

ICC G4-2012

GUIDELINE FOR COMMISSIONING



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ICC G4-2012 Guideline for Commissioning

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Foreword

An important yet underused path to energy savings, greenhouse gas emission reductions and overall building performance is through the *commissioning* of new buildings and the *retrocommissioning* of existing stock. In recent years commissioning has found its way into voluntary rating systems like LEED and, more recently, it has been included in the *International Green Construction Code™* (IgCC™) and CALGreen building codes, and standards such as ASHRAE 189.1, which is helping to move it into the mainstream of construction practices.

The term commissioning comes from ship builders that “commission” their ships to ensure that they are ready for service prior to the ships initial voyage and then are routinely inspected or “retrocommissioned” during their service life to maintain their performance. The commissioning of buildings initially focused on energy performance but now includes other building and site considerations such as mechanical, landscaping, acoustics, water use and air quality.

Many code officials have recognized the challenge and expressed concern over the enforcement of building commissioning since most code officials are not familiar with the process, as it has never been part of the building code. Recognizing the need for a guideline that addresses the various aspects of commissioning that will assist code officials in its implementation, ICC formed a committee with the task of developing such a guideline. The provisions of the guideline are intended to make enforcement simpler for code officials by clarifying the process and the use of approved agencies to perform and certify the commissioning of buildings.

The committee members that developed this guideline were industry experts and professionals from the design and enforcement communities. They recognize the importance of developing a guideline focused on commissioning as it pertains to enforcement and implementation and that encompasses the larger considerations that a building might need to improve and maintain higher performance levels.

Although it would seem that commissioning would be standard industry practice, in truth, buildings are rarely commissioned. Where buildings have been commissioned, the results are impressive. Case studies of large-scale commissioning efforts show positive energy savings and reasonable payback on the investment.

The authors of this guideline provided an extensive diversity of expertise and experience. The guideline was publicly vetted and the committee fully considered the numerous comments to make this a very comprehensive document. The guideline will provide a level of consistency that will assist the enforcement and design communities in the successful implementation of building commissioning.

Dave Walls
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Preface

Introduction

The principal purpose of the ICC Guideline series is to provide a state-of-the-art volume of knowledge that will contribute to public health, safety and general welfare in the built environment. Guideline projects are established based on market relevancy, demand and the realization that existing technical information, regulations or standards, if any, do not adequately address the subject or that such existing technical information needs to be enhanced, clarified and made more user friendly. ICC Guidelines are in-depth, topic-specific technical publications that have global relevancy and may be used internationally. They are different from codes or standards in that they will generally use nonmandatory language.

Moreover, the committee addressed what it deemed essential processes such as the owner's project requirements and the basis of design. Given their significance to the commissioning process, the Committee felt it was appropriate and important to address them in this document.

Development

Development of the ICC Guideline series was approved by the ICC Board of Directors in September 2008. ICC Policy GP 33-08 governs the development of ICC Guidelines and can be viewed on the ICC website at www.iccsafe.org. ICC Guidelines are developed with the establishment of a Guideline Development Committee (GDC). The GDC is made up of a diverse stakeholder population and the participants are focused on ensuring high-quality and timely technical information for the built environment's usage. Upon the GDC reaching consensus, the final draft is posted for a "Public Comment" period for 30 days. The GDC considers all public comments, revises the public comment draft as appropriate and sends its recommendations to ICC for publication.

Adoption

The *Guideline for Commissioning* is available for application and use around the world. Its use within a governmental entity or responsible agency is intended to be accomplished through adoption by reference in accordance with proceedings established by local laws, regulations and procedures. At the time of adoption, provisions requiring specific local information, such as the name of the adopting entity or agency should be inserted.

To accommodate the standardization of the *Guideline for Commissioning* into local law, the text passages of the guideline may need to be interpreted in a specific manner. Where definitive procedures are needed, mandatory language will become necessary and the following substitutions, definitions and rules can be applied to conform to definitive procedures with mandatory language.

- The words "may," "should," "could" and "can" are permissive in nature. Where defini-





tive procedures must be followed, the mandatory words of “must,” “shall” and “will” should be interpreted or substituted for the permissive words found in the guideline as follows:

<u>Permissive Words</u>	<u>Mandatory Words</u>
may	→ must
should	→ shall
could	→ will

- The use of “and” in a provision means that “all” elements in the provision must be complied with, or must exist to make the provisions applicable.
- Where compliance with one or more elements suffices, or where existence of one or more elements makes the provision applicable, “or” (rather than “and”) applies.

Disclaimer

The data contained in this guideline are being provided for reference purposes only and in no event shall the International Code Council (ICC), or the partners in preparation of this report be liable for any general, consequential, indirect, incidental, exemplary, or special damages arising from the use of or reliance upon, in whole or part, the information obtained from this study. This guideline does not intend to overrule national building codes or practices, but to provide a reference for minimum levels of quality to safeguard health, property and public welfare.

This guideline may be adopted and used as a regulatory requirement or standard. If this document is adopted as a mandatory code, all permissive language such as “should” and “may” shall be replaced with mandatory terms such as “shall” and “must.”

Maintenance

ICC Guidelines are not required to be updated on a specific cycle; however, they will be reviewed periodically and may be updated through a GDC-established process as needed based on changing trends, technology or relevant technical information.



About This Guideline

ICC G4-2012 Guideline for Commissioning

The purpose and scope of this guideline is to provide guidance for an authority having jurisdiction (AHJ) to use in order to competently implement commissioning, either with the code official, registered design professional in responsible charge, engineer of record or an independent third-party acting as the approved agency. The guideline specifically addresses items related to the stated goals and criteria (implementation and enforcement). While this guideline is not written in enforceable language, it could be adopted in whole or in part. This guideline was designed to support the adoption and application of the *International Green Construction Code™* (IgCC™) and its alternate compliance paths, ASHRAE 189.1 and the ICC 700, as well as regional green building codes such as CALGreen.

As in other codes and standards, the IgCC does not address how building commissioning should be verified by the building official, nor does it address the process of commissioning. The IgCC specifies which systems need to be commissioned.

In order for the building official to verify that building commissioning is performed appropriately and by qualified personnel, the authoring committee developed minimum requirements to specify the components that must be examined within each system being commissioned, the forms that should be completed, and the minimum information that must be provided in the commissioning plan, as well as other documents. The committee provided information regarding the qualifications and skills that a commissioning agency may have, but left setting the standards for minimum qualifications to be addressed in the future.

Building commissioning has been practiced for many years, but only recently has it become a code requirement. As a result, it has not been regulated and varies in how it is applied, with HVAC usually being the focal point. Additionally, industry practices and codes are moving into new areas of commissioning other than HVAC, such as landscape irrigation systems and renewable energy systems. Based on the expansion of building commissioning into other areas, its growing popularity and the desire to make this document suitable for other codes and standards, the committee addressed more areas than required by the IgCC, such as elevators, waste management and fire suppression systems.

Effective Use of this Guideline

This guideline covers an extensive number of building commissioning activities that may be necessary on a project. Every project is unique and the required activities will vary on every project depending on the applicable code, standard, or specific requirement. This guideline provides recommendations, minimum requirements and best practices based upon industry guidance of system commissioning. The use of the guideline can assist in attaining consistency in the implementation and enforcement of building commissioning.

Although building Commissioning (Cx) has conventionally covered mainly HVAC systems, this guideline covers more disciplines to aid local jurisdictions that may be adopting codes and standards that require commissioning beyond just HVAC. Chapter 3 of this guideline provides the framework for the Cx process. Information on the subsequent chapters is provided below.





Before applying the provisions of this guideline, it is important to identify which code or standard is applicable to the project. The guideline references Table 903.1 of the IgCC, however, the project may be based on other recognized and approved codes or standards such as ASHRAE 189.1 or CALGreen.

This guideline is divided into six chapters; the following is a chapter-by-chapter synopsis:

- Chapter 1 provides background information about the guideline's development and purpose.
- Chapter 2 highlights all acronyms and terms defined in the guideline and lists them in alphabetical order. The guideline often uses terminology that has a unique meaning that may differ from the commonly understood meaning of the term.
- Chapter 3 describes the processes involved in commissioning and provides information regarding the intent, compliance methods, and enforcement and other pertinent information related to commissioning.

The provisions of Chapter 3 establish the framework for the building commissioning process. These elements include the Owner Project Requirements (OPR) which establishes the goals and design criteria desired by the owner, the Basis of Design (BOD) a Commissioning Plan, Documentation and Training, and a Commissioning Report.

- The OPR meets or exceeds minimum code requirements applicable to the project.
- The OPR becomes the criteria for the design of the building and thus for the Basis of Design (BOD) document. The BOD must incorporate all of the criteria from the OPR.
- The commissioning plan which must be prepared to document how the project will be commissioned.
- Documentation of the operational aspects of the building shall be completed within the systems manual.
- A complete report of commissioning process activities must be undertaken through the design.
- Chapter 4 incorporates sample templates and forms that the code official may require from the Cx Agency to show compliance with the commissioning requirements.
- Chapter 5 contains a list of qualifications for each discipline. The code official may use this list in determining proficiency in performing commissioning in each discipline.
- Chapter 6 specifies the various equipment, assemblies and components within each system being commissioned and the corresponding task(s) involved in testing and verifying their functionality. The list is provided for guidance to the code official and is not necessarily limited to the items identified.



About the International Code Council

The International Code Council (ICC), a membership association dedicated to building safety, fire prevention and energy efficiency, develops the codes and standards used to construct residential and commercial buildings, including homes and schools. The mission of ICC is to provide the highest quality codes, standards, products and services for all concerned with the safety and performance of the built environment. Most United States cities, counties and states choose the International Codes, building safety codes developed by the International Code Council.

The International Codes also serve as the basis for construction of federal properties around the world, and as a reference for many nations outside the United States. The Code Council is also dedicated to innovation and sustainability. ICC Evaluation Service, a subsidiary of ICC, issues Evaluation Reports and Listings for innovative building products as well as environmental documents such as ICC-ES VAR Environmental Reports and ICC-ES Environmental Product Declarations (EPDs).

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Other Guidelines of the Series

ICC G1-2010 *Guideline for Replicable Buildings*

ICC G2-2010 *Guideline for Acoustics*

ICC G3-2011 *Global Guideline for Practical Public Toilet Design*



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CHAPTER 1: INTRODUCTION

Section 101 General

101.1 Purpose and scope. The purpose and scope of this guideline is to provide guidance for a code official or regulator to use in order to enforce commissioning competently, either with in-house staff or the use of a third-party agency. It is not intended to specify what the various aspects of the commissioning process are; rather, it deals with only the issues related to the stated goals and criteria (implementation and enforcement). This guideline is not a code and, therefore, is not written in enforceable language. However, this document could be adopted in whole or in part by the authority having jurisdiction (AHJ). This guideline was designed to support the adoption and application of the *International Green Construction Code™* (IgCC™) and its alternate compliance paths, ASHRAE 189.1 and the ICC 700, as well as regional green building codes such as CALGreen.

101.2 Definitions. The definitions used in this document are for purposes of this guideline.



CHAPTER 2: DEFINITIONS

Section 201 Acronyms

201.1 The following acronyms are used throughout the guideline.

BAS	Building automation systems
BOD	Basis of design
CxA	Commissioning agency
EPA	Environmental Protection Agency
FPT	Functional performance test
HVAC	Heating, ventilating and air conditioning
LEED	Leadership in Energy and Environmental Design
O&M	Operations and maintenance
OPR	Owner's project requirements

Section 202 General Definitions

202.1 Acceptance criteria. The conditions that must be met for systems or equipment to meet defined expected outcomes.

202.2 Commissioning (Cx). A process that verifies and documents that the selected building and site systems have been designed, installed and function in accordance with the owner's project requirements and construction documents, and minimum code requirements.

Note from the Commissioning Guideline Committee: Building commissioning involves a quality-assurance process that begins during the predesign phase, and extends through design phases, construction and continues post occupancy. Commissioning verifies that the new building systems are installed and operate as intended, and that building staff are prepared to operate and maintain its systems and equipment.

202.3 Commissioning agency (CxA) An established and recognized agent or agency regularly engaged in conducting tests and furnishing commissioning services. The agency may consist of one or multiple individuals having various expertises. The Commissioning Agency can be a third-party commissioning provider or the owner's in-house staff member.

202.4 Commissioning process. 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 and other approved project documents.

202.5 Commissioning team. The key members of each party involved with the project designated to provide insight and carry out tasks necessary for a successful commissioning project. Team members may include the commissioning agency, owner or owner's representative, building staff, design professionals, contractors or manufacturer's representatives, and testing specialists.



202.6 Issues log. A formal and ongoing record of problem or concerns — and their resolution — that have been raised by members of the commissioning team during the course of the commissioning process.

202.7 O&M manuals. Documents that provide information necessary for the operation and maintenance of installed equipment and systems.

202.8 Owner. The individual or entity holding title to the property on which the building is constructed.

202.9 Owner's representative. An individual or entity assigned by the owner to act and sign on the owner's behalf.

202.10 Process equipment. Energy-using equipment and components that are not used for HVAC, electrical, plumbing and irrigation operations. Such devices include, but are not limited to, heat transfer, water purifying, air cleaning, air vacuum and air compressing.

202.11 Selecting trained personnel (for commissioning). This guideline follows the *International Green Construction Code™* (IgCC™) in that “commissioning shall be performed in accordance with this section by trained personnel with experience on projects of comparable size and complexity.” The trained personnel manage and facilitate the commissioning process. The trained personnel develop and implement the commissioning tasks and documentation relating to systems in accordance with Table 903.1 of the IgCC. Trained personnel may include appropriate members of the owner’s staff, contractor and design team, as well as independent commissioning professionals.

It is essential that there is a single person designated to lead and manage the commissioning activities. In practice, this individual has been referenced by various identifiers, such as a commissioning authority, agent, provider, coordinator, lead, etc. In this guideline, the term “CxA” is used.

The designated CxA may be an independent third-party commissioning professional, a project design team member (e.g., engineer or architect), an owner’s engineer or facility staff, contractor or specialty subcontractor. Methods of evaluating the designated CxA and trained personnel include review of the following:

1. Technical knowledge.
2. Relevant experience.
3. Potential conflict-of-interest concerns.
4. Professional certifications and training.
5. Communication and organizational skills.
6. Reference and sample work products.

202.12 Sequence of operation. A written description of the intended performance and operation of each control element and feature of the equipment and systems.

202.13 Systems manual. The systems manual provides the information needed to understand and properly and optimally operate the building systems and assemblies.

CHAPTER 3: STANDARDS FOR COMPLIANCE WITH BUILDING COMMISSIONING

Section 301 Owner's Project Requirements

301.1 Owner's (or owner representative's) project requirements (OPR). The expectations and requirements of the building appropriate to its phase shall be documented before the design phase of the project begins. This documentation shall include the following:

1. Project program, including facility functions and hours of operation, and a need for after-hours operation.
2. Environmental and sustainability goals.
3. Site development and land use.
4. Energy-efficiency goals.
5. Indoor environmental quality requirements.
6. Building materials selection.
7. Equipment and systems expectations.
8. Building occupant and O&M personnel expectations.
9. Other project requirements.
10. Intent.
11. Compliance.
12. Enforcement.

301.2 Description. The OPR documents the functional requirements of a project and expectations of the building use and operation, as it relates to systems being commissioned. The document describes the physical and functional building characteristics desired by the owner and establishes performance and acceptance criteria. The OPR is most effective when developed during predesign and used to develop the basis of design (BOD) during the design process. The level of detail and complexity of the OPR will vary according to building use, type and systems.

301.3 Compliance method. Compliance is demonstrated by the owner or owner's representative developing and/or approving the OPR document, and can be defined as follows:

1. Project program, including facility functions and hours of operation, and the need for after-hours operation—describe the primary purpose, program and use of a proposed project, including:
 - 1.1. Building size, number of stories, construction type, occupancy type and number.
 - 1.2. Building program areas, including intended use and anticipated occupancy schedules.
 - 1.3. Future expandability and flexibility of spaces.
 - 1.4. Quality and/or durability of materials and building lifespan desired.
 - 1.5. Budget or operational constraints.
 - 1.6. Applicable, locally adopted codes.



- 
2. Environmental and sustainability goals. This includes a description of the environmental project goals and objectives exceeding locally adopted codes for the project's sustainability, which may include:
 - 2.1. Voluntary measures; a specific green building rating system or program credits; and/or level of certification sought.
 - 2.2. Specific environmental or sustainability goals, such as water efficiency, water reuse, carbon dioxide (CO₂) monitoring or xeriscaping.
 3. Site development and land use. Site conditions are established that include, at a minimum, the following:
 - 3.1. A narrative of existing vegetation and land features.
 - 3.2. A description of the ways in which building and site development will encourage natural resource conservation and environmentally responsible land use.
 4. Energy-efficiency goals. Goals and targets affecting energy efficiency are established, and may include:
 - 4.1. Overall energy efficiency that meets or exceeds the *International Energy Conservation Code®* (IECC®) performance approach energy budget by ____ percent.
 - 4.2. Lighting system efficiency that meets or exceeds the IECC performance approach energy budget by ____ percent.
 - 4.3. HVAC equipment efficiency and characteristics.
 - 4.4. Any other measures affecting energy efficiency desired by owner, including, but not limited to:
 - 4.4.1. Building orientation and siting.
 - 4.4.2. Daylighting.
 - 4.4.3. Facade, envelope and fenestration.
 - 4.4.4. Roof.
 - 4.4.5. Natural ventilation.
 - 4.4.6. On-site renewable power generation and net-zero energy use.
 - 4.4.7. Landscaping and shading.
 - 4.5. Indoor environmental quality requirements. For each program space, a description of indoor environmental requirements, including their intended use and anticipated schedule, shall be provided:
 - 4.5.1. Lighting.
 - 4.5.2. Temperature and humidity.
 - 4.5.3. Acoustics.
 - 4.5.4. Air quality, ventilation and filtration.
 - 4.5.5. Desired adjustability of system controls.
 - 4.5.6. Accommodations for after-hours use.
 - 4.5.7. Other owner requirements, including natural ventilation, operable windows, daylight, views, etc.
 - 4.6. Building materials selection. A description of how the building will prevent the accumulation of moisture shall be provided. A list of materials that will mitigate moisture away from the building shall also be provided.



- 4.7. Equipment and system expectations. For each system commissioned, the following shall be described:
 - 4.7.1. Level of quality, reliability, equipment type, automation, flexibility, maintenance and complexity desired.
 - 4.7.2. Specific efficiency targets, desired technologies or preferred manufacturers for building systems, acoustics and vibration.
 - 4.7.3. Degree of system integration, automation and functionality for controls (e.g., load shedding, demand response, energy management, etc.).
- 4.8. Building occupant and O&M personnel expectations. The following shall be described:
 - 4.8.1. How buildings will be operated and by whom.
 - 4.8.2. Level of training and orientation required to understand, operate and use the building systems for building operation and maintenance staff, as well as occupants.
 - 4.8.3. Building operation and maintenance staff location and capabilities (e.g., certifications, education, etc.).
- 4.9. Optional systems (not required by the IgCC). Any other system(s) the owner wishes to include in the commissioning process shall be identified.

