and vendors

provide the training instruction and provide training materials. Additional operator skill training ***MAY*** be provided as an additional scope item if desired by the Owner.

The CA ***MAY*** document Owner training events by video taping presentations and demonstrations for future use by the Owner.

12.5.3.8 Update the OPR and BOD
The Owner must update the OPR and the design professionals must update the BOD during Construction Phase to incorporate any approved Fire Protection changes that may have developed due to changes, additions, deletions, or other modifications incorporated during the Acceptance Phase.

12.5.3.9 Update the Commissioning Plan
The CA ***SHALL*** update the Commissioning Plan to include any changes to the Commissioning Team members, their responsibilities, their contact information, procedures, schedules or changes to the commissioning requirements as a result of the acceptance Phase. The Commissioning Plan shall also be updated to include all revised or added check sheets or forms utilized during the Functional Performance Tests. The Commissioning Plan ***SHOULD*** include:

a. Description of the commissioning process utilized for the project
b. Commissioning Team member identification and contact information
c. Team member responsibilities
d. Commissioning FPT forms index
e. Copies of all typical FPT forms

12.5.3.10 Issues Log & Deficiency Resolution
The Owner must manage the Issue Log as to timely issue answers and resolutions. The Owner shall have final authority over issue resolution disagreements or interpretations. The final Issues Log, its statements and its statement answers ***SHALL*** become permanent record of the commissioning process.

12.5.3.11 Update the Issues Log
The CA ***SHALL*** report deficiencies from the FPT on the Issues Log and it ***SHALL*** be distributed to the appropriate members of the Commissioning Team for resolution. The CA ***SHALL*** work with the Commissioning Team Members to ensure that the issues are completely understood and the responsibilities for response or corrective action are completely understood. The Owner must manage the issue log for resolution of all outstanding issues and the CA ***SHALL*** assist as necessary to complete the issue log. After corrective action, retests ***SHALL*** be performed to verify conformance. When deficiencies are resolved, the issues ***SHALL*** be signed off on the Issues Log by the CA and the appropriate Commissioning Team Member(s). All issue log items ***SHALL*** be resolved or answered by the appropriate commissioning team member. Issues that are resolved in a manner that are not consistent with the OPR must be approved by the Owner. If after three attempts by the CA to obtain an issue resolution a CA can issue a certified report by clearly describing the unresolved issue in the Commissioning Report executive summary.

12.5.3.12 Final Commissioning Report
Based on the accumulated commissioning work completed as described above, the CA ***SHALL*** assemble the data into a final Commissioning Report. The final report will incorporate the final record documents for each system, as appropriate. The Commissioning Report ***SHALL*** include:

a. Report Title Page ***(SHALL)***

b. Report Certification Page ***(SHALL)***
c. Table of Contents Page ***(SHALL)***
d. Executive Summary ***(SHALL)***
e. Project OPR ***(SHOULD)***
f. Commissioning Plan ***(SHALL)***
g. Final Issue Log ***(SHALL)***
h. Completed Pre Functional Test Forms and Check Sheets ***(SHALL)***
i. Completed Functional Performance Test Forms and Check Sheets ***(SHALL)***
j. Observation Reports ***(SHALL)***
k. Training Verification Records ***(SHOULD)***
l. Commissioning Communications ***(SHALL)***
m. Test Instrument Page ***(SHALL)***

12.5.3.13 Systems Manual

At the end of the Acceptance Phase the CA ***MAY*** produce the Systems Manual. The purpose of the Systems Manual is to provide the Owner and his operators with a permanent record of all pertinent documents required for future operation, commissioning and validation processes of the facility. The Systems Manual ***SHOULD*** be provided to the Owner in electronic format. At a minimum the final system manual ***SHOULD*** include the following:

a. Summary
b. The final Approved Submittals and Shop Drawings
c. Final OPR
d. Final BOD
e. Final Contract Documents (Record Drawings/ As-Builts)
f. Final Operating and Maintenance Manuals
g. Final Commissioning Report
h. Operator Training materials
i. Recommended Standard Operating Procedures

12.5.4 ACCEPTANCE PHASE DOCUMENTATION

The following commissioning documents are produced during the Acceptance Phase commissioning if these activities are included in commissioning scope of work:

a. Completed Functional Performance Tests Report Forms ***(SHALL)***
b. O&M Review Document ***(SHOULD)***
c. Commissioning Report ***(SHALL)***
d. Systems Manual ***(MAY)***
e. Training Agenda ***(SHOULD)***

12.6 WARRANTY PHASE COMMISSIONING

12.6.1 INTRODUCTION

During the Warranty Phase the Commissioning Team works to verify the installed equipment and systems are meeting the OPR at the end of the warranty period.

