

Denver Fire Department

Fire Protection and Fire Alarm Testing Guide



This Testing Guide was developed in good faith to establish the expectations for testing with the Denver Fire Department. All contractors are reminded that they are responsible for installing, pre-testing and acceptance testing per the latest Denver Amendments and permit review comments. Contractor acknowledges that project requirements may result in deviating from what is in this testing guide.

Developed in conjunction with:



Revisions	
23-Apr-21	Smoke Control updates + updates for 2019 DBC
15-Dec-20	Update the Cover Sheet
24-Nov-20	Incorporate DFD Elevator Comments
13-Feb-20	Fix DEN Sign-Off Logic
29-Oct-19	Incorporate DFD Comments
20-Jul-19	Initial Release - Validation

July 2019

Thank you for taking time to review this testing guide of how the Denver Fire Department (DFD) tests fire protection and fire alarm systems.

Denver is growing and new construction is booming. Owners are hiring designers and contractors to build new buildings that are changing Denver's skyline.

The City and County of Denver (CCD), the Denver Fire Department (DFD), Owners, Designers and Contractors all are working under the same constraints. We are all working within a budget and that budget only supports a specific number of people.

For 2019, DFD's Testing and Inspections Division budget provides for eight (8) Testing Technicians. These 8 Testing Technicians are responsible for testing all new fire protection and fire alarm system in the City and County of Denver for both new construction and remodels.

The construction industry can save everyone time and effort by not scheduling DFD's Testing & Inspection Team until you are ready. Only schedule DFD after:

- 1) a complete and thorough pre-testing of all fire protection/fire alarm systems has been performed
- 2) you have the building in a state that is ready for move-in

The goal of this testing guide is to clearly communicate how DFD's Testing Technicians will be testing your fire protection and fire alarm systems. It has always been the responsibility of the construction teams to pre-test 100% all systems prior to calling DFD for the testing and inspection of a fire protection/fire alarm system. This testing guide will make pre-testing by the construction team more defined and systematic.

Systematic pre-testing of all systems by the construction teams will result in:

- 1) faster testing with DFD's Testing & Inspection Team
- 2) less failed tests
- 3) more time for DFD's Testing Team to support testing city wide

When scheduling inspections, it is helpful for me to understand the specifics of what will be tested. Appendix 5 has a form you can fill out that will clearly communicate this information to me. Appendix 6 will help you navigate the permitting process while appendix 7 will help you understand the steps and sequence of for obtaining TCO/CO signoff.

Here is to successful testing the first time,

Lieutenant Derrick Johnson, Lead Testing & Inspections Division

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720.913.3480 (testing and inspections line)

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General Order of Testing (from top to bottom)

	DFD Fire Protection Engineer (FPE)	DFD Line Shop	DFD Flammables Team	DFD Inspection Team	DFD CO2 Inspector	3rd Party Elevator Inspector (State of CO Approved)	DFD Life Safety Team
		720.913.1820	720.913.3518	720.913.3480	720.865.2952		720.913.3409
Permits							
Fire Alarm - 2 ways, Bi-Directional Amplifiers (BDA)	X						
Fire Alarm - 2 way communications	X						
Fire Protection - temporary FDC & standpipe	X						
Fire Protection - fire pumps, fire suppression, standpipe for construction phase	X						
Deferred Smoke Control	X						
Generator Sets	X						
Leak Detection (refrigerant, ammonia, CO etc.)	X						
On-site inspections to approve location of equipment:							
of temp construction Fire Department Connection (FDC) & standpipe (required once construction is ≥ 30ft above ground level)				X			
of the Fire Department Connection (FDC) & "water gong" (must be within 20' of the FDC)				X			
of the layout of all the equipment in the Fire Command Center (FCC)				X			
of all releasing panels (reference special systems)				X			
of the radio and antenna for the 24/7 Fire Alarm monitoring station callout system		X					
Generator Inspection							
on-site inspection to locate the generator remote annunciator			X				
installation verification			X				
witness fueling & tank alarm levels			X				
Fire Protection & Fire Alarm Testing							
fire protection systems				X			
underground fire water main flush per NFPA 13/NFPA 24 (performed by the installing contractor & witnessed by CCD's Plumbing Inspector)				X			
fire water backflow preventer certifications (installing contractor to contract with DFD approved 3rd party)				★ X			
fire pump with emergency generator & pressure reducing valves (PRVs)				X			
wet systems & dry systems				X			
fire alarm systems				X			
detection devices (spot, duct, beam, flame, carbon monoxide, etc.)				X			
initiation devices (pull stations and water flow switches)				X			
notification appliances				X			
communications system				X			
public-address system				X			
firefighters emergency communications				X			
radio enhancement system		X		X			
special systems				X			
kitchen hoods (Ansul), clean agent, VESDA, leak detection [refrigerant, ammonia, CO], etc.				X			
On-site inspection of equipment using CO2 or N2 (beverage dispensing, industrial equipment, etc.)							
					X		
Elevators							
3rd party inspector						★ X	
Elevator recall (phase I & II) & emergency dial out				★ X			
Smoke Control Acceptance Testing							
	X			★ X			
Life Safety Walk (Site Access, Knox Box, Fire Hydrants, Exit Signs, Emergency Lighting, Free Egress, Fire Extinguishers, etc.)							
							★ X

This is the focus of this Testing Guide

★ = use generator to support testing

Fire Pump, Generator and Pressure Reducing Valve (PRVs)

Pre-planning

- Provide a method to test the standpipes at the top of the stairwells.
 - A plan is needed for stairwells that do not access the roof
- Water mitigation plan
 - How will the fire pump test water be handled?
 - lane closures to prevent hydroplaning of vehicular traffic
 - icing if below freezing outside
 - DFD typically does not test fire pumps if it is below 40 degrees F.
 - open excavations - assure water will not flood any deep excavations
 - shaded areas that are frozen or will freeze
 - North side of the building in winter
 - How will 500 gpm of fire water from the roof manifold be handled? What is the path from the roof to the storm drain?
- Restrict vertical circulation within the building when the PRVs are being tested
- The stairwell(s) with the PRVs need to be closed to general traffic and clean of dust, dirt and debris
- DFD HazMat to provide a site inspection and locate the remote annunciator for the Generator
- Verify the following electrical rooms ARE NOT sprinklered (per Denver Amendments 903.3.10)
 - electrical rooms under the control of a public utility
 - electrical rooms dedicated to electrical distribution equipment and operating at 600 volts or more

Testing rules of thumb:

- 1.5 hrs. for 1 fire pump
- 2.5 hrs. for 1 fire pump with a generator
- 4 additional hours added for testing up to 20 PRVs

Project Status - what must be complete in order for DFD to conduct testing

- Generator has been started up, tested and signed off by DFD's Flammable's Engineer
- Fire Protection system is complete
- Fire Alarm system can support fire pump testing:
 - no ground faults
 - no trouble on the fire alarm loops that are being tested
- Building is clean

Pre-testing

- Generator started up, tested, load-banked and fueled per NFPA 10
- Functionality of all Transfer Switches
- Pretest 100% of all devices being tested
- Point lit graphics pre-tested for the fire protection points being tested
- Graphics workstation pre-tested for the fire protection points being tested

Trade Participation (be prepared to show proof of State & Municipal licensing)

- 1 Manufacturer representative for the fire pump and fire pump controller
- 2 Pipe Fitters
- 1 Building electrician
- 1 Fire Alarm Technician (if fire pump is reporting to fire alarm system and it is ready to be tested)
- 1 General Contractor representative
- 2-3 Pipe Fitters for each PRV testing skid

Equipment required for the day of the test

- Play pipe assemblies (hose monsters)
 - 3 minimum is preferred
- Calibrated pitot tube for measuring water flow through the play pipes
- Liquid filled gauges are required
- Tachometer for measuring RPMs of the fire pump
- Appropriately rated arc flash suit - for measuring volts/amps inside the fire pump controller
- Minimum two (2) sets of PRV testing skids
 - 2 Liquid filled gauges reading PSI (one BEFORE the PRV and one AFTER the PRV)
 - Liquid filled gauges reading GPM. Must have hash marks for reading 100 gpm & 250 gpm (note: 100 gpm is not a typical hash marking)

← Indicates DFD's activities during testing. Have all paperwork ready for inspection and all devices/sequences pre-tested.