301.4 Enforcement. At his or her discretion, the code official shall confirm demonstrated compliance at plan intake by:

1. Receipt of a copy of the OPR document; and
2. Receipt of a form (see the OPR form in Chapter 4) signed by the owner or owner's representative attesting that the OPR has been completed and approved by the owner.

Section 302 Basis of Design

302.1 Basis of design (BOD). A written explanation of how the design of the building system meets the OPR shall be completed at the design phase of the building project, and updated as necessary during the design and construction phases. The BOD document shall cover the following areas:

1. Site development and land use.
2. Materials.
3. Energy.
4. Lighting.
5. Water.
6. Indoor environmental quality.
7. Optional systems (not required by the IgCC).
8. Intent.

302.2 BOD description. The basis of design (BOD) describes the building components or systems to be commissioned and outlines design assumptions not indicated in the design documents. The design team develops the BOD to describe how the



building systems design meets the OPR and why the systems were selected. The BOD is most effective when developed early in the project design and updated as necessary throughout the design process.

302.3 Compliance method. Compliance requires the completion of the BOD and should include the following, where applicable.

1. Site development and land use.
2. Vegetation and soil protection and restoration.
3. Storm water management and erosion control.
4. Land-clearing debris and soil reuse.
5. Site exterior lighting.

302.3.1 Site development and land use. These shall include:

1. Natural resources and base line conditions of building site:
 - 1.1. Identify invasive vegetation.
 - 1.2. Determine location of any protection areas and to what extent the native soils and hydrological conditions have been disturbed on site.
 - 1.3. Applicable codes.
2. Landscape irrigation systems:
 - 2.1. A narrative description of the system shall be provided, including type, performance and water usage.
 - 2.2. The reason for the system selection shall be described, including why the chosen system is better than the alternatives. Issues such as performance, efficiency, reliability, flexibility, expandability, cost, owner preference and simplicity shall be addressed.
 - 2.3. Sequence of operation, including operating schedules and set points shall be listed.
 - 2.4. How the system meets the OPR shall be described.
 - 2.5. Applicable codes shall be listed.

302.3.2 Vegetation and soil protection and restoration. A vegetation and soil protection plan shall be provided in accordance with the following:

1. Existing vegetation location on a building site that is to be preserved and protected.
2. Portions of the building site to be designated vegetation and soil protection areas (VSPAs) during the construction process.
3. Methods to be used to maintain the protection of the designated VSPAs.
4. Temporary locations. Temporary locations for the stockpiling of topsoil that could be potentially damaged by construction activities or equipment shall be identified.
5. Placement of soil. Soil placement or replacement to establish or restore the ability of the soil to support vegetation shall be identified.
6. Topsoils. The design team shall ensure that topsoils or soil blends imported to a building site to serve as topsoil are not mined from greenfield sites or farmlands.
7. Absorption and percolation. A narrative identifying all proposed absorption



systems and percolation tests to be performed on the building site shall be provided.

8. Applicable codes. All applicable codes shall be listed on the vegetation and soil protection plan.

302.3.3 Storm water management and erosion control.

1. A narrative description of the system and how the increase in runoff from the resulting development will be addressed shall be provided.
2. The reason for the best management practice (BMPs) selection, including why the chosen BMPs are better than the alternatives; and issues, such as site conditions, performance, efficiency, reliability, flexibility, simplicity, expandability, cost and owner preference, shall be described.
3. How the system meets the OPR shall be described.
4. Applicable codes shall be listed for storm water management and erosion control.

302.3.4 Land-clearing debris and soil reuse.

1. A plan that will recycle or salvage 75 percent of the land-clearing debris and excavated soils shall be developed.
2. Materials to be diverted from disposal through recycling or reuse shall be identified.
3. The amount of materials to be diverted (by weight or volume) and the location as to where they will be diverted shall be specified.
4. The removal and disposal of invasive plant species shall be addressed.
5. The method, amount and location of disposal and treatment of contaminated soils shall be provided.
6. Applicable codes shall be listed for land-clearing debris and soil reuse.

302.3.5 Site exterior lighting.

1. A narrative description of the system, including type of fixtures, lamps, ballasts and controls shall be provided.
2. The reason for system selection, including why the chosen system is better than the alternatives; and issues, such as visual comfort, performance, efficiency, reliability, cost, flexibility, owner preference, color rendering, integration with daylighting and ease of control, shall be described.
3. Design criteria for each type of space shall be provided:
 - 3.1. Applicable codes, guidelines, regulations and other references used.
 - 3.2. Illumination design targets [footcandle (lux)] and lighting calculation assumptions.
4. Lighting design targets shall be provided, including uplight rating, glare rating and backlight rating.

302.4 How the system meets the OPR materials.

302.4.1 Building materials criteria. Recognized performance and quality criteria for the selection of building materials shall be described. Criteria might address, for example, durability; water, vapor and air movement control; energy performance; local availability; availability of repair and replacement materials; ease of maintenance.

302.4.2 Applicable codes shall be listed.



302.5 Energy.

302.5.1 Energy metering, monitoring and reporting.

1. All energy-load types to be metered shall be identified.
2. All energy types that are applicable to the building shall be identified.
3. A narrative of the energy data acquisition and management system to be selected shall be provided.
4. Sequence of operation, including operating schedules, set points and stage capacity shall be defined.
5. How the system meets the OPR shall be described.
6. Applicable codes for energy metering, monitoring and reporting shall be listed.

302.5.2 Mechanical systems completion.

1. The means for system balancing, duct testing and O&M systems manual shall be provided.
2. A narrative description of HVAC system, including system type, location, control type, efficiency features, outdoor air ventilation strategy, indoor air quality features, environmental benefits and other special features shall be provided.
3. Reasons for the system selection, including why the chosen system is better than the alternatives; and issues, such as comfort, performance, efficiency, reliability, flexibility, simplicity, cost, owner preference, site constraints, climate, maintenance and acoustics shall be described.
4. Design criteria shall be provided, including the following:
 - 4.1. Load calculation method/software.
 - 4.2. Summer outdoor design conditions (____°F dry bulb and ____°F wet bulb).
 - 4.3. Winter outdoor design conditions (____°F dry bulb and ____°F wet bulb).
 - 4.4. Indoor design conditions (____°F dry bulb cooling, ____ percent RH cooling, ____°F dry bulb heating, ____ percent RH heating).
 - 4.5. Applicable codes, guidelines, regulations and other references used.
 - 4.6. Load calculation assumptions.
5. Sequence of operations, including operating schedules and set points shall be defined. This may refer to plans or specifications if the sequence is indicated within the permit documents.
6. How the system meets the OPR shall be described.
7. Applicable codes regarding mechanical systems completion shall be listed.

302.5.3 Renewable energy systems.

A narrative description of the system, including type, performance, control type, energy savings and payback period shall be provided.

1. The reason for the system selection, including why the chosen system is better than the alternatives; and issues, such as performance, efficiency, reliability, flexibility, simplicity, expandability, cost, payback period, utility company incentives, and owner preference, shall be described.
2. Sequence of operation, including operating schedules, set points and energy storage capacity shall be described.



3. How the system meets the OPR shall be described.
4. Applicable codes regarding renewable energy systems shall be listed.

302.6 Lighting. A narrative description of the lighting system, including type of fixtures, lamps, ballasts and controls shall be provided.

302.6.1 System selection. The reason for the system selection, including why the chosen system is better than the alternatives; and issues, such as visual comfort, performance, efficiency, reliability, cost, flexibility, owner preference, color rendering, integration with daylighting and ease of control, shall be described.

302.6.2 Design criteria. Design criteria for each type of space shall be provided, including the following:

1. Applicable codes, guidelines, regulations and other references used.
2. Illumination design targets [footcandle (lux)] and lighting calculation assumptions.

302.6.3 Lighting power testing. Lighting power design targets for each type of space shall be provided.

1. IECC lighting power allowance and lighting power design target (watts/ft²).

302.6.4 Lighting control strategies. Lighting control strategies for each type of space including sequence of operation, operating schedules and lighting level set-points shall be described. How the system meets the OPR shall be described.

302.7 Water.

302.7.1 Water reuse systems. A narrative description of the system, including type, performance, capacity and reuse purpose shall be provided.

1. The reason for the system selection, including why the chosen system is better than the alternatives; and issues, such as site constraints, climatic conditions, performance, efficiency, reliability, flexibility, expandability, cost, owner preference and simplicity, shall be described.
2. Sequence of operation, including operating schedules and set points shall be defined.
3. How the system meets the OPR shall be described.
4. Applicable codes regarding water reuse systems shall be listed.

302.8 Indoor environmental quality.

302.8.1 Sound reduction barriers. A narrative of proposed sound reduction barriers used to dampen noise from mechanical and emergency generator equipment located outside of buildings shall be provided.

302.8.2 HVAC background noise. A narrative for how HVAC background noise will be addressed shall be provided.

302.8.3 Applicable codes. Applicable codes regarding indoor environmental quality shall be listed

302.9 Optional systems (not required by the IgCC). For each additional system selected:

1. A narrative of system(s) to be commissioned shall be provided.



2. The reason for the system selection, including why the chosen system is better than the alternatives; and issues, such as site constraints, climatic conditions, performance, efficiency, reliability, flexibility, expandability, cost, owner preference and simplicity shall be described.
3. Sequence of operation, including operating schedules and set points shall be defined.
4. How systems meet the OPR shall be defined.
5. Applicable codes regarding optional systems shall be listed.

302.10 Enforcement. At his or her discretion, the code official shall confirm demonstrated compliance at plan intake by:

1. Receipt of a copy of the BOD document; and
2. Receipt of a form (see the BOD form in Chapter 4) signed by the architect, engineer or designer of record, attesting that the BOD has been completed and meets the requirements of the OPR.

Section 303

Commissioning Measures Shown in the Construction Documents

303.1 Commissioning requirements. For new buildings, commissioning shall be included in the design and construction processes. Commissioning requirements shall include:

1. OPR.
2. BOD.
3. Commissioning measures shown in the construction documents.
4. Commissioning plan.
5. Design documents review.
6. Submittal review for commissioned systems.
7. Installation verification.
8. Functional performance testing.
9. Documentation.
10. Training.
11. Commissioning report.

303.2 Intent. Commissioning measures or requirements should be clear, detailed and complete to clarify the commissioning process. These include commissioning measures or requirements in the construction documents (plans and specifications) in accordance with IgCC Section 104.1, Information on Construction Documents, and IgCC Table 903.1, Commissioning Plan.

303.3 Compliance method. Compliance is achieved by including commissioning requirements in the project specifications. The commissioning specifications should include the following:

1. Primary (and optionally all) commissioning requirements are included in the general specification division (typically, Division 1), and clear cross references of all commissioning requirements to and from the general division are included to ensure all subcontractors are held to them.

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2. A list of the systems and assemblies covered by the commissioning requirements.
 3. Roles and responsibilities of all parties including:
 - 3.1. General contractor and subcontractors, vendors, and construction manager.
 - 3.2. Commissioning agency.
 - 3.3. Owner and facility staff.
 - 3.4. Architect and design engineers.
 - 3.5. The noncontractor parties in the construction specifications is for informational purposes only to provide the contractor with context for their work.
 - 3.6. Who writes checklists and tests, who reviews and approves test forms, who directs tests, who executes tests, who documents test results and who approves completed tests. These roles may vary by system or assembly.
 4. Meeting requirements.
 5. Commissioning schedule management procedures.
 6. Issue and remedy procedures.
 7. Requirements for execution and documentation of installation, checkout and start up, including controls point-to-point checks and calibrations.
 8. Specific testing requirements by system, including:
 - 8.1. Monitoring and trending.
 - 8.2. Opposite season or deferred testing requirements, functions and modes to be tested.
 - 8.3. Conditions of test.
 - 8.4. Acceptance criteria and any allowed sampling.
 - 8.5. Details of the format and rigor of the test forms required to document test execution.
 - 8.6. Example forms are recommended.
 9. Submittal review requirements and approval process.
 10. Content, authority and approval process of the commissioning plan.
 11. Commissioning documentation and reporting requirements.
 12. Facility staff training requirements and verification procedures.
 13. O&M manual review and approval procedures.
 14. System's manual development, and approval requirements and procedures.
 15. Definitions section.

303.4 Enforcement. At his discretion, the code official confirms demonstrated compliance at plan intake by:

1. Receipt of a copy of the commissioning specifications; and
2. Receipt of a form (see the Sample Commissioning Measures in Construction Documents form in Chapter 4) signed by the owner or owner's representative, or designer of record, attesting that the owner-approved commissioning specifications are included in the construction documents.



Section 304 Commissioning Plan

304.1 Commissioning plan. Prior to permit issuance, a commissioning plan based on Table 903.1 of the IgCC shall be completed to document how the project will be commissioned and shall be started during the design phase of the building project. The commissioning plan shall include the following:

1. General project information.
2. Commissioning goals.
3. Systems to be commissioned. Plans to test systems and components shall include:
 - 3.1. An explanation of the original design intent.
 - 3.2. Equipment and systems to be tested, including the extent of tests.
 - 3.3. Functions to be tested.
 - 3.4. Conditions under which the test shall be performed.
 - 3.5. Measurable criteria for acceptable performance.
4. Commissioning team information.
5. Commissioning process activities, schedules and responsibilities. Plans for the completion of commissioning requirements listed in Table 903.1 of the IgCC shall be included.

304.2 Intent. The Commissioning plan should be clear, detailed and complete. The commissioning plan establishes the commissioning process guideline for the project and the commissioning team's level of effort by identifying the required commissioning activities to ensure that the OPR and the BOD are met. The commissioning plan also includes a commissioning schedule from design to occupancy.

304.3 Compliance method. Compliance is demonstrated by the preparation of a project-specific commissioning plan that includes the elements listed in the definition at the beginning of this section. The following gives guidance for developing the components of the commissioning plan:

1. General project information—provide project-identifying information, including, but not limited to, the following:
 - 1.1. Project name, owner and location.
 - 1.2. Building type and building area.
 - 1.3. Code information, including type of construction, building areas, occupancy, number of stories, etc.
 - 1.4. Project schedule.
 - 1.5. Contact information of individual/company providing the commissioning services.
2. Commissioning goals—document the commissioning goals, including, but not limited to:
 - 2.1. Meeting locally adopted code requirements for commissioning.
 - 2.2. Meeting the OPR and BOD requirements.
 - 2.3. Carrying out requirements for commissioning activities as specified in the plans and specifications.



3. Systems to be commissioned—see BOD.
 - 3.1. An explanation of the original design intent—document the performance objectives and design intent for each system listed to be commissioned in a written narrative.
 - 3.1.1. Refer to the OPR and BOD documents.
 - 3.2. Equipment and systems to be tested, including the extent of tests.
 - 3.2.1. Provide a list of equipment and systems to be tested.
 - 3.2.2. Describe the range and extent of tests to be performed for each system component, and interface between systems.
 - 3.3. Functions to be tested—provide example functional test procedures to identify the level of testing detail required.
 - 3.4. Conditions under which the test shall be performed—identify the conditions under which the major operational system functions are to be tested, including:
 - 3.4.1. Normal operations and part-load operations.
 - 3.4.2. Seasonal testing requirements.
 - 3.4.3. Restart of equipment and systems after power loss.
 - 3.4.4. System alarm confirmations.
 - 3.5. Measurable criteria for acceptable performance—include measurable criteria for acceptable performance of each system to be tested.
4. Commissioning team information—provide a contact list for all commissioning team members, including, but not limited to:
 - 4.1. Owner and owner's representative.
 - 4.2. Architect and engineers.
 - 4.3. Designated commissioning representative or approved agency.
 - 4.4. General contractor, subcontractors and construction manager.
5. Commissioning process activities, schedules and responsibilities.
 - 5.1. Establish prescribed commissioning process steps and activities to be accomplished by the commissioning team throughout the design to occupancy.
 - 5.2. For each phase of the work, define the roles and responsibilities for each member of the commissioning team.
 - 5.3. List the required commissioning deliverables, reports, forms and verifications expected at each stage of the commissioning effort.
 - 5.4. Include the confirmation process for the O&M manual, systems manual, and the facility operator and maintenance staff training.

304.4 Enforcement. At his discretion, the code official confirms demonstrated compliance at plan intake by:

1. Receipt of a copy of the commissioning plan; and
2. Receipt of a form (see the Commissioning Plan Sample Compliance form in Chapter 4) signed by the owner or owner's representative, attesting that the commissioning plan has been completed.



304.5 Schedule. Where application is made for construction as described in Section 903 of the IgCC, the approved agency shall perform commissioning during construction and after occupancy as required by Table 903.1 of the IgCC. Where Table 903.1 of the IgCC specifies that commissioning is to be performed on a periodic basis, the registered design professional in responsible charge shall provide a schedule of periodic commissioning with the submittal documents that shall be reviewed by the code official.

304.6 Approved agency. The approved agency shall be qualified and shall demonstrate competence to the satisfaction of the code official, for the commissioning of the particular type of construction or operation. The approved agency shall provide written documentation to the code official demonstrating competence and relevant experience or training. Experience or training shall be considered relevant where the documented experience or training is related in complexity to the same type of commissioning activities for projects of similar complexity and material qualities.

Section 305 Functional Performance Testing

305.1 Functional performance testing (FPT). A documented test of the dynamic functioning operation of equipment and systems with the goal of verifying that the project owner's requirements are met. FPT is based on scope of work and contract documents. Test procedures are developed and results documented by the commissioning agency. FPTs shall demonstrate installation and operations of each operating component and system-to-system interface in accordance with the approved design plans and the owner's project requirements. Functional testing shall include mechanical, electrical, plumbing, acoustical levels, irrigation systems and process equipment [e.g., Building Management Systems (BMS) etc.].

These components may include, but are not limited to:

1. Central plant. Chillers, cooling towers, chilled and condenser water pumps.
2. Air-handling equipment.
3. Supply and exhaust fans.
4. Variable air volume box (VAV).
5. Refrigeration systems.
6. Humidification and dehumidification.
7. Variable frequency drive (VFD).
8. Heating hot water boilers and circulating pumps.
9. Domestic hot water and circulating pumps.
10. Sewage ejectors.
11. Sump pumps.
12. Storm water pumps.
13. Water pumps.
14. Water fountains/landscape.
15. Interior and exterior lighting controls.
16. Control systems.

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17. Emergency power generator system sequence of operations and uninterruptible power systems (UPS).
 18. Air compressor, vacuum pumps and process water.

305.2 Prerequisite documentation. Prior to all functional testing, prerequisite/pre-functional verification and startup documentation will be provided by the installing contractor and/or factory-trained personnel for each piece of equipment. This information ensures the operating success of each component and proper functionality of all system operations. This information shall contain, but is not limited to:

1. Date and responsible party of installation start up.
2. Identifier information.
3. Manufacturer model and serial number.
4. Design and actual operating information, such as voltage, amperage, wattage, motor nameplate information, sheave, pulleys, belts and air filters, revolutions per minute (RPM) of motors and fans, refrigerant operating conditions, temperature splits, gas pressures, water pressures, and test and balance report.
5. Precautionary measures and methods of procedure regarding safety interaction with all personnel.

