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Commissioning and Integrated System Testing Handbook

2012 Edition

Edited by

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With the complete text of the 2012 edition of NFPA® 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*

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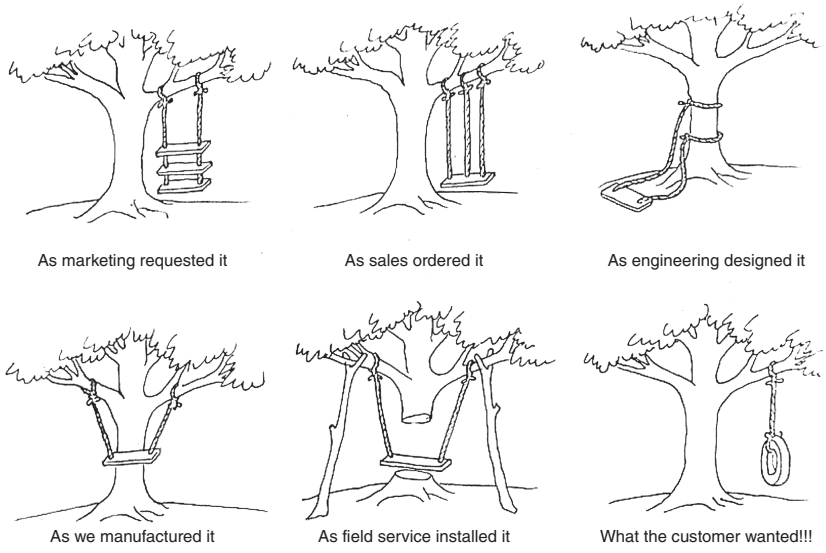
Preface

If you asked 100 people what the term *commissioning* means, you would most likely get 100 different answers. If you had asked the 46 principal and alternate members of the National Fire Protection Association (NFPA) Technical Committee on Commissioning Fire Protection Systems at their first technical committee meeting what commissioning means, you *certainly* would have gotten 46 different answers. The various interpretations of what commissioning means are analogous to a cartoon that is well-known to members of the design and construction industry, *The Tree Swing*. This cartoon shown below illustrates how a simple concept such as the construction of a child's tree swing can be viewed differently by many people in the same industry. These various interpretations can lead to wasted money, wasted time, and unhappy customers.



(Source: Retrieved from http://www.businessballs.com/treeswing.htm, March 2012. Precise origins unknown.)

Commissioning is no different. Depending on the industry, and more specifically, the role an individual plays in that industry, the concept of commissioning can vary greatly. Many people associate commissioning with a series of tests that must be conducted prior to the use of a system. Some people believe that commissioning is a ceremony or unveiling of a building, system, vehicle, or structure. Others believe commissioning is associated only with placing naval vessels into active service. No matter whom you ask, you will most likely hear a different explanation.

The building design and construction industry, including the National Institute of Building Sciences (NIBS), has gone to great lengths to define the concept of total building commissioning. In 2007, NIBS formally requested that NFPA establish a new technical committee to address commissioning of fire protection and life safety systems. The NFPA Standards Council sought

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input from various existing technical committees, as well as the general public, and in late 2007 established the Technical Committee on Commissioning Fire Protection Systems. The technical committee met and quickly realized that the scope of the committee needed to be expanded beyond commissioning to address testing of integrated fire protection and life safety systems. The committee name was changed to Technical Committee on Commissioning of Fire Protection Systems with the responsibility of developing a document to address these items.

One of the goals of the technical committee assigned to the task of developing NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems,* was to get the fire protection and life safety industry on the same page, in terms of what commissioning means to them. The starting point was identifying the purpose of commissioning a building, system, or series of systems within a building, to ensure that fire protection and life safety systems perform in conformity with the design intent. The depth and breadth of the process ensuring that end result developed over several years of committee meetings and document drafts, culminating in the document discussed in this handbook.

The process outlined in NFPA 3 addresses the administrative and procedural concepts of fire protection and life safety system commissioning and provides direction on conducting tests on integrated systems. It is also designed to identify the commissioning team members, their qualifications, and their roles and responsibilities. This recommended practice addresses the concept of commissioning from the incipient stages of a project through the occupancy and operation of the facility.

There are several key documents identified in the recommended practice, such as the owner's project requirements (OPR) and the basis of design (BOD), which provide direction to the commissioning team members as they execute the commissioning plan. These documents, which are generated during the design phase, are implemented during construction. One of the major milestones discussed in the commissioning (Cx) process is testing of integrated fire protection systems. These tests are a means of confirming that the systems function as intended.

The recommendations of NFPA 3 also apply to the commissioning of existing buildings through the concepts of retro-commissioning (RCx) and re-commissioning (Re-Cx). For existing buildings that have never been commissioned, an RCx plan is developed and executed to establish a benchmark for the facility. Existing buildings that have been previously commissioned are periodically re-commissioned and compared to the compliance benchmarks established in the original commissioning plan. NFPA 3 contains many forms that are available to assist in project documentation and the implementation of the commissioning program.

This first edition of the Commissioning and Integrated System Testing Handbook provides the full text of NFPA 3 and offers expert commentary to expand on the concepts covered in NFPA 3. This handbook was developed to explain the reasoning behind why the committee made specific recommendations and to discuss the intent of the committee to ensure that the user fully understands the recommendations in NFPA 3. Part I of this handbook provides the NFPA 3 text and commentary, and Part II provides a detailed sample Cx plan with explanation throughout. As an added bonus for the reader, this handbook provides an overview of the Cx process on a handy reference card, which is included in the inside cover of this book. Exclusive additional material is also available to the reader online at www.nfpa.org/3handbook.

Thanks to all of the hard work and dedication of the technical committee that developed NFPA 3, there is now a detailed process for commissioning fire protection systems, which starts at the pre-design phase and continues through occupancy. (This might just work for tree swings too.)

Matthew J. Klaus

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Acknowledgments

The development of this handbook mirrored the development of NFPA 3 in so many ways, it is almost unimaginable. The format changed, the players changed, we "slipped cycle," and we managed to put together a document that provides an extraordinary amount of information about a process upon which we have only just begun to scratch the surface. I would like to thank the members of the Technical Committee on Commissioning Fire Protection Systems for their participation in and dedication to the process that generated a great document, which was the foundation for this handbook. Special thanks to TC Chair Maurice Pillette and TC Secretary Kimberly Gruner for going the extra mile during development of the recommended practice.

To the contributors of this handbook, who pull double-duty as technical committee members — Cecil Bilbo, Jr., Doug Fisher, and Dave Hague — I want to offer a special thanks for putting in extra time away from your families and your day jobs to help make this first edition as thorough as I had hoped it would be.

Producing this handbook has taken a tremendous amount of effort on the part of a number of people on the NFPA staff as well — specifically, Debra Rose and Khela Thorne — who, in addition to being experts in their respective fields, are now qualified fire commissioning agents (FCxAs) after spending hundreds of hours dredging the depths of the commissioning world. Also a special thanks to NFPA's greatest cross-functional team: Kirsten Barron, Lynne Grant, Tim Menard, Jeanne Moreau, Ryan Quinn, Dan Whiting, and Patrick Woomer for their continued support in my efforts to "explore the studio space."

Last, but certainly not least, I would like to thank my family. Thank you to my wife, Lisa, for her patience, understanding, and support over the last decade as my work has dragged me all around the world. To my children, Olivia, Mackenzie, Riley, and Elena, whose artwork, although not quite ready for this handbook, proudly adorns my office walls and reminds me why I do what I do for a living.

Matthew J. Klaus

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NFPA 3 with Commentary

PART I

Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems

Part I of this handbook includes the complete text and figures of the 2012 edition of NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems.* The text, tables, and figures from the recommended practice are printed in black and are the official recommendations of NFPA 3. Line drawings and photographs from the recommended practice are labeled as "Figures."

An asterisk (*) following a recommended practice paragraph number indicates that advisory annex material pertaining to that paragraph appears in Annex A. Paragraphs that begin with the letter *A* are extracted from Annex A of the recommended practice. Although printed in black ink, this nonmandatory material is purely explanatory in nature. For ease of use, this handbook places Annex A material immediately after the recommended practice paragraph to which it refers.

In addition to text and annexes from the recommended practice, Part I includes explanatory commentary that provides the history and other background information for specific paragraphs in the recommended practice. This insightful commentary takes the reader behind the scenes, into the reasons underlying the recommended practice.

Commentary text, captions, and tables are printed in green, to clearly identify the commentary material. Line drawings in the commentary are labeled as "Exhibits" so that the reader can easily distinguish between art from NFPA 3 and art from the commentary.

Frequently Asked Questions (FAQs) are included in this handbook. The FAQs are based on the most commonly asked questions of the NFPA 3 staff. This handbook also includes the following features to help guide the readers:

- Critical Point – highlights important information that appears in the commentary
- Case in Point – explains some of the commentary in more detail
- Myth versus Fact – discusses some of the common misconceptions in commissioning
- Terms-at-a-Glance – lists important acronyms that are helpful for the reader to know

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Administration

CHAPTER 1

Commissioning of fire protection and life safety systems is one portion of the total building commissioning (Cx) process. NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems,* is a new document that was developed to create a set of recommendations that can be used as part of total building commissioning or as stand-alone commissioning for individual fire protection and life safety systems. While it might appear that commissioning provides value only for large, complex facilities such as casinos, high-rise buildings, or stadiums, it has strong merits for all facilities where more than one fire protection or life safety system is installed.

In general, the Cx process documents the planning, design, construction, and occupancy of a project. Fire and life safety commissioning is a quality control process that holds each of the stakeholders accountable by requiring documentation of their qualifications and activities through the fire commissioning agent (FCxA).

Commissioning is typically an owner-driven requirement to ensure that the building and its systems are designed, installed, and operated in accordance with the owner's needs, as documented on the owner's project requirements (OPR). Commissioning is distinctly different from acceptance testing, which is found in NFPA installation standards. See the commentary following 3.3.21.1 for more details on the difference between commissioning and acceptance testing.

Chapter 1 of NFPA 3 provides the administrative recommendations for the commissioning and integrated testing of fire protection and life safety systems. Readers should pay particular attention to the scope and purpose of NFPA 3. This document was developed as a recommended practice, not a standard; therefore, it provides recommendations rather than requirements on how the fire protection and life safety systems Cx process and integrated testing should occur.

1.1 Scope

This recommended practice provides the recommended procedures, methods, and documentation for commissioning and integrated testing of active and passive fire protection and life safety systems and their interconnections with other building systems.

Special emphasis should be placed on the phrase "recommended procedures, methods, and documentation." The recommendations in this document provide a framework for commissioning and integrated testing. Although the actual commissioning of systems might not be the same for two different buildings, it should follow the same process. Similarly, the actual integrated testing of two systems in one building might not be the same as integrated testing in a second building for a variety of reasons. However, the process that is followed, as noted in NFPA 3, should remain the same.

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Myth vs **Fact**

MYTH: NFPA 3 cannot be used on projects because it is written as a recommended practice and not a standard.

FACT: NFPA 3 can be used on projects as desired by the owner through the project specification. Several colleges and universities are actively using NFPA 3 for new construction projects.

1.2* Purpose

The purpose of this recommended practice is to describe the commissioning process and integrated testing that will ensure fire protection and life safety systems perform in conformity with the design intent.

A.1.2 System commissioning and integrated testing is critical to ascertain that systems are installed and function in accordance with the BOD and OPR and that testing is documented. It is not the intent of this recommended practice to supplant the existing requirements of other codes and standards, but this recommended practice can provide the appropriate guidance for a specific system or component where testing is not otherwise addressed. Such guidance should be developed by the fire protection and life safety commissioning team.

FAQ

Does NFPA provide specific instructions for how to "commission" a fire protection or life safety system?

NFPA 3 has been developed as a first step to address the concern of both the commissioning industry and regulatory agencies that a gap exists between the individual installation standards. An individual installation standard provides design, installation, and test requirements for a specific system. NFPA 3 bridges the gap between the individual standards to help ensure that fire protection and life safety systems are designed, installed, tested, and verified as a whole.

Commissioning is a process and not an event. This process begins at the planning phase of a project and continues through design, construction, and occupancy. NFPA 3 provides the framework for the Cx process relative to fire protection and life safety systems. The requirements for testing or verification of an individual system are found in the appropriate installation standard. The framework for testing and verification of integrated systems is found in NFPA 3. The specific procedures to be followed should be developed by the commissioning team, using the framework provided in NFPA 3.

1.3* Application

Commissioning is typically an owner-driven requirement, while integrated testing is often an AHJ-driven requirement. As with all recommended practices, this document is

Terms-at-a-Glance

AHJ	Authority Having Jurisdiction	CxA	Commissioning Authority
BIM	Building Information Model	CxT	Commissioning Team
BOD	Basis of Design	ECS	Emergency Communication Systems
CAR	Corrective Action Reports	FCx	Fire and Life Safety Commissioning
CP	Commission Plan	FCxA	Fire Commissioning Agent
Cx	Commissioning	FMP	Facilities Management Personnel

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not required to be applied to a specific project unless required by some other code, standard, contract, or similar document. Owners can require compliance with this document through a contract with the installing contractors or building general contractor. Although commissioning is typically an owner-driven requirement, the process provides significant value to AHJs, particularly with large or complex fire protection or life safety systems.

Critical Point

Commissioning is typically an owner-driven requirement, while integrated testing is often an AHJ-driven requirement.

A.1.3 Planning for fire protection and life safety in and around a building or structure involves an integrated system approach that enables the system designer to analyze all of the components as a total fire safety system package.

It is not the intent of this recommended practice that the commissioning team verify that all permits required for infrastructure are properly filed and approved. That verification is the responsibility of the installing contractor or other entity as might be required by the overall project contract.

The intent of the commissioning process is to verify that infrastructure features are functioning properly in accordance with the OPR and the commissioning plan.

For example, functional performance testing of a fire pump system should not be performed until the FCxA has verified that the emergency power system and water storage facilities have successfully completed their individual functional performance testing.

It cannot be emphasized enough that all fire protection and life safety systems in a facility need to be designed, installed, tested, and verified as a whole, not just as individual systems.

Critical Point

All fire protection and life safety systems in a facility need to be designed, installed, tested, and verified as a whole, not just as individual systems.

1.3.1* This recommended practice applies to passive and active fire protection and life safety equipment and systems including, but not limited to, the following:

A.1.3.1 This recommended practice is not intended to be applied unless required by applicable codes or standards, the OPR, or an AHJ.

(1)* Infrastructure supporting the building fire protection and life safety systems within the boundaries of the project

A.1.3.1(1) Project infrastructure should include those systems and utilities necessary for the support and operation of the fire protection and life safety systems of the proposed project. These infrastructure items can include the following:

(1) Access roadways for general ingress and egress and those necessary for fire department access in accordance with local codes, standards, and policies

Terms-at-a-Glance

HVAC	Heating, Ventilating, and Air Conditioning	OPR	Owner's Project Requirements
IL	Issues Log	RCx	Retro-Commissioning
ITa	Integrated Testing Agent	RDP	Registered Design Professional
ITx	Integrated Testing Plan	Re-Cx	Re-Commissioning
NIBS	National Institute of Building Sciences	RFQ	Request for Quotation
O&M	Operation and Maintenance	TAB	Testing and Balancing

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(2) Utility systems for the provisions of electric power, fuel gas, water, and waste water; communication systems; and any other utility system deemed essential for the support of project operations
(3) On-site combined heat and power generation systems, electric power generation plants or systems, fuel gas storage facilities, water supply and storage facilities, and environmental or waste management systems

(2) Fixed fire suppression and control systems
(3) Fire alarm systems
(4) Emergency communications systems (ECS)
(5) Smoke control and management systems
(6)*Normal, emergency, and standby power systems

A.1.3.1(6) Emergency power supply systems to be commissioned include, but are not limited, to those powering the following:

(1) Smoke control systems
(2) Stair pressurization systems
(3) Smoke-proof enclosure ventilation systems
(4) Electric driven fire pumps
(5) Fire service access elevators
(6) Fire suppression system controllers

(7) Explosion prevention and control systems
(8)*Fire-resistant and smoke-resistant assemblies

A.1.3.1(8) Examples include, but are not limited to, floor ceilings and roof decks, doors, windows, barriers, and walls protected by a firestop system or device for through-penetrations and membrane penetrations, and other fire and smoke control assemblies.

(9)*Firestopping

A.1.3.1(9) Examples include, but are not limited to, fire and smoke resistant–rated assemblies protected by a firestop system or device for through-penetrations and membrane penetrations.

(10) Systems associated with commercial cooking operations
(11) Elevator systems
(12)* Means of egress systems and components

A.1.3.1(12) Egress system and egress components should include the following:

(1) Emergency lighting and exit signs
(2) Major egress components, such as corridors, stairs, ramps, and so forth
(3) Exit path marking systems

(13) Other systems or installations integrated or connected to a fire or life safety system, such as, but not limited to, access control, critical processes, and hazardous operations

Terms-at-a-Glance

AHJ	**Authority Having Jurisdiction**	**CxA**	**Commissioning Authority**
BIM	**Building Information Model**	**CxT**	**Commissioning Team**
BOD	**Basis of Design**	**ECS**	**Emergency Communication Systems**
CAR	**Corrective Action Reports**	**FCx**	**Fire and Life Safety Commissioning**
CP	**Commission Plan**	**FCxA**	**Fire Commissioning Agent**
Cx	**Commissioning**	**FMP**	**Facilities Management Personnel**

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Myth vs **Fact**

MYTH: Performing an integrated test at the end of the construction phase is an acceptable substitute for commissioning as outlined in NFPA 3.

FACT: In order to achieve the full intent of commissioning, documentation of all phases and tasks of the project from planning through occupancy must be included. An integrated test will not show that all of the proper steps were followed.

The Technical Committee on Commissioning Fire Protection Systems spent a significant amount of time on the extent of the application of this recommended practice. The committee's intent is that both commissioning and integrated testing should be viewed in a holistic manner, so that all active and passive features affecting building fire protection and life safety are included in the commissioning and/or integrated testing process as applicable to the specific project.

1.3.2* Commissioning should achieve the following:

A.1.3.2 Fire and life safety systems can have problems during startup and installation. When implemented correctly, a realistic commissioning plan minimizes startup and long-term problems, reduces operational costs, and minimizes future maintenance requirements.

(1) Documentation of the owner's project requirements (OPR) and the basis of design (BOD) provided
(2) Equipment and systems installed as required
(3) Integrated testing for all integrated fire and life safety systems performed and documented
(4) Delivery of operation and maintenance (O&M) documentation
(5)* Training of facility operating and maintenance staff

A.1.3.2(5) Consideration should be given to providing training for emergency response personnel.

Although the intent of commissioning is to provide training for the owner's operations and maintenance (O&M) staff, training for emergency responders should not be overlooked. In complex buildings such as casinos or manufacturing facilities, or in buildings with complex systems such as malls or data centers, training of emergency responders should be strongly encouraged by the commissioning team. Emergency responder training should focus more on prefire planning and include a layout of the building, overview of the fire protection and life safety system, and details on how the emergency responders should use those systems in an emergency.

(6) Identification and documentation of the requirements for maintaining system performance to meet the original design intent during the occupancy phase

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NIBS	National Institute of Building Sciences	RFQ	Request for Quotation
O&M	Operation and Maintenance	TAB	Testing and Balancing

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While one might think that commissioning increases the cost of a project, total building commissioning has been shown to have a negligible first cost (during construction) but long-term savings for the owner due to reduced O&M costs. Since commissioning of fire protection and life safety systems is still in its early stages, research has not been performed to determine the short- and long-term project impacts.

That said, building fire protection and life safety systems that are designed, installed, and tested in accordance with the OPR should result in systems that are less costly to maintain and more reliable, thereby reducing both hard costs (maintenance and replacement) and soft costs (productivity loss due to unnecessary building evacuations, etc.).

Critical Point

Commissioning provides verification that the individual systems function not only as intended but that they all function together in a holistic manner as they should in a fire or other emergency situation.

The value of commissioning to stakeholders, such as owners and AHJs, cannot be overstated. Commissioning provides verification that the individual systems function not only as intended but that they all function together in a holistic manner as they should in a fire or other emergency situation. An added benefit of commissioning, above acceptance testing, is that verification includes an evaluation of the systems from an O&M standpoint. Commissioning would ensure that adequate space is available for proper maintenance and operation through drawing review in the design phase and verify proper clearance during installation.

As a real world example of the importance of commissioning, look at an atrium smoke removal system that was installed in a new educational facility in United States. The smoke removal system consisted of exhaust and supply fans. The atrium enclosure was maintained by doors that closed upon activation of the building fire alarm system. On the first floor, a large opening was provided to "open up" the atrium and allow for ease of student flow. In order to maintain the atrium enclosure, an automatic horizontal door was installed. In a normal state, the door would be stored inside the wall cavity. Upon activation of the fire alarm system, the door would close. The design of the smoke removal system included a delay in the startup of the exhaust fans to allow the door to close.

The atrium exhaust and supply fans, building fire alarm system, and automatic doors were tested by the design engineers in the presence of the AHJ and were found to be operating in accordance with applicable codes and standards. These individual system tests were considered part of the prefunctional testing noted in the commissioning plan. The fire protection commissioning team performed similar individual system tests as part of the functional performance testing. As a final functional performance test, the commissioning team reset all systems to normal state. The atrium smoke exhaust system was activated via smoke detector. As anticipated, the atrium doors closed, including the horizontal door, and the atrium fans started. Since the horizontal door had the ability to be opened after it closed, the commissioning team pushed the "open" button, which caused the door to automatically open 36 in. (914 mm) and remain open for a preset period of

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time. At the conclusion of that time period, the door automatically closed to maintain the fire resistance rating of the atrium enclosure. Due to the exhaust fan operation, however, the door bottom was pulled into the atrium just enough to prohibit the door from closing completely in its track. This caused the door to continually open and close, similar to an elevator door when an object blocks its closing path. Upon further review with the design engineers, it was determined that the exhaust fans were oversized, causing a significant negative pressure in the atrium. The fans were adjusted and the systems were retested and functioned properly, including the door opening and closing.

Standard system installation acceptance testing indicated that all systems were functioning properly. Integrated systems testing, via the Cx process, indicated a significant deficiency with the overall system performance. Had these systems not been subjected to the Cx process, this deficiency would not have been discovered.

1.3.3 Integrated testing should verify and document the following:

(1) Performance in accordance with applicable codes and standards
(2) Compliance with BOD and OPR
(3)* Sequence of operation

A.1.3.3(3) See Figure A.3.3.16(a) for a sample sequence of operation.

(4) Installation in accordance with manufacturers' published instructions
(5) Accuracy of diagrams of system interconnections and device locations

1.3.4* The recommendations for the commissioning of fire protection and life safety systems and equipment in this document should apply when required by the project specification.

A.1.3.4 In order to invoke the commissioning recommendations in NFPA 3, specifications should read, "The building fire protection systems shall be designed, installed, tested, commissioned, and maintained in accordance with commissioning process of NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*."

As stated previously, commissioning of fire protection and life safety systems is currently not required by any building code or NFPA standard. Owners should clearly call out the requirement for compliance with NFPA 3 in their contract documents with the installation contractor or general contractor. Since NFPA 3 is a recommended practice, it is not considered an "industry standard," and therefore, the owner should not assume that the installation contractor or general contractor will include the effort required in their scope of work. More importantly, the owner's contract should clearly state the relationship for the FCxA.

More detailed recommendations on the relationship between the owner, FCxA, installation contractor, and general contractor are provided in Chapter 4. The FCxA should be contracted directly with the owner as the FCxA represents only the owner's interest.

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Myth	Fact
MYTH: Not following all the steps of the commissioning process outlined here will result in an improperly functioning building.	**FACT:** The commissioning process outlined in NFPA 3 provides an in-depth level of review and documentation of the design and construction process, and when followed, will help to confirm the intended operation and functionality of the building. Where alternative approaches or forms of documentation are approved, they can be used in lieu of the approach stated herein.

The language noted in A.1.3.4 will clearly indicate to the installation contractor and general contractor that compliance with NFPA 3 is part of the project; however, the relationship between the FCxA and the owner is the responsibility of the owner.

1.3.5* The recommendations for the integrated testing of fire protection and life safety systems and equipment in this document should apply when required by applicable codes or standards or the project specification.

A.1.3.5 For some buildings, the integrated testing recommendations of NFPA 3 can be considered satisfied by performing the acceptance tests and the inspection, testing, and maintenance required by the NFPA standards for the systems in a building. For example, a building with a small automatic sprinkler and fire alarm systems can meet the integrated testing recommendations of NFPA 3 by meeting the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, and *NFPA 72*, *National Fire Alarm and Signaling Code*.

1.4* New Technology

New technology, proposed for installation, for which there is no published product instruction or installation standard, should function as intended throughout its life cycle in accordance with the OPR, BOD, and requirements of the authority having jurisdiction (AHJ).

A.1.4 This section provides guidance for new technologies or alternative materials, devices, methods, or arrangements that are not covered by other sections of this document.

New technology includes fire protection systems or features not currently addressed by NFPA standards. New methods could include functional performance testing using an environmentally safe test liquid in lieu of foam concentrate on foam systems or simulation where the effects of testing required by an installation standard would be detrimental to the building operation, such as building power shutdown in an operating data center.

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1.4.1* Design Documentation.

Designs using new technology should be submitted to the AHJ for review and approval.

A.1.4.1 The burden of proof of equivalency lies with the applicant who proposes the use of alternative materials or methods. The authority having jurisdiction should determine whether identified performance objectives of the proposed new technology are appropriate and have met the intent of the performance objectives of this document, the OPR, BOD, and applicable codes and ordinances of the jurisdiction. The type of information required includes test data in accordance with referenced standards, evidence of compliance with the referenced standard specifications, and design calculations.

As stated in Section 1.4 above, the intent of this section is to allow the use of new technology or methods, provided that the technology/methods perform in the manner described in the OPR and applicable codes. Whoever proposes the new technology, whether it be the designer, installer, or commissioning team, should provide adequate documentation to satisfy the AHJ and owner that whatever is proposed will function properly or simulate a test properly. Since the burden of proof lies with whoever proposed the new technology or method, they should be prepared to provide whatever documentation is necessary to satisfy the AHJ and the owner.

1.4.1.1* Submittals should include documentation, in an approved format, of each performance objective and applicable scenario, together with any calculations, modeling, or other technical substantiation used to establish the fire protection and life safety performance of the design.

A.1.4.1.1 Supporting data and tests, where necessary to assist in the approval of materials or assemblies not specifically provided for in this recommended practice, should consist of valid research reports from approved sources. A research report issued by an authoritative agency is particularly useful in providing the authority having jurisdiction with the technical basis for evaluation and approval of new and innovative materials and methods of construction.

Sufficient technical data, test reports, and documentation should be provided for the AHJ to make a decision as to the appropriateness of an alternative material or method. Reports providing evidence of this equivalency should be required to be supplied by an approved source, meaning a source that the AHJ confirms is considered to be reliable and accurate.

1.4.1.2* Tests submitted in support of an application should be performed by an agency approved by the AHJ.

A.1.4.1.2 Approval should be based on evidence that the agency has the technical expertise, test equipment, and quality assurance to properly conduct and report the necessary testing. In the absence of recognized and accepted test methods, the AHJ can approve the test methods required. Methods of testing should be preapproved by the AHJ.

One of the benefits of the Cx process is that the design phase is given a defined structure that relies on communication and documentation. Any approvals that are needed by the

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AHJ can be written into the commissioning plan and included in the commissioning schedule. Including this task of AHJ preapproval early in the Cx process eliminates last-minute contingencies that fall outside of the OPR and BOD.

1.4.1.3 The AHJ should be permitted to require the submission of additional information and data necessary to assist in the determination of equivalency.

1.4.1.4* The AHJ should be authorized to engage such expert opinion as deemed necessary to evaluate the new technology at no expense to the jurisdiction.

A.1.4.1.4 The AHJ can require design submittals for new technologies to bear a third-party review and approval when the complexity of the design exceeds the capabilities of the AHJ to determine the appropriateness of the proposed design, operation, process, or interoperability.

Including the AHJ early in the Cx process will help to outline areas where third parties might be necessary. This allows the owner and the FCxA to build the fiduciary and scheduling constraints associated with the third party review into the project budget and commissioning plan.

1.4.2 Acceptance Requirements.

Upon completion of the installation, functional and interoperability testing should be conducted demonstrating performance consistent with the OPR and the BOD in a method acceptable to the AHJ.

1.4.3* Maintenance Documentation.

Final documentation should contain required inspection, maintenance, and testing methods and intervals.

A.1.4.3 The applicant should provide system design and operational documentation containing testing methods and intervals to assist in the continued operation and interoperability of system components and associated equipment.

The maintenance documentation required for new technology or alternative methods should be stored with all of the fire protection and life safety system documentation noted in Chapter 9. As with all of the individual system and commissioning documentation, maintenance documentation for new technology or alternative methods should be retained for the life of the system. If this documentation is not maintained, re-commissioning (Re-Cx) will be difficult without background information on the new technology or alternative methods used in original commissioning. Similarly, maintenance documentation should be kept in an accessible location for the life of the system to ensure proper maintenance is performed.

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Referenced Publications

CHAPTER 2

Documents that are cited within the main text of NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*, are formally referenced in Chapter 2. Compliance with the requirements in these referenced documents is recommended in order to carry out the commissioning process as identified in NFPA 3. Annex D lists the publications that are referenced in the annexes of NFPA 3 as well as additional references that may be useful to the fire and life safety commissioning team members during a commissioning project. By listing the information in this chapter immediately following Chapter 1, "Administration," the user is presented with the complete list of publications needed for effective use of the document before reading the specific recommendations.

FAQ

What is the difference between the documents listed in Chapter 2 and those listed in Annex D?

2.1 General

The documents or portions thereof listed in this chapter are referenced within this recommended practice and should be considered part of the recommendations of this document.

2.2 NFPA Publications

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 72®, *National Fire Alarm and Signaling Code,* 2010 edition.

NFPA 731, *Standard for the Installation of Electronic Premises Security Systems,* 2011 edition.

2.3 Other Publications

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Recommendations Sections

NFPA *101®*, *Life Safety Code®*, 2012 edition.

NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities,* 2012 edition.

NFPA 1031, *Standard for Professional Qualifications for Fire Inspector and Plan Examiner,* 2009 edition.

NFPA 5000®, *Building Construction and Safety Code®*, 2012 edition.

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Definitions

CHAPTER 3

Chapter 3 covers the definitions of words or terms that are used in NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*. Anyone who has volunteered on an NFPA committee knows that many hours are often spent discussing whether a document's language is easy to understand and whether it expresses the committee's intent. In order to understand the committee's recommendations, the words being used to describe these recommendations must be clearly understood. If a word is not defined in an NFPA document, readers are expected to use the definition found the dictionary. According to the NFPA, this source is *Merriam-Webster's Collegiate Dictionary*, 11th edition.

In the world of fire and life safety commissioning, some common words are used that have a slightly different meaning than might be expected. The best example of this is found with the word *commissioning*. In NFPA 3, there has been a dramatic change to the usual understanding of commissioning. Prior to this document being released, those who worked in the field of fire protection and life safety would likely have said that the word *commissioning* means "acceptance testing" or "final acceptance and placement into service" of these systems. Commissioning was typically considered to include the very last steps to one of these systems being placed into service.

NFPA 3 has been written to show that with the advent of building information modeling (BIM), the definition of commissioning has been expanded greatly by the building industry. BIM is the process of generating and managing building data for the life cycle of the structure. The presence of BIM in the design and construction industry has been the catalyst for the expansion of the concept of commissioning to include the entire life cycle of the building, from concept through the building's occupancy. The NFPA 3 Technical Committee on Commissioning Fire Protection Systems followed the structure the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) established for their commissioning document. The technical committee reviewed the work of other organizations to aid in the development of some of the definitions, as some commissioning concepts carry over from industry to industry. However, many of the definitions found in NFPA 3 were created to specifically apply to the commissioning of fire protection and life safety systems. So there are probably some words in this document that carry a different meaning than what is expected.

3.1 General

The definitions contained in this chapter apply to the terms used in this recommended practice. Where terms are not defined in this chapter or within another chapter, they should be

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defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, is the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions

Section 3.2, NFPA Official Definitions, contains NFPA definitions for five terms that are not subject to change by the technical committees responsible for this recommended practice. The official definitions are provided for terms that are common among the NFPA codes and standards and for which multiple definitions would confuse users. See Section 3.3, General Definitions, for terms that are specifically defined for use with the provisions of NFPA 3.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

FAQ

What is the difference between the terms *approved* and *listed*?

In the context of NFPA 3, the term *approved* has a different meaning from the term *listed,* which is defined in 3.2.3. A component that is approved is not necessarily listed. Components critical to the proper operation of a system are generally both listed and approved. Noncritical components are not generally required to be listed, but are required to be approved. See the commentary following A.3.2.3 for more information on the term *listed.*

Components that are required to be approved are necessary to maintain an acceptable level of system reliability. However, their impairment would not generally render a system out of service.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual

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such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

The term *authority having jurisdiction* (AHJ) refers to that person or office responsible for enforcing codes and standards referenced by this recommended practice. In cases where the codes and standards are to be legally enforced, the AHJ is usually a fire marshal or building official. It is common for multiple AHJs to review the same project and have responsibility for enforcement. In many cases involving NFPA 3, the insuring agency, owner, or registered design professional (RDP) for the facility might have requirements that differ from or exceed the requirements contained in the referenced codes and standards. Communicating with all of the appropriate AHJs is important in achieving the goals of this document.

3.2.3* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

A.3.2.3 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

Most components that are critical to system performance must be listed. However, there are some exceptions. Certain materials such as conduit, pipe, and fittings that meet specific industry standards are not required to be listed, because they have a long-established track record of acceptable performance.

At least one listing agency uses the designation *classified* to indicate that a specific product meets its testing and evaluation requirements. Materials with this designation meet the intent of the term *listed.* Subsection A.3.2.3 clarifies that the evaluation of the product should address reliable operation for the intended function.

FAQ

Is the term *listed* the same as the term *classified*?

3.2.4* Recommended Practice. A document that is similar in content and structure to a code or standard but that contains only nonmandatory provisions using the word "should" to indicate recommendations in the body of the text.

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Myth vs Fact

MYTH: NFPA official definitions can be modified by the technical committees when they are using the terms outside of the definitions listed in the *NFPA Glossary of Terms*.

FACT: NFPA official definitions can only be modified when approved by the NFPA Standards Council.

NFPA 3 is a recommended practice and as such does not contain mandatory language. The language in this document is intended to give the fire and life safety commissioning (FCx) team the ability to create the most appropriate commissioning plan for the facility. The genesis of NFPA 3 was a request from the National Institute of Building Sciences (NIBS). NIBS had requested that NFPA, along with other standards development organizations, prepare a commissioning document that could be used as part of an overall commissioning program validating the completeness and accuracy of a finished building project. The NFPA 3 Technical Committee on Commissioning Fire Protection Systems intended this document to fit into the NIBS Total Building Commissioning Program. This document is the template provided by ASHRAE Guideline 0, *The Commissioning Process*, for the creation of new documents on commissioning.

A.3.2.4 Recommended Practice. A document that is similar in content and structure to a code or standard but that contains only nonmandatory provisions using the word "should" to indicate recommendations in the body of the text.

3.2.5 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions

The terms that are defined in Section 3.3 were identified by the Technical Committee on Commissioning Fire Protection Systems and are specifically defined for use with the recommendations in NFPA 3.

3.3.1* Basis of Design (BOD). A document that shows the concepts and decisions used to meet the owner's project requirements and applicable standards, laws, and regulations.

A.3.3.1 Basis of Design (BOD). The BOD is normally used to assist the commissioning authority and the AHJ in the plan review, inspection, and acceptance process.

Once the building owner has hired a design team, which is often an architect or engineering firm, the owner will supply the FCx team with information that will help create the owner's project requirements (OPR). The OPR is used by the design team to create a

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document known as the basis of design (BOD). The BOD is provided to ensure the proper functioning of fire protection and life safety systems in accordance with their design. The BOD is usually a written narrative (see 3.3.11) that describes the design theory and operational concepts of these systems and should be submitted along with the plans and specifications.

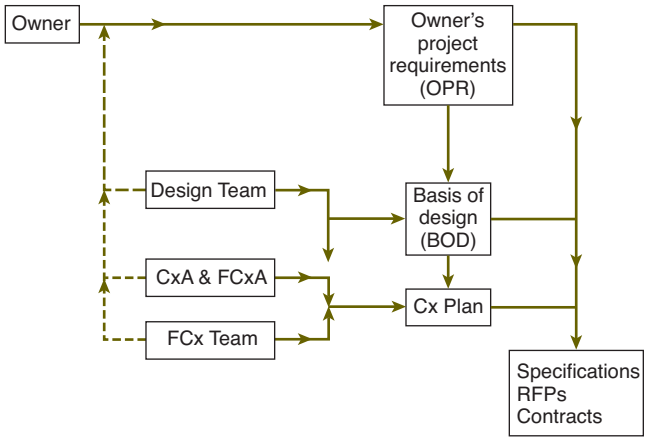
The BOD is the design team's declaration of exactly how they intend to meet the OPR (see 3.3.13) and the requirements of the applicable codes and standards enforced in the jurisdiction where the project is located. The BOD describes the initial design decision-making process. This document is usually in the form of a narrative report (see 3.3.11) and should be created or reviewed by the RDP. The BOD should be submitted for approval by the AHJ prior to the issuance of a permit and the installation of any system.

Critical Point

The BOD is the design team's declaration of how they intend to meet the OPR and the requirements of the applicable codes and standards enforced in the jurisdiction where the project is located.

Exhibit I.3.1 shows that the owner is responsible for identifying the information in the OPR. In creating the OPR, the owner will likely solicit the help of the design team, as indicated in the flowchart by the heavy dashed line. The owner might identify and reach out to the fire commissioning agent (FCxA) and those who might become members of the FCx team. These team members might or might not be given an opportunity to comment on the OPR or the BOD, but they will definitely help develop the commissioning plan.

EXHIBIT I.3.1



Flowchart for Creating Initial Commissioning (Cx) Documents.

Terms-at-a-Glance

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IL	Issues Log	RCx	Retro-Commissioning
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Myth vs Fact

MYTH: NFPA 3 can only be used on occupied buildings.

FACT: NFPA 3 can be implemented on any type of structure employing fire protection or life safety systems, including road tunnels and bridges.

FAQ

Are all the team members named in the BOD?

The BOD is a document from the design team that indicates the technical requirements for the project. It does not list the individual team members. The owner and the design team should have identified a minimal FCx team and given them a chance to comment during development of the OPR. The decision to include additional FCx team members will be based on the information found within the BOD.

3.3.2* Building. Any structure used or intended for supporting or sheltering any use or occupancy. [***101***, 2012]

A.3.3.2 Building. The term *building* is to be understood as if followed by the words "or portions thereof." The intent is to also apply this standard to structures such as roadway and transit tunnels, bridges, towers, fuel storage facilities, and other structures insofar as this document applies.

The committee had many discussions on how to define a building in NFPA 3. They determined that this document could apply to any "earth-based structure" or built environment. The committee came to this conclusion by discussing whether this document should apply to the International Space Station or to an oceangoing cruise ship. This definition would apply to the cruise ship, but not to the space station.

The committee knows that the commissioning (Cx) process will not apply to all buildings, but they needed to include this definition so that the document could be applied to any built environment or structure that is earth-based.

3.3.3 Commissioning.

3.3.3.1 Commissioning (Cx). A systematic process that provides documented confirmation that building systems function according to the intended design criteria set forth in the project documents and satisfy the owner's operational needs, including compliance with applicable laws, regulations, codes, and standards.

This is probably the most significant definition in NFPA 3. For many people in the construction and fire protection industries, the term *commissioning* has been synonymous with the phrase "systems acceptance." This new definition will require many to adapt to a new philosophy that is the basis for the total building commissioning concept. In its

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Myth vs **Fact**

MYTH: The term *commissioning* is universally understood and is always consistent with the definition and NFPA 3.

FACT: The term *commissioning* has dozens of meanings depending on who you talk to and from what part of the world they are from. The definition stated in NFPA 3 has been constructed by the technical committee to include a process for confirming building system functionality and not just a physical test.

simplest form, commissioning is a process that documents the design, construction, and occupancy of a building, as explained in NFPA's *Commissioning of Fire Protection Systems*:

> Commissioning is a quality assurance or quality control process that will verify that a building or system will perform as intended. Performance verification is demonstrated through inspection, testing, and documentation of these activities. The commissioning process varies from the traditional concept of testing and start-up in that commissioning begins at project inception and continues through design, construction, project closeout, and then throughout the facility's operations phase. The ultimate goal of systems or building commissioning is to ensure that a facility meets the operational needs of the building owner and provides for the continued efficient and effective operation of the building or system throughout its intended service life.

Critical Point

In its simplest form, commissioning is a process that documents the design, construction, and occupancy of a building.

3.3.3.2* Commissioning Authority (CxA). The qualified person, company, or agency that plans, coordinates, and oversees the entire commissioning process.

A.3.3.3.2 Commissioning Authority (CxA). A commissioning authority is typically provided and leads the overall fire protection and life safety commissioning team when the commissioning process is applied to more than one building system — that is, building commissioning. When the commissioning process is only applied to fire and life safety systems, the FCxA can assume the role of the commissioning authority.

The commissioning authority (CxA) is an independent entity who works for the owner when a building is subject to the total building commissioning concept outlined in ASHRAE Guideline 0. This person or entity will lead the building's FCx team. If the building is subject to total building commissioning, then the FCxA (see 3.3.3.6) and the FCx team should answer to and work very closely with the CxA.

Terms-at-a-Glance

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Myth vs **Fact**

MYTH: Every construction project will have a commissioning authority.

FACT: As commissioning becomes more and more prevalent across many trades in the construction industry, this might become true. At the moment, only projects where more than one commissioning team is employed will likely have a commissioning authority.

3.3.3.3* Commissioning Plan. The document prepared for each project that identifies the processes and procedures necessary for a successful commissioning process.

A.3.3.3.3 Commissioning Plan. The commissioning plan establishes the framework for how commissioning will be handled and managed on a given project.

3.3.3.4 Commissioning Record. The complete set of commissioning documentation for the project that is turned over to the owner at the end of the construction phase.

The commissioning plan (see 3.3.3.3) and the commissioning record (see 3.3.3.4) encompass nearly everything for which NFPA 3 provides guidance. The responsibility of gathering and creating this documentation falls mainly to the FCxA. Other FCx team members will be responsible for completing and submitting parts of the documentation, but the FCxA will collect and add those portions to the commissioning record.

The commissioning plan is the blueprint for the successful documentation of quality control and delivery of the building project to the owner. The plan will detail all of the work to be done and the deliverables to be provided by the various members of the FCx team.

The FCxA will need to document every milestone in the commissioning plan to create and maintain the commissioning record. All of the commissioning documents described in NFPA 3 will become part of the commissioning record. While the FCxA might not create each of these documents, it is the FCxA's responsibility to collect and organize them into the commissioning record.

3.3.3.5* Fire and Life Safety Commissioning (Cx). A systematic process that provides documented confirmation that fire and life safety systems function according to the intended design criteria set forth in the project documents and satisfy the owner's operational needs, including compliance with requirements of any applicable laws, regulations, codes, and standards requiring fire and life safety systems.

A.3.3.3.5 Fire and Life Safety Commissioning (Cx). Commissioning is achieved in the design phase by documenting the design intent and continuing throughout construction, acceptance, and the warranty period with actual verification of performance, O&M documentation verification, and the training of operating personnel.

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Myth vs **Fact**

MYTH: Re-commissioning and retro-commissioning are synonymous terms that apply to existing buildings.

FACT: Re-commissioning applies to buildings that have previously been commissioned, while retro-commissioning applies to buildings that have never been commissioned.

3.3.3.6 Fire Commissioning Agent. (FCxA). A person or entity identified by the owner, who leads, plans, schedules, documents, coordinates the fire protection and life safety commissioning team, and implements the commissioning process and integrated testing of fire and life safety systems.

The FCxA is an independent entity who works for the owner. This person or entity will lead the FCx team. The FCxA and the FCx team should answer to and work very closely with the CxA. The term *agent* is used to demonstrate that this person is responsible only for leading and documenting the Cx process.

When the Cx process is applied only to fire and life safety systems, the FCxA can assume the role of the CxA as outlined in ASHRAE Guideline 0.

3.3.3.7* Re-commissioning (Re-Cx). The process of verifying the performance of existing fire protection and life safety systems that have been previously commissioned to ensure that the systems continue to operate according to the design intent or current operating needs.

A.3.3.3.7 Re-commissioning (Re-Cx). Re-commissioning can be initiated periodically or in response to building renovation or a change in building use.

Re-commissioning (Re-Cx) is an important concept, as it provides assurance to the property owner that although buildings evolve and see significant modifications to their systems and system connections during their lifetime, there is a mechanism to assure that the intent of the designers and engineers will be confirmed. Re-Cx plans and frequencies are often written into the commissioning plan to provide triggers in the future to reaffirm the building's functionality.

Critical Point

Re-Cx provides assurance to the property owner that although buildings evolve and see significant modifications to their systems and system connections during their lifetime, there is a mechanism to assure that the intent of the designers and engineers will be confirmed.

3.3.3.8* Retro-commissioning (RCx). The process of commissioning existing fire protection and life safety systems that were not commissioned when originally installed.

A.3.3.3.8 Retro-commissioning (RCx). Retro-commissioning is a process that ensures that building systems perform

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Myth vs Fact

MYTH: The retro-commissioning process is similar in structure to a standard commissioning process for a new building.

FACT: The retro-commissioning process requires a long and often tedious discovery period that is not necessary for re- and retro-commissioning. This discovery period includes building extensive building surveys and document review.

interactively according to the design intent and/or to meet the owner's current operational needs. This is achieved by documenting the design intent where possible and the current operational needs, measuring the existing performance, and implementing necessary operational and/or system modifications, followed by actual verification of performance, verification of O&M documentation, and training of operating personnel. Retro-commissioning explains the analogy and methodology used by the designers in the design of the systems for the protection of the building, occupants, and emergency response personnel.

Retro-commissioning (RCx) is an extremely valuable tool for property owners to establish code compliance and system functionality benchmarks for their properties. This concept is applied to buildings that have never been commissioned and is very common for companies that are purchasing existing buildings. The commissioning of existing buildings is quickly becoming an important part of the real estate and building management industries. As the existing building stock changes ownership and use, it is profitable and socially responsible to see that these buildings undergo the Cx process. The phases for Re-Cx and RCx existing buildings are very similar to those for new buildings, but are inherently and understandably different. The California Commissioning Collaborative's *California Commissioning Guide: Existing Buildings* describes the following phases for the commissioning of existing buildings: planning phase, investigation phase, implementation phase, and hand-off phase.

Critical Point

RCx is an extremely valuable tool for property owners to establish code compliance and system functionality benchmarks for their properties. This concept is applied to buildings that have never been commissioned and is very common for companies that are purchasing existing buildings.

3.3.4 Component. A part of an architectural, electrical, or mechanical system. [***5000,*** 2012]

3.3.5 Construction Document. The plans, specifications, and other documents that describe the construction project.

Construction documents are also commonly known as the "contract documents" in the construction industry. This set of documents is most often created by an architectural or

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engineering firm. In some situations, these documents, or a portion thereof, have been created by contractors for the building owner's use and distribution. When the total building Cx process is used, these documents might contain a specification and/or a request for proposal (RFP) for fire and life safety commissioning.

3.3.6 Drawings.

3.3.6.1 Coordination Drawing. Reproducible drawings showing work with horizontal and vertical dimensions to avoid interference with structural framing, ceilings, partitions, equipment, lights, mechanical, electrical, conveying systems, and other services.

When the Cx process is part of a building information model (BIM), the coordination drawings are used for 3D conflict resolution. They are also used to create and update the fourth dimension of time/scheduling and the fifth dimension of cost management. These dimensions have become the latest use of coordination drawings in the BIM process and can have a significant impact for owners and the various FCxAs assigned to a project.

3.3.6.2 Record (Plan) Drawing. A design, working drawing, or as-built drawing that is submitted as the final record of documentation for the project. A drawing is also referred to as a plan.

3.3.6.3 Shop Drawings. Scaled working drawings, equipment cutsheets, and design calculations. [**1031**, 2009]

Shop drawings are normally prepared by the installing contractor or manufacturer. This package of information will typically include scaled drawings (usually becoming the working plans that are described in 3.3.6.4); data sheets that provide the details of the products being used on a project; and calculations that show the adequacy of the system or systems being installed, such as fire sprinkler system calculations or alarm battery calculations.

3.3.6.4 Working (Plan) Drawing. Those approved plans and drawings that are used for construction of the project.

These plans will have been submitted as shop drawings (see 3.3.6.3) or will closely mirror the shop drawings.

3.3.7 Inspection. A visual examination of a system or portion thereof to verify that it appears to be in operating condition and is free of physical damage. [**820**, 2012]

Inspections at various points in the construction phase can be integral to the success of a commissioning plan. Although much of the focus of the commissioning process revolves around paperwork and administration, this is a field activity that can be used to keep a project on schedule and identify problems when they are small and manageable.

Critical Point

Inspections at various points in the construction phase can be integral to the success of a commissioning plan. Paperwork and administration is a field activity that can be used to keep a project on schedule and identify problems when they are small and manageable.

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Myth vs **Fact**

MYTH: An issues log has little value on smaller projects and projects with limited system interactions.

FACT: An issues log is not only valuable for a project being constructed but can also be retained by the owner for projects with similar sizes and scopes. Avoiding one or two errors or concerns based on knowledge from previous jobs can save the owner a significant amount of money, especially on smaller jobs.

3.3.8* Installation Contractor. A company that provides labor and materials to install systems and equipment.

A.3.3.8 Installation Contractor. Installation contractors often provide shop drawings, working plans, and other related documents.

Installation contractors should be licensed and insured in accordance with applicable laws and ordinances. Each country, state, province, county, and city can have different requirements for the licensing of installation contractors. The Cx process should document the competency and qualification of the installing contractor.

3.3.9 Integrated Testing Agent (ITa). A person or entity identified by the owner, who, plans, schedules, documents, coordinates, and implements the integrated testing of the fire protection and life safety systems and their associated subsystems.

The integrated testing agent (ITa) is a person or an entity who can be hired to coordinate and document integrated testing. On a small or less complex project, this could simply be the FCxA. On very small projects, the owner might allow the AHJ to coordinate the limited integrated testing that would be needed. In this case, the FCxA would still need to document compliance with system standards and the commissioning plan.

On larger or more complex projects, the owner can elect to hire an ITa who will be responsible for the many tasks involved with integrated testing. The person or entity will need to meet all of the recommendations of this recommended practice for the ITa.

Critical Point

The issues log is one of the most effective tools an FCxA can have in their toolbox. By documenting project issues or "lessons learned," the FCxA can limit the potential for wasting project resources, such as time, money, or materials, throughout the design and construction process.

3.3.10 Issues Log. A formal and ongoing record of failures, deficiencies, or concerns, as well as associated priorities, implications, and resolutions.

The issues log (IL) is one of the most effective tools an FCxA can have in their toolbox. By documenting project issues or "lessons

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learned," the FCxA can limit the potential for wasting project resources, such as time, money, or materials, throughout the design and construction process. It can also be the most challenging tool to maintain and keep up to date. An effective commissioning plan will continually use the issues log to re-examine and update the plan. The commissioning record will contain a copy of the project's IL.

3.3.11* Narrative. A written summary description of the building(s) or structure(s), including exterior property boundaries and all applicable fire protection and life safety systems and related integrated operational features.

Building construction and/or fire protection narratives are becoming more and more common, but are not necessarily used on all projects. These narratives are an instrumental tool for the FCx team as they bring together the team and make life easier for the AHJ during the plan review period.

Critical Point

Building construction and/or fire protection narratives are an instrumental tool for the FCx team as they bring together the team and make life easier for the AHJ during the plan review period.

A.3.3.11 Narrative. The narrative is written to assist and expedite the plan review and inspection process by the AHJ. It is maintained on file for use at the time of final inspection and for periodic reviews during future field inspections. It is referenced by the building owner and authority having jurisdiction to ensure that all future modifications, alterations, additions, or deletions to the original systems are current and that the original system's protection and required system performance are not compromised or have not been altered without building or fire official prior review. The narrative should be recognized by all entities that it is one of the key documents associated with the commissioning process.

Building owners benefit by knowing how their building's fire protection and life safety systems work. The narrative provides a procedure including methods for testing and maintenance. A copy of the narrative report should be kept on the premises and should be available for review prior to testing and proposed modifications to any portion of the building's fire protection and life safety systems.

Development Format. The narrative is prepared by a qualified, identified individual who has "taken charge" in the development of an entire coordinated narrative that includes all information regarding the design basis, sequence of operation, and testing criteria associated with all required or non-required fire protection systems set forth by applicable laws, codes, regulations, and local ordinances of the jurisdiction and applicable national and/or international standards.

The narrative should be submitted with plans and specifications for review and approval by the AHJ prior to the issuance of a building permit. The narrative should be written in a clear conversational format. The construction specifications should not be considered a narrative; however, some applicable portions of the construction specifications could be included to support or clarify the intent of the narrative. The narrative is a stand-alone document, it should be 8½ in. × 11 in. for filing and ease of use by the AHJ and building owners, and it

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should include an administrative cover page identifying the project name, building address, and name, address, and phone number of the individual who has "taken charge" in the preparation of the narrative.

Commentary. Codes and standards are written in a way to require uniformity in design and construction for all buildings and structures. The codes and standards can be subjective and are subject to interpretation by building owners, designers, and the AHJ; uniformity is not always necessarily achieved. The narrative should attempt to clarify to the AHJ the designer's intent and interpretation of the code and standards. The AHJ can agree or disagree with the designer's interpretation. Historically, the requirements for fire protection and life safety systems have become site-specific, and building code requirements are not uniformly enforced. The size of the community, fire department staffing, fire department equipment availability, and suppression tactics established by the local fire department have affected the uniformity of enforcement. Site-specific requirements more or less than that of the building code can have reasonable intent; however, this type of enforcement in some cases has proven to be controversial in the applicability of code uniformity. The narrative can be and should be a valuable instrument when accurately prepared, and it will establish a line of communication between the designer and the authority having jurisdiction, resulting in what the building codes and standards mandate, which is uniformity and consensus in the interpretation of the codes and standards. The narrative should be written in a three-sectional format with subsections as necessary (methodology, sequence of operation, and testing criteria sections) for clarity and should be limited to a summary. A sample narrative outline can be found in Annex B.

3.3.12 Operation and Maintenance Manual. A system-focused composite document that includes the operation and maintenance requirements and additional information of use to the owner during the occupancy and operations phase.

The contents of the operation and maintenance (O&M) manuals are discussed in 5.3.3 of this document. These should not be confused with the systems manual (see 3.3.20). The systems manual expands on the current concept of the O&M manual. The intent of the NFPA 3 Technical Committee on Commissioning Fire Protection Systems was that the O&M manuals would be a sufficient requirement for the fire protection and life safety systems under FCx. If a building project is subject to total building commissioning, then the O&Ms should be part of the systems manual.

3.3.13 Owner's Project Requirements (OPR). The documentation that provides the owner's vision for the planned facility, integrated requirements, expectations for how it will be used and operated, and benchmarks and criteria for performance.

The development of the OPR is the first step in the Cx process. This document drives the creation and effectiveness of the commissioning plan, and no other document carries as much weight with the FCx team. Subsection 5.2.3 explains that this document is the basis for all commissioning decisions.

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Myth vs Fact

MYTH: The OPR is developed by the owner and the owner alone.

FACT: The owner can invite other stakeholders and potential users of the building or facility to contribute to the development of the OPR.

3.3.14 Phase.

The definitions provided in 3.3.14.1 through 3.3.14.4 describe the phases of the Cx process. These phases allow the FCx team to create a plan and assign responsibilities around events and tasks that are common in new building construction. It is important to understand that these phases can and will overlap as different trades and professions carry on the work of creating a new building. It is not always critical that every step in the commissioning process outlined in NFPA 3 be completed before the next step is begun. What is important is to recognize how each event impacts the other and to be able to adapt the commissioning plan accordingly. This is why the issues log (see 3.3.10) is such an important tool.

The fact that various phases of the design and construction process are outlined and clearly defined within NFPA 3 highlights the long-term, procedural nature of the commissioning process.

Critical Point

The fact that various phases of the design and construction process are outlined and clearly defined within NFPA 3 highlights the long-term, procedural nature of the commissioning process.

3.3.14.1 Construction Phase. The phase during which the systems and materials are fabricated and installed, tested, and accepted.

3.3.14.2 Design Phase. The phase during which the basis of design is produced, and drawings and calculations, including those for design and fabrication, are produced, and testing procedures are developed.

3.3.14.3 Occupancy Phase. The phase during which the training and periodic inspection, testing, and maintenance are scheduled and performed.

3.3.14.4 Planning Phase. The phase during which the fire protection and life safety commissioning team is formed and initial project concepts and the owner's project requirements are developed.

3.3.15 Registered Design Professional (RDP). In commissioning, an individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the jurisdiction in which the project is to be constructed, or other professional with qualifications or credentials acceptable to the jurisdiction in which the project is to be constructed.

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Myth vs **Fact**

MYTH: Life safety systems that can utilize and benefit from the commissioning process are limited to traditional fire protection systems such as sprinkler systems, fire alarm systems, and smoke management systems.

FACT: Life safety systems that can utilize and benefit from the commissioning process include traditional fire protection systems as well as passive systems such as fire-resistance-rated walls.

3.3.16* Sequence of Operation. A matrix, narrative, or table of system inputs and outputs that can be used to illustrate the interactions of interconnected fire protection systems.

A.3.3.16 Sequence of Operation. See Figure A.3.3.16(a) and Figure A.3.3.16(b). The matrix and the sequence of operations form are examples only, and they might need to be modified based on the actual installation requirements. The system outputs on the sequence of operations matrix correspond to the system outputs on the sequence of operation form.

Critical Point

Successful integrated testing should include a document that describes the intended flow of interactions between those systems that are designed to save lives and protect them from fire.

The sequence of operations is a building-specific document that graphically shows the relationships between systems for the purposes of verifying successful interaction between those systems. This document should be created to show individual system activation and appropriate throughput for total "start-to-finish" system interactions. The scope of NFPA 3 covers the requirements for integrated testing. Successful integrated testing should include a document that describes the intended flow of interactions between those systems that are designed to save lives and protect them from fire. These interactions are best described in the sequence of operations.

3.3.17 Stakeholder. Any individual, group, or organization that might affect, be affected by, or perceive itself to be affected by the risk.

3.3.18 System.

3.3.18.1* Active Fire Protection System. A system that uses moving mechanical or electrical parts to achieve a fire protection goal.

A.3.3.18.1 Active Fire Protection System. Examples of active systems include, but are not limited to, gaseous extinguishing systems, sprinklers, standpipes, dampers, or fire alarm systems.

3.3.18.2 Fire Protection Systems. Systems, devices, and equipment used to detect a fire and its by-products, actuate an alarm, or suppress or control a fire and its by-products, or any combination thereof. [**1031,** 2009]

Terms-at-a-Glance

AHJ	**Authority Having Jurisdiction**	**CxA**	**Commissioning Authority**
BIM	**Building Information Model**	**CxT**	**Commissioning Team**
BOD	**Basis of Design**	**ECS**	**Emergency Communication Systems**
CAR	**Corrective Action Reports**	**FCx**	**Fire and Life Safety Commissioning**
CP	**Commission Plan**	**FCxA**	**Fire Commissioning Agent**
Cx	**Commissioning**	**FMP**	**Facilities Management Personnel**

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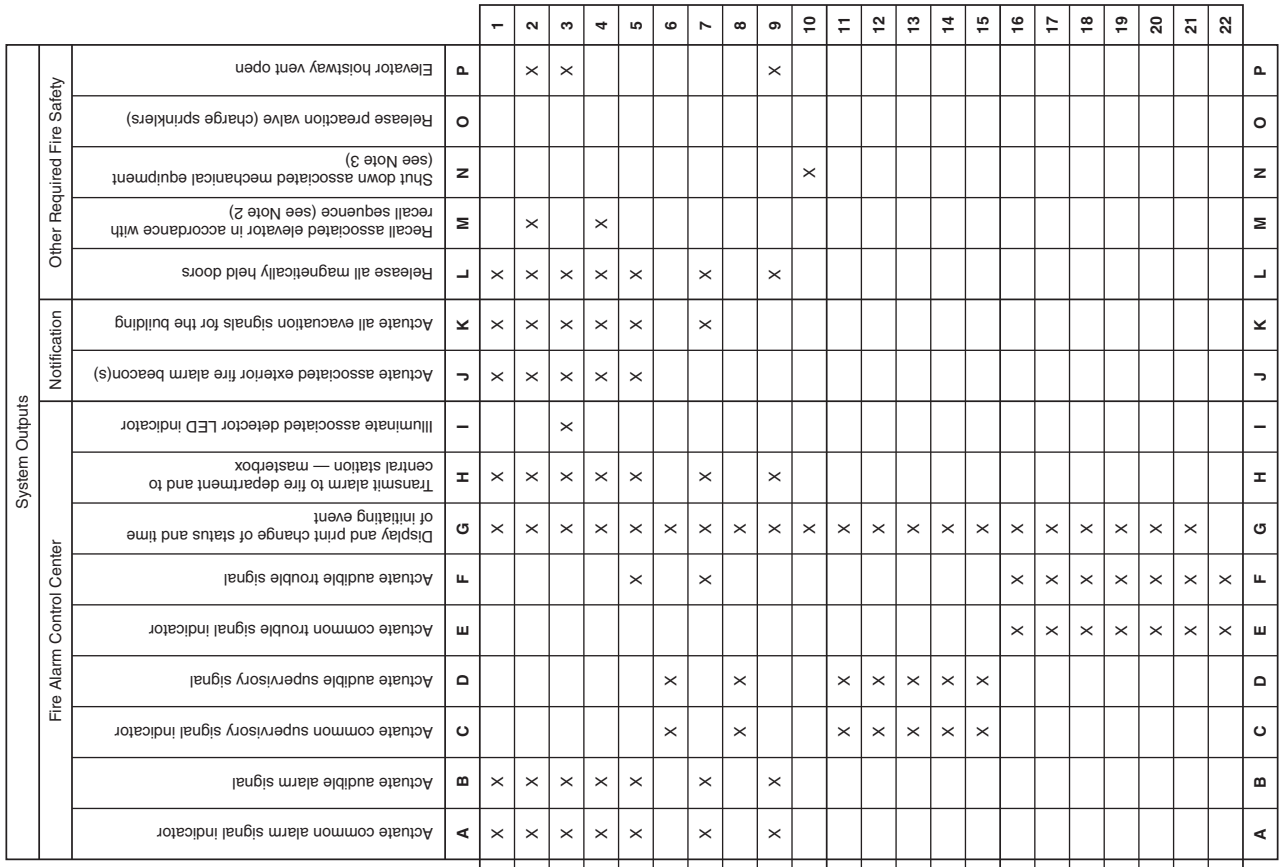

System Inputs				System Outputs																					
				Fire Alarm Control Center												Notification		Other Required Fire Safety							
				A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P						
				Actuate common alarm signal indicator	Actuate audible alarm signal	Actuate common supervisory signal indicator	Actuate audible supervisory signal	Actuate common trouble signal indicator	Actuate audible trouble signal	Display and print change of status and time of initiating event	Transmit alarm to fire department and to central station — masterbox	Illuminate associated detector LED indicator	Actuate associated exterior fire alarm beacon(s)	Actuate all evacuation signals for the building	Release all magnetically held doors	Recall associated elevator in accordance with recall sequence (see Note 2)	Shut down associated mechanical equipment (see Note 3)	Release preaction valve (charge sprinklers)	Elevator hoistway vent open						
Fire Alarm System	Fire Alarm Inputs	1	Typical manual pull station (by device) — levels 1–5	X	X					X	X		X	X	X									
		2	Typical elevator recall smoke detector (by device) — by floor (lobby)	X	X					X	X		X	X	X	X			X					
		3	Elevator machine room smoke detector	X	X					X	X	X	X	X	X				X					
		4	Typical smoke detector (by device) — computer room (third floor) — preaction system	X	X					X	X		X	X	X	X								
		5	Typical wet sprinkler system flow control valve assembly flow switch — by floor	X	X				X	X	X		X	X	X									
		6	Typical wet sprinkler system flow control valve assembly tamper switch — by floor			X	X			X														
		7	Typical preaction sprinkler system flow control valve assembly flow switch — by floor	X	X				X	X	X			X	X									
		8	Typical preaction sprinkler system flow control valve assembly tamper switch — by floor			X	X			X														
		9	Kitchen cafeteria ansul system — first floor	X	X					X	X				X				X					
		10	Typical duct-in smoke detector (by device) — by floor							X							X							
Building		11	Fire pump running			X	X			X														
		12	Fire pump power failure			X	X			X														
		13	Fire pump phase reversal			X	X			X														
		14	Fire pump connected to emergency power			X	X			X														
		15	Fire pump circuit breaker at generator output			X	X			X														
FACP		16	Fire alarm system open circuit					X	X	X														
		17	Fire alarm system ground fault					X	X	X														
		18	Fire alarm system battery disconnect					X	X	X														
		19	Fire alarm system low battery					X	X	X														
		20	Fire alarm system ac power failure					X	X	X														
Misc.		21	Fire alarm system amplifier failure					X	X	X														
		22	Generator status indicator					X	X															

Notes:
1. Five-story office building, use Group B. Cafeteria (use Group A) on first floor equipped with an ansul system. Computer room on third floor equipped with a preaction system.
2. Upon activation of elevator recall the elevator should stop at primary recall floor. If fire is on primary recall floor the elevator should stop at an alternate recall floor. Primary and alternate recall floor should be coordinated with the fire department.
3. Shutdown of mechanical equipment should be interfaced with building automation system.