Paperwork to review with DFD prior to the start testing

- Verify all the following paperwork is organized and in the Fire Command Center prior to DFD's arrival
- Fire protection permits
- Fire protection drawings that have been stamped by DFD's Plan Review from DFD's Fire Protection Engineer (FPE)
 - Fire pump product data with pump curves
- Changes to the DFD approved drawings
 - common sense changes of - add missing devices, adjust device locations, etc. ok, no documentation required except for redlines/as-builts
 - substantial changes (to devices or the sequence) must have separate permit
 - minor changes can be approved via DFD's e-permitting process
- NFPA 13/NFPA 24 Underground Firewater Main flushing for filled out by the installing contractor
- Fire protection permit sign off cards/sheets with a "200 psi hydro/OK to Test" notation by CCD/CPD Plumbing Inspector
- Electrical sign off for the Fire Pump and Fire Pump Controller by CCD Electrical Inspector.
- Licenses
 - Pump license for pump/controller representative
 - Licenses for installing pipe fitters
 - Journeymen and apprentice
 - Verification that the ratio does not exceed 2 apprentices to 1 journeyman
- Pump curve from the factory test for the fire pump that is installed - as tested at the factory
- Calibrations are current (within 1 year of the date of test)

- Pitot tube calibration
- PRV test skid liquid-filled psi gauge
- PRV test skid liquid-filled gpm gauge
- Contractor's pre-testing documentation for Pressure Reducing Valves (PRVs) using DFD's template (see Appendix 1)
- Blank PRV Adjustment Form from the DFD website (check web site for updated forms)

https://www.denvergov.org/content/dam/denvergov/Portals/678/documents/FPB/DFD_PRV_Standpipe_Testing_Template.pdf

Review Specifics on how Testing will be Performed

- How will fire pump test water be handled:
 - at the street level
 - at the roof level (500 gpm at the roof manifold)
- How many play pipes will be used to test the fire pump?
- What pitot readings will we be looking for at:
 - 50% flow = _____ psi from _____ hoses
 - 100% flow = _____ psi from _____ hoses
 - 150% flow = _____ psi from _____ hoses
 - 500 gpm at roof hydrant = _____ psi from 1 hose
 - flow at top of stairway standpipes:
 - 500 gpm if building has one (1) stairwell
 - 750 gpm if building has two (2) stairwells (500 gpm + 250 gpm)
 - 1,000 gpm if building has three (3) stairwells (500 gpm + 250 gpm + 250 gpm)

FIELD INSPECTIONS/VERIFICATIONS

- Verify that the fire pump & fire pump name plate that is installed is the fire pump & fire pump nameplate that was submitted on and approved by DFD's Fire Protection Engineer (FPE)
 - this is sometimes referred to as verifying the nameplate data
 - IF this is a diesel fire pump that is located inside the building, verify the following:
 - Verify combustion air is provided to the engine
 - Verify all dampers (combustion air and cooling air) fail OPEN
 - Verify exhaust routing and terminations
- Verify that the fire pump controller that is installed is the fire pump controller that was submitted on and approved by DFD Fire Protection Engineer (FPE)
- Verify that the jockey pump, jockey pump name plate & controller that is installed is the jockey pump, jockey pump name plate & controller that was submitted on and approved by DFD FPE
- Review the installation for code compliance and that the installation is in a "workmanship like manner"
 - Verify there are two (2) main water flow switches
 - One (1) waterflow switch on the suction side of the pump - programmed as a supervisory (monitoring for a broken water supply line)
 - if there are multiple water feeds to the fire pump, each fire water supply line is to have this flow switch
 - One (1) waterflow switch on the discharge side of the pump - programmed as an alarm (it is monitoring for ANY water flow through the fire protection system)
 - location is after the fire pump bypass loop and prior to any branch lines or valves per NFPA 20
- Verify installation of the Fire Pump Remote Status Panel (usually located in the Fire Command Center)
 - Verify every point properly displays on the Fire Pump Remote Status Panel
 - trigger each point from the fire pump controller - verify it annunciates on the Fire Pump Remote Status Panel
 - OPTIONAL - if the fire alarm system is ready, these points can also be verified as properly reporting to the Fire Alarm Control Panel as supervisory alarms
 - If the fire alarm system is not ready these can be tested with the fire alarm system tests. The pipe fitter can trigger the points for this testing.
- Verify signage
 - All valves are clearly labeled with "Normally OPEN" or "Normally CLOSED". Do not abbreviate "NC" or "NO"
 - All room signs are in place
 - The same room name/number used on room signage matches the Fire Alarm Graphics (point lit graphic map & graphic workstation)
- Verify Knox Caps are provided at the FDC and Fire Pump Test Header

Fire Pump Test (NFPA 20 - Figure A.14.2.6.6)

	Test Sequence	Power Source	Adjust Flow (PSI)	Record						If there is a Generator:		
				RPM	VOLTS			AMPS			Disconnect Main Power to the Building	Generator On-Line, Pump up to speed in 60 seconds
					A	B	C	A	B	C		
<input type="checkbox"/>	START Fire Pump											
<input type="checkbox"/>	Test Churn	Normal										
<input type="checkbox"/>	Test at 50% water flow	Normal										
<input type="checkbox"/>	Test at 100% water flow	Normal										
<input type="checkbox"/>	Test at 150% water flow	Normal										
<input type="checkbox"/>	Test at 150% water flow	Emergency										
<input type="checkbox"/>	STOP Fire Pump											

Pump Representative to generate Acceptance Test Report including plotting the curves (factory vs. actual) per NFPA 20

This must be submitted to DFD FPE for review. Submit to:

Fire Protection Contractor

General Contractor

DFD's Fire Protection Engineer who performed the plan review

(DFD's Test Lead may take a picture of this and upload it for the DFD FPE to review.)

DFD's Lieutenant - Testing & Inspections Division

DFD's Testing Lead Technician

Acceptance/Approval is required prior to final sign off of the Fire Alarm System & Fire Protection Permit

Test System Connected to the Fire Pump

Roof Manifold

Go to the most remote point. For new construction, this will be the roof manifold.

Connect hose and play pipe (hose monster) to roof manifold.

Connect calibrated liquid filled PSI gauge in test port for reading residual pressure (usually located inside the building)

OPEN roof manifold.