305.3 Documentation. FPT documentation shall address the step-by-step instruction sequence of each operation with interconnecting safety interlocks, temperature sensors, pressure transducers, building management system (BMS) integration, lighting controllers, irrigation timers and manually controlled operations.

Modes of operation verification will include, but are not limited to:

1. Occupied and unoccupied.
2. Emergency failure and recovery.
3. Seasonal weather conditions.
4. Temperature reset of air handler, boiler and chilled, and condenser water systems.
5. Supply and exhaust air static pressure reset.
6. Demand-controlled ventilation (DCV).
7. Renewable energy.
8. Daylight savings and holiday schedules.
9. Electrical load shedding reduction.
10. Manually programmable timers.
11. Sump water system and alarm integration.

305.4 Reports. FPT reports shall contain information addressing each of the building components tested; testing methods utilized; and include any readings and adjustments made.

The functional testing documentation shall incorporate a signature block information format containing:

1. Date.
2. Responsible party identifier.
3. Required testing instruments.
4. Measurable pass-fail of testing sequence.



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5. Expected response of operating perimeters.
 6. Results of testing that is performed.
 7. Operating condition of equipment status upon completion of each test sequence.

A deficiencies list shall be incorporated into the functional testing documentation; this list will track and clarify all failed operating sequences and components. The deficiencies list will act as a living document until all components or sequence of operation have been completed. The building department and building owner/owner's representative will require all parties to perform their duties to correct deficient items. The commissioning agent will confirm all corrected issues have been completed and resolved.

Section 306 Documentation and Training

306.1 Systems manual. Documentation of the operational aspects of the building shall be completed within the systems manual, and delivered to the building owner or representative and facilities operator. The systems manual shall include the following:

1. Site information, including facility description, history and current requirements.
2. Site contact information.
3. Basic O&M, including general-site operating procedures, basic troubleshooting, recommended maintenance requirements and site events log.
4. Major systems.
5. Site equipment inventory and maintenance notes.
6. A copy of all special inspection verifications required by the enforcing agency or locally adopted codes.
7. Other resources and documentation.
8. Intent. The systems manual documents information focusing on the operation of the building systems. This document provides information needed to understand, operate, and maintain the equipment and systems, and informs those not involved in the design and construction of the building systems. This document is in addition to the record construction drawings, documents, and the O&M manuals supplied by the contractor. The systems manual is assembled during the construction phase and is available during the contractors' training of the facility staff.
9. Compliance method. Compliance is demonstrated by providing the systems manual. The information in the systems manual includes the following information:
 - 9.1. Site information, including facility description, history and current requirements.
 - 9.1.1. Site information.
 - 9.1.1.1. Location of property, including address.
 - 9.1.1.2. Site acreage.
 - 9.1.1.3. Local utility information.
 - 9.1.1.3.1. Water service provider.
 - 9.1.1.3.2. Natural/liquefied petroleum gas (LP-gas) service provider.
 - 9.1.1.3.3. Electrical service provider.
 - 9.1.1.3.4. Telecommunications service provider.



- 9.1.1.3.5. Other service providers.
 - 9.1.2. Facility description.
 - 9.1.2.1. Use/function.
 - 9.1.2.2. Square footage (m^2).
 - 9.1.2.3. Occupancy type.
 - 9.1.2.4. Construction type.
 - 9.1.2.5. BOD.
 - 9.1.2.6. Location of major systems and equipment.
 - 9.1.3. Project history.
 - 9.1.3.1. Project requirements.
 - 9.1.3.1.1. OPR.
 - 9.1.3.1.2. BOD.
 - 9.1.3.2. Project undocumented events.
 - 9.1.3.3. Record drawings and documents.
 - 9.1.3.3.1. Final control drawings and schematics.
 - 9.1.3.3.2. Final control sequences.
 - 9.1.3.4. Construction documents, including location or delivery information.
 - 9.1.3.4.1. Architectural, civil, structural, mechanical/plumbing and electrical drawings.
 - 9.1.3.4.2. Specifications.
 - 9.1.3.4.3. Submittals.
 - 9.1.3.4.4. Project change orders and information.
 - 9.1.4. Current requirements.
 - 9.1.4.1. Building operating schedules.
 - 9.1.4.2. Space temperature, humidity and pressure, and CO_2 set points.
 - 9.1.4.3. Summer and winter setback schedules.
 - 9.1.4.4. Chilled and hot water temperatures.
 - 9.1.4.5. As-built control set points and parameters.
10. Site contact information.
- 10.1. Owner information.
 - 10.2. Emergency contacts.
 - 10.3. Design team, including architect, mechanical, engineer, electrical engineer, etc.
 - 10.4. Prime contractor contact information.
 - 10.5. Subcontractor information.
 - 10.6. Equipment supplier contact information.
11. Basic O&M, including general-site operating procedures, basic trouble shooting, recommended maintenance requirements and site events log.
- 11.1. Basic operation.



- 11.1.1. Written narratives of basic equipment operation.
- 11.1.2. Interfaces, interlocks and interaction with other equipment and systems.
- 11.1.3. Initial maintenance provided by contractor.
- 11.2. General-site operating procedures.
 - 11.2.1. Instructions for changes in major system operating schedules.
 - 11.2.2. Instructions for changes in major system holiday and weekend schedules.
- 11.3. Basic troubleshooting.
 - 11.3.1. Cite any recommended troubleshooting procedures specific to the major systems and equipment installed in the building.
 - 11.3.2. Manual operation procedures.
 - 11.3.3. Standby/backup operation procedures.
 - 11.3.4. Bypass operation procedures.
 - 11.3.5. Major system power-fail resets and restarts.
 - 11.3.6. Trend log listing.
- 11.4. Recommended maintenance events log.
 - 11.4.1. HVAC air filter replacement schedule and log.
 - 11.4.2. Building control system sensor calibration schedule and log.
 - 11.4.3. Lamp replacement for lighting fixture log.
- 11.5. O&M manuals, including location or delivery information.
- 12. Major systems.
 - 12.1. HVAC systems and controls.
 - 12.1.1. Air-conditioning equipment (chillers, cooling towers, pumps, heat exchangers, thermal energy storage tanks, etc.).
 - 12.1.2. Heating equipment (boilers, pumps, tanks, heat exchangers, etc.).
 - 12.1.3. Air distribution equipment (fans, terminal units, accessories, etc.).
 - 12.1.4. Ventilation equipment (fans, accessories and controls).
 - 12.1.5. Building automation system (workstation, servers, panels, variable frequency drives, local control devices, sensors, actuators, thermostats, etc.).
 - 12.2. Indoor lighting systems and controls.
 - 12.2.1. Lighting control panels.
 - 12.2.2. Occupancy sensors.
 - 12.2.3. Daylight harvesting systems.
 - 12.2.4. Energy management system (EMS).
 - 12.3. Renewable energy systems.
 - 12.3.1. Photovoltaic panels and inverters.
 - 12.3.2. Wind-powered electrical generators and inverters.
 - 12.4. Landscape irrigation systems.
 - 12.4.1. Water distribution diagrams.



- 12.4.2. Control system.
- 12.5. Water reuse systems.
 - 12.5.1. Reclaimed water system for indoor use.
 - 12.5.2. Reclaimed water for irrigation use.
- 13. Site equipment inventory and maintenance notes.
 - 13.1. Spare parts inventory.
 - 13.2. Frequently required parts and supplies.
 - 13.3. Special equipment required to operate or maintain systems.
 - 13.4. Special tools required to operate or maintain systems.
- 14. A copy of all special inspection verifications required by the enforcing agency of the locally adopted codes.
- 15. Other resources and documentation.
- 16. Enforcement.
 - 16.1. At his discretion, the code official confirms demonstrated compliance during on-site enforcement by:
 - 16.1.1. Receipt of a copy of the systems manual; and
 - 16.1.2. Receipt of a form signed by the owner or owner's representative attesting that the systems manual has been completed (see the sample form in Chapter 4).

306.2 Systems operations training. The training of the appropriate maintenance staff for each equipment type and/or system shall be documented in the commissioning report and shall include the following:

- 1. System/equipment overview (what it is, what it does and with what other systems and/or equipment it interfaces).
- 2. Review and demonstration of servicing/preventive maintenance.
- 3. Review of the information in the systems manual.
- 4. Review of the record drawings on the system/equipment.
- 5. Intent. The systems operation training verifies that a training program is developed to provide training to the appropriate maintenance staff for each equipment type and/or system, and that this training program is documented in the commissioning report. The systems operation training program is specified in the project specifications for the major systems listed. The systems manual, O&M documentation and record drawings are prepared and available to the maintenance staff prior to the implementation of any training or the development of a written training program. The training program is to be administered when the appropriate maintenance staff is made available to receive training.
- 6. Compliance method. The written training program includes: (a) learning goals and objectives for each session; (b) training agenda, topics and length of instruction for each session; (c) instructor information and qualifications; (d) location of training sessions (on-site, off-site, manufacturer's or vendor's facility); (e) attendance forms; (f) training materials; and (g) description on how the training will be archived for future use.



- 6.1. Systems/equipment overview.
 - 6.1.1. Review the OPR and BOD related to the major systems and equipment.
 - 6.1.2. Describe system type and configuration.
 - 6.1.3. Explain operation of all major systems and equipment, and how it interfaces with other systems and equipment.
 - 6.1.4. Describe operations of critical devices, controls and accessories.
 - 6.1.5. Review locations of the major systems and equipment.
 - 6.1.6. Describe operations of the control system for each system, location of critical control elements and procedures to operate control system properly.
 - 6.1.7. Review recommendations for implementation to reduce energy and water use.
- 6.2. Review and demonstration of servicing/preventive maintenance.
 - 6.2.1. Explain location or delivery contact of the O&M manuals.
 - 6.2.2. Review of all manufacturers' recommended maintenance activities to maintain the warranty.
 - 6.2.3. Review and demonstrate frequent maintenance activities (air filter replacement, lubrication, fan belt inspection and/or replacement, condenser water treatment, etc.), and suggested schedule.
 - 6.2.4. Review and demonstrate typical servicing procedures and techniques (electrical current, pressure and flow readings, calibration procedures, point trending, power fail restart procedures, etc.).
 - 6.2.5. Locate, observe and identify major equipment, systems, accessories and controls.
 - 6.2.6. Review emergency shutoffs and procedures.
7. Review of the information in the systems manual.
 - 7.1. Describe use of the systems manual.
 - 7.2. Review elements of the systems manual.
 - 7.3. Explain how to update and add revisions to the systems manual.
8. Review record drawings on the systems/equipment.
 - 8.1. Explain location or delivery contact of the record drawings.
 - 8.2. Review record drawings, revisions and changes to the original design drawings.
 - 8.3. Review equipment schedules and compare with actual installed systems.
9. Enforcement. At his discretion, the code official confirms demonstrated compliance during on-site enforcement by:
 - 9.1. Receipt of a copy of the written training program and completed attendance forms; and
 - 9.2. Receipt of a form signed by the owner or owner's representative attesting that the training program and delivery of training has been completed (see the sample form in Chapter 4).



Section 307 Commissioning Report

307.1 Commissioning report. A complete report of commissioning process activities undertaken through the design, construction and reporting recommendations for the post-construction phases of the building project shall be completed and provided to the owner or owner's representative.

1. Intent. The commissioning report documents the commissioning process and test results. The report includes confirmation from the commissioning agent verifying that commissioned systems meet the conditions of the OPR, BOD and contract documents. The report should identify and discuss any substitutions, compromises or variances between the final design intent, contract documents and as-built conditions.
2. Compliance method. The components of the commissioning report include the following and are defined as follows:
 - 2.1. Executive summary of process and results of commissioning program, including observations, conclusions and any outstanding items.
 - 2.2. List of system deficiencies and how they were resolved.
 - 2.2.1. Include outstanding deficiencies and plans for resolution.
 - 2.2.2. Include plans for seasonal testing scheduled for a later date.
 - 2.3. System performance test results and evaluations.
 - 2.4. Comparison of metered energy usage by fuel type (if available) to energy efficiency goals in OPR.
 - 2.4.1. Include recommendations for further monitoring of energy usage.
 - 2.4.2. Include recommendations for resolution of energy usage in excess of goals.
 - 2.5. Summary of training process completed and scheduled.
 - 2.6. Attach commissioning process documents.
 - 2.6.1. Commissioning plan.
 - 2.6.2. OPR.
 - 2.6.3. BOD.
 - 2.6.4. Executed installation checklists.
 - 2.6.5. Executed functional performance (FPT) forms.
 - 2.6.6. Trend reports.
 - 2.6.7. Record of systems operations training given to owners or representatives.
 - 2.6.8. Recommendations for end-of-warranty review activities.
3. Enforcement. At his discretion, the code official confirms demonstrated compliance by:
 - 3.1. Receipt of a copy of the commissioning report; and
 - 3.2. Receipt of a form signed by the owner or owner's representative attesting that the commissioning report has been completed (see the sample form in Chapter 4).



CHAPTER 4: COMPLIANCE TEMPLATES AND FORMS

Section 401 Owner's Project Requirements



401.1 Template. OPR are a required step of commissioning. This template is a guide for collecting the information associated with OPR. The information should be developed by the project team in collaboration with the owner.

401.2 Owner and user requirements. These are typically, already covered in the project scope, as described in the building program. They include the primary purpose, program and use of project; and may also describe future expansion needs, flexibility, quality of materials, construction and operation costs.

401.3 Environmental and sustainability goals.

1. Project shall meet the performance requirements required by the owner.
2. Other owner requirements, such as owner priorities among the *International Green Construction Code* or other areas, shall be identified.
3. Site development and land use.
 - 3.1. Existing vegetation on site is identified and the significance of preserving such vegetation is discussed.
 - 3.2. Attention to existing land features has been incorporated into the design of the building and site such that any negative impact to the environment is minimized.

401.4 Energy-efficiency goals. The project shall comply with the *International Energy Conservation Code* or achieve an increased level of efficiency, as determined by the owner.

1. Lighting systems offering cost-effective, energy-saving potential, and lighting fixtures and/or controls shall be selected to exceed the *International Energy Conservation Code*'s minimum efficiency requirements by level, as determined by the owner.
2. High-efficiency HVAC equipment offers cost-effective energy savings, and HVAC equipment shall be selected that meets or exceeds the *International Energy Conservation Code*'s minimum efficiency requirements by level, as determined by the owner.
3. Additional energy-efficiency measures that provide cost-effective energy savings shall be included wherever feasible.
4. Other owner requirements, such as orientation, siting, daylighting, cool roof, natural ventilation or landscaping, shall be identified.

401.5 Indoor environmental quality requirements.

1. Any specific nonstandard indoor lighting requirements, such as pendant-mounted lighting, illumination requirements or special applications, shall be listed.
2. Any nonstandard occupant lighting requirements, such as multiple-mode controls for assembly spaces, shall be listed.
3. Any nonstandard temperature or humidity requirements used for thermal comfort shall be listed.



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4. Any nonstandard ventilation and filtration requirements shall be listed.
 5. Any nonstandard occupancy HVAC control requirements, such as integration with existing control systems.
 6. Any nonstandard acoustic environment requirements, such as local noise sources requiring mitigation; and spaces, such as classrooms, that require low background noise and short reverberation times, shall be listed.
 7. Other owner requirements, e.g., natural ventilation, operable windows, daylight, views.

401.6 Building materials selection. Materials used to keep moisture from accumulating inside the building, such as flashing, waterproofing, subdrains, etc., shall be listed.

401.7 Equipment and systems expectations.

1. Special HVAC equipment requirements, such as equipment type, quality, reliability, efficiency, control system type, preferred manufacturers, maintenance requirements, etc., shall be listed.
2. Unacceptable HVAC system types or equipment shall be listed.
3. Special lighting equipment requirements, such as list-preferred lamp and ballast types that comply with the owner's standards, shall be listed.
4. Other system requirements:
 - 4.1. Building occupant and O&M personnel expectations.
 - 4.2. Day-to-day HVAC operation by occupants and the operating staff.
 - 4.3. Periodic HVAC maintenance performed by building occupants, the operating staff, a service company, the owner's staff or other persons.
 - 4.4. Lighting system maintenance will be performed by building occupants, the operating staff, a service company, the owner's staff or other persons.
 - 4.5. Training required for building occupants, such as demonstrations and instruction documents.
 - 4.6. Training required for operating and maintenance staff, e.g., demonstrations, classroom training and instruction documents.
 - 4.7. Other owner's requirements, such as fire suppression systems, fire alarms (FAs), waste management, elevators and escalators.



**OWNER'S PROJECT REQUIREMENTS SAMPLE COMPLIANCE FORM
(2012 IgCC)**
Incorporate This Form into the Plans

Project Address: _____ Permit Number: _____

Item#	OPR ITEMS	PAGE NUMBER IN OPR DOCUMENT
Project Program		
1	General building information (e.g., size, stories, construction type, occupancy type and number)	
2	Intended uses and schedules	
3	Future expandability and flexibility of spaces	
4	Quality and/or durability of materials and desired building lifespan	
5	Budget or operation constraints	
Environmental and Sustainability Goals		
6	Level of compliance with the IgCC	
7	Specific environmental or sustainability goals (e.g., water efficiency, water reuse, CO ₂ monitoring, xeriscaping, etc.)	
Energy Efficiency Goals		
8	Overall efficiency of building shall meet the IECC or exceed by ____ percent	
9	Lighting system efficiency shall meet the IECC or exceed by ____ percent	
10	HVAC equipment efficiency and characteristics	
11	Other measures affecting energy efficiency desired by the owner (e.g., building orientation, shading, daylighting, natural ventilation, renewable power, etc.)	
Indoor Environmental Quality Requirements		
12	Lighting	
13	Temperature and humidity	
14	Acoustics	
15	Air quality, ventilation and filtration	
16	Desired adjustability of system controls	
17	Accommodations for after-hours use	
18	Other owner requirements (e.g., natural ventilation, daylighting, views, etc.)	
Equipment and Systems Expectations		
19	Level of quality, reliability, equipment type, flexibility, maintenance and complexity desired	
20	Specific efficiency targets, desired technologies or preferred manufacturers for building systems, acoustics and vibration	
21	Degree of system integration, automation and functionality for controls (e.g., load shedding, demand response, energy management, etc.)	
Building Occupant and O&M Personnel Expectations		
22	Description of how the building will be operated and by whom	
23	Level of training and orientation required to understand, operate and use the building systems for building operation and maintenance staff, as well as occupants	
24	Building operation and maintenance staff location and capabilities	

(continued)



Commissioning Agent Information		
25	Name of Commissioning Agency:	
26	Address of Agency:	
27	Contact person(s) Name(s):	

Owner/Owner's Representative Acknowledgement

Owner's project requirements (OPR). The expectations and requirements of the building appropriate to its phase shall be documented before the design phase of the project begins. The OPR includes the elements listed in this form and have been approved by the owner or owner's representative.