FIGURE A.3.3.16(a) *Sequence of Operation.*

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SEQUENCE OF OPERATION TEST FORM

Building Information

Building name: _____

Building address: _____

Owner's name: _____

Owners address: _____

Owner's phone/fax/e-mail: _____

Installing Contractor

Company name: _____

Address: _____

Contact person: _____

Phone/fax/e-mail: _____

System Input	System Output	Test Results	Date	Initials
1. Typical manual pull station (by device) floors 1–5	A. Actuate common alarm signal indicator			
	B. Actuate audible alarm signal			
	G. Display and print change of status and time of initiating event			
	H. Transmit alarm to FD and central station masterbox			
	J. Actuate associated exterior fire alarm beacons			
	K. Actuate all evacuation signals for the building			
	L. Release all magnetically held doors			
2. Typical elevator recall smoke detector (by device) by floor (lobby)	A. Actuate common alarm signal indicator			
	B. Actuate audible alarm signal			
	G. Display and print change of status and time of initiating event			
	H. Transmit alarm to FD and central station masterbox			
	J. Actuate associated exterior fire alarm beacons			
	K. Actuate all evacuation signals for the building			
	L. Release all magnetically held doors			
	M. Recall associated elevator in accordance with recall sequence			
	P. Elevator hoistway open			
3. Elevator machine room smoke detector	A. Actuate common alarm signal indicator			
	B. Actuate audible alarm signal			
	G. Display and print change of status and time of initiating event			
	H. Transmit alarm to FD and central station masterbox			
	I. Illuminate associated detector LED indicator			

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FIGURE A.3.3.16(b) *Sequence of Operation Form.*

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SEQUENCE OF OPERATION TEST FORM *(continued)*

System Input	System Output	Test Results	Date	Initials
3. Elevator machine room smoke detector *(continued)*	J. Actuate associated exterior fire alarm beacons			
	K. Actuate all evacuation signals for the building			
	L. Release all magnetically held doors			
	P. Elevator hoistway open			
4. Typical smoke detector (by device) computer room (3rd floor) preaction system	A. Actuate common alarm signal indicator			
	B. Actuate audible alarm signal			
	G. Display and print change of status and time of initiating event			
	H. Transmit alarm to FD and central station masterbox			
	J. Actuate associated exterior fire alarm beacons			
	K. Actuate all evacuation signals for the building			
	L. Release all magnetically held doors			
	M. Recall associated elevator in accordance with recall sequence			
5. Typical wet sprinkler system flow control valve assembly flow switch — by floor	A. Actuate common alarm signal indicator			
	B. Actuate audible alarm signal			
	F. Actuate audible trouble signal			
	G. Display and print change of status and time of initiating event			
	H. Transmit alarm to FD and central station masterbox			
	J. Actuate associated exterior fire alarm beacons			
	K. Actuate all evacuation signals for the building			
	L. Release all magnetically held doors			
6. Typical wet sprinkler system flow control valve assembly tamper switch — by floor	C. Actuate common supervisory signal indicator			
	D. Actuate audible supervisory signal			
	G. Display and print change of status and time of initiating event			
7. Typical preaction sprinkler system flow control valve assembly flow switch — by floor	A. Actuate common alarm signal indicator			
	B. Actuate audible alarm signal			
	F. Actuate audible trouble signal			
	G. Display and print change of status and time of initiating event			
	H. Transmit alarm to FD and central station masterbox			
	K. Actuate all evacuation signals for the building			
	L. Release all magnetically held doors			
8. Typical preaction sprinkler system flow control valve assembly tamper switch — by floor	C. Actuate common supervisory signal indicator			
	D. Actuate audible supervisory signal			
	G. Display and print change of status and time of initiating event			

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FIGURE A.3.3.16(b) *Continued.*

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SEQUENCE OF OPERATION TEST FORM *(continued)*

System Input	System Output	Test Results	Date	Initials
9. Kitchen cafeteria wet chemical system — 1st floor	A. Actuate common alarm signal indicator			
	B. Actuate audible alarm signal			
	G. Display and print change of status and time of initiating event			
	H. Transmit alarm to FD and central station masterbox			
	L. Release all magnetically held doors			
	P. Elevator hoistway open			
10. Typical duct smoke detector (by device) — by floor	G. Display and print change of status and time of initiating event			
	N. Shutdown associated mechanical equipment			
11. Fire pump running	C. Actuate common supervisory signal indicator			
	D. Actuate audible supervisory signal			
	G. Display and print change of status and time of initiating event			
12. Fire pump power failure	C. Actuate common supervisory signal indicator			
	D. Actuate audible supervisory signal			
	G. Display and print change of status and time of initiating event			
13. Fire pump phase reversal	C. Actuate common supervisory signal indicator			
	D. Actuate audible supervisory signal			
	G. Display and print change of status and time of initiating event			
14. Fire pump connected to emergency power	C. Actuate common supervisory signal indicator			
	D. Actuate audible supervisory signal			
	G. Display and print change of status and time of initiating event			
15. Fire pump circuit breaker at generator output	C. Actuate common supervisory signal indicator			
	D. Actuate audible supervisory signal			
	G. Display and print change of status and time of initiating event			
16. Fire alarm system open circuit	E. Actuate common trouble signal indicator			
	F. Actuate audible trouble signal			
	G. Display and print change of status and time of initiating event			
17. Fire alarm system ground fault	E. Actuate common trouble signal indicator			
	F. Actuate audible trouble signal			
	G. Display and print change of status and time of initiating event			

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FIGURE A.3.3.16(b) *Continued.*

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SEQUENCE OF OPERATION TEST FORM *(continued)*

System Input	System Output	Test Results	Date	Initials
18. Fire alarm system battery disconnect	E. Actuate common trouble signal indicator			
	F. Actuate audible trouble signal			
	G. Display and print change of status and time of initiating event			
19. Fire alarm system low batttery	E. Actuate common trouble signal indicator			
	F. Actuate audible trouble signal			
	G. Display and print change of status and time of initiating event			
20. Fire alarm system ac power failure	E. Actuate common trouble signal indicator			
	F. Actuate audible trouble signal			
	G. Display and print change of status and time of initiating event			
21. Fire alarm system amplifier failure	E. Actuate common trouble signal indicator			
	F. Actuate audible trouble signal			
	G. Display and print change of status and time of initiating event			
22. Generator status indicator	E. Actuate common trouble signal indicator			
	F. Actuate audible trouble signal			

Date system left in service: _____

Test Witnessed by

Owner/authorized agent	Title	Date
Owner/authorized agent	Title	Date

Additional explanations/notes: _____

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FIGURE A.3.3.16(b) *Continued.*

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Myth vs Fact

MYTH: All integrated systems contain physical interconnections.

FACT: Integrated systems do not need to be interconnected. For example, a pressurized stair shaft relies upon an active system consisting of fans, ductwork, and louvers, as well as a passive system consisting of shaft wall construction that keeps the space pressurized as intended. All interconnected systems are considered integrated systems.

3.3.18.3* Life Safety Systems. Those systems that enhance or facilitate evacuation, smoke control, compartmentalization, and/or isolation. [**1031,** 2009]

A.3.3.18.3 Life Safety Systems. Life safety systems can include both active and passive fire protection systems, devices, or assemblies. These systems are comprised of several items of equipment, processes, actions, or behaviors, grouped or interconnected so as to reduce injuries or death from fire or other life-threatening event.

3.3.18.4* Passive Fire Protection System. Any portion of a building or structure that provides protection from fire or smoke without any type of system activation or movement.

A.3.3.18.4 Passive Fire Protection System. Examples of passive systems include, but are not limited to, floor-ceilings and roof, door, window, and wall assemblies, spray-applied fire-resistant materials, and other fire and smoke control assemblies. Passive fire protection systems can include active components and can be impacted by active systems, such as fire dampers.

FAQ

Why are passive fire protection systems, such as fire-rated walls and doors, discussed in this document?

Fire-rated doors and walls are important fire protection systems in the built environment, and therefore, they should be considered part of the commissioning plan. They also can be part of integrated systems. Fire-rated doors are often integrated with fire alarm systems. Fire-rated walls and doors are involved in the successful operation of smoke management systems and gaseous fire protection systems. As such, their installation and maintenance become part of an integrated testing plan.

3.3.19 System Connection.

3.3.19.1* Integrated System. A combination of systems that are required to operate together as a whole to achieve the fire protection and life safety objectives.

A.3.3.19.1 Integrated System. An integrated system contains systems that are physically connected and others that are not. An integrated system can contain a combination of fire protection and life safety systems and non–fire protection and life safety systems

Terms-at-a-Glance

AHJ	Authority Having Jurisdiction	CxA	Commissioning Authority
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CAR	Corrective Action Reports	FCx	Fire and Life Safety Commissioning
CP	Commission Plan	FCxA	Fire Commissioning Agent
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(i.e., building systems such as elevators, HVAC systems, and automatic door closures) that might or might not be physically connected, but that are required to operate together as a whole to achieve overall fire protection and life safety objectives. For example, a smoke control system is often activated by water flow in a sprinkler system but the sprinkler system is not physically connected to the HVAC system. The physical connection is from the sprinkler system to the fire alarm system and then to the building automation system. Further examples of integrated systems include the need for wall integrity when using total flooding suppression agents or automatic door closers that are to close upon activation of smoke control systems or stair pressurization systems. See Figure A.3.3.19.1 for examples of integrated systems.

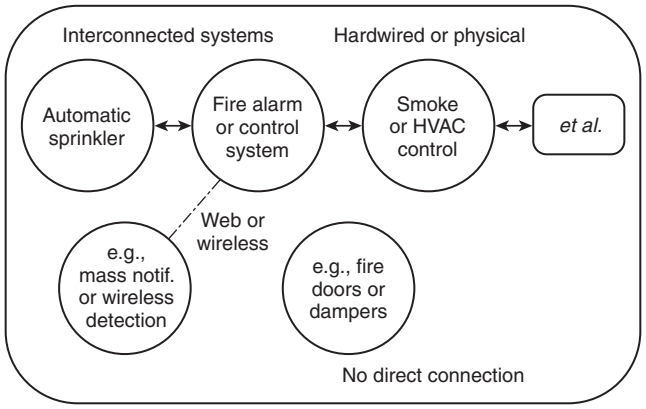

FIGURE A.3.3.19.1 *Integrated System.*

3.3.19.2 Interconnected System. An integrated system that has component systems or devices connected to achieve fire protection and life safety objectives.

3.3.19.2.1* Switch Connection. A subset of interconnected systems in which one system monitors a switch or relay in another system for either normal or not-normal conditions.

A.3.3.19.2.1 Switch Connection. For purposes of this definition, a relay is an electrically controlled switch. An example of a monitored switch is a waterflow switch that is either open or closed (normal/not-normal output), which when connected to the input of a fire alarm system can cause multiple outputs in the fire alarm system including sounding the waterflow bell and notification appliances, starting smoke control systems, and so forth. An example of a relay as a switch connection is for elevator control when a fire alarm relay controls when the fire fighters' recall occurs through the elevator control monitoring the status of the fire alarm relay.

Terms-at-a-Glance

HVAC	Heating, Ventilating, and Air Conditioning	OPR	Owner's Project Requirements
IL	Issues Log	RCx	Retro-Commissioning
ITa	Integrated Testing Agent	RDP	Registered Design Professional
ITx	Integrated Testing Plan	Re-Cx	Re-Commissioning
NIBS	National Institute of Building Sciences	RFQ	Request for Quotation
O&M	Operation and Maintenance	TAB	Testing and Balancing

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3.3.19.2.2* Data Sharing System. A subset of interconnected systems in which data streams are transferred between two or more control units.

A.3.3.19.2.2 Data Sharing System. Data sharing systems are connected such that data from one component system is shared with other component systems, which then make independent decisions to achieve a desired result. The communication can be one-way or two-way, serial or parallel. A data sharing system can have components that are switch connections too.

3.3.19.3* Interconnection. The physical connections between interconnected systems.

A.3.3.19.3 Interconnection. Interconnections could consist of electrical binary connections or data transfer protocols. Example of data transfers are BACnet or other data exchange protocols.

3.3.20 Systems Manual. A compilation of all operational and maintenance manuals and description of the integrated fire protection and life safety systems.

The concept of the systems manual is to gather together all of the various O&M manuals for all of the building systems, not just the fire protection and life safety systems. The systems manual should also include information on system changes and updates that happen during the occupancy phase.

As described in ASHRAE Guideline 0, the systems manual "should provide the information needed to understand, operate, and maintain the systems and assemblies and to inform those not involved in the design and construction process about the systems and assemblies."

The CxA is responsible for preparing and updating the systems manual. The FCxA is responsible for providing the CxA with O&M manuals and other information for the systems manual. However, when the Cx process is applied only to fire and life safety systems, the FCxA is responsible for creating a complete and accurate systems manual.

3.3.21 Testing.

In 5.2.2.6, NFPA 3 recommends that the FCxA organize, coordinate, and witness system testing. The individual system design standards such as NFPA 13, *Standard for the Installation of Sprinkler Systems*, and *NFPA 72®*, *National Fire Alarm and Signaling Code*, provide acceptance test requirements for the individual systems and their components. Since the scope of these documents does not permit them to address testing outside of the individual system, the most commonly referred to system test is the system acceptance test. Because NFPA 3 proposes more than the current acceptance testing addressed in the individual system design documents, the definitions for integrated testing and pre-functional testing have been included. It is imperative that the depth and breadth of testing be well-defined in the contract documents for each system. Much of the testing needed during the construction phase of the Cx process deals with integrated or interconnected systems.

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As such, it will often be necessary to have more than one trade or profession present to address system-specific issues that might arise during the test. In some instances, there might be a single technician who is trained to handle multiple systems such as sprinklers and fire alarms. In these cases, it is not necessary to have multiple trade representatives present for the testing. These concepts should be outlined in the commissioning and/or integrated testing plan. Understanding the definitions of the three types of tests discussed within this document will ensure clarity in the commissioning plan.

3.3.21.1 Acceptance Testing. Tests performed at the completion of installation to confirm compliance with applicable manufacturers' installation specifications, applicable codes and standards, and the project BOD and OPR.

An acceptance test is defined as functionally testing system components to verify that the individual system was installed and is operational in conformance with applicable standards and the AHJ. The key differentiator between this type of testing and commissioning is that acceptance testing applies to an individual system and is verifying compliance with installation standards. Commissioning is a holistic approach to system testing that provides verification that the systems will function as planned and can be operated and maintained as the owner needs them to.

FAQ

What are the differences between an acceptance test and commissioning?

NFPA 3 does not address acceptance testing of individual systems. The requirements for the acceptance testing of individual systems and their components can be found in the design and installation standards for those systems.

Critical Point

NFPA 3 does not address acceptance testing of individual systems. The requirements for the acceptance testing of individual systems and their components can be found in the design and installation standards for those systems.

3.3.21.2* Integrated Testing. An assessment of fire protection and life safety systems function and operation using direct observation or other monitoring methods to verify the correct interaction and coordination of multiple systems in conformance with the fire protection and life safety objectives.

A.3.3.21.2 Integrated Testing. Integrated testing can include other building systems integrated to fire and life safety systems such as elevator recall or HVAC control.

The issue of integrated testing is one of the major reasons that the NFPA Standards Council approved the creation of NFPA 3. There is no rule or requirement for how to perform the testing of integrated systems anywhere in the NFPA family of codes and standards. Some individual system standards have a few rules for certain integrated testing. However, the concept of integrated systems testing takes on a new meaning in NFPA 3.

The committee wanted to be very clear that the intent of NFPA 3 is not to address the individual system testing that is required by various system standards, but rather to recommend something often referred to as "end-to-end testing." This testing adequately describes what the committee discussed and considered to be "integrated testing."

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ITa	Integrated Testing Agent	RDP	Registered Design Professional
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The idea that a single action on one system could cause multiple actions on multiple systems needs to be shown to work in the field. These systems must work as designed and the only way to actually verify their functionality is to perform end-to-end or integrated testing.

3.3.21.3* Pre-Functional Testing. Tests performed prior to acceptance testing to confirm compliance with manufacturers' specification, applicable codes and standards, and the project BODs and OPRs.

A.3.3.21.3 Pre-Functional Testing. Pre-functional testing is conducted in preparation for other types of testing, including integrated testing and acceptance testing. This testing is typically conducted according to a checklist developed by the FCxA that incorporates manufacturers' requirements and ensures that equipment and components are functioning as intended prior to final acceptance testing. These tests can be complete or partial. In many cases, such as with fire pumps per NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, this is required prior to acceptance testing, as the coordination of attendance by multiple members of the commissioning team may be required. Pre-functional testing is synonymous with the term *preliminary testing*.

References Cited in Commentary

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Terms-at-a-Glance

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Qualifications of Commissioning Personnel

CHAPTER 4

Chapter 3 is included in NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems,* as a minimum recommendation for the qualifications of the fire protection and life safety commissioning (FCx) team members. It is important that members of the total building commissioning team be qualified for the area of work in which they are involved. This is particularly important for those members who will participate in the FCx team.

The NFPA 3 Technical Committee on Commissioning Fire Protection Systems did not try to specify either the exact level of experience needed or a specific license or certification required to fill each role. The intent of the committee was to make recommendations that will help the owner to address this issue and make an informed decision about who is the right person to fill a position. Different countries, states, and regions have varying requirements for the level of qualifications for many of the personnel involved in construction and, therefore, the commissioning (Cx) process. It is important for the owner and fire commissioning agent (FCxA) to understand that these jurisdictional licensure requirements are above and beyond the information provided in this chapter. While NFPA 3 does not address specific licensure for individuals on the team, the owner and FCxA need to be aware of any jurisdictional requirements that might be in play.

Critical Point

It is important that members of the total building commissioning team be qualified for the area of work in which they are involved.

See 5.2.2 for a list of recommended participants who should make up the FCx team. As discussed in Chapter 5, not every project will require an individual to fill each of the 13 roles identified, and in some cases, several people will perform the same commissioning function due to the size and schedule of the project.

4.1 Applicability

Members of the fire protection and life safety commissioning team should meet the requirements of this chapter.

There could be instances where certain recommendations for qualifications cannot be met. The inclusion of individuals who do not illustrate the qualifications outlined herein is at the discretion of the owner. In addition to the qualifications outlined in this chapter, it is important to refer to state and local ordinances for qualifications of individuals carrying out certain tasks that are included in the Cx process.

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Myth	Fact
MYTH: NFPA 3 requires commissioning team members to have specific certifications and licenses to be considered part of the team.	**FACT:** NFPA 3 does not require commissioning team members to have any specific licensure or certification. However, many jurisdictions have qualification requirements above and beyond what is stated in standards and recommended practices. These jurisdictional requirements should be verified on a project-by-project basis.

4.2 Qualifications

4.2.1 Fire Commissioning Agent (FCxA).

4.2.1.1* General.

A.4.2.1.1 Examples of individuals qualified to provide FCxA services can include, but are not limited to, the following individuals:

(1) Registered professional fire protection engineers
(2) Registered professional engineers in other disciplines with sufficient knowledge in the applicable fire protection and life safety systems
(3) Professionals experienced in the design, operation, or construction of the type of facility to be commissioned
(4) Professionals experienced in the design, operation, or installation of the type of fire and life safety systems installed

The FCxA should have no financial interest (owner, division or subsidiary, partner, operating officer, distributor, salesman, or technical representative) in any fire protection or life safety equipment manufacturers, suppliers, or installers for any such equipment provided as part of this project. As such, qualified independent third-party firms or individuals should be considered for designation as the FCxA. The FCxA should have a minimum of five years' experience in facility construction, inspection, acceptance testing, or commissioning as it relates to fire protection and life safety.

NFPA 3 recommends that the owner choose an FCxA as soon as the planning process begins. If it is not chosen right away, the design team should request that the owner identify and hire the appropriate person or entity for the project as soon as possible. NFPA 3 recommends certain skills that would be ideal for the FCxA to have, but the appropriate person for the position will depend on many factors, such as the project's complexity, budget, and location.

Terms-at-a-Glance

AHJ	Authority Having Jurisdiction	CxA	Commissioning Authority
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BOD	Basis of Design	ECS	Emergency Communication Systems
CAR	Corrective Action Reports	FCx	Fire and Life Safety Commissioning
CP	Commission Plan	FCxA	Fire Commissioning Agent
Cx	Commissioning	FMP	Facilities Management Personnel

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Myth vs **Fact**

MYTH: Based on their understanding of the construction projects and fire protection systems, the FCxA and general contractor should be one in the same.

FACT: The general contractor has financial stake in the project and cannot be considered unbiased from a scheduling point of view, so the general contractor and FCxA roles on the commissioning team should be filled by different people.

It is also important that the FCxA has experience commensurate with the complexity of the project in which they are involved. Certifications are available for those involved in the Cx process. While there are currently no certifications for the FCxA, there are certifications available through the Building Commissioning Association for those involved in the total building commissioning process. It is likely that there will soon be a designation that would be suitable for the FCxA. Until a standard is put forward for the minimum experience and qualification of the FCxA, NFPA 3 recommends that the owner and other team members be satisfied with the level of experience and knowledge that the FCxA holds.

NFPA 3 recommends that the FCxA be independent from the suppliers, installers, and manufacturers associated with the project or with any of the contracted services for the project, including the architectural and engineering firms that are part of the project's design team. The NFPA 3 committee places importance on this issue because it ensures that no one on the team has an ulterior motive.

Critical Point

The FCxA should be independent from the suppliers, installers, and manufacturers associated with the project or with any of the contracted services for the project, including the project's design team.

The FCxA is responsible for delivering the project in accordance with the commissioning plan, which would incorporate the requirements of all applicable codes and standards as well as the commissioning schedule. If the FCxA has a financial, contractual, or other relationship with other parties in the design and construction process, the FCxA might be more willing to stray from the commissioning plan in favor of keeping the project on schedule or not follow protocol to avoid financial implications.

The FCxA does not contract with any of the FCx team members but is usually under direct contract with the owner or builder. However, the FCxA will work directly with the owner, the design team (architect and engineers), the builder (the general contractor or the construction manager), the installing contractors (fire alarm, fire sprinkler, HVAC, drywall, etc.), and the facility's management and operations team (building superintendant, maintenance department supervisors, or leasing companies). The FCxA will document and maintain the commissioning record based on the work of these parties.

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ITa	Integrated Testing Agent	RDP	Registered Design Professional
ITx	Integrated Testing Plan	Re-Cx	Re-Commissioning
NIBS	National Institute of Building Sciences	RFQ	Request for Quotation
O&M	Operation and Maintenance	TAB	Testing and Balancing

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Case in Point

The unbiased perspective of the FCxA along with fiscal independence from other team members and vendors is critical. One of the primary goals of the FCxA is to execute the commissioning plan as constructed by the FCx team.

This plan is fundamentally generated based on key project documents such as the OPR and BOD.

Therefore, by executing the plan, the FCxA is confirming that the owner's requirements and expectations are being met, along with providing assurances that the owner is getting what was paid for. When an FCxA has financial stake in moving a project along to stay on schedule, shows bias to a certain team member(s), or accepts substandard materials or work to stay under budget, this is diametrically opposed to the basic principles of the entire commissioning process.

This concept can often make the FCxA's decisions unpopular on a construction site as errors are often highlighted that are otherwise swept under the rug; however, that is part-and-parcel to the role of the FCxA. Commissioning is about getting it done right, not getting it done quickly and inexpensively at the cost of the owner and, eventually, the building occupants.

4.2.1.1.1 The FCxA should be knowledgeable and experienced in the proper application of commissioning recommendations of this recommended practice and general industry practices.

4.2.1.1.2 The FCxA should be individually identified on the specifications or other enabling documentation.

4.2.1.1.3 The FCxA should provide an objective and unbiased point of view.

4.2.1.2 Requisite Knowledge. A qualified FCxA should have an advanced understanding of the installation, operation, and maintenance of all fire protection and life safety systems proposed to be installed, with particular emphasis on system integrated testing.

4.2.1.3 Requisite Skills. An FCxA should have the ability to do the following:

(1) Read and interpret drawings and specifications for the purpose of understanding system installation, testing, operation, and maintenance.
(2) Analyze and facilitate resolution of issues related to failures in fire protection and life safety systems.
(3) Provide clear, concise written reports and verbal communication, and have the ability to resolve conflicts.

The FCxA is the "go-to source" for all issues that arise during the Cx process for fire protection and life safety systems. This requires the FCxA to be a solid communicator and often act as an arbitrator between the various parties involved in the Cx process. This role highlights the need for the FCxA to be unbiased and unattached from the other parties involved in the Cx process. When issues arise that need sound technical decision making, the decision-making process cannot be compromised due to financial relationships with certain team members.

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4.2.2 Installation Contractor.

4.2.2.1 Installation contractors should be knowledgeable and experienced in the installation of the type of system proposed to be installed.

4.2.2.2* The installation contractor should submit evidence of required license or certification to the FCxA.

A.4.2.2.2 Installation contractors should be certified by an organization responsible for certification of technical installation personnel and approved by the AHJ.

Many jurisdictions require that installation contractors have licenses or qualifications to perform the work for which they are contracted. NFPA 3 recommends that the FCxA be responsible for documenting that the installation contractor has the appropriate licenses and qualifications for the work being performed. This will vary by ordinance, region, building owner, or insurer. These requirements might include carrying the appropriate levels of insurance or bonding while performing the work.

4.2.3 Registered Design Professional (RDP).

4.2.3.1 The RDP should be individually identified in the specifications or other enabling documentation.

4.2.3.2 Requisite Knowledge. A qualified RDP should have comprehensive knowledge of the following:

(1) The design, installation, operation, and maintenance of all systems proposed to be installed
(2) How individual and integrated systems operate during a fire or other emergency

There are many different requirements, based on jurisdiction, for the qualifications of the registered design professional (RDP). It is important that RDPs not practice outside of their area of expertise. Most state and regional licensing laws require that RDPs demonstrate a high level of ethics in their work and that they work only within their field of expertise. NFPA 3 recommends that the FCxA be responsible for verifying and documenting that the RDP is experienced in the field of fire protection and life safety. This can be accomplished by asking to see a state license, professional paperwork, proof of insurance, or some other appropriate documentation.

4.2.4* Construction Manager and General Contractor.

Construction managers and general contractors should be knowledgeable and experienced in the field of construction project management.

A.4.2.4 Construction managers and general contractors should possess skills in the following categories of construction management:

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O&M	Operation and Maintenance	TAB	Testing and Balancing

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(1) Project management planning
(2) Cost management
(3) Time management
(4) Quality management
(5) Contract administration
(6) Safety management
(7) Professional practice

This should include specific activities such as defining the responsibilities and management structure of the project management team, organizing and leading by implementing project controls, defining roles and responsibilities and developing communication protocols, and identifying elements of project design and construction likely to give rise to disputes and claims.

FAQ

Are the qualifications and requirements the same for construction managers and general contractors?

There are usually different qualifications for construction managers and general contractors. While a general contractor might be required to be licensed as a builder and installer, construction managers generally do not physically construct the building and have different requirements for licensing. The requirements for insurance and bonding are also relatively different for these roles. NFPA 3 recommends that the FCxA document the qualifications, licenses, and certifications of the construction manager or general contractor.

4.2.5 Facilities Management Personnel.

Facilities management personnel should include building maintenance and service personnel, building engineering personnel, and similar job functions.

4.2.5.1 Facilities management personnel should have the ability to perform the following:

(1) Assess a facility's need for building systems and recommend building systems.
(2) Oversee the operation of building systems.
(3) Establish practices and procedures.
(4) Administer the allocation of building systems resources.
(5) Monitor and evaluate how well building systems perform.
(6) Manage corrective, preventative, and predictive maintenance of building systems.
(7) Develop and implement emergency procedures and disaster recovery plans.

4.2.5.2* Facilities management personnel should be knowledgeable and qualified in the operation and maintenance of the fire protection and life safety systems installed in their facility.

A.4.2.5.2 The level of knowledge required should be commensurate with the level of interaction with the systems.

4.2.5.3 Facilities management personnel who perform the ongoing system operation, inspection, testing, and maintenance should be thoroughly familiar with the required and recommended operation and maintenance tasks.

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Case in Point

Not all facilities management personnel will be brought onto a project with the requisite knowledge on all systems that are installed. Many buildings contain unique and less-frequently installed systems such as aerosol suppression systems or air sampling systems. These systems require detailed maintenance practices that are often manufacturer-specific and could require on-site training. This highlights the need for facilities management training and a comprehensive O&M manual as discussed throughout NFPA 3.

4.2.5.4 Facilities management personnel who will be responsible for management of a contract for system operation, inspection, testing, and maintenance should be thoroughly familiar with the tasks to be performed and the frequency of such tasks, but not necessarily the implementation of those tasks.

Facilities management personnel generally work for the owner and should be named as part of the Cx team as they become involved in the project. They can get involved as early as the planning phase or as late as the occupancy phase. The timing of their involvement will vary due to many factors, including whether the owner is the occupant, when the planning for occupancy begins, and the size and scope of the project. Facilities management personnel need to have a very wide array of knowledge regarding building operations. NFPA 3 recommends that they understand the operation of the fire protection and life safety systems for their building. This has not been the case in many buildings in the past, and this represents a new standard that is expected of facilities management personnel.

4.2.6 Third-Party Test Entity.

4.2.6.1 Third-party test entities should have an advanced understanding of the installation, operation, and maintenance of all fire protection and life safety systems proposed to be tested, with particular emphasis on system integrated testing.

4.2.6.2* Third-party test entities should be licensed or certified where required by the AHJ and/or codes and standards.

A.4.2.6.2 License and/or certification requirements can be provided by the AHJ or other applicable NFPA or industry standards.

4.2.6.3 The third-party test entities should have the ability to do the following:

(1) Read and interpret drawings and specifications for the purpose of understanding system installation, testing, operation, and maintenance.
(2) Provide good written, verbal, conflict resolution, and organizational skills.

Critical Point

NFPA 3 does not identify specific licensure for third-party team members; however, this needs to be confirmed with the AHJ(s) on the project.

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Building owners often hire a third-party test entity to deliver an unbiased assessment of the performance of building systems. NFPA 3 recommends that the qualifications for this entity are the same as for the rest of the FCx team. They should have experience regarding fire protection and life safety systems. The FCxA should document the qualifications, experience, and insurance or bonding capacity of any third-party testing entity.

4.2.7* Authority Having Jurisdiction (AHJ).

A.4.2.7 Governmental AHJs (fire inspection personnel) should have the ability to determine the operational readiness of fire detection and alarm systems and fire suppression systems, given test documentation and field observations, so that systems are in an operational state. Fire inspection personnel should be able to verify code compliance of heating, ventilating, and air conditioning (HVAC) equipment and operations so that the systems and other equipment are maintained in accordance with applicable codes and standards. In addition, fire inspection personnel involved in fire protection system commissioning should be able to witness an acceptance test for integrated fire protection systems so that the test is conducted in accordance with the approved design and applicable codes and standards, and the system performance can be evaluated for compliance. Individuals should be able to demonstrate knowledge of the codes and standards related to the installation and operational requirements of integrated fire and life safety systems, such as elevator recall or operation of a smoke removal system upon activation of fire detection devices, or other integrated operations of fire protection systems in a structure in accordance with the applicable building, mechanical, and/or fire codes of the jurisdiction.

4.2.7.1 The AHJ should be knowledgeable in the applicable codes, ordinances, and standards as they relate to the fire protection and life safety systems installed.

There might be instances where an AHJ is not familiar with less-frequently installed systems and the standards that provide direction for their design and installation. In these instances, the AHJ can choose to use an independent third party to review these systems or certain portions of these systems.

4.2.7.2 The AHJ should have the ability to interface with the RDP and the commissioning authority in all phases of the commissioning process.

FAQ

How involved should the AHJ be in the commissioning process?

The AHJ might not have the ability to attend commissioning meetings and will not be available to the FCx team at all times. It is important, however, to include the AHJ in the Cx process as it will promote communication between the various parties. In some instances due to cost or schedule, the AHJ might choose to bring in a third party to review plans and provide inspections. In this instance, the third party needs to make themselves available to the FCx team at each phase of the process.

4.2.7.3 The AHJ should have the ability to determine the operational readiness of the fire protection and life safety systems installed.

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Myth vs **Fact**

MYTH: The AHJ must complete the tasks assigned to them on the project by the commissioning team — specifically, items identified in the roles and responsibilities matrix.

FACT: The AHJ is the loan commissioning team member not employed by the owner. The AHJ is not under a contractual obligation with the owner to perform any level of service but is only required to perform the services required by their jurisdiction.

In instances where the AHJ is not comfortable determining the operational readiness of certain systems that are not commonly installed, such as air sampling detection systems or AFFF suppression systems, the AHJ might choose to bring in a third-party reviewer to serve this function.

4.2.7.4 The AHJ should have the ability to interface with the fire protection and life safety commissioning team in order to verify completion of integrated testing for the purpose of system acceptance.

NFPA 3 recommends that the various members of the FCx team interact with the AHJ to demonstrate that their installation complies with local codes, standards, and laws. The FCxA should communicate with the AHJ from to time to ensure that the project is progressing as expected and meets the AHJ's approval. The FCxA will verify and document the relationship between the AHJ and the installers by collecting and recording the acceptance documentation for each system being installed.

Critical Point

The various members of the FCx team should interact with the AHJ to demonstrate that their installation complies with local codes, standards, and laws.

4.2.8 Integrated Testing Agent (ITa).

4.2.8.1 The ITa should have an understanding of the design, installation, and operation and maintenance of the type of fire protection and life safety systems installed.

4.2.8.2 The ITa should demonstrate experience and knowledge of performance verification methods to validate functionality of integrated systems and components.

4.2.8.3 The ITa should demonstrate knowledge, experience, and understanding of the operating components of all systems and subsystems to the extent they affect the installation and operation of the fire protection and life safety systems in accordance with the approved design.

The concept of an integrated testing agent (ITa) is relatively new in the design and construction industry. There are no standards or certifications that allow an individual to be a "qualified ITa." NFPA 3 recommends that the minimum qualifications specified in 4.2.8

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Case in Point

The level of understanding necessary for an ITa will vary based on the systems installed. Some buildings might have only a fire alarm system and sprinkler system, in which case the pool of people that would qualify as an ITa is rather large.

Where special suppression systems or other less frequently installed systems are considered in the design, the pool of qualified individuals is diminished. Where less frequently installed systems are included in the designs, the FCxA should work closely with the owner in selecting an ITa who illustrates sufficient experience in dealing with a wide range of system types, consistent with what is being installed.

Many of the less frequently installed systems are extremely complicated, and their interactions with other systems are equally complex. Due to their complexity, "on-the-job" training is not desirable as it can lead to delays and added costs. It is also a good idea to pull in the manufacturers where the ITa needs some assistance in setting up and executing test plans for complex systems.

are those that an ITa should have. As with every member of the FCx team, the ITa should have experience with each and every system being installed in the facility.

4.2.9 Insurance Representative.

The insurance representative should be knowledgeable and experienced in property loss prevention and life safety to mitigate possible risk.

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Commissioning

CHAPTER 5

This chapter of NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*, is a guide for creating a commissioning plan. It provides recommendations on what should be included in the commissioning process, who should be responsible for each piece and when they should be provided, and how to document the process at each step along the way. Also provided are general recommendations for a basis of design (BOD) document, suggestions for an acceptable operation and maintenance (O&M) manual, and recommendations for structured training programs for operating personnel. As stated earlier, NFPA 3 follows the structure outlined in ASHRAE Guideline 0, *The Commissioning Process*.

In general, the commissioning (Cx) process is the documentation of the planning, design, construction, and occupancy of a project. Commissioning is a quality control process that holds each of the stakeholders accountable by requiring documentation of their qualifications and activities through the fire commissioning agent (FCxA). The process follows the common industry path for building systems and is intended to assure the owner that they are receiving everything they contracted for and that their expectations are being met.

This chapter breaks down the recommendations for commissioning activities into project phases. For specific recommendations for each project phase, refer to Section 5.2 through Section 5.5.

To those individuals and companies that have been actively involved in commissioning of building systems, the benefits of the commissioning process are widely known. The process is a highly effective method of improving the performance of building systems

Case in Point

Leadership in Energy and Environmental Design (LEED) is a program developed by the U.S. Green Building Council (USGBC) consisting of a series of design and construction rating systems aimed at quantifying environmental and energy efficiencies by providing "credits" for buildings. The LEED program includes multiple levels of commissioning, with each level offering a different amount of credits.

Enhanced commissioning in the LEED program involves end-to-end commissioning, with commissioning activities taking place in both the design and construction phases of a project. A project using this method of commissioning receives more LEED credits than it would with "basic commissioning," as commissioning throughout all phases of a project leads to a greater assurance of system functionality.

The commissioning process described in NFPA 3 is similar to that used in LEED enhanced commissioning, as commissioning activities are recommended throughout the life of a project. The systems considered in NFPA 3 differ from those addressed in the LEED program; however, the need for a verification system to increase building functionality and reliability is equally important, as an improperly working life safety system could lead to a major financial loss or loss of life.

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and equipment and reducing the cost of building ownership and management over the life span of the property. One industry that has been ahead of the curve in terms of commissioning is the environmental design industry.

5.1 General

5.1.1* This chapter provides the recommendations for commissioning fire protection and life safety systems.

A.5.1.1 The fire protection and life safety commissioning team should review with the owner and AHJ to determine the systems that should be subject to commissioning. Commissioning might not be required for all facilities, systems, or components. However, acceptance and integrated testing should still be performed. A reasonable degree of protection for life and property can be provided by acceptance and integrated testing for small systems or those integrated systems having simple logic. For examples of roles and responsibilities, see Table A.5.1.1.

It is critical that the roles and responsibilities be clearly defined if the commissioning plan is to be successful. The request for quotation (RFQ) or the project specification should contain this information.

5.1.2* Commissioning of fire protection and life safety systems should include, but not be limited to, the planning phase, design phase, construction phase, and occupancy phase. *[See Figure A.5.1.2(a), Figure A.5.1.2(b), and Figure A.5.1.2(c).]*

Critical Point

This document does not propose any broad changes to the construction process and should not change the way buildings are planned, designed, or built.

The four phases of planning, design, construction, and occupancy comprise the structure of commissioning. It is intended that these phases mimic the construction process itself. As such, it is important to remember that these phases are a general outline of what is expected during the Cx process and who will be responsible for performing certain portions of the process. Because it is a general outline, it should be understood that these phases might overlap and not have definite "beginning" and "end" points. It is not the intent of this document that one phase must be complete before another phase begins.

It should be clear that this document does not propose any broad changes to the construction process and should not change the way buildings are planned, designed, or built. This document recommends only that appropriate documentation be administered, maintained, and delivered to demonstrate the building was built as planned with approved modifications. The documentation should be updated for the life of a building if the owner intends to follow the Cx process.

A.5.1.2 Figure A.5.1.2(a), Figure A.5.1.2(b), and Figure A.5.1.2(c) are offered to provide an example of how to perform a commissioning plan.

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TABLE A.5.1.1 *Roles and Responsibility Matrix*

	Owner	Facility Manager or Operations Personnel	Insurance Rep	Owner Technical Support	Construction Manager	Installation Contractor	Cx Agent	RDP
Planning Stage								
Identify commissioning team	L/A	S	S	P/S	—	—	—	—
Develop owner's project requirements	L/A	S	S	S	—	—	—	—
Develop preliminary commissioning scope	L	S	S	P/S	—	—	—	—
Develop preliminary commissioning plan	L	S	S	S	—	—	—	—
Establish budget for all Cx work and integrate costs for commissioning into project budget	L	S	—	S	—	—	—	—
Include time for Cx in initial project schedule	L	I	I	I	—	—	—	—
Include Cx responsibilities in architect/engineer and construction manager scope of services	L/A	S	—	S	—	—	—	—
Design Stage								
Contract for commissioning agent services	L/A	P	—	P	L	—	—	—
Hold design stage Cx meetings	P	P	P	P	P	—	L	P
Identify project-specific responsibilities	L	L	—	S	S	—	P	P
Review owner's project requirements documentation for completeness and clarity	S	S	I	—	I	—	L	I
Develop basis of design	A	P	P	S/A	I	—	I	L
Perform focused Cx reviews of design drawings and specifications	P	P	P	P	S	—	L	S
Perform project constructability reviews	P	—	—	I/P	L	—	I/S	S
Incorporate appropriate changes to construction documents based upon design reviews	A	P	—	I	I	—	I	L
Refine owner's project requirements based upon design stage decisions	A	P	—	S	I	—	L	S
Create Cx specifications including testing protocols for all commissioned equipment systems	I	I	I	P/S	S	—	L	S

(continues)

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TABLE A.5.1.1 Continued

	Owner	Facility Manager or Operations Personnel	Insurance Rep	Owner Technical Support	Construction Manager	Installation Contractor	Cx Agent	RDP
Integrate Cx activities into project schedule	A	I	—	I	L	—	S	I
Coordinate integration issues and responsibilities between equipment, systems, and disciplines	A	I	—	P/S	S	—	V	L
Update commissioning plan	A	I	I	I	S	—	L	I
Incorporate commissioning requirements into construction contractor's scope of work	A	—	—	I	L	—	S	S
Construction Stage								
Revise commissioning plan as necessary	A	I	—	I	I	S	I	L
Review submittals applicable to equipment/systems being commissioned	I	—	A	P	A	S	S	L
Review project submittals for construction quality control and specification conformance	I	—	—	I/P	A	L	S	V
Develop functional test procedures and documentation formats for all commissioned equipment and assemblies	A	I	I	S/A	S	S	I	L
Include Cx requirements and activities in each purchase order and subcontract written	A	—	—	—	—	A	L	V
Develop construction checklists for equipment/ systems to be commissioned	A	—	—	P	I	I	I	L
Install components and systems	I	I	—	—	A	A	L	V
Review requests for information and changes for impacts on Cx	A	I	—	I/S	S	L	S	V
Demonstrate operation of systems	I	—	P/I	—	I	P	L	V
Complete construction checklists as the work is accomplished	I	I	—	I	I	S	L	A
Continuously maintain the record drawings and submit as detailed in the construction documents	A	S	—	—	I	S	L	V

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TABLE A.5.1.1 *Continued*

	Owner	Facility Manager or Operations Personnel	Insurance Rep	Owner Technical Support	Construction Manager	Installation Contractor	Cx Agent	RDP
Coordinate functional testing for all commissioned systems and assemblies	I	I	—	P/A	I	S	S	L/A
Perform quality control inspections	I	—	I	I/P	—	L	S	P/I
Maintain record of functional testing	I	I	I	I/P	I	S	S	L
Prepare Cx progress reports	A	I	—	I/P	I	P	S	L
Hold construction phase Cx meetings	P	P	P	P	P	P	P	L
Maintain master issues log	I	I	—	I	I	S	I	L
Review equipment warranties to ensure owner responsibilities are clearly defined	I	I	—	—	—	S	S	L
Implement training program for operating personnel	I	P	P	I/S	P	S	S	L
Compile and deliver turnover package	A	A	—	—	S	S	L	S/V
Deliver commissioning record	A	P	—	I	S	S	S	L
Occupancy Stage								
Coordinate and supervise deficiency corrections	A	P	—	I	I/S	L	S	I
Coordinate and supervise deferred and seasonal testing	A	P	—	I	—	S	—	I
Review and address outstanding issues	A	P	I	I	I/S	S	S	I
Review current building operation at 10 months into 12-month warranty period	A	P	I	I	S	S	—	I
Address concerns with operating facility as intended	A	P	I	I	S	S	S	S
Complete final commissioning report	A	P	—	—	I/P	I	—	I
Perform final satisfaction review with customer agency 12 months after occupancy	A	S	I	S	—	S	—	S

L: Lead. P: Participate. S: Support. I: Inform. A: Accept. V: Verify.

Note: The following definitions apply to Table A.5.1.1:

Lead (L) = Direct and take overall responsibility for accomplishment

Support (S) = Provide assistance

Accept (A) = Formally accept either in writing or verbal communication depending on the situation

Participate (P) = Take part in the activity (e.g., attend meetings)

Inform (I) = Make the party aware of the activity or result or provide a copy of the deliverable

Verify (V) = Confirm the accuracy or completeness of the task

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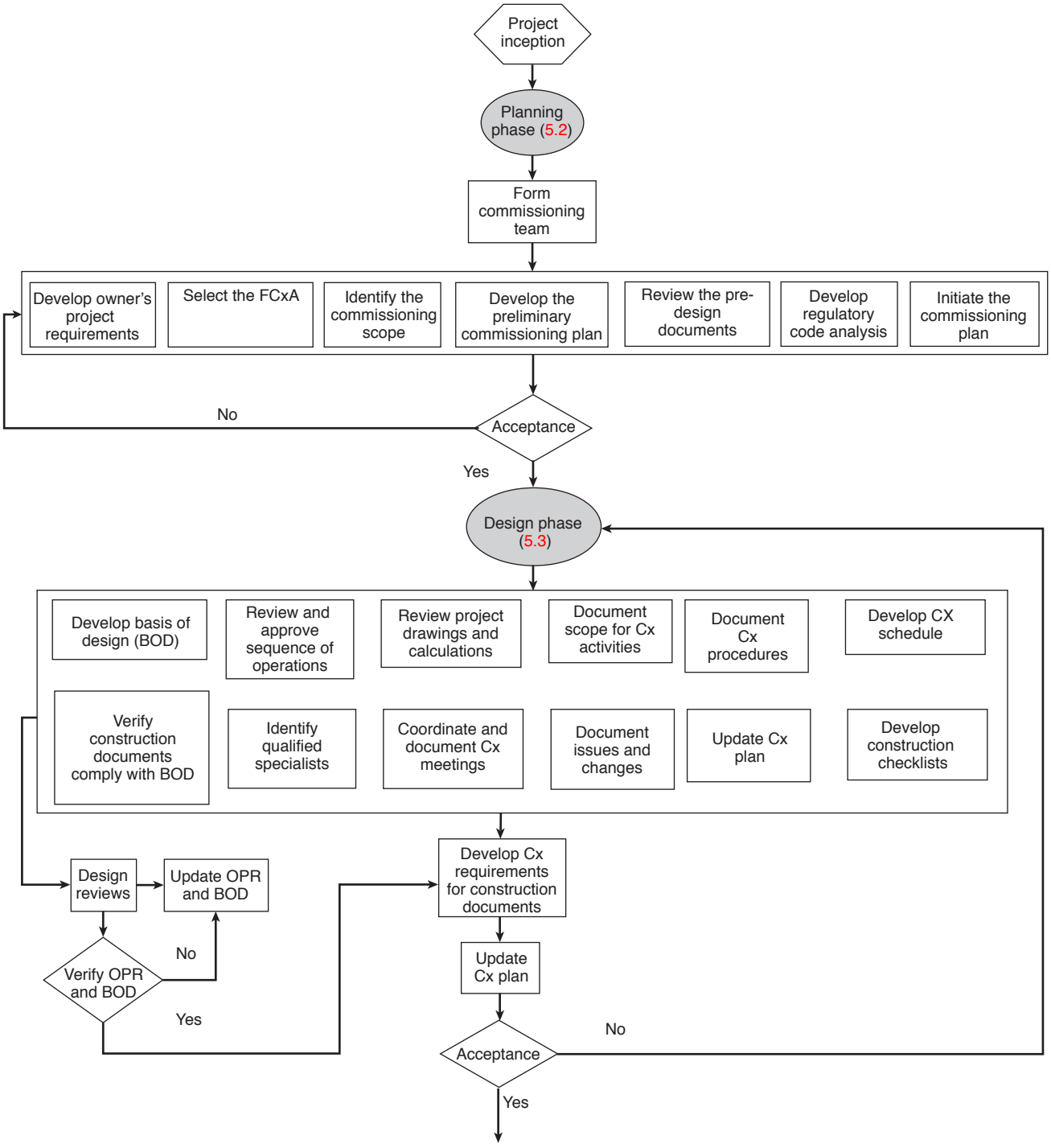

FIGURE A.5.1.2(a) *The Commissioning Process — Design Phase.*

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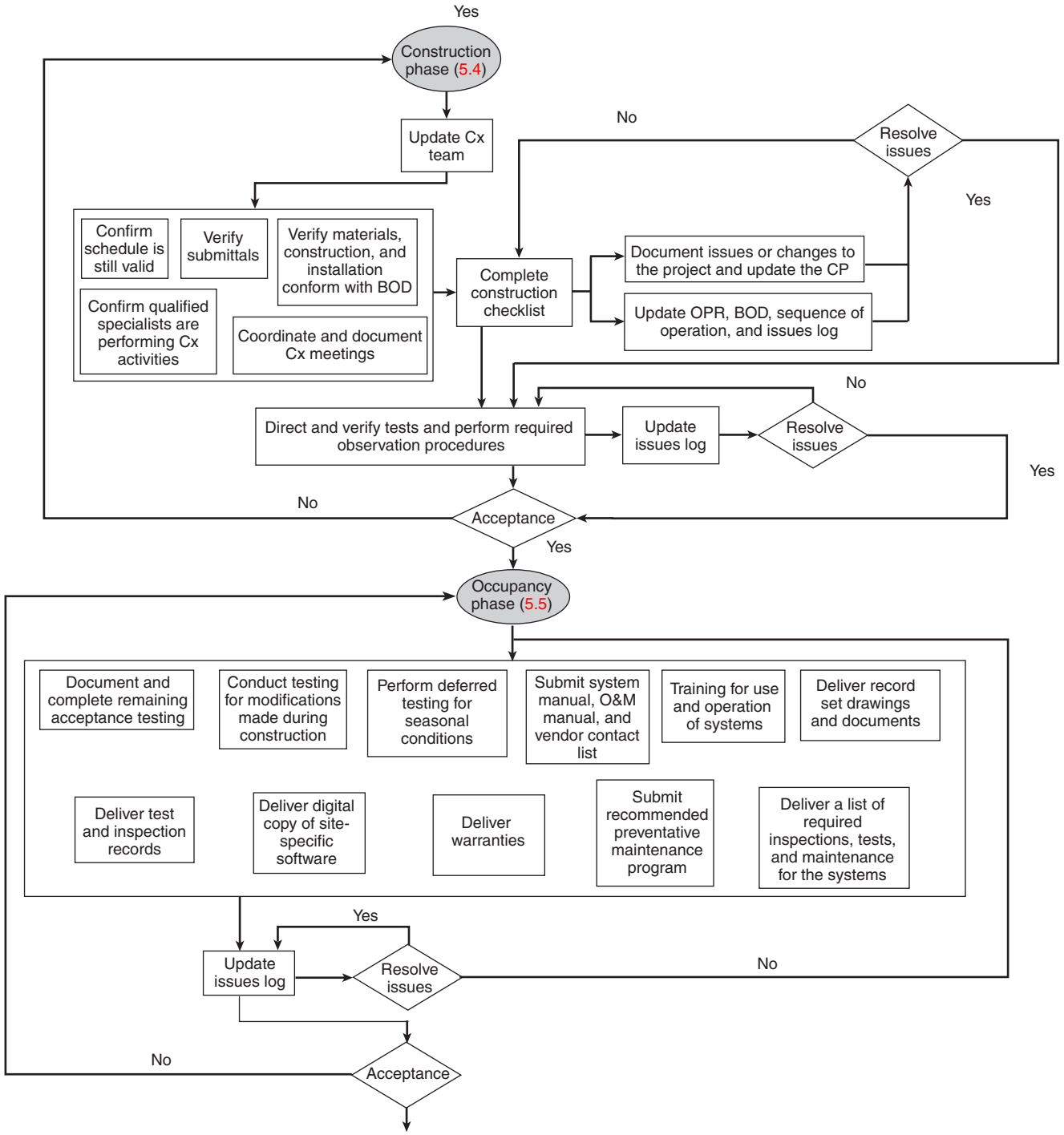

FIGURE A.5.1.2(b) *The Commissioning Process — Construction and Occupancy Phase.*

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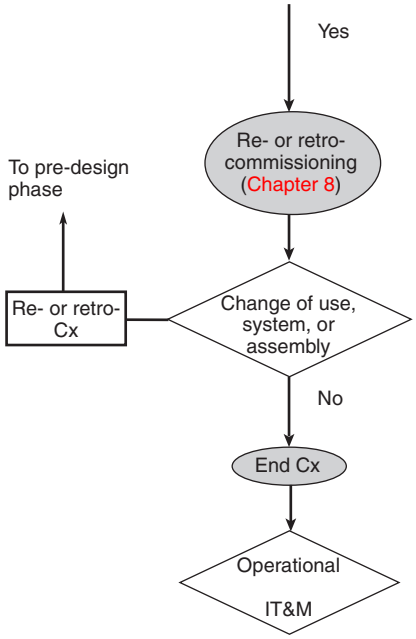

FIGURE A.5.1.2(c) *The Commissioning Process — Ongoing Commissioning.*

5.2 Planning Phase

Section 5.2 discusses the planning phase. This section defines the fire and life safety commissioning (FCx) team and lists the responsibilities of various team members throughout the Cx process. With this information in place, this section then calls for creation of the owner's project requirements (OPR) and the commissioning plan.

5.2.1 Activities.

5.2.1.1* The fire protection and life safety commissioning team should be established during the planning phase.

FAQ

Are there certain FCx team members who can be added after the planning phase?

It is recommended that the team be established during the planning phase, but not necessarily completely filled out at that time. Often team personnel such as facilities managers, third party review personnel, installing contractors, and general contractors are not identified until well into the design phase, which is acceptable. The sooner these roles can be filled the better, as it helps to stabilize project documents such as the Cx plan, roles and

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Myth vs Fact

MYTH: The commissioning process flowcharts shown in Figure A.5.1.2(a) through Figure A.5.1.2(c) must be followed in sequence in order to successfully commission a system or building.

FACT: These flowcharts are intended to provide a snapshot of the commissioning process so the commissioning team can see how certain commissioning activities can impact other activities. Many commissioning projects will follow a similar path to what is outlined in these flowcharts; however, certain items can be omitted or rearranged based on project needs.

responsibilities matrix, and project schedule. The later in the process these individuals are added it makes it harder to manipulate these documents in a way that is agreeable to the owner and the rest of the FCx team.

A.5.2.1.1 The fire protection and life safety commissioning team can be part of a larger building commissioning team with team members whose focus is on commissioning electrical, mechanical, plumbing, and electronics systems. The overall team can be led by a commissioning authority whose responsibility is defined in ASHRAE Guideline 0, *The Commissioning Process*. The individuals and entities listed are not all inclusive and should be modified on a project by project basis. If the entity listed is not part of the project, it is not the intent of this standard to require those entities to become part of the project fire protection and life safety commissioning team. The number of members of the fire protection and life safety commissioning team should be determined by project type, size, and complexity.

The FCx team should start to come to life during the planning phase. The OPR is developed during this phase and is the basis on which all commissioning documentation is created. The size and composition of the FCx team will vary with each building. The team might not be fully appointed until the BOD has been created. Large projects will find the FCx team to be a subset of the total building commissioning team, with many more reporting requirements for a completely commissioned building. However, smaller projects may need a smaller team that has minimal reporting requirements in order to meet the OPR. The NFPA 3 committee purposefully created language that would allow a team to be the size needed for a particular project.

5.2.1.2 During the planning phase of the project, the fire protection and life safety commissioning team should do the following:

(1) Develop the OPR in accordance with Section 5.2.
(2) Select the FCxA.
(3) Identify the commissioning scope.
(4) Develop the preliminary commissioning plan in accordance with Section 5.2.

Terms-at-a-Glance

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Myth	Fact
MYTH: All 13 members listed in 5.2.2.1 must be included on all commissioning teams.	**FACT:** Depending on the size of the project and the types and number of systems present, the commissioning team can vary from five or six members to dozens of members.

(5) Review the planning documents in accordance with Section 5.2.
(6)* Develop regulatory code analysis.

A.5.2.1.2(6) This analysis should involve making direct contact with the various federal, state, and local regulatory agencies to verify what laws, rules, regulations, codes, standards, policies, and practices are in force and applicable to the project.

(7) Initiate the commissioning plan.

Planning phase activities are important in establishing the level of commissioning that will meet the owner's needs. The development of the OPR, the commissioning scope, and the regulatory code analysis will help the FCx team to fully understand the goals and the cost of commissioning. The completion of these activities leads to an effective kick-off of the commissioning process by the FCxA when the plan is initiated as identified in 5.2.1.2(7). The success of the commissioning effort will be most affected by these first steps.

5.2.2* Fire Protection and Life Safety Commissioning Team.

The fire protection and life safety commissioning team should be identified and documented.

A.5.2.2 Fire protection and life safety commissioning team members should be selected as their role in the project is established.

5.2.2.1 The exact size and members of the fire protection and life safety commissioning team can vary depending on project type, size, and complexity and could include the following members:

(1) Owner
(2) Commissioning authority
(3) FCxA
(4)* Installation contractor(s)

A.5.2.2.1(4) The installation contractor cannot be identified until the construction phase and therefore would not be a participant in the planning or design phases.

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(5)* Manufacturer's representatives

A.5.2.2.1(5) Manufacturer's representatives cannot be identified until the design phase and therefore would not be a participant during the planning phase.

(6) RDP(s)
(7) Construction manager/general contractor
(8) Owner's technical support personnel
(9) Facility manager or operations personnel
(10) Insurance representative
(11) Third-party test entity
(12)* AHJ

A.5.2.2.1(12) The definition of AHJ as set forth in 3.2.2 and A.3.2.2 provides information as to the large range of entities and individuals that can be an AHJ. Any and all AHJs should be included as part of the fire protection and life safety commissioning team to the extent they are deemed to need to be involved.

(13)* ITa

A.5.2.2.1(13) See 7.4.3 for the responsibilities of the ITa. The responsibilities of an ITa can be fulfilled by the FCxA.

5.2.2.2* Entities listed in 5.2.2 not included as part of the project should not be required to be part of the fire protection and life safety commissioning team.

A.5.2.2.2 The owner, FCxA, and RDP should be part of the fire protection and life safety commissioning team at this phase. Other key team members will be identified and selected as the project progresses and as their roles and responsibilities require their participation.

One of the first activities that the owner should do during the planning phase is to establish the FCx team (see 5.2.1.1). The exact time in the process at which this should happen is not specified. However, clearly identifying the team members early in the process will lead to better team cohesiveness and will add more structure to the commissioning roles and responsibilities matrix. In some instances, the owner, commissioning authority (CxA), and other individuals responsible for developing the FCx team might not have the foresight to identify each team member during the planning phase. In these instances, there is nothing that prohibits the team from adding members as the project dictates, but doing so might require revisions to project documentation, which should be identified and coordinated by the FCxA.

As the project enters the planning phase, the owner has likely selected the registered design professional (RDP) and might be able to identify the AHJ, general contractor, insurance representative, and other members of the FCx team. It will be necessary for the owner to employ the FCxA at this point for involvement in the planning phase activities.

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Myth	Fact
MYTH: The owner is obligated to hire only commissioning team personnel who meet the exact descriptions outlined in Chapter 4 of NFPA 3.	**FACT:** Hiring commissioning team members, with the exception of the AHJ, is at the discretion of the owner. It is not recommended that the owner hire individuals who cannot illustrate proficiency in all areas outlined in Chapter 4 for a specific team role; however, some on-the-job training might be necessary for certain roles on the team.

The owner should be advised and decide which of the other FCx team members should join the team for the specific project.

5.2.2.3 The fire protection and life safety commissioning team members should meet the requirements of Chapter 4.

Chapter 4 of NFPA 3 outlines minimum qualifications for the team members. However, 5.2.2.1 through 5.2.2.15 outline the responsibilities of each entity on the FCx team. This outline will help develop the commissioning scope and will also be useful in developing project specifications and requests for proposals (RFPs) for each of the FCx team members.

List items 5.2.1.2 (4) and (7) recommend that the commissioning plan be developed and initiated during the planning phase. This plan can be somewhat preliminary and is expected to evolve with the project. But as the plan is developed, it is important for the owner, RDP, and FCxA to understand and define the roles of each entity on the FCx team.

5.2.2.4 Owner.

5.2.2.4.1 The owner should be responsible for the commissioning of all fire and life safety systems.

5.2.2.4.2* The owner should be permitted to delegate the responsibility for commissioning to a designated representative.

Many owners feel that they have more important things to do than keep a watchful eye over the design and construction of their properties. Others simply do not feel that they have sufficient expertise or time to be part of the Cx process. For whatever reason, the owner can elect to delegate the owner's responsibilities in the Cx process to someone who can dedicate more time and effort to the execution of the process.

A.5.2.2.4.2 Examples of a designated representative include the occupant, management firm, or managing individual. Delegation can be through specific provisions in a lease, written use agreement, or management contract.

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Myth vs **Fact**

MYTH: In 5.2.2.4.1, the owner is required to be involved in every step of the commissioning process.

FACT: The owner is responsible for the commissioning of all fire and life safety systems from the standpoint of establishing the team and providing direction for the owner's requirements. Individual FCx team members are assigned roles and responsibilities, and it is up to them to complete those items, not the owner. The owner and FCxA are responsible for making sure those items are addressed, but they are not responsible for caring about them.

5.2.2.4.3 The owner responsibilities should include the following:

(1) Contracting and delegating the commissioning process
(2) Assisting in the development of and approval of the OPR
(3) Assigning operations and maintenance personnel to participate in the commissioning process
(4) Reviewing and approving any changes to the OPR
(5) Reviewing and approving the construction documents
(6) Reviewing and approving commissioning process progress reports
(7) Reviewing and approving the fire protection and life safety commissioning team progress reports
(8) Reviewing and approving the final commissioning report

Critical Point

The final commissioning report is primarily a tool for building owners.

It cannot be overstated that the final commissioning report is primarily a tool for building owners. The owner or the owner's representative will need to be very involved for commissioning to be successful and to see a value for the owner's investment. The Cx process will be complete only if the owner is diligent in fulfilling the responsibilities listed above, as described in the four phases of commissioning.

5.2.2.5* Commissioning Authority (CxA). The CxA should be responsible for coordinating between the FCxA and the remainder of the building commissioning team, when applicable.

Building commissioning and system commissioning are becoming more and more prevalent, especially in LEED-certified design and construction projects. Other building systems, such as mechanical systems or building envelope systems, might be commissioned and have their own system commissioning agents or system commissioning

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team leaders. The CxA is responsible for coordinating efforts across the spectrum of commissioning projects that are going on for the total building commissioning process.

