



## Fire Safety - Integrated Testing and Commissioning

*Safety Design in Buildings*

Date: 8th December, 2015

Presented by: John Noone

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Muscat Conference

Crowne Plaza Muscat, Tuesday, December 8, 2015



# Course Description

The integration of a group of systems to meet the fire and life safety performance requirements of the fire strategy is an important component to successfully handing over a building. It involves a broad team to achieve this such as the fire engineer, commissioning agent, individual building system specialists, building operator to name a few. While all systems are tested in isolation there is the need to determine the correct interaction and coordination for fire safety, the presenter shall discuss this topic for modern buildings.

# Presenter

John Noone

*Associate Director, Arup*

John is the leader of Arup's Fire Engineering Practice in the Gulf. A Chartered Fire Safety Engineer he holds a BSc Hons in Fire Safety Engineering.

John has gained a wide range of experience in fire engineering in Middle East, Africa, UK, Ireland, Russia and across Continental Europe.

He applies his expertise primarily in fire safety design, on-site implementation and handover of Aviation, Assembly and transportation projects across the built environment.

John is a visiting lecturer at Trinity College Dublin on the fundamentals of fire safety science and fire dynamics.

John's passion is for advancing the field of fire engineering in its application into the design and operation of the built environment. He represents Arup and the industry in promoting this message on fire safety at targeted fire safety seminars and conferences.

# Learning Objectives

1. *Understand the differences between commissioning, stand alone testing and integrated testing.*
2. *Understand the pitfalls with the current approaches taken to commissioning.*
3. *Understand the codes available to assist with developing a suitable commissioning programme.*
4. *Understand the approaches that can be applied through various stages of a buildings life in relation to successful integrated system testing.*

The purpose of this presentation is to convey technical knowledge to the conference participants.

The presentation also contains slides with text that summarises the content of the presentation and the main learning objectives.

These may be used to update CPD records for relevant organisations including the Chartered Institute of Building (CIOB).

# 1. Introduction

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What is commissioning and where does integrated testing sit in the overall process?