12.6.2 WARRANTY PHASE RESPONSIBILITIES

12.6.2.1 Commissioning Team Members

The required Commissioning Team members for the Warranty Phase should be:

a. Owner's Representatives
b. Commissioning Authority
c. Design Team Representatives
d. Construction Manager Representatives
e. General Contractor Representatives
f. Applicable Subcontractors
g. Applicable Vendors

12.6.2.2 Commissioning Team Responsibilities
The Commissioning Team has the responsibility of facilitating the commissioning process for the project. Each individual team member shall be responsible for contributing to the commissioning processes according to their individual project responsibilities.

12.6.3 WARRANTY PHASE ACTIVITIES

12.6.3.1 Deferred Systems Tests
The CA and all applicable contractors and vendors ***SHALL*** provide any required deferred system Functional Performance Tests required by the commissioning plan. Functional Performance Test's ***SHALL*** be designed by the CA and performed by the contractors or Owner. The CA ***SHOULD*** observe and facilitate all functional performance tests for all systems that have operating sequences. The CA ***SHALL*** provide final approval for Functional Performance test results.

12.6.3.2 Warranty Visit
The CA ***SHOULD*** inspect the site and interview building operating personnel to identify any outstanding warranty failures and to identify any persistent equipment failure issues that should be handled within the warranty period. This site visit should occur approximately two months prior to the end of the warranty period.

12.6.3.3 Lessons Learned Workshop
The CA ***MAY*** perform a lessons learned workshop with the owner, designers and/or construction team members. The purpose of the lessons learened workshop is to determine how to improve the process for future projects.

12.6.4 WARRANTY PHASE DOCUMENTATION

The following commissioning documents are produced during the Warranty Phase commissioning if these activities are included in commissioning scope of work.

a. Deferred Functional Performance Tests Check Sheets and Forms ***(SHALL)***
b. Warranty visit documentation with associated issues ***(SHALL)***
c. Commissioning Report Addenda with deferred testing results ***(SHALL)***
d. Lessons Learned Workshop Report ***(MAY)***