A.5.2.2.5 A CxA will only be part of the fire protection and life safety commissioning team when the fire protection and life safety systems are included in a larger building commissioning process. If the scope of the project includes fire protection and life safety systems only, then a CxA will not be present nor part of the fire protection and life safety commissioning team.

5.2.2.6 Fire Commissioning Agent (FCxA). The FCxA responsibilities should include the following:

(1) Organize and lead the fire protection and life safety commissioning team.
(2) Coordinate and attend fire protection and life safety commissioning team meetings.
(3) Facilitate the development of and document the OPR.
(4) Verify that commissioning process activities are clearly stated in all scopes of work.
(5) Identify and integrate the commissioning process activities into the project schedule.
(6) Prepare the commissioning plan.
(7) Prepare the commissioning process activities to be included in the project specification.
(8) Execute the commissioning process.
(9) Review the plans and specifications during the planning and design phases.
(10) Attend pre-bid meeting to detail the commissioning contractor requirements.
(11) Review and approve the O&Ms to compile the systems manual.
(12) Track and document issues and deviations to the OPR and log resolutions in the issues log.
(13) Write and review commissioning process progress reports.
(14) Organize and coordinate system testing.
(15) Witness system testing.
(16) Review installation and record documents.
(17) Recommend acceptance of the systems to the owner.
(18) Track development, accuracy, and compliance with sequence of operation.
(19) Compile and submit the final fire protection and life safety commissioning team report to the owner.
(20) Compile and submit to the owner all fire protection and life safety systems commissioning documents required by the AHJ.

The FCxA is seen as the pivotal team member for completing the Cx process, and has the largest role to play in executing and documenting the Cx process. The FCxA will lead the FCx team in creating, recording, filing, and delivering the commissioning report to the owner. Coordinating and organizing meetings, inspections, tests, and documentation exist in every phase of the Cx process for the FCxA.

The FCxA might be part of the total building commissioning (Cx) team and report to the commissioning agent leading that team, which is typically the CxA mentioned in

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Myth vs Fact

MYTH: NFPA 3 significantly increases the amount of work that must be done by the installing contractors.

FACT: The majority of the work expected from an installation contractor as outlined in 5.2.2.7 is already being done or is already required to be done. NFPA 3 aims to clarify to installing contractors what is expected for project documentation and provide more structure to this role. Some items, including implementing training and developing test plans, are not universally done, but many contractors are already doing this work.

5.2.2.5. Or, the FCxA might be the only commissioning provider for the project, in which case, the FCxA would report directly to the owner or the owner's representative in accordance with their contractual arrangement.

5.2.2.7 Installation Contractor. The installation contractor responsibilities should include the following:

(1) Provide commissioning process requirements and activities as specified in the construction documents.
(2) Attend required fire protection and life safety commissioning team meetings.
(3) Include or comply with commissioning process milestones in the project schedule.
(4) Implement the training program as required by the construction documents.
(5) Provide submittals to the RDP, owner, and fire protection and life safety commissioning team.
(6) Develop an individual system test plan, including acceptance and integrated testing.
(7) Notify the general contractor, third-party test entity, and FCxA when systems are ready for testing.
(8) Demonstrate the performance of the systems, including integration.
(9) Complete the construction checklists as the work is accomplished.
(10) Continuously maintain the record drawings as required by the construction documents.

This list of responsibilities should come as no surprise to any qualified installation contractor, but the following items are two new concepts that previously have not been part of most installation contractors' activities:

- Item (4) recommends that the installation contractor develop and deliver a formal training program to the owner or occupants regarding the operation and maintenance of the system installed.

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- Items (6) and (8) recommend that the installation contractor participate in formal integrated testing for systems that are interconnected or integrated on a project.

5.2.2.8 Manufacturer's Representative. The manufacturer's representative responsibilities should include the following:

(1) Provide technical support to the installation contractor.
(2) Provide all information required for the operation and maintenance of the system.
(3) Provide the requirements to maintain the warranty as part of the initial submittal.
(4) Assist the installation contractor in the development of the individual systems test plans.
(5) Assist the installation contractor and fire protection and life safety commissioning team with installation verification and testing.
(6) Assist in development and implementation of system training.

This list of responsibilities becomes more important when the equipment or product provided by the manufacturer requires assistance or direction from the manufacturer to ensure proper installation, use, care, and maintenance. The following items are two concepts that are in the list of responsibilities for the manufacturer and the installer that are not addressed in many project documents not implementing a Cx process:

- Item (4) recommends that the manufacturer's representative participate in developing a formal testing plan for the system. Interconnected or integrated systems on a project will also need to have integrated testing performed. The integrated testing (ITx) plan will outline the manufacturer's roles and responsibilities for this portion of the work.
- Item (6) recommends that the installation contractor participate in formal integrated testing for systems that are interconnected or integrated on a project. The ITx plan will outline the installer's role and responsibilities for this portion of the work.

5.2.2.9 RDP. The RDP responsibilities should include the following:

(1) Participate and assist in the development of the OPR.
(2) Create and document the basis of design.
(3) Prepare construction documents.
(4) Respond to the fire protection and life safety commissioning team's design submission review comments.
(5) Specify operation and maintenance of systems in the project specification.
(6) Review and incorporate the fire protection and life safety commissioning team's comments, as appropriate.
(7) Review test procedures submitted by the installation contractor.
(8) Review and comment on the commissioning record.
(9) Review and accept record documents as required by the construction documents.

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CP	**Commission Plan**	**FCxA**	**Fire Commissioning Agent**
Cx	**Commissioning**	**FMP**	**Facilities Management Personnel**

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(10) Review and comment on the final commissioning record.
(11) Recommend final acceptance of the systems to the owner.

This is another list of responsibilities that is not new to the construction industry. The RDP is one of the key members of the FCx team. The level of responsibility and risk that this entity endures is tied very closely with their contractual relationship to the owner and the project. As such, it is imperative that the RDP be held accountable for the actions outlined in this list. This entity is often a key team member in developing the OPR. The OPR leads to the BOD, which is one of the most important documents in the Cx process. The RDP develops the BOD so that a proper commissioning plan and an ITx plan can be accomplished. See 5.3.2 for more information on the BOD in the design phase.

5.2.2.10 Construction Manager/General Contractor. The construction manager's/general contractor's responsibilities should include the following:

(1) Include commissioning process requirements and activities in all contracts.
(2) Obtain cooperation and participation of all subcontractors and manufacturers' representatives.
(3) Attend required fire protection and life safety commissioning team meetings.
(4) Include commissioning process milestones in the project schedule.
(5) Notify the FCxA when systems are ready for testing.
(6) Certify that all work has been completed and the facility is operational in accordance with the construction documents.
(7) Remedy deficiencies identified by the fire protection and life safety commissioning team during installation verification or testing.
(8) Review and comment on the final commissioning record.

The construction manager and the general contractor play an important role in successful commissioning. Because commissioning is an owner's tool for ensuring quality in the built environment, it makes sense to have the owner's responsibilities included so that they are adequately documented by the FCxA. Most of these responsibilities are already part of the work being performed on most projects. However, the term *commissioning* and the perceived rigid structure of the commissioning plan and schedule might be new to many construction managers and general contractors. This list adds recommendations that make the construction manager and the general contractor responsible for working with, reporting to, and being active on the FCx team. This section also assigns the construction manager and the general contractor some responsibility for corrective actions.

5.2.2.11* Insurance Representative. The insurance representative(s) responsibilities should include the following services, as contracted with the owner:

A.5.2.2.11 Discussions should be performed between insurance representatives and the fire protection and life safety commissioning team during the planning phase to determine the overall scope of services to be provided by the insurance representative.

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(1) Provide fire protection recommendations to RDP for inclusion in the basis of design and other construction documents.
(2) Review the construction documents during the planning and design phases to evaluate alignment with insurance risk management recommendations.
(3) Participate in commissioning team (CxT) meetings, as necessary, to ensure scope of project, responsibilities, and project timeline (including commissioning) is established/agreed to.
(4) Visit project site during installation phase to review physical/actual installation is consistent with reviewed/accepted construction documents, as necessary.
(5) Review and approve proposed inspection, testing, performance criteria, and documentation recommended for acceptance of commissioning.
(6) Witness installation verification and system testing in conjunction with the CxT, as necessary.
(7) Verify any issues detected during commissioning are resolved in timely and appropriate manner.
(8)* Verify adequate training and documentation is provided for onsite personnel.

A.5.2.2.11(8) This includes adequate signage on equipment for operation of a fire protection system and complete record drawings.

(9) Review final commissioning documentation.

It is important to have the insurance representative included in the FCx team as early as possible. Insurance companies often have requirements for fire protection systems that are above and beyond what is specified in applicable codes and standards enforced by the local AHJ. When these items are identified during the construction phase, the results can be disastrous from both a financial and timing perspective. As long as the insurance representative is brought into the team early enough, any additional requirements will be highlighted when the project exists on paper, which is easy enough to modify.

Due to the need for enforcing additional design requirements above and beyond what a municipal fire or building department personnel enforces, often the insurance representative might need to pull double duty.

FAQ

Can the insurance representative also serve as an AHJ?

5.2.2.12 Owner's Technical Support Personnel. The owner's technical support personnel's responsibilities should include the following:

(1) Review and comment on the OPR.
(2) Provide technical assistance to the fire protection and life safety commissioning team, RDP, and installation contractor.
(3) Review any changes to the OPR.
(4) Review the construction documents.
(5) Review the fire protection and life safety commissioning team's commissioning process progress reports.
(6) Review the fire protection and life safety commissioning team's progress reports.

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Myth	Fact
MYTH: Facilities managers must be the individuals who physically conduct all of the system maintenance and system testing after occupancy.	**FACT:** The intent is to get the facility managers and operations personnel up to speed on the system functionality and interconnectivity so they can direct and administer the testing and maintenance of equipment. In many instances, this will simply require the facility manager to communicate this knowledge to an outside agent who is responsible for testing.

(7) Review the fire protection and life safety commissioning team's commissioning record.
(8) Review the systems manual.

The Technical Committee on Commissioning Fire Protection Systems felt it was important to include the responsibilities for the owner's staff and technical support personnel, as they often bridge the gap between the technical portions of the project and the owner's concerns. In most instances, the owner of a project is not well versed in design and construction practices and relies on a support team to provide project status updates and assurances that the process is moving forward as intended.

5.2.2.13 Third-Party Test Entity. The third-party test entity's responsibilities should include the following:

(1) Include all commissioning process requirements and activities in the scope of services.
(2) Attend required fire protection and life safety commissioning team meetings.
(3) Include commissioning process milestones in the project schedule.
(4) Develop individual system test plan, including acceptance and integrated testing.
(5) Demonstrate the performance of the systems, including integration.
(6) Complete the construction checklists as the work is accomplished.
(7) Develop and submit final testing documentation.

Many building owners use a third-party test entity to coordinate and perform the needed acceptance tests for a project. One of the new concepts in this document includes a recommendation for integrated testing. Because of the complexity of many of today's built environments, it is often in the owner's best interest to hire an outside firm that will schedule, coordinate, track, and report the results of integrated testing.

5.2.2.14 Facility Manager or Operations Personnel. The facility manager or operations personnel's responsibilities should include the following:

(1) Attend systems training sessions.
(2) Review and comment on the OPR.

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(3) Review and comment on the systems manuals.
(4) Organize, coordinate, and implement system inspection, testing, and maintenance as required by the systems manuals.

5.2.2.15 AHJ. The AHJ's responsibilities should include the following:

(1) Participate in fire protection and life safety commissioning team meetings as necessary.
(2) Provide all inspection, testing, and performance criteria required for acceptance and issuance of certificate of occupancy to be included in the commissioning plan.
(3) Witness installation verification and system testing in conjunction with the fire protection and life safety commissioning team, as necessary.
(4) Identify AHJ personnel to attend training.

Due to dwindling budgets and staffing cuts in many fire departments across the United States and other countries, the role of AHJs and their responsibilities during the Cx process will vary greatly. It is important to make contact with the AHJs and discuss the breadth and depth of their role in the process. Including them early on in the process will allow them to feel like an active participant in the design and construction process and prevent them from feeling like they are forced into an adversarial role with the design team. Due to scheduling and budgetary restrictions, the role the AHJ agrees to might not be consistent with what is desired by the owner, CxA, or FCxA, but that is simply the nature of the beast. The owner does not have the ability to require anything of the AHJ in terms of documentation or participation in Cx meetings outside of what is required by the jurisdiction. In these instances, education and communication of the Cx process with the AHJ is vital, as the team might have limited access to the AHJ.

5.2.3 Owner's Project Requirements (OPR).

5.2.3.1 The OPR should form the basis from which all design, construction, acceptance, and operational decisions are made.

Critical Point

Creating the OPR is the most important first step of commissioning. NFPA 3 was written specifically with the owner in mind, and as such, it requires the owner to have a high level of participation in the Cx process.

Creating the OPR is the most important first step of commissioning. NFPA 3 has been written specifically with the owner in mind, and as such, it requires the owner to have a high level of participation in the Cx process. The owner is required to communicate to the design and construction teams exactly what is needed and desired in the building. In the Cx process, this is communicated through the OPR. Subsection 5.2.3 details all of the information that should be considered for inclusion in the OPR.

In order to ensure that the building is delivered according to the owner's needs, the FCx team will return to the OPR often for guidance in creating the commissioning plan and

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determining which issues need to be resolved on the project. The design team will use the OPR to create the BOD document, which is the primary reason the OPR is developed first in the Cx process.

5.2.3.2* The OPR should be developed with input from the owner and all key facility users and operators.

A.5.2.3.2 The OPR development should include the AHJ in order to provide input regarding issues of fire department operations and access to the site and facility. Other appropriate issues for review might include emergency medical response and police issues.

5.2.3.3* The OPR should be documented at the planning stage of the project.

A.5.2.3.3 The OPR should include the following sections: introduction, owner's key project requirements (i.e., insurance underwriter's standards), general project description, project objectives, functional uses, occupancy requirements, budget considerations and limitations, performance criteria, and project history. The fire and life safety OPR can be a section of the overall building commissioning documentation. *(See Annex C for a sample OPR.)* The OPR is intended to be a living document that is regularly updated and modified. During the design phase the OPR can change significantly based on the needs of the proposed design.

5.2.3.3.1 Each item of the OPR should have defined performance and acceptance criteria.

While the owner and commissioning team leaders carry the primary responsibility for developing the OPR, certain members of the team often will be called upon to contribute. Since the intent of the OPR is to highlight performance and acceptance criteria for the various line items in the OPR, subject experts are often required to get involved to provide this information. The FCxA would be the initial source for the more complex scenarios. Where they are not able to complete the information for these line items, the owner, FCxA, and CxA might choose to get additional participation in the development of the OPR where these team members are already engaged.

FAQ

Is the owner solely responsible for preparing the OPR?

5.2.3.3.2 The OPR should include, but is not limited to, the following:

(1) Infrastructure requirements (utilities, roads, site access)
(2) Facility type, size, height
(3) Intended use
(4) Occupancy classification, number of occupants, number and hours of operation
(5) Future expansion requirements
(6) Applicable codes and standards
(7) Specific user requirements
(8) Training requirements
(9) Warranty, operations, and maintenance requirements
(10) Integrated system requirements in accordance with Chapter 5

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Myth vs Fact

MYTH: The OPR should be written without any interference or influence from members of the FCx team.

FACT: In some instances, the owner might choose to have certain RDPs and/or the FCxA actively involved, as they can often keep the owner on the right track in terms of the cost, labor, and aesthetic factors associated with systems that will be required based on the owner's desired architectural program.

(11) Specific performance criteria
(12) Third-party requirements

5.2.3.4 The OPR should be updated as required by the fire protection and life safety commissioning team throughout the planning, design, construction, and occupancy phases of the building life cycle.

Commissioning should be seen as a dynamic process. As the FCx team makes their way through the building life cycle, they should be willing to re-examine the OPR and compare it with the BOD and the commissioning plan. This will ensure that as the project develops, the building will meet the needs of the owner as outlined in the OPR.

5.2.4 Commissioning Plan.

The central focus of NFPA 3 is the commissioning plan. This document defines the work of every member of the FCx team. The commissioning plan is unique to the project and will be updated from time to time to account for current project conditions. The commissioning plan can be rather large in scope on complex building projects and very simple for smaller projects. It is also intended to consider and discuss the entire life cycle of the building. As such, the commissioning plan represents a renewed paradigm in the building industry. Rather than constructing buildings quickly without regard to impacts outside of immediate finances and schedules, the building industry is starting to again focus on long-term, successful use of buildings.

5.2.4.1 The commissioning plan should be continuously updated by the fire protection and life safety commissioning team throughout the planning, design, construction, and occupancy phases of the building life cycle.

FAQ

Who is responsible for modifying the Cx plan as the project moves from phase to phase?

The FCxA is responsible for making changes to the commissioning plan and providing updates to the FCx team. In some instances, the changes are minor and are simply an update to project documentation. In other instances, the changes to the plan might result in a shift in project schedule or responsibilities of team members. In those cases, the FCxA

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Case in Point

To assist in development of the OPR, some organizations hold workshops to better define the project intent and program. These workshops are typically attended by individuals representing "users" of the proposed building or structure. If the structure being commissioned is a hospital, for example, attendees at the workshop might include physicians, nurses, administrators, facility managers, security personnel, and communications specialists. In some instances, the owner might choose to include people who will not use the facility as employees but as members of the general public. In a hospital, this might include potential patients or local law enforcement personnel.

At the workshop, the attendees work with the owner to identify the needs and the function of the space. The owner might be aware of the global concept needed for the facility, but the users are aware of "lessons learned" from their experiences in similar facilities that can lead to a better overall design. These issues could be as simple as how egress corridors can be arranged or smoke compartments designated. Although these are small issues, conceptually they allow for greater functionality of the building.

The owner might choose to ask the attendees a series of questions regarding positive and negative experiences with certain building systems or building concepts. The answers to these questions can be compiled by the CxA, owner, or owner's representative and shaped into project requirements that appear in the OPR. The OPR is one of the cornerstone documents in the Cx process, so it will provide the RDPs and the FCxA with guidance as they make design decisions later in the process.

might find it useful to call the FCx team for a meeting to confirm that the modifications of the plan are reasonable and will not lead to problems. This communication will help prevent the eleventh-hour disasters that can cost owners tens of thousands of dollars and wipe out profit margins for contractors. These modifications and communication between team members are consistent with the fundamental concepts of commissioning, which include having effective procedures, communication, and administration of a plan.

5.2.4.2* The commissioning plan should contain the following information:

(1) Commissioning scope and overview specific to the project
(2) General project information
(3) Fire protection and life safety commissioning team members, roles, and responsibilities
(4) General communication plan and protocol
(5) Commissioning process tasks and activities through all phases
(6) Commissioning schedule
(7) Commissioning process documentation and deliverables
(8) Testing procedures, including integrated testing
(9) Recommended training
(10) Establishment of an integrated testing frequency, as applicable

A sample commissioning plan, along with commentary on how the plan is assembled and what the critical decisions are in the development of the plan, can be found in Part II of this handbook.

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Myth	Fact
MYTH: The commissioning process and the commissioning plan is "one-size-fits-all."	**FACT:** Commissioning projects will vary greatly depending on the size and function of the building. Recycling an old commissioning plan tends to leave out important steps, team members, and processes that are necessary on a new project.

A.5.2.4.2 All information in the commissioning plan must be project specific. The suggested structure of the commissioning plan is as follows:

(1) Introduction — purpose and general summary of the plan
(2) Commissioning scope — identifies which building assemblies, systems, subsystems, and equipment will be subjected to the commissioning processes identified in Chapter 5
(3) General project information — overview of the project, emphasizing key project information and delivery method characteristics, including the OPR and project BOD
(4) Team contacts — project-specific fire protection and life safety commissioning team members and contact information
(5) Communication plan and protocols — documentation of the communication channels to be used throughout the project
(6) Commissioning process — detailed description of the project specific tasks to be accomplished during the planning, design, construction, and tenant occupancy stages with associated roles and responsibilities
(7) Commissioning documentation — list of commissioning documents required to identify expectations, track conditions and decisions, and validate/certify performance
(8) Commissioning schedule — specific sequences of operation of events and relative timeframes, dates, and durations

5.2.4.3 The following materials should be added as annex sections of the completed commissioning plan:

(1) A — Owner's project requirements
(2) B — Basis of design
(3) C — Commissioning specifications
(4) D — Design review
(5) E — Submittal review
(6) F — Issues log
(7) G — Construction checklists

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Case in Point

The warranty review process highlights the owner's benefits of system commissioning. While focused on running the business and keeping up daily operations in the facility, the owner might not be attuned to what is considered typical wear and tear and what field issues are the result of improper installation or malfunctioning equipment. These reviews allow the owners to do what they do best — run their businesses — and still provide them with a mechanism to protect their investments and their assets.

These tests are included in the commissioning plan early in the process and are presumably budgeted by the owner, so there are no hidden costs associated with conducting the review. The items identified during this activity can save the owner tens of thousands of dollars simply because there is a process in place that helps identify the issues while someone else is responsible for the systems' performance.

The typical contractor warranty is 1 year. Therefore, these tasks are often scheduled for 11 months after the facility receives the certificate of occupancy. This timing might vary depending on the number of tests to be conducted and the complexity of the facility. The scope of the review, along with the FCx team members' responsibilities, should be outlined in the commissioning plan.

(8) H — Site visit and commissioning meeting minutes
(9) I — Systems manual review
(10) J — Training
(11) K — Integrated testing procedures
(12)* L — Warranty review

A.5.2.4.3(12) Warranty review includes a review of all documentation relating to inspection, testing, maintenance, repair, and/or inadvertent system activation that occurred during the warranty period. The purpose of the warranty review is to determine if any modifications or adjustments to the system(s) are required.

Where written into the commissioning plan, additional commissioning tasks beyond standard operations and maintenance and inspection, testing, and maintenance (ITM) activities might occur post-occupancy. In some instances, the FCxA and other specified team members might return to the facility to conduct commissioning activities prior to the expiration of the contractor's warranty. These activities could include testing of integrated systems on a limited basis or random testing of individual systems components. Interviewing maintenance personnel is also common, especially where there might have been frequent maintenance issues dealing with specific systems. A review of maintenance logs is common to help identify what the FCxA might consider abnormalities in the building systems.

(13) M — Test data reports
(14) N — Sequence of operation

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5.2.4.4 The commissioning plan, including all annexes, should form the commissioning record at the end of the construction phase.

5.2.4.5 A current copy of the commissioning record should be presented to the owner at the end of the construction phase.

Critical Point

The commissioning plan should cover the entire life cycle of the building.

As stated previously, the commissioning plan should cover the entire life cycle of the building. There also should be an ongoing effort to ensure that the building meets the needs of the owner for the life of the building. However, the Cx process needs to have milestones for deliverables. Therefore, NFPA 3 recommends that the FCx team deliver the commissioning record to the owner at the end of the construction phase. This is at or near the beginning of the occupancy phase of the project and indicates a kind of "turnover" in the Cx process.

5.2.5 Planning Review.

5.2.5.1 The FCxA should review the planning documentation to compare the design concept with the interests and needs of the owner as defined in the OPR.

5.2.5.2 The FCxA should identify required changes and improvements affecting operations and maintenance.

5.2.5.3 It should not be the intent of the planning review to verify compliance with local, state and federal codes, unless specifically identified in the commissioning scope.

FAQ

Why is the planning review not intended to address compliance with codes and standards?

Compliance with construction codes and systems design standards are the responsibility of the RDP, not the FCxA. This step in the Cx process is simply an opportunity for the owner to get some confirmation that the project is moving as intended. If there are design features that are incongruous with the OPR, it is better for the FCxA to identify them now as opposed to after they are installed.

5.2.6 Planning Approval Documentation.

5.2.6.1 The FCxA should submit documentation stating completion and recommending acceptance of the planning requirements to the owner or other designated individual.

5.2.6.2 The documentation should include, but is not limited to, the following information:

(1) Receipt, review, and approval of planning submittal
(2) Updates to the commissioning plan, as applicable
(3) Any additional comments or requests for information considered by the FCxA to be appropriate to the commissioning process
(4) Preliminary sequence of operation

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Myth vs **Fact**

MYTH: There cannot be any overlap in the phases of a commissioning project.

FACT: As noted with the flowcharts in A.5.1.2, not all projects happen in a linear fashion. In order to beat a desired schedule or completion deadline, there might be a need to overlap certain design phase activities with the beginning of the construction phase.

5.3* Design Phase

Section 5.3 discusses the design phase. This section initially calls for the creation of the BOD. It also provides the recommendations for further commissioning plan documentation as well as plan submittal and review.

The phases of commissioning are easily understood by those involved in the building industry. However, it can be difficult to realize that while the project phases are clearly outlined in NFPA 3, they often overlap, and on some projects they can be broken up with space between some of the activities in each phase. It should be understood that the Cx process is dynamic and that the FCx team members should be flexible enough to adapt to current project conditions.

A.5.3 Construction phase documents can be started during the design phase. These documents are intended to include working plans, shop drawings, or fabrication drawings, as well as operations and maintenance manuals. These documents can be created during the design or construction phases of a project without changing the responsibilities of those charged with creating these documents.

5.3.1* Design phase activities should include, but not be limited to, the following:

(1) Developing the BOD
(2) Review and approval of the sequence of operation
(3) Review of project drawings and calculations affecting fire protection and life safety systems
(4)* Documentation of the scope for commissioning activities in the construction documents

A.5.3.1 If commissioning starts later in the design or construction process, the requirements of the previous commissioning phases should be reviewed and implemented to the extent practical.

A.5.3.1(4) It is important to document the scope and extent of commissioning activities in the construction documents, typically via the specification. This allows members of the

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commissioning team, not yet part of the project, to understand the commissioning scope prior to joining the project.

(5) Documentation of the commissioning procedures
(6) Developing a commissioning schedule
(7) Verifying that the construction documents comply with the requirements of the BOD
(8) Identifying qualified specialists in accordance with Chapter 4 and their responsibilities
(9) Coordinating and documenting fire protection and life safety commissioning team meetings and progress reports
(10)* Documenting issues and changes

A.5.3.1(10) The issues and changes should be included in a log that documents the date the issue was raised, the responsibility for resolution of the issue, the resolution of the issue, and the date the issue was resolved.

(11) Updating the commissioning plan
(12)* Developing construction checklists

A.5.3.1(12) Include checklists requiring when AHJs and Cx team members are to be present during acceptance testing.

5.3.2 Basis of Design.

The BOD is the document on which most of the work on a project is based. This technical submission describes how the design team determined the requirements for the building project. The BOD is descriptive and is most likely to be provided in a narrative form (often referred to as "the narrative") so that the design team's decision-making process is clearly understood. The BOD should be used to secure initial project approval from the AHJ. The design team uses the OPR, building codes and standards, applicable laws, and geographical features when making the decisions described in the BOD. As with most documents in the Cx process, the BOD can change during the phases of the project.

Critical Point

The BOD is the document on which most of the work on a project is based.

Paragraphs 5.3.2.1 through 5.3.2.7 are dedicated to helping the design team create a thorough BOD. All of these requirements should always be part of the design process on any building project. These paragraphs are not intended to dictate any specific design parameters to the design team; they are to be used as a guide for creating the BOD.

These paragraphs will help the owner and the FCxA understand the intent of the design and verify that the OPR is fulfilled.

5.3.2.1 General.

5.3.2.1.1 The basis of design should be the documentation describing the initial design decision-making process and description of systems.

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Myth vs Fact

MYTH: Once it is completed, the BOD is simply a reference for the project team for the remainder of the commissioning process.

FACT: The BOD is a "living document" and will be updated throughout the process as the building and system designs morph into their final shape.

5.3.2.1.2 The document described in 5.3.2.1.1 should be in the form of a narrative report and should be submitted for review prior to the installation of any system.

5.3.2.1.3 The basis of design should include but not be limited to the following:

(1) A description of the building or structure
(2) A description of fire protection or life safety systems and components
(3) Performance objectives and criteria
(4) Referenced codes and standards
(5) Alternative means and methods incorporated into the original design
(6) Testing and start-up requirements
(7) Inspection, testing, and maintenance requirements

5.3.2.1.4 The BOD should be included with other required submittals to facilitate plan review and approval by the AHJ prior to the issuance of a permit to install the system.

Many people lose sight of the fact that the AHJ is considered part of the FCx team, and as such, they can have access to the BOD. Although the BOD is typically associated with the system designers and the development side of the project, the plan review process moves along more expeditiously when the AHJ has access to the thoughts and intentions of those putting the plans together.

5.3.2.1.5 The BOD should be updated in accordance with the recommendations for OPR in 5.2.3 after every revision of the design documents.

5.3.2.1.6 The outline for the BOD should include the items in 5.3.2.2 through 5.3.2.7.

5.3.2.2* Applicable Standards, Laws, and Regulations. This section should identify the codes and standards that apply to the design, plan review, installation, testing, acceptance, inspection, and maintenance of the proposed fire protection and life safety systems.

A.5.3.2.2 Editions referenced in this document are the latest available during the development of this recommended practice. The user should always consult the AHJ to ensure compliance with local requirements.

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Critical Point

It is important to review and consider the applicable standards with all AHJs and stakeholders, not just with the AHJ representing the municipality.

It is important to review and consider the applicable standards with all AHJs and stakeholders, not just with the AHJ representing the municipality. The definition of AHJ extends beyond municipal employees and might include insurance representatives for certain building or governmental agencies, such as the Department of Transportation for road tunnel projects. Failing to identify these AHJs and the standards and regulations they enforce can lead to costly change orders and long delays to accommodate design or construction changes.

5.3.2.2.1 All codes and standards should be referenced as they apply, including, but not limited to, the following:

(1) NFPA standards, including edition used for the design of each fire protection/life safety system
(2) Applicable local, state, and federal laws and regulations (OSHA, ADA, etc.)
(3) Specialized codes and standards (HVAC, plumbing, etc.)
(4) Green building design considerations that affect fire and life safety systems

5.3.2.3 Building Description. The following specific features of fire protection and life safety systems should be identified in the BOD:

(1) Building use group or occupancy classification
(2) Total area of the building
(3) Building height
(4) Number of floors above grade
(5) Number of floors below grade
(6) Area per floor
(7) Type(s) of hazardous areas within buildings
(8) Type(s) of construction
(9) Site access arrangement for emergency response vehicles
(10) Descriptions of fire protection and life safety systems

5.3.2.4 Fire Protection and Life Safety System Objectives and Decisions.

This portion of the BOD is particularly important to the FCx team, as this team focuses on the design, installation, acceptance, and ongoing care of these systems. It also sets the standard of care for the project and establishes the level of protection expected for building occupants.

5.3.2.4.1 The BOD should describe the performance objectives of each fire protection and life safety system, including, but not limited to, the following:

(1) Whether each system is required by code or installed voluntarily
(2) Whether it is a complete or partial installation
(3) Whether it is an addition or modification to an existing system

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5.3.2.4.2 The BOD should describe the decisions made and the criteria established to achieve the performance objectives, including, but not limited to, the following:

(1) Building occupant notification and evacuation procedures
(2) Emergency personnel response
(3) Site and systems features
(4) Safeguards during construction, including fire prevention and emergency procedures
(5) Impairment plans when modifying existing systems
(6) Methods for inspection, testing, and maintenance of systems

5.3.2.5 Consideration and Description of Alternative Means and Methods. The design intent of any alternatives to prescriptive requirements of the codes and standards, including, but not limited to, the following, should be identified:

(1) Interpretations and clarifications
(2) Waiver or variance sought through the regulatory appeal process

Performance-based design is becoming more and more popular as owners and architects are demanding aesthetically pleasing system designs to fit in with the architectural themes of their buildings. The majority of design standards and model codes requires the submission of technical documentation supporting all equivalencies and modifications; however, this concept is restated in NFPA 3 for several reasons. The Cx process is founded on communication, documentation, and transparency. Providing detailed descriptions and technical support for all concepts that are outside of the prescriptive design requirements is consistent with these themes. Allowing the entire team, including the AHJ, the opportunity to see the intent of the performance design or variance approach in writing will lead to better communication and prevent the potential for lost time in the commissioning schedule when these issues would otherwise be identified.

5.3.2.6 Testing Criteria.

5.3.2.6.1 The FCxA should be responsible for all items listed in 5.2.2.6.

5.3.2.6.2 Testing criteria should be established and documented.

5.3.2.6.3 The methods for prefunctional and integrated testing should be documented.

This first mention of documenting integrated testing is an important milestone in NFPA's mission and history. It has always been the intent of the codes and standards to require that systems function properly. However, there has never been a written requirement that all of the various integrated systems on a project be tested together in a way that demonstrates an end-to-end functionality of these connected systems. See Chapter 6 and Chapter 7 for more information on these types of systems. This section recommends the proposed methods for integrated testing be described in the BOD.

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5.3.2.7* Equipment and Tools. The FCxA should identify and document the tools and equipment necessary for testing.

A.5.3.2.7 FCxA should review manuals, standards, manufacturers' documents, and other sources to determine the equipment and tools necessary for each phase of testing. FCxA should also confirm which contractors or other appropriate parties should calibrate and schedule the availability of the tools and equipment for the testing dates.

5.3.3 Operation and Maintenance Manuals (O&Ms).

The NFPA 3 committee decided to use the term *operation and maintenance manuals* (O&Ms) to describe the technical literature associated with fire protection and life safety systems that is provided to the owner. It should be noted that ASHRAE Guideline 0, recommends using the term *systems manual*. The committee intends to meet the requirement for systems manuals in the total building commissioning process with the O&Ms outlined in 5.3.3 of NFPA 3.

5.3.3.1 O&Ms should be provided.

5.3.3.2 O&Ms should contain, but not be limited to, the following information:

(1) Project name and address
(2) Discipline (i.e., fire protection)
(3) Specification section number
(4) Volume number

5.3.3.3* The RDP should review and approve the O&Ms for conformance with the OPR.

A.5.3.3.3 O&Ms should be organized and written in a complete and concise manner to improve the ability of the building operator or maintenance technician to fully understand the performance characteristics of the system and the maintenance requirements necessary to achieve the intended performance. O&Ms should be of durable materials and contain complete project identification including, but not limited to, the following:

(1) Title sheet including the complete name and address of the project and the complete name and address of the installing contractor (including telephone number for emergency service)
(2) Complete table of contents
(3) Systems design intent documentation
(4) Complete list of equipment
(5) List of equipment suppliers and/or manufacturers
(6) Operation and maintenance instructions for major components
(7) Inspection and test reports
(8) Recommended spare parts

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(9) Riser diagrams or schematic drawings
(10) "As-built" drawings and calculations
(11) Warranty
(12) Other special requirements of the installation specification or installation standard such as valve tags and charts, hydraulic data nameplate information (for sprinkler systems), and so forth

5.3.4 Training of Operations Personnel.

The content, duration, and learning outcomes of training for operations personnel should be provided in the design documentation in accordance with Section 5.3.

Another subject that might be new for many owners and developers is the recommendation to provide training to the building operations personnel. To date, this has been seen universally as a positive requirement and appears to be a welcome change to the NFPA codes and standards. The installer is usually the party to develop and deliver the training to the owner's operations personnel. The training might be contracted with a manufacturer or third party in order to adequately prepare the operations personnel to act appropriately in emergency situations or when accidental activation of the fire protection and life safety system occurs.

5.3.5 Design Methodology.

5.3.5.1* The design should take into consideration the final commissioning of the active and passive fire protection systems.

A.5.3.5.1 Passive fire protection systems include, but are not limited to, the following:

(1) Fire and smoke dampers
(2) Fire and smoke doors
(3) Through penetration fire stops
(4) Smoke vents
(5) Smoke drafts
(6) Smoke and fire assemblies

The focus of many individuals who employ their own commissioning methods is on the active systems. While the active systems are more prone to malfunctions due to their moving parts, interconnections, and often complex subcomponent structures, the failure to confirm the status of passive systems can also lead to headaches for owners. Assuring that all penetrations in fire-resistance-rated or smoke-tight construction are sealed can be critical in limiting fire and smoke damage within a building to the area or room of origin. Poorly sealed penetrations, leaking ducts, or fire and smoke doors that do not seal allow the areas of a building impacted by smoke damage to grow exponentially, costing owners

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tens of thousands to hundreds of thousands of dollars in remediation and abatement for a series of inspections that take a matter of a couple of days.

5.3.5.2 The recommendations for design consideration should include, but not be limited to, the following:

(1) Materials and equipment applied in such a manner that will not affect their listing or their intended use where applicable
(2) Materials and equipment have the capacity to perform their intended use
(3) Design documents or details to demonstrate how the systems operate and communicate to attain the desired outcome
(4) Design documents and/or details to demonstrate the application of fire protection systems in the construction
(5) Locations of fire protection systems
(6) The procedures for verification of fire protection systems
(7) Assignment of responsibility for the testing and inspection of the fire protection systems during the construction phase
(8) Specification of the deliverables, including final documentation for the conclusion of the project
(9) Specification of the format of the deliverables

5.4 Construction Phase

During the construction phase the systems should be delivered, installed, and tested in accordance with the OPR, construction documents, shop drawings, and coordination drawings.

Critical Point

Shop drawings for the various systems are actually verified and reviewed as part of the construction phase activities. This activity is often one that can overlap across the commissioning phases.

Section 5.4 discusses the construction phase. This section calls for the documentation of meetings, inspections of materials and installations, testing, and the logging of issues and their resolutions, integrated testing, owner training, and closeout documents.

The construction phase is where the design concepts and theories explored during the planning and design phase become tangible. It is important to realize that the shop drawings for the various systems are actually verified and reviewed as part of the construction phase activities. This activity is often one that can overlap across the commissioning phases. If it seems that these are activities for the design phase, take note of the activity's proximity to the design phase. It is important not to be concerned with where the written "lines" between the phases might be, but rather, to realize that the review and verification is what is already understood to be the construction process.

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Myth	Fact
MYTH: Once the project enters the construction phase, the commissioning schedule cannot be manipulated.	**FACT:** Although it is not desirable to manipulate the commissioning schedule, the benefit of commissioning is that all planning and scheduling decisions are well thought out and based on the documentation provided by the commissioning team. This documentation and information will allow the FCxA and owner to make informed decisions on whether or not it is appropriate to manipulate the schedule.

5.4.1 Construction Phase Commissioning Activities.

5.4.1.1 The fire protection and life safety commissioning team should complete the following:

(1) Confirm that the commissioning schedule is still valid, and update if required.

As a general rule, it should be understood that the Cx process demands that the commissioning plan be continually updated. Every step and every action should cause a re-examination of the commissioning plan for validity and application to the OPR and the BOD.

(2) Verify that submittals, including, but not limited to, working plans and product data sheets, are in conformance with the BOD and have been reviewed.

Verification and review of submittals, installations, testing, and similar activities by the FCxA are not intended to be of the same depth and caliber as the activities of the RDP and the AHJ. The FCxA simply verifies and documents that the activities have occurred and demonstrates conformance to the BOD. The FCxA ensures that the appropriate documents are being gathered for the commissioning record. Which FCx team member is responsible for these activities is discussed in Chapter 4.

(3) Verify that materials, construction, and installation are in conformance with the BOD.
(4) Confirm qualified specialists are performing commissioning activities per commission plan (CP).
(5) Coordinate and document fire protection and life safety commissioning team meetings and progress reports.
(6) Document any issues and changes to the project and update the CP.
(7) Complete Cx construction checklists.
(8) Perform required observation procedures or cause them to be performed by the responsible party.

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(9) Update related documents to record and adjust for any revisions and/or changes.
(10) Verify and document testing performed in the construction phase.

5.4.1.2 Construction should take into consideration the final commissioning of the passive fire protection systems.

5.4.1.3 The recommendations for installation should include but not be limited to the following:

(1) Conformance to the approved drawings and specifications
(2) Compliance with the manufacturers' published instructions
(3) Compliance with applicable codes and standards
(4) Materials and equipment of proper rating for the use

5.4.2 Construction Inspections.

This section is a welcomed addition to the written portion of the construction process. While it has been common practice in various localities to require the inspections as described below, NFPA 3 includes them as an expected part of the Cx process. The impact on quality of installation and conformance with design intent will be dramatically improved as these milestones are implemented during the construction process.

It is important to note that this section requires planning and notification of the schedules, procedures, and processes of expected inspections. The list can be generalized to require rough-in, finish, testing, and acceptance as the separate descriptions of inspections that will be needed in the commissioning plan.

5.4.2.1 Pre-Installation or Preconstruction.

5.4.2.1.1 A preconstruction conference should be held to ensure the fire protection and life safety commissioning team and those performing the work all understand the schedule, procedures, and process.

5.4.2.1.2 Schedule commissioning process activities should include the following:

(1) Address any outstanding issues that are best resolved in this venue.
(2) Verify coordination has taken place among trades.
(3) Identify and establish benchmarks to be met during the construction phase.
(4) Verify submittals are in accordance with design intent documents and approvals and permits are secured.
(5) Confirm integrated testing requirements are being addressed.
(6) Develop test data records.
(7) Confirm compliance with sequence of operation.

5.4.2.2 Rough-In Phase. The following tasks should be performed prior to concealment of the installed material:

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(1) Inspect and verify delivered materials meet requirements.
(2) Verify installation is proceeding in accordance with coordinated, approved shop drawings.
(3) Complete periodic site visits to verify compliance with the owner's commissioning plan.
(4) Inspect installation as outlined in the commissioning plan.
(5) Perform testing as applicable.
(6) Update owner project requirements and address any outstanding issues.
(7) Update commissioning plan as needed.
(8) Issue rough-in phase commissioning progress report.

Rough-in inspections are often a critical yet overlooked part of the Cx process. Rough-in inspections are often referred to as "prerock" inspections as they are conducted prior to system components, such as piping and wiring, being covered up by sheetrock. These inspections can lead to the detection of project-wide installation deficiencies that will never be seen once the wall and ceiling materials are installed. Once these deficiencies are concealed, they can create major liability concerns for the property owner that can be extremely costly if identified as part of a due diligence inspection when the owner sells the building.

The other value of rough-in inspections is that they allow for easy, inexpensive fixes to issues that become largely impractical once sheetrock is installed. Examples of these include back boxes installed at the wrong height for fire alarm components or the omission of a thermal barrier behind a tub or shower in a nonsprinklered "small" bathroom. Prior to the installation of sheetrock, the fixes to these issues are relatively minor from a labor perspective and do not require destruction of finished material. If these issues are not caught until a final inspection, it might require extensive labor, including pulling multiple trades back onto the project.

5.4.2.3 Finish Phase. The following tasks should be performed after the rough-in phase is complete:

(1) Inspect and verify delivered materials meet requirements.
(2) Verify installation is proceeding in accordance with coordinated, approved shop drawings.
(3) Complete periodic site visits to verify compliance with OPR.
(4) Inspect installation as outlined in the commissioning plan.
(5) Perform testing as applicable (post-concealment).
(6) Update OPR and address any outstanding issues.
(7) Update commissioning plan.
(8) Issue finish phase commissioning progress report.

5.4.3 Testing and Inspection.

5.4.3.1 Testing and inspection should include passive fire protection systems.

5.4.3.2 The recommendations for testing and inspection should include, but not be limited to, the recommendations of Chapters 7 and 9.

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5.4.3.2.1* Fire protection systems that have no operating components should be inspected to verify conformance with the BOD.

This section is simply intended to separate the concepts of inspection versus testing. It is not the intent of NFPA 3 to recommend testing passive construction, but rather, to simply visually inspect the condition of these passive components to validate their installation per the RDP's instructions.

A.5.4.3.2.1 Examples of fire protection systems with no operating components include, but are not limited to, the following:

(1) Through-penetration firestop systems
(2) Rated fire and smoke assemblies
(3) Spray-applied fire-resistant material

5.4.3.2.2 Fire protection systems that have operating components should have their functionality tested to demonstrate compliance with the BOD.

5.4.3.2.3 Written documentation of the testing and inspection should be provided.

5.4.3.2.4 Inspection and testing should be repeated if changes are made to systems.

5.4.3.3 Testing and inspection of passive fire protection systems should be completed as required during construction.

5.4.4 Completion and Acceptance Testing.

The following tasks should be performed as part of the acceptance of the fire protection and life safety systems:

(1) Verify installation is in accordance with coordinated, approved shop drawings.
(2) Inspect overall installation as outlined in the commissioning plan.
(3) Perform prefunctional testing of all systems to provide proper functionality and to ensure interoperability.
(4) Perform and document testing of all systems to provide proper functionality, to ensure integration, and to ensure the systems were left in a state of operational readiness.
(5) Update owner project requirements and address any outstanding issues.
(6) Update commissioning plan/record.
(7) Issue completion/acceptance phase commissioning progress report.
(8) Verify compliance and accuracy of sequence of operation.

5.4.5* Owner Training.

Training should be permitted to take place in the construction phase.

A.5.4.5 Training often needs to begin in the construction phase; however, some systems can require ongoing training during the occupancy and post-construction phases.

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Training might begin during the construction phase but is generally considered an occupancy phase activity. This should reiterate the idea of not being concerned about where the written lines are between phases.

The committee debated requiring a minimum amount of time needed for training but felt it best to allow the FCx team to define the appropriate level of training for each facility based on the number and complexity of the fire protection and life safety systems on any given project.

Documentation and assessments are important components of the expected training programs for each system and for an understanding of the integration of the systems on the project. See 5.5.4 for more guidance on training.

5.4.6* Closeout Documents.

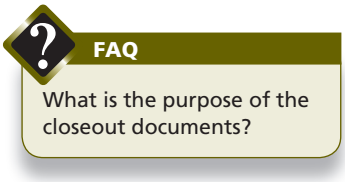
Closeout documents should include, but not be limited to, the following:

(1) Compiled list of all deficiencies and resolutions and verification of resolution achieved
(2) Operations and maintenance manuals
(3) Compile test results and certificate
(4) As-built drawings
(5) Warranty and extended warranties
(6) Spare parts list and supplier listings
(7) Re-commissioning plan (integrated testing)
(8) Sequence of operation

A.5.4.6 This can include documents required by other codes and standards or by AHJs.

The closeout documents have been an important part of the construction process for many years. The project specifications are usually where the requirements for the closeout documents are found. In the absence of such requirements, they should be called for in the commissioning plan.

The closeout documents will be the owner's final record of the construction phase of the building project. It is important that they be included in the commissioning record.



5.5 Occupancy Phase

Section 5.5 discusses the occupancy phase. This phase calls for final testing and acceptance of the fire protection and life safety systems, turnover of all system documents and software, and beginning the inspection, testing, and maintenance plans for the systems installed.

Once the closeout documents mentioned in the construction phase have been delivered, the Cx process is close to completion. While true commissioning goes on for the life of the building, there must be a point at which the FCxA turns over the commissioning

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Myth	Fact
MYTH: Once the building has received its certificate of occupancy, the commissioning process is finished.	**FACT:** The commissioning process, which includes facilities personnel, carries on into building occupancy to assure that system functionality is maintained over the building's lifetime.

record to the owner. The occupancy phase is the point at which the NFPA 3 committee feels this turnover is appropriate.

Final project testing and acceptance can be conducted during this phase. Implementation (or at least delivery) of the inspection, testing, and maintenance plans for all of the building's fire protection and life safety systems should begin prior to delivery of the commissioning record to the owner. Those familiar with the occupancy phase of a building project will find the activities to be familiar and in line with current construction industry practices.

5.5.1 Occupancy phase should be the final stage of the commissioning process for the fire protection or life safety systems.

5.5.2 The recommendations for occupancy phase should include but not be limited to the following:

(1) Documentation and completion of remaining acceptance testing and inspections
(2) Testing conducted for modifications made during the construction phase commissioning
(3)* Performing deferred testing for seasonal conditions

A.5.5.2(3) For example, it can be appropriate to test stair pressurization in both winter and summer conditions.

(4) Submission of the system manual, operation and maintenance manuals, and vendor emergency contact list
(5) Training on the use and operation of the fire protection and life safety systems
(6) Delivery of the record set drawings and documents
(7) Delivery of the test and inspection records for the fire protection and life safety systems
(8)* Delivery of a digital copy of site-specific software for fire protection and life safety systems that is current with the installed system

A.5.5.2(8) This would include a digital copy of site-specific software for building automation or other integrated systems.

(9)* Delivery of warranties for the systems and equipment

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A.5.5.2(9) The building owner or a designated representative should police the building systems through inspection, testing, and maintenance prior to the expiration of the warranty. This helps identify needed repairs.

(10) Submission of recommended preventative maintenance program for fire protection and life safety systems
(11) Delivery of a list of required inspections, tests, and maintenance for fire protection and life safety systems

5.5.3 Administrative Controls.

The owner should be responsible for the continued performance of fire protection and life safety systems.

5.5.3.1* Applicable inspection and testing should be performed when modifications are made.

A.5.5.3.1 Additions, modifications, or alterations to systems can cause unintended consequences. The testing procedure should be re-evaluated to make sure that the repeat testing is adequate to determine the correctness of the revision.

5.5.3.2* When changes are made to the use of the facility, the OPR should be re-evaluated.

A.5.5.3.2 Significant changes to the OPR can precipitate a need to do a re-commission process.

5.5.3.3* The design documents should be maintained for future reference.

A.5.5.3.3 Design documents should be kept for the life of the facility. When there is a change in ownership, the documents should be transferred to the new owner.

5.5.3.4 Inspection, testing, and maintenance should be performed as specified in the installation standard or manufacturer's instructions.

5.5.3.5 Integrated systems should be inspected, tested, and maintained in accordance with the commissioning plan.

5.5.4 Training.

5.5.4.1* The training should include, but not be limited to, the following:

(1) The systems, component systems, and devices for which training will be required
(2) The capabilities and knowledge of the occupants and maintenance personnel
(3) The number and type of training sessions
(4) The location and organization of operation and maintenance manuals

A.5.5.4.1 A quality training session for system operation and maintenance will generally include the following components:

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(1) Practical examples and hands-on operation of the system
(2) A course agenda
(3) The expected system performance
(4) Problems or modifications encountered during construction
(5) Routine testing and maintenance requirements
(6) Operation and maintenance manuals

Additional training should be conducted after several years. This will allow the facility staff to be trained on system upgrades or modifications. This can be accomplished in conjunction with lesson-learned workshops.

Training is not only valuable at the time the building is turned over to the owner and facilities management personnel but also for new hires who will have responsibility for operating and maintaining the building systems. It is important to update the training when new systems are brought online to make sure that new hires are not being trained with material that is no longer relevant to the building.

5.5.4.2* Systems training should be scheduled to be completed at or as close as possible to final systems acceptance.

A.5.5.4.2 An appropriate time to schedule the initial training is at system acceptance in order to maximize its value to the participants. Secondary systems training should be held after integrated testing has been completed to allow follow-up questions and the opportunity to ask questions about situations and problems that have occurred after final acceptance.

5.5.4.3* Training session scope and attendees should be documented as part of the commissioning record.

A.5.5.4.3 Sign-in sheets are useful for the contractor and fire protection and life safety commissioning team to demonstrate that training was conducted. Training sessions can be recorded to allow for future reference of the material and training for new employees.

5.5.4.4* Facilities personnel or their designated representatives should receive periodic retraining as determined by the commissioning agent.

Critical Point

The training of facilities personnel is likely the last of the commissioning activities conducted before the commissioning record is turned over to the owner by the FCxA.

A.5.5.4.4 Continuous training can ensure the systems are maintained and tested properly and the building or structure operates successfully.

The training of facilities personnel is likely the last of the commissioning activities conducted before the commissioning record is turned over to the owner by the FCxA. The concept of retraining and updating training materials as described in 5.5.4.4 and A.5.5.4.4 should indicate that commissioning is intended to continue for the life of the building to ensure that

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the owner's needs continue to be met and that lives and property will be saved when the fire protection and life safety systems are called upon to work in the event of a fire.

Reference Cited in Commentary

ASHRAE Guideline 0, *The Commissioning Process*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA, 2005.

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Integrated Systems Commissioning

CHAPTER 6

Chapter 6 provides the recommended approach for commissioning integrated fire protection and/or life safety systems. As explained in A.3.3.19.1, integrated systems are a combination of systems that are required to operate as a whole to achieve the fire protection and life safety objectives. Integrated systems might be physically connected, such as an elevator and fire alarm system for recall, or they might not be directly connected, such as a smoke control fan startup and door closure. In both instances, the entire integrated system should be included in the commissioning (Cx) process.

The recommendations for commissioning of integrated systems can be thought of as a subset of overall fire protection and life safety systems commissioning outlined in Chapter 5. In essence, if commissioning of a single integrated system is being performed, the recommendations provided in Chapter 6 should be followed. If overall fire protection and life safety systems commissioning is being performed, including those systems that are integrated, the recommendations of both Chapters 5 and 6 should be followed.

This chapter covers integrated systems commissioning and recommends actions to be taken at each stage during three phases of the Cx process. Section 6.2 discusses recommendations for the design phase; Section 6.3 discusses recommendations for the construction phase; and Section 6.4 discusses recommendations for the occupancy phase.

6.1 General

This chapter should apply to the functions of integrated systems provided for fire protection or life safety in the design phase, construction phase, and occupancy phase of the commissioning process of Chapter 5.

Whether commissioning an individual fire protection or life safety system or an integrated fire protection or life safety system, the process begins during the design phase and continues through the occupancy phase. Commissioning integrated systems is an extremely important part of the Cx process because these systems can be very complex and have far-reaching effects.

Myth	Fact
MYTH: Integrated testing is already required to get a certificate of occupancy.	**FACT:** Most model codes and standards do not specify that an integrated test must be done; they simply require acceptance testing in accordance with the design standards.

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Case in Point

An atrium smoke control system that includes an automatic door must close to separate the atrium from the remainder of the space. Commissioning the smoke control system separately from the automatic door device might seem appropriate, especially since one system involves the mechanical installation contractor and the other involves the door installation contractor.

The fire commissioning agent (FCxA) might commission both systems individually and determine that they function properly. In a fire or other emergency event, however, these two systems must function in an integrated fashion. If the two systems are not included as an integrated system, the FCxA might not identify that the automatic door cannot properly close with the atrium fans running due to the negative pressure created by the fans.

Although these two individual systems are not directly connected, commissioning them as an integrated system would identify this failure point.

6.2 Design Phase

Critical Point

The narrative report should be part of the BOD when a BOD is developed.

This section calls for the creation of a narrative report and the development of the design methodology. The narrative report covered in 6.2.1 is similar to the basis of design (BOD) discussed in 5.3.2; however, the narrative is much simpler. The narrative report should be part of the BOD when a BOD is developed.

6.2.1 Narrative Report.

Construction documents should include a narrative report of the system interactions, including but not limited to the following:

(1) Sequence of operations of integrated fire protection or life safety systems
(2) Performance objectives of system interactions
(3) Analysis of the impact that interactions will have on the proper operation of each independent fire protection or life safety system
(4) Owner's expectation of how fire protection or life safety systems work together

As noted in Chapter 5, documentation in the owner's project requirements (OPR) of the operation of the fire protection and life safety systems is very important to verify that all systems function properly. The FCxA must view the fire protection and life safety systems in a holistic manner (throughout a building or multiple buildings) and not simply as individual systems. The narrative report should place special emphasis on the integrated fire protection and life safety systems. The items noted in 6.2.1 are key to ensuring that the FCxA, the owner, and all installation contractors have a good understanding of how the systems interact with each other to meet the overall fire protection and life safety objectives.

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6.2.2 Design Methodology.

6.2.2.1 The design should take into consideration the interconnections of the fire protection or life safety systems.

It is not uncommon for the registered design professional (RDP) to provide a "performance" design of the fire alarm system, sprinkler system, or special hazards system and leave the detailed design to the installation contractor. This approach is acceptable as long as the "performance" design provides an appropriate level of detail in the design documents so that the installation contractors are aware of the interconnection and/or integration of the fire protection or life safety systems. Further discussion on the *minimum* information that should be provided in the design documents can be found in 6.2.2.2.

When reviewing the design documents, the FCxA should ensure that these documents detail the interconnection and integration of the fire protection or life safety systems.

Critical Point

It is not uncommon for the RDP to provide a "performance" design of the fire alarm system, sprinkler system, or special hazards system and leave the detailed design to the installation contractor.

6.2.2.2 The recommendations for design consideration should include, but not be limited to, the following:

(1) Materials and equipment interconnected in such a manner that will not affect their listing or their intended use where applicable
(2)* Materials and equipment have the capacity to perform their intended use

A.6.2.2.2(2) Examples of equipment capacity ratings are as follows:

(1) Electrical: amperage, voltage, wattage, and so forth
(2) Strength: working pressure, tensile, structural, and so forth
(3) Life expectancy: years, number of cycles, and so forth

(3)* Design documents or details to demonstrate how the systems operate and communicate to attain the desired outcome

A.6.2.2.2(3) A system description should be produced as an engineering document to describe system integration and functions. Each component system within the integrated system should be defined. Each interconnection should be defined. A fire hazard analysis should be produced to describe active and passive fire protection features and describe the interactions between the fire protection features of the building.

(4)* Design documents or details to demonstrate how operations of integrated systems do not impair the functionality of other component systems, unless designed to impair another system

A.6.2.2.2(4) For individual systems to work together there must be consideration of the various interconnections that can occur. Some interconnections can be directly connected, and

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others can be more remotely involved. An example of the first is an emergency power off (EPO) system that in its operation causes loss of power to a fire protection system or the EPO system itself. An example of the second is an atrium smoke control system that functions correctly mechanically, but the air movement prevents the automatic doors from closing.

(5)* Sequence of operation for integrated systems

A.6.2.2.2(5) This is often done by using a sequence of operation to plot inputs and outputs.

(6)*Locations of interconnections

A.6.2.2.2(6) In addition to noting the location of the interconnection on the drawing, it is helpful to have a labeling system to identify the interconnections in the installation.

(7) Procedures for integrated testing
(8)* Required frequency for integrated testing

A.6.2.2.2(8) The interactions within integrated systems need to be tested often enough to ensure reliability.

(9) Assignment of responsibility for the testing and inspection of the systems and interconnections during the construction phase
(10) Specification of the deliverables, including final documentation for the conclusion of the project
(11)* Specification of the format of the deliverables

A.6.2.2.2(11) Examples of formats for deliverables are as follows:

(1) Drawings on paper or electronic format
(2) Electronic format such as PDF or DWG
(3) Media format such as floppy disk, flash drive, CD, or FTP
(4) Owner's manuals on paper, accessible from Internet hyperlink, and so forth

6.2.2.3* The methods for pre-functional and integrated testing should be included in the construction and systems manual.

Critical Point

It is very important to document the methods used for pre-functional and integrated testing so that future commissioning and/or testing can use the same methodology.

A.6.2.2.3 It is important to document the scope and extent of pre-functional and integrated testing activities in the construction documents, typically via the specification. This allows the general contractor and installation subcontractors, not yet part of the project, to understand the testing scope prior to joining the project.

It is very important to document the methods used for pre-functional and integrated testing so that future commissioning and/or testing can use the same methodology. If the methodology, including pass/fail criteria, is not available for future use, the FCxA or integrated testing agent (ITa) will need to

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spend a significant amount of time recreating the original design intent and redeveloping testing methodology. The same system can be tested using two different methods and could pass one while failing the other. For example, an atrium smoke exhaust system could have originally been tested using airflow rates and smoke pencil movement as the pass/fail criteria. Future testing using cold smoke from a smoke generator could lead to a nonpassing result. Without the documentation of the original testing criteria, it might be difficult to explain to the stakeholders why the system is not "passing" now but had "passed" originally.

6.3 Construction Phase

The recommendations for installation of integrated systems should include but not be limited to the following:

(1) Conformance to the approved drawings and specifications
(2) Compliance with the manufacturers' published instructions
(3) Compliance with applicable codes and standards
(4) Review of material and equipment submittals of proper rating for the use
(5) Coordination of all contractors' submittal drawings, sequence of operation, and procedures

Critical Point

During the construction phase, or sooner if all installation contractors have been selected, the FCxA should review the design documents with the installation contractors to ensure the contractors are aware of the interconnection and/or integration between individual fire protection or life safety systems and other building systems.

This section provides recommendations of actions to complete during the construction phase to verify proper system installation. During the construction phase, or sooner if all installation contractors have been selected, the FCxA should review the design documents with the installation contractors to ensure the contractors are aware of the interconnection and/or integration between individual fire protection or life safety systems and other building systems. During this discussion, the extent of each contractor's work should be established with assistance from the general contractor or construction manager. For example, the fire alarm contractor typically provides control modules to initiate elevator recall but does not actually connect the control modules to the elevator controller. The FCxA should facilitate the discussion as to who will provide the wire for the interconnection and how the final connections will be made.

The FCxA should review the individual installation contractor's submittal drawings to ensure that the requirements of the OPR and BOD are met, with particular emphasis on individual system interconnection and integration. The testing plan and schedule should also be reviewed to ensure that all interconnected or integrated systems are ready for functional performance testing at the appropriate time. For example, if the elevator and HVAC systems have not been tested and accepted, it might not be prudent to test the fire



FAQ

Who verifies that the design intent in terms of system integration has been considered on the submittal drawings?

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Myth	Fact
MYTH: Periodic integrated testing is not useful because the property owner and maintenance personnel will be aware of any changes in system functionality.	**FACT:** A large percentage of failures associated with fire protection systems are caused by system connections that have been altered or disconnected during building upgrades or maintenance and are not identified by building staff.

alarm system. Elevator recall and HVAC shutdown might not be able to be functionally tested if those systems are not operational. It might be more prudent to wait for all the interconnected and integrated systems to be functionally tested and accepted prior to final fire alarm functional performance testing.

6.4 Occupancy Phase

This section provides recommendations for final system verification during the occupancy phase as well as guidance for verification after system modification.

6.4.1 The recommendations for occupancy consideration should include but not be limited to the following:

(1) Verification that individual system testing and inspection is complete and documented in accordance with applicable codes and standards and the design specifications for the project
(2) Verification that integrated system testing and inspection is complete and documented in accordance with the design specifications and the commissioning plan for the project
(3) Approval of modifications made to the system or interconnections by the design professional
(4) Retesting as determined by the ITa
(5) Interconnections documented in operation and owner manuals
(6) Training as recommended in 5.3.4, 5.4.5, and 5.5.4 on the use and operation of the systems and interconnections
(7) The vendor emergency contact list
(8) The as-built documents for the systems and interconnections
(9) A copy of test and inspection records of the systems and interconnections
(10) A copy of site-specific software of the systems and interconnections that is current with the installed system

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(11) A copy of warranties for the systems and interconnections
(12) A copy of a recommended preventative maintenance program for the systems and interconnections
(13) A list of recommended periodic inspections and tests for the systems

Critical Point

It cannot be stressed enough that commissioning does not end when the certificate of occupancy is issued.

The recommendations provided in 6.4.1 are intended to assist the owner in developing the pass/fail criteria for occupancy. Items (1) and (2) ensure that the integrated systems are installed and function in accordance with the OPR and applicable codes and standards. Items (6) through (9) provide the owner with the training and understanding of the system operation during day-to-day building use. Items (11) through (13) provide adequate information to the owner so that proper inspection, testing, and maintenance of the individual and integrated systems can be performed and the results verified against the original inspection and test results. Proper inspection, testing, and maintenance should improve system reliability and extend the service life, thereby reducing long-term cost to the owner.

It cannot be stressed enough that commissioning does not end when the certificate of occupancy is issued. The FCxA should ensure that the items noted in this section are complete, correct, and have been submitted to the owner.

6.4.2* The design documents should be maintained for future reference.

A.6.4.2 It is recommended that design documents be retained for the life of the appropriate systems.

Chapter 9 provides guidance for commissioning documents and retention thereof. Subsection 6.4.2 pertains to the design documents relative to the fire protection and life safety systems. While proper commissioning documentation will provide information for future recommissioning and verification of system performance, the design documents provide more detail on the original system design, intent, interaction, and sequence of operation.

Sample forms that can be used in the commissioning process can be found in Annex C. These forms are examples of how the process can be documented, but they might not be right for every project. It is incumbent upon the commissioning team to make sure the forms they use provide all of the relevant information that needs to be captured for their facility.

FAQ

Where can I find sample forms that will assist in documenting integrated system commissioning?