Name: _____

Owner Owner's Representative

Company Name (if applicable): _____

Signature: _____ Date: _____

Section 402 Basis of Design

402.1 Template. Documentation of the BOD is a required step of the commissioning process. This template is a guide for use by the design team.

402.2 Site development and land use.

1. Natural resources and base line conditions of building site.
2. Landscape irrigation systems.
 - 2.1. Narrative description of system, including system type(s), location, control type, performance, efficiency and water savings. How the system meets any special requirements listed in the OPR document shall be described.
 - 2.2. Reasons for system selection shall include the reasons that the selected landscape irrigation systems are a better choice than the alternatives (e.g., performance, efficiency, reliability, flexibility, simplicity, expandability, cost, payback period, utility company incentives, cost, owner preferences, ease of maintenance, etc.).
 - 2.3. For landscape irrigation system calculations, describe the sizing calculation method, assumptions and results.
3. Vegetation and soil protection and restoration.
4. Storm water management and erosion control.
5. Land debris and soil reuse.
6. Site lighting.

402.3 Materials.

1. A narrative description of foundation drainage and waterproofing materials shall be provided.
2. A narrative description of flashing shall be provided.
3. A narrative description of exterior wall coverings shall be provided.
4. A narrative description of roof coverings shall be provided.

402.4 Energy.

1. Energy monitoring and reporting.



2. Mechanical systems completion. The narrative description of the system shall include: system type(s), location, control type, efficiency features, outdoor air ventilation strategy, indoor air quality features, noise reduction features, environmental benefits and other special features. How the system meets any special requirements listed in the OPR document shall be described.

2.1. Reasons for system selection shall include the reasons that the selected system is a better choice than the alternatives (e.g., comfort performance, efficiency, reliability, flexibility, simplicity, cost, owner preferences, site constraints, climate, availability of maintenance, acoustics, etc.).

2.2. Load calculations.

2.2.1. Load calculation method/software: _____.

2.2.2. Summer outdoor design conditions: ____ °F dry bulb, ____ °F wet bulb.

2.2.3. Winter outdoor design conditions: ____ °F dry bulb.

2.2.4. Indoor design conditions: ____ °F; ____ percent RH cooling; ____ °F heating.

2.2.5. Internal heat gain assumptions:

SPACE	LIGHTING LOAD	PLUG LOAD	OCCUPANT LOAD	INFILTRATION LOAD	OTHER

2.2.6. Calculated cooling loads and system size:

SYSTEM/AIR HANDLER ID	CALCULATED PEAK COOLING LOAD	SELECTED SYSTEM COOLING CAPACITY	REASONS FOR DIFFERENCE BETWEEN CALCULATED LOAD AND SELECTED SYSTEM CAPACITY

2.3. Sequence of operations. Operating schedules, set points, etc., may refer to plans and/or specifications if the sequence of operations is included there.

3. Renewable energy systems. The narrative description of the system shall include: system type(s), location, inverter type, control type, performance, efficiency, energy savings and payback period. How the system meets any special requirements listed in the OPR document shall be described.

3.1. Reasons for system selection shall include the reasons that the selected renewable energy systems are a better choice than the alternatives (e.g., performance, efficiency, reliability, flexibility, simplicity, expandability, cost, payback period, utility company incentives, space constraints, cost, owner preferences, ease of maintenance, etc.).

3.2. Renewable energy system generation calculations, including a description of the sizing calculation method, assumptions and results.

402.5 Lighting. The narrative description of the system shall include:

1. Fixture type(s).
2. Lamp and ballast type.
3. Control type.



4. Describe how the system meets any special requirements listed in the OPR document.
5. Reasons for system selection shall include the reasons that the selected lighting system is a better choice than the alternatives (e.g., visual comfort performance, efficiency, reliability, flexibility, simplicity, cost, owner preferences, color rendering, integration with daylighting, ease of maintenance, etc.).
6. Lighting design criteria shall include the following:

SPACE ID	SPACE TYPE	ILLUMINATION DESIGN TARGET (footcandle)	SOURCE OF TARGET ^a	OTHER LIGHTING DESIGN CRITERIA ^b

For SI: 1 footcandle = 10.76 lux.

a. Examples include IES standards and owner's requirements.

b. Additional criteria include CRI and CCT.

7. Lighting power design targets shall include the following:

SPACE TYPE	IECC LIGHTING POWER ALLOWANCE (watts/ft ²)	LIGHTING POWER DESIGN TARGET (watts/ft ²)

For SI: 1 watt/ft² = 10.76 Kg/s³



402.6 Water. Narrative description of system shall include the system type(s), location, control type, efficiency features, environmental benefits and other special features. How the system meets any special requirements listed in the OPR document shall be described.

1. Reasons for system selection shall include the reasons that the selected water heating system is a better choice than the alternatives (e.g., performance, efficiency, reliability, simplicity, space constraints, cost, owner preferences, ease of maintenance, utility company incentives, etc.).
2. Water heating load calculations shall describe the sizing calculation method, assumptions and results.
3. Water reuse systems shall include:
 - 3.1. Narrative description of the system, including: system type(s), location, space requirements, equipment requirements, control type, performance, efficiency, potable water savings and payback period. How the system meets any special requirements listed in the OPR document shall be described.
 - 3.2. Reasons for system selection shall include the reasons that the selected water reuse systems are a better choice than the alternatives (e.g., performance, efficiency, reliability, flexibility, simplicity, expandability, cost, payback period, utility company incentives, space constraints, cost, owner preferences, ease of maintenance, etc.).
 - 3.3. Water reuse system calculations shall describe the sizing calculation method, assumptions and results.

402.7 Indoor environmental quality. Features that will dampen mechanical and emergency generator equipment shall be described.

402.8 Other systems (not required by the IgCC). For each system to be commissioned that is not covered by the IgCC, the following shall be included: system information, rationale for selection, description of how the system meets OPR and, if applicable, design criteria. Examples of applicable systems include, but are not limited to, fire suppression systems, FAs, elevators, escalators and demolition/construction waste management.

**BASIS OF DESIGN SAMPLE COMPLIANCE FORM
(2012 IgCC)****Incorporate This Form into the Plan**

Project Address:

Permit Number:

ITEM #	BOD ITEMS	PAGE NUMBER IN BOD DOCUMENT
Site Development and Land Use		
1	An assessment of existing site conditions and narrative relating to the preservation of native soil and hydrological conditions	
2	Narrative description of the landscape irrigation systems, including reason for selection, sequence of operation and relation to the OPR	
3	Narrative description of all proposed absorption systems and percolation tests to be performed; instructions regarding the proper topsoil replacement; and a vegetation and soil protection and restoration plan addressing protected vegetation, location of VSPAs, and temporary locations for the stockpiling of soil	
4	Narrative description of the best management practices to be used on the site for proper storm water management and erosion control, including reasons for selection and relation to the OPR	
5	A listing of all species of invasive plants to be removed; and a waste management plan addressing land-clearing debris removal and recycling and soil reuse	
6	Narrative description for the site lighting system used, including reason for selection, design criteria, design targets and relation to OPR	
Materials		
7	Narrative description of the foundation drainage and waterproofing materials used	
8	Narrative description of flashing materials used	
9	Narrative description of exterior wall covering materials used	
10	Narrative description of roof-covering materials used	
Energy		
11	Narrative description of energy data acquisition and management system to be used, including sequence of operation, all energy loads to be metered, energy types applicable to the building and relation to OPR	
12	Narrative description of HVAC system, including means for system balancing, duct testing, O&M manual, reason for system selection, design criteria, sequence of operation and relation to OPR	
13	Narrative description of the renewable energy systems, including reason for system selection, sequence of operation, system generation calculations and relation to OPR	
Lighting		
14	Narrative description of indoor lighting system, including reason for system selection, sequence of operation and relation to OPR	
Water		
15	Narrative descriptions of water reuse system, including reason for system selection, sequence of operation, water reuse system calculations and relation to OPR	
Indoor Environmental Quality		
16	Narrative description of proposed sound reduction barriers used	
17	Narrative description of how HVAC background noise will be addressed	
Optional Systems (Not Required By the IgCC)		
18	Narrative description of each optional system(s), reason for system(s) selection, sequence of operation(s) and relation to OPR	

(continued)



Architect/Engineer/Designer Acknowledgement				
I hereby acknowledge the basis of design document has been completed and meets the owner's project requirements.				
	NAME	LICENSE NUMBER	SIGNATURE	DATE
Architect of Record				
HVAC Designer				
Electrical Designer				
Plumbing Designer				
Landscape Architect				
Renewable Energy System Designer				
Other (specify):				
Commissioning Agent Acknowledgement				
I have reviewed the basis of design and verified that it meets the owner's project requirements:				
Name: _____				
Company Name (if applicable): _____				
Agent's Signature: _____				Date: _____

**SAMPLE COMMISSIONING MEASURES IN CONSTRUCTION DOCUMENTS
(2012 IgCC)**

Project Address: _____ Permit Number: _____

ITEM #	COMMISSIONING MEASURES ITEMS
1	Measures shown in the specifications and cross referenced
2	List of commissioned equipment and systems
3	Cx roles and responsibilities of all parties
4	Meeting requirements
5	Commissioning schedule management procedures
6	Procedures for addressing outstanding issues or noncompliance
7	Requirements for the execution and documentation of installation and equipment start up
8	Specific testing requirements for each system type
9	Submittal review and approval requirements
10	Contents and approval process of the commissioning plan
11	Cx documentation and reporting requirements
12	Facility staff training requirements and verification procedures
13	O&M manual review and approval procedures
14	Systems manual development and approval procedures
15	Definitions

Commissioning Agent Acknowledgment

I have reviewed the construction documents listed in this form and verified their compliance with the owner's project requirements, basis of design and commissioning plan.

Name: _____

Company Name (if applicable): _____

Agent's signature: _____ Date: _____



COMMISSIONING PLAN SAMPLE COMPLIANCE FORM (2012 IgCC)

ITEM #	COMMISSIONING PLAN ITEMS	PAGE NUMBER IN COMMISSIONING PLAN DOCUMENT
General Project Information		
1	Project name, owner and location	
2	Building type and building area	
3	Overall project commissioning schedule	
4	Contact information for individual/company providing commissioning services	
Commissioning Goals		
5	Meeting the IgCC requirements for commissioning	
6	Meeting OPR and BOD requirements	
7	Carrying out requirements for commissioning activities as specified in plans and specifications	
Systems To Be Commissioned		
8	Explanation of the original design intent (refer to OPR and BOD documents)	
9	Equipment and systems to be tested, functions to be tested, conditions under which the test shall be performed and measurable criteria for acceptable performance	
Commissioning Team Information		
10	List of all team members and contact information (e.g., owner; owner's representative; architect; engineers; designated commissioning representative; and, if available, general contractor, subcontractors and construction manager)	
Commissioning Process Activities, Schedules and Responsibilities		
11	Prescribed commissioning process steps and activities to be accomplished by the CxA team throughout the design to occupancy	
12	Roles and responsibilities for each member of the CxA team for each phase of the work	
13	Required Cx deliverables, reports, forms, and verifications expected at each stage of the commissioning effort	
14	Confirmation process for the O&M manual, systems manual and the facility operator and maintenance staff training	
Owner/Owner's Representative Acknowledgement		
The commissioning plan includes the items listed in this form and have been approved by the owner or owner's representative.		
Name: _____		
<input type="checkbox"/> Owner	<input type="checkbox"/> Owner's Representative	
Company Name (if applicable): _____		
Signature: _____ Date: _____		

SAMPLE COMPLIANCE FORM FOR FUNCTIONAL TESTING (2012 IgCC)

This Form is to be Completed at the Time of Inspection

Project Address: _____ Permit Number: _____

List the functional test reports in this form for all systems to be tested

a. For example, FPT-003.

Commissioning Agent Acknowledgment

I have reviewed the test reports listed in this form and verified that they are complete; these tests have been executed with deficiencies corrected.

Name: _____

Company Name (if applicable):

Agent's signature: _____ Date: _____



MINIMUM REQUIREMENTS FOR FUNCTIONAL TESTING REPORT

Functional performance tests shall demonstrate the correct installation and operation of each component, system and system-to-system interface in accordance with the approved plans and specifications. Functional performance testing reports shall contain information addressing each of the building components tested, the testing methods utilized, and include any readings and adjustments made. Test forms have been developed for each piece of commissioned equipment and system, and include the checked elements listed below. These tests have been executed with deficiencies corrected.

	FUNCTIONAL TEST ELEMENTS	INCLUDED
1	Date and responsible party	<input type="checkbox"/>
2	Signature block—confirming test results are complete and accurate	<input type="checkbox"/>
3	Prerequisites	<input type="checkbox"/>
4	Precautions	<input type="checkbox"/>
5	Instrumentation	<input type="checkbox"/>
6	Reference to the operating source being confirmed	<input type="checkbox"/>
7	Test instructions	<input type="checkbox"/>
8	Acceptance criteria	<input type="checkbox"/>
9	Results	<input type="checkbox"/>
10	Return-to-normal sequence of operations	<input type="checkbox"/>
11	Deficiency list	<input type="checkbox"/>

CxA Signature_____ Date_____

**DOCUMENTATION AND TRAINING SAMPLE COMPLIANCE FORM
(2012 IgCC)****This Form is to be Completed at the Time of Inspection**

Project Address: _____ Permit Number: _____

Part 1: Documentation

ITEM #	SYSTEM MANUAL ELEMENTS	PAGE NUMBER IN TRAINING MANUAL DOCUMENTS
Site Information		
1	General (e.g., address, acreage, local utility information, other)	
2	Facility description [e.g., use/function; square footage (m^2); occupancy type; construction type; BOD; location of major systems and equipment]	
3	Project history (e.g., project requirements (BOD/OPR); project's undocumented events; record drawings and documents; final control drawings and schematics; final control sequences; construction documents)	
4	Current requirements [e.g., building operating schedules; space temperature; humidity; pressure; CO_2 set points; summer and winter setback schedules; chilled and hot water temperatures; as-built control set points and parameters]	
Site Contact Information		
5	Owner	
6	Emergency contacts	
7	Design team (e.g., architect, professional engineer, electrical engineer, other)	
8	Prime contractor	
9	Subcontractor	
10	Equipment supplier	
Basic O&M		
11	Basic operation (e.g., narratives of basic equipment operation; interfaces, interlocks and interaction with other equipment and systems; initial maintenance provided by the contractor)	
12	General site operating schedules (e.g., instructions for changes in major system operating schedules; instructions for changes in major system holiday and weekend schedules)	
13	Basic troubleshooting (e.g., cite-recommended troubleshooting procedures specific to major systems and equipment; manual operation procedures; standby/backup/bypass operation procedures; major system power fail resets and restarts; trend log listing)	
14	Recommended maintenance events log (e.g., HVAC air filter replacement schedule and log; building control system sensor calibration schedule and log)	
15	O&M manuals (location or delivery information)	
Major Systems		
16	HVAC systems and controls (e.g., air-conditioning equipment, heating equipment, air distribution equipment, ventilation equipment, building automation system)	
17	Indoor lighting systems and controls (e.g., lighting control panels, occupancy sensors, daylight harvesting systems)	
18	Renewable energy systems (e.g., photovoltaic panels and inverters; wind-powered electrical generators and inverters)	
19	Landscape irrigation systems (e.g., water distribution diagrams and control system)	
20	Water reuse systems (e.g., reclaimed water system for indoor use, reclaimed water for irrigation use)	

(continued)



Site Equipment Inventory and Maintenance Notes		
21	Spare parts inventory	
22	Frequently required parts and supplies	
23	Special equipment required to operate or maintain systems	
24	Special tools required to operate or maintain systems	
Special Inspections		
25	Copies of any special inspection verifications	
Other		
26	Other resources and documentation	

Part 2: Training

ITEM #	TRAINING PROGRAM ELEMENTS	PAGE NUMBER IN TRAINING DOCUMENT
1	System/equipment overview (e.g., what it is; what it does; and with what other systems and/or equipment it interfaces)	
2	Review and demonstration of servicing and preventative maintenance	
3	Review of the information in the systems manual	
4	Review of the record drawings on the system/equipment	

Owner/Owner's Representative Acknowledgement

- Documentation of the operation aspects of the building shall be completed within the systems manual and delivered to the building owner or representative and the facilities operator. The systems manual includes the elements listed in Part 1 of this form.
- When the appropriate maintenance staff is made available prior to the certificate of occupancy, the written training program will be executed to these staff. The written training program includes the elements listed in Part 2 of this form.

Name: _____

 Owner Owner's Representative

Company Name (if applicable): _____

Signature: _____ Date: _____

**COMMISSIONING REPORT SAMPLE COMPLIANCE FORM
(2012 IgCC)****This Form is to be Completed at the Time of Inspection**

Project Address: _____ Permit Number: _____

A complete report of commissioning process activities undertaken through the design, construction and reporting recommendations for the post-construction phases of the building project shall be completed and provided to the owner or owner's representative. The commissioning report includes the checked elements listed below and has been approved by the owner or owner's representative.

	COMMISSIONING REPORT ELEMENTS	INCLUDED
1	Executive summary with conclusions and outstanding issues	<input type="checkbox"/>
2	History of system deficiencies and resolution	<input type="checkbox"/>
3	Summary of system functional test results	<input type="checkbox"/>
4	Summary of training completion	<input type="checkbox"/>
5	Comparison of metered energy usage (if available) to energy efficiency goals in BOD	<input type="checkbox"/>
6	Attachments of commissioning plan, OPR, BOD, executed (filled in) installation checklists, executed functional tests, and recommendations for end-of-warranty review	<input type="checkbox"/>

Owner and Commissioning Agent Acknowledgment

The commissioning report includes the items listed in this form and is approved by the owner/owner's representative and commissioning agent.

1. Owner/Owner's Representative

The commissioning report includes the items listed in this form and has been approved by the owner or owner's representative.

Name: _____

 Owner Owner's Representative

Company Name (if applicable): _____

Signature: _____ Date: _____

2. Commissioning Agent

Name: _____

Company Name (if applicable): _____

Signature: _____ Date: _____

CHAPTER 5: REQUIRED SKILLS AND MINIMUM QUALIFICATIONS

Section 501 Site Development and Land Use

501.1 Landscape irrigation systems. Landscaping irrigation systems require the knowledge of:

1. Local (municipal) regulations pertaining to landscape irrigation.
2. Landscape irrigation design principles.
3. Landscape irrigation components.
4. Regional vegetation pertaining to minimal water requirements for sustainable growth.
5. Both potable and nonpotable water sources.
6. Basic plumbing systems.
7. Landscape design and systems.

501.2 Outdoor fountains and water features. Outdoor fountains and water features require the knowledge of:

1. Local (municipal) regulations pertaining to outdoor fountains and water features.
2. Fountain and water feature design principles.
3. Fountain and water feature components.
4. Fountain and water feature materials.
5. Nonpotable water sources.
6. Codes and standards pertaining to erosion control.
7. Principles and practice of controlling sediment, erosion and other storm water pollutants.
8. Hydrology, water quality, air quality, habitat conservation and site grading.