NEBB COMMISSIONING REQUIREMENTS - FIRE PROTECTION SYSTEMS			
Item	***SHALL***	***SHOULD***	***MAY***
PRE DESIGN PHASE COMMISSIONING *(If included in commissioning scope)*			
Commissioning Scope defined on Certification page	Owner Establishes	CA Assist	
Create OPR	Owner Perform	CA Assists	CA Perform
Create Preliminary Commissioning Plan	CA Perform		
Create Issues Log	CA Perform		
System Manual Requirements			CA Perform
DESIGN PHASE COMMISSIONING (DPC) *(If included in commissioning scope)*			
Create or Update Commissioning Plan	CA Perform		
Create or Update Issues Log	CA Perform		
Design Kick Off Meeting		CA Perform	
Schematic Design Review			CA Perform
Update OPR	Owner Perform	CA Perform	
Update BOD	Engineer Perform		
Basis of Design Review		CA Perform	
Specification & Drawing Review near 100% CD's	CA Perform		
Define training requirements for Owners personnel	Owner Perform	CA Perform	
Create Commissioning Specifications		CA Perform	
Pre Bid Meeting		Owner Perform	CA Assist
CONSTRUCTION PHASE COMMISSIONING			
Construction Kick Off Meeting	CA Perform		
Create Commissioning Duration Schedules		CA Perform	
Submittal and Shop Drawing Review	CA Perform		
Update Issues Log	CA Perform		
Update Commissioning Plan	CA Perform		
Update OPR and BOD	Owner Perform	CA Perform	
Site Observations for all Systems and Equipment	CA Perform		
Site Observations for all Control Systems and Equipment	CA Perform		
Create Pre Functional Equipment Installation Check Sheets	Contractor Perform	CA Perform	
Perform Pre Functional Equipment Installation Check Sheets	Contractor Perform	CA Verify	CA Perform
Create Pre Functional Test Equipment Start Up Sheets	Mfr. / Vendor Perform		CA Perform
Perform & Doc Pre Functional Equipment Start Up Tests	Contractor Perform		CA Observe
Create Controls Pre Functional Installation Check Sheets	Contractor Perform	CA Perform	
Perform & Doc Controls Pre Functional Installation Check Sheets	Contractor Perform	CA Perform	CA Perform
Perform & Document Static Tests	Contractor Perform		CA Observe
Create Pre Functional Controls Point to Point Check Sheets	CA Perform		
Perform Pre Functional Controls Point to Point Check Sheets	CA Perform		
ACCEPTANCE PHASE COMMISSIONING			
Create Functional Performance Test Check Sheets	CA Perform		
Program, run & Doc Functional Performance Tests	Contractor Perform	CA Observe	Owner or CA Perform
Witness functionality of FPT tests	CA Perform		
Approve Functional Tests results	CA Perform		
Verify Chemical Treatment	Contractor Perform	CA Observe	
Review Operating and Maintenance Manuals	Engineer Perform	CA Perform	
Create Training Schedules with Owner	Contractor Perform	CA Assist	CA Perform
Assist contractors in developing Training Agendas		CA Perform	
Update Issues Log	CA Perform		
Update OPR	Owner Perform	CA Perform	
Update BOD	Engineer Perform		
Document Owner Training			CA Perform
Create Final Commissioning Report	CA Perform		
Create Final System Manual			CA Perform
WARRANTY PHASE COMMISSIONING *(If included in commissioning scope)*			
Create Deferred Functional Test Check Sheets	CA Perform		
Perform & Document Deferred Functional Tests	Contractor Perform	CA Observe	Owner or CA Perform
Witness functionality of FPT tests	CA Perform		
Approve Deferred Functional Tests results	CA Perform		
Perform Warranty Visit & Documentation		CA Perform	
Create Commissioning Report Addenda	CA Perform		
Update Issues Log	CA Perform		
Perform a Lessons learned workshop			CA Perform

APPENDICES

APPENDIX A
THE COMMISSIONING PROCESS MATRIX

Task		Description	Documents	Comments	Responsibilities			
					Owner	Cx	Designer	Contractors
Pre-Design Phase								
a.	Cx Agent Selection	• Develop an RFP for commissioning services. RFP should follow the NEBB format for qualifications based selection. • If interviews are conducted, the recommended scoring system should be used to evaluate qualifications of proposing firms.	• RFP Format • Scope of Work Matrix • Scoring Matrix	• Cx Agent selection should occur as early the Design process as possible. However, whenever the Cx Agent is selected, the selection should follow the proscribed process.	• RFP • Define Scope of Work • Score Matrix	• Format RFP If requested. • Provide Scope of Work Matrix and scoring criteria matrix if requested		
b.	Cx Project Contract	• Negotiate, prepare and execute a commissioning contract.	• Commissioning Contract		• Commissioning Contract	• Provide sample Commissioning contract if requested.		
c.	Cx Plan	• The Draft Commissioning Plan describes the commissioning process as detailed in the commissioning scope of work.	• Draft Commissioning Plan		• Approve commissioning plan	• Create Commissioning Plan	Review & Comment on commissioning plan	
d.	OPR	• In cooperation with the Owner and, if available, the Owner's Design Team, the Cx Agent shall prepare a design intent summary document. This document will serve as the basis for all design, inspection, commissioning and acceptance testing for the project.	• Owners Project Requirements (OPR) Summary	• Establishes criteria for basis of design	• Provide input for performance requirements.	• Design Intent Summary containing all OPR's.	Provide input for performance requirements.	
e.	Issue Log	• Create initial Issues Log	• Issues Log	• Establishes the format for tracking commissioning related issues throughout the project	• Approve Issues Log format	• Create Issues Log		