6.5 Data Sharing Systems

During the design phase, the fire protection and life safety commissioning team should document the following:

(1) Where data sharing systems occur in the project
(2) Compatibility of data sharing systems

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(3) Where gateways or interfaces are recommended between data sharing systems
(4) The responsible parties for each portion of the interconnection
(5) Degrade mode for each data sharing system upon loss of communication

Data sharing is where two or more systems are integrated via the back-and-forth sharing of data from one system to the other. A simple data sharing system would be two fire alarm control panels installed on the same network in a peer-to-peer arrangement. Data sharing should be clearly documented in the BOD to assist the commissioning team with developing the commissioning plan.

Data sharing systems can be a critical part of integrated fire protection and life safety systems and must be included in commissioning to ensure that the interaction between the systems is properly connected and communicating. Data sharing can be as simple as one fire alarm control panel (FACP) to a sub-FACP on the same network, or as complicated as a BACnet® or LonWorks (or other communication protocol) connection between mechanical systems as part of an overall smoke management strategy for a project.

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Integrated System Testing

CHAPTER 7

Chapter 7 provides recommendations for testing integrated fire protection and/or life safety systems. As explained in A.3.3.19.1, integrated systems are a combination of systems that are required to operate together as a whole to achieve the fire protection and life safety objectives. Integrated systems might be physically connected (interconnected), such as an elevator and fire alarm system for recall, or they might not be directly connected, such as a smoke control fan startup and door closure. In both instances, the entire integrated system must be tested as one system.

The integrated test should be considered a test of the integrated system or process, which begins at the system's activation device (an end point) and continues through to the desired response, function, result, or action. This test is intended to be an "end-to-end" test to show that integrated systems perform effectively together to achieve the fire protection and life safety goals.

Critical Point

The integrated test should be considered a test of the integrated system or process, which begins at the system's activation device (an end point) and continues through to the desired response, function, result, or action.

Case in Point

One of the primary goals of fire protection and life safety industry leaders is to design and build safer buildings. In order to achieve this, often many basic fire protection systems must be interconnected to enhance their impact on property protection and occupant safety. While these interconnected systems are commonly designed and installed, often they are not tested to confirm that the interconnections and integrated features function as intended. One of the problems with integrated systems from a standards development perspective is ownership of scope.

The committee and document scopes for individual system documents, such as *NFPA 72®, National Fire Alarm and Signaling Code*, and NFPA 13, *Standard for the Installation of Sprinkler Systems*, prohibit those technical committees from providing requirements that address other systems. Therefore, these documents are limited to addressing the specific system that they cover without addressing interconnected/integrated components or features. This has left a hole in the construction industry because there is no formal requirement in any of the design standards that mandates an integrated test. After each individual system goes through its required acceptance testing, there is often a call from the authority having jurisdiction (AHJ) for a test of the integrated systems to confirm that they function as the design drawings and narratives indicate they should.

The problem is that none of the design standards or codes provides any direction on conducting the test. Who is responsible for conducting the testing? How many components need to be tested? Is pre-functional testing required? NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems,* helps to bridge this gap because the commissioning plan and integrated test plan can be written into the project documents mandating that these tests occur. Testing responsibilities and protocol will vary for each project. The recommendations in this chapter provide direction on how these tests can be set up and conducted.

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Case in Point

Because of the importance of integrated system testing and the industry outcry for guidance on conducting integrated tests, the committee has dedicated an entire chapter to this topic. One of the major points of contention during the development of NFPA 3 was whether the document should be written as a standard, so that it would include enforceable language, or as a recommended practice, which is written without enforceable language and contains recommendations instead of requirements.

At the heart of the discussion was the need for a standard on integrated testing. The committee did not feel that the commissioning (Cx) process could be standardized, so they settled on a recommended practice for the first edition.

The committee recognized the need throughout the industry for a standard on integrated testing and subsequently made a request to NFPA's Standards Council to split NFPA 3 into two documents. NFPA 3 would continue to handle commissioning, and a new standard, NFPA 4, *Standard for Integrated Fire Protection and Life Safety System Testing,* would address testing of integrated systems and would be written in enforceable language. The concept of NFPA 4 was approved by the Standards Council, and the NFPA 4 standard is currently in development with an anticipated release date of October, 2014.

7.1 General

7.1.1 This chapter applies to the testing of integrated systems provided for fire protection or life safety.

Integrated system testing is very important to ensure that the actual fire protection and life safety systems function in accordance with the owner's project requirements (OPR) and the overall design intent.

Integrated testing is most often overlooked during the occupancy phase. After the certificate of occupancy is issued, the owner might contract with individual testing contractors to perform inspection and testing services in accordance with the applicable NFPA standard. However, if these testing events are not coordinated, the integrated features of these systems will not be verified. The fire alarm inspection and testing contractor might exclude elevator recall testing from their scope of work since they do not have responsibility for the elevator. Coordinating the elevator inspection at the same time as the fire alarm testing will ensure that these systems are tested as an integrated system.

Critical Point

The role, responsibilities, and qualifications of the ITa differ from those of the FCxA.

7.1.2 Personnel responsible for integrated testing should meet the qualifications listed in 4.2.8 for ITa.

The role, responsibilities, and qualifications of the integrated testing agent (ITa) differ from those of the fire commissioning agent (FCxA). While the ITa is part of the fire and life safety commissioning (FCx) team, the ITa's role is clearly defined in 7.4.3, and the ITa's qualifications are provided in 4.2.8. In

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simple terms, the ITa is responsible for ensuring that functional performance testing of the system(s) is properly scheduled, coordinated, and performed.

7.2 Test Frequency

7.2.1* In new construction, integrated testing of fire protection and life safety systems should occur following:

(1) Verification of completeness and integrity of building construction
(2)* Individual system functional operation and acceptance as required in applicable installation standards tests

A.7.2.1(2) Components of interconnected systems should be installed, maintained, and tested in accordance with the applicable codes and standards. Examples include, but are not limited to, those systems listed in Section 1.3.

(3) Completion of pre-functional tests of integrated systems

A.7.2.1 Interconnected systems have component systems that can operate alone for a specific purpose and can be independent of other systems. Integrated systems contain multiple systems that must work in concert to achieve the fire protection and life safety goals. These interconnections need to be tested for proper operation in addition to the acceptance testing of the individual components.

FAQ

Is integrated testing recommended by NFPA 3 for new construction?

Integrated testing is recommended by NFPA 3 for new construction in order to verify that interconnected and integrated systems function in a holistic manner. At present, there is no requirement to conduct an integrated test along with the individual system acceptance tests; however, the value of such a test cannot be overstated. The integrated test will confirm that the building systems function as the registered design professional (RDP) has intended. The specific system functions to be confirmed will largely depend on what is required by the applicable codes and standards that govern the design of these systems and also on unique control and zoning features that are included at the discretion of the RDPs.

Take, for example, an atrium smoke control system that includes an automatic door that must close to separate the atrium from the remainder of the space. Functional performance testing of the smoke control system separately from the automatic door device might seem appropriate, especially since one system involves the mechanical installation contractor and the other involves the door installation contractor. However, in a fire or other emergency event, these two systems must function in an integrated fashion. If the two systems are not included as an integrated system, the ITa might not identify that the automatic door cannot properly close with the atrium fans running due to the negative pressure created by the fans. Although these two individual systems are not directly

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Myth vs Fact

MYTH: Every building must have the same periodic integrated test frequency, regardless of the building's occupancy type and function.

FACT: The ITa should take into consideration the complexity of system interconnections and integration to establish an appropriate test frequency. In some buildings with complex system interconnections that undergo frequent modifications, this frequency might be every 3 years. For buildings with limited system interaction, the desired frequency might be every 7 to 10 years.

connected, functional performance testing of these systems as an integrated system would identify this failure point.

7.2.2 Existing fire protection and life safety systems should have periodic integrated testing.

7.2.2.1 Integrated systems that were commissioned upon installation in accordance with Chapter 6 should have integrated testing at the interval specified in the commissioning plan.

A key component in the commissioning plan is the recommended frequency for integrated testing during the occupancy phase. This frequency should be determined with input from all members of the commissioning team and not be financially onerous to the owner, if at all possible. For example, if the individual installation standard requires testing of smoke detectors annually and testing of elevator recall annually, the recommended frequency for integrated testing of the elevator recall system should be annually, unless there are specific features of the building that would cause the commissioning team concern that the system could fail prior to an annual integrated test.

Critical Point

A key component in the commissioning plan is the recommended frequency for integrated testing during the occupancy phase.

7.2.2.2 For integrated systems that were not commissioned, an integrated testing plan should be developed to identify the appropriate extent and frequency of integrated system testing.

The technical committee debated over the recommendations for integrated testing of existing systems or systems that were not subject to the Cx process. It is the owner's responsibility, as noted in 7.4.1, to ensure that integrated testing is performed. In existing systems, the owner might not be aware of the recommendations for integrated testing and the appropriate frequency of that testing. It is anticipated that the individual installation and inspection/testing standards will, in the future, provide guidance for the recommended

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Myth vs Fact

MYTH: Integrated system connection verification is always done after systems undergo upgrades or modifications.

FACT: In a perfect world, there would always be confirmation of system functionality following work on a particular building system. However, this is not always the case. Establishing a trigger to test system interfaces after a building upgrade or system modification is one way to combat this problem.

frequency of integrated testing of the individual systems. This will assist inspection/testing personnel with educating owners about the recommendations for integrated testing during the occupancy phase.

7.2.3 In addition to periodic integrated testing, integrated system testing should be done when any of the following events occurs:

(1) New component fire protection or life safety systems are installed and interconnected to existing fire protection and life safety systems.
(2) Existing fire protection or life safety systems are modified to become components of interconnected systems.
(3) Interconnections or sequence of operations of existing integrated fire protection and life safety systems are modified.

It is imperative that integrated testing be performed when any of the events noted in 7.2.3 occur. This does not, however, mean that all integrated systems in the building need to be tested. Only those systems that are or can be affected by the new or modified systems should be tested. The recommendations in NFPA 3 are not intended to have owners frivolously spend money on testing that does not provide a benefit or reassurance that system components communicate as intended.

The ITa should thoroughly review the proposed new or modified systems to determine which systems are or can be affected. For example, replacing a stair door self-closing device might not appear to affect any building system; however, its proper operation is affected by the stair pressurization system. Integrated testing of the stair pressurization system, including the new self-closing device, should be performed to ensure that the door closes and latches properly and that the force to open the door does not exceed the requirements of the appropriate NFPA standard.

Critical Point

The ITa should thoroughly review the proposed new or modified systems to determine which systems are or can be affected.

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7.3 Test Method

7.3.1* Integrated testing should demonstrate that the final integrated system installation complies with the specific design objectives for the project and applicable codes and standards

If no design objectives are available, such as with an existing system or one that was not commissioned in accordance with Chapter 6 of this document, the ITa should review the existing fire protection and life safety systems in the building and discuss with the owner to determine the appropriate sequence of operation for the integrated systems. This sequence should be clearly documented as to how it was defined and retained by the owner for the life of the system, if at all possible.

A.7.3.1 The goal of integrated testing is to verify that fire protection and life safety systems operate as designed and as required by codes and standards. The scope of work can include, but is not limited to, the following:

(1) Review of building plans and specifications.
(2) Review of applicable codes and standards.
(3) Review of one line riser diagram of smoke control and exhaust systems, schedules for ducts, fans, dampers, and submittals for damper operators and sequence of operation. Each piece of equipment should be numbered and identified.
(4) Review of system testing matrices and as-built drawings.
(5) Provision of a testing matrix checklist of integrated systems.
(6) Review of final testing and balancing (TAB) reports.
(7) Review of one line riser of emergency electric system.
(8) Review of equipment software submittals.
(9) Establishment of a team of testing participants and assignment of duties.
(10) Coordination of pre-test meetings with stakeholders.
(11) Implementation of integrated testing by appropriate methods and verification and documentation of operation of interface equipment under normal and emergency power after all trades complete their work.
(12) Correction of problems and retest.
(13) Submission of final report and documentation.

7.3.2* Integrated testing of fire protection and life safety systems should verify the interconnections function properly.

FAQ

If two systems are not physically interconnected, do both systems still have to be tested?

The interconnections noted in 7.3.2 apply to both direct and indirect connections. For example, a stair pressurization system and automatic closing stair doors are not physically interconnected; however, they must be tested simultaneously to ensure that each functions properly when the other is operating. If the stair door fails to fully close, the stair might not achieve the appropriate pressure differential. Conversely, if a stair pressurization system is oversized, the stair door might not be able to either open or close properly.

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Myth vs Fact

MYTH: Only the systems listed in A.7.3.2 must be considered when performing integrated tests.

FACT: Any system that interfaces with another fire protection system should be considered in the integrated test plan. The list in A.7.3.2 provides the majority of systems but is not all encompassing.

A.7.3.2 The following are examples of subsystems that can be interconnected in integrated systems:

(1) Fire alarm system
(2) ECS
(3) Building automation management system
(4) Means of egress systems and components
(5) Heating, ventilating, and air conditioning (HVAC) system
(6) Gas detection system
(7) Normal, emergency, and standby power systems
(8) Automatic sprinkler system
(9) Fixed fire suppression and control systems
(10) Automatic operating doors and closures
(11) Smoke control and management systems
(12) Explosion prevention and control systems
(13) Elevator and pedestrian movement systems
(14) Security systems
(15) Commercial cooking operations

7.3.3* During integrated testing, equipment should be tested in accordance with the applicable installation standard to verify systems perform according to their design function.

A.7.3.3 Fire protection or life safety systems can operate equipment that is not necessarily part of the fire protection or life safety system. One such example is shunt trip breakers that should be tested for proper operation.

If no installation standard is applicable (as in the case of the shunt trip breaker), a written test procedure should be developed that can be used for current and future integrated testing so that the baseline performance can be properly compared with future performance.

7.3.4 Written documentation of the testing and inspection should be provided.

This documentation should include, but not be limited to, the individual system testing documentation required by the appropriate installation standard as well as detailed

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Myth	Fact
MYTH: NFPA 3 intends a full end-to-end test every time an integrated system is modified.	**FACT:** The depth of integrated testing should be commensurate with the extent of the work being performed. In many cases where devices are swapped out, a simple interface test can be conducted to verify system functionality.

checklists or forms documenting that the integrated testing and sequence of operation meet the original design intent. These checklists or forms should be specific and tailored to the actual systems and integration methods of the building. Generic checklists or forms will not provide adequate detail for comparison of past and future results. Annex C provides sample documentation that can be used as a starting point to developing project-specific checklists and forms. Documentation should also include the following:

- List of all personnel required to be at the test and who attended the test, including name, contact information, affiliation, and purpose at the test
- List of all testing to be performed, including individual systems tests and integrated tests
- Narrative description of the tests to be performed and how they will be performed, including prerequisite testing, personnel required, tools/equipment required, and pass/fail criteria
- Documentation of actual testing performed as well as pass/fail status
- Corrective actions necessary based on testing results

7.3.5* Testing should be repeated if changes are made to systems.

A.7.3.5 Additions, modifications, or alterations to systems can cause unintended consequences of operation to the interactions of integrated systems. The testing procedure should be re-evaluated to ensure repeat testing is adequate to determine the correctness of the revision.

The extent of retesting should be based on the extent of the work performed.

Retesting of integrated fire protection and life safety systems due to system changes can be very subjective. The extent of re-testing should be based on the extent of the work performed. For example, if a single smoke detector is replaced, it might be acceptable to test only that smoke detector. However, if a new smoke detector is added into an integrated system, the integrated system sequence should be retested to ensure that the proper system output has been programmed for the new

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detector. A similar approach should be taken when devices are removed from a system. Removing a manual pull station from a fire alarm system would normally not require retesting of the fire alarm system; however, removing a door from a stair might necessitate retesting of the stair pressurization system as the leakage paths would change.

7.3.6 Switch connections to fire alarm systems should be tested in accordance with *NFPA 72*, *National Fire Alarm and Signaling Code*.

7.3.7 Control circuits requiring electrical power shall be tested for presence of operating voltage.

7.3.7.1 Loss of power to monitored circuits should be tested to confirm signal receipt at one of the following:

(1) A constantly attended location at the premises
(2) A monitoring station as described in NFPA 731, *Standard for the Installation of Electronic Premises Security Systems*, Chapter 9
(3) A supervising station as described in *NFPA 72*, *National Fire Alarm and Signaling Code*

7.3.8 Integrated testing of data sharing systems should document the following:

(1) Completion of acceptance testing for each component system
(2) Verification of data transfer between component systems
(3) Test of visual and audible signal upon loss of communication
(4) Test of degrade mode for each component system
(5) Proper function of integrated data sharing systems

7.4 Testing Responsibility

7.4.1 The owner should be responsible for integrated testing of fire and life safety systems.

7.4.2 The owner should be permitted to delegate the authority and responsibility for integrated testing of the fire protection and life safety systems to the management firm or managing individual through specific provisions in the lease, written use agreement, or management contract.

As with most NFPA inspection, testing, and maintenance standards, the owner is allowed to delegate the authority and responsibility for integrated testing to some other individual or entity. Leases or contracts should specifically state that integrated systems testing is to be performed in accordance with NFPA 3 to ensure that these recommendations are included.

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7.4.3* The ITa should be responsible for planning, scheduling, documenting, coordinating, and implementing the integrated testing of the fire protection and life safety systems and their associated subsystems.

A.7.4.3 Examples of the responsibilities of an ITa are as follows:

(1) Review the installation contractor requirements.
(2) Review the design and construction documents and specifications for each fire protection and life safety system and their associated subsystems.
(3) Develop the integrated systems testing plan.
(4) Document integrated test performance.
(5) Coordinate the scheduling of trades to perform integrated testing of systems and subsystems.

7.4.4 Where a commissioning plan does not exist, the ITa should prepare a test plan providing, but not limited to, the following information:

(1) A comprehensive functional matrix depicting all system inputs and associated output functions
(2) The extent of systems to be tested under the direct supervision of the ITa
(3) The testing of component systems required by associated NFPA standards conducted separately under contract to the owner
(4) Test processes to be incorporated
(5) Test scenarios developed to verify appropriate system responses to the functional matrix
(6) A test event schedule with the applicable stakeholders

7.4.5* Documentation.

A.7.4.5 Refer to Annex C for sample forms. See also the sample matrix and form in Figure A.3.3.16(a) and Figure A.3.3.16(b).

7.4.5.1 The ITa should maintain a record of faults, failures, and discrepancies discovered through the testing process in an official issues log (IL).

7.4.5.1.1 The IL should list each separate finding and its corresponding resolution, including dates of discovery and resolution.

7.4.5.2 Corrective action reports (CAR) should provide a specific and detailed description of actions taken to remediate faults, failures, and discrepancies discovered during the testing process.

7.4.5.3 Upon completion of testing, the ITa should submit a final test report to the owner and other stakeholders as requested.

7.4.5.4 The final test report should summarize the results of the integrated testing and should include ILs and CARs.

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Final documentation should be maintained for the life of the systems to the extent practical. Typically, a fire alarm control panel (FACP) is central to integrated fire protection and life safety systems. A good practice would be to provide permanent identification inside the FACP indicating the location of the final documentation. With the advent of smaller storage devices, saving the final documentation is a much easier task than it used to be. The final documentation along with the FACP system program and operations and maintenance manuals (O&Ms) can be kept on a flash drive on a short lanyard that is attached to the inside of the FACP door. This type of storage is a good way to maintain the documents in a ready location. The format of these documents should be a universally accepted format, such as PDFs, and, if possible, the electronic files should be stored with the hard copies. Backup hard copies should be stored wherever critical building records are stored.

References Cited in Commentary

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2013 edition, National Fire Protection Association, Quincy, MA.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2013 edition, National Fire Protection Association, Quincy, MA.

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Re-commissioning (Re-Cx) and Retro-commissioning (RCx) of Fire Protection and Life Safety Systems

CHAPTER 8

The NFPA 3 Technical Committee on Commissioning Fire Protection Systems included Chapter 8 as a means to document the commissioning (Cx) process and determine the level of quality of the fire protection and life safety systems installed in existing buildings. Owners who find the Cx process beneficial have asked that existing buildings be commissioned.

Under the National Institute of Building Sciences (NIBS) guidelines for building information modeling (BIM) and Leadership in Energy and Environmental Design (LEED), existing buildings might need to be commissioned before an owner will occupy the building. If a building *has not* previously been commissioned, then it would need to use a retro-commissioning (RCx) program. If a building *has* been subject to the Cx process, when there are changes made to the building or when there is a new owner/occupant of the building, then the building would need to use a re-commissioning (Re-Cx) program.

Another way to look at it is if a Cx process is undertaken for an existing building to establish a compliance and/or performance benchmark for the facility, it would be considered a RCx process. If the purpose of the commissioning activities is to make a comparison to a previously established benchmark, it would be considered Re-Cx process.

FAQ

When does a building use the retro-commissioning (RCx) program or the re-commissioning (Re-Cx) program?

8.1* General

This chapter provides recommendations for the re-commissioning and retro-commissioning recommendations of active and passive fire protection and life safety systems where installed in existing structures.

Active systems include all systems that have a mechanical or electrical element that assists in achieving a fire protection goal. These elements would include items such as fire alarm notification appliances and smoke control system exhaust fans. Passive systems do not rely on electrical or mechanical components but provide an inherent level of safety simply because they are present in a building. These systems include fire-resistance-rated construction and means of egress systems. These systems and components do not perform any function other than to increase the overall level of life safety of a building.

A.8.1 Re-commissioning and retro-commissioning should be considered where expansions, improvements, or additions to existing structures require commissioning of the new fire protection and life safety systems in accordance with the commissioning process of Chapter 5 of this recommended practice. Integrated testing should be considered at intervals appropriate to the structure and systems present.

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Case in Point

Buildings that have been formally commissioned will typically have a Re-Cx schedule built into the original commissioning plan. Depending on the modifications made to the building and the future plans of the owner, the frequency of Re-Cx can vary.

Where changes in use or significant alterations or additions to the building or facility are made, Re-Cx of the facility provides the owner with an understanding of the level of fire protection and life safety that is currently being provided.

Often the Re-Cx process will be a condensed version of the original Cx process, especially where minimal modifications or additions to the fire protection and life safety systems have been made.

Re-Cx can be a costly process for the owner; therefore, owners might look to minimize the impact of commissioning activities and tasks on their budget. Similar to the RCx triggers commonly used, Re-Cx triggers might simply be a new integrated test of the facility when systems are added, interconnected, or modified.

A trigger to perform an integrated test would eliminate many of the administrative and procedural tasks commonly associated with commissioning, while still providing the owner with the assurance that the systems in place function and communicate properly.

8.2 Re-commissioning

8.2.1* Fire protection and life safety systems that have been commissioned upon installation in accordance with the commissioning process of Chapter 5 of this standard should be re-commissioned as specified by a re-commissioning plan.

A.8.2.1 Re-commissioning should be conducted only if design or installation flaws or other operational issues are revealed through either the normal inspection, testing, and maintenance process or following a design review by a registered design professional. Re-commissioning might also be required by the AHJ if changes to the building structure have occurred such as expansions, improvements, or additions or the building occupancy have changed since the system was first placed into service. Re-commissioning is only performed on systems that were previously commissioned.

8.2.2 Recommendations for Re-commissioning.

The following should be achieved during re-commissioning:

(1) A fire protection and life safety commissioning team should be established and responsibilities should be assigned in accordance with 5.2.2.
(2) The fire protection and life safety commissioning team should complete the applicable recommendations of 5.2.1.2, 5.3.1, 5.4.1, and 5.5.2.

The Re-Cx of a building's fire protection and life safety systems requires that a team be appointed to handle the process. Just as for the Cx process for new buildings, the owner should kick off the process and follow the parts and pieces of the original process that

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Myth vs **Fact**

MYTH: The re-commissioning team must employ the same individuals who worked on the original commissioning process for the building.

FACT: While it would save time and money to have people familiar with the original commissioning program involved in the re-commissioning process, the owner can select team members as they deem appropriate.

would apply to their building. Any owner and fire commissioning agent (FCxA) familiar with the Cx process will have no trouble selecting the appropriate portions of Sections 5.2 through 5.5 that will apply to their building project. The previous commissioning plan will be an effective starting point for the Re-Cx of the systems in the building.

There are many reasons for initiating the Re-Cx process. One reason would be that the systems in a building do not perform as expected during the ongoing inspection, testing, and maintenance program that is part of the original commissioning plan. Re-Cx would also be initiated when there is a change of occupancy and, perhaps, even a change of owner. This type of change could occur when there is new construction added to an existing facility or when internal changes are made to processes or staff.

FAQ

What are the reasons for initiating the Re-Cx process?

8.3 Retro-commissioning

RCx is the implementation of the Cx process for an existing building or facility that has not been formally commissioned. RCx is one way to establish a benchmark of the building systems and their interconnectivity. Typically, buildings or facilities undergoing an RCx process are older and have deficiencies that have existed for many years. Therefore, the commissioning plan implemented for an existing building can vary greatly from that of a commissioning plan established for new construction.

Critical Point

RCx will require much more work to inspect, identify, and learn about the systems in the existing facility. These tasks include ensuring that the systems meet the OPR and having an RDP determine the BOD for the existing structure.

8.3.1* Where testing of existing fire protection and life safety systems has not been conducted in accordance with the commissioning process of Chapter 5 of this recommended practice, retro-commissioning should only be specified by a retro-commissioning plan.

The RCx of a building's fire protection and life safety systems requires a thorough analysis of the building and its systems.

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Case in Point

The RCx plan should be developed from a survey or field evaluation of the fire protection and life safety systems installed in the facility. This field survey will often be conducted in parallel with a review of facility documentation if it is available. In many cases, original design documentation might not be available to the commissioning team (CxT) or might no longer be relevant due to modifications made to the building throughout its history.

The RCx process is not necessarily intended to bring these systems into compliance with new codes and standards, but rather to give the building owner and the CxT an understanding of the level of fire protection and life safety provided. The RCx plan could highlight major faults in the existing fire protection and life safety scheme for the facility; however, due to costs and feasibility constraints, other noncritical deficiencies identified during the evaluation portion of the RCx process might not need to be addressed immediately.

Corrective measures for these deficiencies often will be scheduled over a period of several years or will be scheduled for remediation based on a specific trigger identified in the RCx plan.

Another way the correction or improvement might be addressed is by providing triggers in the RCx plan for future integrated system tests. The frequency of integrated system tests is usually based on the triggers established and generated by the initial survey or field evaluation, or by establishing a set frequency in number of years.

No matter what level of effort is anticipated from the CxT as defined by the owner, it is critical that the goals for the RCx process be identified and clearly communicated to those expected to carry them out. RCx of an existing building will vary greatly from the commissioning of a new building, so it is important to highlight the differences and be clear about the intent of the process.

FAQ

What type of action would initiate the RCx process?

Like all other commissioning, RCx requires that a team be appointed to handle the process. Unlike Re-Cx, there will be no existing plan to follow as a guide; therefore, the owner will need to follow nearly all the steps outlined in Sections 5.2 through 5.5. The development of an original owner's project requirements (OPR) and then a basis of design (BOD) would be followed by a new and original fire and life safety commissioning (FCx) plan.

RCx would be initiated when the systems in a building do not perform as expected during the ongoing inspection, testing, and maintenance program. RCx would also be initiated when there is a change of occupancy and, perhaps, even a change of owner. This type of change could occur when there is new construction added to an existing facility or when changes are made to internal processes or staff.

RCx will require much more work to inspect, identify, and learn about the systems in the existing facility. These tasks include ensuring that the systems meet the OPR and having a registered design professional (RDP) determine the BOD for the existing structure.

Benefits for undergoing such a process will include the assurance that the fire protection and life safety systems are suitable, appropriate, and adequate for the building and the owner. Monetary savings will also be realized by the new owner of a building or the existing owner of an expanding building as they move in and understand the building's systems. The required inspection, testing, and maintenance programs would begin. Owners would receive training on the systems they are taking over or that they are adding to the existing building. These assurances that the systems are suitable are valuable to the

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Myth vs **Fact**

MYTH: The purpose of retro-commissioning is to bring a building into compliance with current codes and standards.

FACT: The purpose of retro-commissioning is to establish a benchmark for the building's fire protection and life safety systems. Owners can then choose to work on specific systems upgrades as they see fit, based on their assessment of the risks associated with the findings of the retro-commissioning process.

owners, their customers, their staff, and the general public in the communities in which the owners conduct business.

Finally, no matter what type of commissioning plan is implemented, the FCx team should ensure that an approved integrated testing plan has been put in place and implemented according to the plan. Documenting the entire Cx process and delivering such documentation to the owner will be the final result of Re-Cx and RCx.

A.8.3.1 Retro-commissioning should be conducted only if design or installation flaws or other operational issues are revealed through either the normal inspection, testing, and maintenance process or following a design review by a registered design professional. Retro-commissioning might also be required by the AHJ if changes to the building structure have occurred such as expansions, improvements, or additions or the building occupancy have changed since the system was first placed into service. Retro-commissioning is only performed on systems that were not previously commissioned.

8.3.1.1 A fire protection and life safety commissioning team should be established.

The team developed for RCx activities might not be as comprehensive as a team developed for a new building. Often the owner will bring in an FCxA to conduct a building analysis and then expand the team pending the conclusions of the FCxA.

Critical Point

Often the owner will bring in an FCxA to conduct an building analysis and then expand the team pending the conclusions of the FCxA.

8.3.1.2 The responsibilities of the fire protection and life safety commissioning team should be assigned in accordance with 5.2.2.

As a cost-saving measure, the commissioning plan can utilize facilities management personnel to take an active role, and, in some instances, a leadership role in a RCx project. The positive impacts of using site personnel are numerous. First, the direct costs would be reduced as these individuals are already on the facility payroll; therefore, no additional professional expenses would need to be budgeted. Second, these individuals often have firsthand knowledge of building systems, maintenance reports,

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and issues, and they are knowledgeable on where and how to find building information that would be included in a RCx report. Third, in preparing the RCx documents, these individuals will be doing on-the-job training for the systems they will be writing operation and maintenance (O&M) manuals for.

8.3.1.3 The fire protection and life safety commissioning team should complete the applicable recommendations of 5.2.1.2, 5.3.1, 5.4.1, and 5.5.2.

8.3.2 The retro-commissioning plan should be developed from a survey and evaluation of installed fire protection and life safety systems design and existing conditions.

8.3.3 Integrated testing of fire protection and life safety systems should be performed in accordance with Chapter 6.

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Commissioning Documentation and Forms

CHAPTER 9

Chapter 9 covers the documentation and forms that are recommended to be used in the commissioning process. Documentation is of foremost importance in commissioning, and it should not be overlooked or undervalued. As discussed throughout NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*, the owner's project requirements (OPR) and the basis of design (BOD) are not simply documents to be used during the design phase with functional performance (acceptance) testing forms and checklists to be used only during the construction phase. All of these documents should be used and referred to throughout the life of the systems.

Proper documentation is crucial to establishing baseline system performance as well as reviewing history performance and trends. During the occupancy phase of a project, proper it commissioning documentation should be referred to during scheduled inspection, testing, and maintenance as well as whenever facility or system modifications are to be performed.

Critical Point

Documentation is of foremost importance in commissioning, and it should not be overlooked or undervalued.

9.1* Documentation

Approved commissioning documents and forms should be used to record commissioning and integrated testing of fire and life safety systems.

A.9.1 The forms shown in Annex C are examples of the documentation required by this recommended practice.

Fire protection and life safety system commissioning is typically an owner-driven requirement, not a regulatory-driven requirement. As such, the word "approved" is often used in

Myth vs Fact

MYTH: The FCx team can only use the forms in NFPA 3 for commissioning fire protection and life safety systems.

FACT: The forms provided in NFPA 3 are recommended as a starting point for FCx teams to work with; however, in many cases custom forms or forms taken from other industries might be better suited for certain projects or systems. In these cases, the FCx team should work with the owner and AHJ to make sure the forms selected are comprehensive and appropriate.

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a different context than in other NFPA installation standards. In terms of commissioning, "approved" could simply mean approved by (or acceptable to) the owner and the fire and life safety commissioning (FCx) team. If either commissioning or integrated testing is a requirement of a regulatory agency, the documents and forms should be reviewed and approved by the applicable regulatory agency prior to use.

Critical Point

The forms shown in Annex C are simply examples and should be modified for each project and system to be commissioned.

The forms shown in Annex C are simply examples and should be modified for each project and system to be commissioned. The fire commissioning agent (FCxA) should be aware that developing forms and checklists can be very time consuming, and an appropriate amount of time should be set aside early in the project to ensure that proper documents, forms, and checklists are developed. Generic forms found in NFPA or other industry standard publications are useful as a baseline in developing project-specific documents.

9.2 Allowable Documents

Documents from NFPA and other approved installation standards referenced in the BOD should be utilized.

FAQ

Can I use the forms in other NFPA documents, such as NFPA 13, *Standard for the Installation of Sprinkler Systems,* for my commissioning forms?

Checklists and forms found in other NFPA documents can be used by the FCxA as part of the overall commissioning documentation for the project. The FCxA, however, must keep in mind that forms found in NFPA installation standards might apply only to individual system testing (acceptance testing) or integrated systems testing and might not be sufficient as the sole commissioning documentation. The forms to be used should be clearly identified in the BOD and developed as part of the commissioning plan.

9.3 Forms and Checklists

Where no form or checklist exists, specific forms or checklists should be developed to document successful testing of systems and components.

While standardized forms allow for consistency and ease of understanding by the owner, standardization should not override complete and accurate forms. The individual forms and checklists found in many NFPA installation standards provide a good baseline from which to expand for each project and specific system.

Annex C of this document provides valuable sample forms tailored to generic fire protection and life safety systems commissioning. These should be used as a starting point for project-specific forms and checklists.

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Case in Point

Although the concept of document retention for the life of a building can seem daunting, and in some instances unrealistic, it can prove to be beneficial for the owner and systems designers long after the building is occupied.

When new systems are installed or renovations are made to an existing building, the discovery/due-diligence period can be lengthy and costly. This becomes especially critical where there are complex system interconnections. The presence of an up-to-date sequence of operations matrix can make the design and acceptance testing of any new system much more palatable, and it eliminates a lot of the guesswork often associated with existing building upgrades. It is also incredibly valuable when buildings are being sold, as the original owner can quickly illustrate to potential buyers the building's compliance with applicable codes at the time of construction.

Component lists, and even the original specifications, are useful, as they can help future system users determine component compatibility and prioritize upgrades. Where records of the original system design (and often equally important, the basis for their design and installation) are available, it can be a huge benefit.

9.4* Document Retention

Test documents should be retained by the owner for the life of the system.

A.9.4 The documents should be maintained at the site, but this might not always be practical. If the test documents are kept somewhere other than on site, then the owner should be knowledgeable of the storage method and location of the records.

Commissioning and integrated testing documentation is useful to the owner only if it is retained. The FCxA should work with the owner to help identify how the documentation will be retained, its location, and the storage medium. Care should be taken when storage is via electronic media, as the media might need to be accessed many years in the future. In this case, it might be prudent for the FCxA to develop a recommended media review frequency to update the documentation into a more current electronic media. One way to counteract the potential for technology evolving beyond a point where records can be retrieved is to keep a hard copy on file so that it can always be "scanned" into the latest appropriate software format.

The purpose of Section 9.4 is to recommend that the commissioning or integrated testing documentation be retained by the owner or designated representative — not the FCxA or individual installation/testing contractors — for the life of the building or system(s).

References Cited in Commentary

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2013 edition, National Fire Protection Association, Quincy, MA.

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Explanatory Material

ANNEX



Annex A is not a part of the recommendations of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

Annex material is useful information that is included in this document solely to help the user understand the intent of the recommendations by providing further information, diagrams, examples, or other details.

The Annex A material is not only explanatory material to specific sections of NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*, but it is voted on by the document's technical committee along with the rest of NFPA 3.

The commentary in this handbook differs from the annex material in that it consists of the opinions of the editors and contributors of this handbook — not the committee — to help further explain provisions in the document.

For the convenience of the readers of this handbook, Annex A text is inserted after the appropriate paragraphs in Chapter 1 through Chapter 9 and, therefore, is not repeated here.

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Sample Basis of Design Narrative Report

ANNEX B

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1

The narrative should be written in a three-section format including subsections as necessary (methodology, sequence of operation, and testing criteria sections) for clarity and should be limited to a summary. This annex presents a sample format for a narrative report.

Although many designers and consultants have used the concept of a basis of design (BOD) report for an individual system design, the use of a project-wide BOD is a relatively new concept. Since the BOD is a cornerstone of the commissioning plan, the technical committee felt it was important to show users of NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems,* the type of information that should be included in the BOD and how the BOD can be structured for ease of use. The BOD is referred to throughout the commissioning (Cx) process and during building occupancy, so it is important to provide not only what was included from a design and installation perspective, but also the reasons why it was included.

B.2 Methodology Section

The methodology section of the narrative should document the overall fire protection and life safety system approach used at the facility, and it can be considered the most important section of the BOD. While the areas of sequence of operation and testing cri-

Myth vs Fact

MYTH: The narrative must be formatted exactly as the sample basis of design report is shown in Annex B.

FACT: The sample narrative in Annex B provides a concise, easy-to-read narrative addressing the critical points of the commissioning process. In some instances, the AHJ might request an alternate format or additional information, in which case any format acceptable to the AHJ is permitted to be used.

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Case in Point

The following statement does not provide an adequate level of detail: "The building contains business and factory/industrial occupancies, both light and ordinary hazard Group 1 hazard classification." More adequate statements include the following: "Rooms 101 through 125 and 128 are classified as business occupancies per the model building code. Rooms 101 through 110 are classified as light hazard occupancies, while rooms 111 through 125 and 128 are classified as ordinary hazard Group 1 occupancies per NFPA 13. Rooms 126 and 127 are classified as moderate hazard factory/industrial occupancies per the model building code and as ordinary hazard Group 1 per NFPA 13." The discussion should go on to describe any processes in each of these areas that we reviewed to determine either the occupancy or hazard classification. Whenever possible, the room name (e.g., Room 111 Storage) should be used in lieu of room number only.

A similar narrative discussion should be included to describe the types of construction, hazardous materials storage and use, and method of storage. A preliminary hazardous materials inventory statement would provide significant value for occupancy classification and hazardous materials storage and use requirements in documenting the BOD.

teria are important, those sections can be recreated if the methodology is accurately and completely documented. The registered design professional (RDP) should spend an adequate amount of time on the methodology to fully develop it in a manner that can be understood by future users and reviewers of the BOD. In essence, if the BOD needed to be recreated for any reason, the fire and life safety commissioning (FCx) team would be able to recreate it in its entirety from the methodology section alone.

B.2.1 Subsection 1: Description.

This section should identify specific features of a building that contribute to the overall understanding of the fire protection and life safety systems and features to be provided as part of the design and construction, as follows:

(1) Building and/or structure use group classification in accordance with applicable building code of the jurisdiction
(2) Total aggregate square footage of building
(3) Building height
(4) Number of floors above grade
(5) Number of floors below grade
(6) Square footage per floor
(7) Type(s) of occupancies, hazard classifications, processes
(8) Type(s) of construction
(9) Hazardous material usage and storage
(10) Method of storage arrangements of commodities
(11) Site access arrangement for emergency response vehicles

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Myth	Fact
MYTH: The list of laws, regulations, and codes provided in Subsection 2 is complete and comprehensive.	**FACT:** The list provided is a sample and accounts for the majority of laws, regulations, and codes that are applicable on most construction projects. There might be additional requirements, such as insurance standards and standards that are set forth by the property financier.

The amount of information provided for the description of the building and its features can never be too great. The more information provided by the RDP, the clearer the BOD will be for the FCx team to understand.

The description should include all the occupancy types within the facility as identified from sources such as the model building code or NFPA *101®, Life Safety Code®*. The description should also include the facility's hazard classifications as identified from a source such as NFPA 13, *Standard for the Installation of Sprinkler Systems*. All industrial processes and storage practices associated with the facility should be broken out in the description based on the information that will drive system design. The system requirements associated with industrial processes and storage arrangements are very specific. Modifications to a single variable in either an industrial process or storage arrangement can lead to a dramatically different final system installation.

B.2.2 Subsection 2: Applicable Laws, Regulations, Codes, Ordinances, and Standards.

This section identifies regulatory requirements of the jurisdiction that have or can have an impact in the design and approval of fire protection and life safety systems. This section requires the preparer of the narrative to conduct a comprehensive regulatory research such as the following:

(1) Building code fire protection and life safety system requirements
(2) NFPA standards or other applicable recognized standards and edition used for design and or installation of each specific fire protection system
(3) Applicability of any special laws of the jurisdiction that can supersede a code or standard
(4) Applicability of local by-laws or ordinances of the jurisdiction
(5) Applicability of other codes such as plumbing, elevator, and electrical codes that can have an impact on the design, installation, and testing of the fire protection and life safety systems
(6) Applicability of any federal laws such as OSHA, ADA, or other governmental entity

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Along with the applicable laws, regulations, codes, ordinances, and standards, the RDP should make sure to include the applicable edition or enforcement date of the cited references. This simple step will eliminate confusion about it at a later time. General statements, such as "latest edition in effect at the time of development of this document," would require the FCx team and future users to spend time determining when the document was developed and what editions were in effect at that time.

B.2.3 Subsection 3: Design Responsibility for Fire Protection and Life Safety Systems.

This section identifies the accountability (required by the jurisdiction) for a specific fire protection and life safety system design and the accountability for the integration of the fire protection systems constituting a building or structures fire protection and life safety system(s). There could be options permitted by the jurisdiction.

B.2.3.1 The RDP fully designs (complete layout and calculation) and specifies the fire protection and life safety system or systems to be installed, reviews and approves the installing contractor's shop drawings, and certifies system installation(s) for code compliance at completion. There could be multiple RDP associated with a project and should be identified as appropriate.

B.2.3.2 The RDP provides a partial design and specifies the design criteria to be used by the installing contractor(s), who finalizes the system layout and provides calculations to confirm the design criteria. The RDP certifies system installation for code compliance at completion.

B.2.3.3 At design-build, the installing contractor for a specific fire protection and life safety system completely designs and specifies if permitted by the governmental jurisdiction (develops a full system layout, design criteria, and calculations), installs the system, and certifies system installation for regulatory and applicable standard compliance at completion. There can be a RDP involved but not necessarily.

B.2.3.4 Whichever method from B.2.3.1 through B.2.3.3 is selected, the project requires a qualified person to assume responsibility for the coordination of fire protection and life safety systems requiring integration, forming an entire building fire protection and life safety system.

The fire protection RDP should always be the designated person with the overall responsibility of coordinating the design of the building fire protection and life safety features, even though he or she did not actually design each of the individual systems. This subsection should list the designers of each system (e.g., the designers of the smoke control system, passive fire resistance system, fire alarm system, or sprinkler system) with the fire protection RDP listed as the overall coordinator of the building fire protection and life safety features.

Terms-at-a-Glance

AHJ	Authority Having Jurisdiction	CxA	Commissioning Authority
BIM	Building Information Model	CxT	Commissioning Team
BOD	Basis of Design	ECS	Emergency Communication Systems
CAR	Corrective Action Reports	FCx	Fire and Life Safety Commissioning
CP	Commission Plan	FCxA	Fire Commissioning Agent
Cx	Commissioning	FMP	Facilities Management Personnel

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B.2.4 Subsection 4: Fire Protection and Life Safety Systems to be Installed.

This section should identify key performance design criteria and features for each specific fire protection system, as follows:

(1) Water supply system such as municipal or private systems, fire mains and hydrants, storage tanks, and fire pumps
(2) Automatic sprinkler systems, such as wet, dry, pre-action
(3) Standpipe systems, such as wet, dry, and classification
(4) Fire alarm systems, such as manual, automatic detection, evacuation signals
(5) Automatic fire extinguishing systems, such as dry chemical, clean agent
(6) Manual suppression systems
(7) Smoke control/management systems, such as automatic smoke exhaust, stair pressurization
(8) Commercial cooking equipment and exhaust system fire suppression system(s), such as wet chemical or automatic sprinklers
(9) Emergency power systems, such as applicability to fire protection and life safety systems
(10) Hazardous material and process protection, special protection
(11) System supervision, such as method of 24-hour monitoring conditions of fire protection and life safety systems
(12) Passive systems including doors, walls, floors, ceilings, and roof decks

The description (specific features) for the fire protection systems listed above should also indicate if the system(s) are as follows:

(1) Required by laws, codes, standards, ordinance, and so forth
(2) Non-required, building owner provides voluntarily and/or requirement of insurance entity
(3) A complete new system
(4) An addition or expansion to existing system
(5) A modification/repair to existing system
(6) Level of protection to be provided, 100 percent or partial protection or exempt by regulatory code

As with the facility description, the amount of information provided in this subsection can never be too great. Sufficient detail should be provided for each system to fully explain as much important information as possible, such as the type of system, the design criteria, and the interconnection with integrated systems. The more information provided by the RDP, the clearer the BOD will be for the FCx team to understand. A simple statement such as, "A wet pipe sprinkler system will be provided throughout the building per NFPA 13," does not provide an adequate level of detail for review and understanding by the FCx team or future users. Important information such as the extent of the fire sprinkler system, any allowed exceptions, and the design criteria should be provided in full detail.

Terms-at-a-Glance

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ITx	Integrated Testing Plan	Re-Cx	Re-Commissioning
NIBS	National Institute of Building Sciences	RFQ	Request for Quotation
O&M	Operation and Maintenance	TAB	Testing and Balancing

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B.2.5 Subsection 5: Consideration Used in the Design Methodology.

This section identifies the designer's intent in the overall design and criteria development of the fire protection and life safety systems, as follows:

(1) Building occupant notification and evacuation procedures
(2) Emergency response personnel, site, and systems features
(3) Safeguards, fire prevention, and emergency procedures during new construction and impairment plans associated with new and/or existing system modifications
(4) Method for future testing and maintenance of systems and documentation
(5) Special requirements or request of the authority having jurisdiction

As noted, this subsection describes the intent of the overall fire protection and life safety system as developed by the RDP in conjunction with the owner's project requirements (OPR). The intent describes who will be in the building, how they will be notified of an emergency, how they (or outside entities) will respond to that emergency, and what steps will be taken to ensure the systems are operational throughout their life cycle. In addition, any special requirements above and beyond the documents listed in B.2.2 should be documented here.

B.2.6 Subsection 6: Alternatives.

This section identifies the designer's intent to deviate from prescriptive requirements of regulatory codes and standards with alternative methods, as follows:

(1) Application of performance-based design in lieu of prescriptive code requirement
(2) Interpretation/clarification between designer and authority having jurisdiction
(3) Waiver or variance sought and or required by the authority having jurisdiction through the regulatory appeal process

B.3 Sequence of Operation Section

This portion of the narrative is generally a difficult section to write as it entails the specific operation of the fire protection and life safety systems, system devices, and equipment and their related integration, depending on the complexity of the systems installed. The preparer of the narrative should have an overall understanding and knowledge of how all the fire protection and life safety systems should function when integrated together.

While it is preferred that this section be written in a narrative format, a sequence of operation (cause and effect) matrix would provide significant value as well. For any nonstandard items included in the sequence, a narrative description should be provided as to why those nonstandard items are included. An example of a nonstandard item might be

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having an automated storage and retrieval unit return to its home location upon activation of the fire sprinkler waterflow switch serving the automated storage and retrieval system racking.

If there is a question as to whether an item in the sequence should be considered "nonstandard," it is always best to provide a narrative description of its function. These items typically consist of interactions between fire protection systems and nonfire protection systems or interconnections of systems seen less frequently where the system functionality is not obvious to the FCx team.

B.3.1 Subsection 1.

The operational description should include the following:

(1) An operational description of either a system or specific devices within a system and the resulting action associated with the operation of the system or specific devices should be provided.
(2) The operational description should include all interconnected (integrated) fire protection and life safety systems and devices required or non-required forming an entire building fire protection and life safety system.
(3) All signage indicating equipment location, operational and design features, and certified documents attesting to system installation integrity should be provided.
(4) The narrative sequence of operation description should be specifically coordinated with the input and output sequence of operation developed for the systems operation.

This section of the narrative report can be brief as in a simple system such as a one-story, 15,000 ft^2 mercantile building with only a sprinkler system and manual fire alarm pull boxes, notification devices, and system supervision, or complex, such as in a 25-story high-rise with fire pumps, emergency generator, fire alarm and sprinkler zones, automatic standpipes, automatic voice and manual evacuation signals, smoke management system, automatic elevator recall, special extinguishing systems, remote annunciation, automatic locking devices, alarm retransmission methods, and emergency response procedures.

The sequence of operation of a building fire protection and life safety system, particularly with complicated systems, must be reviewed and understood by the building owner, the AHJ, and the entities responsible for installation (generally the fire alarm and building automated systems programming technicians) and future testing and maintenance after the building has been issued a certificate of occupancy. A team approach should be used by developers, designers, equipment suppliers, and contractors including the AHJ (more specifically emergency response personnel, such as the local fire department) to clearly describe and understand the proper operation and use of the integrated fire protection and life safety systems.

When a complex system is proposed, the initial narrative report of the sequence of operation should be viewed as a draft. At various stages of system installation(s), modifications could be made due to design changes, equipment changes, new technology availability, and/or

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changes to codes and standards that would require system modifications. The preparer of the narrative should be familiar with any and all changes to the systems and submit a final accurate narrative for approval and/or acceptance by the AHJ, building owner, and other entities prior to witnessing system(s) operational acceptance and commissioning testing.

Communication between the building owner, designers, builders, and the AHJ is an important element particularly in this phase, as the codes and the standards tend to be flexible and interpretative relative to sequences of operation of the integrated fire protection and life safety systems.

B.4 Testing Criteria Section

This section of the narrative report should be broken down into three sections, B.4.1, B.4.2, and B.4.3.

B.4.1 Subsection 1: Testing Criteria.

This section identifies the individual in charge who will coordinate the final acceptance testing and witnessing by the authority having jurisdiction, as follows:

(1) Identification of qualified person(s) in charge (should be the FCxA and/or multiple agents if applicable) for setting up and coordinating all prefunctional testing and final testing.
(2) Method of verification and confirmation by the qualified person(s) in charge that all fire protection systems, equipment, and devices have been individually tested and tested as an entire system when specific systems are integrated to form a building fire protection and life safety system.
(3) Method of coordination by qualified person in charge of all designers, contractors, equipment distributors, owners' representatives, and the AHJ required to perform and/or witness all testing, testing dates and times, notification to public utilities, and personnel required to perform all required testing as a system or individual system component testing.

The testing criteria subsection is paramount to successful installation and approval of building-wide fire protection and life safety systems. The RDP should ask the following basic questions:

- Who is responsible for coordinating and overseeing the fire protection and life safety systems?
- What is the pass/fail criteria that will be used for both individual and integrated systems?
- Who must be present at functional performance testing? (This might change depending on which individual or integrated system is being validated.)

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Case in Point

When testing an atrium smoke removal system, will system success be determined by verification of the flow rates of the exhaust and intake fans, by removal of cold smoke produced by a smoke generator in the atrium, or by removal of smoke from an actual fire?

If system success is determined by removal of smoke from an actual fire, how big should the fire be, how much smoke must be removed, and at what time interval? If success is determined by removal of smoke produced by a smoke generator, how much smoke is to be produced by the generator, what height is the smoke limited to, and how much obscuration is permitted? The acceptance criteria for a simple atrium smoke removal system can be very complex if the pass/fail criteria is not developed early in the project and approved by all approving entities.

Early documentation of the pass/fail criteria for each individual and integrated system is critical for project success and implementation of the overall fire protection and life safety strategy for the building.

- How much notification is required for all parties to ensure that coordination can occur for a successful test? In addition, how should that notification be made (e.g., formal letter, e-mail, telephone call, or weekly status meeting)?

One of the most difficult aspects of this subsection is determining pass/fail criteria acceptable to all entities. Each approving entity might have a different need that determines their individual pass/fail criteria.

B.4.2 Subsection 2: Equipment and Tools.

This section will identify the necessary equipment available on site at time of witnessing the operational features and/or integrated performance of the fire protection and life safety systems that require validation by the owner and/or the AHJ to expedite the acceptance and commissioning testing, as follows:

(1) Identification of equipment, documents, and procedures to be used to verify system performance and confirm design methodology and specifications, code and standards compliance, and accuracy of fire protection and life safety system(s) sequence of operation.
(2) Examples include but are not limited to the following:
    (a) Manufacturer's instructions
    (b) Specification instructions
    (c) Requirements of the AHJ
    (d) Narrative, sequence of operation section
    (e) Smoke machines, smoke candles
    (f) Sound meters
    (g) Fire hoses, nozzles

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(h) Flow measuring devices
(i) Gauges
(j) Air balancing and air measuring meters
(k) Door force closing and opening measuring devices
(l) Voltage meters
(m) Magnets
(n) Communication radios
(o) Fire department equipment
(p) Special tools, keys
(q) Ladders
(r) Safety equipment
(s) Notifications announcements
(t) Signs
(u) Charts, forms, checklist, logs
(v) Acceptance test forms

Along with the equipment and tools necessary for proper functional performance testing, the entities responsible for the equipment and tools should also be documented so that there is agreement by all entities prior to project completion. If any equipment is required to be calibrated, the criteria for calibration should also be documented.

B.4.3 Subsection 3: Approval Requirements.

This section identifies all the closeout documents required by the owner and the AHJ as part of the overall commissioning process, as follows:

(1) Identify method of approval (acceptance) required (verbal or written) from the owner and the AHJ if system satisfied all applicable code and standards compliance requirements
(2) Identify method of remedial action when a system or portion of a system fails to operate as specified and or as required by codes and standards or the sequence of operations
(3) Documentation to be submitted at completion verifying that systems are in compliance with all applicable codes and standards, requirements of the AHJ, narrative, design and specifications, and sequence of operations
(4) Documentation to be submitted to the AHJ listing names, addresses, and telephone numbers of personnel for emergency notification

Early acceptance of the documentation and approval method for the fire protection and life safety systems reduces confusion and potential arguments at project completion. The fire commissioning agent (FCxA) or another FCx team member representing the owner should document who is required to provide approval and how that approval should be documented. A simple form stating, "I witnessed fire alarm testing," might suffice for a one-story retail facility but not for a multi-story residential facility.

Terms-at-a-Glance

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There are a lot of questions that should be asked, decided, and documented early in the process, such as the following: What criteria will be used to determine if a partial approval can be granted to allow the owner to use a portion of the building? At what point is the system considered to have failed its functional performance test? In the case of a fire alarm system, is one nonfunctioning smoke detector considered failure of the entire system? What if there are 1,000 smoke detectors? What if there are only three?

The criteria for partial approval should be discussed and documented during the design phase, well before the stress of project completion is bearing down on all parties.

References Cited in Commentary

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition, National Fire Protection Association, Quincy, MA.

NFPA *101®, Life Safety Code®*, 2012 edition, National Fire Protection Association, Quincy, MA.

Terms-at-a-Glance

HVAC	**Heating, Ventilating, and Air Conditioning**	**OPR**	**Owner's Project Requirements**
IL	**Issues Log**	**RCx**	**Retro-Commissioning**
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ANNEX C

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

The following annex material is provided as a tool to be used by building owners and commissioning professionals in developing and implementing a fire commissioning plan for a project. There is no intent on the part of the committee to limit the types of forms or to require a format for the data collected as recommended in NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*. The forms used on each commissioning project will look different, depending on the needs of the fire and life safety commissioning (FCx) team and the owner.

The concept of fire protection system commissioning through the process outlined in NFPA 3 is new to the fire protection industry, and as such, the committee felt it important to provide some guidance in this area. As the acceptance of the commissioning (Cx) process grows, the committee intends to update these forms based on user input.

For examples of completed forms, see Supplement 1 to this handbook. The sample project shown and the associated sample documentation will assist the NFPA 3 user in determining which forms to use and to what capacity. Many of these forms, including an owner's project requirements (OPR) form, a basis of design (BOD), an issues log (IL), or a corrective action report (CAR) can be used on any project undergoing commissioning.

C.1

The forms listed in this annex are recommended as useful tools to document critical path activities related to systems commissioning and project management. It is not the intent of this recommended practice to mandate the use of these forms. The user is encouraged to modify the forms or use other documentation to capture and document pertinent commissioning-related activities.

C.1.1 Basis of Design.

Figure C.1.1 can be used to capture the OPR as recommended by 5.2.3.

Myth vs Fact

MYTH: The forms provided in NFPA 3 are the required forms for all fire protection and life safety system commissioning projects.

FACT: The forms provided in NFPA 3 are simply examples of forms that can be used to document commissioning related activities. Each commissioning team is encouraged to manipulate the forms so that they work best for their project.

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BASIS OF DESIGN

Project name _____

Contract number _____

BUILDING

Intended use _____

Construction type(s) _____

Building height _____ Total area (ft²) _____

Number of floors above grade _____ Number of floors below grade _____

Area per floor (ft²) _____

DESCRIPTION OF OCCUPANCIES OR HAZARDS WITHIN BUILDING

_____

_____

_____

_____

DESIGN CODES *(Indicate editions.)*

_____

_____

_____

SITE ACCESS FOR EMERGENCIES *(Include changes during construction stages.)*

_____

_____

_____

RESOURCES FOR FIRE FIGHTING *(List when available during construction stages.)*

_____

_____

_____

SPECIAL CONSIDERATIONS

_____

_____

_____

_____

_____

_____

_____

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FIGURE C.1.1 *Sample Basis of Design.*

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C.1.2 Equipment Scope and Responsible Parties.

Figure C.1.2 is intended to identify the area and application of each fire and life safety system. The form can be used in conjunction with the BOD.

C.1.3 Project Schedule.

The project schedule can be any adaptation of a spreadsheet. The example shown in Figure C.1.3 should be modified to suit the specific parameters of each project.

C.1.4 Project Management Forms.

Figure C.1.4(a) through Figure C.1.4(i) are examples of project management documentation that should be used on most projects where commissioning is required. Any adaptation of these forms should be permitted to document appropriate commissioning activities.

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EQUIPMENT SCOPE AND RESPONSIBLE PARTIES

Equipment	Required (Y/N)	Area Protected	New, Addition, or Modification	Design	Plan Review	Installation	Acceptance
				(List responsible party and specific codes, standards, laws, and regulations applicable for each stage from design to acceptance.)			
Fire alarm							
Water-based sprinkler systems							
Standpipe and hose systems							
Water spray fixed systems							
Foam water systems							
Water mist systems							
Wet chemical systems							
Dry chemical systems							
Inert gas systems							
Low expansion foam systems							
Private fire service mains							
Private hydrants							
Water tanks							
Stationary pumps for fire protection							
Smoke-control systems							
Emergency power systems							
Other							
Other							

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FIGURE C.1.2 *Equipment Scope and Responsible Parties.*

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PROJECT SCHEDULE

Project name _____ Contract number _____ Date _____

Building System																										

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COMMISSIONING SUBMITTAL / APPROVAL

Project: _____ Submittal No.: _____

❑ New ❑ Resubmittal

From (initially): _____ To: _____

Equipment / system name: ID #:

_____ _____

_____ _____

_____ _____

Cx Section No: _____

Submittal Type:

❑ Documentation (describe): _____

_____

❑ Functional test procedure forms: _____

❑ Completed functional test procedure record or report: _____

❑ Prefunctional checklist: _____

❑ Startup and initial checkout forms: _____

❑ Completed startup documentation or report: _____

Submissions / Returns

Path	To: _____ From (initially): _____	To: _____ From: _____	To: _____ From: _____	To: _____ From: _____	To: _____ From: _____
Comments by submitter	❑ Notes attached	❑ Notes attached	❑ Notes attached	❑ Notes attached	❑ Notes attached
Copies					
Submitter signature					
Title					
Date					
Code					

Submitting Codes:

I = Initial submittal: The attached submittal has been reviewed, and the equipment, documents, or performance represented comply with the correct documents.

A = Approved as complying with the contract documents.

C = Note corrections. Approved, but need to resubmit for the record, after correcting.

NA = Not acceptable. Resubmittal required for review.

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FIGURE C.1.4(a) *Commissioning Submittal/Approval.*

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SEQUENCES OF OPERATION AND FUNCTIONAL TEST PROCEDURES SUBMITTAL

Project: _____ Submittal No: _____

❑ New ❑ Resubmittal

From (initially): _____ To (initially): _____

Equipment / System tag and name: _____

Included:

❑ Sequences of operation (enlarged from original control drawings and specification documents)

❑ Functional test procedures and forms

Submissions / Returns

The following checked individuals will receive these documents for review and/or approval:

Party	For review and comment only	For review and approval	For record only
General contractor	❑	❑	❑
Mechanical contractor	❑	❑	❑
Electrical contractor	❑	❑	❑
Controls contractor	❑	❑	❑
Construction manager	❑	❑	❑
Owner's representative	❑	❑	❑
AHJ	❑	❑	❑

Path	To: _____ From: _____	To: _____ From: _____	To: _____ From: _____	To: _____ From: _____	To: _____ From: _____
Comments by submitter	See Key (1) ❑ Notes attached	See Key (1) ❑ Notes attached	See Key (1) ❑ Notes attached	See Key (1) ❑ Notes attached	See Key (1) ❑ Notes attached
Copies					
Submitter signature					
Title					
Date					
Review code					

Key: (1) Review and comment on the sequences and/or test procedures as to their compliance with the specs.
(2) Check tests for personnel safety and to keep equipment warranty in force.

Review Codes:
AM = Approved by mechanical contractor (or electrical contractor) as complying with the contract documents. Tests will not void warranty or damage equipment and do not present unsafe conditions for personnel.
AC = Approved by controls contractor as complying with the contract documents.
AE = Approved by the design engineer as complying with the contract documents.
NC = Note corrections. Approved, but need to resubmit for the record, after correcting.
NA = Not acceptable. Resubmittal required for review.

Abbreviations: CA = commissioning agent/authority, CM = construction manager, GC = general contractor's rep., A/E = architect or engineer of record, Sub = responsible subcontractor or vendor

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FIGURE C.1.4(b) *Sequence of Operation and Functional Test Procedures Submittal.*

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COMMISSIONING TEST OR DOCUMENT APPROVAL

Project: _____ To: _____

From: _____

❑ Completed functional test approval

Equipment/System name: _____ Equipment tag: _____

Functional test description: _____

_____

❑ Document review

Document name and ID: _____

Review description: _____

_____

The test(s) of the above equipment or the review of the referenced document(s) have been completed and performance of the component, system, or documents complies with the acceptance criteria in the testing or document requirements of the Specifications and Contract Documents, subject to the changes being made as listed below or on an attached sheet.

_____ Sheets attached

A copy of the completed test or document review is attached. ❑ Yes ❑ No

Commissioning Agent Approval:

_____ _____

Commissioning Agent Date

Construction Manager Approval:

The test or review results relating to the above equipment has been reviewed and approved as complying with the contract documents.

_____ _____

Construction Manager Date

Exclusions:

_____

_____

_____

_____

_____

cc:

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FIGURE C.1.4(c) *Cx Test or Document Approval.*

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COMMISSIONING PROGRESS REPORT

Project: _____ Date: _____

Prepared by: _____ Reporting period: _____ Report #: _____

Commissioning tasks worked on since last report and general progress: _____

Areas where schedule is not being met: _____

Recommended actions: _____

Requested schedule adjustments: _____

Next steps: _____

Other comments (include general comments and field notes): _____

Issues log attached. ❑ Yes ❑ No

_____
Commissioning Agent

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FIGURE C.1.4(d) *Cx Progress Report.*

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COMMISSIONING ISSUES LOG

Project: _____ Prepared by: _____ Page _____ of _____

Attach additional pages as necessary for issues requiring more explanation and tracking.

#	Issue	Date Found	Code/ Document Reference	Possible Cause	Recommendations	Actions Taken	O&M Doc. Issue?	Signature and Date

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FIGURE C.1.4(e) *Cx Issues Log.*

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CORRECTIVE ACTION REPORT

Project: _____ ID: _____

Equipment/System: _____ Equipment/System ID: _____

Identified from: ❑ Test ❑ Review ❑ Discussion _____ ❑ Site visit _____
Date

The above equipment has been observed and tested, or the performance report reviewed, and was found to not comply with the contract documents.