## Commissioning

### Integrated Testing

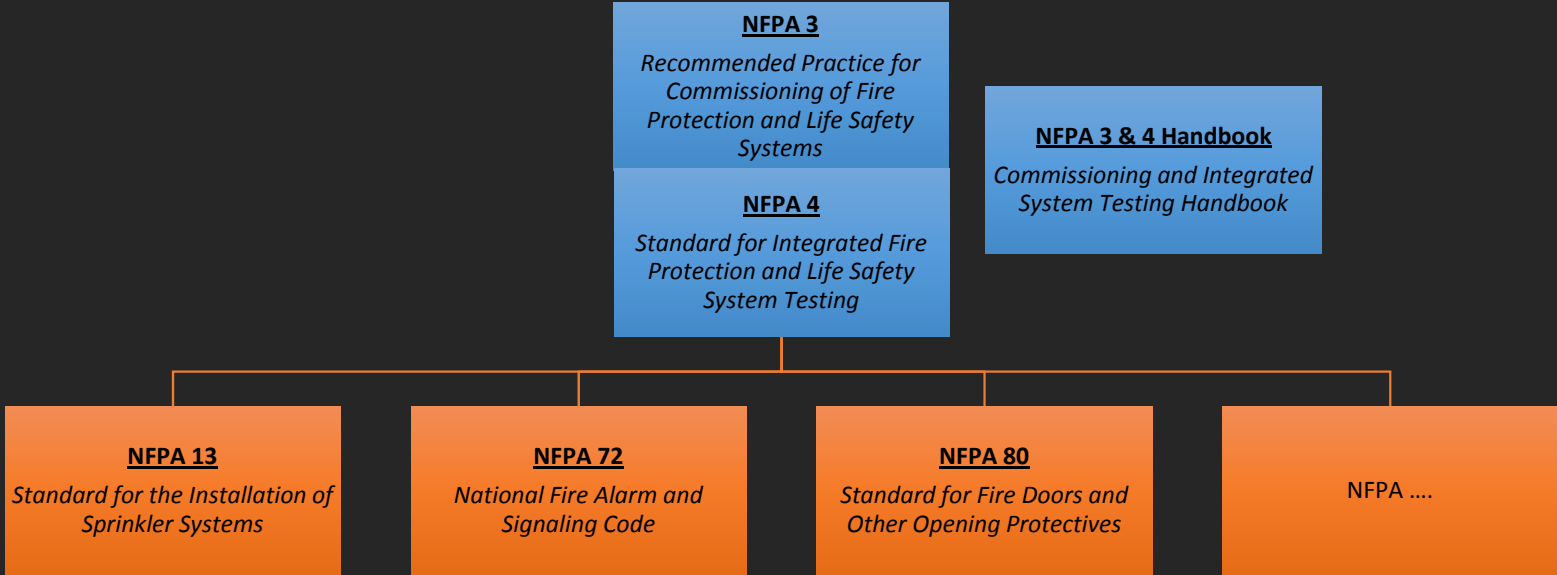
### Standalone Testing

Pre-Functional Tests

Acceptance Tests

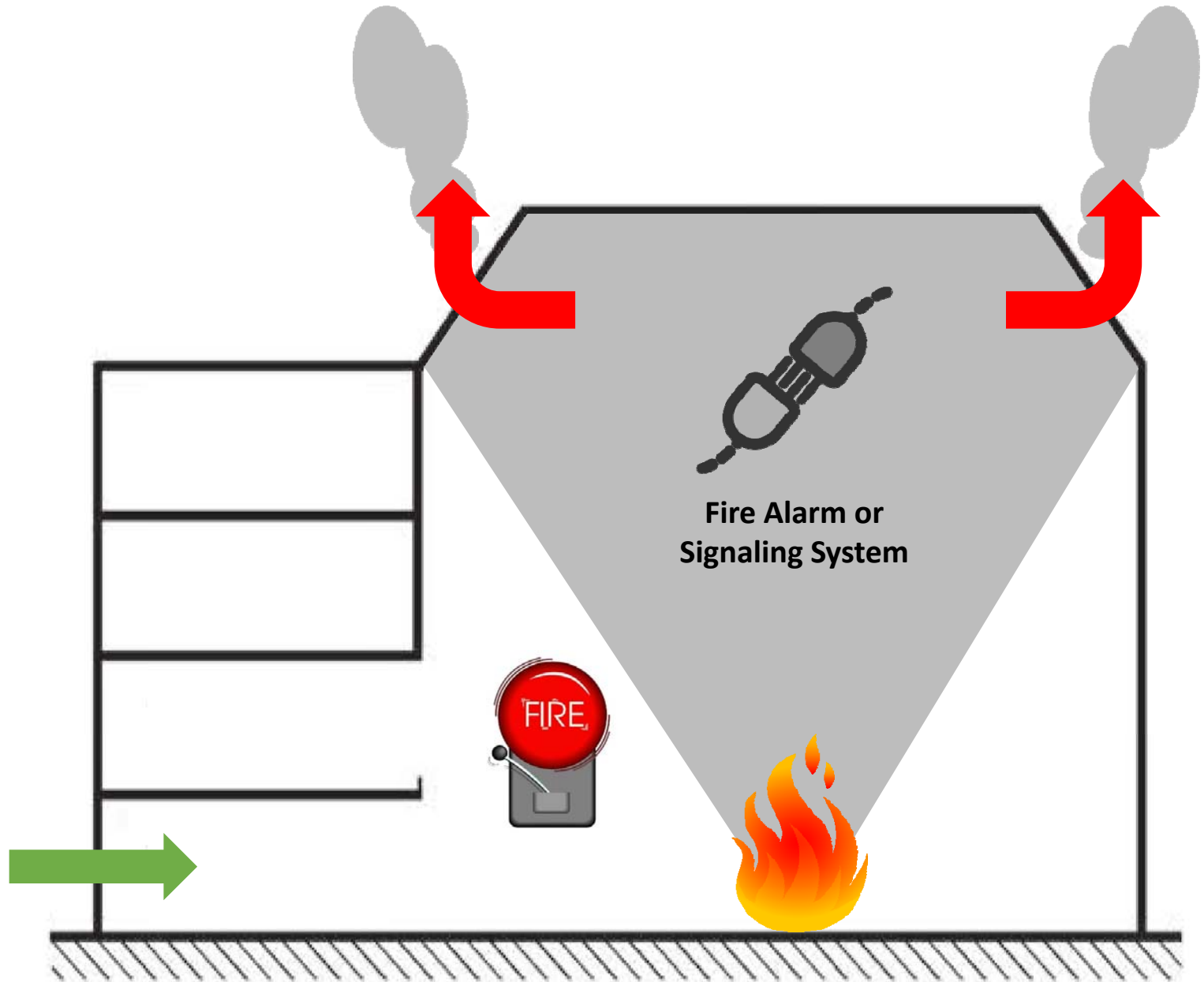
Most model codes and standards do not specify that integrated testing must be done; they simply require acceptance testing in accordance with the appropriate design standards.