501.3 Movement of water. Any movement of water requires the knowledge of:

1. On-site rainfall management as it pertains to volume, duration and discharge.
2. Hydrologic soil groups.
3. Pollutants, including, but not limited to, sediments, organic compounds, nutrients, metals, bacteria, viruses, oils and grease.
4. Ground water contamination.
5. Drainage system elements, including, but not limited to, infiltration, retention and detention basins, and biofilters.
6. Drainage system design techniques, including, but not limited to, two-stage design, basin-side slopes, forebay, low-flow channels, vegetation, maintenance access, multiple use and aesthetics.

501.4 Topography and site grading. In determining topography and site grading, knowledge of the following is necessary:

1. Principles and practice of site grading; and cut and fill regulations and calculation.
2. Hydrology, water quality, air quality, habitat conservation and site grading.
3. Flood plain development.



- 
- 4. Principles of soil mechanics in the investigation, evaluation and design of civil works involving the use of earth materials.

501.5 Construction waste management. Construction waste management requires knowledge of:

- 1. Local or regional regulations pertaining to construction waste management.
- 2. Recycling and salvaging construction materials.
- 3. Materials cost pertaining to their adaptive reuse.
- 4. Hazardous construction and demolition wastes.

501.6 Heat island mitigation. Heat island mitigation requires the knowledge of:

- 1. Local, regional and municipal codes and standards pertaining to heat island mitigation.
- 2. Energy consumption trends, air pollutant emissions, greenhouse gases, water quality and human health and comfort.
- 3. Use of trees and vegetation as they pertain to heat island mitigation.
- 4. Practices and principles involved in green roof and cool roof design and construction.
- 5. Practices and principles involved in pervious and cool pavement design and construction.

501.7 Outdoor and site lighting. Knowledge of the following is required for outdoor and site lighting:

- 1. Local, regional and municipal codes and standards pertaining to outdoor and site lighting.
- 2. White light sources and the benefits thereof.
- 3. Photometrics.
- 4. Principles and practices of site lighting, up lighting, lighting trespass, glare and dark-sky friendliness.

501.8 EPA's 1995 Brownfield Program. Established to limit the liabilities to potential developers, a knowledge of the following is necessary:

- 1. Expansion or redevelopment of sites, which have been abandoned, idled or underused, that have been complicated by real or perceived environmental contamination, structure obsolescence, lack of access to capital and overall neighborhood opposition to the redevelopment of the site.
- 2. Local zoning ordinances.
- 3. Soil science.

501.9 Evaluating the CxA. The following is a list of qualifications that the code official may use in evaluating the CxA. The code official may consider one or more of the qualifications in this list:

- 1. Third-party certification acceptable to the AHJ.
- 2. State licensure or reciprocity may not be a manufacturer of components; and it may not be the installer.
- 3. Prior experience within the landscape irrigation industry.
- 4. Water feature engineer.



5. Civil engineer.
6. National Pollutant Discharge Elimination System Level 1A Certification.
7. Civil engineer experienced and knowledgeable in the practice of soil engineering (soils engineer).
8. Professional Certification: International Waste Manager – Technical status or equal.
9. Building Commissioning Certifications with experience requirements.

Section 502 Materials (Architectural Building Assembly)

502.1 Materials (architectural building assembly). A knowledge of the following is necessary:

1. IgCC 105.4.
2. The *International Building Code®* (IBC®).
3. Building assemblies, architectural detailing and structural system calculations.
4. Energy codes, ASHRAE 90.1.
5. Material safety data sheets (MSDS) and other product verification.
6. Egress requirements.

502.2 Qualifications. The following is a list of qualifications that the code official may use when evaluating the CxA. The code official may consider one or more of the qualifications in this list:

1. Licensed architect.
2. Professional engineer.
3. ICC certified inspector.
4. ICC certified CALGreen inspector.
5. Licensed contractor (third party).

Section 503 Energy

503.1 Management and monitoring systems. In the approval and enforcement of management and monitoring systems, knowledge of the following is required:

1. Energy policy.
2. Assessing the potential value of improved energy management.
3. Securing sufficient resources to implement strategic energy management.
4. Assuring accountability and commitment from core parts of the organization.
5. Identifying opportunities for improvement and ensuing implementation (including staff training).
6. Measuring, tracking, evaluating and communicating results.
7. Technical standards.
8. Indoor air quality.
9. Energy audits.



- 9.1. Inspection, survey and analysis of energy flows for energy conservation.
- 9.2. Types of energy audits.
 - 9.2.1. Benchmarking.
 - 9.2.2. Walk-through or preliminary audit.
 - 9.2.3. General audit.
 - 9.2.4. Investment-grade audit.
10. Procurement.
11. Financing.
12. Codes and standards.
13. Energy accounting and economics.
14. Instrumentation.
15. Alternative finance.
16. Building automation and control systems.
17. Electrical systems.
18. Energy procurement.
19. Green buildings, LEED and Energy Star.
20. Lighting systems.

503.2 Qualifications. The following is a list of qualifications that the code official may use in evaluating the CxA. The code official may consider one or more of the qualifications in this list:

1. Professional engineer.
2. An independent third-party commissioning certification program.

Section 504 HVAC Systems

504.1 HVAC systems. Knowledge and consideration of the following are required when evaluating HVAC systems:

1. Design and construction phase commissioning process.
2. Construction communication protocol.
3. Facility requirements.
4. Sustainability and energy requirements.
5. Facility design and construction requirements.
6. Design conditions (climatic conditions, room conditions, temperature humidity levels, and pressure requirements, etc.).
7. Design methods, techniques and software applications.
8. National, state and local building codes, standards and guidelines.
9. Schematic, design development, construction phase documents.
10. Design of mechanical, electrical and plumbing systems.
11. Electrical—Power distribution, motor control centers, power monitoring, etc.
12. Building automation systems, diagrams, points and sequences.

- 
13. Specification formats.
 14. Construction phase commissioning processes.
 15. Commissioned systems and equipment.
 16. Construction submittals.
 17. Installation requirements of mechanical, electrical and plumbing (MEP) equipment and systems.
 18. O&M requirements.
 19. Equipment manufacturer's start-up procedures.
 20. Mechanical/electrical equipment and system operation.
 21. BAS control diagrams, points, sequences and configuration.
 22. TAB process and procedures.
 23. O&M documentation.
 24. System manual components.
 25. ASHRAE Guideline 1.1- 2007 - HVAC&R *Technical Requirements for The Commissioning Process*
 26. Delivery of training.
 - 26.1. Record test data and results.
 - 26.2. Develop trending and analyze trend reports.
 - 26.3. Facilitate the FPT process.

504.2 Qualifications. The following is a list of qualifications that the code official may use in evaluating the CxA. The code official may consider one or more of the qualifications in this list:

1. Professional engineer.
2. An independent third-party commissioning certification program.

Section 505

Lighting

505.1 Lighting systems. Knowledge of the following is required for the evaluation of lighting systems:

1. Skills and abilities to verify that the systems listed are designed, installed and operate as intended.
2. IEEE standards.
3. NFPA 70.
4. Arc flash safety requirements.
5. Lockout tag-out procedures and medium-voltage power distribution equipment and controls.
6. Motors, starters and VFDs.
7. Generator systems and their associated subsystems [battery charging and starting; lubrication; fuel; ignition; cooling; prime-mover engine (Diesel/turbine); reduction gear; exciter; and generator] of UPS systems and their associated subsystems (backup generator; input/output switch gear; battery and charging).
8. Underwriters Laboratories (UL) standards for lightning protection.



505.2 Qualifications. The following is a list of qualifications that the code official may use in evaluating the CxA. The code official may consider one or more of the qualifications in this list:

1. Professional engineer.
2. Third-party certification acceptable to the AHJ.

Section 506

Water

506.1 Water systems. Knowledge, skills and abilities to verify that the systems listed are designed, installed and operate as intended is required.

506.2 Qualifications. The following is a list of qualifications that the code official may use when evaluating the CxA. The code official may consider one or more of the qualifications in this list:

1. Professional engineer.
2. Third-party certification acceptable to the AHJ.

Section 507

Indoor Environmental Quality

507.1 Indoor environmental quality. Information regarding environmental quality can be found in Section 502, Materials (Architectural Building Assembly), Section 504, HVAC Systems, and Section 505, Lighting.

Section 508

Fire Suppression Systems

508.1 Fire suppression systems. Knowledge of the following is required when evaluating fire suppression systems:

1. Pressure and flow testing.
2. NFPA 13, Installation of Sprinkler Systems.
3. NFPA 13D, Installation of Sprinkler Systems in One- and Two-family Dwellings and Manufactured Homes.
4. NFPA 13R, Installation of Sprinkler Systems in Residential Occupancies up to and including Four or Fewer Stories in Height.
5. NFPA 14, Standard for the Installation of Standpipe and Hose Systems.
6. NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection.
7. NFPA 22, Standard for Water Tanks for Private Fire Protection.
8. NFPA 24, Standard for the Installation of Private Fire Service Mains and their Appurtenances.
9. NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-based Fire Protection Systems.



508.2 Qualifications. The following is a list of qualifications that the code official may use when evaluating the CxA. The code official may consider one or more of the qualifications in this list:

1. Licensed fire sprinkler contractor.
2. Professional mechanical engineer.
3. Fire protection engineer.
4. Third-party certification acceptable to the AHJ.

Section 509 Fire Alarms

509.1 Fire alarms. Knowledge of the following is required when evaluating fire alarms:

1. NFPA 72.
2. NFPA 70.

509.2 Qualifications. The following is a list of qualifications that the code official may use in evaluating the CxA. The code official may consider one or more of the qualifications in this list:

1. Licensed fire alarm contractor.
2. Professional electrical engineer.
3. Fire protection engineer.

Section 510 Vertical Conveyance Systems

510.1 Elevators. Knowledge of the following is required for the approval of elevators:

1. ASME A17.1.
2. ASME A17.2.
3. ASME A17.3.

510.2 Qualifications. The following is a list of qualifications that the code official may use when evaluating the CxA:

1. Qualified Elevator Inspector (QEI) certification.
2. Third-party license.

510.3 Escalators. Knowledge of the following is required for the approval of escalators:

1. ASME A17.1.
2. ASME A17.2.
3. ASME A17.3.
4. Speed measurements as related to escalators.

510.4 Qualifications. The following is a list of qualifications that the code official may use when evaluating the CxA. The code official may consider one or more of the qualifications in this list:

1. QEI certification.
2. State licensing, if applicable.



Section 511

Construction and Demolition Waste Management

511.1 Construction and demolition waste management. Knowledge of the following is required for the evaluation of construction and demolition waste management systems:

1. Federal, state and local regulatory requirements for construction and demolition waste management (C&D WM).
2. Federal, state and local regulatory requirements for C&D hazardous materials WM.
3. Material recycling and salvaging process.
4. Materials cost pertaining to their adaptive use.
5. Federal, state and local requirements for health and safety awareness for C&D material handling and management jobsite process.
6. Project documents and scope of work associated with all materials cited for C&D WM.
7. Methods appropriate for project C&D WM bulk commingling, and diversion or source-site separation and diversion.
8. Project schedule and critical path of C&D WM within all scopes of project work.
9. Communication skills and knowledge of information management for project.

511.2 Qualifications. The following is a list of qualifications that the code official may use when evaluating the CxA. The code official may consider one or more of the qualifications in this list:

1. Approved and recognized training programs for Federal and State Occupational Health and Safety Administration (OSHA) Asbestos Abatement certifications and compliance.
2. Approved and recognized training programs for Federal and State OSHA Lead Abatement certifications and compliance.
3. Approved and recognized training programs for Federal and State OSHA 10 and OSHA 30 certifications.
4. Approved respiratory awareness compliant with OSHA 29 CFR, Part 1910.134.
5. Approved and recognized green construction training programs for construction and demolition waste management.



CHAPTER 6: FUNCTIONAL SYSTEMS CHECKLIST

Section 601 Systems Verification

601.1 Systems verification. The tables in Chapter 6 provide a visual list of equipment/items/components that need to be tested/verified when installed or where applicable.

Table 601
Site Development and Land Use

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Landscape Irrigation: <ul style="list-style-type: none"> • Landscape irrigation design • Static pressure verification • Point of connection • Backflow prevention • Flow meter • O&M manual 	<ul style="list-style-type: none"> • Verify the availability of required static pressure. • Backflow. • O&M manual.
Irrigation Design and Systems: <ul style="list-style-type: none"> • Irrigation controllers with weather or moisture-based capabilities • Irrigation design • Sprinkler head layout at perimeter of building 	<ul style="list-style-type: none"> • Check irrigation controllers for compliance with the plans and specifications. • Check for proper irrigation, proper water spray coverage, and appropriate overlap and spacing in accordance with the plans. • Check for correct sprinkler head emitters with appropriate head rotation to prevent over spraying onto building walls. • Verify sprinkler head per approved plans.
Outdoor Ornamental Fountains and Water Features: <ul style="list-style-type: none"> • System calibration • System performance • Testing of system or related components in-pool items • Testing of mechanical room • Erosion control systems 	<ul style="list-style-type: none"> • For outdoor ornamental fountains and water features, verify the following per plans: <ul style="list-style-type: none"> ▫ Design of water feature or fountain. ▫ Available water source. ▫ Available electrical voltage. ▫ Electrical components. ▫ Mechanical components. ▫ Plumbing components. • Verify calibration of all components, including, but not limited to, pumps, filters, chemical controllers, motors, electrical panels, pipe installation, geo-membranes, surface materials. • Verify performance of leakage tests. • Verify performance of the system as a unit. • Verify performance of all modes of operation. • Verify test of in-pool items, including, but not limited to, nozzles, suction and inlet fittings, overflows and weirs, control valves, lights, junction boxes, cord seals, and level sensors. • Verify test of mechanical room, including, but not limited to, control panel terminations, lighting panel, disconnects and ground-fault device wiring to all equipment, valve tags and flow directional arrows, piping and pressure gauges.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Site drainage:	<ul style="list-style-type: none">• Verify storm water pollution prevention plan (SWPPP), when required, is on site.• Verify drainage system is installed in accordance with site drainage plan.• Check, when required by the plans:<ul style="list-style-type: none">▫ Silt fencing.▫ Construction drive.▫ Erosion control blankets.▫ Erosion control straw logs.• Observation and documentation that all BMP pertaining to erosion control were successfully utilized.• Observation and documentation during construction that all elements of the erosion control plan are in place such that the soil on the site is contained with no chance of run-off.• Verification that collected water after a rain event will move through the site in accordance with the site drainage plan.• Verification and documentation that the drainage system components meet or exceed those specified in the site drainage plan.• Verification and observation that the O&M and systems manual, as submitted, meet the criteria and needs of the end user.
Topography and Grading (cut/fill): <ul style="list-style-type: none">• Grading plan• Soil analysis/compaction plan• Site safety plan• Tree removal/mitigation plan• Soil stabilization and erosion• Control plan• Re-vegetation plan, slope-control planting• Equipment utilization plan• Ground water and infiltration	<ul style="list-style-type: none">• Verify that soils reports are complete and in accordance with local rules and regulations.• Verify site waste reduction plan is consistent with IgCC and/or local ordinance, including tree removal.• Verify vegetation meets the re-vegetation plan.• Ensure air quality plan is part of SWPPP or soil erosion control plan.• Check to ensure site safety plan is in place.• Verify that earth-moving equipment has been maintained and repaired in accordance with the O&M manual pertaining to each piece of equipment.• Verify that all elements of site erosion control are monitored daily for deficiencies or necessary repairs.• Verify that areas of fill are compacted to a level that meets or exceeds the soil compaction plan.• Verify that sufficient soil samples representing a true cross section of the cut and fill areas, and of the material to be used as fill, have been taken and tested under the supervision of a certified soils engineer.• Verification of all field and laboratory tests of the land to be covered with fill to confirm that the characteristics of the soil, including its expansive qualities, and bearing value of the land, consolidation potential, can support the proposed fill and structures.• Verify that laboratory analysis and related data support the proposals to replace, rework or blend, or to stabilize or modify with additives.• Periodic site inspections to verify that the previously disturbed areas are maintaining their slopes and compaction rates.
Land-clearing Debris and Soil Reuse: <ul style="list-style-type: none">• Waste management communication plan• Waste inventory• Salvage• Disposal• Source-separated construction, demolition and land-clearing recycling• Waste management report	<ul style="list-style-type: none">• Verify that the materials on the site are handled as outlined in the waste management plan.• Verify that the recyclables and salvage items are packaged for removal and transported as outlined in the waste management plan.• Verify that hazardous construction materials are handled as outlined in the construction waste management plan.• Verify that the waste management goals and the waste prevention goals met the requirements of the waste management plan.• Verify that the waste inventory reconciles with all disposal manifests or weight tickets.• Verification and documentation that the waste management report correctly reflects the outcome of the waste management plan.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Heat Island Mitigation: <ul style="list-style-type: none">• Energy consumption• Air pollutant emissions• Greenhouse gases• Trees and vegetation	<ul style="list-style-type: none"> • Verify cool roof complies with thermal emittance, solar reflectance, or SRI values per the code. • Verify structural and vegetative elements of the green roof. • Verification of the water quality as it pertains to the mitigation techniques utilized in the original construction of the site. • Verify that the O&M manual meets the needs of the property owner. • Check and document the energy consumption savings as they pertain to the mitigation techniques used in the construction of the site. • Check and document the decreased air pollutant emissions and greenhouse gases produced and released as they pertain to the mitigation techniques utilized in the original construction of the site. • Verification and documentation of the water quality as it pertains to the mitigation techniques utilized in the original construction of the site.
Lighting: <ul style="list-style-type: none">• Site lighting• Security lighting• Area lighting• Landscape lighting• Sports lighting	<ul style="list-style-type: none"> • Verify exterior lighting meets light pollution plan. • Check and document that all fixtures are in compliance with the definitions as defined by the IESNA. • Check peripheral vision enhancement. • Check and document that the smallest wattage lamp source available is used to meet the desired lighting levels. • Check and document that the ratios of illuminance and luminance values are in compliance with the IESNA's <i>9th Edition Handbook Recommended Standards</i>. • Verify that all fixtures installed have been either selected from the specified product group or submitted as approved alternatives, as approved by the governing body of the local area. • Check and document that primary entry lighting, exterior emergency egress lighting, service area lighting, surface parking, parking garage and roadways are in compliance with the final lighting commissioning plan. • Verification and documentation that the O&M manual meets the goals of the owner.
Brownfield Mitigation: <ul style="list-style-type: none">• Baseline risk assessment• Corrective action plan• Remedial action plan• Remedial investigation/ feasibility study	<ul style="list-style-type: none"> • Verification and documentation that the baseline risk assessment clearly and correctly identified and evaluated the threat to human health and the environment. • Verification and documentation that the recommended cleanup criteria and alternatives for remediation are aligned with the extent of contamination on the site. • Observation, verification and documentation that the cleanup of the site is at a level determined to be health protective for its intended use.