Deficiencies or issues and effects:

_____

_____

_____

_____

_____

Corrective action: ❑ Required ❑ Recommended

_____

_____

_____

For testing to proceed in a timely manner, it is imperative that the required corrective action be completed by:

_____
Date or Event

_____ _____ _____ _____
Commissioning Agent Date Owner's Representative Date

Forwarded to the following parties on _____ for corrective action:
Date

_____

_____

Attachments? ❑ Yes ❑ No

Fill in the following section and return entire form to commissioning agent when corrected.

Statement of Correction

The above deficiencies have been corrected with the following actions:

_____

_____

_____

_____ _____ _____
Signature Firm Date

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FIGURE C.1.4(f) *Cx Corrective Action Report.*

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COMMISSIONING FUNCTIONAL TESTING PLAN OVERVIEW

Project: _____ Date: _____ Prepared by: _____

Equipment/ System and Related Controls	When Testing Can Start (date or event)	Estimated Duration of Test (hrs)		Needed Participants at Testing (besides CA)	Test Written?	Test Proced. Needs Review
		During Occupied Period	During Unoccupied Period*			

*These columns are to designate whether tests must be done during hours when the building is not occupied.

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FIGURE C.1.4(g) *Functional Testing Plan Overview.*

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COMMISSIONING FUNCTIONAL TESTING STATUS

Project: _____ Date: _____ Prepared by: _____

Equipment/System	Functionally Tested?	Pass/Fail	When Can It Be Retested?	Next Test Date

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FIGURE C.1.4(h) *Functional Testing Status.*

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TRAINING AND ORIENTATION AGENDA

Project: _____ Date: _____

Equipment/System: _____ Spec section: _____

Section 1. Audience and General Scope *(Owner and Commissioning Agent fill out this section and transmit entire form to responsible contractors. Attach training specification section.)*

Intended audience type (enter number of staff): ____ facility manager, ____ facility engineer, ____ facility technician, ____ project manager, ____ tenant, ____ other: _____

General objectives and scope of training (check all that apply)

❑ A. Provide an overview of the purpose and operation of this equipment, including required interactions of trainees with the equipment.

❑ B. Provide technical information regarding the purpose, operation, and maintenance of this equipment at an intermediate level, expecting that serious malfunctions will be addressed by factory reps.

❑ C. Provide technical information regarding the purpose, operation, troubleshooting, and maintenance of this equipment at a very detailed level, expecting that almost all operation, service, and repair will be provided by the trainees.

Section 2. Instructors *(Commissioning agent fills in company. Trainer fills out the balance, prior to training.)*

ID	Trainer	Company	Position/Qualifications
1)			
2)			
3)			

Section 3. Agenda *(The responsible contractors have their trainers fill out this section and submit to owner and commissioning agent for review and approval prior to conducting training.)*

Location: ❑ Site: _____ Date: _____

❑ Classroom (location): _____ Date: _____

Agenda of General Subjects Covered (✓ all that will be covered) (✓ when completed)	Duration (min.)	Instructor (ID)	Completed (✓)
❑ General purpose of this system or equipment (design intent)			
❑ Review of control drawings and schematics (have copies for attendees)			
❑ Startup, loading, normal operation, unloading, shutdown, unoccupied operation, seasonal changeover, etc., as applicable			
❑ Integral controls (packaged): programming, troubleshooting, alarms, manual operation			
❑ Building automation controls (BAS): programming, troubleshooting, alarms, manual operation, interface with integral controls			

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FIGURE C.1.4(i) *Training and Orientation Agenda.*

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ANNEX D

This annex is not a part of the recommendations of this NFPA document but is included for informational purposes only.

D.1 Referenced Publications

The documents or portions thereof listed in this recommended practice are referenced within this standard and should be considered for use in the commissioning process.

While Chapter 2 lists publications that are referenced within the main body of NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*, Annex D lists publications that are referenced within the document's annexes. Some publications might be listed in both Chapter 2 and in Annex D because they are referenced both in the main body of the document as well as in the annexes. This list is neither an exhaustive list nor an endorsement of the materials mentioned.

D.1.1 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2010 edition.
NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2010 edition.
NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2011 edition.
NFPA 72®, *National Fire Alarm and Signaling Code*, 2010 edition.

D.1.2 Other Publications.

D.1.2.1 ASHRAE Publications. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. 1791 Tullie Circle NE, Atlanta, GA 30329.

ASHRAE Guideline 0, *The Commissioning Process*, 2005.

D.2 Informational References

D.2.1 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2010 edition.
NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2011 edition.

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NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2009 edition.
NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, 2010 edition.
NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height*, 2010 edition.
NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2010 edition.
NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2012 edition.
NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2011 edition.
NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2009 edition.
NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*, 2009 edition.
NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2010 edition.
NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2008 edition.
NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2010 edition.
NFPA 69, *Standard on Explosion Prevention Systems*, 2008 edition.
NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2010 edition.
NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2012 edition.
NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*, 2012 edition.
NFPA 92, *Standard for Smoke Control Systems*, 2012 edition.
NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2011 edition.
NFPA *101®*, *Life Safety Code®*, 2012 edition.
NFPA 101A, *Guide on Alternative Approaches to Life Safety*, 2010 edition.
NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*, 2010 edition.
NFPA 110, *Standard for Emergency and Standby Power Systems*, 2010 edition.
NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*, 2010 edition.
NFPA 115, *Standard for Laser Fire Protection*, 2008 edition.
NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*, 2012 edition.
NFPA 720, *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment*, 2012 edition.
NFPA 731, *Standard for the Installation of Electronic Premises Security Systems*, 2011 edition.
NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2010 edition.
NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2011 edition.
NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*, 2012 edition.
NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2010 edition.
NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2012 edition.
NFPA 2010, *Standard for Fixed Aerosol Fire-Extinguishing Systems*, 2010 edition.
NFPA 5000®, *Building Construction and Safety Code®*, 2012 edition.

D.2.2 Other Publications.

D.2.2.1 ASME Publications.

American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ANSI/ASME A17.1, *Safety Code for Elevators and Escalators,* 2000.

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D.2.2.2 CEN Publications.

European Committee for Standardization, 36 rue de Stassart, B-1050, Brussels.

EN 12845, Fixed firefighting systems. Automatic sprinkler systems. Design, installation and maintenance, 2004.

D.2.2.3 NIBS Publications.

National Institute of Building Sciences, 1090 Vermont Avenue, NW, Suite 700, Washington, DC 20005-4905.

Using the Commissioning Process Guidelines (NIBS).

D.2.2.4 Standards Australia Publications.

Standards Australia, Level 10 The Exchange centre, 20 Bridge St., Sydney / GPO Box 476. Sydney, NSW 2001.

AS 1670.1-2004 Fire Detection, Warning, Control and Intercom Systems – System Design, Installation and Commissioning.

AS 2419.1-2005 Fire Hydrant Installations – System Design, Installation and Commissioning.

AS 2665-2001 Smoke/Heat Venting Systems – Design, Installation and Commissioning.

AS 4528.1-1999 Water Mist Fire Protection Systems – System Design, Installation and Commissioning.

D.2.2.5 ULC Publications.

Underwriters' Laboratories of Canada, 7 Underwriters' Road, Toronto, ON M1R 3B4.

ULCS537 Verification of Fire Alarm Systems.

CAN/ULC-S575 Commissioning of Life Safety and Fire Protection Systems.

D.3 References for Extracts in Informational Sections. (Reserved)

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Commissioning Sample Project

PART II

Part II of this *Commissioning and Integrated System Testing Handbook* is designed to give the reader a "how-to" perspective on executing the commissioning process in a step-by-step fashion and completing a commissioning plan. This part of the handbook offers an example of a completed commissioning plan and the accompanying material for a sample commissioning project. Chapter 1 provides general information about the commissioning plan and the paperwork that is submitted for this sample project. Chapter 2 provides the sample commissioning plan with some commentary explaining certain aspects of the plan. Part II of this handbook is not part of NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems,* but is included as additional information for handbook users.

This part of the handbook outlines how a commissioning program can be organized and implemented for a basic office building-type of project. However, the program described in this section can be applied to any type of building or occupancy and any type of construction. The only differences between this example and other buildings may be occupancy type, construction type, and complexity. The building in this example will be designed for four floors and will include not only office space but a conference center and cafeteria area. The building will be fully sprinklered and will include a standpipe system, fire alarm system, gaseous extinguishing agent system, fire pump, and a wet chemical system protecting the commercial cooking area.

For the user's convenience, the entire sample plan shown in Chapter 2 of this part of the handbook can be downloaded at www.nfpa.org/3handbook. This plan can then be customized to create a specific plan for a project. This handbook also includes an insert card with an overview of the commissioning process, which is also found in Chapter 1 of this part of the handbook.

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Sample Commissioning Plan Overview

CHAPTER 1

This chapter provides an overview of the sample commissioning (Cx) plan in Chapter 2 of this part of the handbook. This handbook is not intended to be a comprehensive review of all facets of a construction project; its main focus is the commissioning and integrated testing of fire and life safety systems.

Commissioning of fire and life safety systems is desirable for a variety of reasons. Most important, commissioning of any system provides more oversight than any conventional project because systems and, consequently, buildings that have been properly commissioned have been subject to a best practice or quality control/quality assurance program. Such a program provides additional assurance and written verification that systems have been properly designed, installed, inspected, documented, and tested prior to placing them in service. Commissioning also is a required part of a Leadership in Environmental Engineering Design (LEED) or green building project. Properly commissioned systems tend to exhibit better performance throughout their service life, resulting in savings on system maintenance. In many cases, the cost of a commissioning program can be recovered through the reduced maintenance costs of a properly commissioned system.

The site selected for the sample project in this part of the handbook is a four-acre parcel located in a suburban area with nearby access to site utilities for power, water, sewer, and gas. The water-based fire protection systems will use a tap from the existing county underground water main as their main water supply. The fire protection systems will be designed, installed, and tested in accordance with the following standards:

- Water supply systems — NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*
- Fire pumps — NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*
- Sprinkler systems — NFPA 13, *Standard for the Installation of Sprinkler Systems*
- Standpipe systems — NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*
- Fire alarm systems — *NFPA 72®, National Fire Alarm and Signaling Code*
- Gaseous suppression systems — NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*
- Commercial cooking protection — NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*, and NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*

This chapter includes Cx work flow diagrams to give the user a general sense of where each phase of the project falls within the commissioning process. The diagrams are sections of Figure A.5.1.2(a) through Figure A.5.1.2(c) from NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems,* and

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they present the necessary steps for the completion of the commissioning process in a logical and efficient order. The commissioning process will vary depending on the specifics of a given project, and the tasks outlined in the work flow diagrams might not always happen in the sequence illustrated in the diagram. There will be some tasks that need to happen out of sequence due to schedule or budgetary constraints. This is common on projects where the commissioning schedule contains some phase overlap.

COMMISSIONING PROCESS OVERVIEW

The steps for creating, implementing, and documenting an efficient and effective commissioning plan are outlined as follows (see the commissioning plan in Part II, Chapter 2):

1. Project Inception: Owner Decides to Build (see Section 1, General Building Information)
2. Planning Phase Begins
    a Create the owner's project requirements (OPR) (see Annex A, Owner's Project Requirements).
    b. Select the fire commissioning agent (FCxA) (see 4.2.1 of NFPA 3).
    c. Define the project's commissioning scope and overview (see Section 2, Scope and Overview, and Annex C, Commissioning Specifications).
    d. Identify commissioning team (CxT) members and define their responsibilities (see Section 3, Commissioning Team Information, and Section 4, Roles and Responsibilities).
    e. Document items (a) through (d) and the rest of the Cx process as outlined in 5.2.4.2 of NFPA 3 [see Section 5, Commissioning (Cx) Process].
    f. Achieve approval and acceptance of the planning documentation.
3. Design Phase Begins
    a. Create the basis of design (BOD) (see Annex B, Basis of Design).
    b. Determine and approve the sequence of operation for the fire protection and life safety systems (see Annex N, Sequence of Operation, and 3.3.16 in NFPA 3).
    c. Create the commissioning schedule (used to establish Annex G, Construction Checklists, and Annex K, Integrated Testing Procedures).
    d. Review and verify that the construction documents comply with the commissioning plan (see Annex D, Design Review, and Annex E, Submittal Review).
    e. Create and approve the operation and maintenance (O&M) manuals (see Annex I, Systems Manual Review).
    f. Determine and approve facility personnel training objectives (see Annex J, Training).
4. Construction Phase Begins
    a. Verify the construction phase activities, including the following:
        i. Verification of schedules (see Annex C, Commissioning Specifications)
        ii. Submittal of plans and material data sheets (see Annex E, Submittal Review)
        iii. Verification of construction, installation, and materials compliance with the BOD (see Annex G, Construction Checklists, and Annex H, Site Visit / Meeting Minutes)
        iv. Identification of CxT members (see Section 3, Commissioning Team Information, and Section 4, Roles and Responsibilities)
        v. Initial system testing (see Annex K, Integrated Testing Procedures, and Annex M, Test Data Reports)
        vi. Passive system verifications (see Annex G, Construction Checklists, and Annex H, Site Visit / Meeting Minutes)
    b. Conduct inspections, including the following (see Annex G, Construction Checklists, and Annex H, Site Visit / Meeting Minutes):
        i. Rough-in phase inspections
        ii. Finish phase inspections

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c. Complete final testing and inspections (see Annex M, Test Data Reports).
   i. Verify compliance with individual system standards.
   ii. Verify compliance with approved shop drawings.
   iii. Verify compliance with commissioning plan.

d. Conduct and verify owner training (see Annex J, Training).
e. Verify completion and delivery of closeout documents, including:
   i. List of deficiencies and resolutions (see Annex F, Issues Log)
   ii. O&M manuals (see Annex I, Systems Manual Review)
   iii. Results of acceptance testing (see Annex M, Test Data Reports)
   iv. As-built drawings
   v. Warranties (see Annex L, Warranty Review)

5. Occupancy Phase Begins
   a. Ensure all deliverables such as test reports; record drawings; site-specific software; warranties; original inspection, testing, and maintenance (ITM) reports; and training results have been produced and recorded. (Gather all data for the commissioning plan and create the final commissioning report.)
   b. Ensure ongoing ITM has been contracted and is in place.

PHASES IN COMMISSIONING PROCESS

Project Inception

The project inception phase includes a multitude of activities such as assembling the design team, which includes selecting an architectural and/or engineering firm for the development of design specifications and bid drawings and then obtaining permits. Once the initial design team has been assembled, several meetings with the building owner should be held to determine the type and function of the facility, which will, in turn, dictate the design and building services needed in the proposed building. Preliminary design

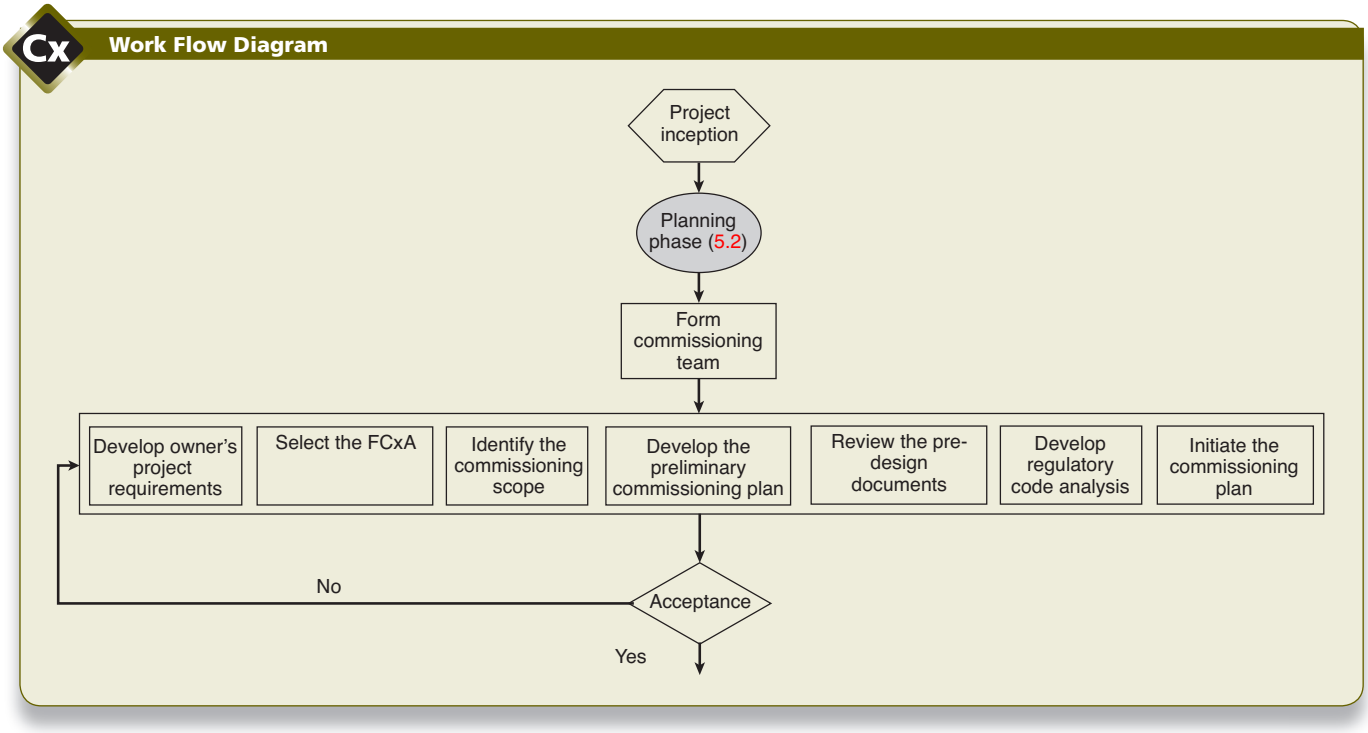

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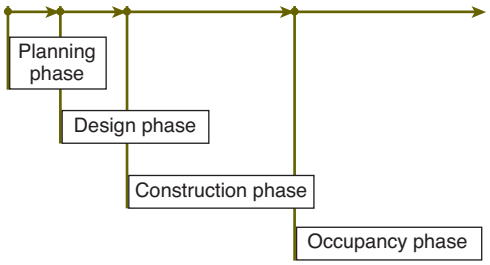
EXHIBIT II.1.1



Common Overlap of Phases in Commissioning Process

drawings serve two purposes: first, to submit to the authority having jurisdiction (AHJ) for a building permit, and second, to solicit bids from general contractors and subsequent bids from subcontractors for each building system. This part of the handbook focuses on fire protection, but subcontractors for other systems should be mentioned as necessary to illustrate how coordination of design, installation, and testing should be completed.

After the project inception, the project moves into the other phases of the commissioning process. In a perfect world, as illustrated in Figures A.5.1.2(a) through (c) of NFPA 3, projects would not advance to the next phase until all current phase activities have been completed and approved. This is often not practical, and overlap of phases can occur, as shown in Exhibit II.1.1. Where these overlaps occur, they should be contemplated in the commissioning plan.

Planning Phase

During the planning phase, as referenced in Figure A.5.1.2(a) of NFPA 3, the OPR is developed. The OPR is spelled out in the general requirements, fire protection, and commissioning sections of the project specification. The OPR is the driving document for all of the design and commissioning requirements of the project. It is critical that the owner's needs are met during all facets of construction so that the completed building meets the owner's needs and expectations.

A sample plan is provided in Chapter 2 of this part of the handbook, along with some useful information about putting the plan together. In this example, the ACME Corporation plans to construct a four-story office building with approximately 26,500 ft^2 per floor or 106,000 ft^2 of total usable space on a four-acre lot. The building will include the aforementioned fire protection features including LEED certification. The OPR is developed by the architectural and/or engineering (A/E) firm and the FCxA in this phase of the project.

In many cases, only the building owner, A/E design team, and FCxA are involved during the development of the OPR and project specifications. One of the most important aspects of commissioning is to encourage the participation of all stakeholders in the project. Therefore, it is very beneficial to involve the AHJ, facilities management personnel (FMP), construction manager (CM) (if one is desired), insurance company representative, general contractor, and subcontractors at the outset of the project, if at all possible. For more complex projects, a third-party test entity and/or integrated testing agent might be hired.

These stakeholders present specialized testing equipment and expertise for very complex systems and can be an asset to more complex projects. Both the general contractors and subcontractors often are not on board at this time, but they must be briefed on all aspects of commissioning before the project commences. Failure to properly communicate

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the critical items of the commissioning plan to the general contractor and subcontractors will lead to problems during installation and particularly during acceptance, because those items will not have been included in their bid and subsequent contract, nor will the contractors have an understanding or appreciation of the elements of the commissioning plan.

Authority Having Jurisdiction. The AHJ must be involved during the planning phase, since many jurisdictions have specific requirements and concerns for their construction projects. By soliciting input from the AHJ during planning, the project will address issues that otherwise might be overlooked and will have a better chance of being approved, thus obtaining the permit and certificate of occupancy in a timely manner. The AHJ might also be involved in various inspections throughout the construction process. In many jurisdictions, these inspections must be incorporated into the project schedule well in advance. If the inspections are not planned for at the outset, they can delay the project schedule. The best time to incorporate these inspections into the project plan is as early in the planning phase as possible.

Fire Commissioning Agent. The FCxA is a critical part of the CxT who must be involved in the project planning to assist in determining the critical milestones for the permitting process, plan review, field inspections, acceptance testing, and documentation at the project completion. The FCxA provides an independent third-party oversight of the project. The FCxA should not be a member of the design team nor the general contractor, but rather a separate entity such as a subcontractor answering directly to the building owner. The role of the FCxA should be clearly defined in the project specifications. For a project of the size used in the example in this handbook, a single individual working only part time can serve as the FCxA with little or no supervision. In most cases, the CxT might consist of a single individual for small projects and several commissioning agents for larger, more complex projects. On large projects, more than one FCxA might be needed to address the complex technical issues associated with fire protection and life safety systems. In any event, the FCxA should report directly to the building owner.

Facilities Management Personnel. The FMP must be involved in the initial planning stages of a project because they will be responsible for the operation and maintenance of the systems and equipment. It is of utmost importance that the FMP provide input on how the building will be used and what the maintenance procedures will be. At this time, the FMP can begin to familiarize themselves with the various systems and equipment proposed for the new building. It is important that training of the FMP be included in the commissioning plan at this time. Training the FMP at the time of project turnover should also be discussed at this stage, and any concerns or input offered by the FMP can be included in the training plan at this time.

Insurance Company Representative. The CxT member who represents the insurance company might have specialized requirements for the construction phase of the project and, more specifically, for the design and installation of fire protection systems. Failure to bring this stakeholder into the project during the planning phase can cause unnecessary delays later in the project and cost overruns due to changes in the design. Including the insurance representative at this time will ensure that the systems meet the underwriting requirements of the insurer.

Owner's Project Requirements. The OPR and project specifications are developed during the planning phase. It is important that the OPR is communicated to all parties involved in the project to ensure that, upon completion, the final product is a usable building based on the building owner's needs. Following acceptance of the OPR, the project specifications and design drawings can be developed and sent out for bid. Once a construction contract has been negotiated and awarded, a multitude of activities follow and the design phase begins, as illustrated in Figure A.5.1.2(a) of NFPA 3.

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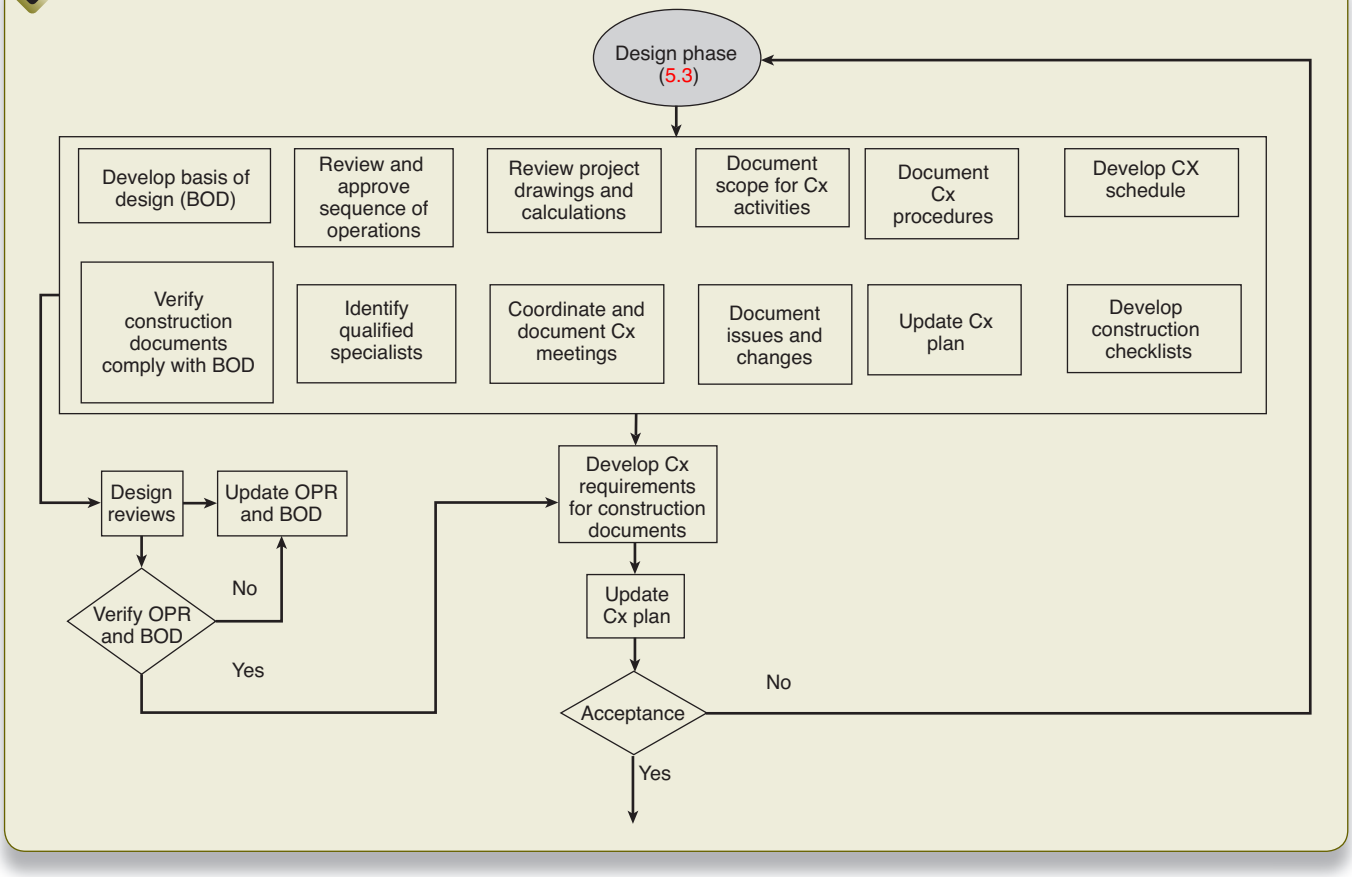
Work Flow Diagram



Design Phase

Basis of Design. A critical milestone of the design phase is the development of the BOD. The BOD is the document that describes the initial decision-making process (i.e., the decisions that the designer makes regarding components, processes, and interactions with other systems) and that establishes the quality assurance or best practices program. The BOD can be in the form of a narrative report or a simple form such as the one shown in Figure C.1.1 of NFPA 3. The BOD should be submitted by the FCxA for review by the registered design professional (RDP) or for approval by the AHJ prior to issuance of a permit and the commencement of construction. As a minimum, the BOD should include the following:

- Building description
- Applicable standards, laws, and regulations
- Design responsibility
- Description of fire protection and/or life safety systems
- Design methodology
- Special consideration and description
- Testing criteria
- Equipment and tools

A BOD should be prepared for all systems installed in new buildings and for modifications to existing buildings or systems. The purpose of the BOD is to assist the RDP, FCxA, and

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AHJ in the plan review, inspection, and final acceptance process. Review of the BOD is intended to ensure that all additions, deletions, or modifications made during construction are rechecked to verify that the original intended performance of the system or component is maintained. A BOD can be found in the sample commissioning plan in Chapter 2 of this part of the handbook.

Commissioning Plan. During the design phase of a project, a commissioning plan is developed. This plan is only the initial plan, since it will be refined as the project is completed. The scope of the intended commissioning plan is based on the complexity of the project. For small projects such as the example in this handbook, the scope is very straightforward, with a minimal amount of input from the FCxA (one individual). For large, complex projects, the commissioning scope might include additional tasks such as inspection reports, pre-functional testing reports, an issues log (IL), and a comprehensive operational matrix. The items of the commissioning plan are listed in 5.2.4 of NFPA 3.

Before the commissioning plan is initiated, several other activities must be completed, including a review of design documents and a regulatory code analysis. A design document review is needed from the standpoint of the OPR, commissioning scope, and the preliminary commissioning plan. This is unlike a code or regulatory plan review; the design document review should be considered to be a quality-control function and should be completed on the basis of accuracy and content, not code issues.

The regulatory code analysis is a brief review of adopted codes and standards for the jurisdiction in which the building is to be constructed. It is important that all specified systems and equipment are designed and installed in accordance with local regulations. Many jurisdictions do not necessarily adopt the latest codes and standards. Differences between the applicable versions of the codes and standards enforced by the AHJ and the latest editions can be significant and can require costly modifications during design and construction if not specified properly during this phase of the project.

The final step in the design phase of a project is the implementation of the commissioning plan. Although it's the final step, it does not mean that modifications to the plan cannot or should not be made. Quite the contrary — changes should be expected to occur as the project unfolds and as better or more efficient means to implement the plan are discovered.

With the design phase comes an increase in commissioning activity. It is critical to the Cx process to incorporate commissioning activities into this phase of the project, so that milestones related to the commissioning plan can be properly specified in the bid documents to avoid cost overruns and construction delays in the later stages of the project.

After design drawings are submitted and while they are being reviewed for code compliance by various AHJs, the sequence of operation should be finalized. While the sequence of operation is not currently required to be submitted and reviewed for code compliance by an AHJ, it should be reviewed and accepted by the RDP and the FCxA. When all drawings and calculations have been reviewed and approved and all permits have been secured, the FCxA should develop a commissioning schedule that coordinates with the construction schedule. Both schedules might in fact be one and the same. Coordinating the schedules is critical, as once construction begins, pre-functional testing, acceptance testing, and integrated testing will commence once all systems have been roughed in to permit such testing. The project schedule will also indicate to the CxT when materials and equipment will be delivered to the job site. This milestone is important, since many commissioning plans might require a formal inspection of all material and equipment for compliance with the project specifications and design drawings. Such inspections should not cause any delays in installation, and therefore, they need to be coordinated and properly scheduled. As the design phase transitions to the construction phase, commissioning meetings might begin, and they should be held on a regular basis depending on the progress of the project. These meetings should be documented and ILs and corrective action

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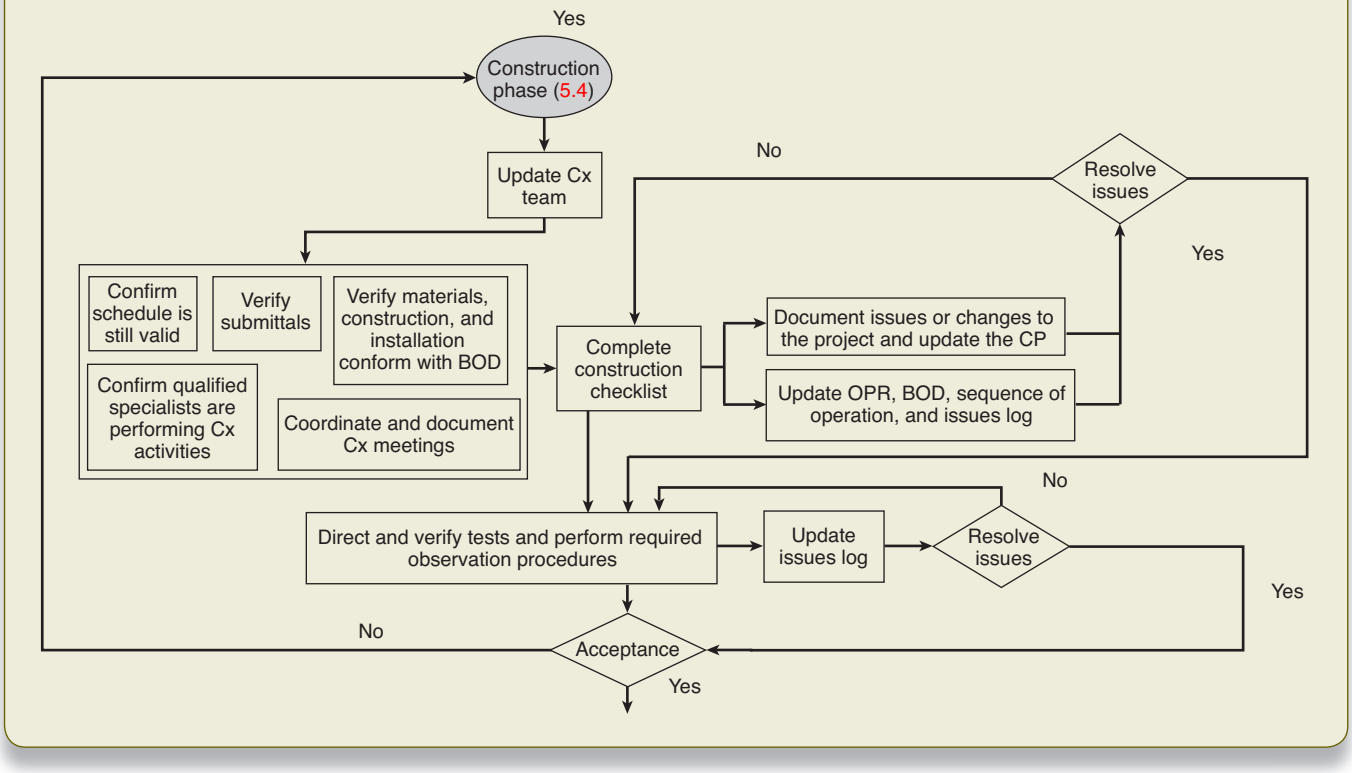
Work Flow Diagram



reports (CARs) generated as necessary. See the sample commissioning plan and turnover documentation for examples of these reports.

Construction Phase

The CxT will be most active during the construction phase. At this time, materials and equipment are delivered to the job site and rough-in installation begins. During these activities, the FCxA is required to complete inspections of material and equipment deliveries and installed systems and perform pre-functional testing. Material and equipment deliveries must be inspected to verify that it complies with the project specifications and design drawings, and a subsequent inspection report must be issued. Nonconforming material and equipment should result in an IL and a CAR.

Inspections of installed or partially installed systems might be needed prior to concealment or partial acceptance of the system. These inspections must be completed in a timely fashion in order to prevent scheduling delays in the project. An inspection report for system rough-in should also be completed at this time.

In addition to these inspections, based on the scope of the commissioning plan, the FCxA might be required to attend construction progress meetings or coordination meetings and will also be required to complete several different types of reports. Documentation examples are shown in the sample O&M manual at the end of this part of the handbook.

Occupancy Phase

As construction transitions to the occupancy phase, the FCxA and all of the subcontractors are often under a great deal of pressure to complete the project, particularly if the project

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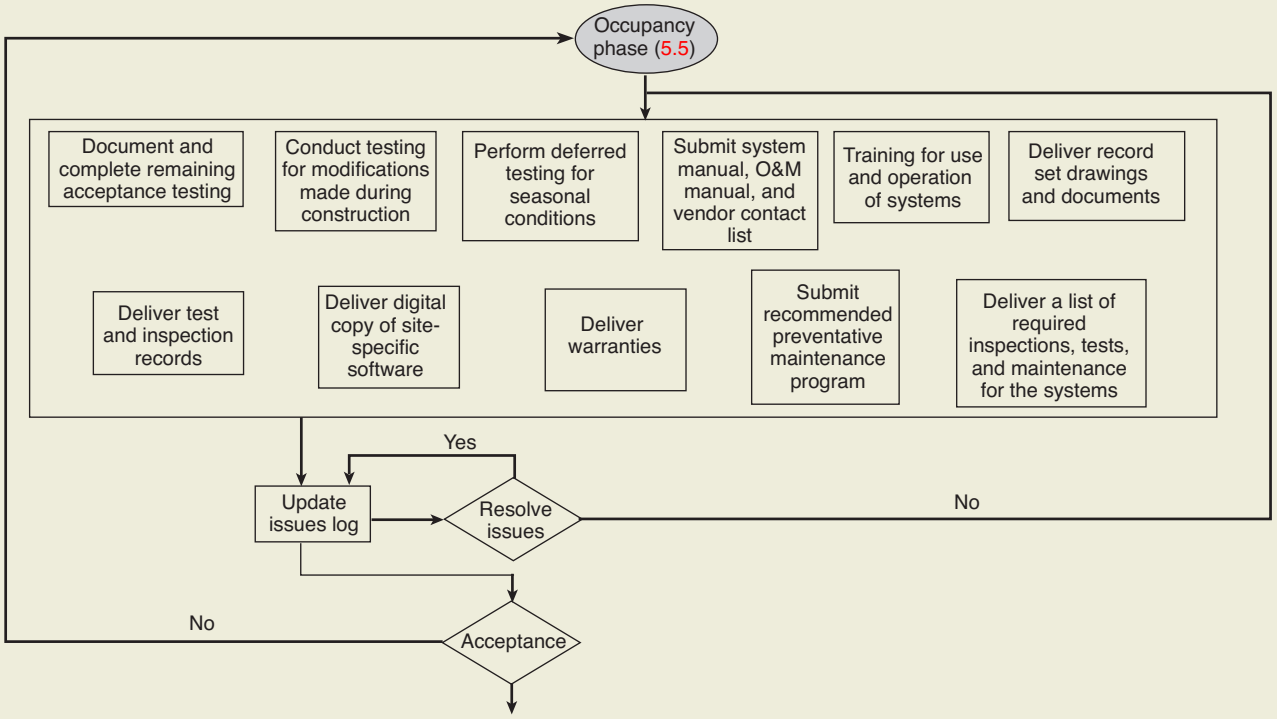
Work Flow Diagram



has fallen behind schedule. At this time, construction loans are due, contractors might be running out of money, and the building owner might be eager to occupy the new building. Everyone is under a great deal of pressure to complete final installation, testing, and whatever activities are necessary to secure a certificate of occupancy. It is sometimes in this flurry of activity that important pieces of final documentation are misplaced or mishandled. Commissioning is intended to place the proper importance on final documentation, including as-built drawings and calculations, test reports, and operation and maintenance instructions. The FCxA should supervise the handling of this documentation and should verify that it meets specifications and commissioning requirements. It is also critical that this documentation is given the treatment and handling it deserves because it will be needed at some point during the life cycle of the building. It would be very costly for a building to lack this information years from this point in time, since no one would know what standards and specifications these systems were designed and installed to meet.

In addition, training of FMP occurs at this time. The FMP might not be familiar with the operation of fire protection systems and must be thoroughly briefed on the importance of inspection, testing, and maintenance of these systems. It is recommended that the O&M manual as required by the commissioning plan be used as an instructional tool for this training. On large, complex projects, formal training should be specified in the project specifications and commissioning plan. Furthermore, FMP training should be held on site and should include a walk-through of the building while demonstrating system operation.

Finally, when the system has been officially accepted and a certificate of occupancy issued, the requirements of the installation standards cease and the time factors for the ITM as required by the appropriate maintenance standards begin.

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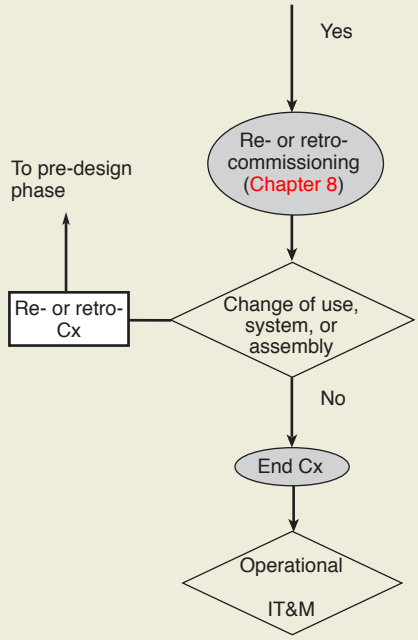
Work Flow Diagram



SUMMARY

Not every building or system needs to be commissioned under a formal commissioning plan. However, complex systems or buildings will benefit from such a program. Properly commissioned buildings and systems undergo intensive scrutiny from design to installation to a vigorous testing program. Nowhere in the installation codes or standards will integrated testing be specified, and as a result, integrated testing, if attempted, is not usually effective. A commissioning plan, if properly written and implemented, will provide better project oversight and improved integrated testing. By following such a program, the building owner should expect superior system performance with reduced maintenance costs.

References Cited

NFPA 3, *Recommended Practice for Testing of Fire Protection and Life Safety Systems*, 2012 edition, National Fire Protection Association, Quincy, MA.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2013 edition, National Fire Protection Association, Quincy, MA.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2010 edition, National Fire Protection Association, Quincy, MA.

NFPA 17A, *Standard for Wet Chemical Extinguishing Systems,* 2009 edition, National Fire Protection Association, Quincy, MA.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2013 edition, National Fire Protection Association, Quincy, MA.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2013 edition, National Fire Protection Association, Quincy, MA.

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NFPA 72®, *National Fire Alarm and Signaling Code*, 2013 edition, National Fire Protection Association, Quincy, MA.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations,* 2011 edition, National Fire Protection Association, Quincy, MA.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2012 edition, National Fire Protection Association, Quincy, MA.

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Commissioning Plan — ACME Corporate Offices

CHAPTER 2

The following document is an example of a commissioning plan that was developed using the recommendations of NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*. Within the document, portions of commentary text have been inserted that are not part of the plan itself, but provide direction to the user on how and why specific parts of this sample plan were included. This direction might include potential variances in commissioning plan content based on factors such as project size or complexity of design. A copy of the plan without the inserted commentary can be downloaded at www.nfpa.org/3handbook.

This sample plan includes text boxes such as this that will provide users with specific information about the action steps to take during the preparation of their plan.

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COMMISSIONING PLAN

For

ACME Corporation

This cover page can be designed many different ways, but it should provide basic information about the project and clearly show who is getting copies of the plan.

Plan Approval:

Ryan Quinn	Ryan Quinn	January 31, 2013
Project Manager	Signature	Date
Olivia Riley	Olivia Riley	February 20, 2013
Architect	Signature	Date
Matt Bielik	Matt Bielik	March 5, 2013
Commissioning Authority	Signature	Date

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Project Overview

1. General Building Information
2. Scope and Overview
   - 2.1 Abbreviations and Definitions
   - 2.2 Purpose
   - 2.3 Commissioning Goals and Objectives
   - 2.4 Commissioning Scope
3. Commissioning Team Information
4. Role and Responsibilities
5. Commissioning Process
   - 5.1 Commissioning Deliverables
   - 5.2 Design Intent Documentation
   - 5.3 Submittals
   - 5.4 Site Visits
   - 5.5 Pre-Functional Checklists and Startup Procedures
   - 5.6 Functional Test Procedures
   - 5.7 Operation and Maintenance Manuals
   - 5.8 Training and Orientation
   - 5.9 Warranty Period

Annex A Owner's Project Requirements
Annex B Basis of Design
Annex C Commissioning Specifications
Annex D Design Review
Annex E Submittal Review
Annex F Issues Log
Annex G Construction Checklists
Annex H Site Visit / Meeting Minutes
Annex I Systems Manual Review
Annex J Training
Annex K Integrated Testing Procedures
Annex L Warranty Review
Annex M Test Data Reports
Annex N Sequence of Operation
Annex O Operation & Maintenance Instructions

The plan should include a project overview or table of contents so that the users can easily find the information they need. It can be either detailed or more general, depending on the size and scope of the project.

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1. General Building Information

Project Name	ACME Corporate Offices
Project Address	1 Acme Place, Anytown, USA
Building Type	Four-Story, Office, Zoned B-1 – Business
Square Footage	106,000 ft^2 total
Building Description	Four-story office occupancy with cafeteria and conference space
Owner Agency	ACME Corporation
Scheduled Completion Date	December 2012

After the project inception, which is when the owner decides to build, the project then moves into the planning phase as the owner works with an architect and/or engineer to determine and document the owner's project requirements (OPR). The information provided in the general information table in Section 1 of this plan is extracted from that OPR. The OPR is intended to provide guidance to the design team on what the final project must entail. For smaller projects or projects where the owner does not have a detailed or definite concept for the building, this table might be fairly succinct as shown. For larger projects or projects where the owner requires detailed information, this table might be several pages long. The content of the table is largely at the discretion of the fire commissioning agent (FCxA) who is developing the plan.

2. Scope and Overview

Once the basic building information has been provided, it is important to be as clear as possible in detailing the scope and overview of the commissioning (Cx) process for the project. This information is the basis for the contract with the FCxA and serves as the foundation for the specifications on which the commissioning portion of the project will be bid.

2.1 Abbreviations and Definitions

The following table lists the commonly used acronyms for this project.

Acronym	Meaning	Acronym	Meaning
A/E	Architect and design engineers	FPC	Fire protection contractor
CM	Construction manager	FPT	Functional performance testing
Cx	Commissioning	GC	General contractor
CxA	Commissioning authority	PF	Pre-functional checklist
Cx Plan	Commissioning plan document	PM	Project manager
FCxA	Fire commissioning agent	RDP	Registered design professional
FMP	Facilities management personnel	Sub	Subcontractor

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While it is not required to include a table of abbreviations in the commissioning plan, this table can help everyone who is involved in the project. Even members of the NFPA 3 Technical Committee on Commissioning Fire Protection Systems have asked that the acronyms in NFPA 3 be minimized or explained. The FCxA should include in the report a table listing abbreviations and acronyms in order to establish effective communication among participants and, in turn, create a quality report. This list will enable owners, facilities management personnel (FMP), and contractors who might not yet be familiar with the Cx process to participate effectively.

2.2 Purpose

The purpose of this commissioning plan is to provide direction for the Cx process during construction; provide resolution to issues involving coordination, installation, and scheduling; define roles and responsibilities, lines of communication, and reporting requirements; and obtain approvals needed for fire protection systems in the proposed building.

2.3 Commissioning Goals and Objectives

2.3.1 This commissioning plan is intended to ensure that the specified building fire protection and life safety systems perform according to the intended design and the owner's project requirements (OPR), as shown in Annex A of this plan. All equipment and systems shall be installed in accordance with the approved shop drawings, manufacturers' recommendations, and project specifications.

2.3.2 Commissioning shall include documentation of the design intent and the activities involving construction, acceptance, and warranty phases of this project.

2.3.3 The three main goals of this Cx process are as follows:

1. Facilitate the acceptance phase of the project in accordance with the project schedule.
2. Facilitate and streamline the transition from construction to occupancy.
3. Provide documented verification that all fire and life safety systems meet the OPR, as shown in Annex A of this plan, and the basis of design (BOD), as shown in Annex B.

2.3.4 This commissioning plan is also intended to achieve the following specific objectives:

1. Document that systems and equipment are installed and tested as required by the OPR, BOD, project specifications, and approved shop drawings.
2. Document the operability of interconnected systems and equipment.
3. Verify and document system performance through functional performance testing.
4. Verify compilation and delivery of operation and maintenance (O&M) manuals.
5. Ensure that FMP are adequately trained in the functioning and operation and maintenance of systems and equipment.

2.4 Commissioning Scope

The number of systems listed in the following table will vary greatly, depending on the OPR and the jurisdictional requirements for the project. Simple projects will have relatively few systems, while more complex projects will have many more systems to handle unique fire protection challenges. This list will be put together by the FCxA and the registered design professional (RDP) once they have identified the systems that are required for the project.

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The following systems shall be commissioned in this project.

System	Equipment	Check
Water Supply	Piping	
	Thrust restraints	
	Hydrants	
Fire Pump	Pump	
	Driver	
	Controller	
Standpipe	Piping	
	Supports	
	Hose	
Sprinkler	Piping	
	Valves	
	Sprinklers	
Wet Chemical	Piping	
	Agent supply	
	Gas shutoff valve	
Clean Agent	Piping	
	Agent supply	
	Control panel	
Fire Alarm	Wiring	
	Initiating devices	
	Audible & visual alarms	

3. Commissioning Team Information

After the building information and commissioning scope have been identified, the members of the commissioning team (CxT) should be identified and included in the plan. The contracts for some of the systems might not be finalized while this portion of the plan is being written, so a place for each system contractor should be reserved in this part of the document. The commissioning plan will be continuously updated during the project, and this should not be seen as a deficiency in the plan.

The following is a list of the members of the commissioning team (CxT) for this project.

Function	Name/Address	Contact Info.
Owner		
Commissioning Authority (CxA)		
FCxA		
Installation Contractor		

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Manufacturer's Representative		
RDP(s)		
Construction Manager (CM) / General Contractor (GC)		
Facilities Management Personnel (FMP)		
Insurance Representative		
Third-Party Test Entity		
Authority Having Jurisdiction (AHJ)		
Integrated Testing Agent (ITa)		
Owner's Tech Support		

4. Roles and Responsibilities

4.1 The commissioning authority (CxA) manages the commissioning program and reports directly to the owner and construction manager (CM). The CxA's responsibilities are detailed in 5.2.2.5 of NFPA 3. All stakeholders must work in coordination with the CM, the project specifications, and NFPA 3.

4.2 The commissioning roles and responsibilities of all parties are described in Chapter 5 of NFPA 3.

> The roles and responsibilities of CxT members will vary, depending on the size and scope of the project. For the smallest facilities, the CxT might be an FCxA and the contractors. Smaller retail outlets might have a CxT that consists of a handful of team members who each take on multiple roles. This section will be expanded and contracted based on the depth and complexity of the project. Larger facilities might have a rather large CxT. As commissioning is introduced and used by various owners, builders, and subcontractors, these responsibilities might seem to be outside of the normal work performed by some of these entities. However, every one of these participants should understand the importance of the roles and responsibilities that are defined in the commissioning specification and the commissioning plan.

4.3 Section 019113 of the project specifications details the scope of work for commissioning this project. See Annex C of this plan.

> The project specifications are based on the Construction Specifications Institute's MasterFormat® for construction projects, which is a system for organizing and standardizing construction project details. More details on this system can be found at www.csinet.org/masterformat.

5. Commissioning Process

> Section 5 of the commissioning plan describes the step-by-step process to be used in commissioning each system in the new project. The steps closely follow the recommendations of NFPA 3 and should be written to meet each of the milestones identified therein.

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5.1 Commissioning Deliverables

The Cx process shall follow the sequence illustrated in Figures A.5.1.2(a) through (c) of NFPA 3 and as detailed in this plan. All deliverables of the Cx process are listed in Annexes A through N.

5.2 Design Intent Documentation

The design intent requirements shall be documented to establish the performance of the systems and components in accordance with the codes, standards, and specifications.

> The documents used to demonstrate design intent will include the OPR, the BOD, and the project's plans and specifications.

5.3 Submittals

The installing contractor shall provide the FCxA with the product data submittals. These submittals shall include the installation, testing, and startup procedures, operation and maintenance data, performance data, and control diagrams.

> There will be several points during the project when the FCxA will need to review and approve submittals. And although the review is not as thorough as that performed by the authority having jurisdiction (AHJ) and the RDP, the requirement for submittals should be included and communicated as part of the commissioning plan.

5.4 Site Visits

> Site visits (Section 5.4) and pre-functional tests (Section 5.5) are both an integral part of the Cx process and need to be included in the commissioning plan. These sections identify who will be responsible for the activities and who will be involved in scheduling and documenting these activities.

5.4.1 The FCxA shall make periodic site visits to inspect material deliveries, inspect system and component installations, and witness pre-functional and acceptance testing.

5.4.2 Each site visit shall include a specific agenda and shall be coordinated with the GC and subcontractors.

5.4.3 The FCxA shall also attend coordination and construction meetings as required by the project specifications to keep informed of the construction progress.

5.4.4 The GC shall keep the FCxA informed of any design changes that could affect the fire and life safety equipment or the project schedule.

5.5 Pre-Functional Checklists and Startup Procedures

5.5.1 A pre-functional inspection checklist shall be developed and maintained for all fire and life safety equipment being commissioned.

5.5.2 The checklist shall include equipment characteristics and the installation status of the component or system.

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5.5.3 The FCxA shall use the checklist to ensure that the system is complete and operational and shall document the installation of each component of the completed system.

5.5.4 The checklist shall be completed by the FCxA based on manufacturer's data, design drawings, and specifications and shall include acceptance testing requirements.

5.5.5 The FCxA shall review and approve the completed checklist before scheduling functional performance testing.

5.6 Functional Test Procedures

Functional testing is considered part of the integrated testing procedures for a project. This testing is an important part of the commissioning process outlined in NFPA 3, as it links the designs on paper to the built environment. The original committee scope from the NFPA Standards Council includes direction on developing the first guidelines for testing of integrated fire protection systems. This portion of the commissioning plan takes on new and important meaning, as it incorporates integrated tests that are not typically mandated in model codes and design standards.

5.6.1 Functional test procedures shall verify the intended operation of components and systems as required by the installation codes, standards, and specifications.

5.6.2 Integrated testing of all interconnected systems and components shall be completed and documented based on the approved sequence of operation.

5.7 Operation and Maintenance Manuals

Operation and maintenance (O&M) manuals have been and continue to be an important resource for building owners and their facilities management personnel (FMP). However, there is a subtle difference between the O&M manuals recommended by NFPA 3 and the traditional "systems manuals" discussed in other commissioning standards. Systems manuals discussed in NFPA 3 are documents that speak to integrated systems and need to be part of the project O&M manuals. The reason for the subtle difference is that the NFPA 3 technical committee wanted to use terminology that was relevant to the fire protection and life safety industry in describing the system submittal documents.

5.7.1 The O&M manual shall be submitted for approval by the FCxA.

5.7.2 The O&M manual shall be submitted at the earliest possible time in the project.

In many projects, the O&M manuals are an afterthought and are not put together until after the building is occupied. Often they are put together out of necessity by the staff hired by the property manager. The NFPA 3 Cx process focuses on preparedness and documentation to increase project efficiency. The sooner the O&M manuals are put together, the sooner the FMP can begin their training.

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5.7.3 The O&M manual shall include recommended spare parts, lubricants, and detailed preventive maintenance instructions.

5.7.4 The O&M manual shall include a table of contents, contact information for the manufacturers of all components, and detailed operation and maintenance instructions.

5.7.5 The O&M manual shall also include as-built drawings (half size), calculations, inspection reports, acceptance test reports, and warranty information for all systems and components.

5.7.6 The O&M manual shall include a recommended periodic inspection, testing, and maintenance frequency where applicable.

5.8 Training and Orientation

One of the newest and most important concepts in the Cx process is the training of the building owner and the FMP. There was uniform agreement across the industry that this should be a recommendation in NFPA 3. The benefits of this training will not only outweigh any cost that the owner incurs, but this investment will return itself to the owner relatively quickly.

5.8.1 The FCxA shall assist the owner and the GC in the development and scheduling of training programs for each fire and life safety system.

5.8.2 A minimum of a 4-hour session shall be planned and delivered for each system type.

5.8.3 The training agenda shall include the training scope, duration, and methods and shall include the name and qualifications of the trainer.

5.8.4 Training sessions shall use the approved O&M manual as a training aid for each training session.

5.9 Warranty Period

The warranty period is another part of the building project that should be familiar to anyone involved in construction. It is important to understand that the FCxA will be involved in determining compliance with the warranty for the fire protection and life safety systems.

5.9.1 All systems and components shall be warranted for a period of 1 year from the date of final acceptance.

5.9.2 All required tests, adjustments, and corrective action shall be completed and accepted prior to the commencement of the warranty period.

5.9.3 Any deficiencies discovered after the acceptance period and prior to the completion of the 1-year warranty period shall be at the expense of the installing contractor.

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Annex A
Owner's Project Requirements

Enough cannot be said about the importance of the OPR. This document will be the basis for all other documents in the commissioning plan and is the basis for the entire Cx process. The owner and the RDP will be responsible for the content of the OPR; however, the FCxA will be responsible for ensuring that the OPR is included in the commissioning plan and that any issues are resolved in a way that ensures compliance with the OPR.

Owners who build multiple sites, such as restaurants or retail stores, might have a single "boilerplate" OPR that they use across the country and modify it only to accommodate jurisdictional requirements. This can make the OPR development process relatively easy, as they know exactly what they are looking for. For "unique" projects, such as academic buildings housing a specific school at a university or a company's corporate headquarters, it might be the only time that the owner needs to consider their needs. In these instances, it is not uncommon for the OPR to be longer and more detailed. It also can take a lot longer to develop and might require more frequent revisions as the owners' desires are often manipulated and pared down once the cost implications of their needs are realized.

The OPR is written originally as a standalone document and is then added to the commissioning plan. Since it is typically the first document the CxT puts together, it might seem like much of the language in this annex of the commissioning plan is repetitive and already addressed in another section of the plan. There is no need to pare down the OPR to take out repetitive language; however, it is important that the OPR does not conflict with the plan in any way.

General Requirements

The office building in this commissioning plan is intended to serve as the primary location for ACME Corporation executive and supporting offices, including training facilities. The intended life expectancy of this facility is 75 years. Plans for future expansion or flexibility for future change of use have not been determined.

The building and its systems and equipment will be constructed and installed in accordance with all state and local codes and regulations. Design of the building structure, systems, and landscaping will also include provisions for LEED certification at the Platinum level. Any special underwriting requirements of the ACME Corporation insurer will also be incorporated into the design.

Existing Site Conditions

The existing four-acre site is presently owned by ACME Corporation and is currently undeveloped. The site is located next to existing utilities for water, sewer, electrical power, and natural gas. The site also is conveniently located near public transportation at the intersection of Interstate 500 and Route 821.

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Facility Activities and Functions

This facility will serve as the executive and supporting offices of ACME Corporation and will include space for training, meetings, data processing, and cafeterias. Parking space for 300 to 400 employees will also be incorporated into the site. The preliminary floor plan information is listed in the following floor plan summary table.

ACME Corporation – Floor Plan Summary					
Floor	**Core Area**	**Meeting/Conference Space**	**Office Space**	**EDP/Mech**	**Cafeteria/Kitchen**
1	3,000 ft^2	15,000 ft^2	1,000 ft^2	1500 ft^2	6,000 ft^2
2	1500 ft^2	2,000 ft^2	23,000 ft^2	0	0
3	1500 ft^2	2,000 ft^2	23,000 ft^2	0	0
4	1500 ft^2	2,000 ft^2	23,000 ft^2	0	0

Building Ownership and Operation

ACME Corporation intends to occupy and maintain this building for its intended life cycle. No tenant space is planned.

Environmental Goals and Requirements

The building will be certified in the LEED process at the Platinum level, as ACME Corporation intends to maintain their environmentally responsible mission.

Expected Phasing of Construction

- Site Preparation — first quarter
- Building Structure — first quarter
- Mechanical Systems:
  - Design and approval — first quarter
  - Fabrication and rough-in — second quarter
  - Functional testing and acceptance — third quarter
  - Fit-out and occupancy — fourth quarter

Construction Budget

The estimated cost for construction is $53 million. Actual costs and a schedule of payments will be determined and agreed to with the GC following the award of the construction contract.

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Annex B
Basis of Design

The OPR is the primary document to guide all decision making during the project, whereas the basis of design (BOD) lays out the technical requirements for the project's systems. When it comes to establishing the sequence of operations and the schedule for the commissioning plan, the BOD will be the guide for the FCxA and the project subcontractors. Therefore, it is imperative that the owner and the RDP ensure the accuracy and thoroughness of this document.

The BOD for this sample project uses a narrative approach. There are other options that might be easier for people who are new to the Cx process, such as using the form in Figure C.1.1 of Annex C, NFPA 3. This option was not used in this sample project to show the user another option. This highlights the fact that every commissioning project can and will be different.

Building Description

The proposed building will be constructed of fire-resistant materials and will be classified by state code as modified fire resistive (MFR) with an exterior insulation and finish system (EIFS) exterior. The structure will house office and conference space with supporting electronic data processing (EDP) and cafeteria spaces. The building will be classified by state building code as Use Group B-1, meaning that primarily business activities with no hazardous processes are carried out in the structure.

The building will be constructed of four stories occupying 26,500 ft^2 each for a total area of 106,000 ft^2. The distance between floors will be 20 ft from the first floor to the second floor and 15 ft between each of the other floors for a total building height of 65 ft. There will be no floors below grade. Site access for emergency vehicles will be maintained throughout the Cx process and will meet state and local regulations when complete. A basic diagram of the proposed building and site is shown in Exhibit B.1.

Applicable Standards, Laws, and Regulations

All standards, laws, and regulations for this project will be the latest editions unless otherwise noted and are referenced as follows:

- NFPA 13, *Standard for the Installation of Sprinkler Systems*
- NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*
- NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*
- NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*
- NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*
- *NFPA 72®, National Fire Alarm and Signaling Code*
- NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

Design Responsibility

The design of this project will be the responsibility of ACE Architects LLC and their registered fire protection engineers. The shop drawings and supervision of the installation of the sprinkler, standpipe, and fire pump systems will be the responsibility of a National Institute for Certification in Engineering Technologies (NICET) certified (Level III or greater in Sprinkler Systems Layout) fire protection contractor. The installation of the fire alarm system will be

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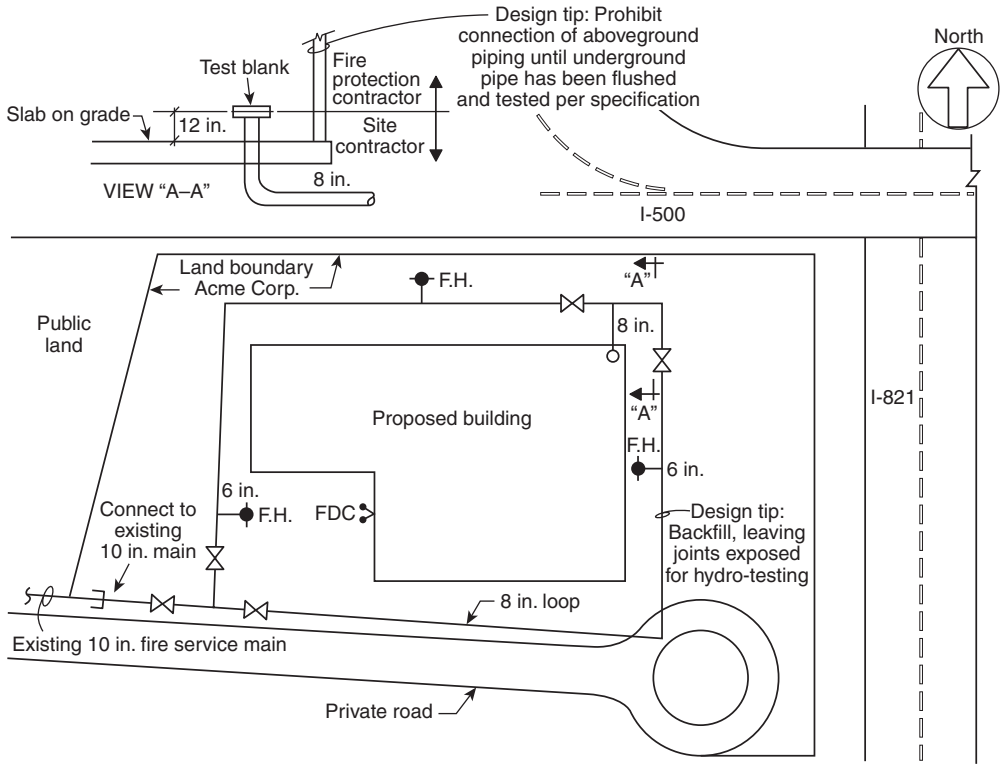
EXHIBIT B.1 Proposed Office Building and Grounds.



the responsibility of a NICET certified (Level III or greater in Fire Alarm Systems Layout) fire alarm contractor. The shop drawings for the gaseous agent and wet chemical systems will be prepared by a state licensed or certified contractor.