# Model Codes



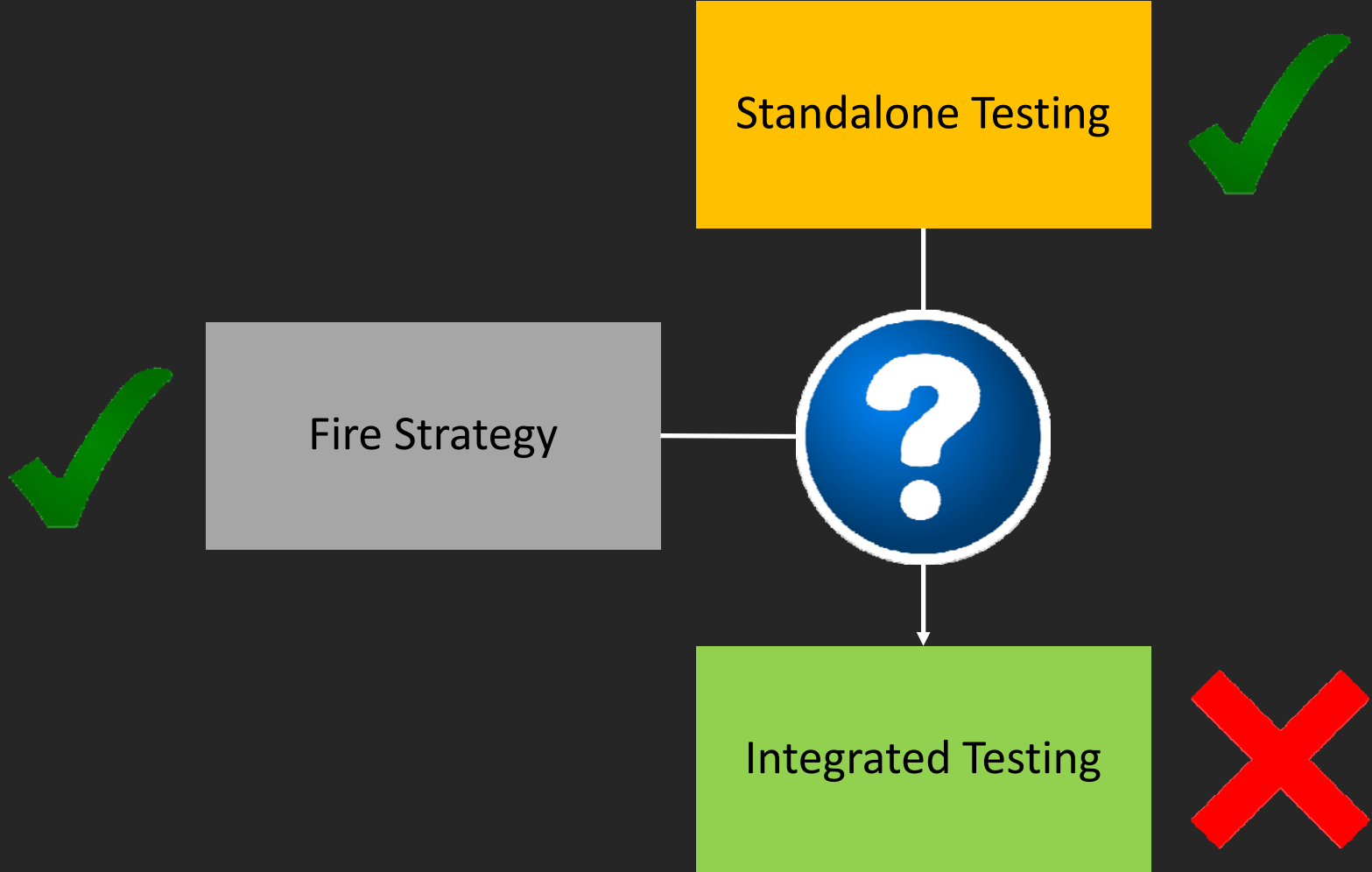
Example

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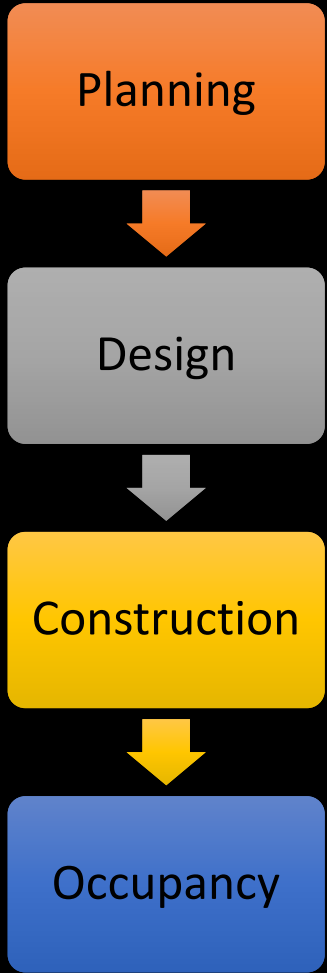




The Problem!