Fire Pump will start

Adjust roof manifold valve to achieve 500 gpm

Record residual pressure (must be greater than 100 psi)

ACTUAL = _____

Flow water until it is clean (no debris) & clear

CLOSE roof manifold

Shut OFF Fire Pump

Pressure Reducing Valve Testing

- Replace building fire protection system gauges with calibrated liquid-filled test gauges - if applicable
- Start at the highest PRV and methodically work down
- Stairwell(s) where testing of the PRV is being conducted should be:
 - CLOSED to general traffic
 - Clean of dust, dirt and debris
- Document on DFD's PRV Adjustment Form (download in a fillable format from DFD's website)

https://www.denvergov.org/content/dam/denvergov/Portals/678/documents/FPB/DFD_PRV_Standpipe_Testing_Template.pdf

DFD PRV Standpipe Testing Report									
Bldg Address:		Test Date:		Test Conducted by Technician:				DFD License#:	
Installing Contractor Name & Address:									
Location	Floor	Brand/Model	Setting	Static Conditions		Flowing 100 GPM		Flowing 250 GPM	
				Inlet (psi)	Discharge (psi)	Inlet (psi)	Discharge (psi)	Inlet (psi)	Discharge (psi)

Notes:

- The fire pump is running during the PRV testing
- Static Pressure downstream of the PRV must be equal to or less than 175psi
- Water is discharged into the express drain adjacent to the PRV
- Residual pressure at 250 gpm must be greater than or equal to 100 psi & lower than 175 psi. (Higher pressures are preferred - i.e. closer to 175 psi)

- DFD's Testing Lead Technician to initial the DFD PRV Adjustment Form showing the "as-tested" readings
- Field Testing of PRVs is complete**

Post-Testing PRV Paperwork

- Plot the documented PRV test data on the Elkhart* PRV performance curve
- Submit the DFD PRV Adjustment Form & Elkhart* PRV performance plots to the DFD FPE for review. Submit to:
 - Fire Protection Contractor
 - General Contractor
 - DFD's Fire Protection Engineer who performed the plan review.
 - DFD's Test Lead may take a picture of this and upload it for the DFD FPE to review.
 - DFD's Lieutenant - Testing & Inspections Division
 - DFD's Testing Lead Technician
- Acceptance/Approval is required prior to final sign off of the Fire Alarm System & Fire Protection Permit

* = Elkhart or equal

Fire Alarm Devices

Pre-planning

- Prior to the start of testing, discuss testing plan with DFD's Test Lead, have an agreed upon plan on how testing will be performed
- Take picture of Elevator Status Panel and send to Mike Stewart (Conveyance Program Manager) for confirmation
 - michael.stewart@denvergov.org
- Management of Fire Water produced from testing
 - Waterflow from the Inspector's Test Stations:
 - Wet systems
 - Dry systems - including water delivery times
 - Dry standpipes - including water delivery times
- DFD Testing & Inspections Team to make an on-site inspection to approve the layout equipment in the Fire Command Center
- Understand the Denver Amendments. Specifically:
 - what is to be provided in the Fire Command Center (FCC)
 - what information is to be included on the point-lit graphic maps
 - what information is to be included on the Firefighters' Smoke Control Panel
- Assure that the proper Freezeproof roof hydrant is used - VIC 707C or similar with the Normally Closed (NC) tamper switch
- CO detectors must be compatible with the FA system and the voltage of the CO detector must match the voltage of the FA system
- Assure that the Fire Alarm graphics (point lit and/or workstations) has all the information required per the Denver Amendments
 - reference Appendix 2 of this Testing Guide - assure you are referencing the code that your project has been permitted under
- Verify fire alarm design incorporates:
 - manual pull station in the Fire Command Center (FCC)
- Verify point lit graphic and computer graphics are oriented in the direction as viewed from the graphic mounted location
 - true north arrow to be included on the graphics
- Verify Fire Command Center (FCC) has the ability to release all magnetic locks to allow free egress
(this cannot be incorporated into the point-lit graphic map or the graphic workstation)

Testing rules of thumb:

- 20-30 minutes per floor for office building
- 45-60 minutes per floor for residential/hotel

Project Status - what must be complete in order for DFD to conduct testing

- Fire Protection system is complete
- Fire Alarm System is "complete, clean and green" (there are no troubles or ground faults)
- Building is clean
- Fire Command Center is 100% complete.
 - All finishes are complete
 - All systems are functional - (Fire Alarm equipment, elevator equipment, dedicated cooling, lighting, etc.)
 - Room is clean and neat
 - Room contains all furniture required by the Denver Amendments (table, chairs, drawing cabinet/rack, binder shelf... - see Appendix 3)
- All permanent signage is installed (temporary signage may be acceptable after discussions with DFD's Testing Lead)
 - Note: Shawn Lord (DFD Life Safety) will perform a courtesy review of the signage package to assure adequate life safety signage is being provided. Send prior to release of the signage package. Ensure adequate time is given for review, revision of shop drawings and production of signage.

shawn.lord@denvergov.org 720.913.3409 Life/Safety Lieutenant
- The building is clean and in "move in ready" condition

Pre-testing

- Generator started up, tested, load-banked and fueled per NFPA 10 (Tested and Passed by DFD)
- Functionality of all Transfer Switches
- Pretest 100% of all devices - fire alarm fire protection, their integration & sequence of operations (SOO)
- Point lit graphics 100% pre-tested
- Graphics workstation 100% pre-tested
- Verify sequence of operations from permitted drawings are followed

Trade Participation (be prepared to show proof of State & Municipal licensing)

- 2 Fire Alarm Installers
- 1 Fire Alarm Technician in the Fire Command Center
- 2 Pipe Fitters (for Flows & Tamper, Dry Systems and Fire Pump Communications testing only)
- 1 General Contractor representative

Equipment required for the day of the test

- test smoke for spot detectors and duct detectors
- test pole for canned smoke
- heat gun for testing heat detectors with extension cords
- canned CO for testing CO detectors
- mesh with proper "rate of obscuration" as defined in the approved DFD fire alarm permit
- ladders as applicable for access (as needed)
- printouts of each graphics page (if applicable) for tracking the testing of each device and for providing markups
- radios for communications
- stop watch for waterflow tests

← Indicates DFD's activities during testing. Have all paperwork ready for inspection and all devices/sequences pre-tested.

Paperwork to review with DFD prior to the start testing

- DFD Stamped Permit set of drawings
- Fire Alarm as-built drawings
- Electrical Permit Card
- Generator Final
- Fire Alarm Rough & "OK to Test"
- Plumbing Rough and Hydro for Fire Protection
- Licenses for fire alarm installers
 - Must be current and on their person
 - For Journeymen and apprentice
 - Verification that the ratio does not exceed 2 apprentices to 1 journeyman
 - Journeymen must be running the test, not the apprentice!