Fire Protection / Life Safety System Description

This building will be protected throughout by an approved combination sprinkler/standpipe system covering all required areas of the structure. The combined system will be supplied by an electrically driven fire booster pump that takes suction from a newly installed private fire service main.

Specialized fire suppression systems will be installed to protect the EDP area and commercial cooking area of the cafeteria. A gaseous clean-agent system will be used to protect the EDP area, and a wet chemical fire suppression system will be used for the commercial cooking area of the cafeteria.

The entire building will be protected by a fire alarm system including smoke detection, manual pull stations, audio/visual alarm, duct damper controls, release of magnetic door locks, and supervision of the combined sprinkler/standpipe system and fire pump.

Design Methodology

The systems installed in this facility will be installed as required by the state building code. Specifically, the fire alarm system is intended for building occupant and fire department notification and building occupant evacuation. A temporary standpipe system for use by the local fire department will be installed for use during construction. The temporary standpipe will employ a fire department connection as its main water supply and hose valves at each floor level with threads conforming to local requirements. Following completion of construction, this standpipe will be permanently connected to the main water supply and booster pump servicing the combined sprinkler/standpipe

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systems. Following acceptance and occupancy, the fire protection systems will be inspected, tested, and maintained in accordance with the appropriate codes and standards for each system type.

Special Considerations and Description

Both gaseous agent and wet chemical systems will be interconnected with the fire alarm system to provide alarm and supervision of each system. In addition, each fire alarm detection zone and sprinkler waterflow switch in each zone will cause fire dampers protecting the same zone to close upon activation, release magnetically held doors, and initiate shutdown and isolation of related mechanical ventilation equipment. A sequence of operation will be developed and submitted for approval prior to installation. The sequence of operation will serve as the basis for integrated testing of the interconnected systems.

Testing Criteria

In addition to the required tests in each installation code or standard, the FCxA will oversee the integrated testing of all interconnected systems in accordance with the sequence of operation. A final test report will be submitted indicating that all interconnected systems performed properly in accordance with the specifications and installation standards and this commissioning plan. Where systems require modification to meet testing requirements, a corrective action report (CAR) will be issued and corrective action verified before final sign-off of the sequence of operation.

Equipment and Tools

All systems and equipment will be tested in accordance with the project specification, installation standard, and manufacturer's recommendations. For this project, no special test procedures other than the sequence of operation will be necessary.

Special equipment as provided by the local fire department will be necessary to test the manual wet standpipe system. That equipment will include a fire department pumper with staffing necessary to operate the vehicle to flow water at the required pressure through standpipe test equipment provided by the installing contractor. Such equipment will include but will not necessarily be limited to hose, nozzles, and pressure gauges.

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Annex C
Commissioning Specifications

The project specifications must include a section on the commissioning of the fire protection and life safety systems. This information will help to ensure that the project can be delivered within budget and on time. This is important for all of the CxT members. The RDP will be the party responsible for developing these specifications, and the owner is responsible for approving them.

Section 019113 – Commissioning of Fire and Life Safety Systems

PART 1 — GENERAL

1.1 Related Documents

A. General

1. Work under this contract shall meet the requirements of Division 1, General Requirements, Conditions of the Contract, and Supplementary Conditions. This specification covers commissioning of the fire and life safety systems for the entire structure.
2. All labor and materials shall be furnished to complete commissioning of fire and life safety systems specified herein.

B. Commissioning work shall be organized and structured to verify that all fire protection and life safety systems and equipment have been properly designed and installed and function together correctly to meet the OPR and BOD. Commissioning shall be in accordance with NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems,* 2012 edition.

C. The CxA retained by ACME Corporation shall have responsibility for coordinating and directing the required steps of the Cx process.

D. Fire protection system installation, start-up, testing, preparation of O&M manuals, and FMP training shall be the responsibility of the Division 15 fire protection contractors. Oversight of the observation, coordination, verification, and commissioning shall be the responsibility of the CxA. The Cx process does not relieve the Division 15 contractors of the obligation to complete all portions of the work in a satisfactory manner and ensure systems are fully operational.

E. Definitions

1. *Commissioning*. A systematic process that provides documented confirmation that specific and interconnected fire and life safety systems function according to the intended design criteria set forth in the project documents and satisfy the owner's operational needs, including compliance requirements of any applicable laws, regulations, codes, and standards requiring fire and life safety systems.
2. *Commissioning Authority (CxA).* The qualified person, company, or agency that plans, coordinates, and oversees the entire Cx process.
3. *Commissioning Plan*. The document prepared for each project, which identifies the processes and procedures necessary for a successful Cx process.
4. *Commissioning Record*. The complete set of commissioning documentation for the project, which is turned over to the owner at the end of the construction phase.
5. *Functional Testing*. Tests performed to verify compliance with manufacturers' specifications, applicable codes and standards, and the project BOD and OPR.

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F. Purpose

1. The purpose of commissioning is to verify the design intent, develop the OPR and BOD to verify that the OPR and BOD are verified through testing, and to provide training for the FMP.

1.2 Scope of Work

A. The commissioning program shall include but shall not be limited to the following:

1. Development of the OPR
2. Development of the BOD
3. Review of design drawings and test procedures
4. Selection of qualified personnel for inspection of installed materials and equipment
5. Selection of qualified personnel for witnessing of testing
6. Development of O&M manual
7. Training and demonstration of system operation for all systems required by this specification section

B. The work identified in this specification section includes a complete and thorough evaluation of the operation and performance of all components, systems, and subsystems. The following systems shall be evaluated:

a. Private water supply system
b. Fire pump and controller
c. Standpipe system
d. Sprinkler system
e. Fire alarm system
f. Gaseous agent extinguishing system
g. Wet chemical extinguishing system
h. Coordination with other trades

C. Detailed documentation is necessary for the successful completion of the Cx process. Documentation required as part of the specified Cx process shall include but not be limited to the following:

a. Development and approval of a commissioning plan
b. Progress status reports
c. Minutes from all project meetings
d. Pre-functional test procedures and test reports
e. Training agenda, schedule, and materials
f. As-built drawings and calculations
g. Final commissioning report
h. O&M manual

D. All required testing shall be performed on all installed components and systems to verify that the system operation and performance conform to approved contract documents. All tests shall be witnessed by the FCxA. The following tests are required as part of the Cx process:

a. Pre-functional performance testing of all individual components and systems requiring an operational test by code or standard
b. Functional performance testing of all individual components and systems requiring an operational test by code or standard
c. Functional testing of all system and/or component interconnections

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E. Formal training of FMPs shall be completed by the installing contractor, and where appropriate by other contractors and vendors, prior to final acceptance of the building or system. Training shall include classroom instruction and hands-on instruction and demonstration of operation for all systems and equipment.

1.3 Quality Assurance

A. The following references should be used to develop and implement the commissioning program as appropriate:

a. NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*.

b. ASHRAE Guideline 0, *The Commissioning Process*.

1.4 Documentation

A. The FCxA shall coordinate and maintain the project commissioning documentation. The commissioning documentation shall be maintained in three-ring binders on the project site. It shall be available for inspection by the building owner, RDP, and AHJ on request and shall be organized by system and subsystem where possible. All pages shall be numbered, and a table of contents shall be included. The commissioning documentation shall include but shall not be limited to the following:

a. OPR

b. BOD

c. Copy of building permit and permit to install individual systems as required by local code

d. Approved shop drawings and hydraulic calculations (half size to fit binders)

e. Approved test procedures and pre-functional test checklists

f. Approved sequence of operation

g. System inspection checklists

h. Final inspection reports and CARs

i. Final performance test checklists and test results

j. O&M manual

1.5 Execution

1.6 General

A. A pre-construction meeting shall be held to familiarize all stakeholders with the Cx process and outline the responsibility of each member of the construction team.

B. The installing contractor shall complete the work in a timely fashion to allow for the starting, testing, balancing, and acceptance procedures to be completed within the project schedule. This work includes the complete installation of systems and equipment, including pipe, fittings, pipe supports, valves, and controls as indicated on the contract documents, and implementing all corrective actions, clarifications, and change orders.

C. Acceptance procedures shall begin prior to completion of the system installation and shall be coordinated with the installing contractor. Start of acceptance procedures prior to system completion does not relieve the contractor of completing those systems as required by the project schedule.

D. The FCxA shall coordinate with the installing contractor to verify that the Cx process does not interfere with the completion of work in accordance with the project schedule.

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1.7 Acceptance Procedures

A. The installing contractor shall provide qualified technicians to start up all systems in this specification section.

B. System performance deficiencies might require additional labor, reconstruction of systems, and/or replacement of system components as part of the required corrective action.

1.8 Acceptance Tests

A. Tests shall be completed to verify that all components, equipment, systems, subsystems, and system interconnections operate in accordance with the contract documents.

B. These tests are intended to include all operating modes, interconnections, control responses, and verification of response to the building automation systems and sensors.

C. The FCxA shall be responsible for preparing the scope of all pre-functional and functional testing. All contractors, manufacturers, and suppliers shall include all costs to complete the work involved in the tests in their proposals.

D. The installing fire protection contractor shall include the services of a technician(s) who is familiar with the installation and operation of the system.

E. The electrical contractor shall provide a licensed electrician familiar with the interlocks, interfaces with the emergency power supply, interconnections with the fire alarm, and life-safety systems.

1.9 Verification Procedures

A. The FCxA shall direct and witness the operating tests and checks for all systems and equipment.

B. Systems shall be set to the operating mode to be tested for normal shutdown, automatic position, manual position, emergency power, and alarm conditions.

C. The FCxA shall verify the position of each component and interconnection in the checklist. Each line item shall be signed off as acceptable (Y) or (N).

D. If during any operating test a deficiency is observed, corrective action reports and verification shall be initiated.

1.10 Documentation and Reporting Requirements

A. All inspection and testing reports shall be documented, signed, and included in the final commissioning report to the building owner in accordance with the commissioning plan.

B. CARs shall also be included.

1.11 Operation and Maintenance Manual

A. The O&M manual shall be provided in 8½ × 11 format in three-ring binders and shall include the following:

a. Title page

b. Table of contents

c. Name, address, phone number, and other information for all installing contractors and component manufacturers

d. OPR

e. BOD

f. Copy of all permits to install

g. Product data sheets for all system components

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h. Operation and maintenance instructions for all components
i. Recommended lubricants and spare parts
j. Contractor's material and test certificate
k. As-built drawings and calculations (half size in plastic sleeve)

1.12 FMP Training

A. The installing contractor shall provide qualified instructors for classroom and field training for all FMP.
B. The training shall be based on the contents of the O&M manual.
C. The contractor shall provide a proposed training agenda and training schedule.

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Annex D
Design Review

The FCxA will be responsible for working with the owner and the RDP to ensure that the design phase documents comply with the OPR and the BOD. The commissioning approval and transmittal forms are record documents for the project to provide the documentation of project milestones. These documents are references for the design team as well as facilities personnel once the building is nearing the occupancy phase to confirm the completion of these tasks. (See Exhibit D.1 and Exhibit D.2.)

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EXHIBIT D.1 Commissioning submittal/approval. [Source: NFPA 3, 2012, Figure C.1.4(a)]

COMMISSIONING SUBMITTAL / APPROVAL

Project: ACME Corp. Offices

Submittal No.: 13-001

☑ New ❑ Resubmittal

From (initially): ABC Sprinkler

To: J.S. General Contractors

Equipment / system name:	ID #:
Sprinkler	3-01
Fire pump	3-02

Cx Section No: 15500

Submittal Type:

☑ Documentation (describe): Hydrostatic test procedure for sprinkler and fire pump system piping

❑ Functional test procedure forms:

❑ Completed functional test procedure record or report:

❑ Prefunctional checklist:

❑ Startup and initial checkout forms:

❑ Completed startup documentation or report:

Submissions / Returns

Path	To: G.C. From (initially): ABC Sprinkler	To: From:	To: From:	To: From:	To: From:
Comments by submitter	For approval ❑ Notes attached	❑ Notes attached	❑ Notes attached	❑ Notes attached	❑ Notes attached
Copies	2 ea.				
Submitter signature	Ryan Quinn				
Title	Design Mgr				
Date	3-14-11				
Code	I				

Submitting Codes:

I = Initial submittal: The attached submittal has been reviewed, and the equipment, documents, or performance represented comply with the correct documents.

A = Approved as complying with the contract documents.

C = Note corrections. Approved, but need to resubmit for the record, after correcting.

NA = Not acceptable. Resubmittal required for review.

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EXHIBIT D.2 Standard transmittal.

STANDARD TRANSMITTAL FORM

Project: ACME Corp. Date: 5-2-11 Change Request No.: N/A

Contract No: 3-2005

From (initially): ABC Sprinkler
100 Oak St.
Anytown, USA

To: Fire Protection Consultants
5000 Main St.
Anytown, USA

Subcontractor: Signed:

Consultant: Subject:

- ❑ Transmittal
- ☑ Request for clarification
- ❑ Authorization of services
- ❑ Speed memorandum
- ❑ Enclosed/attached
- ❑ Under separate cover
- ❑ VIA
- ❑ Other

CAT	SERVICES	DESCRIPTION	DETAILS
A	On-site inspectors:	N/A	
B	Submittal review:	Verification of no sprinkler protection in noncombustible concealed spaces per specification and NFPA 13.	Transmittal Nos.: 13-010
C	Office services:		☑ Authorized – see remarks for details Estimated hours* 0 Actual hours* 0 ❑ Required due to errors or omissions
D	Meetings/inspections:		❑ Authorized – see remarks for details Estimated hours* Actual hours* ❑ Required due to errors or omissions
E	Extra services:		

FCxA remarks: Verified–no sprinkler protection required for noncombustible concealed spaces per specification and NFPA 13.

A/E remarks: A/E concurs w/above.

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Annex E
Submittal Review

The RDP and the AHJ will be responsible for the approval of the project submittals. The FCxA will need to verify compliance with the OPR and BOD by performing sample reviews of the documents that are submitted. The FCxA can base final approval of submittals on acceptance by the RDP and the AHJ. (See Exhibit E.1 and Exhibit E.2.)

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EXHIBIT E.1 Sequence of operation and functional test procedures submittal. [Source: NFPA 3, 2012, Figure C.1.4(b)]

SEQUENCES OF OPERATION AND FUNCTIONAL TEST PROCEDURES SUBMITTAL

Project: ACME Corp. offices

Submittal No: 13-020

☑ New ❑ Resubmittal

From (initially): ABC Sprinkler

To (initially): J.S. General Contractor

Equipment / System tag and name: Fire alarm/sprinkler interface

Included:

☑ Sequences of operation (enlarged from original control drawings and specification documents)

❑ Functional test procedures and forms

Submissions / Returns

The following checked individuals will receive these documents for review and/or approval:

Party	For review and comment only	For review and approval	For record only
General contractor	☑	❑	❑
Mechanical contractor	☑	❑	❑
Electrical contractor	☑	❑	❑
Controls contractor	❑	☑	❑
Construction manager	❑	☑	❑
Owner's representative	❑	❑	☑
AHJ	❑	☑	❑

Path	To: / From:	To: / From:	To: / From:	To: / From:	To: / From:
Comments by submitter	See Key (1) ❑ Notes attached	See Key (1) ❑ Notes attached	See Key (1) ❑ Notes attached	See Key (1) ❑ Notes attached	See Key (1) ❑ Notes attached
Copies	2 each				
Submitter signature	Ryan Quinn				
Title	Design Mgr				
Date	4-23-11				
Review code					

Key: (1) Review and comment on the sequences and/or test procedures as to their compliance with the specs.
(2) Check tests for personnel safety and to keep equipment warranty in force.

Review Codes: AM = Approved by mechanical contractor (or electrical contractor) as complying with the contract documents. Tests will not void warranty or damage equipment and do not present unsafe conditions for personnel.
AC = Approved by controls contractor as complying with the contract documents.
AE = Approved by the design engineer as complying with the contract documents.
NC = Note corrections. Approved, but need to resubmit for the record, after correcting.
NA = Not acceptable. Resubmittal required for review.

Abbreviations: CA = commissioning agent/authority, CM = construction manager, GC = general contractor's rep., A/E = architect or engineer of record, Sub = responsible subcontractor or vendor

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EXHIBIT E.2 Commissioning test or document approval. [Source: NFPA 3, 2012, Figure C.1.4(c)]

COMMISSIONING TEST OR DOCUMENT APPROVAL

Project: ACME Corp. offices

To: Matt Bielik

From: Ryan Quinn

☑ Completed functional test approval

Equipment/System name: Fire pump Equipment tag: FP-1

Functional test description: _____

☐ Document review

Document name and ID: _____

Review description: Rotational test verification

The test(s) of the above equipment or the review of the referenced document(s) have been completed, and performance of the component, system, or documents complies with the acceptance criteria in the testing or document requirements of the Specifications and Contract Documents, subject to the changes being made as listed below or on an attached sheet.

0 Sheets attached

A copy of the completed test or document review is attached. ☐ Yes ☑ No

Commissioning Agent Approval:

Matt Bielik — Commissioning Agent

4–13–11 — Date

Construction Manager Approval:

The test or review results relating to the above equipment have been reviewed and approved as complying with the contract documents.

Derick Fors — Construction Manager

4–15–11 — Date

Exclusions:

None. Rotational test witnessed and CW rotation verified in accordance with specification and approved shop drawings.

cc: ABC Sprinkler

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Annex F
Issues Log

The issues log is a living document that will guide the entire CxT as they move through the Cx process. It will provide the team with guidance on resolving any issues that appear during the commissioning of this project and will show when and how any problems and questions that arise are dealt with. (See Exhibits F.1 through F.8.)

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EXHIBIT F.1 Commissioning Issues Log. [Source: NFPA 3, Figure C.1.4(e)]

COMMISSIONING ISSUES LOG

Project: ACME Corp. Prepared by: Matt Bielik Page 1 of 1

Attach additional pages as necessary for issues requiring more explanation and tracking.

#	Issue	Date Found	Code/ Document Reference	Possible Cause	Recommendations	Actions Taken	O&M Doc. Issue?	Signature and Date
1	Fire pump rotation incorrect	3/15	NFPA 20	Power wiring reversed	Check power supply wiring	Re-wired power supply	No	M.B. 3/17
2	Incorrect sprinkler finish–chrome specified, brass shipped from Mfg.	5/2	Fire prot. spec. 15500	Mfg. shipping error	Return and replace with correct finish	Return auth. obtained re-ordered	No	M.B. 5/15
3	Seismic bracing not per approved plans	5/30	NFPA 13 Chap 9 spec.15500	Unknown	Remove & replace with approved components	Bracing replaced	No	M.B. 6/15
4	Failed hydro test standpipe system	7/6	NFPA 14	Missing press. ga. riser#1	Install press. ga. and re-test	Re-tested with completed installation	No	M.B. 7/20
5	No flow or tamper switch signals–zone #4	8/15	NFPA 13 & 72	Switches wired incorrectly	Verify proper wiring of switches	Re-test completed after rewiring	No	M.B. 8/16
6	Excessive delay flow switch–zone #4	8/16	NFPA 13	Excessive time delay setting	Adjust flow switch time delay to 90 sec	Switch re-tested after adjustment	No	M.B. 8/17
7	Wet chemical system–gas shutoff valve failure	8/20	NFPA 17A	Defective valve	Replace valve and re-test	Valve replaced and re-tested	No	M.B. 8/21

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EXHIBIT F.2 Commissioning Corrective Action Report — Issue 1. [Source: NFPA 3, 2012, Figure C.1.4(f)]

CORRECTIVE ACTION REPORT

Project: ACME Corp. ID: _____

Equipment/System: Fire pump Equipment/System ID: _____

Identified from: ☑ Test ❑ Review ❑ Discussion _____ ❑ Site visit 3–15–11 (Date)

The above equipment has been observed and tested, or the performance report reviewed, and was found to not comply with the contract documents.

Deficiencies or issues and effects:

Rotational test found that fire pump is operating in CCW direction. Plans, specification and purchase order require CW rotation.

Corrective action: ☑ Required ❑ Recommended

Verify correct wiring method and re-test.

For testing to proceed in a timely manner, it is imperative that the required corrective action be completed by:

3–16–11
Date or Event

Matt Bielik	3–15–11	Olivia Riley	3–15–11
Commissioning Agent	Date	Owner's Representative	Date

Forwarded to the following parties on 3–15–11 (Date) for corrective action:

ABC Sprinkler

Attachments? ❑ Yes ☑ No

Fill in the following section and return entire form to commissioning agent when corrected.

Statement of Correction

The above deficiencies have been corrected with the following actions:

Wiring connections corrected, pump was re-tested and correct rotation observed.

Matt Bielik	ACME Corp.	3–17–11
Signature	Firm	Date

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EXHIBIT F.3 Commissioning Corrective Action Report — Issue 2. [Source: NFPA 3, 2012, Figure C.1.4(f)]

CORRECTIVE ACTION REPORT

Project: ACME Corp. ID: _____

Equipment/System: Sprinklers Equipment/System ID: _____

Identified from: ❑ Test ❑ Review ❑ Discussion _____ ☑ Site visit 5–2–11
Date

The above equipment has been observed and tested, or the performance report reviewed, and was found to not comply with the contract documents.

Deficiencies or issues and effects:

While completing inspection of received material delivery, it was discovered that brass sprinklers have been received. Chrome-plated sprinklers were specified and were approved.

Corrective action: ☑ Required ❑ Recommended

Obtain return authorization from manufacturer and re-order with correct finish.

For testing to proceed in a timely manner, it is imperative that the required corrective action be completed by:

5–15–11
Date or Event

Matt Bielik	5–15–11	Olivia Riley	5–15–11
Commissioning Agent	Date	Owner's Representative	Date

Forwarded to the following parties on 5–15–11 Date for corrective action:

ABC Sprinkler

Attachments? ❑ Yes ☑ No

Fill in the following section and return entire form to commissioning agent when corrected.

Statement of Correction

The above deficiencies have been corrected with the following actions:

Brass sprinklers have been returned, and chrome-plated sprinklers have been ordered.

Matt Bielik	ACME Corp.	5–15–11
Signature	Firm	Date

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EXHIBIT F.4 Commissioning Corrective Action Report — Issue 3. [Source: NFPA 3, 2012, Figure C.1.4(f)]

CORRECTIVE ACTION REPORT

Project: ACME Corp. ID: _____

Equipment/System: Seismic bracing Equipment/System ID: _____

Identified from: ❑ Test ❑ Review ❑ Discussion _____ ☑ Site visit 5–30–11 (Date)

The above equipment has been observed and tested, or the performance report reviewed, and was found to not comply with the contract documents.

Deficiencies or issues and effects:

While completing site inspection of sprinkler system rough-in, incorrect seismic bracing was observed to be installed. Installed bracing does not meet specification and is not approved for installation.

Corrective action: ☑ Required ❑ Recommended

Either remove existing bracing and replace with approved materials and components or submit product data on installed bracing for approval.

For testing to proceed in a timely manner, it is imperative that the required corrective action be completed by:

5–30–11
Date or Event

Matt Bielik	5–13–11	Olivia Riley	5–13–11
Commissioning Agent	Date	Owner's Representative	Date

Forwarded to the following parties on 5–30–11 (Date) for corrective action:

ABC Sprinkler

Attachments? ❑ Yes ☑ No

Fill in the following section and return entire form to commissioning agent when corrected.

Statement of Correction

The above deficiencies have been corrected with the following actions:

Installed bracing has been removed and replaced with approved components.

Matt Bielik	ACME Corp.	5–30–11
Signature	Firm	Date

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EXHIBIT F.5 Commissioning Corrective Action Report — Issue 4. [Source: NFPA 3, 2012, Figure C.1.4(f)]

CORRECTIVE ACTION REPORT

Project: ACME Corp. ID: _____

Equipment/System: Standpipe System Equipment/System ID: _____

Identified from: ❑ Test ❑ Review ❑ Discussion _____ ☑ Site visit 7–6–11 (Date)

The above equipment has been observed and tested, or the performance report reviewed, and was found to not comply with the contract documents.

Deficiencies or issues and effects:

Failed hydrostatic test due to incomplete installation.

Corrective action: ☑ Required ❑ Recommended

Verify that the installation is complete and watertight, then re-test.

For testing to proceed in a timely manner, it is imperative that the required corrective action be completed by:

7–20–11
Date or Event

Matt Bielik	7–20–11	Olivia Riley	7–20–11
Commissioning Agent	Date	Owner's Representative	Date

Forwarded to the following parties on 7–20–11 (Date) for corrective action:

ABC Sprinkler

Attachments? ❑ Yes ☑ No

Fill in the following section and return entire form to commissioning agent when corrected.

Statement of Correction

The above deficiencies have been corrected with the following actions:

All connections to system have been verified to be watertight, system was re-tested successfully.

Matt Bielik	ACME Corp.	7–20–11
Signature	Firm	Date

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EXHIBIT F.6 Commissioning Corrective Action Report — Issue 5. [Source: NFPA 3, 2012, Figure C.1.4(f)]

CORRECTIVE ACTION REPORT

Project: ACME Corp. ID: _____

Equipment/System: Flow and Tamper Switches Equipment/System ID: _____

Identified from: ❑ Test ❑ Review ❑ Discussion _____ ☑ Site visit 8–15–11 (Date)

The above equipment has been observed and tested, or the performance report reviewed, and was found to not comply with the contract documents.

Deficiencies or issues and effects:

No signal from flow or tamper switches sprinkler system zone #4 to fire alarm panel.

Corrective action: ☑ Required ❑ Recommended

Verify that the installation is complete and connections are correct, then re-test.

For testing to proceed in a timely manner, it is imperative that the required corrective action be completed by:

8–16–11
Date or Event

Matt Bielik	8–16–11	Olivia Riley	8-16-11
Commissioning Agent	Date	Owner's Representative	Date

Forwarded to the following parties on 8–16–11 (Date) for corrective action:

ABC Sprinkler and National Fire Alarm Co.

Attachments? ❑ Yes ☑ No

Fill in the following section and return entire form to commissioning agent when corrected.

Statement of Correction

The above deficiencies have been corrected with the following actions:

All wiring to flow and tamper switches completed and verified by re-test.

Matt Bielik	ACME Corp.	8–16–11
Signature	Firm	Date

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EXHIBIT F.7 Commissioning Corrective Action Report — Issue 6. [Source: NFPA 3, 2012, Figure C.1.4(f)]

CORRECTIVE ACTION REPORT

Project: ACME Corp. ID: _____

Equipment/System: Flow switch signal delay Equipment/System ID: _____

Identified from: ☑ Test ❑ Review ❑ Discussion _____ ☑ Site visit 8–16–11 (Date)

The above equipment has been observed and tested, or the performance report reviewed, and was found to not comply with the contract documents.

Deficiencies or issues and effects:

Flow switch for Zone #4 rings in at 120 seconds.

Corrective action: ☑ Required ❑ Recommended

Adjust flow switch retard setting per manufacturer's recommendations and re-test.

For testing to proceed in a timely manner, it is imperative that the required corrective action be completed by:

8–17–11
Date or Event

Matt Bielik	8–17–11	Olivia Riley	8–17–11
Commissioning Agent	Date	Owner's Representative	Date

Forwarded to the following parties on 8–17–11 (Date) for corrective action:

ABC Sprinkler and National Fire Alarm Co.

Attachments? ❑ Yes ☑ No

Fill in the following section and return entire form to commissioning agent when corrected.

Statement of Correction

The above deficiencies have been corrected with the following actions:

Flow switch readjusted and rings in at 85 seconds.

Matt Bielik	ACME Corp.	8–17–11
Signature	Firm	Date

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EXHIBIT F.8 Commissioning Corrective Action Report — Issue 7. [Source: NFPA 3, 2012, Figure C.1.4(f)]

CORRECTIVE ACTION REPORT

Project: ACME Corp. ID: _____

Equipment/System: Wet Chemical System Equipment/System ID: _____

Identified from: ☑ Test ❑ Review ❑ Discussion _____ ☑ Site visit 8–20–11 (Date)

The above equipment has been observed and tested, or the performance report reviewed, and was found to not comply with the contract documents.

Deficiencies or issues and effects:

Gas shutoff valve failure. Gas shutoff valve does not operate upon wet chemical system actuation.

Corrective action: ☑ Required ❑ Recommended

Repair or replace valve and re-test.

For testing to proceed in a timely manner, it is imperative that the required corrective action be completed by:

8–21–11
Date or Event

Matt Bielik	8–21–11	Olivia Riley	8–21–11
Commissioning Agent	Date	Owner's Representative	Date

Forwarded to the following parties on 8–21–11 (Date) for corrective action:

ABC Sprinkler and National Fire Alarm Co.

Attachments? ❑ Yes ☑ No

Fill in the following section and return entire form to commissioning agent when corrected.

Statement of Correction

The above deficiencies have been corrected with the following actions:

Valve found to be defective. Valve replace and re-test completed successfully.

Matt Bielik	ACME Corp.	8–21–11
Signature	Firm	Date

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Annex G
Construction Checklists

Construction checklists are used as guides for the entire construction team to stay on schedule and to ensure that each and every system is delivered and installed as designed. The FCxA will depend on these lists to ensure the documentation of systems compliance with the OPR and BOD. (See Exhibit G.1 through Exhibit G.3.)

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EXHIBIT G.1 Commissioning Progress Report — Design Phase. [Source: NFPA 3, 2012, Figure C.1.4(d)]

COMMISSIONING PROGRESS REPORT

Project: ACME Corp. Date: 3–14–11

Prepared by: Matt Bielik Reporting period: Design phase Report #: 1

Commissioning tasks worked on since last report and general progress: Per the project schedule, all design drawings and data have been submitted for approval and have been approved. Fabrication is proceeding on schedule.

Areas where schedule is not being met: Minor delay in acceptance of underground piping due to failed hydrostatic test. Corrective action report has been completed and re-test has been completed successfully.

Recommended actions: None at this time.

Requested schedule adjustments: N/A

Next steps: Monitoring material deliveries and system rough-in.

Other comments (include general comments and field notes):

Issues log attached. ☑ Yes ❑ No

Matt Bielik
Commissioning Agent

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EXHIBIT G.2 Commissioning Progress Report — Construction Phase. [Source: NFPA 3, 2012, Figure C.1.4(d)]

COMMISSIONING PROGRESS REPORT

Project: ACME Corp. Date: 6–27–11

Prepared by: Matt Bielik Reporting period: Construction phase Report #: 2

Commissioning tasks worked on since last report and general progress: Per the project schedule, all systems are substantially roughed in and testing is about to proceed.

Areas where schedule is not being met: Minor delay with fire alarm system due to inadequate staffing of installation crew. This has been addressed with contractor, and staffing has been increased to meet schedule.

Recommended actions: Ongoing monitoring of staffing for all contractors.

Requested schedule adjustments: N/A

Next steps: Witnessing acceptance testing.

Other comments (include general comments and field notes):

Issues log attached. ☑ Yes ❑ No

Matt Bielik
Commissioning Agent

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EXHIBIT G.3 Commissioning Progress Report — Occupancy Phase. [Source: NFPA 3, 2012, Figure C.1.4(d)]

COMMISSIONING PROGRESS REPORT

Project: ACME Corp. Date: 9–26–11

Prepared by: Matt Bielik Reporting period: Occupancy phase Report #: 3

Commissioning tasks worked on since last report and general progress: All acceptance testing and training has been completed per specification and project schedule. Project is ready for final acceptance by local fire marshal and building owner.

Areas where schedule is not being met: As-built drawings and operation and maintenance manuals have not been submitted for approval at this time.

Recommended actions: Withhold final payment until all final documentation has been submitted and approved and pending receipt of occupancy permit by the fire and building departments.

Requested schedule adjustments: N/A

Next steps: Coordination and review/acceptance of final submittals.

Other comments (include general comments and field notes):

Issues log attached. ❑ Yes ☑ No

Matt Bielik
Commissioning Agent

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Annex H
Site Visit / Meeting Minutes

The documentation of site visits and meeting minutes is the preferred method of communication from the FCxA to the CxT members. These documents will help every team member understand where the Cx process stands and the work that remains. (See Exhibit H.1.)

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EXHIBIT H.1 Site Visit Report.

Site Visit Report

Company name: ACME Corporate Offices

Company address: 1 Acme Place

Anytown, USA

Date: 3–14–11

Conferred with: John Smith

Proposed completion date: December 2011

Report by Date:

❑ New plant ☑ New Bldg(s), give names(s) and/or number(s)
❑ New addition

Proposed occupancy: Four story office building, zone B-1 business

Construction details (dimensions, walls, floors, roof): 106,000 ft^2 total. Concrete/steel construction, membrane roof.

General contractor: J.S. General Contractors Tel. No.: 000-555-9999 Contact: John Smith

Sprinkler contractor: ABC Sprinkler Tel. No.: 000-555-1212 Contact: Ryan Quinn

Status of	Scheduled start date	Plans reviewed Ok'd	Plans reviewed Rec #	Percent completed to daate 0%	25	50	75	100	Scheduled completion date	Actual completion date
Foundation	1–1–11	✓						100		
Structural steel	2–1–11	✓					75		4–1–11	
Walls	2–28–11	✓				50			6–28–11	
Roof	7–1–11	✓		0					7–31–11	
Floor	1–31–11	✓						100	3–1–11	3–1–11
Gas & oil fired equip.				0						
Elec. & mech. equip.					20					
Underground	2–1–11	✓						100	3–14–11	3–14–11
Water supply (1)	2–1–11	✓						100	3–14–11	3–14–11
Water supply (2)	N/A									
Hydrants & related equip.	2–1–11	✓						100	3–14–11	3–14–11
Auto sprinklers (1)	4–11–11	✓		0						
Auto sprinklers (2)	5–2–11	✓		0						
Auto sprinklers (3)	5–23–11	✓		0						
Auto sprinklers (4)	6–13–11	✓		0						
Standpipes	3–21–11	✓		20						
Overall project	12–1–11	✓			35				12–31–11	

Describe deviations and temporary conditions:

No deviations to date, temporary heat, light & power available to all trades.

Recommendations:

Storage of all construction materials should prevent exposure to weather.

Date next visit should be conducted: Site visits should be conducted weekly & should be coordinated with significant project milestones such as material deliveries, req'd inspections and pre-functional and acceptance tests.

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Annex I
Systems Manual Review

The systems manual review will ensure that the documents transferred to the FMP are adequate for the building owner's purposes. (See Exhibit I.1.)

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EXHIBIT I.1 Commissioning Submittal/Approval. [Source: NFPA 3, 2012, Figure C.1.4(a)]

COMMISSIONING SUBMITTAL / APPROVAL

Project: ACME Corp. Offices

Submittal No.: 1

☑ New ❑ Resubmittal

From (initially): ABC Sprinkler

To: J.S. General Contractors

Equipment / system name: Fire protection O&M

ID #:

Cx Section No: 15395

Submittal Type:

☑ Documentation (describe): Operation & maintenance instructions for sprinkler, standpipe and fire pump systems.

❑ Functional test procedure forms:

❑ Completed functional test procedure record or report:

❑ Prefunctional checklist:

❑ Startup and initial checkout forms:

❑ Completed startup documentation or report:

Submissions / Returns

Path	To: From (initially):	To: From:	To: From:	To: From:	To: From:
Comments by submitter	For approval ❑ Notes attached	❑ Notes attached	❑ Notes attached	❑ Notes attached	❑ Notes attached
Copies	4				
Submitter signature	Ryan Quinn				
Title	Design Mgr				
Date	2-21-11				
Code	I				

Submitting Codes:
I = Initial submittal: The attached submittal has been reviewed, and the equipment, documents, or performance represented comply with the correct documents.
A = Approved as complying with the contract documents.
C = Note corrections. Approved, but need to resubmit for the record, after correcting.
NA = Not acceptable. Resubmittal required for review.

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Annex J
Training

The advantages of owner training should be readily apparent and should be strongly enforced by the FCxA. It might even be prudent to invite the local AHJ to the training sessions that will be held. The installer and the manufacturer might both be involved in conducting this training. The FCxA will be responsible for ensuring the training records are a part of the commissioning records. (See Exhibit J.1.)

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EXHIBIT J.1 Training and Orientation Agenda. [Source: NFPA 3, 2012, Figure C.1.4(i)]

TRAINING AND ORIENTATION AGENDA

Project: ACME Corp. Date: August 29

Equipment/System: Fire pump & controller Spec section: 15520

Section 1. Audience and General Scope *(Owner and Commissioning Agent fill out this section and transmit entire form to responsible contractors. Attach training specification section.)*

Intended audience type (enter number of staff): 1 facility manager, 1 facility engineer, 2 facility technician, 1 project manager, ____ tenant, ____ other: RDP & AHJ

General objectives and scope of training (check all that apply)

- ☑ A. Provide an overview of the purpose and operation of this equipment, including required interactions of trainees with the equipment.
- ☑ B. Provide technical information regarding the purpose, operation, and maintenance of this equipment at an intermediate level, expecting that serious malfunctions will be addressed by factory reps.
- ❑ C. Provide technical information regarding the purpose, operation, troubleshooting, and maintenance of this equipment at a very detailed level, expecting that almost all operation, service, and repair will be provided by the trainees.

Section 2. Instructors *(Commissioning agent fills in company. Trainer fills out the balance, prior to training.)*

ID	Trainer	Company	Position/Qualifications
1)	Ryan Quinn	ABC Sprinkler	Design manager
2)			
3)			

Section 3. Agenda *(The responsible contractors have their trainers fill out this section and submit to owner and commissioning agent for review and approval prior to conducting training.)*

Location: ❑ Site: Conference room Date: August 29

❑ Classroom (location): ____ Date: ____

Agenda of General Subjects Covered (✓ all that will be covered) (✓ when completed)	Duration (min.)	Instructor (ID)	Completed (✓)
☑ General purpose of this system or equipment (design intent)	60	RQ	✓
☑ Review of control drawings and schematics (have copies for attendees)	20	RQ	✓
☑ Startup, loading, normal operation, unloading, shutdown, unoccupied operation, seasonal changeover, etc., as applicable	90	RQ	✓
❑ Integral controls (packaged): programming, troubleshooting, alarms, manual operation			
☑ Building automation controls (BAS): programming, troubleshooting, alarms, manual operation, interface with integral controls	60	RQ	✓
☑ Interactions with other sytems, operation during power outage and fire	20	RQ	✓

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EXHIBIT J.1 Continued

✓	Common troubleshooting issues and methods, control system warnings and error messages, including using the control system for diagnostics	20	RQ	✓
✓	Service, maintenance, and preventative maintenance (sources, spare parts inventory, special tools, etc.)	20	RQ	✓
✓	Question and answer period	15	RQ	✓
✓	Emergency responder procedure	10	RQ	✓

Other subjects covered, specific to the equipment:	**Duration**	**Instructor**	**Completed**

Total duration of training (hrs) >5.25

Training methods that will be included (clarify as needed): (Trainer checks all that apply)

✓ Use of the O&M manuals, illustrating where the verbal training information is found in writing

✓ Each attendee will be provided: 1) the control drawing schematic and sequence of operations;
2) a copy of this agenda.

✓ Discussion/lecture at site

✓ Site demonstration of equipment operation

___ Written handouts

✓ Manufacturer training manual

✓ Classroom lecture

___ Classroom hands-on equipment

___ Video presentation

✓ Question and answer period

Section 4. Approvals and Use *(Once the Agenda has been filled out by the Trainer, the Owner and Commissioning Agent for review, make edits, sign, and return to Contractor, who provides to the Trainer for use during training. Copies of Agenda shall be provided to trainees.)*

This *plan* has been approved by the following individuals, subject to the additions and clarifications noted in the left columns marked "add." *(This is not an approval of training completion.)*

Matt Bielik
Owner's Representative

August 29
Date

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Annex K
Integrated Testing Procedures

This section of the commissioning plan will be unique for every project. The NFPA 3 technical committee developed a recommended practice that will offer the best chance to ensure that all of the systems within a structure work together. It is the goal of NFPA 3 to ensure that an "end-to-end" test be performed of any systems that are expected to work together to perform any life safety or fire protection goals. The integrated testing (ITx) plan should be thorough enough to show that all functions will perform as expected during an emergency event. (See Exhibit K.1 and Exhibit K.2.)

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EXHIBIT K.1 Functional Testing Plan Overview. [Source: NFPA 3, 2012, Figure C.1.4(g)]

COMMISSIONING FUNCTIONAL TESTING PLAN OVERVIEW

Project: ACME Corp. Date: Jan 10 Prepared by: Matt Bielik

Equipment/ System and Related Controls	When Testing Can Start (date or event)	Estimated Duration of Test (hrs)		Needed Participants at Testing (besides FCxA)	Test Written?	Test Proced. Needs Review
		During Occupied Period	During Unoccupied Period*			
Fire service main	Feb 28	2 hrs		Site utilities contractor	Yes	Yes
Fire pump	April 4	4 hrs		Inst. contractor, pump & controller field representative.	Yes	Yes
Sprinkler, Zone 1	July	4 hrs		Sprinkler contractor	Per Code	No
Sprinkler, Zone 2	July	4 hrs		Sprinkler contractor	Per Code	No
Sprinkler, Zone 3	July	4 hrs		Sprinkler contractor	Per Code	No
Sprinkler, Zone 4	July	4 hrs		Sprinkler contractor	Per Code	No
Clean agent	September 12		4 hrs	Suppression systems contractor	Per Code	Yes
Wet chemical	Following rough-in	2 hrs		Suppression systems contractor	Per Code	Yes

*These columns are to designate whether tests must be done during hours when the building is not occupied.

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EXHIBIT K.2 Functional Testing Status. [Source: NFPA 3, 2012, Figure C.1.4(h)]

COMMISSIONING FUNCTIONAL TESTING STATUS

Project: ACME Corp. Date: Feb 28 Prepared by: Matt Bielik

Equipment/System	Functionally Tested?	Pass/Fail	When Can It Be Retested?	Next Test Date
Fire service main	Feb 28	F	March 14	March 14
Fire service main	March 14	P	N/A	N/A
Fire pump	April 4	P		
Sprinkler, Zone 1	July 11	P		
Sprinkler, Zone 2	July 12	P		
Sprinkler, Zone 3	July 13	P		
Sprinkler, Zone 4	July 14	P		
Clean agent	August 15	P		
Wet chemical	August 22	P		

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Annex L
Warranty Review

This annex is reserved for the warranties for each system being installed on the project. The FCxA will be responsible for assembling and providing these documents.

Per the project specifications, our services, products, and installation, we offer a 1-year parts and labor warranty for the installed fire protection systems and equipment.

The fire protection system installation warranty covers any part or system failure based upon manufacturer or installation defect and/or natural wear and tear of the system. Correction or repair of any defect will be completed at no cost to the building owner.

This warranty excludes the following:

- Damage caused by natural disasters such as fire, flood, lightning, or freezing
- External damage such as damage from any equipment, vehicle, or person
- Problems or damage caused by self-servicing of any part of the system
- Systems serviced by a source other than the approved installer

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Annex M
Test Data Reports

These test data reports will include the individual test reports for each system involved in the Cx process. This annex is also where the integrated testing reports will be attached. (See Exhibit M.1 through Exhibit M.9.)

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EXHIBIT M.1 Contractor's Material and Test Certificate for Underground Piping. (Source: NFPA 24, 2010, Figure 10.10.1)

Contractor's Material and Test Certificate for Underground Piping

PROCEDURE

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

Property name: ACME Corporate Offices — Date: 3–14–11

Property address: 1 Acme Place, Anytown, USA

Plans

Accepted by approving authorities (names): Anytown Fire Dept.

Address: 10 Main St., Anytown, USA

Installation conforms to accepted plans — ☑ Yes ☐ No

Equipment used is approved — ☑ Yes ☐ No

If no, state deviations

Instructions

Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? — ☑ Yes ☐ No

If no, explain

Have copies of appropriate instructions and care and maintenance charts been left on premises? — ☑ Yes ☐ No

If no, explain

Location

Supplies buildings: Corporate office

Underground pipes and joints

Pipe types and class: Ductile iron CL53 — Type joint: Mechanical joint

Pipe conforms to AWWA C110 standard — ☑ Yes ☐ No

Fittings conform to B16.9 standard — ☑ Yes ☐ No

If no, explain

Joints needing anchorage clamped, strapped, or blocked in accordance with AWWA standard — ☑ Yes ☐ No

If no, explain

Test description

Flushing: Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush at flows not less than 390 gpm (1476 L/min) for 4 in. pipe, 880 gpm (3331 L/min) for 6 in. pipe, 1560 gpm (5905 L/min) for 8 in. pipe, 2440 gpm (9235 L/min) for 10 in. pipe, and 3520 gpm (13,323 L/min) for 12 in. pipe. When supply cannot produce stipulated flow rates, obtain maximum available.

Hydrostatic: All piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at 200 psi (13.8 bar) or 50 psi (3.4 bar) in excess of the system working pressure, whichever is greater, and shall maintain that pressure ± 5 psi for 2 hours.

Hydrostatic Testing Allowance: Where additional water is added to the system to maintain the test pressures required by 10.10.2.2.1, the amount of water shall be measured and shall not exceed the limits of the following equation (For metric equation, see 10.10.2.2.4):

$$L = \frac{SD\sqrt{P}}{148{,}000}$$

L = testing allowance (makeup water), in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of the pipe, in inches
P = average test pressure during the hydrostatic test, in pounds per square inch (gauge)

Flushing tests

New underground piping flushed according to NFPA 24 standard by (company) — ☑ Yes ☐ No

If no, explain

How flushing flow was obtained: ☑ Public water ☐ Tank or reservoir ☐ Fire pump

Through what type opening: ☑ Hydrant butt ☐ Open pipe

Lead-ins flushed according to NFPA 24 standard by (company) — ☑ Yes ☐ No

If no, explain

How flushing flow was obtained: ☑ Public water ☐ Tank or reservoir ☐ Fire pump

Through what type opening: ☑ Y connection to flange and spigot ☐ Open pipe

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EXHIBIT M.1 Continued

Hydrostatic test	All new underground piping hydrostatically tested at 203 psi for 2 hours		Joints covered ☐ Yes ☑ No
Leakage test	Total amount of leakage measured ~5 gallons 2 hours Allowable leakage ~77 gallons 2 hours		
Hydrants	Number installed 3	Type and make American Darling	All operate satisfactorily ☑ Yes ☐ No
Control valves	Water control valves left wide open ☑ Yes ☐ No If no, state reason Hose threads of fire department connections and hydrants interchangeable with those of fire department answering alarm ☑ Yes ☐ No		
Remarks	Date left in service 3–14–11		
Signatures	Name of installing contractor ABC Sprinkler–100 Oak St.–Anytown, USA Tel: 000-55501212 Fax: 000-55501234 **Tests witnessed by**		
	For property owner (signed) Matt Bielik	Title Cx Agent	Date 3–14–11
	For installing contractor (signed) Ryan Quinn	Title Design Manager	Date 3–14–11

Additional explanation and notes

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EXHIBIT M.2 Sample Annual Performance Tests for Fire Pumps. (Source: *Water-Based Fire Protection Systems Handbook*, 2011, Form S4.2)

FORM 8-I

Fire Pumps

Annual Performance Tests

Date: 7-11-11 **Inspector:** Elena Mackenzie

Location: ACME Corporate Offices

Y = Satisfactory **N** = Unsatisfactory (explain below)

Pump manufacturer and model: FP-1

Type: ☒ Centrifugal ☐ Turbine

Controller manufacturer and model: FP-1

Rated capacity: 1000 gpm (L/min)

Water supply source: Public supply

Rated pressure: 40 psi (bar) Rated speed: 1750 rpm

Power: ☒ Electric ☐ Diesel ☐ Steam

Automatic starts performed 6 times.	Y	Timer indicates total run time: 10 min.	
Automatic start functions properly.	Y	Timer reset and graph paper changed?	NA
Automatic stop functions properly.	Y	Test data and flow charts completed. (Attach all water-flow charts, electrical power charts, performance curves, etc.)	Y
Automatic start: 35 psi (bar)		Fire pump electrical power readings recorded at each flow condition?	Y
Automatic stop: 45 psi (bar)		Fire pump motor speed: 1750 rpm	
Manual starts performed 6 times.	Y	Fire pump discharge flow: 1000 gpm (L/min)	
Manual start functions properly.	Y	Jockey pump operational.	Y
Manual stop functions properly.	Y	Jockey pump appears properly aligned.	Y
Manual start: 40 psi (bar)		Jockey pump valves open.	Y
Manual stop: 45 psi (bar)		Jockey pump "turn-on": 40 psi (bar)	
Remote start functions properly.	Y	Jockey pump "turn-off": 45 psi (bar)	
Remote stop functions properly.	Y		
Remote start: 35 psi (bar)			
Remote stop: 45 psi (bar)			

Notes

Continue on reverse if necessary.

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EXHIBIT M.3 Sample Annual Test Summary Page for Fire Pumps. (Source: *Water-Based Fire Protection Systems Handbook*, 2011, Form S4.3)

FORM 8-J

Fire Pumps

Annual Test Summary Page

Date: 7-11-11 **Inspector:** Elena Mackenzie

Location: ACME Corporate Offices

	Test 1	Test 2	Test 3
Approximate percent of rated pump discharge (gpm)/(L/min)	0	100%	150%
Nozzle size in inches (mm) 1 ¼	No flow	1 ¼ in.	1 ¾ in.
Pitot pressure in psi (bar)	None	29	30
Flow in gpm (L/min) 251 x 4	None	(4) @ 251 1004	(3) @ 501 1503
Pump suction in psi (bar)	40	30	20
Pump discharge in psi (bar)	88	70	46
Net pump head (discharge pressure minus suction pressure)	48	40	26
Pump speed (rpm)	1750	1750	1750
Operate electric circuit breaker.	✓		
Test emergency power supply.	NA		
Check for excessive back pressure in exhaust system.	NA		

Notes

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EXHIBIT M.4 Water Supply Analysis Graph.

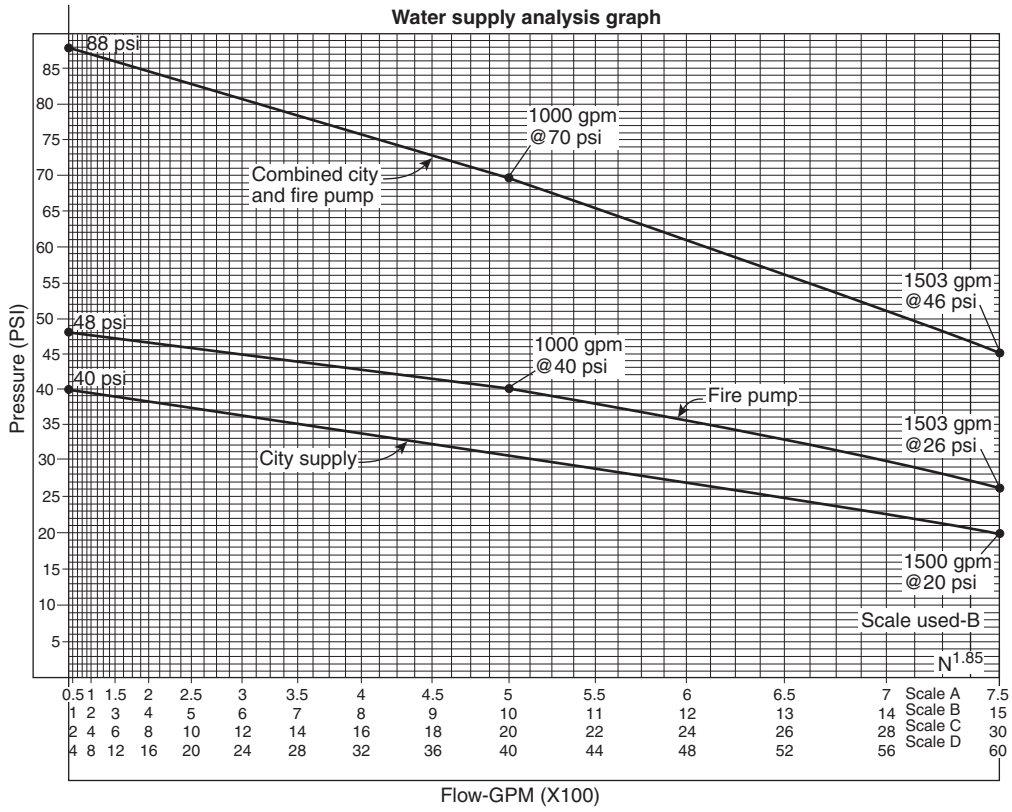

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EXHIBIT M.5 Contractor's Material and Test Certificate for Aboveground Piping — First Floor. (Source: NFPA 13, 2013, Figure 25.1)

Contractor's Material and Test Certificate for Aboveground Piping

PROCEDURE

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by the property owner or their authorized agent. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

Property name	ACME Corporate Offices	Date 8–15–11
Property address	1 Acme Place, Anytown, USA	

Plans

Accepted by approving authorities (names)	Anytown bldg. dept.	Anytown fire dept.
Address	1 Main St., Anytown, USA	10 Main St., Anytown, USA
Installation conforms to accepted plans	☑ Yes ☐ No	
Equipment used is approved	☑ Yes ☐ No	
If no, explain deviations		

Instructions

Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment?	☑ Yes ☐ No
If no, explain	
Have copies of the following been left on the premises?	
1. System components instructions	☑ Yes ☐ No
2. Care and maintenance instructions	☑ Yes ☐ No
3. NFPA 25	☑ Yes ☐ No

Location of system

Supplies buildings First floor 25,000 ft²

Sprinklers

Make	Model	Year of manufacture	Orifice size	Quantity	Temperature rating
Viking	Vk–1	2011	1/2"	170	165°F

Pipe and fittings

Type of pipe Sch10 mains, Sch 40 branchlines

Type of fittings Grooved for mains, threaded for branchlines

Alarm valve or flow indicator

Alarm device			Maximum time to operate through test connection	
Type	Make	Model	Minutes	Seconds
Flow switch	VSR–1	Potter	1	30

Dry pipe operating test

Dry valve			Q. O. D.		
Make	Model	Serial no.	Make	Model	Serial no.
N/A					

	Time to trip through test connection[a,b]		Water pressure	Air pressure	Trip point air pressure	Time water reached test outlet[a,b]		Alarm operated properly	
	Minutes	Seconds	psi	psi	psi	Minutes	Seconds	Yes	No
Without Q.O.D.									
With Q.O.D.									

If no, explain

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[a] Measured from time inspector's test connection is opened.
[b] NFPA 13 only requires the 60-second limitation in specific sections.

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EXHIBIT M.5 Continued

Deluge and preaction valves

Operation ❑ Pneumatic ❑ Electric ❑ Hydraulics

Piping supervised ❑ Yes ❑ No | Detecting media supervised ❑ Yes ❑ No

Does valve operate from the manual trip, remote, or both control stations? ❑ Yes ❑ No

Is there an accessible facility in each circuit for testing? ❑ Yes ❑ No | If no, explain

Make	Model	Does each circuit operate supervision loss alarm?		Does each circuit operate valve release?		Maximum time to operate release	
		Yes	No	Yes	No	Minutes	Seconds
N/A							

Pressure-reducing valve test

Location and floor	Make and model	Setting	Static pressure		Residual pressure (flowing)		Flow rate
			Inlet (psi)	Outlet (psi)	Inlet (psi)	Outlet (psi)	Flow (gpm)
N/A							

Test description

~~Hydrostatic:~~ Hydrostatic tests shall be made at not less than 200 psi (13.6 bar) for 2 hours or 50 psi (3.4 bar) above static pressure in excess of 150 psi (10.2 bar) for 2 hours. Differential dry pipe valve clappers shall be left open during the test to prevent damage. All aboveground piping leakage shall be stopped.

~~Pneumatic:~~ Establish 40 psi (2.7 bar) air pressure and measure drop, which shall not exceed 1½ psi (0.1 bar) in 24 hours. Test pressure tanks at normal water level and air pressure and measure air pressure drop, which shall not exceed 1½ psi (0.1 bar) in 24 hours.

Tests

All piping hydrostatically tested at 200 psi (—— bar) for 2 hours ❑ Yes ☑ No N/A | If no, state reason

Dry piping pneumatically tested ☑ Yes ❑ No

Equipment operates properly ☑ Yes ❑ No

Do you certify as the sprinkler contractor that additives and corrosive chemicals, sodium silicate or derivatives of sodium silicate, brine, or other corrosive chemicals were not used for testing systems or stopping leaks? ☑ Yes ❑ No

Drain test | Reading of gauge located near water supply test connection: 40 psi (—— bar) | Residual pressure with valve in test connection open wide: 37 psi (—— bar)

Underground mains and lead-in connections to system risers flushed before connection made to sprinkler piping

Verified by copy of the Contractor's Material and Test Certificate for Underground Piping. ☑ Yes ❑ No | Other | Explain

Flushed by installer of underground sprinkler piping ☑ Yes ❑ No

If powder-driven fasteners are used in concrete, has representative sample testing been satisfactorily completed? ☑ Yes ❑ No | If no, explain

Blank testing gaskets

Number used	Locations	Number removed
0		

Welding

Welding piping ☑ Yes ❑ No

If yes . . .

Do you certify as the sprinkler contractor that welding procedures used complied with the minimum requirements of AWS B2.1, ASME Section IX *Welding and Brazing Qualifications,* or other applicable qualification standard as required by the AHJ? ☑ Yes ❑ No

Do you certify that all welding was performed by welders or welding operators qualified in accordance with the minimum requirements of AWS B2.1, ASME Section IX *Welding and Brazing Qualifications,* or other applicable qualification standard as required by the AHJ? ☑ Yes ❑ No

Do you certify that the welding was conducted in compliance with a documented quality control procedure to ensure that (1) all discs are retrieved; (2) that openings in piping are smooth, that slag and other welding residue are removed; (3) the internal diameters of piping are not penetrated; (4) completed welds are free from cracks, incomplete fusion, surface porosity greater than 1/16 in. diameter, undercut deeper than the lesser of 25% of the wall thickness or 1/32 in.; and (5) completed circumferential butt weld reinforcement does not exceed 3/32 in.? ☑ Yes ❑ No

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EXHIBIT M.5 Continued

Cutouts (discs)	Do you certify that you have a control feature to ensure that all cutouts (discs) are retrieved? ☑ Yes ☐ No	
Hydraulic data nameplate	Nameplate provided ☑ Yes ☐ No	If no, explain
Sprinkler contractor removed all caps and straps? ☐ Yes ☐ No		
Remarks	Date left in service with all control valves open 8–26–11	
Signatures	Name of sprinkler contractor ABC Sprinkler 100 Oak St., Anytown, USA Tel: 000-555-1212, Fax: 000-555-1234	
	Tests witnessed by	
	The property owner or their authorized agent (signed) Matt Bielik	Title Commissioning Agent — Date 8–15–11
	For sprinkler contractor (signed) Ryan Quinn	Title Design Manager — Date 8–15–11

Additional explanations and notes

First floor zone only.

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EXHIBIT M.6 Contractor's Material and Test Certificate for Aboveground Piping — Second Floor. (Source: NFPA 13, 2013, Figure 25.1)

Contractor's Material and Test Certificate for Aboveground Piping

PROCEDURE

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by the property owner or their authorized agent. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

Property name: ACME Corporate Offices — Date: 8–16–11

Property address: 1 Acme Place, Anytown, USA

Plans

Accepted by approving authorities (names): Anytown bldg. dept. / Anytown fire dept.

Address: 1 Main St., Anytown, USA / 10 Main St., Anytown, USA

Installation conforms to accepted plans: ☑ Yes ☐ No

Equipment used is approved: ☑ Yes ☐ No

If no, explain deviations:

Instructions

Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? ☑ Yes ☐ No

If no, explain:

Have copies of the following been left on the premises?

1. System components instructions ☑ Yes ☐ No
2. Care and maintenance instructions ☑ Yes ☐ No
3. NFPA 25 ☑ Yes ☐ No
4. With whom have the copies been left? John Smith

Location of system

Supplies buildings: Second floor 25,000 ft²

Sprinklers

Make	Model	Year of manufacture	Orifice size	Quantity	Temperature rating
Viking	Vk–1	2011	1/2"	170	165°F

Pipe and fittings

Type of pipe: Sch10 mains, Sch 40 branchlines

Type of fittings: Grooved for mains, threaded for branchlines

Alarm valve or flow indicator

Alarm device			Maximum time to operate through test connection	
Type	Make	Model	Minutes	Seconds
Flow switch	VSR–1	Potter	1	30

Dry pipe operating test

Dry valve			Q. O. D.		
Make	Model	Serial no.	Make	Model	Serial no.
N/A					

	Time to trip through test connection[a,b]		Water pressure	Air pressure	Trip point air pressure	Time water reached test outlet[a,b]		Alarm operated properly	
	Minutes	Seconds	psi	psi	psi	Minutes	Seconds	Yes	No
Without Q.O.D.									
With Q.O.D.									

If no, explain

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[a] Measured from time inspector's test connection is opened.
[b] NFPA 13 only requires the 60-second limitation in specific sections.

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EXHIBIT M.6 Continued

Deluge and preaction valves

Operation ❑ Pneumatic ❑ Electric ❑ Hydraulics

Piping supervised ❑ Yes ❑ No | Detecting media supervised ❑ Yes ❑ No

Does valve operate from the manual trip, remote, or both control stations? ❑ Yes ❑ No

Is there an accessible facility in each circuit for testing? ❑ Yes ❑ No | If no, explain

Make	Model	Does each circuit operate supervision loss alarm?		Does each circuit operate valve release?		Maximum time to operate release	
		Yes	No	Yes	No	Minutes	Seconds
N/A							

Pressure-reducing valve test

Location and floor	Make and model	Setting	Static pressure		Residual pressure (flowing)		Flow rate
			Inlet (psi)	Outlet (psi)	Inlet (psi)	Outlet (psi)	Flow (gpm)
N/A							

Test description

~~Hydrostatic:~~ Hydrostatic tests shall be made at not less than 200 psi (13.6 bar) for 2 hours or 50 psi (3.4 bar) above static pressure in excess of 150 psi (10.2 bar) for 2 hours. Differential dry pipe valve clappers shall be left open during the test to prevent damage. All aboveground piping leakage shall be stopped.

~~Pneumatic:~~ Establish 40 psi (2.7 bar) air pressure and measure drop, which shall not exceed 1½ psi (0.1 bar) in 24 hours. Test pressure tanks at normal water level and air pressure and measure air pressure drop, which shall not exceed 1½ psi (0.1 bar) in 24 hours.

Tests

All piping hydrostatically tested at 200 psi (—— bar) for 2 hours ❑ Yes ☑ No N/A | If no, state reason

Dry piping pneumatically tested ☑ Yes ❑ No

Equipment operates properly ☑ Yes ❑ No

Do you certify as the sprinkler contractor that additives and corrosive chemicals, sodium silicate or derivatives of sodium silicate, brine, or other corrosive chemicals were not used for testing systems or stopping leaks? ☑ Yes ❑ No

Drain test | Reading of gauge located near water supply test connection: 40 psi (—— bar) | Residual pressure with valve in test connection open wide: 37 psi (—— bar)

Underground mains and lead-in connections to system risers flushed before connection made to sprinkler piping

Verified by copy of the Contractor's Material and Test Certificate for Underground Piping. ☑ Yes ❑ No | Other | Explain

Flushed by installer of underground sprinkler piping ☑ Yes ❑ No

If powder-driven fasteners are used in concrete, has representative sample testing been satisfactorily completed? ☑ Yes ❑ No | If no, explain

Blank testing gaskets

Number used	Locations	Number removed
0		

Welding

Welding piping ☑ Yes ❑ No

If yes . . .