Table 602
Materials (Architectural Building Assembly)

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
• Foundations subsoil drainage system	
• Foundation damp proofing and waterproofing	
• Flashing at: exterior doors, skylights, wall flashing and drainage systems	<ul style="list-style-type: none"> • Verify compliance with approved plans, specifications and construction documents.
• Exterior wall coverings	
Optional systems (not in the IgCC):	
• Moisture envelopes	<ul style="list-style-type: none"> • Meet OPR, BOD, Cx specifications.
• Exterior below-grade walls	<ul style="list-style-type: none"> • Check for proper drainage system at exterior wall perimeter to keep water from entering the building.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
<ul style="list-style-type: none"> • External floor and soffits, slab-on-grade 	<ul style="list-style-type: none"> • Check for thermal resistance or insulation when required. • Check the IECC, when applicable. • Slabs: Check drainage for moisture penetration.
<ul style="list-style-type: none"> • Exterior walls 	<ul style="list-style-type: none"> • Check drawings for wall assembly requirements and any sound transmission class (STC) requirements in accordance with ASTM E 90 and ASTM E 413. • Check for compliance with Section 1403.2 of the 2009 <i>International Building Code</i> (IBC).
<ul style="list-style-type: none"> • Exterior glazed window fenestration: windows, glazed doors and skylights 	<p>Drawing reviews and contractor submittal reviews:</p> <ul style="list-style-type: none"> • Check that fenestration products are labeled with a <i>U</i>-factor (see NFRC 100) and a solar heat gain coefficient (SHGC) (see NFRC 200), and certification for the air infiltration requirement of 0.3 cfm/ft² of the 2010 <i>California Energy Code</i> (CEC) or other approved standards. • Check for proper flashing and caulking at walls and roof assemblies. <p>Glazed doors:</p> <ul style="list-style-type: none"> • Check for proper flashing, and seals and gaskets; and proper pull force, if provided with a closer. • Check for proper door swing. • Check for STC requirements, if applicable.
<ul style="list-style-type: none"> • Site-built fenestration: curtain walls and store-front systems, and atrium roof systems 	<ul style="list-style-type: none"> • Check for a label certificate issued by the National Fenestration Rating Council (NFRC) or a label certificate issued by the glazing fabricator that meets the default <i>U</i>-factor of the 2008 CEC and SHGC; or an NFRC component modeling approach (CMA) label certificate or another approved standard. • Check for proper door swing. • Check for STC requirements, if applicable.
<ul style="list-style-type: none"> • Field-fabricated fenestrations: fenestration made at the site, not preformed or cut 	<ul style="list-style-type: none"> • Check for compliance with the default <i>U</i>-factor and the default SHGC in accordance with the tables of the 2008 CEC or another approved standard.
<ul style="list-style-type: none"> • Exterior doors 	<ul style="list-style-type: none"> • Check for proper flashing installation at header, walls and floor. • Check for <i>U</i>-factor requirements for swinging and nonswinging doors. • Check for appropriate manufacturer's referenced standard [American Architectural Manufacturer's Association (AAMA); Canadian Standards Association (CSA); and Window and Door Manufacturer's Association (WDMA) or other approved standard] product data sheets.
<ul style="list-style-type: none"> • Sealants, control joints and flashing (stationary and moveable) 	<ul style="list-style-type: none"> • Check for proper installation in accordance with the manufacturer's written instructions. • Check for proper flashing installation.
<ul style="list-style-type: none"> • Shading devices (stationary and moveable) 	<ul style="list-style-type: none"> • Check for proper anchoring to building with proper flashing at wall connections. • At mechanical devices: check for proper installation and controls.
<ul style="list-style-type: none"> • Structural systems 	<ul style="list-style-type: none"> • Check for proper anchoring in accordance with construction documents, including metal connectors and beam supports.
<ul style="list-style-type: none"> • Materials and finishes 	<ul style="list-style-type: none"> • Check for compliance with allowed volatile organic compound limits and proper manufacturer's installation application. • Review product data sheets.

For SI: 1 cubic foot per minute per square foot = 0.00508 m³/(s · m²).

Other Project Requirements (not required by the IgCC)

<ul style="list-style-type: none"> • Structural systems 	<ul style="list-style-type: none"> • Check for proper anchoring in accordance with the construction documents, including metal connectors and beam supports.
<ul style="list-style-type: none"> • Structural requirements for mechanical systems and renewable energy systems 	<ul style="list-style-type: none"> • Prefunctional checklists, site observations and construction testing.



Table 603
Energy

Management and Monitoring Systems

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
<ul style="list-style-type: none"> • Workstation graphic displays • Public display systems • Central processing/monitoring hardware and software • Network communications/alarm functions • User interface with emergency medical services • Monitoring functions required for facility operations • Local control panels and individual monitoring points 	
Integrated Automation Instrumentation for HVAC Systems: <ul style="list-style-type: none"> • Actuators and operators • Sensors and transmitters • Control valves • Control dampers • Flow meters 	<p>Verify the following is consistent with the commissioning plan:</p> <ul style="list-style-type: none"> • Systems design. • System specifications. • System submittals. • System installations. • System prestartup inspection checklist. • System functional performance testing. • Systems training.
Integrated Automation Instrumentation for Plumbing Systems: <ul style="list-style-type: none"> • Domestic water metering • Grey water metering • Fuel system (gas, oil) metering 	<ul style="list-style-type: none"> ▫ Device Point to Point checkout (Static Testing). ▫ Device Point to Point checkout (Dynamic Testing). ▫ Sensor calibration. ▫ Valve and damper stroke setup and check. ▫ Coil valve leak check. ▫ Isolation valve or system valve leak check.
Integrated Automation Instrumentation and Terminal Devices for Electrical Systems: <ul style="list-style-type: none"> • Power meters • Kilowatt (kW) transducers • Current sensors • Battery monitors • Lighting relays • UPS monitors 	
Integrated Automation of Renewable Energy Systems: <ul style="list-style-type: none"> • Solar photovoltaic • Wind generation • Geothermal 	
<ul style="list-style-type: none"> • Building management systems 	<ul style="list-style-type: none"> • Confirm installation complies with the contract documents
<ul style="list-style-type: none"> • Electrical systems 	
<ul style="list-style-type: none"> • Lighting systems 	
<ul style="list-style-type: none"> • Alternative power systems 	
<ul style="list-style-type: none"> • On-site renewable energy 	<ul style="list-style-type: none"> • Confirm installation complies with the contract documents
<ul style="list-style-type: none"> • Whole-building energy analysis 	
<ul style="list-style-type: none"> • Controllability of lighting systems 	
<ul style="list-style-type: none"> • Controllability of thermal systems 	



Table 604
HVAC Systems

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Instrumentation and Control for HVAC: <ul style="list-style-type: none">• Actuators and operators• Sensors and transmitters• Control valves• Control dampers• Direct-digital control system	(tasks included on previous page)
Unitary HVAC Equipment: <ul style="list-style-type: none">• Packaged terminal air conditioners• Room air conditioners• Self-contained air conditioners• Computer room air conditioners• Split-system air conditioners• Air-source unitary heat pumps• Water-source unitary heat pumps	<ul style="list-style-type: none">• Verify air system balancing.• Verify hydronic system balancing.• Verify duct system testing.• Verify that mechanical system manuals and construction documents required by the O&M manual are submitted.• Verify functional performance testing of HVAC equipment and associated controls and control systems.
Humidity Control Equipment: <ul style="list-style-type: none">• Humidifiers• Heated-pan humidifiers• Wetted-element humidifiers• Atomizing humidifiers• Direct-steam-injection humidifiers• Jacketed, steam humidifiers• Self-contained steam humidifiers• Portable humidifiers, mechanical dehumidification units• Outdoor, mechanical dehumidification units• Indoor, mechanical dehumidification units• Portable dehumidifiers• Desiccant dehumidification units	<ul style="list-style-type: none">• Verify acceptance of HVAC systems and equipment/system verification report.• Verify that preparation and distribution of final HVAC system is complete and in accordance with the contract documents.• Confirm construction documents, required drawings, manuals, balancing reports and commissioning report are provided.<ul style="list-style-type: none">▫ Confirm they are provided to the owner.• Verify air-handling system access.• Verify air-handling system filters.• Verify temperature and humidity in occupied spaces.• Verify specific indoor air quality and pollutant control measures.• Verify listing, installation and venting of fireplaces and combustion appliances.• Verify that mechanical and emergency generator equipment is located outside building or located where exposed to the exterior environment.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Convection Heating and Cooling Units: <ul style="list-style-type: none"> • Chilled beams • Air coils • Fan coil units • Unit ventilators • Induction units • Radiators convectors • Finned-tube radiation heaters • Unit heaters • Cabinet unit heaters • Propeller unit heaters • Wall and ceiling unit heaters • Water-to-water heat pumps 	<ul style="list-style-type: none"> • Verify air system balancing. • Verify hydronic system balancing. • Verify mechanical system manuals construction documents required by the O&M and systems manual are submitted. • Verify functional performance testing of HVAC equipment and associated controls and control systems. • Verify acceptance of HVAC systems and equipment/system verification report.
Humidity Control Equipment: <ul style="list-style-type: none"> • Humidifiers • Heated-pan humidifiers • Wetted-element humidifiers • Atomizing humidifiers • Direct-steam-injection humidifiers • Jacketed, steam humidifiers • Self-contained steam humidifiers • Portable humidifiers • Mechanical dehumidification units • Outdoor, mechanical dehumidification units • Indoor, mechanical dehumidification units • Portable dehumidifiers • Desiccant dehumidification units 	<ul style="list-style-type: none"> • Verify that preparation and distribution of final HVAC system is complete and in accordance with the contract documents. • Confirm construction documents, required drawings, manuals, balancing reports and commissioning report are provided. <ul style="list-style-type: none"> ▫ Confirm they are provided to the owner. • Verify air-handling system access. • Verify air-handling system filters. • Verify temperature and humidity in occupied spaces. • Verify specific indoor air quality and pollutant control measures. • Verify listing, installation and venting of fireplaces and combustion appliances. • Verify that mechanical and emergency generator equipment is located outside of the building or located where exposed to the exterior environment.
Radiant Heating Units: <ul style="list-style-type: none"> • Radiant-heating electric cables • Radiant-heating electric mats • Radiant-heating hydronic piping • Radiant-heating electric panels • Gas-fired radiant heaters • Electric radiant heaters 	



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
<p>Central Heating Equipment—Breechings, Chimneys and Stacks:</p> <ul style="list-style-type: none">• Draft control devices• Draft-induction fans• Vent dampers• Barometric dampers• Fabricated breechings and accessories• Fabricated stacks• Gas vents• Insulated sectional chimneys• Flue-gas filtration equipment• Gaseous filtration• Particulate filtration	<ul style="list-style-type: none">• Verify air system balancing and a means for providing the system balancing.• Verify hydronic system balancing and a means for providing the system balancing.• Verify duct system testing.• Verify that mechanical system manuals and construction documents required by the O&M manual are submitted.• Verify functional performance testing of HVAC equipment and associated controls and control systems.• Verify acceptance of HVAC systems and equipment/system verification report.• Verify that preparation and distribution of final HVAC system is complete and in accordance with the contract documents.• Confirm construction documents, required drawings, manuals, balancing reports and commissioning report are provided.<ul style="list-style-type: none">▫ Confirm they are provided to the owner.• Verify air-handling system access.• Verify air-handling system filters.• Verify temperature and humidity in occupied spaces.• Verify specific indoor air quality and pollutant control measures.• Verify listing, installation and venting of fireplaces and combustion appliances.• Verify that mechanical and emergency generator equipment is located outside of the building or located where exposed to the exterior environment.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Fuel-fired Heaters: <ul style="list-style-type: none"> • Fuel-fired duct heaters • Oil-fired duct heaters • Gas-fired duct heaters • Gas-fired radiant heaters • Fuel-fired unit heaters • Oil-fired unit heaters • Gas-fired unit heaters 	
Furnaces: <ul style="list-style-type: none"> • Electric-resistance furnaces • Fuel-fired furnaces • Gas-fired furnaces • Oil-fired furnaces 	
Heat Exchangers for HVAC: <ul style="list-style-type: none"> • Steam-to-steam heat exchangers, steam-to-water heat exchangers • Liquid-to-liquid heat exchangers • Plate-type, liquid-to-liquid heat exchangers • Shell-type, liquid-to-liquid heat exchangers • Direct-geoexchange heat exchangers 	<ul style="list-style-type: none"> • Verify air system balancing and a means for providing the system balancing. • Verify hydronic system balancing and a means for providing the system balancing. • Verify duct system testing. • Verify that mechanical system manuals and construction documents required by the O&M manual are submitted. • Verify functional performance testing of HVAC equipment and associated controls and control systems. • Verify acceptance of HVAC systems and equipment/system verification report.
Heating Boiler Feedwater Equipment: <ul style="list-style-type: none"> • Boiler feedwater pumps • De-aerators 	<ul style="list-style-type: none"> • Verify that preparation and distribution of final HVAC system is complete and in accordance with the contract documents. • Confirm construction documents, required drawings, manuals, balancing reports and commissioning report are provided.
Heating Boilers: <ul style="list-style-type: none"> • Electric boilers • Condensing boilers • Stainless-steel condensing boilers • Aluminum condensing boilers • Low-mass boilers • Pulse combustion boilers • Cast-iron boilers • Water-tube boilers • Finned water-tube boilers • Steel water-tube boilers • Copper water-tube boilers • Fire-tube boilers • Scotch marine boilers • Steel fire-tube boilers • Boiler blowdown systems 	<ul style="list-style-type: none"> ▫ Confirm they are provided to the owner. • Verify air-handling system access. • Verify air-handling system filters. • Verify temperature and humidity in occupied spaces. • Verify specific indoor air quality and pollutant control measures. • Verify listing, installation and venting of fireplaces and combustion appliances. • Verify that mechanical and emergency generator equipment is located outside of the building or located where exposed to the exterior environment.
Solar Energy Heating Equipment: <ul style="list-style-type: none"> • Heating solar collectors • Heating solar flat-plate collectors • Heating solar concentrating collectors • Heating solar vacuum-tube collectors • Packaged solar heating equipment 	



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Central Cooling Equipment: <ul style="list-style-type: none">• Refrigerant compressors• Centrifugal refrigerant compressors• Noncondensable, gas-purge equipment• Reciprocating refrigerant compressors• Scroll refrigerant compressors• Rotary-screw refrigerant compressors• Compressor and condenser units, packaged air/water-cooled refrigerant compressor and condenser units	<ul style="list-style-type: none">• Verify air system balancing and a means for providing the system balancing.• Verify hydronic system balancing and a means for providing the system balancing.• Verify duct system testing.• Verify that mechanical system manuals and construction documents required by the O&M manual are submitted.• Verify functional performance testing of HVAC equipment and associated controls and control systems.
Cooling Towers: <ul style="list-style-type: none">• Forced-draft cooling towers• Open-circuit, forced-draft cooling towers• Closed-circuit, forced-draft cooling towers• Natural-draft cooling towers• Liquid coolers	<ul style="list-style-type: none">• Verify acceptance of HVAC systems and equipment/system verification report.• Verify that preparation and distribution of final HVAC system is complete and in accordance with the contract documents.• Confirm construction documents, required drawings, manuals, balancing reports and commissioning report are provided.<ul style="list-style-type: none">▫ Confirm they are provided to the owner.• Verify air-handling system access.
Packaged Water Chillers: <ul style="list-style-type: none">• Absorption water chillers• Direct-fired absorption water chillers• Indirect-fired absorption water chillers• Centrifugal water chillers• Air-cooled centrifugal water chillers• Water-cooled centrifugal water chillers reciprocating water chillers• Scroll water chillers• Rotary-screw water chillers	<ul style="list-style-type: none">• Verify air-handling system filters.• Verify temperature and humidity in occupied spaces.• Verify specific indoor air quality and pollutant control measures.• Verify listing, installation and venting of fireplaces and combustion appliances.• Verify that mechanical and emergency generator equipment is located outside of the building or located where exposed to the exterior environment.
Thermal Storage: <ul style="list-style-type: none">• Chilled-water thermal storage• Ice thermal storage• Ice-slurry thermal storage	<ul style="list-style-type: none">• Verify air system balancing and a means for providing the system balancing.• Verify hydronic system balancing and a means for providing the system balancing.• Verify duct system testing.• Verify that mechanical system manuals and construction documents required by the O&M manual are submitted.• Verify functional performance testing of HVAC equipment and associated controls and control systems.• Verify acceptance of HVAC systems and equipment/system verification report.• Verify that preparation and distribution of final HVAC system is complete and in accordance with the contract documents.• Confirm construction documents, required drawings, manuals, balancing reports and commissioning report are provided.<ul style="list-style-type: none">▫ Confirm they are provided to the owner.• Verify air-handling system access.• Verify air-handling system filters.• Verify temperature and humidity in occupied spaces.• Verify specific indoor air quality and pollutant control measures.• Verify listing, installation and venting of fireplaces and combustion appliances.• Verify that mechanical and emergency generator equipment is located outside of the building or located where exposed to the exterior environment.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Air Outlets and Inlets: <ul style="list-style-type: none"> • Diffusers, registers and grilles • HVAC gravity ventilators • HVAC gravity dome ventilators • HVAC gravity-louvered penthouse ventilators • HVAC gravity upblast ventilators 	<ul style="list-style-type: none"> • Verify air system balancing. • Verify hydronic system balancing. • Verify duct system testing.
Air Terminal Units: <ul style="list-style-type: none"> • Constant-air-volume units • VAV units 	<ul style="list-style-type: none"> • Verify that mechanical system manuals and construction documents required by the O&M manual are submitted. • Verify functional performance testing of HVAC equipment and associated controls and control systems.
Electronic Air Cleaners: <ul style="list-style-type: none"> • Washable electronic air cleaners • Self-contained electronic air cleaners 	<ul style="list-style-type: none"> • Verify acceptance of HVAC systems and equipment/system verification report. • Verify that preparation and distribution of final HVAC system is complete and in accordance with the contract documents. • Confirm construction documents, required drawings, manuals, balancing reports and commissioning report are provided.
Gas-phase Air Filtration: <ul style="list-style-type: none"> • Activated-carbon air filtration • Chemically impregnated adsorption air filtration • Catalytic-adsorption air filtration 	<ul style="list-style-type: none"> ▫ Confirm they are provided to the owner. • Verify air-handling system access. • Verify air-handling system filters. • Verify temperature and humidity in occupied spaces.
HVAC Air Cleaning Devices—Particulate Air Filtration: <ul style="list-style-type: none"> • Panel air filters • Renewable-media air filters • Washable air filters • Extended surface filters • High-efficiency particulate filtration 	<ul style="list-style-type: none"> • Verify specific indoor air quality and pollutant control measures. • Verify listing, installation and venting of fireplaces and combustion appliances. • Verify that mechanical and emergency generator equipment is located outside of the building or located where exposed to the exterior environment.
HVAC Air Distribution: <ul style="list-style-type: none"> • Dampers • Volume-control dampers • Fire dampers • Smoke-control dampers • Backdraft dampers • Duct silencers • Turning vanes • Duct- access doors • HVAC fans • Axial HVAC fans • Centrifugal HVAC fans. • HVAC power ventilators • Air curtains 	
Special Exhaust Systems: <ul style="list-style-type: none"> • Dust-collection systems • Sawdust collection systems • Engine exhaust systems • Positive-pressure engine exhaust systems • Mechanical engine exhaust systems 	<p>(Included in above tasks/comments)</p> <ul style="list-style-type: none"> • Verify compliance with local codes
Ventilation Hoods: <ul style="list-style-type: none"> • Commercial kitchen hoods • Listed commercial kitchen hoods • Standard commercial kitchen hoods • Fume hoods 	