# Today's Buildings



## 2. Planning Phase

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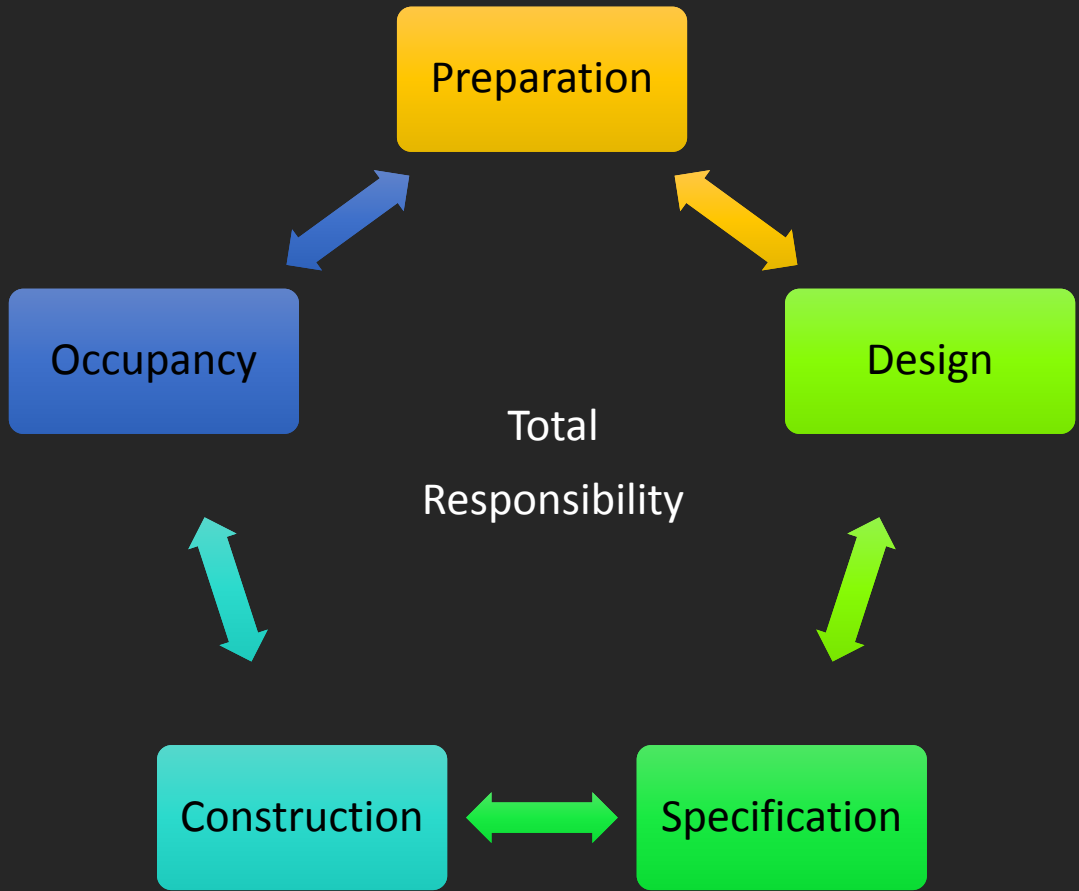
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Planning Phase