Do you certify as the sprinkler contractor that welding procedures used complied with the minimum requirements of AWS B2.1, ASME Section IX *Welding and Brazing Qualifications,* or other applicable qualification standard as required by the AHJ? ☑ Yes ❑ No

Do you certify that all welding was performed by welders or welding operators qualified in accordance with the minimum requirements of AWS B2.1, ASME Section IX *Welding and Brazing Qualifications,* or other applicable qualification standard as required by the AHJ? ☑ Yes ❑ No

Do you certify that the welding was conducted in compliance with a documented quality control procedure to ensure that (1) all discs are retrieved; (2) that openings in piping are smooth, that slag and other welding residue are removed; (3) the internal diameters of piping are not penetrated; (4) completed welds are free from cracks, incomplete fusion, surface porosity greater than 1/16 in. diameter, undercut deeper than the lesser of 25% of the wall thickness or 1/32 in.; and (5) completed circumferential butt weld reinforcement does not exceed 3/32 in.? ☑ Yes ❑ No

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EXHIBIT M.6 Continued

Cutouts (discs)	Do you certify that you have a control feature to ensure that all cutouts (discs) are retrieved? ☑ Yes ☐ No	
Hydraulic data nameplate	Nameplate provided ☑ Yes ☐ No	If no, explain
Sprinkler contractor removed all caps and straps? ☐ Yes ☐ No		
Remarks	Date left in service with all control valves open 8–26–11	
Signatures	Name of sprinkler contractor ABC Sprinkler 100 Oak St., Anytown, USA Tel: 000-555-1212, Fax: 000-555-1234	
	Tests witnessed by	
	The property owner or their authorized agent (signed) Matt Bielik	Title Commissioning Agent / Date 8–16–11
	For sprinkler contractor (signed) Ryan Quinn	Title Design Manager / Date 8–16–11

Additional explanations and notes

Second floor zone only.

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EXHIBIT M.7 Contractor's Material and Test Certificate for Aboveground Piping — Third Floor. (Source: NFPA 13, 2013, Figure 25.1)

Contractor's Material and Test Certificate for Aboveground Piping

PROCEDURE

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by the property owner or their authorized agent. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

Property name: ACME Corporate Offices — Date: 8–17–11

Property address: 1 Acme Place, Anytown, USA

Plans

Accepted by approving authorities (names): Anytown bldg. dept. / Anytown fire dept.

Address: 1 Main St., Anytown, USA / 10 Main St., Anytown, USA

Installation conforms to accepted plans: ☑ Yes ☐ No

Equipment used is approved: ☑ Yes ☐ No

If no, explain deviations:

Instructions

Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? ☑ Yes ☐ No

If no, explain:

Have copies of the following been left on the premises?

1. System components instructions ☑ Yes ☐ No
2. Care and maintenance instructions ☑ Yes ☐ No
3. NFPA 25 ☑ Yes ☐ No
4. With whom have the copies been left? John Smith

Location of system

Supplies buildings: Third floor 25,000 ft²

Sprinklers

Make	Model	Year of manufacture	Orifice size	Quantity	Temperature rating
Viking	Vk–1	2011	1/2"	170	165°F

Pipe and fittings

Type of pipe: Sch10 mains, Sch 40 branchlines

Type of fittings: Grooved for mains, threaded for branchlines

Alarm valve or flow indicator

Alarm device			Maximum time to operate through test connection	
Type	Make	Model	Minutes	Seconds
Flow switch	VSR–1	Potter	1	30

Dry pipe operating test

Dry valve			Q. O. D.		
Make	Model	Serial no.	Make	Model	Serial no.
N/A					

	Time to trip through test connection[a,b]		Water pressure	Air pressure	Trip point air pressure	Time water reached test outlet[a,b]		Alarm operated properly	
	Minutes	Seconds	psi	psi	psi	Minutes	Seconds	Yes	No
Without Q.O.D.									
With Q.O.D.									

If no, explain

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[a] Measured from time inspector's test connection is opened.
[b] NFPA 13 only requires the 60-second limitation in specific sections.

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EXHIBIT M.7 Continued

Deluge and preaction valves

Operation ❑ Pneumatic ❑ Electric ❑ Hydraulics

Piping supervised ❑ Yes ❑ No — Detecting media supervised ❑ Yes ❑ No

Does valve operate from the manual trip, remote, or both control stations? ❑ Yes ❑ No

Is there an accessible facility in each circuit for testing? ❑ Yes ❑ No — If no, explain

Make	Model	Does each circuit operate supervision loss alarm?		Does each circuit operate valve release?		Maximum time to operate release	
		Yes	No	Yes	No	Minutes	Seconds
N/A							

Pressure-reducing valve test

Location and floor	Make and model	Setting	Static pressure		Residual pressure (flowing)		Flow rate
			Inlet (psi)	Outlet (psi)	Inlet (psi)	Outlet (psi)	Flow (gpm)
N/A							

Test description

~~Hydrostatic:~~ Hydrostatic tests shall be made at not less than 200 psi (13.6 bar) for 2 hours or 50 psi (3.4 bar) above static pressure in excess of 150 psi (10.2 bar) for 2 hours. Differential dry pipe valve clappers shall be left open during the test to prevent damage. All aboveground piping leakage shall be stopped.

~~Pneumatic:~~ Establish 40 psi (2.7 bar) air pressure and measure drop, which shall not exceed 1½ psi (0.1 bar) in 24 hours. Test pressure tanks at normal water level and air pressure and measure air pressure drop, which shall not exceed 1½ psi (0.1 bar) in 24 hours.

Tests

All piping hydrostatically tested at 200 psi (___ bar) for 2 hours — If no, state reason

Dry piping pneumatically tested ❑ Yes ☑ No N/A

Equipment operates properly ☑ Yes ❑ No

Do you certify as the sprinkler contractor that additives and corrosive chemicals, sodium silicate or derivatives of sodium silicate, brine, or other corrosive chemicals were not used for testing systems or stopping leaks? ☑ Yes ❑ No

Drain test — Reading of gauge located near water supply test connection: 40 psi (___ bar) — Residual pressure with valve in test connection open wide: 37 psi (___ bar)

Underground mains and lead-in connections to system risers flushed before connection made to sprinkler piping

Verified by copy of the Contractor's Material and Test Certificate for Underground Piping. ☑ Yes ❑ No

Flushed by installer of underground sprinkler piping ☑ Yes ❑ No

Other Explain

If powder-driven fasteners are used in concrete, has representative sample testing been satisfactorily completed? ☑ Yes ❑ No — If no, explain

Blank testing gaskets

Number used	Locations	Number removed
0		

Welding

Welding piping ☑ Yes ❑ No

If yes . . .

Do you certify as the sprinkler contractor that welding procedures used complied with the minimum requirements of AWS B2.1, ASME Section IX *Welding and Brazing Qualifications,* or other applicable qualification standard as required by the AHJ? ☑ Yes ❑ No

Do you certify that all welding was performed by welders or welding operators qualified in accordance with the minimum requirements of AWS B2.1, ASME Section IX *Welding and Brazing Qualifications,* or other applicable qualification standard as required by the AHJ? ☑ Yes ❑ No

Do you certify that the welding was conducted in compliance with a documented quality control procedure to ensure that (1) all discs are retrieved; (2) that openings in piping are smooth, that slag and other welding residue are removed; (3) the internal diameters of piping are not penetrated; (4) completed welds are free from cracks, incomplete fusion, surface porosity greater than 1/16 in. diameter, undercut deeper than the lesser of 25% of the wall thickness or 1/32 in.; and (5) completed circumferential butt weld reinforcement does not exceed 3/32 in.? ☑ Yes ❑ No

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EXHIBIT M.7 Continued

Cutouts (discs)	Do you certify that you have a control feature to ensure that all cutouts (discs) are retrieved? ☑ Yes ☐ No	
Hydraulic data nameplate	Nameplate provided ☑ Yes ☐ No	If no, explain
Sprinkler contractor removed all caps and straps? ☐ Yes ☐ No		
Remarks	Date left in service with all control valves open 8–26–11	
Signatures	Name of sprinkler contractor ABC Sprinkler 100 Oak St., Anytown, USA Tel: 000-555-1212, Fax: 000-555-1234	
	Tests witnessed by	
	The property owner or their authorized agent (signed) Matt Bielik	Title Commissioning Agent — Date 8–17–11
	For sprinkler contractor (signed) Ryan Quinn	Title Design Manager — Date 8–17–11

Additional explanations and notes

Third floor zone only.

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EXHIBIT M.8 Contractor's Material and Test Certificate for Aboveground Piping — Fourth Floor. (Source: NFPA 13, 2013, Figure 25.1)

Contractor's Material and Test Certificate for Aboveground Piping

PROCEDURE

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by the property owner or their authorized agent. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

Property name: ACME Corporate Offices — Date: 8–18–11

Property address: 1 Acme Place, Anytown, USA

Plans

Accepted by approving authorities (names): Anytown bldg. dept. / Anytown fire dept.

Address: 1 Main St., Anytown, USA / 10 Main St., Anytown, USA

Installation conforms to accepted plans: ☑ Yes ☐ No

Equipment used is approved: ☑ Yes ☐ No

If no, explain deviations:

Instructions

Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? ☑ Yes ☐ No

If no, explain:

Have copies of the following been left on the premises?

1. System components instructions ☑ Yes ☐ No
2. Care and maintenance instructions ☑ Yes ☐ No
3. NFPA 25 ☑ Yes ☐ No
4. With whom have the copies been left? John Smith

Location of system

Supplies buildings: Fourth floor 25,000 ft²

Sprinklers

Make	Model	Year of manufacture	Orifice size	Quantity	Temperature rating
Viking	Vk–1	2011	1/2"	170	165°F

Pipe and fittings

Type of pipe: Sch10 mains, Sch 40 branchlines

Type of fittings: Grooved for mains, threaded for branchlines

Alarm valve or flow indicator

Alarm device			Maximum time to operate through test connection	
Type	Make	Model	Minutes	Seconds
Flow switch	VSR–1	Potter	1	30

Dry pipe operating test

Dry valve			Q. O. D.		
Make	Model	Serial no.	Make	Model	Serial no.
N/A					

	Time to trip through test connection[a,b]		Water pressure	Air pressure	Trip point air pressure	Time water reached test outlet[a,b]		Alarm operated properly	
	Minutes	Seconds	psi	psi	psi	Minutes	Seconds	Yes	No
Without Q.O.D.									
With Q.O.D.									

If no, explain

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[a] Measured from time inspector's test connection is opened.
[b] NFPA 13 only requires the 60-second limitation in specific sections.

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EXHIBIT M.8 Continued

Deluge and preaction valves

Operation ❑ Pneumatic ❑ Electric ❑ Hydraulics

Piping supervised ❑ Yes ❑ No — Detecting media supervised ❑ Yes ❑ No

Does valve operate from the manual trip, remote, or both control stations? ❑ Yes ❑ No

Is there an accessible facility in each circuit for testing? ❑ Yes ❑ No — If no, explain

Make	Model	Does each circuit operate supervision loss alarm?		Does each circuit operate valve release?		Maximum time to operate release	
		Yes	No	Yes	No	Minutes	Seconds
N/A							

Pressure-reducing valve test

Location and floor	Make and model	Setting	Static pressure		Residual pressure (flowing)		Flow rate
			Inlet (psi)	Outlet (psi)	Inlet (psi)	Outlet (psi)	Flow (gpm)
N/A							

Test description

~~Hydrostatic:~~ Hydrostatic tests shall be made at not less than 200 psi (13.6 bar) for 2 hours or 50 psi (3.4 bar) above static pressure in excess of 150 psi (10.2 bar) for 2 hours. Differential dry pipe valve clappers shall be left open during the test to prevent damage. All aboveground piping leakage shall be stopped.

~~Pneumatic:~~ Establish 40 psi (2.7 bar) air pressure and measure drop, which shall not exceed 1½ psi (0.1 bar) in 24 hours. Test pressure tanks at normal water level and air pressure and measure air pressure drop, which shall not exceed 1½ psi (0.1 bar) in 24 hours.

Tests

All piping hydrostatically tested at 200 psi (___ bar) for 2 hours ❑ Yes ☑ No N/A — If no, state reason

Dry piping pneumatically tested ❑ Yes ☑ No

Equipment operates properly ☑ Yes ❑ No

Do you certify as the sprinkler contractor that additives and corrosive chemicals, sodium silicate or derivatives of sodium silicate, brine, or other corrosive chemicals were not used for testing systems or stopping leaks? ☑ Yes ❑ No

Drain test — Reading of gauge located near water supply test connection: 40 psi (___ bar) — Residual pressure with valve in test connection open wide: 37 psi (___ bar)

Underground mains and lead-in connections to system risers flushed before connection made to sprinkler piping

Verified by copy of the Contractor's Material and Test Certificate for Underground Piping. ☑ Yes ❑ No

Flushed by installer of underground sprinkler piping ☑ Yes ❑ No

Other Explain

If powder-driven fasteners are used in concrete, has representative sample testing been satisfactorily completed? ☑ Yes ❑ No — If no, explain

Blank testing gaskets

Number used	Locations	Number removed
0		

Welding

Welding piping ☑ Yes ❑ No

If yes . . .

Do you certify as the sprinkler contractor that welding procedures used complied with the minimum requirements of AWS B2.1, ASME Section IX *Welding and Brazing Qualifications,* or other applicable qualification standard as required by the AHJ? ☑ Yes ❑ No

Do you certify that all welding was performed by welders or welding operators qualified in accordance with the minimum requirements of AWS B2.1, ASME Section IX *Welding and Brazing Qualifications,* or other applicable qualification standard as required by the AHJ? ☑ Yes ❑ No

Do you certify that the welding was conducted in compliance with a documented quality control procedure to ensure that (1) all discs are retrieved; (2) that openings in piping are smooth, that slag and other welding residue are removed; (3) the internal diameters of piping are not penetrated; (4) completed welds are free from cracks, incomplete fusion, surface porosity greater than 1/16 in. diameter, undercut deeper than the lesser of 25% of the wall thickness or 1/32 in.; and (5) completed circumferential butt weld reinforcement does not exceed 3/32 in.? ☑ Yes ❑ No

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EXHIBIT M.8 Continued

Cutouts (discs)	Do you certify that you have a control feature to ensure that all cutouts (discs) are retrieved? ☑ Yes ☐ No	
Hydraulic data nameplate	Nameplate provided ☑ Yes ☐ No	If no, explain
Sprinkler contractor removed all caps and straps? ☐ Yes ☐ No		
Remarks	Date left in service with all control valves open 8–26–11	
Signatures	Name of sprinkler contractor ABC Sprinkler 100 Oak St., Anytown, USA Tel: 000-555-1212, Fax: 000-555-1234	
	Tests witnessed by	
	The property owner or their authorized agent (signed) Matt Bielik	Title Commissioning Agent / Date 8–18–11
	For sprinkler contractor (signed) Ryan Quinn	Title Design Manager / Date 8–18–11

Additional explanations and notes

Fourth floor zone only.

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EXHIBIT M.9 Owner's Information Certificate. [Source: NFPA 13, 2013, Figure A.23.1(b)]

OWNER'S INFORMATION CERTIFICATE

Name/address of property to be protected with sprinkler protection:

ACME Corp.

Name of owner: Same

Existing or planned construction is:

- ☑ Fire resistive or noncombustible
- ❑ Wood frame or ordinary (masonry walls with wood beams)
- ❑ Unknown

Describe the intended use of the building: Office with conference and cafeteria facilities

Note regarding speculative buildings: The design and installation of the fire sprinkler system is dependent on an accurate description of the likely use of the building. Without specific information, assumptions will need to be made that will limit the actual use of the building. Make sure that you communicate any and all use considerations to the fire sprinkler contractor in this form and that you abide by all limitations regarding the use of the building based on the limitations of the fire sprinkler system that is eventually designed and installed.

Is the system installation intended for one of the following special occupancies:

Aircraft hangar	❑ Yes	☑ No
Fixed guideway transit system	❑ Yes	☑ No
Race track stable	❑ Yes	☑ No
Marine terminal, pier, or wharf	❑ Yes	☑ No
Airport terminal	❑ Yes	☑ No
Aircraft engine test facility	❑ Yes	☑ No
Power plant	❑ Yes	☑ No
Water-cooling tower	❑ Yes	☑ No

If the answer to any of the above is "yes," the appropriate NFPA standard should be referenced for sprinkler density/area criteria.

Indicate whether any of the following special materials are intended to be present:

Flammable or combustible liquids	❑ Yes	☑ No
Aerosol products	❑ Yes	☑ No
Nitrate film	❑ Yes	☑ No
Pyroxylin plastic	❑ Yes	☑ No
Compressed or liquefied gas cylinders	❑ Yes	☑ No
Liquid or solid oxidizers	❑ Yes	☑ No
Organic peroxide formulations	❑ Yes	☑ No
Idle pallets	❑ Yes	☑ No

If the answer to any of the above is "yes," describe type, location, arrangement, and intended maximum quantities.

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EXHIBIT M.9 Continued

Indicate whether the protection is intended for one of the following specialized occupancies or areas:

Spray area or mixing room	❑ Yes	☑ No
Solvent extraction	❑ Yes	☑ No
Laboratory using chemicals	❑ Yes	☑ No
Oxygen-fuel gas system for welding or cutting	❑ Yes	☑ No
Acetylene cylinder charging	❑ Yes	☑ No
Production or use of compressed or liquefied gases	❑ Yes	☑ No
Commercial cooking operation	☑ Yes	❑ No
Class A hyperbaric chamber	❑ Yes	☑ No
Cleanroom	❑ Yes	☑ No
Incinerator or waste handling system	❑ Yes	☑ No
Linen handling system	❑ Yes	☑ No
Industrial furnace	❑ Yes	☑ No
Water-cooling tower	❑ Yes	☑ No

If the answer to any of the above is "yes," describe type, location, arrangement, and intended maximum quantities.

Wet chemical system above cooking appliances in cafeteria

Will there be any storage of products over 12 ft (3.6 m) in height? ❑ Yes ☑ No

If the answer is "yes," describe product, intended storage arrangement, and height.

Will there be any storage of plastic, rubber, or similar products over 5 ft (1.5 m) high except as described above? ❑ Yes ☑ No

If the answer is "yes," describe product, intended storage arrangement, and height.

Is there any special information concerning the water supply? ❑ Yes ☑ No

If the answer is "yes," provide the information, including known environmental conditions that might be responsible for corrosion, including microbiologically influenced corrosion (MIC).

I certify that I have knowledge of the intended use of the property and that the above information is correct.

Signature of owner's representative or agent: Matt Bielik Date: 9–26–11

Name of owner's representative or agent completing certificate (print): Matt Bielik

Relationship and firm of agent (print): Cx Agent

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Annex N
Sequence of Operation

In conjunction with the ITx reports, the completed sequence of operations and systems matrices will be required to verify that the systems are completely and successfully integrated. (See Exhibit N.1 and Exhibit N.2.)

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EXHIBIT N.1 Sequence of Operation.

		System Inputs														
		Fire alarm control center									Notification		Other required fire safety			
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Typical manual pull station (by device) levels 1-4	✓	✓					✓	✓		✓	✓	✓				
2	Typical elevator recall smoke detector (by device) by floor/lobby	✓	✓					✓	✓		✓	✓	✓	✓			✓
3	Elevator machine room smoke detector	✓	✓					✓	✓	✓	✓	✓	✓				✓
4	Typical smoke detector (by device) 3rd floor clean agent system	✓	✓					✓	✓		✓	✓	✓	✓			
5	Typical sprinkler system flow switch floors 1-4	✓	✓				✓	✓	✓		✓	✓	✓				
6	Typical sprinkler system control valve tamper switch floors 1-4			✓	✓			✓									
7	Standpipe riser isolation valve tamper switch stairs 1 and 2	✓	✓				✓	✓	✓			✓	✓				
8	Backflow preventer isolation valves tamper switch			✓	✓			✓									
9	Kitchen cafeteria wet chemical system 1st floor	✓	✓					✓	✓				✓				✓
10	Typical duct smoke detector floors 1-4							✓							✓		
11	Fire pump running			✓	✓			✓									
12	Fire pump power failure			✓	✓			✓									
13	Fire pump phase reversal			✓	✓			✓									
14	Fire pump connect to emergency power			✓	✓			✓									
15	Fire pump circuit breaker at generator output			✓	✓			✓									
16	Fire alarm system open circuit					✓	✓	✓									
17	Fire alarm system ground fault					✓	✓	✓									
18	Fire alarm system battery disconnect					✓	✓	✓									
19	Fire alarm system low battery					✓	✓	✓									
20	Fire alarm system ac power failure					✓	✓	✓									
21	Fire alarm system amplifier failure					✓	✓	✓									
22	Generator status indicator					✓	✓										

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EXHIBIT N.2 Sequence of Operation Test Form. [Source: NFPA 3, 2012, Figure A.3.3.16(b)]

SEQUENCE OF OPERATION TEST FORM

Building Information

Building name: ACME Corporation

Building address: 1 Acme Place, Anytown, USA

Owner's name: Same

Owners address: Same

Owner's phone/fax/e-mail: 999-555-1212/acme.com

Installing Contractor

Company name: ABC Sprinkler

Address: 100 Oak St., Anytown, USA

Contact person: Ryan Quinn

Phone/fax/e-mail: 000-555-1212

System Input	System Output	Test Results	Date	Initials
1. Typical manual pull station (by device) floors 1–5	A. Actuate common alarm signal indicator	Pass	8-15-11	RQ
	B. Actuate audible alarm signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
	H. Transmit alarm to FD and central station masterbox	Pass	8-15-11	RQ
	J. Actuate associated exterior fire alarm beacons	Pass	8-15-11	RQ
	K. Actuate all evacuation signals for the building	Pass	8-15-11	RQ
	L. Release all magnetically held doors	Pass	8-15-11	RQ
2. Typical elevator recall smoke detector (by device) by floor (lobby)	A. Actuate common alarm signal indicator	Pass	8-15-11	RQ
	B. Actuate audible alarm signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
	H. Transmit alarm to FD and central station masterbox	Pass	8-15-11	RQ
	J. Actuate associated exterior fire alarm beacons	Pass	8-15-11	RQ
	K. Actuate all evacuation signals for the building	Pass	8-15-11	RQ
	L. Release all magnetically held doors	Pass	8-15-11	RQ
	M. Recall associated elevator in accordance with recall sequence	Pass	8-15-11	RQ
	P. Elevator hoistway open	Pass	8-15-11	RQ
3. Elevator machine room smoke detector	A. Actuate common alarm signal indicator	Pass	8-15-11	RQ
	B. Actuate audible alarm signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
	H. Transmit alarm to FD and central station masterbox	Pass	8-15-11	RQ
	I. Illuminate associated detector LED indicator	Pass	8-15-11	RQ

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EXHIBIT N.2 Continued

SEQUENCE OF OPERATION TEST FORM *(continued)*

System Input	System Output	Test Results	Date	Initials
3. Elevator machine room smoke detector *(continued)*	J. Actuate associated exterior fire alarm beacons	Pass	8-15-11	RQ
	K. Actuate all evacuation signals for the building	Pass	8-15-11	RQ
	L. Release all magnetically held doors	Pass	8-15-11	RQ
	P. Elevator hoistway open	Pass	8-15-11	RQ
4. Typical smoke detector (by device) computer room (3rd floor) preaction system	A. Actuate common alarm signal indicator	Pass	8-15-11	RQ
	B. Actuate audible alarm signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
	H. Transmit alarm to FD and central station masterbox	Pass	8-15-11	RQ
	J. Actuate associated exterior fire alarm beacons	Pass	8-15-11	RQ
	K. Actuate all evacuation signals for the building	Pass	8-15-11	RQ
	L. Release all magnetically held doors	Pass	8-15-11	RQ
	M. Recall associated elevator in accordance with recall sequence	Pass	8-15-11	RQ
5. Typical wet sprinkler system flow control valve assembly flow switch — by floor	A. Actuate common alarm signal indicator	Pass	8-15-11	RQ
	B. Actuate audible alarm signal	Pass	8-15-11	RQ
	F. Actuate audible trouble signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
	H. Transmit alarm to FD and central station masterbox	Pass	8-15-11	RQ
	J. Actuate associated exterior fire alarm beacons	Pass	8-15-11	RQ
	K. Actuate all evacuation signals for the building	Pass	8-15-11	RQ
	L. Release all magnetically held doors	Pass	8-15-11	RQ
6. Typical wet sprinkler system flow control valve assembly tamper switch — by floor	C. Actuate common supervisory signal indicator	Pass	8-15-11	RQ
	D. Actuate audible supervisory signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
7. Typical preaction sprinkler system flow control valve assembly flow switch — by floor	A. Actuate common alarm signal indicator	Pass	8-15-11	RQ
	B. Actuate audible alarm signal	Pass	8-15-11	RQ
	F. Actuate audible trouble signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
	H. Transmit alarm to FD and central station masterbox	Pass	8-15-11	RQ
	K. Actuate all evacuation signals for the building	Pass	8-15-11	RQ
	L. Release all magnetically held doors	Pass	8-15-11	RQ
8. Typical preaction sprinkler system flow control valve assembly tamper switch — by floor	C. Actuate common supervisory signal indicator	Pass	8-15-11	RQ
	D. Actuate audible supervisory signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ

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EXHIBIT N.2 Continued

SEQUENCE OF OPERATION TEST FORM *(continued)*

System Input	System Output	Test Results	Date	Initials
9. Kitchen cafeteria wet chemical system — 1st floor	A. Actuate common alarm signal indicator	Pass	8-15-11	RQ
	B. Actuate audible alarm signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
	H. Transmit alarm to FD and central station masterbox	Pass	8-15-11	RQ
	L. Release all magnetically held doors	Pass	8-15-11	RQ
	P. Elevator hoistway open	Pass	8-15-11	RQ
10. Typical duct smoke detector (by device) — by floor	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
	N. Shut down associated mechanical equipment	Pass	8-15-11	RQ
11. Fire pump running	C. Actuate common supervisory signal indicator	Pass	8-15-11	RQ
	D. Actuate audible supervisory signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
12. Fire pump power failure	C. Actuate common supervisory signal indicator	Pass	8-15-11	RQ
	D. Actuate audible supervisory signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
13. Fire pump phase reversal	C. Actuate common supervisory signal indicator	Pass	8-15-11	RQ
	D. Actuate audible supervisory signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
14. Fire pump connected to emergency power	C. Actuate common supervisory signal indicator	Pass	8-15-11	RQ
	D. Actuate audible supervisory signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
15. Fire pump circuit breaker at generator output	C. Actuate common supervisory signal indicator	Pass	8-15-11	RQ
	D. Actuate audible supervisory signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
16. Fire alarm system open circuit	E. Actuate common trouble signal indicator	Pass	8-15-11	RQ
	F. Actuate audible trouble signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
17. Fire alarm system ground fault	E. Actuate common trouble signal indicator	Pass	8-15-11	RQ
	F. Actuate audible trouble signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ

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EXHIBIT N.2 Continued

SEQUENCE OF OPERATION TEST FORM *(continued)*

System Input	System Output	Test Results	Date	Initials
18. Fire alarm system battery disconnect	E. Actuate common trouble signal indicator	Pass	8-15-11	RQ
	F. Actuate audible trouble signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
19. Fire alarm system low batttery	E. Actuate common trouble signal indicator	Pass	8-15-11	RQ
	F. Actuate audible trouble signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
20. Fire alarm system ac power failure	E. Actuate common trouble signal indicator	Pass	8-15-11	RQ
	F. Actuate audible trouble signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
21. Fire alarm system amplifier failure	E. Actuate common trouble signal indicator	Pass	8-15-11	RQ
	F. Actuate audible trouble signal	Pass	8-15-11	RQ
	G. Display and print change of status and time of initiating event	Pass	8-15-11	RQ
22. Generator status indicator	E. Actuate common trouble signal indicator	Pass	8-15-11	RQ
	F. Actuate audible trouble signal	Pass	8-15-11	RQ

Date system left in service: _____

Test Witnessed by

Matt Bielik	Cx Agent	8-15-11
Owner/authorized agent	Title	Date
Ryan Quinn	Design Manager	8-15-11
Owner/authorized agent	Title	Date

Additional explanations/notes: _____

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Annex O
Operation & Maintenance Instructions

The following documents will be compiled as the O&M manual for the owner.

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Fire Protection Systems Specification Section 15500

Operation and Maintenance Instructions

ACME Corporate Offices

1 Acme Place

Anytown, USA

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Project Overview

1.0 Systems Summary
- 1.1 Fire Alarm System
- 1.2 Sprinkler/Standpipe System
- 1.3 Fire Pump System
- 1.4 Wet Chemical Suppression System
- 1.5 Clean Agent Suppression System

2.0 Operation and Maintenance Data
- 2.1 Sprinklers
- 2.2 Alarm Valve
- 2.3 OS&Y Valve
- 2.4 Butterfly Valve
- 2.5 Check Valve
- 2.6 Backflow Preventer
- 2.7 Fire Department Connection
- 2.8 Standpipe Hose Valve and Cabinet
- 2.9 Tamper Switch
- 2.10 Flow Switch

3.0 Recommended Spare Parts
- 3.1 Sprinklers
- 3.2 Valves
- 3.3 Fire Pump
- 3.4 Flow and Tamper Switches

4.0 Completed Test Reports

5.0 Warranties

6.0 Maintenance Schedules
- 6.1 Fire Alarm System
- 6.2 Sprinkler System
- 6.3 Standpipe System
- 6.4 Fire Pump
- 6.5 Wet Chemical System
- 6.6 Clean Agent System

7.0 Project Schedule

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1.0 Systems Summary

1.1 Fire Alarm System. This building is equipped with a complete fire alarm system in accordance with *NFPA 72®*, *National Fire Alarm and Signaling Code*, and local/state codes and ordinances. In addition to detection and notification of fire and smoke, the fire alarm system offers a number of integrated alarms and monitoring circuits. Relative to the sprinkler system, the fire alarm system monitors water flow and tamper switches and provides audible and visual alarms for each component. The fire alarm system also monitors several functions associated with interconnected systems as follows: fire pump and controller, wet chemical kitchen protection, clean agent suppression system, elevator recall, and smoke/fire management in the HVAC system by closing dampers.

1.2 Sprinkler/Standpipe System. This building is protected throughout by a fully automatic combination sprinkler/standpipe system, installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems,* NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* and all local and state codes and ordinances. The sprinkler system is divided into four distinct zones, one zone for each floor of the building. Each sprinkler zone is supplied by two zone control stations, one in each stairway (stairways #1 and #2) for redundancy. Zone control stations include isolation valves, flow switches, and inspectors to test and drain valves. The standpipe system is classified as a Class I system intended for fire department use only. The standpipe system provides a 2½ in. fire department valve in each stairway on each floor with one valve provided on the roof.

1.3 Fire Pump System. The combination sprinkler/standpipe system is supplied by an electrically driven fire pump that includes a fire pump, electric drive, fire pump controller, and power transfer switch. The fire pump is arranged to operate on normal building power with backup power supplied by an on-site emergency generator.

1.4 Wet Chemical Suppression System. Cooking appliances in the kitchen area are protected by a wet chemical suppression system designed and installed in accordance with NFPA 17A, *Standard for Wet Chemical Extinguishing Systems,* and local and state codes and ordinances. The suppression system is equipped with a fuel shut-off in the event of operation as well as an interconnection for local alarms through the fire alarm system.

1.5 Clean Agent Suppression System. The electronic data processing (EDP) room is protected by a clean agent suppression system designed to operate by means of a local dedicated fire alarm releasing panel. A cross-zoned smoke detection system is dedicated to the clean agent system and is also interfaced with the building fire alarm system. The clean agent will discharge into the EDP room and underfloor area following a pre-discharge alarm.

2.0 Operation and Maintenance Data

2.1 Sprinklers. Sprinklers are relatively maintenance free; however, they will require some attention. Sprinklers should be inspected from the floor each year, and any sprinkler showing signs of corrosion or buildup of paint or other material might require replacement of the component. Once every 50 years, a sample of 1 percent (or no less than 4 percent) of the total number of installed sprinklers should be removed and sent to a testing lab for evaluation.

2.2 Alarm Valve. The system alarm valve should be inspected each month to verify that it is accessible and is not leaking. An internal inspection is needed every 5 years.

2.3 OS&Y Valve. The OS&Y valve should be inspected monthly to verify that it is in the open position and is accessible. This valve should be operated through its full range of motion annually and the valve stem lubricated at this time.

2.4 Butterfly Valve. The butterfly valve should be inspected monthly to verify that it is in the open position and is accessible. This valve should be operated through its full range of motion annually.

2.5 Check Valve. The check valve should be inspected monthly for signs of damage or leaks and should be inspected internally every 5 years for corrosion and/or obstruction.

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2.6 Backflow Preventer. The backflow preventer must be tested for full flow each year at the system demand flow rate. In addition, for environmental purposes, the backflow prevention capabilities of the valve must be tested annually.

2.7 Fire Department Connection. The fire department connection must be inspected monthly to verify that it is not obstructed, is accessible, is fully operational, and is not leaking.

2.8 Standpipe Hose Valve and Cabinet. The hose valve and cabinet should be inspected monthly to verify that they are not obstructed, are not leaking, and are fully operational.

2.9 Tamper Switch. The tamper switch should be tested every 6 months to verify that it transmits a supervisory signal to the fire alarm system, indicating that the valve is closed.

2.10 Flow Switch. The waterflow alarm switch should be tested every 6 months by flowing water through the inspector's test connect to verify that the switch transmits a flow alarm to the fire alarm system.

3.0 Recommended Spare Parts

3.1 Sprinklers. A spare sprinkler cabinet must be maintained on site at all times and should include a reserve supply of twelve sprinklers and a sprinkler wrench. A roll of Teflon® tape is also recommended.

3.2 Valves. A repair kit for all alarm valves is recommended that includes all gaskets, o-rings, and seals for emergency repair. A repair kit for the OS&Y and backflow preventer valves is also recommended that includes replacement packing glands, o-rings, and gaskets.

3.3 Fire Pump. For recommended spare parts for the fire pump, see the manufacturer's approved equipment manual. In addition, special lubricants as per the manufacturer should be maintained on site.

3.4 Flow and Tamper Switches. No recommended spare parts are intended for these devices. Replacement of faulty components is recommended.

4.0 Completed Test Reports

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EXHIBIT O.1 Functional Testing Status. [Source: NFPA 3, 2012, Figure C.1.4(h)]

COMMISSIONING FUNCTIONAL TESTING STATUS

Project: ACME Corp. Date: Feb 28 Prepared by: Matt Bielik

Equipment/System	Functionally Tested?	Pass/Fail	When Can It Be Retested?	Next Test Date
Fire service main	Feb 28	F	March 14	March 14
Fire service main	March 14	P	N/A	N/A
Fire pump	April 4	P		
Sprinkler, zone 1	July 11	P		
Sprinkler, zone 2	July 12	P		
Sprinkler, zone 3	July 13	P		
Sprinkler, zone 4	July 14	P		
Clean agent	August 15	P		
Wet chemical	August 22	P		

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EXHIBIT O.2 Commissioning Issues Log. [Source: NFPA 3, 2012, Figure C.1.4(e)]

COMMISSIONING ISSUES LOG

Project: Acme Corp. Prepared by: Matt Bielik Page ____ of ____

Attach additional pages as necessary for issues requiring more explanation and tracking.

#	Issue	Date Found	Code/ Document Reference	Possible Cause	Recommendations	Actions Taken	O&M Doc. Issue?	Signature and Date
	Hydro test	2/28	NFPA 24	Poor gasket seal	See corrective action report	Re-work gaskets to remove contaminants, dirt or other foreign material. Verify that gasket is sealing properly.	No	

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EXHIBIT O.3 Commissioning Progress Report. [Source: NFPA 3, 2012, Figure C.1.4(d)]

COMMISSIONING PROGRESS REPORT

Project: Acme Corp. Date: 2-28-11

Prepared by: Matt Bielik Reporting period: 1st Qtr Report #: 03-02

Commissioning tasks worked on since last report and general progress: This is second report issued on this project. First report was accepted following inspection of underground piping shipment.

Areas where schedule is not being met: Project is one week behind schedule due to unsatisfactory underground fire main hydro test.

Recommended actions: Rework gaskets at pipe joints to verify proper seal prior to re-test. See corrective action report.

Requested schedule adjustments: One week to complete gasket re-work and one week to reschedule hydro test.

Next steps: Completion of issues log and corrective action report.

Other comments (include general comments and field notes): Hydro test not accepted due to leakage beyond amount permitted by NFPA 24.

Issues log attached. ☑ Yes ❑ No

Matt Bielik
Commissioning Agent

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EXHIBIT O.4 Commissioning Corrective Action Report. [Source: NFPA 3, 2012, Figure C.1.4(f)]

CORRECTIVE ACTION REPORT

Project: ACME Corp. ID: _____

Equipment/System: Private fire service main Equipment/System ID: _____

Identified from: ☑ Test ❑ Review ❑ Discussion _____ ☑ Site visit 2-28-11 (Date)

The above equipment has been observed and tested, or the performance report reviewed, and was found to not comply with the contract documents.

Deficiencies or issues and effects:

During hydrostatic test, test pressure was not maintained due to leaks and/or air in the piping system.

Corrective action: ☑ Required ❑ Recommended

Bleed air from system and verify that all gaskets are free from sand or dirt and are not pinched and are properly sealing pipe joint.

For testing to proceed in a timely manner, it is imperative that the required corrective action be completed by:

March 14—see project schedule (Date or Event)

Matt Bielik	2–28–11	Olivia Riley	3–2–11
Commissioning Agent	Date	Owner's Representative	Date

Forwarded to the following parties on 3–12–11 (Date) for corrective action:

Attachments? ❑ Yes ☑ No

Fill in the following section and return entire form to commissioning agent when corrected.

Statement of Correction

The above deficiencies have been corrected with the following actions:

Following air bleed from system and cleaning of gaskets, hydro test was completed in accordance with project specifications and NFPA 24.

Matt Bielik	ACME Corp.	3–12–11
Signature	Firm	Date

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EXHIBIT O.5 Functional Testing Plan Overview. [Source: NFPA 3, 2012, Figure C.1.4(g)]

COMMISSIONING FUNCTIONAL TESTING PLAN OVERVIEW

Project: ACME Corp. Date: Jan 10 Prepared by: Matt Bielik

Equipment/ System and Related Controls	When Testing Can Start (date or event)	Estimated Duration of Test (hrs)		Needed Participants at Testing (besides CA)	Test Written?	Test Proced. Needs Review
		During Occupied Period	During Unoccupied Period*			
Fire service main	Feb 28	2 hrs		Site utilities contractor	Yes	Yes
Fire pump	April 4	4 hrs		Inst. contractor, pump & controller field representative	Yes	Yes
Sprinkler, Zone 1	July	4 hrs		Sprinkler contractor	Per Code	No
Sprinkler, Zone 2	July	4 hrs		Sprinkler contractor	Per Code	No
Sprinkler, Zone 3	July	4 hrs		Sprinkler contractor	Per Code	No
Sprinkler, Zone 4	July	4 hrs		Sprinkler contractor	Per Code	No
Clean agent	September 12		4 hrs	Suppression systems contractor	Per Code	Yes
Wet chemical	Following rough-in	2 hrs		Suppression systems contractor	Per Code	Yes

*These columns are to designate whether tests must be done during hours when the building is not occupied.

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EXHIBIT O.6 Material Inspection Report 1.

Material Inspection Report

Project Information

Building name:	ACME Corporation
Building address:	1 Acme Place, Anytown, USA
Owner's name:	Same
Owner's address:	Same
Owner's phone/fax/e-mail	999-555-1212/acme.com

Contractor Information

Company name:	ABC Sprinkler
Building address:	100 Oak St., Anytown, USA
Contact person:	Ryan Quinn
Phone/fax/e-mail	000-555-1212

System	Description of Material/Equipment	P.O. #	Received
Sprinkler	Pipe, fittings and pipe supports for zones 1-4	C-1001	3–17–11

☑ Released for Construction ❑ Hold for Corrections ❑ Non-conformance, return to supplier

Matt Bielik	Cx Agent	3–17–11
Cx Agent	Title	Date
Ryan Quinn	Design Manager	3–17–11
Contractor	Title	Date

Additional Comments/Notes

Pipe type, fitting type and pipe supports verified as complying with NFPA 13 and project specification.

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EXHIBIT O.7 Material Inspection Report 2.

Material Inspection Report

Project Information

Building name:	ACME Corporation
Building address:	1 Acme Place, Anytown, USA
Owner's name:	Same
Owner's address:	Same
Owner's phone/fax/e-mail	999-555-1212/acme.com

Contractor Information

Company name:	ABC Sprinkler
Building address:	100 Oak St., Anytown, USA
Contact person:	Ryan Quinn
Phone/fax/e-mail	000-555-1212

System	Description of Material/Equipment	P.O. #	Received
Sprinkler	Sprinklers, flow switches, tamper switches	C-1002	6–13–11

☑ Released for Construction ❑ Hold for Corrections ❑ Non-conformance, return to supplier

Matt Bielik	Cx Agent	6–13–11
Cx Agent	Title	Date
Ryan Quinn	Design Manager	6–13–11
Contractor	Title	Date

Additional Comments/Notes

Sprinklers and switches verified as complying with NFPA 13 and project specification.

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EXHIBIT O.8 Training and Orientation Agenda. [Source: NFPA 3, 2012, Figure C.1.4(i)]

TRAINING AND ORIENTATION AGENDA

Project: ACME Corp. Date: August 29

Equipment/System: Fire pump & controller Spec section: 15520

Section 1. Audience and General Scope *(Owner and Commissioning Agent fill out this section and transmit entire form to responsible contractors. Attach training specification section.)*

Intended audience type (enter number of staff): 1 facility manager, 1 facility engineer, 2 facility technician, 1 project manager, ____ tenant, ____ other: RDP & AHJ

General objectives and scope of training (check all that apply)

- ☑ A. Provide an overview of the purpose and operation of this equipment, including required interactions of trainees with the equipment.
- ☑ B. Provide technical information regarding the purpose, operation, and maintenance of this equipment at an intermediate level, expecting that serious malfunctions will be addressed by factory reps.
- ❑ C. Provide technical information regarding the purpose, operation, troubleshooting, and maintenance of this equipment at a very detailed level, expecting that almost all operation, service, and repair will be provided by the trainees.

Section 2. Instructors *(Commissioning agent fills in company. Trainer fills out the balance, prior to training.)*

ID	Trainer	Company	Position/Qualifications
1)	Ryan Quinn	ABC Sprinkler	Design Manager
2)			
3)			

Section 3. Agenda *(The responsible contractors have their trainers fill out this section and submit to Owner and Commissioning Agent for review and approval prior to conducting training.)*

Location: ☑ Site: Conference room Date: August 29

❑ Classroom (location): ____ Date: ____

Agenda of General Subjects Covered (✓ all that will be covered) (✓ when completed)	Duration (min.)	Instructor (ID)	Completed (✓)
☑ General purpose of this system or equipment (design intent)	60	RQ	✓
☑ Review of control drawings and schematics (have copies for attendees)	20	RQ	✓
☑ Startup, loading, normal operation, unloading, shutdown, unoccupied operation, seasonal changeover, etc., as applicable	90	RQ	✓
❑ Integral controls (packaged): programming, troubleshooting, alarms, manual operation			
☑ Building automation controls (BAS): programming, troubleshooting, alarms, manual operation, interface with integral controls	60	RQ	✓

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EXHIBIT O.8 Continued

☑ Interactions with other systems, operation during power outage and fire	20	RQ	✓
☑ Common troubleshooting issues and methods, control system warnings and error messages, including using the control system for diagnostics	20	RQ	✓
☑ Service, maintenance, and preventative maintenance (sources, spare parts inventory, special tools, etc.)	20	RQ	✓
☑ Question and answer period	15	RQ	✓
☑ Emergency responder procedure	10	RQ	✓

Other subjects covered, specific to the equipment:	**Duration**	**Instructor**	**Completed**

Total duration of training (hrs) >5.25

Training methods that will be included (clarify as needed): (Trainer checks all that apply)

✓ Use of the O&M manuals, illustrating where the verbal training information is found in writing
✓ Each attendee will be provided: 1) the control drawing schematic and sequence of operations;
2) a copy of this agenda.
✓ Discussion/lecture at site
✓ Site demonstration of equipment operation
__ Written handouts
✓ Manufacturer training manual
✓ Classroom lecture
__ Classroom hands-on equipment
__ Video presentation
✓ Question and answer period

Section 4. Approvals and Use *(Once the Agenda has been filled out by the Trainer, the Owner and Commissioning Agent for review, make edits, sign, and return to Contractor, who provides to the Trainer for use during training. Copies of Agenda shall be provided to trainees.)*

This *plan* has been approved by the following individuals, subject to the additions and clarifications noted in the left columns marked "add." *(This is not an approval of training completion.)*

Olivia Riley
Owner's Representative

August 29
Date

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5.0 Warranties

Per the project specifications, our services, products, and installation, we offer a 1 year parts and labor warranty for the installed fire protection systems and equipment.

The fire protection system installation warranty covers any part or system failure based upon manufacturer or installation defect and/or natural wear and tear of the system. Correction or repair of any defect will be completed at no cost to the building owner.

This warranty excludes:

- Damage from natural disaster such as fire, flood, lightning, or freezing
- External damage such as damage from any equipment, vehicle or person
- Problems or damage caused by self-servicing of any part of the system
- Systems serviced by a source other than the approved installer

6.0 Maintenance Schedules

6.1 Fire Alarm System

TABLE 6.1.1 *Visual Inspection Frequencies*

	Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually
1.	Control equipment: fire alarm systems monitored for alarm, supervisory, and trouble signals					
	(a) Fuses	X	—	—	—	X
	(b) Interfaced equipment	X	—	—	—	X
	(c) Lamps and LEDs	X	—	—	—	X
	(d) Primary (main) power supply	X	—	—	—	X
2.	Control equipment: fire alarm systems unmonitored for alarm, supervisory, and trouble signals					
	(a) Fuses	X (weekly)	—	—	—	—
	(b) Interfaced equipment	X (weekly)	—	—	—	—
	(c) Lamps and LEDs	X (weekly)	—	—	—	—
	(d) Primary (main) power supply	X (weekly)	—	—	—	—
3.	Batteries					
	(a) Lead-acid	X	X	—	—	—
	(b) Nickel-cadmium	X	—	—	X	—
	(c) Primary (dry cell)	X	X	—	—	—
	(d) Sealed lead-acid	X	—	—	X	—
4.	Transient suppressors	X	—	—	X	—
5.	Fire alarm control unit trouble signals	X (weekly)	—	—	X	—
6.	Fiber-optic cable connections	X	—	—	—	X
7.	In-building fire emergency voice/ alarm communications equipment	X	—	—	X	—
8.	Remote annunciators	X	—	—	X	—

(continues)

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TABLE 6.1.1 *Continued*

	Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually
9.	Initiating devices					
	(a) Air sampling	X	—	—	X	—
	(b) Duct detectors	X	—	—	X	—
	(c) Electromechanical releasing devices	X	—	—	X	—
	(d) Fire extinguishing system(s) or suppression system(s) switches	X	—	—	X	—
	(e) Manual fire alarm boxes	X	—	—	X	—
	(f) Heat detectors	X	—	—	X	—
	(g) Radiant energy fire detectors	X	—	X	—	—
	(h) Smoke detectors (excluding one- and two-family dwellings)	X	—	—	X	—
	(i) Supervisory signal devices	X	—	X	—	—
	(j) Waterflow devices	X	—	X	—	—
10.	Guard's tour equipment	X	—	—	X	—
11.	Combination systems					
	(a) Fire extinguisher electronic monitoring device/systems	X	—	—	X	—
	(b) Carbon monoxide detectors/ systems	X	—	—	X	—
12.	Interface equipment	X	—	—	X	—
13.	Alarm notification appliances — supervised	X	—	—	X	—
14.	Exit marking audible notification appliances	X	—	—	X	—
15.	Supervising station alarm systems — transmitters					
	(a) DACT	X	—	—	X	—
	(b) DART	X	—	—	X	—
	(c) McCulloh	X	—	—	X	—
	(d) RAT	X	—	—	X	—
16.	Special procedures	X	—	—	X	—
17.	Supervising station alarm systems — receivers*	X	—	—	X	—
18.	Public emergency alarm reporting system transmission equipment					
	(a) Publicly accessible alarm box	X	—	—	X	—
	(b) Auxiliary box	X	—	—	—	X
	(c) Master box					
	(1) Manual operation	X	—	—	X	—
	(2) Auxiliary operation	X	—	—	—	X

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TABLE 6.1.1 *Continued*

	Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually
19.	Mass notification system, supervised					
	(a) Control equipment					
	(1) Fuses	X	—	—	—	X
	(2) Interfaces	X	—	—	—	X
	(3) Lamps/LED	X	—	—	—	X
	(4) Primary (main) power supply	X	—	—	—	X
	(b) Secondary power batteries					
	(1) Lead-acid	X	—	—	—	X
	(2) Nickel-cadmium	X	—	—	—	X
	(3) Primary (dry-cell)	X	—	—	—	X
	(4) Sealed lead-acid	X	—	—	—	X
	(c) Initiating devices	X	—	—	—	X
	(d) Notification appliances	X	—	—	—	X
20.	Mass notification system, non-supervised systems installed prior to adoption of this edition					
	(a) Control equipment					
	(1) Fuses	X		—	X	—
	(2) Interfaces	X		—	X	—
	(3) Lamps/LED	X		—	X	—
	(4) Primary (main) power supply	X		—	X	—
	(b) Secondary power batteries					
	(1) Lead-acid	X		—	X	—
	(2) Nickel-cadmium	X		—	X	—
	(3) Primary (dry cell)	X		—	X	—
	(4) Sealed lead-acid	X		—	X	—
	(c) Initiating devices	X		—	X	—
	(d) Notification appliances	X		—	X	—
21.	Mass notification system Antenna	X	—	—	—	X
22.	Mass notification system Transceivers	X	—	—	—	X

*Reports of automatic signal receipt shall be verified daily.

Source: Table 14.3.1, *NFPA 72*, 2010 edition.

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TABLE 6.1.2 *Test Methods*

Device	Method
1. Control equipment	
(a) Functions	At a minimum, control equipment shall be tested to verify correct receipt of alarm, supervisory, and trouble signals (inputs); operation of evacuation signals and auxiliary functions (outputs); circuit supervision, including detection of open circuits and ground faults; and power supply supervision for detection of loss of ac power and disconnection of secondary batteries.
(b) Fuses	The rating and supervision shall be verified.
(c) Interfaced equipment	Integrity of single or multiple circuits providing interface between two or more control units shall be verified. Interfaced equipment connections shall be tested by operating or simulating operation of the equipment being supervised. Signals required to be transmitted shall be verified at the control unit.
(d) Lamps and LEDs	Lamps and LEDs shall be illuminated.
(e) Primary (main) power supply	All secondary (standby) power shall be disconnected and tested under maximum load, including all alarm appliances requiring simultaneous operation. All secondary (standby) power shall be reconnected at end of test. For redundant power supplies, each shall be tested separately.
2. Engine-driven generator	If an engine-driven generator dedicated to the system is used as a required power source, operation of the generator shall be verified in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems*, by the building owner.
3. Secondary (standby) power supply[a]	All primary (main) power supplies shall be disconnected, and the occurrence of required trouble indication for loss of primary power shall be verified. The system's standby and alarm current demand shall be measured or verified, and, using manufacturer's data, the ability of batteries to meet standby and alarm requirements shall be verified. General alarm systems shall be operated for a minimum of 5 minutes, and emergency voice communications systems for a minimum of 15 minutes. Primary (main) power supply shall be reconnected at end of test.
4. Uninterruptible power supply (UPS)	If a UPS system dedicated to the system is used as a required power source, operation of the UPS system shall be verified by the building owner in accordance with NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*.
5. Batteries — general tests	Prior to conducting any battery testing, the person conducting the test shall ensure that all system software stored in volatile memory is protected from loss.
(a) Visual inspection	Batteries shall be inspected for corrosion or leakage. Tightness of connections shall be checked and ensured. If necessary, battery terminals or connections shall be cleaned and coated. Electrolyte level in lead-acid batteries shall be visually inspected.
(b) Battery replacement	Batteries shall be replaced in accordance with the recommendations of the alarm equipment manufacturer or when the recharged battery voltage or current falls below the manufacturer's recommendations.
(c) Charger test	Operation of battery charger shall be checked in accordance with charger test for the specific type of battery.

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TABLE 6.1.2 *Continued*

	Device	Method
	(d) Discharge test	With the battery charger disconnected, the batteries shall be load tested following the manufacturer's recommendations. The voltage level shall not fall below the levels specified. *Exception: An artificial load equal to the full fire alarm load connected to the battery shall be permitted to be used in conducting this test.*
	(e) Load voltage test	With the battery charger disconnected, the terminal voltage shall be measured while supplying the maximum load required by its application. The voltage level shall not fall below the levels specified for the specific type of battery. If the voltage falls below the level specified, corrective action shall be taken and the batteries shall be retested. *Exception: An artificial load equal to the full fire alarm load connected to the battery shall be permitted to be used in conducting this test.*
6.	Battery tests (specific types)	
	(a) Primary battery load voltage test	The maximum load for a No. 6 primary battery shall not be more than 2 amperes per cell. An individual (1.5 volt) cell shall be replaced when a load of 1 ohm reduces the voltage below 1 volt. A 6 volt assembly shall be replaced when a test load of 4 ohms reduces the voltage below 4 volts.
	(b) Lead-acid type	
	(1) Charger test	With the batteries fully charged and connected to the charger, the voltage across the batteries shall be measured with a voltmeter. The voltage shall be 2.30 volts per cell ±0.02 volts at 77°F (25°C) or as specified by the equipment manufacturer.
	(2) Load voltage test	Under load, the battery shall not fall below 2.05 volts per cell.
	(3) Specific gravity	The specific gravity of the liquid in the pilot cell or all of the cells shall be measured as required. The specific gravity shall be within the range specified by the manufacturer. Although the specified specific gravity varies from manufacturer to manufacturer, a range of 1.205–1.220 is typical for regular lead-acid batteries, while 1.240–1.260 is typical for high-performance batteries. A hydrometer that shows only a pass or fail condition of the battery and does not indicate the specific gravity shall not be used, because such a reading does not give a true indication of the battery condition.
	(c) Nickel-cadmium type	
	(1) Charger test[b]	With the batteries fully charged and connected to the charger, an ampere meter shall be placed in series with the battery under charge. The charging current shall be in accordance with the manufacturer's recommendations for the type of battery used. In the absence of specific information, 1/30 to 1/25 of the battery rating shall be used.
	(2) Load voltage test	Under load, the float voltage for the entire battery shall be 1.42 volts per cell, nominal. If possible, cells shall be measured individually.
	(d) Sealed lead-acid type	
	(1) Charger test	With the batteries fully charged and connected to the charger, the voltage across the batteries shall be measured with a voltmeter. The

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TABLE 6.1.2 *Continued*

	Device	Method
		voltage shall be 2.30 volts per cell ±0.02 volts at 77°C (25°C) or as specified by the equipment manufacturer.
	(2) Load voltage test	Under load, the battery shall perform in accordance with the battery manufacturer's specifications.
7.	Public emergency alarm reporting system power supply	
	(a) Lead-acid type	Perform the battery tests in accordance with item 6(b)
	(b) Nickel-cadmium type	Perform the battery tests in accordance with item 6(c)
	(c) Sealed lead-acid type	Perform the battery tests in accordance with item 6(d)
	(d) Wired system	Manual tests of the power supply for public reporting circuits shall be made and recorded at least once during each 24-hour period. Such tests shall include the following: (1) Current strength of each circuit. Changes in current of any circuit exceeding 10 percent shall be investigated immediately. (2) Voltage across terminals of each circuit inside of terminals of protective devices. Changes in voltage of any circuit exceeding 10 percent shall be investigated immediately. (3)[c] Voltage between ground and circuits. If this test shows a reading in excess of 50 percent of that shown in the test specified in (2), the trouble shall be immediately located and cleared. Readings in excess of 25 percent shall be given early attention. These readings shall be taken with a calibrated voltmeter of not more than 100 ohms resistance per volt. Systems in which each circuit is supplied by an independent current source require tests between ground and each side of each circuit. Common current source systems require voltage tests between ground and each terminal of each battery and other current source. (4) Ground current reading shall be permitted in lieu of (3). If this method of testing is used, all grounds showing a current reading in excess of 5 percent of the supplied line current shall be given immediate attention. (5) Voltage across terminals of common battery, on switchboard side of fuses. (6) Voltage between common battery terminals and ground. Abnormal ground readings shall be investigated immediately. Tests specified in (5) and (6) shall apply only to those systems using a common battery. If more than one common battery is used, each common battery shall be tested.
8.	Public emergency alarm reporting system transmission equipment	
	(a) Publicly accessible alarm box	Publicly accessible initiating device(s) shall be actuated. Receipt of not less than three complete rounds of signal impulses shall be verified. This test shall be performed under normal circuit conditions. If the device is equipped for open circuit operation (ground return), it shall be tested in this condition as one of the semiannual tests.
	(b) Auxiliary box	Each initiating circuit of the auxiliary box shall be tested by actuation of a protected premises initiating device connected to that circuit. Receipt of not less than three complete rounds of signal impulses shall be verified.

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TABLE 6.1.2 *Continued*

	Device	Method
	(c) Master box	
	(1) Manual operation	Perform the tests prescribed for 8(a).
	(2) Auxiliary operation	Perform the tests prescribed for 8(b).
9.	Transient suppressors	Lightning protection equipment shall be inspected and maintained per the manufacturer's published instructions. Additional inspections shall be required after any lightning strikes. Equipment located in moderate to severe areas outlined in NFPA 780, *Standard for the Installation of Lightning Protection Systems*, Annex L, shall be inspected semiannually and after any lightning strikes.
10.	Fire alarm control unit trouble signals	
	(a) Audible and visual	Operation of control unit trouble signals shall be verified, as well as ring-back feature for systems using a trouble-silencing switch that requires resetting.
	(b) Disconnect switches	If control unit has disconnect or isolating switches, performance of intended function of each switch shall be verified and receipt of trouble signal when a supervised function is disconnected shall also be verified.
	(c) Ground-fault monitoring circuit	If the system has a ground detection feature, the occurrence of ground-fault indication shall be verified whenever any installation conductor is grounded.
	(d) Transmission of signals to off-premises location	An initiating device shall be actuated and receipt of alarm signal at the off-premises location shall be verified. A trouble condition shall be created and receipt of a trouble signal at the off-premises location shall be verified. A supervisory device shall be actuated and receipt of a supervisory signal at the off-premises location shall be verified. If a transmission carrier is capable of operation under a single- or multiple-fault condition, an initiating device shall be activated during such fault condition and receipt of a trouble signal at the off-premises location shall be verified, in addition to the alarm signal.
11.	Remote annunciators	The correct operation and identification of annunciators shall be verified. If provided, the correct operation of annunciator under a fault condition shall be verified.
12.	Conductors — metallic	
	(a) Stray voltage	All installation conductors shall be tested with a volt/ohmmeter to verify that there are no stray (unwanted) voltages between installation conductors or between installation conductors and ground. Unless a different threshold is specified in the published manufacturer's instructions for the installed equipment, the maximum allowable stray voltage shall not exceed 1 volt ac/dc.
	(b) Ground faults	All installation conductors, other than those intentionally and permanently grounded, shall be tested for isolation from ground per the installed equipment manufacturer's published instructions.

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TABLE 6.1.2 *Continued*

	Device	Method
	(c) Short-circuit faults	All installation conductors, other than those intentionally connected together, shall be tested for conductor-to-conductor isolation per the published manufacturer's instructions for the installed equipment. These same circuits also shall be tested conductor-to-ground.
	(d) Loop resistance	With each initiating and indicating circuit installation conductor pair short-circuited at the far end, the resistance of each circuit shall be measured and recorded. It shall be verified that the loop resistance does not exceed the limits specified in the published manufacturer's instructions for the installed equipment.
	(e) Supervision	Introduction of a fault in any circuit monitored for integrity shall result in a trouble indication at the fire alarm control unit. One connection shall be opened at not less than 10 percent of the initiating devices, notification appliances and controlled devices on every initiating device circuit, notification appliance circuit, and signaling line circuit.
13.	Conductors — nonmetallic	
	(a) Circuit integrity	Each initiating device, notification appliance, and signaling line circuit shall be tested to confirm that the installation conductors are monitored for integrity in accordance with the requirements of Chapters 10 and 23 [of *NFPA 72*].
	(b) Fiber optics	The fiber-optic transmission line shall be tested in accordance with the manufacturer's published instructions by the use of an optical power meter or by an optical time domain reflectometer used to measure the relative power loss of the line. This relative figure for each fiber-optic line shall be recorded in the fire alarm control unit. If the power level drops 2 percent or more from the value recorded during the initial acceptance test, the transmission line, section thereof, or connectors shall be repaired or replaced by a qualified technician to bring the line back into compliance with the accepted transmission level per the manufacturer's published instructions.
	(c) Supervision	Introduction of a fault in any supervised circuit shall result in a trouble indication at the control unit. One connection shall be opened at not less than 10 percent of the initiating device, notification appliance, and signaling line circuit. Each initiating device, notification appliance, and signaling line circuit shall be tested for correct indication at the control unit. All circuits shall perform as indicated in 23.5.2, 23.5.3, 23.6.2 through 23.6.5, 23.7.2 and 23.7.3 [of *NFPA 72*].
14.	Initiating devices	
	(a) Electromechanical releasing device	
	(1) Nonrestorable-type link	Correct operation shall be verified by removal of the fusible link and operation of the associated device. Any moving parts shall be lubricated as necessary.
	(2) Restorable-type link[d]	Correct operation shall be verified by removal of the fusible link and operation of the associated device. Any moving parts shall be lubricated as necessary.

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TABLE 6.1.2 *Continued*

Device	Method
(b) Fire extinguishing system(s) or suppression system(s) alarm switch	The switch shall be mechanically or electrically operated and receipt of signal by the fire alarm control unit shall be verified.
(c) Fire–gas and other detectors	Fire–gas detectors and other fire detectors shall be tested as prescribed by the manufacturer and as necessary for the application.
(d) Heat detectors	
(1) Fixed-temperature, rate-of-rise, rate of compensation, restorable line, spot type (excluding pneumatic tube type)	Heat test shall be performed with a heat source per the manufacturer's published instructions. A test method shall be used that is specified in the manufacturer's published instructions for the installed equipment, or other method shall be used that will not damage the nonrestorable fixed-temperature element of a combination rate-of-rise/fixed-temperature element detector.
(2) Fixed-temperature, nonrestorable line type	Heat test shall not be performed. Functionality shall be tested mechanically and electrically. Loop resistance shall be measured and recorded. Changes from acceptance test shall be investigated.
(3) Fixed-temperature, nonrestorable spot type	After 15 years from initial installation, all devices shall be replaced or 2 detectors per 100 shall be laboratory tested. The 2 detectors shall be replaced with new devices. If a failure occurs on any of the detectors removed, additional detectors shall be removed and tested to determine either a general problem involving faulty detectors or a localized problem involving 1 or 2 defective detectors. If detectors are tested instead of replaced, tests shall be repeated at intervals of 5 years.
(4) Nonrestorable (general)	Heat tests shall not be performed. Functionality shall be tested mechanically and electrically.
(5) Restorable line type, pneumatic tube only	Heat tests shall be performed (where test chambers are in circuit), or a test with pressure pump shall be conducted.
(6) Single- and multiple-station heat alarms	Functional tests shall be conducted according to manufacturer's published instructions. Nonrestorable heat detectors shall not be tested with heat.
(e) Manual fire alarm boxes	Manual fire alarm boxes shall be operated per the manufacturer's published instructions. Key-operated presignal and general alarm manual fire alarm boxes shall both be tested.
(f) Radiant energy fire detectors	Flame detectors and spark/ember detectors shall be tested in accordance with the manufacturer's published instructions to determine that each detector is operative. Flame detector and spark/ember detector sensitivity shall be determined using any of the following: (1) Calibrated test method (2) Manufacturer's calibrated sensitivity test instrument (3) Listed control unit arranged for the purpose (4) Other approved calibrated sensitivity test method that is directly proportional to the input signal from a fire, consistent with the detector listing or approval If designed to be field adjustable, detectors found to be outside of the approved range of sensitivity shall be replaced or adjusted to bring them into the approved range.