- DFD Flammables
- Generator Rough inspection, Safeties verified & Generator Final by CCD and DFD Flammable Department
- Dry Pipe Systems - capacity of each dry system in gallons
- NFPA 13 Testing Requirements with the table showing the allowable Water Delivery times

Table 8.2.3.6.1 Dry Pipe System Water Delivery

Hazard	Number of Most Remote Sprinklers Initially Open	Maximum Time of Water Delivery (seconds)
Light	1	60
Ordinary I	2	50
Ordinary II	2	50
Extra I	4	45
Extra II	4	45
High piled	4	40

note that the worst case is with one head table from 2019 NFPA 13

- Dry Standpipes - capacity of each dry standpipe
- Documentation of delivery times 3 minutes maximum
- Paper copies of each Fire Alarm graphics panel (for the back lit annunciator) and/or page (for the graphics workstation) for keeping track of devices tested and graphic changes that need to be made (if applicable)
- Manufacturer's installation instructions for CO detectors
- Workstation Login instructions. Password protection is NOT allowed!
- Documentation defining which doors are to be released via the Door Release Switch in the FCC

FIELD INSPECTIONS/VERIFICATIONS

- Fire Command Center**
 - Verify proper layout of all equipment in the Fire Command Center (FCC)
 - Verify proper equipment has been installed in the FCC
 - Fire Alarm Control Panel (FACP) make and model
 - AES make and model (AES is DFD's specified vendor for mesh radios. The Fire Alarm system uses this to communicate with the Central Station
 - AES must be located in the FCC unless a waiver is obtained from DFD's Fire Protection Engineer (FPE)
- Verify all equipment that is required to be in the FCC is there. Reference 508.1.6 of the 2019 Denver Amendments
 - reference Appendix 3 of this Testing Guide

Fire Alarm Control Panel (FACP)

panel is clear "green"

no troubles

no ground faults

battery trouble

loss of AC power

no active "disables"

Verify some TROUBLES

create a NAC trouble and verify it properly reports

turn off 120VAC power to the FACP and verify it reports properly

verify the proper ID of the circuit is labeled on the FACP

verify the circuit breaker is RED and it have a breaker lock to avoid accidental trips

Verify graphic map incorporates all items required by the Denver Amendments - reference Appendix 2 of this Testing Guide

Verify signage

All valves are clearly labeled with "Normally OPEN" or "Normally CLOSED". Do not abbreviate "NC" or "NO"

All room signs are in place

The same room name and number used on room signage matches the Fire Alarm Graphics (point lit graphic map and graphic workstation)

AES functionality:

verify NetCon Score of 5 (best) or 6 (ok with DFD's FPE's approval and backed up via hardwired - copper - phone lines)

verify this AES system is communicating with at least two (2) other AES systems (this is the "mesh" network)

the "Q" score must be 0 (0 = good, 8 =bad)

0 2 = good

0 3 = good

8 0 = bad

verify backup power provided for the AES system upstream of UDACT (Universal Digital Alarm Communicator Transmitter) or RF (Radio Frequency) communicator

- Verify Troubles:
 - battery charger fault
 - loss of antenna
 - power OFF to transceiver
 - loss of power must report within 3 minutes 20 seconds
 - upon powering up - AES system must be completely online within 5 minutes (NetCon = 5 & "Q" = 0)

Graphics

Point Lit Graphics

- LEDs must be functional
- a paper copy of each graphics sheet is acceptable for testing and Temporary Certificate of Occupancy (TCO). The final mylar/screening is required for Certificate of Occupancy (CO)

Graphics Workstation (if applicable to the project)

- operational
- paper copies of each graphics screen for markups
- Workstation Login instructions. Password protection is NOT allowed!

Elevator Status Panel

- Check the installed Elevator Status Panel against the CCD approved panel. Re-occurring issues seem to be:
 - Key Switches for elevators on backup generator power are fabricated different than submitted and approved

Generator Status Panel

- No alarms/faults except for "NOT IN AUTO"

Door Release Switch (this CANNOT be incorporated into the Point Lit Graphic Map or the Firefighters Smoke Control Panel)

- Verify release of all security doors to allow free egress from the building

Knox Vault (this is the preferred solution for high-rise buildings - both Owner and DFD have keys for access so keys can be kept current by the Owner)

- Knox Box is acceptable, but not preferred
- 4 sets of keys minimum (keys and cardkeys)

Device Testing



Reporting criteria



all devices must report status change within 30-40 seconds

the main water flow switch must report within 45-60 seconds

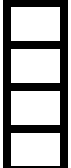


Flow Switches and Tamper Switches



Place Fire Pump in AUTO

Staging of testing personnel:



one (1) licensed pipe fitter in the Fire Pump room/valve room

one (1) licensed pipe fitter with DFD

one (1) licensed fire alarm installer with DFD

one (1) fire alarm technician in Fire Command Center



Start at the top of the building

For each tamper switch:



CLOSE valve by no more than 25% before the supervisory alarm comes in

in Fire Command Center:



call out alarms and device address

verify FACP LCD text, point lit graphic and graphics workstation (if applicable) properly represents the field condition



OPEN valve and supervisory alarm clears



For each water flow switch:



at the inspector's test station, flow water.

START the stop watch



in Fire Command Center:



call out alarms and device address

verify FACP LCD text, point lit graphic and graphics workstation (if applicable) properly represents the field condition



STOP the stop watch when FCC calls out the supervisory alarm



Verify times are +/- 30-40 seconds for zone water flow and +/-45-60 seconds for main water flow (NFPA 13/NFPA 72)

Verify horns and strobes are active per the approved Fire Alarm Sequence of Operations which is typically:



The zone with waterflow, the floor above, the floor below and the 1st floor

Verify audibility (heard or capable of being heard)

- Verify intelligibility of the voice speakers (capability of being understood)
- Verify zone paging capabilities
- Silence the horns/speakers:
 - Verify strobes continue to flash
 - FCC personnel to verify the water "gong" above the FDC is **NOT** silenced. This must be active at all times there is waterflow!
- Stop waterflow
- Silence the water "gong" above the FDC

Usually only done once or twice

Dry-Pipe System

- Inspector's Test Station at the furthest point from the dry valve.
- Area around the inspector's test station must be clean. Compressed air exhausting out of the system will stir up dust.
- Inspector's Test Station must have a knocked out sprinkler head installed to restrict water flow.
 - This must be the same type of sprinkler head that is installed in the system
- Shut off the compressor
 - crack Inspector's Test Station Valve OPEN to bleed air until LO AIR alarm comes in
 - CLOSE dry pipe isolation valve (below the dry valve) until the TAMPER supervisory comes in
 - Test HI AIR PRESSURE supervisory via jumper
- Turn on compressor and re-pressurize the system (this could take 30-60 minutes)
- Open Inspector's Test Station
- Start timer
 - Achieve constant water flow - no sputtering/no air
- Stop timer
 - for dry systems, the time should be within 60 seconds
 - if time is unacceptable, accelerators or other methods will need to be used to get acceptable times per NFPA 13

Repeat for all dry pipe systems so all systems can be re-pressurized at the same time

- in Fire Command Center:
 - call out alarms and device address
 - Dry Pipe Zone waterflow
 - The flow switch is a pressure switch activate by water pressure from the valve chamber. The failure rate on these pressure switches is high.
 - Main waterflow
 - verify FACP LCD text, point lit graphic and graphics workstation (if applicable) properly represents the field conditions
 - Shut Inspector's Test Station valve

Dry Standpipe

- Dry Standpipe hose connection that is to be tested is to be the one furthest from the mainline (the highest hose valve on the standpipe).
- OPEN the hose valve
 - If a hose is needed, it needs to be as short as possible to minimize impacting the test results
- Start timer
 - Achieve constant water flow - no sputtering/no air
 - Stop timer
- Fire Command Center
 - Call out alarms and device address
 - Standpipe waterflow
 - Main waterflow
 - Verify FACP, point-lit graphics & graphics workstation (if applicable) properly represents the field conditions
- Silence the horns:
 - FCC personnel to verify the water "gong" above the FDC is not silenced. This must be active at all times there is waterflow!
- Stop waterflow by CLOSING the standpipe hose valve
- Silence the water "gong" above the FDC
- Close hose valve to STOP waterflow

Usually only done once or twice

Fire Pump

- If not tested with the fire pump testing, test that all the fire pump controller supervisory and alarms report to the Fire Alarm Control Panel (FACP)

All testing with the pipe fitters is now complete. The pipe fitters can be released from fire alarm testing.