Task		Description	Documents	Comments	Responsibilities			
					Owner	Cx	Designer	Contractors
f.	Systems Manual	• Determine Systems Manual Requirements	• Identify the documents needed to create the systems manual.	• Establishes the format, documents and responsibilities for creation of the Systems Manual	• Approve Systems Manual format	• Determine documentation requirements	Determine documentation requirements	
Design Phase Commissioning								
1.	Design Team Kickoff Meeting	• Conduct an initial "Kickoff Meeting" with the Design Team. The purpose of the meeting will be to establish the purpose and proposed process for commissioning this facility and to establish the individual roles of each participating commissioning team member.	• Design Development • Design Commissioning Plan • Meeting Agenda • Meeting Minutes	• Identify Contacts and Responsibilities for Commissioning Team Members	• Facilitate Kickoff Meeting	• Meeting Agenda • Meeting Minutes	• Identify design team members and their Responsibilities	
2.	Owners Project Requirements (OPR)	• In cooperation with the Owner and, if available, the Owner's Design Team, the Cx Agent shall prepare a design intent summary document. This document will serve as the basis for all design, inspection, commissioning and acceptance testing for the project.	• Owners Project Requirements (OPR) Summary	• Establishes criteria for basis of design	• Provide input for performance requirements.	• Design Intent Summary containing all OPR's.	• Provide input for performance requirements.	
3.	Basis of Design	• The design team shall prepare a Basis of Design document in response to the OPR previously established.	• Draft Basis of Design	• Basis of design shall include Engineering Calculations & load data, System selection, system rejection reasoning, Equipment Selection, equipment rejection, failure modes, and critical sequence of operations.		• Review Basis of design document	• Create Basis of Design document	
4.	Commissioning Plan	• The Draft Commissioning Plan describes the design phase commissioning activities	• Draft Commissioning Plan		• Approve commissioning plan	• Create Commissioning Plan	• Review & Comment on commissioning plan	
5.	Commissioning Specifications	• Commissioning specifications shall be included in the design specifications	• Commissioning provider spec. • Contractor commissioning responsibility spec.	• Specifications shall describe the Cx and the contractor's responsibilities.	• Approve Specification	• Create Specification	• Include specifications in design documents	

Task		Description	Documents	Comments	Responsibilities			
					Owner	Cx	Designer	Contractors
6.	35% Plan Review	• Complete a thorough review of the 35% plan documents and submitted criteria to establish the systems to be designed and installed in compliance with the OPR. • 35% documents shall include, Engineering Calculations, System selection and major Component selection.	• Engineering Calculations • Load Data • System Selection • Major Component Selections • Flow Sheets • Mechanical Room Layouts • Mechanical shaft Layouts • Ceiling cuts • Commissioning Review Log	• Review Basis of Design submittal from the design team. • Resolution of any issues.	• Review Basis of Design submittal from the design team. • Resolution of any issues.	• Review and comment on 35% Design Review Log, issue resolution and Preliminary Commissioning Plan	• Basis of Design Document • Engineering Calculations • Major Component Selections • Design Review Log Responses	
7.	65% Plan Review	• Review 65% Design Documents • Draft Preliminary Construction Commissioning Plan, Commissioning Specifications and Supplemental Commissioning Language for other specification sections. • 65% documents shall include zoning requirements, specifications, typical room layouts, system main layouts, riser layouts, standard details, schedules and coordination requirements.	• 65% Plans & Specifications • Updated Basis of Design • Preliminary Draft Commissioning Plan • Commissioning Specifications • Commissioning Review Log	• Zoning requirements, typical room layouts, main ducts, piping mains, risers, standard details, equipment schedules, and coordination of disciplines.	• Owner will review all project submittal documents, assist in resolution of project issues and accept complete submittal.	• Preliminary Commissioning Plan • Commissioning Specifications • Design Review Log	• 65% Plans & Specifications • Design Review Log Responses • Update Basis of Design	
8.	95% Plan Review	• Review 95% Design Documents • Updated Commissioning Plan, Final Commissioning Specifications and Supplemental Commissioning Language for other specification sections. • 95% plans shall be essentially 100% complete except for coordination and review issues.	• 100% Plans & Specifications from design team. • Updated Basis of Design • Commissioning Specifications • Updated Draft Construction Commissioning Plan • Commissioning Review Log • Update/Finalize OPR	• Submittal Review & Acceptance • Plans & Specifications are to be 100% complete	• Owner will review all project documents and assist in resolution of project issues and accept completed documents.	• Final Commissioning Specifications • Updated Commissioning Plan • Design Review Log	• 95% Plans & Specifications • Update Basis of Design	