Responsibility



## Planning Phase

Project  
setup/inception,  
leadership and team



# 3. Design Phase

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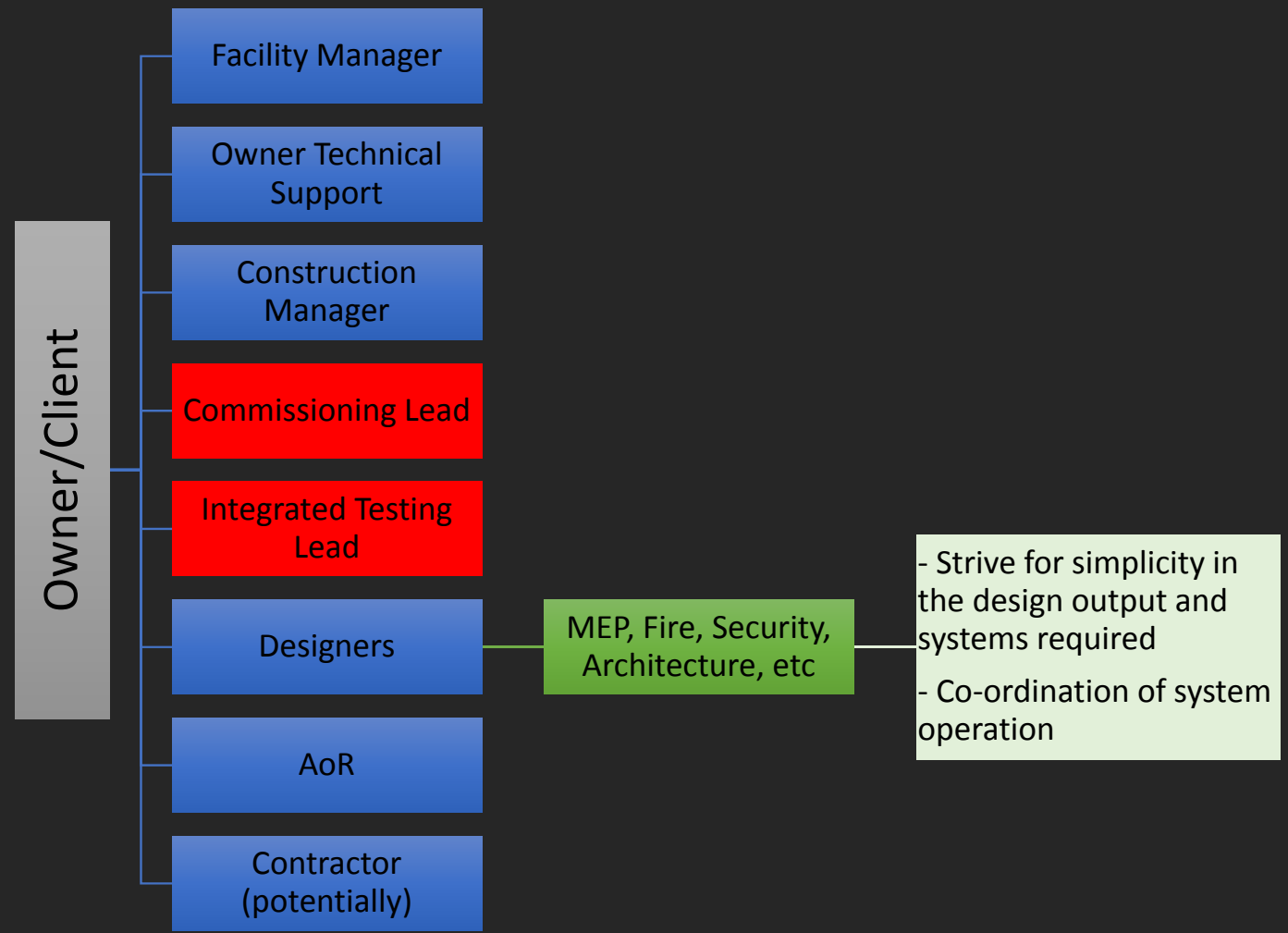


