NFPA 101 2012 edition Atrium Design New and Existing and Retro Commissioning, Commissioning and Maintenance

Michael A Crowley PE and Joseph W. Beadle, CFPS

Jensen Hughes
September 2018

JENSEN HUGHES
Advancing the Science of Safety
1. Identify the new and existing smoke control atrium design criteria.

2. Describe the current requirements for existing atrium smoke control.

3. Describe nationally recognized testing methods (Commissioning) for new and existing smoke control systems.
Old Design Parameters

- Exhaust rate based on volume of the space
- 4 to 6 air changes per hour (Local requirements 10 to 15 air changes per hour)
- Low level make up air.
- Emergency power
- Fans may or may not be temperature rated
- Minimal controls (on / off)
- Natural ventilation was allowed
New Design Parameters

- Exhaust rate based smoke generation calculation based on the highest walking surface in the atrium.
- Exhaust rate increases with the height of the clean air to smoke interface.
- Make up air added below the smoke to clean air interface.
- Emergency power
- Fans must be temperature rated
- Fans must have redundant drive belts if not direct drive.
- Full control at the FFCP
Previously approved existing Atrium

- No requirement in NFPA 101 for testing
- Periodic Testing is required by NFPA 92 Section 8.6.
- No frequency is set but there should be a policy and test program for TJC or CMS to review
- Building must be fully sprinkler protected
- Periodic testing will be similar to the original commissioning tests. The more complex the system the more involved the testing.
NFPA 101 2012 Requirements for Atrium

New Atrium

- NFPA 101 for testing based on engineered system
- Periodic Testing is required by NFPA 92 Section 8.6.
- No frequency is set but there should be a policy and test program for TJC or CMS to review
- Building must be fully sprinkler protected
- Commissioning will start during design. Commissioning agent will determine the test methods and equipment to verify the engineer of records design criteria is met.
- Normal power and emergency power operations will be tested.
- Manual activation, automatic sprinkler and fire detection activations will be tested.
- Fire Fighters Control Panel (FFCP) will be used and verified
- No hot or cold smoke should be used.
Never Commissioned Atrium (Retro Commissioning)

- Determine the design parameters for the atrium smoke control
- Prepare test protocol to evaluate the design parameters
- Plan alternatives if the system does not reach the design parameters.
- Document the testing and test procedures
- Set a periodic maintenance testing for the future.
Smoke Control Commissioning or Retro

- Initial testing of system required upon installation in building
- Component testing
- Sequence of operations testing
- Performance testing
  - Air balancing
  - Hot and cold smoke tests
Goals of Commissioning

- Verify Initial Functionality of Installed Smoke Control System Components
- Verify System Capable of Operating As Designed
Special Inspection Requirement

- Some Codes Require a Third Party Special Inspector to Verify Functionality of Installed Smoke Control System
  - Designer as 3rd Party?
  - Independent 3rd Party?
- Engineer of Record Required to Sign Off Special Inspection
Smoke Control System Implementation

Typical Time Line

- Rational Analysis
- Site Permit
- Building Permit
- Sprinkler Shop Drawings
- Fire Alarm & Smoke Control Submittal
- Smoke Control System Commissioning
- TCO
General Commissioning Steps

- Inspect the building and equipment
  - Smoke barriers
  - Identify critical equipment
  - Equipment locations
  - Equipment installations
  - Duct Leakage
Functionally Test all the fans, dampers, etc

- Verify status indication at the FFCP
- FFCP configuration
- Verify proper control
  - Priority over normal operation
- Verify proper monitoring (Supervision)
  - Status of all critical parts
  - Monitoring methods
  - Presence of Power
  - What equipment needs to be monitored?
General Commissioning Steps (cont)

- **Sequence of Operations Testing**
  - Initiating fire alarm devices
  - Confirm proper component alignment
    - Based on Sequence of Operations in Smoke Control Report, AND
    - Understanding of the smoke control concept

- **Performance Testing**
  - Pressures and Door Forces
  - Exhaust and Other Airflow Quantities as appropriate
General Commissioning Steps (cont)

- Test Under Emergency Power
- Periodic Self-Test (supervision)
  - Tests all critical equipment
- Commissioning Report
Testing and Acceptance Approach

- Physical Inspection
- Equipment Functional Testing
- Sequence of Operations Testing
- System Performance Testing
- System Self-Testing
Physical Inspection of Barriers

- Looking for holes in smoke zone boundaries
- Critical Areas
  - Floor
  - Shafts (Inside and outside)
  - Return enclosure in penthouse
  - ATS separation from normal switchgear and transformers
Physical Inspection

- Fire / Smoke Dampers (FSDs)
  - Installation - Seal Angles
  - Labels - Fire and Smoke Rating (1 ½ Hour - Class II)
  - Control Devices (Fire Alarm and/or BMS)
  - Monitoring Devices - END SWITCHES
  - Field Examples
FSD Installation
Physical Inspection

- Fans (and Motors)
  - Installation - Non-Combustible Supports
  - Rating for Airflow, Horsepower and Service Factor
  - Number of Belts and Tension
  - Power and Disconnects
  - Monitoring Devices Field Examples
Return Fan VFD