Task		Description	Documents	Comments	Responsibilities			
					Owner	Cx	Designer	Contractors
9.	Pre-bid Meeting and Assistance During Bidding process.	• Pre-bid meeting to assist contractors in answering any questions about the systems or the commissioning process or work that may come up at that time. Provide assistance in answering written questions (in the form of clarifications or addendum recommendations) during the bidding process.	• Written Responses or Recommendations		• Hold pre-bid meeting.	• Attend pre-bid meeting to answer commissioning questions.	• Attend pre-bid meeting to answer system questions.	• Attend pre-bid meeting.
Construction Phase Commissioning								
10.	Construction Commissioning Kick Off meeting	• Conduct an initial commissioning meeting with all contractors and commissioning team members. The purpose of the meeting will be to establish the purpose and proposed process for commissioning this facility in the construction, acceptance and warranties phases of the project. Review the individual roles and responsibilities of each participating commissioning team member as specified in the Construction Documents.	• Meeting Minutes • Final Commissioning Plan with specific with specific individual responsibilities identified.		• Facilitate commissioning kick off meeting.	• Conduct initial commissioning kick off meeting. • Meeting Minutes • Updated Commissioning Plan		• Identify Contacts and Responsibilities for Commissioning Team Members
11.	Prepare Duration Schedule for Commissioning Activities	• Based on the final commissioning plan, Prepare a duration schedule for the contractors for the commissioning activities required by the commissioning plan. This duration schedule should be incorporated into the contractor's project schedule to track all commissioning activities of the commissioning team.	• Duration Schedule		• Facilitate Schedule Coordination and Approve Construction Schedule	• Create and coordinate Cx duration schedule		• Provide construction schedule for coordination with commissioning schedule. • Incorporate Commissioning Activities into CPM Project Schedule

Task		Description	Documents	Comments	Responsibilities			
					Owner	Cx	Designer	Contractors
12.	Submittal & Shop Drawing Review	• Review all pertinent approved shop drawings to support the Commissioning Process. Review of the shop drawings is for the purpose of developing appropriate PFT (FIV, OPT) and FPT documents. Submittals & Shop drawings shall be reviewed for commissionability, maintainability and for compliance to the OPR. • Note any issues identified in the Shop Drawing Review that might compromise the final commissioned system on the 'Commissioning Review Log' and submit comment to the Design Team for resolution.	• Commissioning Review Log	• Cx reviews submittals & shop drawings that have already been reviewed/approved by the design team.	• Assist in resolution of project issues if required.	• Review approved shop drawings. • Create Design Review Log	• Design Review Log Responses	• Incorporate shop drawing and submittal changes as directed by the design team.
13.	Finalize Construction Commissioning Plan	• Based on the work completed in the items above, we will finalize the Commissioning Plan for this project. The final commissioning plan will incorporate all changes established by review with your staff and the design team members. The final commissioning plan will also include complete PFT (FIV, OPT) and FPT protocols for each system.	• Final Construction Commissioning Plan • Create all FIV, OPT and FPT documents. • Design FPT protocols.			• Final commissioning plan		
14.	Site Observations (SO)	• During the course of construction, visit the site to inspect the progress of construction with respect to the systems being commissioned. The purpose of the inspections is to verify that the construction complies with the plans & specifications and standard construction quality practices.	• FIV Check Sheets • Observation Reports • Commissioning Issues Log		• Review submitted documents. • Provide Response to any Owner Related Commissioning Issue	• FIV Check Sheets. • Site Observation Reports. • Daily Logs • Commissioning Issues Log	• Review submitted commissioning issue logs. • Provide Response to any Design Related issues.	• Review issues logs. • Provide Response to any issues.
15.	Commissioning Team Meetings	• Hold commissioning meetings on a regular basis with the commissioning team to review progress of the commissioning effort and reinforce individual responsibilities. Review completed work and agree upon the acceptability of the delivered product.	• Meeting Minutes • Commissioning Issues Log		• Attend meetings • Assist in resolution of project issues if required.	• Hold commissioning meetings • Keep commissioning issues log current.	• Attend meetings • Assist in resolution of design issues if required.	• Attend meetings • Assist in resolution of project issues