Smoke Detectors/Heat Detectors/Duct Detectors (for HVAC Shutdown)/Beam Detectors

Start at the top of the building

Verify installation:

Smoke Detectors (SD)/Heat Detectors (HD)/Duct Detectors (DD)/ (BM) Beam Detectors

SD	HD	DD	BD
X	X		
	X		
		X	
X	X	X	X

Installation verification

- installed at least 3' away from any air movement (supply air/return air/transfer grill)
- must be at least 4" away from the wall/ceiling intersection
- there must be reasonable access
- install per Manufacturer's recommendations

Beam Pockets

If the beam pocket represents more than 10% of the ceiling, then additional detection devices are required in each beam pocket

Activate each device

smoke detector with canned smoke on a testing stick

duct detector - remove cover and use canned smoke

heat detectors with a heat gun

beam detectors use a mesh screen with a specific "rate of obscuration". Refer to DFD permit for proper size mesh for testing:
a fully blocked beam detector results in a TROUBLE to reduce the number of false alarms due to items like balloons & signage

Fire Command Center

Call out alarms and device address

know your Sequence of Operations (SOO). Some devices have "sounder bases" (hotel room smoke detectors) that:
only sound in room (locally)
report to Fire Alarm system as a Supervisory

Verify FACP, point-lit graphics & graphics workstation (if applicable) properly represents the field conditions

- Remote Indicators** These allow the fire department to find the device in alarm behind closed/locked doors (solid/glass)
 - Verify installation criteria
 - must be on the same wall that the door is on
 - must typically be +/- 12" above the door header - although slightly to one side or the other may be acceptable to the DFD
 - Testing Lead
 - must be progressive. If the path to the device is through 3 doors, then all three (3) doors must have a remote indicator
 - one remote indicator LED can be used to indicate more than one device is on the other side of the door
 - every remote indicator must be labeled
 - labels must list ALL devices that the remote indicator is used for

- Verify Remote Indicator LED lights for the devices listed
- Verify Remote Indicator LED lights brightness is adequate

Verify proper Sequence of Operations (SOO)

- proper activation of the NAC (Notification Appliance Circuits)
- release of fire doors
- release of door hold opens
- isolation - CLOSING of dampers to secure shafts and compartments
- shutdown of HVAC equipment

Fire Alarm Booster Panels (inspect these during device testing on each floor)

- Verify booster panels are clean and free of debris
 - clean on the inside
 - free of drywall mud and paint on the outside
- Verify booster panels are installed in a workmanship like manner and in a readily accessible location per NEC
- Verify TROUBLE
 - Loss of Power
 - Charger fault
 - Battery fault



CO Detectors



Verify installation:



Installed per the Manufacturer's installation manual



Typical installation is above residential fireplaces, near gas-fired appliances (boilers, furnaces, hot water heaters), etc.



Activate CO detector per the Manufacturer's testing criteria



use canned CO



press and hold the "TEST" button



the CO detector should emit a local "beep"



Fire Command Center



Call out alarms and device address



the building shall be in "alarm"



Verify FACP, point-lit graphics & graphics workstation (if applicable) properly represents the field conditions



Verify this "dials out" as a HAZ MAT - CO alarm



Combination Smoke/CO Detector



verify combination detector is labeled as "Smoke". The detector CANNOT be labeled as "SMOKE/CO"



if in a common area, the combination Smoke/CO must have a sounder base



detection of smoke results in building being put into alarm



detection of CO results in sounder base activation



annunciation must have separate "smoke" and "CO" indication



Spot check circuit integrity



OPEN NAC/SLC circuits to verify the trouble properly report



Area of Refuge (AOR) Call Stations (Note, this is a great fill in testing activity to finish out a day of testing)



Verify installation:



All phones labeled with:




Address of building



Floor number



Exact location on the floor (stair number if appropriate)



Verify the following TROUBLE conditions

- headend issue
- battery issue
- loss of power

Verify dial-out

- phone rings to Fire Command Center (FCC) for 1 minute
- phone rolls over to 24 hour monitoring after 1 minute

For each AOR station:

- Pickup phone
- FCC answers and calls out location of phone
- voice quality needs to be clear
- label head-end with instructions for determining where the last call came from (this will assist responding crews)

Elevators

Pre-planning

- Verify that elevator status panel matches the DFD approved panel (stamped panel drawing)
- There are reoccurring issues with key switches for EM power to different elevators
- Verify that fire alarm and fire protection have coordinated with the specific types of elevators (sprinkled or non-sprinkled hoistways)
- Elevator, Fire Alarm, and Fire Protection plans all match installation
- Verify that elevator and fire alarm coordinated elevator shunt requirements including battery backup
- Verify that elevator and fire alarm coordinated elevator flashing hat for impacted elevator cars
- Elevator installer to pull a City & County of Denver permit for each elevator cab/car

What devices are required in the elevator shaft/pit/machine room/lobby

- See the Elevator matrices at the end of this "Elevators" section

Testing rules of thumb:

- 4-8 hrs. for most high rises

Project Status - what must be complete in order for DFD to conduct testing

- Elevator lobbies must be completely done:
 - Clean
 - Elevator call stations properly installed in the final architectural finishes
 - Elevator finishes are completely installed (flooring, wall panels, stone, mirrors, ceiling, etc.)
- Fire alarm testing is in progress
- Elevators have been tested by a State of Colorado 3rd party inspector (signed with no deficiencies)
- DFD's Conveyance Team has issued a OK to Operate certificate for each elevator car
- Elevator recall has been pre-tested
- Elevator emergency phones are functioning properly and pre-tested with monitoring company

Pre-testing

- Generator started up, tested, load-banked and fueled per NFPA 10 (Tested and Passed by DFD)
- Functionality of Electrical Transfer Switches
- Pretest 100% of all devices - fire alarm & elevator, their integration & sequence of operations (SOO)
- Point lit graphics 100% pre-tested
- Graphics workstation 100% pre-tested
- Transfer of power to each cab from FCC switching panel while on generator/emergency power

Trade Participation (be prepared to show proof of State & Municipal licensing)

- 1 electrician to put building on emergency power
- 2 elevator technicians
- 1 fire alarm install technician in the field testing devices
- 1 fire alarm technician operating the FACP & graphics (if applicable) in the FCC

Equipment required for the day of the test

- test pole for testing smoke detectors
- heat gun for testing heat detectors
- ladders as applicable for access (as needed)
- radios for communication

← Indicates DFD's activities during testing. Have all paperwork ready for inspection and all devices/sequences pre-tested.