- Fan Control by VFD
Control Issues (con’t)

- Maintenance Disconnects
  - Code requires monitoring
  - Real-Time monitoring at FFCP

- VFD Experience
  - Use of VFD “Fire Mode” Contact did not render OFF button inoperable
  - Button could not be monitored
  - Manufacturer-initiated VFD changes likely
Physical Inspection

- Firefighter’s Control Panel (FFCP)
  - Matches Approved Design
  - Graphically Depicts Building
  - Satisfies SFFD Indication Requirements
    - ON is GREEN; OFF is RED; FAULT is YELLOW
  - Listed-UUKL (Existing not required based on the age)

- Fire Alarm Control Panel (FACP)
  - Listed for Smoke Control-UL (Existing not required based on the age)

- Building Management System (BMS)
  - Listed for Smoke Control-UL (Existing not required based on the age)
Fire Fighters Control Panels (FFCP)
Firefighters Control Panel
FFCP Design
FFCP - Atrium System
The goal is to verify that equipment is operational and capable of working properly as part of the automated system.

Functional testing can be performed before completion of automated system components.

- Often only requires presence of power.
- May be operated solely by FFCP.
Equipment Functional Testing

- Inspectors
  - One at FFCP to Manually Operate
  - One at Equipment (Fan or Damper)

- Timing
  - Fans - 1 min
  - Dampers - 30s

- FAULT Condition
  - Equipment Fails to Operate as Commanded
  - Operates Too Slowly
  - Equipment Loses Power
FSD Functional Testing

- Simulate FAULT Condition (Field)
  - Disconnect Power Leads
  - Turn OFF Breaker or Local Disconnect
  - Loosen Motor Set-Screw and Rotate Jackshaft
  - Verify All Jackshafts are Monitored-Examples
- Verify Indication at FFCP (FFCP)
System Performance Testing

- **Building and Equipment Status:**
  - Smoke Control System is Complete
  - Smoke Zones are Complete
    - Barriers Sealed
    - Doors Closed
    - Door Jams, Sills, Hardware Installed

- **Equipment Operating Status**
  - Normal HVAC and Smoke Control Equipment Simulates Smoke Event
System Performance Testing

- Pressurization Method Acceptance Criteria
  - Pressure Differentials per Rational Analysis
  - Across Adjacent Zone Boundaries
  - Across Passive Sub-Zone Boundaries
  - Door Opening Forces per Rational Analysis
Sequence of Operations

- Single Zone Sequence
  - Test One of Each Type of Initiating Device per Zone
    - Smoke, Waterflow, Manual Pull
  - Verify:
    - Proper Equipment Operating Status and Timing
    - Measure Fan Performance
- Verify Second Zone Alarms are Ignored
- Standby Power Test
  - Drop All Normal Building Power
  - Duplicate One Representative Sequence
Underwriters’ Labs - UUKL Listing

- Control systems shall be listed in accordance with UL 864, category UUKL.
- Smoke control panels listed under UUKL have the capability of performing a weekly self-test of dedicated system components.
- Meets intent of supervising system components.
- Greatly improves smoke control system reliability.
Periodic Self-Test

- Purpose is to Verify Readiness of Dedicated Smoke Control Equipment
- Performed by FACP or BMS not FFCP
- Test Sequence:
  - Set Clock to Auto-Initiate
  - Verify All Dedicated Components are Exercised (Fans and FSDs)
  - Simulate FAULT an No-FAULT Conditions
  - Confirm Accurate Report Generated
Commissioning Report

- Document Design Basis
  - Reference Codes and Rational Analysis
  - Detailed Comparison to Code
- Test Procedure
- Test Results
  - \( \Delta P_s \), Door Opening Forces
  - Air Flow Measurements
- Detailed Information on Equipment
  - Equipment cut sheets (e.g. fans, dampers, FACP, monitoring devices, etc.)
Reliability of the System Directly Dependent on How Well it is Maintained

- Test Frequencies are a Function of Use
  - Dedicated vs. Non-Dedicated Equipment
- Pressure Differentials Need to be Periodically Verified in Zones Employing Pressurization Method
- Smoke Damper Operation Must be Periodically Verified
Recommended Re-Testing

- **Alarm System**
  - Verify appropriate new devices initiate smoke control.
  - Verify existing devices still initiate smoke control.

- **Smoke Zone Changes**
  - Verify new barrier construction.
  - Assess impact of barrier changes on smoke control zoning, sequence of operations.

- **New Dampers/Fans**
  - Verify proper operation.

- **Performance Testing**
  - Re-measure pressure differential
SUMMARY OF PRESENTATION

- Existing previously approved atria can remain
- Periodic testing is required per NFPA 92
- Commissioning for new is required
- Retro Commissioning is not required
- Documentation is required
Contact
Michael A Crowley P.E., FSFPE, FASHE
+1 281-640-7100
mcrowley@jensenhughes.com
Joseph W. Beadle, CFPS
+1 860-793-8600
jbeadle@phillipsllc.com
For More Information Visit
jensenhughes.com