Task		Description	Documents	Comments	Responsibilities			
					Owner	Cx	Designer	Contractors
16.	Complete all Pre-Functional Installation and Static Tests	• Complete all Pre-Functional installation inspections and static test inspections. Complete al PFT check sheets.	• Completed PFT check sheets. • Completed Static Test check sheets • Commissioning Issues Log		• Assist in resolution of project issues if required.	• Verify FIV and static check sheets have been complete.	• Assist in resolution of design issues if required.	• Complete and Resolve any FIV check sheet issues.
17.	Pre Functional Start Up Tests	• Complete all equipment and system start up procedures. The Contractor will execute all start up and point-to-point tests. The Cx will verify the controls point to point PFT with no sampling strategies allowed.	• Completed PFT's. • Commissioning Issues Log		• Assist in resolution of project issues if required.	• Observe or document all PFT's	• Assist in resolution of design issues if required.	• Complete startup and PFT's.
Acceptance Phase Commissioning								
18.	Functional Performance Tests (FPT)	• Observe and facilitate all FPT testing. FPT's shall be designed by the Cx and performed by the contractors.	• FPT Check Sheets • Commissioning Issues Log		• Assist in resolution of project issues if required.	• Create FPT Test Designs • Observe FPT tests. • Keep commissioning Issues Log current.	• Provide Response to any Design issues if required.	• Perform FPT tests. • Resolve any FPT check sheet issues.
19.	O&M review	• Review Operating Manuals and As Built shop drawings for accuracy and completeness • Verify they are ready to hand over to the owner for operator use	• O&M Manual • Shop Drawings		• Receives Documents	• Review Documents	• Approves documents	• Provides documents
20.	Operator Training	• Work with the contractor and owner to schedule and plan training activities so that training occurs in a coordinated and coherent fashion. Assist in the development of training schedules and agendas, encourage the use of a combination of "classroom" and field training, and assist the contractors in the development of training agendas for each system or component installed in the project. • Contractors and vendors provide all training. Additional skill training can be provided as an additional scope item if desired by the owner.	• Coordinated Training Agendas		• Schedule operators to attend training	• Assist in coordinating training, and training agendas.	• Participate as required by the owner.	• Provide training as required.

Task		Description	Documents	Comments	Responsibilities			
					Owner	Cx	Designer	Contractors
21.	Prepare Final Commissioning Report	• Based on the accumulated commissioning work completed as described above, we will assemble the data into a final commissioning report. The final report will incorporate the final record documents for each system, as appropriate. The report will also include a summary of commissioning that will highlight the final condition of each system commissioned.	• Final Commissioning Report	• If Warranty Phase commissioning or deferred testing (off season) is included in the scope of work, this report can be submitted as a draft report pending completion of final testing and inspections.	• Review final report	• Create report		
Warranty Phase Commissioning								
22.	Deferred (Off season) Testing	• Conduct any testing required by the commissioning plan that was deferred from the acceptance period.	• Warranty Commissioning Plan • FPT Test check sheets		• Review report addenda.	• Observe off season tests.		• Conduct off season FPT tests. • Resolve any FPT check sheet issues.
23.	Lessons Learned Workshop	• CA may hold a lessons learned workshop to review the processes utilized and the perceived effectiveness of those processes for the project.	• Lessons learned report	• Intended to improve the process and results for future projects.	• Participate in meeting	• Chair meeting	• Participate in meeting	• Participate in meeting
24.	Ten Month Warranty Visit	• Cx will inspect the site and interview building operating personnel to identify any outstanding warranty failures and to identify any persistent equipment failure issues that should be handled within the warranty period.	• Commissioning Warranty Issues Log • Commissioning report addenda.		• Review report addenda. • Review final issues log.	• Conduct warranty visit. • Follow up on any warranty repair issues.		• Resolve any warranty issues.