Paperwork to review with DFD prior to the start testing

- Licenses of elevator installers
- 3rd party inspections that must include the following
 - proper street address
 - elevator car number
- "Ok to Test" on the permit card by Electrical FA Signoff
- Elevator product data sheets
- showing the fire rating (or lack of a rating) on the steel cables or rubber belts

FIELD INSPECTIONS/VERIFICATIONS

Top of Hoistway

- activate smoke detector
 - impacted elevator(s) will recall to the primary floor
 - the HAT (firefighter indicator) inside the impacted elevator(s) will FLASH
 - the HAT is SOLID outside the elevator door on the primary recall floor
- activate heat detector
 - elevator shall shunt elevator power
 - exception: non-sprinklered hoistways
 - shall not shunt power, but recall and activate flashing hat

Bottom of Hoistway

- activate smoke detector
 - impacted elevator(s) will recall to the primary floor
 - the HAT (firefighter indicator) inside the impacted elevator(s) will FLASH
 - the HAT is SOLID outside the elevator door on the primary recall floor
- activate heat detector
 - elevator shall shunt elevator power
 - exception: non-sprinklered hoistways
 - shall not shunt power, but recall and activate flashing hat

Elevator Machine Room

- activate smoke detector
 - impacted elevator(s) will recall to the primary floor
 - the HAT inside the impacted elevator(s) will FLASH
 - the HAT is SOLID outside the elevator door on the primary recall floor
- activate heat detector
 - elevator shall shunt elevator power
 - exception: non-sprinklered machine rooms
 - shall not shunt power, but recall and activate flashing hat

- Elevator Lobby Smoke Detectors**
 - activate smoke detector
 - impacted elevator(s) will recall to the primary floor
 - the HAT (firefighter indicator) is SOLID inside the impacted elevator(s) and outside elevator door on the primary floor
- Secondary Recall**
 - activate smoke detector in primary recall elevator lobby
 - elevator will recall to the secondary floor
 - alternate recall floor is determined by DFD, but usually the first floor above primary recall floor
 - the HAT (firefighter indicator) is SOLID inside the impacted elevator(s)
- Flashing Hat Transition**
 - activate smoke detector in elevator lobby
 - elevator will recall to the primary or secondary floor (depending on which floor smoke detector is activated)
 - the HAT (firefighter indicator) is SOLID inside the impacted elevator(s) and outside elevator door on the primary floor
 - activate smoke detector in machine room
 - the HAT (firefighter indicator) shall transition to FLASHING inside the impacted elevator(s)
- Test Recall via Key Switches at the primary recall floor and from FCC (from the elevator status panel)**
 - initiate smoke detector in elevator lobby of primary recall floor
 - elevator recalls to alternate floor
 - initiate elevator recall from primary floor elevator recall key switch
 - the elevator DOES NOT recall
 - restore key switch to normal
 - initiate elevator recall from the FCC (key switch on the elevator status panel)
 - the elevator DOES NOT recall
 - initiate elevator recall from primary floor elevator recall key switch
 - the elevator DOES recall (requires both recall key switch from primary floor elevator and FCC elevator status panel for recall)
 - reset FACP of the primary recall floor smoke detector
 - unplug monitoring company phone line
 - LED on primary floor recall station will illuminate to show communications failure

- Elevator Door "Time Out" Close**
 - Buildings with smoke control are required to have "Time Out" elevator door closure (within 60 seconds)
 - Verify recalled elevator doors open upon reaching recall floor (primary/secondary) and close within 60 seconds
 - Verify if elevator is in independent and smoke is initiated, doors must shut and override to recall within 60 seconds
 - Verify elevator doors reopen after "Time Out" with push of call button in lobby or from door open button in cab

- Phase II**
 - Phase II is initiated by using the fireman's key in the elevator
 - this initiates the "peek-a-boo" sequence
 - Call Cancel Function
 - activate elevator calls
 - hit call function once car is moving full speed
 - elevator calls cancel and car stops at next available floor
 - Throw Stop Switch
 - car should not move
 - Switch back to 'ON'
 - car shall recall to primary floor

- Verify with Monitoring Company (test with power off)**
 - Speaker sound is loud and clear
 - Correct street address and city
 - Correct elevator car number
 - Verify actions for this specific question. **ARE YOU HURT?**
 - YES = emergency and DFD is called to perform a rescue
 - correct phone number to call DFD for rescue (720.913.2400)
 - NO = non-emergency and elevator company will be dispatched with 20 min max response time
 - DFD is to be called first, not the elevator company!

- Provide elevator elevation maps on the wall in the FCC**
 - These elevations shall indicate elevator stops and blind shafts

Fire Alarm & Fire Protection Requirements for Elevator Shafts, Pits & Lobbies

Location		Type of Protection		Type of Elevator			
				Traction Elevators		Machine-Room-Less	
				Hydraulic		with RATED steel cables/belts	with NON-RATED steel cables/belts
Top of Shaft		Fire Protection		LO Temp (135 degree) Heat Detector(s) for Elevator Recall	Smoke Detector(s) for Elevator Recall	HI Temp (194 degree) Heat Detector(s) to shunt trip power to ALL elevators in the hoistway	Heat Detector(s) to be with in 2 feet of the fire protection head
Fire Alarm							
Elevator Lobbies		Fire Protection	Nothing different than what is required for the fire protection system for that specific floor				
Fire Alarm		A Smoke Detector must be with in 21' of the centerline of each elevator door. Provide as many Smoke Detectors as is required to meet this criteria. Smoke Detector(s) are for Elevator Recall					
Elevator Pit		Fire Protection	HI Temp (286 degree "blue bulb") Fire Protection Head(s) Isolation Valve outside elevator shaft to isolate elevator fire protection from rest of fire protection system		HI Temp (286 degree "blue bulb") Fire Protection Head(s) Isolation Valve outside elevator shaft to isolate elevator fire protection from rest of fire protection system	Smoke Detector(s) for Elevator Recall, if pit is unconditioned LO Temp (135 degree) Heat Detector(s) for recall	Smoke Detector(s) for Elevator Recall, if pit is unconditioned LO Temp (135 degree) Heat Detector(s) for recall
Fire Alarm		HI Temp (194 degree) Heat Detector(s) to shunt trip power to ALL elevators in the hoistway Heat Detector(s) to be with in 2 feet of the fire protection head					

Fire Alarm & Fire Protection Required for Elevator Machine Rooms

Machine Room serving Hydraulic or Traction Elevators	
SERVING	
a Firefighters Access Elevator (FAS)	NOT SERVING
a Firefighters Access Elevator (FAS)	a Firefighters Access Elevator (FAS)
Fire Protection	HI Temp (286 degree "blue bulb") Fire Protection Head(s) Isolation Valve outside elevator machine room to isolate elevator fire protection from the rest of fire protection system
Machine Room	HI Temp (194 degree) Heat Detector(s) Shunt trip power to ALL elevators in the hoistway Heat Detector(s) to be with in 2 feet of the fire protection head(s) Smoke Detector(s) for Elevator Recall & Flashing Hat (for all elevators served by machine room)
Fire Alarm	Smoke Detector(s) for Elevator Recall & Flashing Hat (for all elevators served by machine room) A Heat Detector (135 degree) shall be used in lieu of the Smoke Detector if the ambient temperature is outside the UL listed operating temperatures for the Smoke Detector

Machine-Room-Less			
Controller in Elevator Door Jam This usually the top most floor (This Elevator Lobby is considered "The Machine Room")		Controller in separate Enclosure/Closet located inside the Elevator Shaft (unique to OTIS)	
Fire Protection	Nothing different than what is required for any other elevator lobby	Fire Protection	Nothing different than what is required for any other elevator lobby
Fire Alarm	Smoke Detector For Elevator Recall & Flashing Hat This the smoke detector(s) in the elevator lobby. This is not an additional smoke detector.	Fire Alarm	Smoke Detector in Controller Enclosure/Closet For Elevator Recall & Flashing HAT A Heat Detector (135 degree) shall be used in lieu of the Smoke Detector if the ambient temperature is outside the UL listed operating temperatures for the Smoke Detector
HVAC	<i>No HI Temp Heat Detector Required</i>	HVAC	The machine Enclosure/Closet must be appropriately conditioned (heated and cooled) for the equipment contained inside the enclosure Heat & Cooling must be on Emergency Power
Elevator Disconnect	Locate Elevator Disconnect on Fire Alarm Graphic Map and Add Signage to Door that Accesses the Disconnecting means for the Elevator Power	Elevator Disconnect	Locate Elevator Disconnect on Fire Alarm Graphic Map and Add Signage to Door that Accesses the Disconnecting means for the Elevator Power
The Elevator Lobby with the Controller is considered The Machine Room			
Requirement for the Enclosure/Closet in the Elevator Shaft			