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# Design Phase

## Commissioning Steering Group



Design Phase

Commissioning steering group responsibilities at design stage

Develop BOD (sample available in NFPA 4)		
	Develop commissioning plan	Develop integrated testing plan



## Design Phase

### Basis of Design

**Basis of Design (BOD)** is defined as a document that shows the concepts and decisions used to meet the owner's project requirements and the requirements of governing laws, codes, regulations and standards.

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

- (1) Building description
- (2) Description of fire protection or life safety systems
- (3) Performance objectives and criteria
- (4) Referenced codes and standards
- (5) Design methodology
- (6) Testing criteria
- (7) Inspection, testing, and maintenance requirements

## Design Phase

### Commissioning Plan (initial plan)

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

The commissioning plan should contain the following information:

- (1) Commissioning scope
- (2) Project information
- (3) Team members, roles, and responsibilities
- (4) 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

## Design Phase

### Integrated Testing Plan (initial plan)

**Integrated Testing** is defined as A test performed on fire protection and life safety systems to confirm that operation, interaction, and coordination of multiple individual systems perform their intended function.

The integrated testing plan should contain the following information:

- (1) **Written verification** of individual system installation and acceptance testing completion
- (2) List of the individual systems to be tested
- (3) Integrated test team and additional entities required to be in attendance
- (4) Equipment required for testing
- (5) A comprehensive functional matrix depicting all system inputs and output
- (6) List of necessary drawings, including riser diagrams and control diagrams
- (7) **Narrative description of the test scenarios**
- (8) The extent of systems to be tested
- (9) Test schedule, including individual systems
- (10) Periodic integrated systems test frequency