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
HVAC Piping and Pumps; Hydronic Piping and Pumps: <ul style="list-style-type: none">• Hydronic piping• Underground hydronic piping• Above-ground hydronic piping• Ground-loop heat-pump piping• Hydronic piping specialties• Hydronic pumps• In-line centrifugal hydronic pumps• Base-mounted, centrifugal hydronic pumps• Vertical-mounted, double-suction centrifugal hydronic pumps• Vertical-turbine hydronic pump, automatic	
HVAC Water Treatment: <ul style="list-style-type: none">• Water treatment for closed-loop hydronic systems• Water treatment for open hydronic systems• Water treatment for steam system feedwater	<ul style="list-style-type: none">• Installed in compliance with contract documents.• Flushing and cleaning plan submitted and approved.• System properly flushed and cleaned and temporary piping removed.• Piping pressure tested according to contract document.• Isolation valves provided at all branches and main takeoffs as required by the contract documents.• Valves installed in the proper direction.
Internal-combustion Engine Piping: <ul style="list-style-type: none">• Internal-combustion engine remote-radiator coolant piping• Internal-combustion engine exhaust piping	<ul style="list-style-type: none">• Valves that require a positive shutoff are verified to not leak when closed at normal operating pressure.• Valves tagged and valve schedule submitted and displayed per contract documents.• Temperature, pressure and flow gages and sensors installed.• Piping gages, BAS and associated panel temperature and pressure readouts match.
Refrigerant Piping: <ul style="list-style-type: none">• Refrigerant piping valves• Refrigerant piping specialties• Refrigerant safety relief valve discharge piping• Refrigerants	
Steam and Condensate Piping and Pumps: <ul style="list-style-type: none">• Steam and condensate pump units• Steam and condensate heating piping• Steam and condensate heating piping specialties• Steam condensate pumps• Electric-driven steam condensate pumps• Pressure-powered steam condensate pumps	

Table 605
Lighting and Electrical

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Lighting and Electrical: <ul style="list-style-type: none"> • Automatic demand-reduction control system functionality • Plug load controls • Connection of appliances to switched receptacles • Verification of transformer nameplate efficiency • Lamps (lighting installations) • Ballasts (lighting installations) 	<ul style="list-style-type: none"> • Devices installed per manufacturer's instructions and specifications.
<ul style="list-style-type: none"> • Lighting control systems (low voltage) 	<ul style="list-style-type: none"> • Verify a representative sample of zones for sweep warning effectiveness, override capability and zone size. • Test accuracy of schedule, sweep warning system and sweep override switches.
<ul style="list-style-type: none"> • Automatic daylight harvesting 	<ul style="list-style-type: none"> • Verify photosensors are properly placed and aimed. • Verify daylight control zones correspond to available daylight. • Calibrate dimming set points without the presence of daylighting. • Calibrate dimming gain in presence of daylighting. • Calibrate switching deadbands and set points. • Performance test a representative sample of daylight zones.
<ul style="list-style-type: none"> • Occupancy and vacancy sensors 	<ul style="list-style-type: none"> • Calibrate sensitivity sensor and time delay adjustment. • Performance test a representative sample of control zones, including entry tests, hand-motion tests and perimeter tests.

Optional Items (not required by the IgCC)

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Medium-voltage: <ul style="list-style-type: none"> • Substations • Switches • Circuit breakers • Switchgear • Switchboards • Panel boards • Emergency systems 	<ul style="list-style-type: none"> • Verify coordination study is complete, and that breaker and relay settings are set in accordance with the study. • Witnessing of factory tests, as appropriate. • Ensure all necessary representatives are present (e.g., installer, factory representative, etc.). • Review start-up checklist. • Test transformers. • Test protective devices. • Test control circuits, e.g., potential transformers and current transformers. • Test switchgear, e.g., electrical and mechanical operations. • Test circuit breakers. • Local operational tests. • Remote operational tests, if applicable. • Verify training of operating personnel for O&M of equipment.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Low-voltage: <ul style="list-style-type: none">• Substations• Disconnects• Circuit breakers• Motor control centers• Panel boards• Emergency systems	<ul style="list-style-type: none">• Verify coordination study is complete, and that breaker and relay settings are set in accordance with the study.• Witnessing of factory tests, as appropriate.• Ensure all necessary representatives are present (e.g., installer, factory representative, etc.).• Review start-up checklist.• Test transformers.• Test protective devices, e.g., potential transformers and current transformers.• Test control circuits.• Test switchgear, e.g., electrical and mechanical operations.• Test circuit breakers.• Local operational tests.• Remote operational tests, if applicable.• Verify training of operating personnel for O&M of equipment.
<ul style="list-style-type: none">• Motors, motor starters and drives (VFD)	<ul style="list-style-type: none">• Witnessing of factory tests, as appropriate.• Ensure all necessary representatives are present (e.g., installer, factory representative, etc.).• Review start-up checklist.• Verify motor and starter data match specification and each other.• Inspect the installation.• Take voltage and current reading; compare with nameplate and manufacturer's specifications.• Test for proper motor rotation; if VFD, verify proper motor rotation when in VFD bypass mode.• Local operational tests.• Remote operational tests, if applicable.• Verify training of operating personnel for O&M of equipment.• Monitor operations.
<ul style="list-style-type: none">• Emergency generators and distribution systems	<ul style="list-style-type: none">• Verify coordination study is complete, and that breaker and relay settings are set in accordance with the study.• Witnessing of factory tests, as appropriate.• Ensure all necessary representatives are present (e.g., installer, factory representative, etc.).• Review start-up checklist and factory commissioning plan.• Inspect the installation.• Follow factory commissioning plan.• Local operational tests.• Remote operational tests, if applicable.• Load and duration tests (increasing loads over increasing durations).• Verify training of operating personnel for O&M of equipment.• Monitor operation.
<ul style="list-style-type: none">• UPS	<ul style="list-style-type: none">• Witnessing of factory tests, as appropriate.• Ensure all necessary representatives are present (e.g., installer, factory representative, etc.).• Review start-up checklist and factory commissioning plan.• Inspect the installation.• Follow factory commissioning plans (transfer testing, to generator, to bypass, to maintenance bypass, etc.).• Verify training of operating personnel for O&M of equipment.• Monitor operation.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
<ul style="list-style-type: none"> • Grounding equipment and building grounding systems 	<ul style="list-style-type: none"> • See IEEE 81. • Ensure all necessary representatives are present (e.g., installer, factory representative, etc.). • Inspect the installation. • Verify training of operating personnel for O&M of equipment.
<ul style="list-style-type: none"> • Lightning protection equipment and systems 	<ul style="list-style-type: none"> • Ensure all necessary representatives are present (e.g., installer, factory representative, etc.). • Inspect the installation. • Ensure installer is listed by UL, and that a master label application is submitted to UL for the installation. • Ensure owner signs the master label application. • Ensure receipt of master label from the installer. • Place master label on the protected structure, as requested. • Take voltage and current reading; compare with nameplate and manufacturer's specifications. • Test for proper motor rotation; if VFD, verify proper motor rotation when in VFD bypass mode. • Verify training of operating personnel for O&M of equipment. • Monitor operation.

**Other Electrical Systems (Communications—
Including Telecom, Intercom, Public Address, Television, Video, etc.)**

Optional items (not required by the IgCC).

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
<p>Medium-voltage:</p> <ul style="list-style-type: none"> • Transformers • Substations • Switches • Circuit breakers • Switchgear • Switchboards • Panel boards • Emergency systems 	<ul style="list-style-type: none"> • Verify coordination study is complete, and that breaker, fuse and relay settings are set in accordance with the study. • Witnessing of factory tests, as appropriate. • Ensure all necessary representatives are present (e.g., installer, factory representative, etc.). • Review start-up checklist. • Test transformers. • Test protective devices. • Test control circuits, e.g., potential transformers and current transformers. • Test switchgear, e.g., electrical and mechanical operation. • Test circuit breakers. • Local operational tests. • Remote operational tests, if applicable. • Test all mechanical connections using an infrared camera after initial energizing and after the system is loaded. • Verify training of operating personnel for O&M of equipment.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Low-voltage: <ul style="list-style-type: none">• Transformers• Substations• Disconnects• Bus duct• Circuit breakers (air circuit breakers not molded case circuit breakers)• Motor control centers• Panel boards• Emergency systems	<ul style="list-style-type: none">• Verify coordination study is complete, and that breaker, fuse and relay settings are set in accordance with the study.• Witnessing of factory tests, as appropriate.• Ensure all necessary representatives are present (e.g., installer, factory representative, etc.).• Review start-up checklist.• Test transformers.• Test protective devices, e.g., potential transformers and current transformers.• Test control circuits.• Test switchgear, e.g., electrical and mechanical operation.• Test circuit breakers.• Local operational tests.• Remote operational tests, if applicable.• Test all mechanical connections using an infrared camera after initial energizing and after the system is loaded.• Verify training of operating personnel for O&M of equipment.
<ul style="list-style-type: none">• Motors, motor starters and drives (VFD)	<ul style="list-style-type: none">• Witnessing of factory tests, as appropriate.• Ensure all necessary representatives are present, e.g., installer, factory representative, etc.• Review start-up checklist.• Verify motor and starter data match specification and each other.• Inspect the installation.• Take voltage and current reading, compare with nameplate and manufacturer's specifications.• Test for proper motor rotation; if VFD, verify proper motor rotation when in VFD bypass mode.• Local operational tests.• Remote operational tests, if applicable.• Verify training of operating personnel for O&M of equipment.• Monitor operation.
<ul style="list-style-type: none">• Emergency generators and distribution systems	<ul style="list-style-type: none">• Verify coordination study is complete, and that breaker, fuse and relay settings are set in accordance with the study.• Witnessing of factory tests, as appropriate.• Ensure all necessary representatives are present (e.g., installer, factory representative, etc.).• Review start-up checklist and factory commissioning plan.• Inspect the installation.• Follow factory commissioning plan.• Local operational tests.• Remote operational tests, if applicable.• Test all mechanical connections using an infrared camera after initial energizing and after the system is loaded.• Load and duration tests (increasing loads over increasing durations).• Verify training of operating personnel for O&M of equipment.• Monitor operation.
<ul style="list-style-type: none">• UPS	<ul style="list-style-type: none">• Witnessing of factory tests, as appropriate.• Ensure all necessary representatives are present (e.g., installer, factory representative, etc.).• Review start-up checklist and factory commissioning plan.• Inspect the installation.• Follow factory commissioning plans (transfer testing to generator, to bypass, to maintenance bypass, etc.).• Test all mechanical connections using an infrared camera after initial energizing and after the system is loaded.• Verify training of operating personnel for O&M of equipment.• Monitor operation.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
<ul style="list-style-type: none"> • Grounding equipment and building grounding systems 	<ul style="list-style-type: none"> • Ensure all necessary representatives are present (e.g., installer, factory representative, etc.). • Inspect the installation. • Verify training of operating personnel for O&M of equipment.
<ul style="list-style-type: none"> • Lightning protection equipment and systems 	<ul style="list-style-type: none"> • Ensure all necessary representatives are present (e.g., installer, factory representative, etc.). • Inspect the installation. • Ensure installer is listed by UL and that a master label application is submitted to UL for the installation. • Ensure building owner signs the master label application. • Ensure receipt of master label from the installer. • Place master label on the protected structure, as requested. • Take voltage and current reading, compare with nameplate and manufacturer's specifications. • Test for proper motor rotation; if VFD, verify proper motor rotation when in VFD bypass mode. • Verify training of operating personnel for O&M of equipment. • Monitor operation.

Table 606
Water

Plumbing Systems (Water Distribution, Sanitary/Storm Water, Rainwater, Gray Water, etc.)

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Facility Water Distribution Piping: <ul style="list-style-type: none"> • Domestic water piping • Domestic water piping specialties • Domestic water pumps • Domestic water-packaged booster pumps 	<ul style="list-style-type: none"> • Installed in compliance with contract document. • Flushing and cleaning plan submitted and approved. • Piping pressure tested according to contract document.
Facility potable-water-storage tanks	<ul style="list-style-type: none"> • Installed in compliance with contract document.
Facility Sanitary Sewerage: <ul style="list-style-type: none"> • Sanitary waste piping specialties • Sanitary drains • Fats, oils and grease disposal systems • Grease removal devices • Backwater valves • Air admittance valves • Sanitary waste interceptors and separators • Sanitary sewerage pumps • Wet pit-mounted, vertical sewerage pumps • Submersible sewerage pumps • Sewerage pump basins and pits • Facility septic tanks • Facility gray water tanks 	<ul style="list-style-type: none"> • Installed in compliance with contract document. • Flushing and cleaning plan submitted and approved. • System properly flushed and cleaned and temporary piping removed. • Piping pressure tested according to contract document. • Valves installed in the proper direction. • Valves that require a positive shutoff are verified to not leak when closed at normal operating pressure. • Valves tagged and valve schedule submitted and displayed per contract documents.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Facility Storm Drainage: <ul style="list-style-type: none">• Facility storm drainage piping• Sump pump discharge piping• Sump pumps• Submersible sump pumps• Sump-pump basins and pits• Packaged, pedestal drainage pump units• Packaged, submersible, drainage pump units• Rainwater storage tanks	<ul style="list-style-type: none">• Installed in compliance with contract documents.• Flushing and cleaning plan submitted and approved.• System properly flushed and cleaned and temporary piping removed.• Piping pressure tested according to contract documents.• Valves installed in the proper direction.• Valves that require a positive shutoff are verified to not leak when closed at normal operating pressure.• Valves tagged and valve schedule submitted and displayed per contract documents.• Check electrical connections.
General service compressed-air systems	<ul style="list-style-type: none">• Verify installation in compliance with contract document
Domestic Water Heat Exchangers: <ul style="list-style-type: none">• Instantaneous domestic water heat exchangers• Heating fluid-in-coil, instantaneous domestic water heat exchangers• Domestic water-in-coil, instantaneous domestic water heat exchangers• Heating fluid, instantaneous domestic water heat exchangers• Circulating, domestic water heat exchangers• Circulating, compact domestic water heat exchangers• Circulating, storage domestic water heat exchangers• Noncirculating, domestic water heat exchangers• Noncirculating, storage domestic water heat exchangers• Domestic water brazed-plate heat exchangers• Domestic water frame-and-plate heat exchangers• Domestic water heat reclaimers	<ul style="list-style-type: none">• Comply with manufacturer's recommended checkout and startup procedures.• Manufacturer's recommended spare parts are provided.• Equipment label permanently affixed.• Pumps in place and properly supported.• Pressure/temperature relief valves installed per contract documents.• Shaft seal is leak free.• Insulation installed per contract documents.• All electrical connections are tight.• Grounding installed and operational.• Safeties installed and operational.• Control system interlocks connected and functional.• Pump rotates in correct direction.• Temperature and pressure gages and sensors installed per contract documents.
Domestic Water Softeners; Domestic Water Filtration Equipment; Electric Domestic Water Heaters: <ul style="list-style-type: none">• Instantaneous electric domestic water heaters• Flow-control, instantaneous electric domestic water heaters• Thermostat-control, instantaneous electric domestic water heaters• Electric domestic water heaters• Small-capacity electric domestic water heaters.• Residential, storage electric domestic water heaters• Collector-to-tank, solar-electric domestic water heaters• Collector-to-tank, heat-exchanger-coil, solar-electric domestic water heaters• Light-commercial electric domestic water heaters• Commercial domestic water electric booster heaters• Commercial domestic water electric booster heaters• Commercial storage electric domestic water heaters	<ul style="list-style-type: none">• Comply with manufacturer's recommended checkout and startup procedures.• Manufacturer's recommended spare parts are provided.• Equipment label permanently affixed.• Pumps in place and properly supported.• Pressure/temperature relief valves installed per contract documents.• Shaft seal is leak free.• Insulation installed per contract documents.• All electrical connections are tight.• Grounding installed and operational.• Safeties installed and operational.• Control system interlocks connected and functional.• Pump rotates in correct direction.• Temperature and pressure gages and sensors installed per contract documents.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Fuel-fired Domestic Water Heaters: <ul style="list-style-type: none"> • Instantaneous, tankless, gas domestic water heaters • Residential gas domestic water heaters • Residential, atmospheric, gas domestic water heaters • Residential, direct-vent, gas domestic water heaters • Residential, power-vent, gas domestic water heaters • Commercial gas domestic water heaters • Commercial, atmospheric, gas domestic water heaters • Commercial, power-burner, gas domestic water heaters • Commercial, power-vent, gas domestic water heaters • Commercial, high-efficiency, gas domestic water heaters • Commercial, coil-type, finned-tube, gas domestic water heaters • Commercial, grid-type, finned-tube, gas domestic water heaters • Oil-fired domestic water heaters • Large-capacity, oil-fired domestic water heaters • Dual fuel-fired domestic water heaters 	<ul style="list-style-type: none"> • Comply with manufacturer's recommended checkout and startup procedures. • Manufacturer's recommended spare parts are provided. • Equipment label permanently affixed. • Pumps in place and properly supported. • Pressure/temperature relief valves installed per contract documents. • Shaft seal is leak free • Insulation installed per contract documents. • All electrical and fuel connections are tight. • Grounding installed and operational. • Safeties installed and operational. • Control system interlocks connected and functional. • Pump rotates in correct direction. • Temperature and pressure gages and sensors installed per contract documents.
Commercial Plumbing Fixtures: <ul style="list-style-type: none"> • Commercial water closets, urinals and bidets • Commercial water closets • Commercial urinals • Commercial lavatories and sinks • Commercial lavatories • Commercial sinks • Commercial bathtubs • Commercial showers • Commercial disposers • Wash fountains • Commercial faucets, supplies and trim • Flushometers 	<ul style="list-style-type: none"> • Installation is per manufacturer's instructions. • Pipe fittings complete and properly supported. • Faucet/flush handles secure and properly aligned. • Associated trim and accessories consistent with contract documents. • Joints between fixtures, walls and floors and counters sealed. • Insulation installed per contract documents. • Fixtures consistent with ADA. • Water pressure meets contract documents. • Hot water temperature meets contract documents. • Automatic flush valves and sensors verified for proper operation and sensitivity adjustment.
Emergency Plumbing Fixtures: <ul style="list-style-type: none"> • Emergency showers • Eyewash equipment • Self-contained eyewash equipment 	<ul style="list-style-type: none"> • Installation is per manufacturer's instructions. • Water pressure meets contract documents. • Hot water temperature meets contract documents.
Drinking Fountains and Water Coolers: <ul style="list-style-type: none"> • Drinking fountains • Pressure water coolers • Water-station water coolers • Remote water coolers 	<ul style="list-style-type: none"> • Installation is per manufacturer's instructions. • Water pressure meets contract documents. • Water temperature meets contract documents.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Fountain Plumbing Systems: <ul style="list-style-type: none"> • Fountain piping • Fountain pumps • Fountain water treatment equipment • Fountain equipment controls 	<ul style="list-style-type: none"> • Comply with manufacturer's recommended checkout and startup procedures. • Manufacturer's recommended spare parts are provided. • Equipment label permanently affixed. • Pumps in place and properly supported. • Pressure / temperature relief valves installed per contract documents.
Swimming Pool Plumbing Systems: <ul style="list-style-type: none"> • Swimming pool pumps • Swimming pool water treatment equipment • Swimming pool equipment controls 	<ul style="list-style-type: none"> • Shaft seal is leak free. • Insulation installed per contract documents. • All electrical connections are tight. • Grounding installed and operational. • Safeties installed and operational. • Control system interlocks connected and functional. • Pump rotates in correct direction.