Kitchen Hood (Ansul System)

Pre-planning

- Obtain a separate "Kitchen Hood Extinguishing System" Permit per the Denver Amendments to the International Fire Code

Testing rules of thumb:

- 30 min. when testing with other Fire Alarm device testing

Project Status - what must be complete in order for DFD to conduct testing

- Clean physical environment
- Fire Alarm testing is in progress
- Kitchen equipment installation and hookup (gas & electric) is complete

Pre-testing

- Pretest 100% of all devices - fire alarm & kitchen hood, their integration & sequence of operations (SOO)
- Point lit graphics 100% pre-tested
- Graphics workstation 100% pre-tested

Trade Participation (be prepared to show proof of State & Municipal licensing)

- Special Systems installer (Ansul)
- Fire Alarm Technician in the Fire Command Center
- Electrician to reset the Kitchen equipment electrical shunt trip breaker
- General Contractor representative

FIELD INSPECTIONS/VERIFICATIONS by CCD Mechanical Inspector

- Equipment required for the day of the test**
 - Test canisters (CO2) for testing the Ansul system
- Verify Installation**
 - Verify there is one exhaust duct for each 12' of hood
 - Verify nozzle locations are per the approved shop drawings
 - Verify nozzle types are per the approved shop drawings
 - Verify manual pull stations are:
 - 10' from hood
 - next to exit door
- Verify that an Ansul ALARM condition results in:
 - CLOSING of the solenoid gas valve to stop gas flow to all the gas appliances
 - Shunt TRIP of all electrical circuits under the hood(s)
 - Override control and START hood exhaust fan(s)
 - Shut Down Supply/Makeup air to the Kitchen Hood

← Indicates DFD's activities during testing. Have all paperwork ready for inspection and all devices/sequences pre-tested.

Paperwork to review with DFD prior to the start testing

- Kitchen Hood Extinguishing System Permit
- CCD's Plumbing Inspector signoff for:
 - gas piping, Rough & Final including for the solenoid valve that shuts off gas to the kitchen appliances during an Ansul event
 - Ansul piping Rough & Final
- CCD's HVAC inspector signoffs for:
 - kitchen hood installation - Rough & Final
 - kitchen hood Sequence of Operations (SOO) - a typical SOO is provided below
- CCD's Electrical inspector signoffs for:
 - shunt trip of electrical equipment under the kitchen hood

FIELD INSPECTIONS/VERIFICATIONS by Denver Fire Department

- Field Inspection - Fire Command Center
 - Base Building Fire Alarm Control Panel
 - no troubles
 - no ground faults
- Verify Ansul system communicates with Fire Alarm System:
 - ALARM - via jumping contacts on Ansul manual pull station
 - verify the Ansul zone reports and annunciates separately to the building fire alarm system

PRE-ACTION

Pre-planning

- Pre-Action Systems typically require a separate Fire Alarm permit
- Understand if Pre-Action Point-Lit Graphic Panels are required. Required on larger installations per the Denver Amendments 907.6.7

Testing rules of thumb:

- 1 hr. minimum

Project Status - what must be complete in order for DFD to conduct testing

- Fire Alarm testing is in progress
- When the Fire Alarm Control Panel to be clear of all troubles and ground faults
- When the Special System Releasing Panel is clear of all troubles and ground faults
- When the building is done and clean

Pre-testing

- Pretest 100% of all devices
- Point lit graphics 100% pre-tested
- Graphics workstation 100% pre-tested

Trade Participation (be prepared to show proof of State & Municipal licensing)

- 1 Pipe Fitter
- 1 Special Systems Installer
- 1 Fire Alarm Technician in the Fire Command Center
- 1 General Contractor representative

Equipment required for the day of the test

- a screwdriver to verify magnetism of the releasing solenoid

← Indicates DFD's activities during testing. Have all paperwork ready for inspection and all devices/sequences pre-tested.

Paperwork to review with DFD prior to the start testing

- Confirm that:
 - there are NO countdown timers in any of the programming
 - there is no way to ABORT the pre-action system
 - if a stand alone pre-action system without special protection systems, no notification is driven from the releasing panel
- Pre-Action Permit Card signed off with:
 - Fire Alarm Rough-In "OK to Test"

FIELD INSPECTIONS/VERIFICATIONS

- Pre-Action System**
 - Field Inspection - Fire Command Center**
 - Base Building Fire Alarm Control Panel**
 - no troubles
 - no ground faults
 - Test Trouble**
 - Releasing Panel Ground Fault
 - Releasing Panel Battery Disconnected
 - Loss of AC power to Releasing Panel
 - Test Alarm - (below with SOO)**

- Pre-Action Sequence of Operations (SOO)**
- Field Inspection - Fire Command Center**
- Base Building Fire Alarm Control Panel**
 - no troubles
 - no ground faults
- Sequence of Operations (SOO) Testing**
- Verify Pre-Action Valve**
 - Verify tamper switch reports properly to Releasing Panel as a Supervisory
 - Verify LO Air switch reports properly to Releasing Panel as a Supervisory
 - Configure Pre-Action Isolation Valve for testing
 - Set valve to approximately 90% CLOSED / 10% OPEN
 - Verify Solenoid Valve is connected and ready to test
- A single pull station (if part of system)**
 - Pull Station
 - if applicable, verify the Pre-Action system point-lit graphic panel accurately represents device in alarm
 - Pre-Action Solenoid Valve immediately releases
 - As soon as Flow Switch reports to Releasing Panel, CLOSE the Pre-Action Valve (that is 90% CLOSED / 10% OPEN)
- Verify a Single Zoned, Single Interlock Pre-Action System**
 - One (1) smoke detector activate release (this is single zone portion - 1 detector must go into alarm)
 - Activate smoke detector (this is the single interlock portion - one event (smoke/heat) results in the solenoid pre-action valve Opening resulting in water being introduced into the fire protection piping)
 - if applicable, verify the Pre-Action system point-lit graphic panel accurately represents device in alarm
 - verify base building is in alarm
 - Pre-Action Solenoid Valve immediately releases
 - As soon as Flow Switch reports to Releasing Panel, CLOSE the Pre-Action Valve (that is 90% CLOSED / 10% OPEN)
 - Repeat for every smoke detector
 - The ONLY difference is the Solenoid can be disconnected and activation is verified by magnetization of the solenoid valve
 - Not magnetized = normal = Pre-Action valve is CLOSED, NO discharge
 - Magnetized = in ALARM = Pre-Action valve is OPEN, water release!