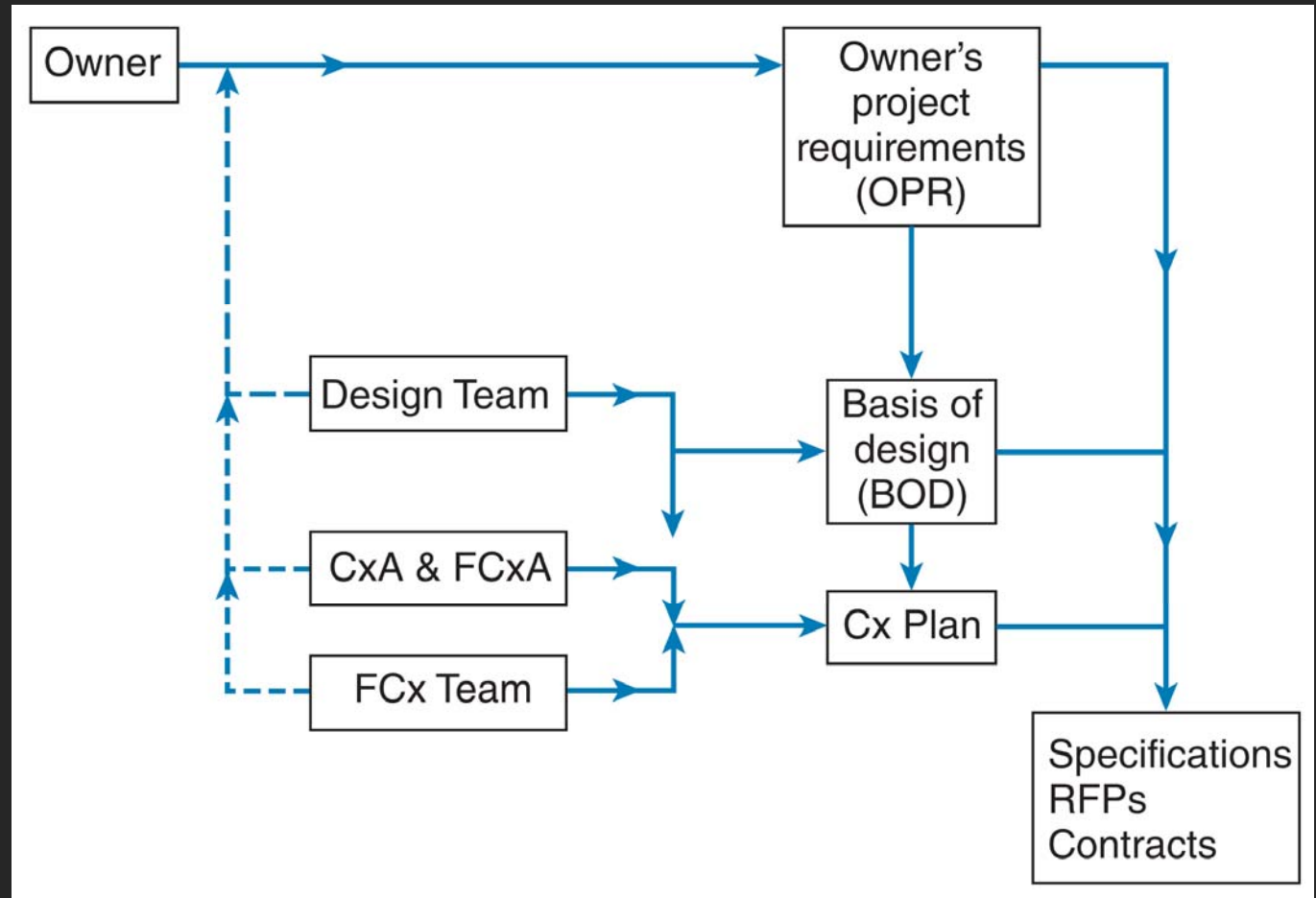
## Design Phase

## Desktop trials

Scenario	Area	Initiation Device(s)	Initiation Procedure	Test Objectives
1	MTB	Smoke Detector	Initiate smoke detector at bridge to VCN, acknowledge at FCC and acknowledge alarm as false. (b) Initiate smoke detector again, do not acknowledge at FCC	<ul style="list-style-type: none"> <li>• Check PAS false alarm</li> <li>• Check elevator recall</li> <li>• Check escalator/walkway stop</li> <li>• Check automatic closing doors</li> </ul>
2	Concourse A (third floor)	Manual Pull	Initiate manual pull and acknowledge in FCC before 15 seconds, initiate alarm directly from FCC	<ul style="list-style-type: none"> <li>• Check PAS override at FCC</li> <li>• Check Concourse A evacuation message</li> <li>• Check for no public alert message</li> </ul>
3	MTB and Concourse B	Waterflow(MTB) and Smoke Detector (Concourse B)	Initiate a water flow device in MTB (cannot acknowledge) Activate smoke detector in Concourse B after evacuation and alert messages have started	<ul style="list-style-type: none"> <li>• Check PAS w/waterflow</li> <li>• Check multi-zone announcement synchronization</li> <li>• Check Concourse B smoke exhaust</li> </ul>
4	Concourse C (baggage)	Smoke Detector and Manual Pull	Initiate smoke detector and acknowledge at FCC before 15 seconds. Before 180 seconds elapse, initiate manual pull station	<ul style="list-style-type: none"> <li>• Check PAS double knock</li> <li>• Check baggage conveyor shutdown</li> <li>• Check baggage shutters close</li> <li>• Check horns/strobes in zone</li> </ul>
5	VCN	Manual Pull	Initiate manual pull in garage portion of VCN, do not acknowledge	<ul style="list-style-type: none"> <li>• Check announcement compatibility</li> <li>• Check Garage/PTC integration</li> <li>• Check garage alarm signal at FCC</li> </ul>
6	Concourse B (emer. power test)	Waterflow	Initiate waterflow device (cannot acknowledge at FCC)	<ul style="list-style-type: none"> <li>• Check Concourse B smoke exhaust</li> <li>• Check exit sign lighting</li> <li>• Check emergency lighting</li> </ul> <p><u>(All on emergency power)</u></p>

## Design Phase

Flow chart for creating commissioning documents



Ref: NFPA 3 & 4 Commissioning and Integrated System Testing Handbook

# 4. Construction Phase

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## Construction Phase

### Updating of documentation

#### Planning Phase

- Basis of Design fixed at planning or early design phase.