Table 607
Indoor Environmental Quality

IEQ Requires	TASKS/COMMENTS
<ul style="list-style-type: none"> • For IEQ requirements for individual systems see the following sections: <ul style="list-style-type: none"> ▫ See Table 603, Energy, and Table 604, HVAC Systems. 	—
<ul style="list-style-type: none"> • Optional systems (not required by the IgCC). <ul style="list-style-type: none"> ▫ See Table 602, Materials (Architectural Building Assembly). 	—

Table 608
Fire Suppression Systems

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
General:	<ul style="list-style-type: none"> • Person must be familiar with the administrative code.
<ul style="list-style-type: none"> • Building permit and building inspection record on site 	<ul style="list-style-type: none"> • Verify type of system to be installed.
<ul style="list-style-type: none"> • Approved fire sprinkler plans, hydraulic calculations and architectural plans shall be on site 	<ul style="list-style-type: none"> • Commissioning agent shall be proficient in all applicable codes. See NFPA 13, NFPA 13D, NFPA 13R, NFPA 14, NFPA 20, NFPA 22, NFPA 24 and NFPA 25.
<ul style="list-style-type: none"> • All materials and equipment 	<ul style="list-style-type: none"> • Verify all materials and equipment used are listed and approved.
Overhead piping:	
<ul style="list-style-type: none"> • All piping 	<ul style="list-style-type: none"> • Witness hydrostatic test for all piping systems.
<ul style="list-style-type: none"> • Pipe sizing 	<ul style="list-style-type: none"> • Verify pipe sizes are in accordance with the approved plans.
<ul style="list-style-type: none"> • Sprinklers 	<ul style="list-style-type: none"> • Verify sprinkler spacing and positions are in accordance with the approved plans, listing and locally adopted codes.
<ul style="list-style-type: none"> • Hangers 	<ul style="list-style-type: none"> • Verify spacing is in accordance with the approved plans and listing.
<ul style="list-style-type: none"> • Seismic bracing 	<ul style="list-style-type: none"> • Verify spacing is in accordance with the approved plans and listing.
<ul style="list-style-type: none"> • Branch line supports 	<ul style="list-style-type: none"> • Verify spacing is in accordance with the approved plans.
<ul style="list-style-type: none"> • Flow switches 	<ul style="list-style-type: none"> • Verify location, listing and operation.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
• Inspector's test connection	• Witness operation and verify annunciation of alarm in required time.
• Sprinkler control valves and tamper switches	• Witness operation and verify annunciation of alarm in required time.
• Sprinkler fire alarm control panel indication	• Witness operation and verify annunciation of alarm in required time.
• Drainage for riser drain and inspector's test	• Verify drain pipe size.
Underground Piping:	
• Underground pipe	• Witness hydrostatic test for all piping.
• Pipe size	• Verify pipe size installed in accordance with the approved plans.
• Depth of cover	• Verify pipe is installed to proper depth.
• Piping restrain	• Verify pipe is restrained properly.
• Fire department inlet connection	• Verify fire department connection (FDC) piping is properly sized.
• Back flush fire department inlet connections	• Witness flushing.
• Pipe flushing	• Witness flushing.
• Protection for mechanical damage	• Verify pipe is protected properly from mechanical damage.
Standpipe Systems:	
• Underground piping	• Witness hydrostatic test.
• Pipe sizing	• Verify pipe size installed in accordance with the approved plans.
• Hangers	• Verify hangers are installed in accordance with the approved plan and listing, and locally adopted codes.
• Seismic bracing	• Verify braces are installed in accordance with the approved plan and listing, and locally adopted codes.
• Standpipe	• Verify standpipe outlets are installed in accordance with locally adopted codes.
• Isolation valves and access	• Verify standpipe outlets are installed in accordance with locally adopted codes.
• Flush and flow test	• Witness test meets flow requirements in accordance with locally adopted codes.
• Hose connection and pressure rating	• Check for listing, damage, leakage, missing caps and obstructions.
Fire Pump Systems:	
• Certified curve for the fire pump	• Obtain certified curve from pump manufacturer.
• Fire pump identification number	• Compare approved plans and curve to pump nameplate.
• Pump room: floor drain, ventilation and rating	• Verify drainage, ventilation and rating of room is adequate inspection by others.
• Pipe hangers	• Verify hanger location in accordance with the approved plan and installed in accordance with locally adopted codes.
• Seismic bracing	• Verify braces in accordance with the approved plan and locally adopted codes.
• Test header outlets	• Verify location pipe size in accordance with the approved plan and installed in accordance with locally adopted codes.
• Relief valves	• Verify size and location in accordance with the approved plans and installed in accordance with locally adopted codes.
• Jockey pump	• Verify suction and discharge is installed in correct locations in accordance with locally adopted codes.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
• Controller and pressure-sensing piping	• Verify installation in accordance with locally adopted codes.
Water Storage Tank:	See NFPA 22.
• Water in tank	• Check water level and water condition.
• Water level alarms	• Verify high- and low-level alarms.
• Water level indicators	• Verify location, accuracy and freedom of movement.
• Drain valve	• Verify flow.
• Tank vent	• Verify size in accordance with the approved plan and vent screen.
• Tank overflow	• Verify size in accordance with the approved plan.
• Supervised alarms	• Verify connection to a constantly attended location.
• Tank exterior	• Inspect damage exterior paint, foundation or supporting structure, catwalk or ladders.
• Area around the tank	• Free of combustible storage, trash, debris or other materials that could present a fire exposure hazard.
• Expansion joints	• Verify listing and check for cracks.
Preaction Automatic Sprinkler Systems:	
• Control valves (locked or supervised)	• Verify listing. • Verify position.
• Water flow alarm devices	• Operate to verify initiation and receipt of alarm. • Verify alarm test valve alignment and tamper switch.
• Preaction valve and trim	• Inspect exterior of valves, gauges and trim alignment. • Verify valve pressure and legibility of hydraulic nameplate.
• Main drain	Conduct main drain test to verify supply (valve position).
• FDC	• Verify accessibility and condition. • Check for obstructions, and missing or removed caps.
Deluge Sprinkler Systems:	
• Control valves (locked or supervised)	• Verify listing. • Verify position (open/close).
• Water flow alarms devices	• Operate to verify initiation and receipt of alarm. • Verify alarm test valve alignment and tamper switch.
• FDC	• Inspect exterior of valves, gauges and trim alignment. • Verify valve pressure and legibility of hydraulic nameplate.
• Main drain	Conduct main drain test to verify supply (valve position).
• FDC	• Verify accessibility and condition. • Check for obstructions, and missing or removed caps.
Dry Pipe Automatic Sprinkler Systems:	
• Control valves	• Verify listing. • Verify position (open/close).
• Water flow alarm devices	• Verify listing. • Operate to verify initiation and receipt of alarm. • Verify alarm test valve alignment and tamper switch.
• Dry pipe alarm valve and trim	• Verify listing. • Visually inspect exterior of valves, gauges and trim alignment. • Verify valve pressure and legibility of hydraulic nameplate.
• Main drain	• Conduct main drain test to verify supply (valve position).
• FDC	• Verify accessibility and condition. • Check for obstructions, and missing or removed caps.



Table 609
Fire Alarms

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
• Approved plans on site	
• Pretest sheet completed	• Make sure forms are completed by installation contractors and field inspectors.
• Permanent power to fire alarm (FA) system	• Verify permanent power is provided to FA and accessory systems.
• Test booklet/list of devices on site	• Verify FA device list is prepared, accurate and categorized by type of device and by floor.
• Approved sequence of operations posted	• Verify the sequence of operation is accurate and posted adjacent to FA panel.
• Operating instructions posted for FA system	
• Label all FA panels with the electrical circuit number	• Verify the presence of labels.
• Lock-ons all FA electrical circuits	• Verify that circuits serving FA system have lock devices.
• Date all batteries in FA system	• Verify all batteries have installation dates.
• Approval of panel layout in fire control room	• Verify that layout accurately depicts location of life safety systems.
• Inspect construction of fire control room	• Fire control room shall have the correct fire rating.
• Access keys	• Obtain keys for building access; fire control room and FA panels/manual pull stations for key box. A lock box shall be provided at building entrance and at fire control room with required access keys.
• Approval of matrix annunciation	• Verify the annunciation panel matches the approved plans.
• Test operation of remote annunciators, if provided	• Verify that annunciation is synchronized with (matches) activated devices.
• Fire alarm control panel (FACP) to monitor connection to matrix/remote annunciators	• Verify electrical supervision of circuits to remote annunciation.
• FACP clear and trouble free prior to start of testing	• System shall be free of device and supervisory troubles.
• FACP to monitor ground faults/power supply-battery troubles	• Verify that ground-fault power supply/battery troubles/notification circuits annunciate as trouble signals to FACP.
• FACP to monitor troubles on initiating and notification circuits	
• FACP to monitor fire pump, water storage tank levels, fuel, emergency generator, smoke control panel switch status's supervisory signals	• Verify that FACP indicates trouble on non-normal status of these systems.
• FACP to monitor elevator heat shunt trip breaker as supervisory signal	• Verify proper operation to match approved fire department plans.
• Primary and alternate floor elevator recall programming to be tested	• Verify proper operation to match approved fire department plans.
• Central station signaling system (CSSS) to be tested	• Verify signals from FACP are properly sent by CSSS to monitor company and verify that the monitor company has correct jurisdictional contact.
• 24-hour battery test	• To be performed (5 or 15 minutes). Perform voltage check after discharge test.
• Voice evacuation, where required	• Test all zones, elevators and stairwells to make sure they operate as indicated on the voice evacuation panel.
• Voice evacuation/notification zones shall match each other and be tested	• Verify proper operation.
• Fire-fighter communication system	• Shall be tested [sound powered, amplified, bi-directional antenna (BDA), etc.]. Test handsets and input jacks.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
• Handsets	• Verify proper number of handsets is provided for fire-fighter communication system.
• Initiating devices	• All initiating devices to be tested to verify programming and sequence of operations. All initiating devices to be installed in accordance with NFPA 72.
• Subsequent alarm/sequence of operation	• Subsequent alarm/sequence of operation programming to be tested. Sequence of operations to be verified include: FACP programming, annunciation on matrix annunciator, signal sent to CSSS, smoke control activation, activation of notification devices, magnetic door holder release, activation of smoke/fire dampers, HVAC shutdown, audio-visual shunt, elevator recall, release of door locks in the path of egress, release of stairwell door locks, restoration of egress lighting in assembly occupancies.
• Duct detectors	• Remote light-emitting diodes (LED's) for duct detectors to be tested.
• Elevator lobby door locks	• Elevator lobby door locking systems to be tested.
• Flow devices and tampers	• Test all water flow devices and tampers. Verify the correct signal to the FACP.
• Special extinguishing systems, e.g., pre-action and deluge systems	• Test interaction/connection of special extinguishing systems to FACP.
• Inspect signage on FA panels, doors to rooms with FA panels inside	• Ensure signage is in accordance with the approved plans.
• Notification devices	• Inspect correct locations in accordance with the approved plans. Notification device candela ratings to be inspected. Audibility and intelligibility levels to be tested for notification devices.
• Mass notification systems	• Shall be tested for proper operation.

Table 610
Elevators

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
• Building permit and building inspection record on site	
• Approved elevator plans shall be on site	• Verify documents.
• All materials and equipment shall be listed/approved	
• Elevator speed	• Verify contract speed.
• Stopping zones	• Verify zones with the manufacturer's testing procedures and specifications.
• Door open speed	• Measure door open speed time.
• Short hold open	• Verify door operation in accordance with the manufacturer's specifications.
• Interrupted ray hold	• Verify operation of door reopening device.
• Nudging hold open	• Verify operation.
• Stall pressure	• Measure door torque.
• Long hold open	• Measure door-open time in accordance with the manufacturer's specifications.
• Lanterns call notification	• Verify operation of hall lantern functions [in accordance with the Americans with Disabilities Act (ADA)].
• Acceleration	• Verify car acceleration specification with the manufacturer.
• Quality of stop	• Subject to the manufacturer's specifications.



RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
• Door operation (how smooth)	• Subjective to the manufacturer's specifications.
• Door-open buttons	• Verify operation of door-open buttons.
• Alarm buttons	• Verify operation of alarm buttons.
• Emergency light	• Verify operation of emergency lighting.
• Fire service, Phase 1	
• Fire service, Phase 2 <ul style="list-style-type: none"> ▫ Standby power ▫ Telephone ▫ Intercom 	• Verify operation.
• Car lighting guarded/mounted	• Car interior lighting in accordance with locally adopted codes and the manufacturer's specifications.
• False call cancel	• If provided, verify operation.
• Seismic operators	
• Door restriction	• Verify operation.

Table 611
Escalators

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
General:	
• Building permit and building inspection record on site	
• Approved escalator plans shall be on site	• Verify documents.
• All materials and equipment shall be listed/approved	
External Evaluation:	
• Handrail	• Inspect condition, tracking and clearances.
• Handrail entry devices	• Inspect operation of safety devices.
• Combplate condition/contrast	• Inspect in accordance with the manufacturer's specifications.
• Indexing of steps/alignment in comb teeth	• Inspect in accordance with the manufacturer's specifications.
• Floor plates and landing plates	• Tripping hazards, lighting, mounted in accordance with the manufacturer's specifications.
• Deck	• Mounted, anti-slide, gaps and edge hazards in accordance with the specifications.
• Balustrade panels	• Mounted in accordance with the manufacturer's specifications.
• Skirt panels	• Check with locally adopted codes for compliance with the performance index and the manufacturer's specifications.
• Skirt brushes	
• Emergency stop switches and audible alarms	• Inspect operation of safety devices.
• Start switches/direction reversal	• Inspect markings and operation of safety device.
• Combplate lighting	• Meet illumination requirements.
• Understep demarcation lighting	• Verify operation of the demarcation (minimum two green lights).
• General lighting requirements	• Verify minimum illumination levels [5 footcandles (53.82 lux)].
• Steps	• Check tread clearances.
• Ride quality	• Verify compliance with the manufacturer's specifications.



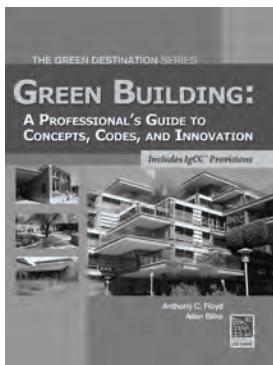
RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
• Newel ends	• Check for entry guards and operations.
• Deck barricades	• Install in accordance with locally adopted codes: low-deck escalators.
• Ceiling guards at intersections	• Verify proper installation.
• Caution signage	• Verify location and verbiage.
Testing:	
• Measured speed steps	• Verify speed of steps within the manufacturer's specifications.
• Handrails	• Verify speed of handrail.
• Stop-slide directions, both directions if possible—load/no load	• Verify for consistency with the manufacturer's specifications.
• Stop-chain length—10 steps nose-to-nose	• In accordance with the manufacturer's specifications.
• Handrail—speed monitoring devices	• Inspect operation of safety devices in accordance with locally adopted codes.
• Skirt-to-step clearance	• Verify minimum and maximum required clearances.
Internal Evaluations:	
• Skirt switches	• Inspect operation of safety devices.
• Track pressure switches	
• Machine—lubrication, gears, bearings and couplings	• In accordance with the manufacturer's specifications.
• Machine area stop switches	• Inspect operation of safety devices in accordance with locally adopted codes.
• Brakes	• In accordance with locally adopted codes and the manufacturer's specifications.
• Machine break torque	• Measure break torque.
• Handrail chain-tensioning systems	• Check tensioning devices.
• Handrail chain lubrication	• Check automatic lube in accordance with the manufacturer's specifications.
• Step chain lubrication	
• Broken drive—chain devices	• Check operation of safety devices.
• Step rollers	• Check that it meets the manufacturer's specifications.
• Step upthrust devices	• Inspect operation of safety devices.
• Pit light	• Verify operation and location.
• Pit receptacle	
• Missing step devices	• Inspect operation of safety devices.
• Pit stop switches	• Inspect operation of safety devices.
• Step guard	• Verify position and materials.
• Broken step-chain devices (step-chain tension carriage switches)	• Inspect operation of safety devices.
• Step level devices	
• Comb-step impact devices	
• Access cover switches	
• Step lateral displacement devices	

Table 612
Construction and Demolition Waste Management

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
<ul style="list-style-type: none"> • C&D waste diversion goals • Integrated waste management plan within all scopes of project work • C&D WM project team coordinator • C&D WM field worker requirements • Project staging and coordination issues • Establish types of materials to be diverted, salvaged and or recycled • Identify known and potential hazardous materials on project • Material consumption during project development and design • Material consumption and waste during all project phases and scopes of work • Desired method of C&D WM • Verification documents and information management process reporting • C&D WM schedule of events within project critical path 	<ul style="list-style-type: none"> • External verification documentation and reporting. • Internal information management process reporting and records. • Monitor and evaluate progress and coordinate adjustments, as necessary. • Coordinate progress and events; and communicate through proper documentation, meetings and other communications. • Verification that the integrated waste management plan on site is communicated and documented to a qualified and approved waste hauler. • Verification for the proper handling of hazardous C&D materials on site, and that they are transferred to an approved waste hauler for hazardous C&D materials removed from the project site. • Verification that project material consumption goals are being met. • Verification that recycled and salvaged material intended for project reuse, meets all material design requirements, codes, standards and project documents. • Verification of material cost savings and diversion goals, as they relate to recycled and salvaged materials. • Verification and amount of source site separation and diversion, for each material identified. • Verification and amount of bulk commingling and diversion, for all materials with an estimate for each type of material used on project. • Verification that workers are approved and meet all necessary federal, state and local regulatory requirements for handling hazardous materials. • Verification of project closeout; all documentation required for the project is complete, up-to-date, and reported as required by the AHJ and contract documents.



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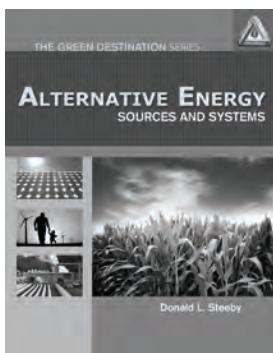
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