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TABLE 6.1.2 *Continued*

Device	Method
	Flame detector and spark/ember detector sensitivity shall not be determined using a light source that administers an unmeasured quantity of radiation at an undefined distance from the detector.
(g) Smoke detectors	
(1) In other than one- and two-family dwellings, system detectors and single- or multiple-station smoke alarms	[e]Smoke detectors/smoke alarms shall be tested in place to ensure smoke entry into the sensing chamber and an alarm response. Testing with smoke or listed aerosol, acceptable to the manufacturer of the aerosol or the manufacturer of the smoke detector/smoke alarm and identified in their published instructions, shall be permitted as acceptable test methods. Other methods listed in the manufacturer's published instructions that ensure smoke entry from the protected area, through the vents, into the sensing chamber shall be permitted. Any of the following tests shall be performed to ensure that each smoke detector is within its listed and marked sensitivity range: (1) Calibrated test method (2) Manufacturer's calibrated sensitivity test instrument (3) Listed control equipment arranged for the purpose (4) Smoke detector/control unit arrangement whereby the detector causes a signal at the control unit when its sensitivity is outside its listed sensitivity range (5) Other calibrated sensitivity test method approved by the authority having jurisdiction
(2) Smoke/carbon monoxide alarms in other than one- and two-family dwellings.	The smoke alarms shall be tested in place to ensure smoke entry into the sensing chamber and an alarm response. Testing with real smoke or listed simulated aerosol or listed smoke particulate approved by the manufacturer shall be permitted as acceptable test methods. Other methods listed in the manufacturer's published instructions that ensure smoke entry from the protected area, through the vents, into the sensing chamber shall be permitted. Any of the following tests shall be performed to ensure that each smoke alarm is within its listed and marked sensitivity range: (1) Calibrated test method (2) Manufacturer's calibrated sensitivity test instrument (3) Other calibrated sensitivity test method approved by the authority having jurisdiction The carbon monoxide alarm shall be tested in accordance with NFPA 720.
(3) Single-and multiple-station smoke alarms connected to protected premises systems	A functional test shall be performed on all single-and-multiple station smoke alarms connected to a protected premises fire alarm system by putting the smoke alarm into an alarm condition and verifying that the protected premises system receives a supervisory signal and does not cause a fire alarm signal.
(4) Single- and multiple-station smoke alarms and system smoke detectors used in one- and two-family dwellings	Functional tests shall be conducted according to manufacturer's published instructions.
(5) Air sampling	Per test methods documented in the manufacturer's published instructions, detector alarm response shall be verified through the end sampling port on each pipe run; airflow through all other ports shall be verified as well.

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TABLE 6.1.2 *Continued*

Device	Method
(6) Duct type	In addition to the testing required in Table 6.1.2(14)(g)(1), duct smoke detectors utilizing sampling tubes shall be tested by verifying the correct pressure differential (within the manufacturer's published ranges) between the inlet and exhaust tubes using a method acceptable to the manufacturer to ensure that the device will properly sample the airstream. These tests shall be made in accordance with the manufacturer's published instructions for the device installed.
(7) Projected beam type	The detector shall be tested by introducing smoke, other aerosol, or an optical filter into the beam path.
(8) Smoke detector with built-in thermal element	Both portions of the detector shall be operated independently as described for the respective devices.
(9) Smoke detectors with control output functions	It shall be verified that the control capability shall remain operable even if all of the initiating devices connected to the same initiating device circuit or signaling line circuit are in an alarm state.
(h) Carbon monoxide detectors/ carbon monoxide alarms for the purposes of fire detection	The devices shall be tested in place to ensure CO entry to the sensing chamber by introduction of CO gas from the protected area, through the vents, to the sensing chamber.
(i) Initiating devices, supervisory	
(1) Control valve switch	Valve shall be operated and signal receipt shall be verified to be within the first two revolutions of the handwheel or within one-fifth of the travel distance, or per the manufacturer's published instructions.
(2) High- or low-air pressure switch	Switch shall be operated. Receipt of signal obtained where the required pressure is increased or decreased a maximum 10 psi (70 kPa) from the required pressure level shall be verified.
(3) Room temperature switch	Switch shall be operated. Receipt of signal to indicate the decrease in room temperature to 40°F (4.4°C) and its restoration to above 40°F (4.4°C) shall be verified.
(4) Water level switch	Switch shall be operated. Receipt of signal indicating the water level raised or lowered a maximum 3 in. (70 mm) from the required level within a pressure tank, or a maximum 12 in. (300 mm) from the required level of a nonpressure tank, shall be verified, as shall its restoral to required level.
(5) Water temperature switch	Switch shall be operated. Receipt of signal to indicate the decrease in water temperature to 40°F (4.4°C) and its restoration to above 40°F (4.4°C) shall be verified.
(j) Mechanical, electrosonic, or pressure-type waterflow device	Water shall be flowed through an inspector's test connection indicating the flow of water equal to that from a single sprinkler of the smallest orifice size installed in the system for wet-pipe systems, or an alarm test bypass connection for dry-pipe, pre-action, or deluge systems in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.
(k) Multi-sensor fire detector or multi-criteria fire detector or combination fire detector	(1) Each of the detection principles present within the detector (e.g. smoke/heat/CO, etc.) shall be tested independently for the specific detection principle, regardless of the configuration status at the time of testing. Each detector shall also be tested in accordance with the published manufacturer's instructions.

(continues)

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TABLE 6.1.2 *Continued*

	Device	Method
		(2) Individual sensors shall be tested together if the technology allows individual sensor responses to be verified. (3) Tests shall be performed as described for the respective devices by introduction of the physical phenomena to the sensing chamber of element, and an electronic check (magnets, analogue values, etc.) is not sufficient to comply with this requirement. (4) The result of each sensor test shall be confirmed. This shall be through indication at the detector or control unit. (5) Where individual sensors cannot be tested individually, the primary sensor shall be tested[f] (6) All tests and results shall be recorded.
15.	Alarm notification appliances	
	(a) Audible	(1) Initial and reacceptance testing shall comply with the following: Sound pressure levels for signals shall be measured with a sound level meter meeting ANSI S1.4a, *Specifications for Sound Level Meters,* Type 2 requirements. Sound pressure levels throughout the protected area shall be measured to confirm that they are in compliance with Chapter 18 [of *NFPA 72*]. The sound level meter shall be set in accordance with ANSI S3.41, *American National Standard Audible Evacuation Signal,* using the time-weighted characteristic F (FAST). (2) Periodic testing shall comply with the following: Sound pressure levels for signals shall be measured with a sound level meter meeting ANSI S1.4a, *Specifications for Sound Level Meters,* Type 2 requirements. Sound pressure levels shall be measured for conformity to Chapter 18 [of *NFPA 72*] where building, system, or occupancy changes have occurred. The sound level meter shall be set in accordance with ANSI S3.41, *American National Standard Audible Evacuation Signal,* using the time-weighted characteristic F (FAST).
	(b) Audible textual notification appliances (speakers and other appliances to convey voice messages)	(1) Initial and reacceptance testing shall comply with the following: Sound pressure levels for signals shall be measured with a sound level meter meeting ANSI S1.4a, *Specifications for Sound Level Meters,* Type 2 requirements. Sound pressure levels throughout the protected area shall be measured to confirm that they are in compliance with Chapter 18 [of *NFPA 72*]. The sound level meter shall be set in accordance with ANSI S3.41, *American National Standard Audible Evacuation Signal,* using the time-weighted characteristic F (FAST). Audible information shall be verified to be distinguishable and understandable and shall comply with 14.4.13 [of *NFPA 72*]. (2) Periodic testing shall comply with the following: Sound pressure levels for signals shall be measured with a sound level meter meeting ANSI S1.4a, *Specifications for Sound Level Meters,* Type 2 requirements. Sound pressure levels shall be measured for conformity to Chapter 18 [of *NFPA 72*] where building, system, or occupancy changes have occurred. The sound level meter shall be set in accordance with ANSI S3.41, *American National Standard Audible Evacuation Signal,* using the time-weighted characteristic F (FAST). Audible information shall be verified to be distinguishable and understandable and shall comply with 14.4.13 [of *NFPA 72*] where building, system, or occupancy changes have occurred.

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TABLE 6.1.2 *Continued*

	Device	Method
	(c) Visible	Test shall be performed in accordance with the manufacturer's published instructions. Appliance locations shall be verified to be per approved layout, and it shall be confirmed that no floor plan changes affect the approved layout. It shall be verified that the candela rating marking agrees with the approved drawing. It shall be confirmed that each appliance flashes.
16.	Exit marking audible notification appliance	Tests shall be performed in accordance with manufacturer's published instructions.
17.	Special hazard equipment	
	(a) Abort switch (dead-man type)	Abort switch shall be operated. Correct sequence and operation shall be verified.
	(b) Abort switch (recycle type)	Abort switch shall be operated. Development of correct matrix with each sensor operated shall be verified.
	(c) Abort switch (special type)	Abort switch shall be operated. Correct sequence and operation in accordance with authority having jurisdiction shall be verified. Sequencing on as-built drawings or in system owner's manual shall be observed.
	(d) Cross-zone detection circuit	One sensor or detector on each zone shall be operated. Occurrence of correct sequence with operation of first zone and then with operation of second zone shall be verified.
	(e) Matrix-type circuit	All sensors in system shall be operated. Development of correct matrix with each sensor operated shall be verified.
	(f) Release solenoid circuit	Solenoid shall be used with equal current requirements. Operation of solenoid shall be verified.
	(g) Squibb release circuit	AGI flashbulb or other test light approved by the manufacturer shall be used. Operation of flashbulb or light shall be verified.
	(h) Verified, sequential, or counting zone circuit	Required sensors at a minimum of four locations in circuit shall be operated. Correct sequence with both the first and second detector in alarm shall be verified.
	(i) All above devices or circuits or combinations thereof	Supervision of circuits shall be verified by creating an open circuit.
18.	Supervising station alarm systems — transmission equipment[g]	
	(a) All equipment	Test shall be performed on all system functions and features in accordance with the equipment manufacturer's published instructions for correct operation in conformance with the applicable sections of Chapter 26 [of *NFPA 72*]. Initiating device shall be actuated. Receipt of the correct initiating device signal at the supervising station within 90 seconds shall be verified. Upon completion of the test, the system shall be restored to its functional operating condition. If test jacks are used, the first and last tests shall be made without the use of the test jack.
	(b) Digital alarm communicator transmitter (DACT)	Connection of the DACT to two separate means of transmission shall be ensured.

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TABLE 6.1.2 *Continued*

Device	Method
	Exception: DACTs that are connected to a telephone line (number) that is also supervised for adverse conditions by a derived local channel.
	DACT shall be tested for line seizure capability by initiating a signal while using the primary line for a telephone call. Receipt of the correct signal at the supervising station shall be verified. Completion of the transmission attempt within 90 seconds from going off-hook to on-hook shall be verified.
	The primary line from the DACT shall be disconnected. Indication of the DACT trouble signal at the premises shall be verified, as well as transmission to the supervising station within 4 minutes of detection of the fault.
	The secondary means of transmission from the DACT shall be disconnected. Indication of the DACT trouble signal at the premises shall be verified as well as transmission to the supervising station within 4 minutes of detection of the fault.
	The DACT shall be caused to transmit a signal to the DACR while a fault in the primary telephone number is simulated. Utilization of the secondary telephone number by the DACT to complete the transmission to the DACR shall be verified.
(c) Digital alarm radio transmitter (DART)	The primary telephone line shall be disconnected. Transmission of a trouble signal to the supervising station by the DART within 4 minutes shall be verified.
(d) McCulloh transmitter	Initiating device shall be actuated. Production of not less than three complete rounds of not less than three signal impulses each by the McCulloh transmitter shall be verified.
	If end-to-end metallic continuity is present and with a balanced circuit, each of the following four transmission channel fault conditions shall be caused in turn, and receipt of correct signals at the supervising station shall be verified: (1) Open (2) Ground (3) Wire-to-wire short (4) Open and ground
	If end-to-end metallic continuity is not present and with a properly balanced circuit, each of the following three transmission channel fault conditions shall be caused in turn, and receipt of correct signals at the supervising station shall be verified: (1) Open (2) Ground (3) Wire-to-wire short
(e) Radio alarm transmitter (RAT)	A fault between elements of the transmitting equipment shall be caused. Indication of the fault at the protected premises shall be verified, or it shall be verified that a trouble signal is transmitted to the supervising station.

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TABLE 6.1.2 *Continued*

	Device	Method
19.	Supervising station alarm systems — receiving equipment	
	(a) All equipment	Tests shall be performed on all system functions and features in accordance with the equipment manufacturer's published instructions for correct operation in conformance with the applicable sections of Chapter 26 [of *NFPA 72*].
		Initiating device shall be actuated. Receipt of the correct initiating device signal at the supervising station within 90 seconds shall be verified. Upon completion of the test, the system shall be restored to its functional operating condition.
		If test jacks are used, the first and last tests shall be made without the use of the test jack.
	(b) Digital alarm communicator receiver (DACR)	Each telephone line (number) shall be disconnected in turn from the DACR, and audible and visual annunciation of a trouble signal in the supervising station shall be verified.
		A signal shall be caused to be transmitted on each individual incoming DACR line at least once every 24 hours. Receipt of these signals shall be verified.
	(c) Digital alarm radio receiver (DARR)	The following conditions of all DARRs on all subsidiary and repeater station receiving equipment shall be caused. Receipt at the supervising station of correct signals for each of the following conditions shall be verified:
		(1) AC power failure of the radio equipment
		(2) Receiver malfunction
		(3) Antenna and interconnecting cable failure
		(4) Indication of automatic switchover of the DARR
		(5) Data transmission line failure between the DARR and the supervising or subsidiary station
	(d) McCulloh systems	The current on each circuit at each supervising and subsidiary station under the following conditions shall be tested and recorded:
		(1) During functional operation
		(2) On each side of the circuit with the receiving equipment conditioned for an open circuit
		A single break or ground condition shall be caused on each transmission channel. If such a fault prevents the functioning of the circuit, receipt of a trouble signal shall be verified.
		Each of the following conditions at each of the supervising or subsidiary stations and all repeater station radio transmitting and receiving equipment shall be caused; receipt of correct signals at the supervising station shall be verified:
		(1) RF transmitter in use (radiating)
		(2) AC power failure supplying the radio equipment
		(3) RF receiver malfunction
		(4) Indication of automatic switchover

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TABLE 6.1.2 *Continued*

	Device	Method
	(e) Radio alarm supervising station receiver (RASSR) and radio alarm repeater station receiver (RARSR)	Each of the following conditions at each of the supervising or subsidiary stations and all repeater station radio transmitting and receiving equipment shall be caused; receipt of correct signals at the supervising station shall be verified: (1) AC power failure supplying the radio equipment (2) RF receiver malfunction (3) Indication of automatic switchover, if applicable
	(f) Private microwave radio systems	Each of the following conditions at each of the supervising or subsidiary stations and all repeater station radio transmitting and receiving equipment shall be caused; receipt of correct signals at the supervising station shall be verified: (1) RF transmitter in use (radiating) (2) AC power failure supplying the radio equipment (3) RF receiver malfunction (4) Indication of automatic switchover
20.	Emergency communications equipment	
	(a) Amplifier/tone generators	Correct switching and operation of backup equipment shall be verified.
	(b) Call-in signal silence	Function shall be operated and receipt of correct visual and audible signals at control unit shall be verified.
	(c) Off-hook indicator (ring down)	Phone set shall be installed or phone shall be removed from hook and receipt of signal at control unit shall be verified.
	(d) Phone jacks	Phone jack shall be visually inspected and communications path through jack shall be initiated.
	(e) Phone set	Each phone set shall be activated and correct operation shall be verified.
	(f) System performance	System shall be operated with a minimum of any five handsets simultaneously. Voice quality and clarity shall be verified.
21.	Combination systems	
	(a) Fire extinguisher electronic monitoring device/system	Communication between the device connecting the fire extinguisher electronic monitoring device/system and the fire alarm control unit shall be tested to ensure proper signals are received at the fire alarm control unit and remote annunciator(s) if applicable.
22.	Interface equipment	Interface equipment connections shall be tested by operating or simulating the equipment being supervised. Signals required to be transmitted shall be verified at the control unit. Test frequency for interface equipment shall be the same as the frequency required by the applicable NFPA standard(s) for the equipment being supervised.
23.	Emergency control functions[h]	Emergency control functions (i.e., fan control, smoke damper operation, elevator recall, elevator power shutdown, door holder release, shutter release, door unlocking, etc.) shall be tested by operating or simulating alarm signals. Testing frequency for emergency control functions shall be the same as the frequency required for the initiating device that activates the emergency control function.
24.	Guard's tour equipment	The device shall be tested in accordance with the manufacturer's published instructions.

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TABLE 6.1.2 *Continued*

	Device	Method
25.	Special procedures	
	(a) Alarm verification	Time delay and alarm response for smoke detector circuits identified as having alarm verification shall be verified.
	(b) Multiplex systems	Communications between sending and receiving units under both primary and secondary power shall be verified. Communications between sending and receiving units under open circuit and short circuit trouble conditions shall be verified. Communications between sending and receiving units in all directions where multiple communications pathways are provided shall be verified. If redundant central control equipment is provided, switchover and all required functions and operations of secondary control equipment shall be verified. All system functions and features shall be verified in accordance with manufacturer's published instructions.
26.	Low-power radio (wireless systems)	The following procedures describe additional acceptance and reacceptance test methods to verify wireless protection system operation: (1) The manufacturer's published instructions and the as-built drawings provided by the system supplier shall be used to verify correct operation after the initial testing phase has been performed by the supplier or by the supplier's designated representative. (2) Starting from the functional operating condition, the system shall be initialized in accordance with the manufacturer's published instructions. A test shall be conducted to verify the alternative path, or paths, by turning off or disconnecting the primary wireless repeater. The alternative communications path shall exist between the wireless control unit and peripheral devices used to establish initiation, indication, control, and annunciation. The system shall be tested for both alarm and trouble conditions. (3) Batteries for all components in the system shall be checked monthly. If the control unit checks all batteries and all components daily, the system shall not require monthly testing of the batteries.
27.	Mass notification systems	
	(a) Functions	At a minimum, control equipment shall be tested to verify correct receipt of alarm, supervisory, and trouble signals (inputs); operation of evacuation signals and auxiliary functions (outputs); circuit supervision, including detection of open circuits and ground faults; and power supply supervision for detection of loss of ac power and disconnection of secondary batteries.
	(b) Fuses	The rating and supervision shall be verified.
	(c) Interfaced equipment	Integrity of single or multiple circuits providing interface between two or more control units shall be verified. Interfaced equipment connections shall be tested by operating or simulating operation of the equipment being supervised. Signals required to be transmitted shall be verified at the control unit.
	(d) Lamps and LEDs	Lamps and LEDs shall be illuminated.
	(e) Primary (main) power supply	All secondary (standby) power shall be disconnected and tested under maximum load, including all alarm appliances requiring simultaneous operation. All secondary (standby) power shall be reconnected at end of test. For redundant power supplies, each shall be tested separately.

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TABLE 6.1.2 *Continued*

Device	Method
(f) Audible textual notification appliances (speakers and other appliances to convey voice messages)	Sound pressure level shall be measured with a sound level meter meeting ANSI S1.2a, *Specifications for Sound Level Meters,* Type 2 requirements. Levels throughout protected area shall be measured and recorded. The sound level meter shall be set in accordance with ANSI S3.41, *American National Standard Audible Evacuation Signal,* using the time-weighted characteristic F (FAST). The maximum output shall be recorded when the audible emergency evacuation signal is on. Audible information shall be verified to be distinguishable and understandable.
(g) Visible	Test shall be performed in accordance with manufacturer's published instructions. Appliance locations shall be verified to be per approved layout, and it shall be confirmed that no floor plan changes affect the approved layout. It shall be verified that the candela rating marking agrees with the approved drawing. It shall be confirmed that each appliance flashes.
(h) Control unit functions and no diagnostic failures are indicated	Review event log file, verify that the correct events were logged. Review system diagnostic log file; correct deficiencies noted in file. Delete unneeded log files. Delete unneeded error files. Verify that sufficient free disk space is available. Verify unobstructed flow of cooling air is available. Change/ clean filters, cooling fans, and intake vents.
(i) Control unit reset	Power down the central control unit computer and restart it.
(j) Control unit security	If remote control software is loaded onto the system, verify that it is disabled to prevent unauthorized system access.
(k) Audible/visible functional test	Send out an alert to a diverse set of predesignated receiving devices and confirm receipt. Include at least one of each type of receiving device.
(l) Software backup	Make full system software backup. Rotate backups based on accepted practice at site.
(m) Secondary power test	Disconnect ac power. Verify the ac power failure alarm status on central control equipment. With ac power disconnected, verify battery voltage under load.
(n) Wireless signals	Check forward/reflected radio power is within specifications.
(o) Antenna	Check forward/reflected radio power is within specifications. Verify solid electrical connections with no observable corrosion.
(p) Transceivers	Verify proper operation and mounting is not compromised.

[a]See A.14.4.2.2 [of *NFPA 72*].

[b]Example: 4000 mAh × 1/25 = 160 mA charging current at 77°F (25°C).

[c]The voltmeter sensitivity has been changed from 1000 ohms per volt to 100 ohms per volt so that false ground readings (caused by induced voltages) are minimized.

[d]Fusible thermal link detectors are commonly used to close fire doors and fire dampers. They are actuated by the presence of external heat, which causes a solder element in the link to fuse, or by an electric thermal device, which, when energized, generates heat within the body of the link, causing the link to fuse and separate.

[e]Note, it is customary for the manufacturer of the smoke detector/smoke alarm to test a particular product from an aerosol provider to determine acceptability for use in smoke entry testing of their smoke detector/ smoke alarm.

[f]For example, it might not be possible to individually test the heat sensor in a thermally enhanced smoke detector.

[g]See A.14.4.2.2 [of *NFPA 72*].

[h]See A.14.4.2.2 [of *NFPA 72*].

Source: Table 14.4.2.2, *NFPA 72*, 2010 edition.

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TABLE 6.1.3 *Testing Frequencies*

	Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually	Table 6.1.2 Reference
1.	Control equipment — building systems connected to supervising station						1, 7, 18, 19
	(a) Functions	X	—	—	—	X	—
	(b) Fuses	X	—	—	—	X	—
	(c) Interfaced equipment	X	—	—	—	X	—
	(d) Lamps and LEDs	X	—	—	—	X	—
	(e) Primary (main) power supply	X	—	—	—	X	—
	(f) Transponders	X	—	—	—	X	—
2.	Control equipment — building systems not connected to a supervising station						1
	(a) Functions	X	—	X	—	—	—
	(b) Fuses	X	—	X	—	—	—
	(c) Interfaced equipment	X	—	X	—	—	—
	(d) Lamps and LEDs	X	—	X	—	—	—
	(e) Primary (main) power supply	X	—	X	—	—	—
	(f) Transponders	X	—	X	—	—	—
3.	Engine-driven generator — central station facilities and fire alarm systems	X	X	—	—	—	—
4.	Engine-driven generator — public emergency alarm reporting systems	X (weekly)	—	—	—	—	—
5.	Batteries — central station facilities						
	(a) Lead-acid type						6b
	(1) Charger test (Replace battery as needed.)	X	—	—	—	X	—
	(2) Discharge test (30 minutes)	X	X	—	—	—	—
	(3) Load voltage test	X	X	—	—	—	—
	(4) Specific gravity	X	—	—	X	—	—
	(b) Nickel-cadmium type						6c
	(1) Charger test (Replace battery as needed.)	X	—	X	—	—	—

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TABLE 6.1.3 *Continued*

Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually	Table 6.1.2 Reference
(2) Discharge test (30 minutes)	X	—	—	—	X	—
(3) Load voltage test	X	—	—	—	X	—
(c) Sealed lead-acid type						6d
(1) Charger test (Replace battery within 5 years after manufacture or more frequently as needed.)	X	X	X	—	—	—
(2) Discharge test (30 minutes)	X	X	—	—	—	—
(3) Load voltage test	X	X	—	—	—	—
6. Batteries — fire alarm systems						
(a) Lead-acid type						6b
(1) Charger test (Replace battery as needed.)	X	—	—	—	X	—
(2) Discharge test (30 minutes)	X	—	—	X	—	—
(3) Load voltage test	X	—	—	X	—	—
(4) Specific gravity	X	—	—	X	—	—
(b) Nickel-cadmium type						6c
(1) Charger test (Replace battery as needed.)	X	—	—	—	X	—
(2) Discharge test (30 minutes)	X	—	—	—	X	—
(3) Load voltage test	X	—	—	X	—	—
(c) Primary type (dry cell)						6a
(1) Age test	X	X	—	—	—	—
(d) Sealed lead-acid type						6d
(1) Charger test (Replace battery within 5 years after manufacture or more frequently as needed.)	X	—	—	—	X	—
(2) Discharge test (30 minutes)	X	—	—	—	X	—
(3) Load voltage test	X	—	—	X	—	—

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TABLE 6.1.3 *Continued*

	Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually	Table 6.1.2 Reference
7.	Power supply — public emergency alarm reporting systems						
	(a) Lead-acid type batteries						6b
	(1) Charger test (Replace battery as needed.)	X	—	—	—	X	—
	(2) Discharge test (2 hours)	X	—	X	—	—	—
	(3) Load voltage test	X	—	X	—	—	—
	(4) Specific gravity	X	—	—	X	—	—
	(b) Nickel-cadmium type batteries						6c
	(1) Charger test (Replace battery as needed.)	X	—	—	—	X	—
	(2) Discharge test (2 hours)	X	—	—	—	X	—
	(3) Load voltage test	X	—	X	—	—	—
	(c) Sealed lead-acid type batteries						6d
	(1) Charger test (Replace battery within 5 years after manufacture or more frequently if needed	X	—	—	—	X	—
	(2) Discharge test (2 hours)	X	—	—	—	X	—
	(3) Load voltage test	X	—	X	—	—	—
	(d) Wired system — voltage tests	X (daily)	—	—	—	—	7d
8.	Fiber-optic cable power	X	—	—	—	X	13b
9.	Control unit trouble signals	X	—	—	—	X	10
10.	Conductors — metallic	X	—	—	—	—	12
11.	Conductors — nonmetallic	X	—	—	—	—	13
12.	In-building fire emergency voice/alarm communications equipment	X	—	—	—	X	20

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TABLE 6.1.3 *Continued*

	Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually	Table 6.1.2 Reference
13.	Retransmission Equipment (The requirements of 14.4.10 [of *NFPA 72*] shall apply.)	X	—	—	—	—	—
14.	Remote Annunciators	X	—	—	—	X	11
15.	Initiating Devices*						14
	(a) Duct detectors	X	—	—	—	X	—
	(b) Electromechanical releasing device	X	—	—	—	X	—
	(c) Fire extinguishing system(s) or suppression system(s) switches	X	—	—	—	X	—
	(d) Fire, gas and other detectors	X	—	—	—	X	—
	(e) Heat detectors (The requirements of 14.4.5.5 [of *NFPA 72*] shall apply.)	X	—	—	—	X	—
	(f) Manual fire alarm boxes	X	—	—	—	X	—
	(g) Radiant energy fire detectors	X	—	—	X	—	—
	(h) System smoke detectors — functional test	X	—	—	—	X	—
	(i) Smoke detectors — sensitivity testing in other than one- and two-family dwellings (The requirements of 14.4.5.3 [of *NFPA 72*] shall apply.)	—	—	—	—	—	—
	(j) Single- and multiple-station smoke alarms (The requirements for monthly testing in accordance with 14.4.6 3 [of *NFPA 72*] shall also apply.)	X	—	—	—	X	—
	(k) Single- and multiple-station heat alarms	X	—	—	—	X	—
	(l) Supervisory signal devices						
	(1) Valve supervisory switches	X	—	—	X	—	—

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TABLE 6.1.3 *Continued*

	Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually	Table 6.1.2 Reference
	(2) Pressure supervisory indicating devices	X	—	X	—	—	—
	(3) Water level supervisory indicating devices	X	—	X	—	—	—
	(4) Water temperature supervisory indicating devices	X	—	X	—	—	—
	(5) Room temperature supervisory indicating devices	X	—	X	—	—	—
	(6) Other suppression system supervisory initiating devices	X	—	X	—	—	—
	(7) Other supervisory initiating devices	X	—	—	—	X	—
	(m) Waterflow devices	X	—	—	X	—	—
16.	Guard's tour equipment	X	—	—	—	X	24
17.	Combination systems						
	(a) Fire extinguisher electronic monitoring device/systems	X	—	—	—	X	21a
	(b) Carbon monoxide detectors/systems	X	—	—	—	X	
18.	Interface equipment and emergency control functions	X	—	—	—	X	22, 23
19.	Special hazard equipment	X	—	—	—	X	17
20.	Alarm notification appliances						15
	(a) Audible devices	X	—	—	—	X	—
	(b) Audible textual notification appliances	X	—	—	—	X	—
	(c) Visible devices	X	—	—	—	X	—
21.	Exit marking notification appliances	X	—	—	—	X	16
22.	Supervising station alarm systems — transmitters	X	—	—	—	X	18
23.	Special procedures	X	—	—	—	X	25

(continues)

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TABLE 6.1.3 *Continued*

	Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually	Table 6.1.2 Reference
24.	Supervising station alarm systems — receivers						19
	(a) DACR	X	X	—	—	—	—
	(b) DARR	X	X	—	—	—	—
	(c) McCulloh systems	X	X	—	—	—	—
	(d) Two-way RF multiplex	X	X	—	—	—	—
	(e) RASSR	X	X	—	—	—	—
	(f) RARSR	X	X	—	—	—	—
	(g) Private microwave	X	X	—	—	—	—
25.	Public emergency alarm reporting system transmission equipment						—
	(a) Publicly accessible alarm box	X	—	—	X	—	8a
	(b) Auxiliary box	X	—	—	—	X	8b
	(c) Master box	—	—	—	—	—	8c
	(1) Manual operation	X	—	—	X	—	—
	(2) Auxiliary operation	X	—	—	—	X	—
26.	Mass notification system — protected premise, supervised						27
	(a) Control unit functions and no diagnostic failures are indicated	X	—	—	—	X	27
	(b) Audible/visible functional test	X	—	—	—	X	27
	(c) Secondary power	X	—	—	—	X	27
	(d) Verify content of prerecorded messages	X	—	—	—	X	27
	(e) Verify activation of correct prerecorded messages	X	—	—	—	X	27
	(f) Verify activation of correct prerecorded message based on a targeted area	X	—	—	—	X	27
	(g) Verify control unit security mechanism is functional	X	—	—	—	X	27

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TABLE 6.1.3 *Continued*

	Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually	Table 6.1.2 Reference
27.	Mass notification system — protected premise, nonsupervised systems installed prior to adoption of this Code						27
	(a) Control unit functions and no diagnostic failures are indicated	X		—	X	—	27
	(b) Audible/visible functional test	X		—	X	—	27
	(c) Secondary power	X		—	X	—	27
	(d) Verify content of prerecorded messages	X		—	X	—	27
	(e) Verify activation of correct prerecorded message based on a selected event	X		—	X	—	27
	(f) Verify activation of correct prerecorded message based on a targeted area	X		—	X	—	27
	(g) Verify control unit security mechanism is functional	X		—	X	—	27
28.	Mass notification system — wide-area (UFC 4-021-01)						27
	(a) Control unit functions and no diagnostic failures are indicated	X	—	—	—	X	27
	(b) Control unit reset	X	—	—	—	X	27
	(c) Control unit security	X	—	—	—	X	27
	(d) Audible/visible functional test	X	—	—	—	X	27
	(e) Software backup	X	—	—	—	X	27
	(f) Secondary power test	X	—	—	—	X	27
	(g) Antenna	X	—	—	—	X	27
	(h) Transceivers	X	—	—	—	X	27
	(i) Verify content of prerecorded messages	X	—	—	—	X	27
	(j) Verify activation of correct prerecorded message based on a selected event	X	—	—	—	X	27

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TABLE 6.1.3 *Continued*

Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually	Table 6.1.2 Reference
(k) Verify activation of correct prerecorded message base on a targeted area	X	—	—	—	X	27
(l) Verify control unit security mechanism is functional	X	—	—	—	X	27

*See A.14.4.5 [of *NFPA 72*].

Source: Table 14.4.5, *NFPA 72*, 2010 edition.

6.2 Sprinkler System

TABLE 6.2.1 *Summary of Sprinkler System Inspection, Testing, and Maintenance*

Item	Frequency	Reference [in NFPA 25]
Inspection		
Gauges (dry, preaction, and deluge systems)	Weekly/monthly	5.2.4.2, 5.2.4.3, 5.2.4.4
Control valves		Table 13.1
Waterflow alarm devices	Quarterly	5.2.5
Valve supervisory alarm devices	Quarterly	5.2.5
Supervisory signal devices (except valve supervisory switches)	Quarterly	5.2.5
Gauges (wet pipe systems)	Monthly	5.2.4.1
Hydraulic nameplate	Quarterly	5.2.6
Buildings	Annually (prior to freezing weather)	4.1.1.1
Hanger/seismic bracing	Annually	5.2.3
Pipe and fittings	Annually	5.2.2
Sprinklers	Annually	5.2.1
Spare sprinklers	Annually	5.2.1.4
Information sign	Annually	5.2.6.1
Fire department connections		Table 13.1
Valves (all types)		Table 13.1
Obstruction, internal inspection of piping	5 years	14.2
Test		
Waterflow alarm devices		
Mechanical devices	Quarterly	5.3.3.1
Vane and pressure switch type devices	Semiannually	5.3.3.2
Valves supervisory alarm devices		Table 13.1
Supervisory signal devices (except valve supervisory switches)		Table 13.1
Main drain		Table 13.1
Antifreeze solution	Annually	5.3.4

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TABLE 6.2.1 *Continued*

Item	Frequency	Reference [in NFPA 25]
Gauges	5 years	5.3.2
Sprinklers — extra-high temperature	5 years	5.3.1.1.1.4
Sprinklers — fast-response	At 20 years and every 10 years thereafter	5.3.1.1.1.3
Sprinklers	At 50 years and every 10 years thereafter	5.3.1.1.1
Sprinklers	At 75 years and every 5 years thereafter	5.3.1.1.1.5
Sprinklers — dry	At 10 years and every 10 years thereafter	5.3.1.1.1.6
Maintenance		
Valves (all types)		Table 13.1
Low-point drains (dry pipe system)		13.4.4.3.2
Sprinklers and automatic spray nozzles protecting commercial cooking equipment and ventilation systems	Annually	5.4.1.9
Investigation		
Obstruction		14.3

Source: Table 5.1.1.2, NFPA 25, 2011 edition.

TABLE 6.2.2 *Summary of Component Replacement Action Requirements*

Component	Adjust	Repair/ Recondition	Replace	Required Action
Water Delivery Components				
Pipe and fittings affecting less than 20 sprinklers	X	X	X	Check for leaks at system working pressure
Pipe and fittings affecting more than 20 sprinklers	X	X	X	Hydrostatic test in conformance with NFPA 13, *Standard for the Installation of Sprinkler Systems*
Sprinklers, less than 20	X		X	Check for leaks at system working pressure
Sprinklers, more than 20	X		X	Hydrostatic test in conformance with NFPA 13
Fire department connections	X	X	X	See Chapter 13 [in NFPA 25]
Antifreeze solution	X		X	Check freezing point of solution Check for leaks at system working pressure
Valves				See Chapter 13 [in NFPA 25]
Fire pump				See Chapter 8 [in NFPA 25]
Alarm and Supervisory Components				
Vane-type waterflow	X	X	X	Operational test using inspector's test connection
Pressure switch–type waterflow	X	X	X	Operational test using inspector's test connection

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TABLE 6.2.2 *Continued*

Component	Adjust	Repair/ Recondition	Replace	Required Action
Water motor gong	X	X	X	Operational test using inspector's test connection
High and low air pressure switch	X	X	X	Operational test of high and low settings
Valve supervisory device	X	X	X	Test for conformance with NFPA 13 and/or *NFPA 72, National Fire Alarm and Signaling Code*
Detection system (for deluge or preaction system)	X	X	X	Operational test for conformance with NFPA 13 and/or *NFPA 72*
Status-Indicating Components				
Gauges			X	Verify at 0 bar (0 psi) and system working pressure
Testing and Maintenance Components				
Air compressor	X	X	X	Operational test for conformance with NFPA 13
Automatic air maintenance device	X	X	X	Operational test for conformance with NFPA 13
Main drain	X	X	X	Main drain test
Auxiliary drains	X	X	X	Check for leaks at system working pressure; Main drain test
Inspector's test connection	X	X	X	Check for leaks at system working pressure; Main drain test
Structural Components				
Hanger/seismic bracing	X	X	X	Check for conformance with NFPA 13
Pipe stands	X	X	X	Check for conformance with NFPA 13
Informational Components				
Identification signs	X	X	X	Check for conformance with NFPA 13
Hydraulic placards	X	X	X	Check for conformance with NFPA 13

Source: Table 5.5.1, NFPA 25, 2011 edition.

6.3 Standpipe System

TABLE 6.3.1 *Summary of Standpipe and Hose Systems Inspection, Testing, and Maintenance*

Item	Frequency	Reference*
Inspection		
Control valves		Table 13.1
Pressure regulating devices		Table 13.1
Piping	Annually	6.2.1
Hose connections		Table 13.1
Cabinet	Annually	NFPA 1962

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TABLE 6.3.1 *Continued*

Item	Frequency	Reference*
Gauges	Weekly	6.2.2
Hose	Annually	NFPA 1962
Hose storage device	Annually	NFPA 1962
Hose nozzle	Annually and after each use	NFPA 1962
Hydraulic design information sign	Annually	6.2.3
Test		
Waterflow alarm devices		Table 13.1
Valve supervisory alarm devices		Table 13.1
Supervisory signal devices (except valve supervisory switches)		Table 13.1
Hose storage device	Annually	NFPA 1962
Hose	5 years/3 years	NFPA 1962
Pressure control valve		Table 13.1
Pressure reducing valve		Table 13.1
Hydrostatic test	5 years	6.3.2
Flow test	5 years	6.3.1
Main drain test		Table 13.1
Maintenance		
Hose connections	Annually	Table 6.1.2
Valves (all types)	Annually/as needed	Table 13.1

*References are from NFPA 25 unless otherwise noted.
Source: Table 6.1.1.2, NFPA 25, 2011 edition.

TABLE 6.3.2 *Summary of Component Replacement Action Requirements*

Component	Adjust	Repair	Replace	Required Action
Water Delivery Components				
Control valves	X	X	X	See Chapter 13 [in NFPA 25]
Hose valve pressure regulating devices	X	X	X	See Chapter 13 [in NFPA 25]
System pressure regulating devices	X	X	X	See Chapter 13 [in NFPA 25]
Piping	X	X	X	Hydrostatic test in conformance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*
Fire hose			X	
Hose valve	X	X	X	See Chapter 13 [in NFPA 25]
Fire department connections	X	X	X	See Chapter 13 [in NFPA 25]
Backflow prevention device	X	X	X	See Chapter 13 [in NFPA 25]
Valves				See Chapter 13 [in NFPA 25]
Fire pump				See Chapter 8 [in NFPA 25]

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TABLE 6.3.2 *Continued*

Component	Adjust	Repair	Replace	Required Action
Alarm and Supervisory Components				
Vane-type waterflow	X	X		Operational test using inspector's test connection
Vane-type waterflow			X	Operational test using inspector's test connection
Pressure switch–type waterflow	X	X	X	Operational test using inspector's test connection
Water motor gong	X	X	X	Operational test using inspector's test connection
Valve supervisory device	X	X	X	Operational test for receipt of alarms and verification of conformance with NFPA 14 and/or *NFPA 72, National Fire Alarm and Signaling Code*
Status-Indicating Components				
Gauges			X	Verify at 0 psi and system working pressure
System Housing and Protection Components				
Cabinet	X	X	X	Verify compliance with NFPA 14
Hose storage rack	X	X	X	Verify compliance with NFPA 14
Testing and Maintenance Components				
Drain riser	X	X	X	Check for leaks while flowing from connection above the repair
Auxiliary drains	X	X	X	Check for leaks at system working pressure
Main drain	X	X	X	Check for leaks and residual pressure during main drain test
Structural Components				
Hanger/seismic bracing	X	X	X	Verify conformance with NFPA 14
Pipe stands	X	X	X	Verify conformance with NFPA 14
Informational Components				
Identification signs	X	X	X	Verify conformance with NFPA 14
Hydraulic placards	X	X	X	Verify conformance with NFPA 14

Source: Table 6.5.1, NFPA 25, 2011 edition.

6.4 Fire Pump

TABLE 6.4.1 *Alternative Fire Pump Inspection, Testing, and Maintenance Procedures*

Complete as Applicable	Visual Inspection	Check	Change	Clean	Test	Frequency
Pump System						
Lubricate pump bearings			X			Annually
Check pump shaft end play		X				Annually

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TABLE 6.4.1 *Continued*

Complete as Applicable	Visual Inspection	Check	Change	Clean	Test	Frequency
Check accuracy of pressure gauges and sensors		X	X			Annually (change or recalibrate when 5% out of calibration)
Check pump coupling alignment		X				Annually
Wet pit suction screens		X		X		After each pump operation
Mechanical Transmission						
Lubricate coupling			X			Annually
Lubricate right-angle gear drive			X			Annually
Electrical System						
Exercise isolating switch and circuit breaker					X	Monthly
Trip circuit breaker (if mechanism provided)					X	Annually
Operate manual starting means (electrical)					X	Semiannually
Inspect and operate emergency manual starting means (without power)	X				X	Annually
Tighten electrical connections as necessary		X				Annually
Lubricate mechanical moving parts (excluding starters and relays)		X				Annually
Calibrate pressure switch settings		X				Annually
Grease motor bearings			X			Annually
Voltmeter and ammeter for accuracy (5%)		X				Annually
Any corrosion on printed circuit boards (PCBs)	X					Annually
Any cracked cable/wire insulation	X					Annually
Any leaks in plumbing parts	X					Annually
Any signs of water on electrical parts	X					Annually
Diesel Engine System						
Fuel						
Tank level	X	X				Weekly
Tank float switch	X				X	Weekly
Solenoid valve operation	X				X	Weekly
Strainer, filter, or dirt leg, or combination thereof				X		Quarterly
Water and foreign material in tank				X		Annually
Water in system		X		X		Weekly
Flexible hoses and connectors	X					Weekly
Tank vents and overflow piping unobstructed		X			X	Annually
Piping	X					Annually
Lubrication system						
Oil level	X	X				Weekly

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TABLE 6.4.1 *Continued*

Complete as Applicable	Visual Inspection	Check	Change	Clean	Test	Frequency
Oil change			X			50 hours or annually
Oil filter(s)			X			50 hours or annually
Lube oil heater		X				Weekly
Crankcase breather	X		X	X		Quarterly
Cooling system						
Level	X	X				Weekly
Antifreeze protection level					X	Semiannually
Antifreeze		X				Annually
Adequate cooling water to heat exchanger		X				Weekly
Rod out heat exchanger				X		Annually
Water pump(s)	X					Weekly
Condition of flexible hoses and connections	X	X				Weekly
Jacket water heater		X				Weekly
Inspect duct work, clean louvers (combustion air)	X	X	X			Annually
Water strainer				X		Quarterly
Exhaust system						
Leakage	X	X				Weekly
Drain condensate trap		X				Weekly
Insulation and fire hazards	X					Quarterly
Excessive back pressure					X	Annually
Exhaust system hangers and supports	X					Annually
Flexible exhaust section	X					Semiannually
Battery system						
Electrolyte level		X				Weekly
Terminals clean and tight	X	X				Quarterly
Case exterior clean and dry	X	X				Monthly
Specific gravity or state of charge					X	Monthly
Charger and charge rate	X					Monthly
Equalize charge		X				Monthly
Clean terminals				X		Annually
Cranking voltage exceeds 9 volts on a 12 volt system or 18 volts on a 24 volt system		X				Weekly
Electrical system						
General inspection	X					Weekly
Tighten control and power wiring connections		X				Annually
Wire chafing where subject to movement	X	X				Quarterly
Operation of safeties and alarms		X			X	Semiannually

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TABLE 6.4.1 *Continued*

Complete as Applicable	Visual Inspection	Check	Change	Clean	Test	Frequency
Boxes, panels, and cabinets				X		Semiannually
Circuit breakers or fuses	X	X				Monthly
Circuit breakers or fuses			X			Biennially
Voltmeter and ammeter for accuracy (5%)		X				Annually
Any corrosion on printed circuit boards (PCBs)	X					Annually
Any cracked cable/wire insulation	X					Annually
Any leaks in plumbing parts	X					Annually
Any signs of water on electrical parts	X					Annually

Source: Table 8.1.2, NFPA 25, 2011 edition.

TABLE 6.4.2 *Summary of Component Replacement Testing Requirements*

Component	Adjust	Repair	Rebuild	Replace	Test Criteria
Fire Pump System					
Entire pump assembly				X	Perform acceptance test in accordance with NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*
Impeller/rotating assembly		X		X	Perform acceptance test in accordance with NFPA 20
Casing		X		X	Perform acceptance test in accordance with NFPA 20
Bearings				X	Perform annual test in accordance with 8.3.3 [in NFPA 25]
Sleeves				X	Perform annual test in accordance with 8.3.3 [in NFPA 25]
Wear rings				X	Perform annual test in accordance with 8.3.3 [in NFPA 25]
Main shaft		X		X	Perform annual test in accordance with 8.3.3 [in NFPA 25]
Packing	X			X	Perform test in accordance with 8.3.2 [in NFPA 25]
Mechanical Transmission					
Gear right angle drives		X	X	X	Perform acceptance test in accordance with NFPA 20
Drive coupling	X	X	X	X	Perform test in accordance with 8.3.2 [in NFPA 25]
Electrical System/ Controller					
Entire controller		X	X	X	Perform acceptance test in accordance with NFPA 20
Isolating switch				X	Perform test in accordance with 8.3.2 [in NFPA 25] and exercise six times

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TABLE 6.4.2 *Continued*

Component	Adjust	Repair	Rebuild	Replace	Test Criteria
Circuit breaker	X				Perform six momentary starts in accordance with NFPA 20
Circuit breaker				X	Perform a 1-hour full-load current test
Electrical connections	X				Perform test in accordance with 8.3.2 [in NFPA 25]
Main contactor			X		Perform test in accordance with 8.3.2 [in NFPA 25]
Main contactor				X	Perform acceptance test in accordance with NFPA 20
Power monitor				X	Perform test in accordance with 8.3.2 [in NFPA 25]
Start relay				X	Perform test in accordance with 8.3.2 [in NFPA 25]
Pressure switch	X			X	Perform test in accordance with 8.3.2 [in NFPA 25] and exercise six times automatically
Pressure transducer	X			X	Perform acceptance test in accordance with NFPA 20
Manual start or stop switch				X	Perform six operations under load
Transfer switch — load carrying parts		X	X	X	Perform a 1-hour full-load current test, and transfer from normal power to emergency power and back one time
Transfer switch — non-load parts		X	X	X	Perform six no-load operations of transfer of power
Electric Motor Driver					
Electric motor		X	X	X	Perform acceptance test in accordance with NFPA 20
Motor bearings				X	Perform annual test in accordance with 8.3.3 [in NFPA 25]
Incoming power conductors				X	Perform a 1-hour full-load current test
Diesel Engine Driver					
Entire engine			X	X	Perform acceptance test in accordance with NFPA 20
Fuel transfer pump	X		X	X	Perform test in accordance with 8.3.2 [in NFPA 25]
Fuel injector pump	X			X	Perform test in accordance with 8.3.2 [in NFPA 25]
Fuel system filter		X		X	Perform test in accordance with 8.3.2 [in NFPA 25]
Combustion air intake system		X		X	Perform test in accordance with 8.3.2 [in NFPA 25]
Fuel tank		X		X	Perform test in accordance with 8.3.2 [in NFPA 25]
Cooling system		X	X	X	Perform test in accordance with 8.3.2 [in NFPA 25]

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TABLE 6.4.2 *Continued*

Component	Adjust	Repair	Rebuild	Replace	Test Criteria
Batteries		X		X	Perform a start/stop sequence in accordance with NFPA 25
Battery charger		X		X	Perform test in accordance with 8.3.2 [in NFPA 25]
Electric system		X		X	Perform test in accordance with 8.3.2 [in NFPA 25]
Lubrication filter/oil service		X		X	Perform test in accordance with 8.3.2 [in NFPA 25]
Steam Turbines					
Steam turbine		X		X	Perform acceptance test in accordance with NFPA 20
Steam regulator or source upgrade		X		X	Perform annual test in accordance with NFPA 20
Positive Displacement Pumps					
Entire pump				X	Perform acceptance test in accordance with NFPA 20
Rotors				X	Perform annual test in accordance with 8.3.3 [in NFPA 25]
Plungers				X	Perform annual test in accordance with 8.3.3 [in NFPA 25]
Shaft				X	Perform annual test in accordance with 8.3.3 [in NFPA 25]
Driver		X	X	X	Perform acceptance test in accordance with NFPA 20
Bearings				X	Perform annual test in accordance with 8.3.3 [in NFPA 25]
Seals				X	Perform test in accordance with 8.3.2 [in NFPA 25]
Pump House and Miscellaneous Components					
Base plate		X		X	Perform test in accordance with 8.3.2 [in NFPA 25] with alignment check
Foundation		X	X	X	Perform test in accordance with 8.3.2 [in NFPA 25] with alignment check
Suction/discharge pipe		X		X	Perform visual inspection in accordance with 8.3.3.7 [in NFPA 25]
Suction/discharge fittings		X		X	Perform visual inspection in accordance with 8.3.3.7 [in NFPA 25]
Suction/discharge valves		X	X	X	Perform operational test in accordance with 13.3.3.1 [in NFPA 25]

Source: Table 8.6.1, NFPA 25, 2011 edition.

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6.5 Wet Chemical System

The following information is extracted from Chapter 7 of NFPA 17A, 2009 edition. However, the numbering has been changed to coincide with the numbering in this document.

6.5.1 Owner's Inspection.

6.5.1.1 On a monthly basis, inspection shall be conducted in accordance with the manufacturer's listed installation and maintenance manual or the owner's manual.

6.5.1.2 At a minimum, this "quick check" or inspection shall include verification of the following:

(1) The extinguishing system is in its proper location.
(2) The manual actuators are unobstructed.
(3) The tamper indicators and seals are intact.
(4) The maintenance tag or certificate is in place.
(5) No obvious physical damage or condition exists that might prevent operation.
(6) The pressure gauge(s), if provided, shall be inspected physically or electronically to ensure it is in the operable range.
(7) The nozzle blowoff caps, where provided, are intact and undamaged.
(8) Neither the protected equipment nor the hazard has not been replaced, modified, or relocated.

6.5.1.3 If any deficiencies are found, appropriate corrective action shall be taken immediately.

6.5.1.3.1 Where the corrective action involves maintenance, it shall be conducted by a service technician as outlined in 6.5.2.1.

6.5.1.4 Personnel making inspections shall keep records for those extinguishing systems that were found to require corrective actions.

6.5.1.5 At least monthly, the date the inspection is performed and the initials of the person performing the inspection shall be recorded.

6.5.1.6 The records shall be retained for the period between the semiannual maintenance inspections.

6.5.2 Maintenance.

6.5.2.1 A service technician who performs maintenance on an extinguishing system shall be trained and shall have passed a written or online test that is acceptable to the authority having jurisdiction.

A.6.5.2.1 A reasonable program for qualification of service technicians is for an individual to pass a written or online examination. The test should contain a reasonable number of questions to challenge the individual's knowledge of the subject matter.

6.5.2.1.1 The service technician shall possess a certification document confirming the requirements in 6.5.2.1 and issued by the manufacturer or testing organization that is acceptable to the authority having jurisdiction.

6.5.2.2 A service technician who has the applicable manufacturer's listed installation and maintenance manual and service bulletins shall service the wet chemical fire-extinguishing system at intervals no more than 6 months apart as outlined in 6.5.2.3.

A.6.5.2.2 It is recommended that system maintenance personnel be certified with the manufacturer's requirements. It is standard industry practice to provide expiration dates on training certificates.

6.5.2.3 At least semiannually, maintenance shall be conducted in accordance with the manufacturer's listed installation and maintenance manual.

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A.6.5.2.3 Regular service contracts with the equipment manufacturer or an authorized installation or maintenance company are recommended.

6.5.2.3.1 Maintenance shall include the following:

(1) A check to see that the hazard has not changed

(2) An examination of all detectors, the expellant gas container(s), the agent container(s), releasing devices, piping, hose assemblies, nozzles, signals, all auxiliary equipment, and the liquid level of all nonpressurized wet chemical containers

(3)* Verification that the agent distribution piping is not obstructed

A.6.5.2.3.1(3) The following methods can be used to verify that piping is not obstructed:

(1) Disassembly of all piping

(2) Conducting a full or partial discharge test

(3) Utilizing other methods recommended by the manufacturer

6.5.2.3.2* Where semiannual maintenance of any wet chemical containers or system components reveals conditions such as, but not limited to, corrosion or pitting in excess of the manufacturer's limits; structural damage or fire damage; or repairs by soldering, welding, or brazing, the affected part(s) shall be replaced or hydrostatically tested in accordance with the recommendations of the manufacturer or the listing agency.

A.6.5.2.3.2 The hydrostatic testing of wet chemical containers should follow the applicable procedures outlined in Section 7.5 [of NFPA 17A].

6.5.2.3.3* All wet chemical systems shall be tested, which shall include the operation of the detection system signals and releasing devices, including manual stations and other associated equipment.

A.6.5.2.3.3 A discharge of the wet chemical normally is not part of this test.

6.5.2.3.4 Where the maintenance of the system(s) reveals defective parts that could cause an impairment or failure of proper operation of the system(s), the affected parts shall be replaced or repaired in accordance with the manufacturer's recommendations.

6.5.2.3.4.1 Until such repairs are accomplished, the systems shall be tagged as noncompliant, and the owner or owner's representative responsible for the system and the authority having jurisdiction shall be notified of the impairment.

6.5.2.3.4.2 When all repairs have been accomplished and the system has been restored to full operating conditions, all previously notified parties shall be informed that the system is in the full operating condition.

6.5.2.3.5 The maintenance report, including any recommendations, shall be filed with the owner or with the owner's representative.

6.5.2.3.5.1 The owner or owner's representative shall retain all maintenance reports for a period of 1 year after the next maintenance of that type required by the standard.

6.5.2.3.6* Each wet chemical system shall have a tag or label securely attached, indicating the month and year the maintenance is performed and identifying the person performing the service. Only the current tag or label shall remain in place.

A.6.5.2.3.6 Under special circumstances or when local requirements are in effect, additional information can be desirable or required.

6.5.2.4* Fixed temperature-sensing elements of the fusible metal alloy type shall be replaced at least semiannually from the date of installation, or more frequently, if necessary. They shall be destroyed when removed.

A.6.5.2.4 The date of manufacture marked on fusible metal alloy–temperature-sensing elements does not limit when they can be used. These devices have unlimited shelf life. The intent of 6.5.2.4 is to require replacement of

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fusible metal alloy–temperature-sensing elements that have been installed for up to 1 year in environments subjecting them to contaminant loading, such as grease in restaurant hoods and ducts, that could adversely affect their proper operation.

6.5.2.4.1 The year of manufacture and the date of installation of the fixed temperature-sensing element shall be marked on the system inspection tag. The tag shall be signed or initialed by the installer.

6.5.2.5 Fixed temperature-sensing elements other than the fusible metal alloy type shall be permitted to remain continuously in service, provided they are inspected and cleaned or replaced if necessary in accordance with the manufacturer's instructions, every 12 months or more frequently to ensure proper operation of the system.

6.5.2.5.1 At a minimum, inspection and testing for restorable-type heat detectors shall include the following:

(1) A visual inspection to determine whether there is damage to the detector or buildup of foreign debris
(2) An operational/functional test in accordance with the detector manufacturer's testing instructions
(3) A calibration verification test, if applicable, in accordance with the detector manufacturer's instructions

6.5.2.5.2 Nonrestorable heat detectors shall be functionally tested in accordance with the manufacturer's recommendations.

6.5.2.5.3 Heat detectors and all associated wiring that show signs of fire damage shall be tested in accordance with the manufacturer's recommendations and replaced if necessary.

6.6 Clean Agent System

The following information is extracted from NFPA 2001, 2012 edition. However, the numbering has changed to coincide with the numbering in this document.

6.6.1 Inspection and Tests.

6.6.1.1 At least annually, all systems shall be thoroughly inspected and tested for proper operation by personnel qualified in the installation and testing of clean agent extinguishing systems. Discharge tests shall not be required.

6.6.1.2 The inspection report with recommendations shall be filed with the owner of the system.

6.6.1.3 At least semiannually, the agent quantity and pressure of refillable containers shall be checked.

6.6.1.3.1 For halocarbon clean agents, if a container shows a loss in agent quantity of more than 5 percent or a loss in pressure (adjusted for temperature) of more than 10 percent, it shall be refilled or replaced.

6.6.1.3.2 For inert gas clean agents that are not liquefied, pressure is an indication of agent quantity. If an inert gas clean agent container shows a loss in pressure (adjusted for temperature) of more than 5 percent, it shall be refilled or replaced. Where container pressure gauges are used for this purpose, they shall be compared to a separate calibrated device at least annually.

6.6.1.3.3 Where the amount of agent in the container is determined by special measuring devices, these devices shall be listed.

6.6.1.4* All halocarbon clean agent removed from refillable containers during service or maintenance procedures shall be collected and recycled or disposed of in an environmentally sound manner and in accordance with existing laws and regulations.

A.6.6.1.4 All inert gas clean agents based on those gases normally found in the earth's atmosphere need not be recycled.

6.6.1.5 Factory-charged, nonrefillable containers that do not have a means of pressure indication shall have the agent quantity checked at least semiannually. If a container shows a loss in agent quantity of more than 5 percent, it shall be replaced. All factory-charged, nonrefillable containers removed from useful service shall be returned for

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recycling of the agent or disposed of in an environmentally sound manner and in accordance with existing laws and regulations.

6.6.1.6 For halocarbon clean agents, the date of inspection, gross weight of cylinder plus agent or net weight of agent, type of agent, person performing the inspection, and, where applicable, the pressure at a recorded temperature shall be recorded on a tag attached to the container. For inert gas clean agents, the date of inspection, type of agent, person performing the inspection, and the pressure at a recorded temperature shall be recorded on a tag attached to the container.

6.6.2* Maintenance.

A.6.6.2 The manufacturer's maintenance procedure should be guided by the following outline:

(1) System
  (a) Check overall physical appearance.
  (b) Disarm system prior to test.
(2) Hazard
  (a) Determine size.
  (b) Determine configuration.
  (c) Check for unclosable openings.
  (d) Determine fuels.
  (e) Determine other aspects of the hazard that could impair effectiveness of the extinguishing systems.
(3) Supervised circuits
  (a) Exercise all functions.
  (b) Check all electrical or pneumatic supervisory circuits for proper operation.
(4) Control panel
  (a) Exercise all functions.
  (b) Check supervision if applicable, of each circuit (including releasing devices) as recommended by the manufacturer.
(5) Power supply
  (a) Check routing, circuit breakers, fuses, disconnects.
(6) Emergency power
  (a) Check battery condition.
  (b) Check charger operation; check fuse.
  (c) Check automatic changeover.
  (d) Check maintenance of generator (if one exists).
(7) Detectors
  (a) Test each detector using heat, smoke, or manufacturer's approved test device. (See NFPA 72.)
  (b) Electric type.
    i. Clean and adjust smoke detector and check sensitivity.
    ii. Check wiring condition.
  (c) Pneumatic type: Check tightness of tubing and operation of mercury checks, using manometer.
(8) Time delay
  (a) Exercise functions.
  (b) Check time limit.

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(c) Check that timer will complete its cycle even though wiring between it and the detector circuit is interrupted.

(9) Alarms
- (a) Test for operation (audible and visual).
- (b) Check to see that warning signs are properly displayed.

(10) Selector (directional) valves
- (a) Exercise functions.
- (b) Reset properly.

(11) Release devices
- (a) Check for complete closure of dampers.
- (b) Check doors; check for any doors blocked open.

(12) Equipment shutdown
- (a) Test shutdown function.
- (b) Check adequacy (all necessary equipment included).

(13) Manual releases
- (a) Mechanical type.
  - i. Check pull, force, and length of pull required.
  - ii. Operate and adjust all devices.
  - iii. Check tightness of connectors.
  - iv. Check condition of conduit.
  - v. Check condition and operation of corner pulleys.
- (b) Electric type.
  - i. Test manual release.
  - ii. Check that covers are in place.
- (c) Check pneumatic releases.
- (d) Check accessibility during fire.
- (e) Separate main and reserve manual pulls that require only one operation, to obtain discharge of either main or reserve supply of gas.
- (f) Clearly mark and identify all manual releases.

(14) Piping
- (a) Check security; check that piping is adequately supported.
- (b) Check condition; check for any corrosion.

(15) Nozzles
- (a) Check orientation and orifice size; make sure they are unchanged from original design.
- (b) Check cleanliness.
- (c) Check security.
- (d) Check seals where needed.

(16) Containers
- (a) Check physical condition; check for any sign of corrosion.
- (b) Check the contents for weight by acceptable methods for each cylinder. If the contents are below the required amount specified in 6.6.1.3.1 and 6.6.1.3.2, then the containers must be refilled or replaced. (Proper operation of the liquid level gauge should be verified.)

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(c) Check that cylinders are securely held in position.

(d) Check hydrostatic test date.

(e) Check cylinder connectors for integrity and condition.

(f) Check weights and cables of mechanical release system.

(g) Check release devices; check for proper arrangement and security.

(h) Check explosive release devices; check replacement date; check condition.

(17) Test

(a) Perform recommended discharge tests when there is any question about the adequacy of the system.

(b) Perform recommended full discharge test when cylinder hydrostatic test is required.

(18) Return all parts of system to full service.

(19) Give certificate of inspection to owner.

(a) Regular service contracts with the manufacturer or installing company are recommended. Work should be performed by personnel thoroughly trained and regularly engaged in providing such service.

6.6.2.1 These systems shall be maintained in full operating condition at all times. Actuation, impairment, and restoration of this protection shall be reported promptly to the authority having jurisdiction.

6.6.2.2 Any troubles or impairments shall be corrected in a timely manner consistent with the hazard protected.

6.6.2.3* Any penetrations made through the enclosure protected by the clean agent shall be sealed immediately. The method of sealing shall restore the original fire resistance rating of the enclosure.

A.6.6.2.3 The method of sealing should not introduce any new hazards.

7.0 Project Schedule

EXHIBIT O.9 Project Schedule.

ACME Corp - Executive Offices
Project Schedule

System/Sub-System	January					February				March					April				May					June				July				August				September				October				November				December			
	3	10	17	24	31	7	14	21	28	7	14	21	28		4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26
Water supply	D	A	A	F	F	I/I	I	I	T																											TR				FA												
Fire pump		D	A	A	F	F	F	F	F	F	I/I	I	I		PFT													PFT						IT	IT	TR				FA												
Standpipe			D					A	A	F	F	I/R	R		R													PFT						IT	IT	TR				FA												
Sprinkler-1st floor				D				A	A	F	F					I/R	R	R										PFT	FI					IT	IT		TR			FA												
Sprinkler-2nd floor					D			A	A	F	F								I/R	R	R							PFT	FI					IT	IT		TR			FA												
Sprinkler-3rd floor						D		A	A	F	F											I/R	R	R				PFT			FI			IT	IT		TR			FA												
Sprinkler-4th floor							D	A	A	F	F														I/R	R	R	PFT			FI			IT	IT		TR			FA												
Clean agent								D	A	A																	F	F	F	F	I/I	I		IT	IT			TR		FA												
Wet chemical									D	A	A																		F	F	F	I/I		IT	IT			TR		FA												
Fire alarm						D	D	D	D	A	A	F	F		F	F	I/I	I	I	I	I	I	I	I	I	I	I	PFT						IT	IT				TR	FA												
FI = Final instalation																																																			
D = Design																																																			
A = Approval																																																			
F = Fabrication																																																			
R = Rough-in																																																			
I/I =Inspection/Installation																																																			
T = Test																																																			
PFT = Pre-functional test																																																			
TR = Training																																																			
FA = Final acceptance																																																			
IT = Integrated testing																																																			

Note: Dark shading denotes Cx activity.
Note: Light shading denotes contractor activity

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