#### Design Phase

- Initial commissioning plan prepared.
- Initial integrated system testing plan prepared.

#### Construction Phase

- Commissioning and integrated system test plans updated and further detailed to reflect contractor appointment, construction planning, etc while aligning with original BOD requirements.

# Construction Phase

## Testing Sequence

### Pre-Functional tests (standalone)

Initial tests performed prior to acceptance testing to confirm operation and compliance with intended function.

### Acceptance Tests (standalone)

Tests performed on an installation to confirm compliance with applicable manufacturers' installation specifications, applicable codes and standards, and the project BOD and OPR requirements.

### Integrated Testing

A test performed on fire protection and life safety systems to confirm that operation, interaction, and coordination of multiple individual systems perform their intended function.



## Construction Phase

### Example acceptance testing methodology

A testing methodology for each stand alone system should have been established at design stage and should also include a pass/fail criteria. Model codes may provide limited information on the acceptance testing process.

For example a elevator and stair pressurization system testing methodology could include:

- No. of doors assumed open (there locations, how may scenarios need tested);
- Is 12.5pa to be maintained when both systems are running – between the stair door/elevator door and lobby?
- Is lobby door assumed closed or open?
- How is systems to be initiated? Etc.

## Construction Phase

Integrated testing approach and summary of example scenarios

Scenario	Area	Initiation Device(s)	Initiation Procedure	Test Objectives
1	MTB	Smoke Detector	(a) Initiate smoke detector at bridge to VCN, acknowledge at FCC and acknowledge alarm as false. (b) Initiate smoke detector again, do not acknowledge at FCC	<ul style="list-style-type: none"> <li>• (a) Check PAS false alarm</li> <li>• (b) Check elevator recall</li> <li>• (b) Check escalator/walkway stop</li> <li>• (b) Check automatic closing doors</li> </ul>
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## Construction Phase

## Documentation

Summary of Information for Final Test Report. Complete list in NFPA 4.

- (1) Summary results of integrated testing.
- (2) A narrative or matrix describing each test and the responses of the system.
- (3) Detail individual system where a response occurred as the result of a simulated condition.
- (4) Statement that all input and output functions of the integrated system have been tested and operate as intended.
- (5) A description of any faults recorded shall be made in an issues log.
- (6) Where any test result does not comply with the intended design, corrective action report shall be prepared.
- (7) The integrated test team shall maintain a record of faults, failures, and discrepancies discovered through the testing process in the issues log.
- (8) The issues log shall list the resolutions and dates for closure.

# 5. Occupancy Phase

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## Occupancy Phase

### Frequency of integrated testing

#### Upon installation (initial integrated systems test)

- Performed at installation where required by a commissioning or integrated system test plan.
- Existing buildings that have not undergone integrated testing shall do so in accordance with NFPA 4.

#### Periodically

- Periodically as specified in the commissioning plan. Interval to be based on a risk assessment taking into account building type, occupancy, hazard, height, etc.
- Within 5 years of adoption of NFPA 4 existing buildings shall have an integrated test plan developed or shall undergo integrated testing.

#### Upon existing system modification

- When new fire safety systems are installed and connected to the existing integrated system.
- Existing fire safety systems are modified to be connected to an integrated system. Only those portions of the integrated system that are impacted should be tested.
- Changes are made to fire safety system software.

# 6. Conclusion

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## Conclusion

### The Problem!

- Lack of understanding when it comes to integrated testing.

### Planning Phase

- Total responsibility across the team.
- Project inception/setup, leadership and team selection.

### Design Phase

- Commissioning steering group.
- Basis of design.
- Commissioning plan including integrated testing methods.
- Appropriate testing methodologies.

### Construction Phase

- Updating of commissioning and integrated testing plans.
- Appropriate sequence of testing.
- Acceptance testing methodology.
- Integrated testing scenarios.

### Occupancy Phase

- Frequency of testing.