- Verify a Cross Zoned, Single Interlock Pre-Action System**
- Two (2) smoke detectors activate release (this is cross zone portion - 2 detectors must go into alarm)
 - Activate 1st smoke detector
 - if applicable, verify the Pre-Action system point-lit graphic panel accurately represents device in alarm
 - verify base building is in alarm
 - Activate 2nd smoke detector (this is the single interlock portion - one event (smoke/heat) results in the solenoid pre-action valve Opening resulting in water being introduced into the fire protection piping)
 - if applicable, verify the Pre-Action system point-lit graphic panel accurately represents device in alarm
 - Pre-Action Solenoid Valve immediately releases
 - As soon as Flow Switch reports to Releasing Panel, CLOSE the Pre-Action Valve (that is 90% CLOSED / 10% OPEN)
- Repeat for every combination of 2 smoke detectors, both above and below the floor
 - The ONLY difference is the Solenoid can be disconnected and activation is verified by magnetization of the solenoid valve
 - Not magnetized = normal = Pre-Action valve is CLOSED, NO discharge
 - Magnetized = in ALARM = Pre-Action valve is OPEN, water release!

CLEAN AGENT

Pre-planning

- Clean Agent requires a separate Fire Alarm permit
- Location of the Special System Releasing Panel to be pre-approved by DFD
 - It is NEVER to be located inside the room that is being protected
- Assure piping system is installed per the approved design (size and routing)

Testing rules of thumb:

- 2 hrs. minimum

Project Status - what must be complete in order for DFD to conduct testing

- Fire Alarm testing is in progress
- When the Fire Alarm Control Panel to be clear of all troubles and ground faults
- When the Special System Releasing Panel is clear of all troubles and ground faults
- When the building is done and clean

Pre-testing

- Pretest 100% of all devices - fire alarm & clean agent, their integration & sequence of operations (SOO)
- Point lit graphics 100% pre-tested
- Graphics workstation 100% pre-tested

Trade Participation (be prepared to show proof of State & Municipal licensing)

- 1 Special Systems Installer
- 1 Fire Alarm Technician in the Fire Command Center
- 1 General Contractor representative

Equipment required for the day of the test

- if needed, suction cups to remove raised access floor panels
- test smoke for spot detectors

← Indicates DFD's activities during testing. Have all paperwork ready for inspection and all devices/sequences pre-tested.

Paperwork to review with DFD prior to the start testing

- Door Fan Test (Blower Door Test) results - Submit test results, approved by Engineer of Record to DFD
- For Single Interlock system, provide:
 - the Pull Station countdown timer is set at _____ seconds
 - the Smoke Detector countdown timer is set at _____ seconds
- Clean Agent Permit Cards signed off with:
 - Fire Alarm Rough-In "OK to Test"
 - Plumbing Rough-In with "OK to Test"

FIELD INSPECTIONS/VERIFICATIONS

- Clean Agent System - Cross Zoned**
 - Field Inspection - Fire Command Center**
 - Base Building Fire Alarm Control Panel**
 - no troubles
 - no ground faults
 - Special Agent Tanks**
 - Installation is neat and safe.
 - Tanks are adequately protected
 - Visual inspection of Burst Pins - the agent is not released for testing so the Burst Pins must be removed from the tanks

Signage - Manufacturer's signage (or equivalent) at entrance and exit to protected room. Amber Horn/Strobe must be located at signage

At Entrance to room. Signage must state not to enter room without the proper PPE

At Exit of room. Signage must state to leave the room if Horn/Strobe is active

Test Trouble

Releasing Panel Ground Fault

Releasing Panel Battery Disconnected

A Releasing Panel abort switch (located in the protected area) is active

Loss of AC power to Releasing Panel

Test Supervisory

Service Disconnect Switch - used to disable release in order to perform maintenance

Test Alarm - (below with SOO)

Clean Agent Sequence of Operations (SOO) Testing

A single pull station activates agent release

Pull a Pull Station

Immediately push and hold the ABORT button - the ABORT button DOES NOT abort the count down timer

A counter timer starts (this is usually a short countdown - 10 seconds or less)

Amber Horn/Strobe is SOLID Horn

verify release by visually inspecting the Burst Pins


Two (2) smoke detectors activate release (this is cross-zoning portion - 2 detectors must go into alarm)

Activate 1st smoke detector

verify base building is in alarm

verify Amber Horn/Strobe inside/outside of protected room are active

horn should be a S-L-O-W WHOOP (this indicated pre-release)

- 
- Activate 2nd smoke detector
 - horn should be FAST WHOOP
 - countdown timer begins countdown (typically 30 seconds)
 - HIT and HOLD the ABORT button - SOO is suspended for the duration that the ABORT button is held in
 - Verify a Releasing Panel Supervisory Alarm
 - RELEASE the ABORT button
 - Countdown timer picks up where it was suspended or picks up at mid-point (15 seconds)
 - Clean Agent is release after countdown timer expires
 - Amber Horn/Strobe goes to a SOLID Horn
 - Verify release by visually inspecting the Burst Pins
 - Repeat for every combination of 2 smoke detectors, both above and below the floor

VESDA (Very Early Smoke Detection Apparatus)

Pre-planning

- VESDA requires a separate Fire Alarm permit

Testing rules of thumb:

- 2 hrs. minimum

Project Status - what must be complete in order for DFD to conduct testing

- Fire Alarm testing is in progress
- When the Fire Alarm Control Panel to be clear of all troubles and ground faults
- When all VESDA units are clear of all troubles and ground faults
- When the building is done and clean

Pre-testing

- Pretest 100% of all devices - fire alarm & VESDA, their integration & sequence of operations (SOO)
- Point lit graphics 100% pre-tested
- Graphics workstation 100% pre-tested

Trade Participation (be prepared to show proof of State & Municipal licensing)

- 1 Special Systems installer
- 1 Fire Alarm Technician in the Fire Command Center
- 1 General Contractor representative

Equipment required for the day of the test

- if needed, suction cups to remove raised access floor panels
- testing equipment per the manufacturer - typically a wire-burner

← Indicates DFD's activities during testing. Have all paperwork ready for inspection and all devices/sequences pre-tested.

Paperwork to review with DFD prior to the start testing

- Manufacturer's Testing Requirements
- VESDA Permit Card signed off with:
 - Fire Alarm Rough-In "OK to Test"
 - Plumbing Rough-In with "OK to Test"

FIELD INSPECTIONS/VERIFICATIONS

- VESDA - Very Early Smoke Detection Apparatus**
 - Field Inspection - Fire Command Center**
 - Base Building Fire Alarm Control Panel**
 - no troubles
 - no ground faults
 - Verify Installation**
 - Verify VESDA system is installed per the requirements of the CCD/DFD permit
 - Verify VESDA system piping is installed per the manufactured APPROVED shop drawings
 - routing/size/lengths of piping
 - locations/size/quantity of air intakes
 - air transport time must be less than 90 seconds
 - Verify Map of protected area
 - matches shop drawings and installation
 - shows the routing of each individual pipe run

Sequence of Operations (SOO) Testing

Test VESDA System

Test per the Manufacture's Test procedure - typically a wire burn test

Test at the end of each run

Keep track of time for detection - must be less than 90 seconds

Verify all stages were sensed by VESDA and properly relayed to the Base Building FACP

ALERT = Supervisory

FIRE 1 = Alarm

FIRE 2 = TRIP

Testing must be preformed per the approved SOO in the permitted drawings

Repeat for each Zone or End-of-Pipe run

LEAK DETECTION

Pre-planning

- Leak Detection requires a Deferred Submittal in order to obtain a Leak Detection Permit
 - refer to the Denver Amendments section 606.8 for the specifics
 - submit Occupational Exposure Limits (OEL) values
 - for refrigerant, a leak detection alarm shall be actuated at a value not greater than the OEL values identified in the International Mechanical Code for the refrigerant classification.
 - for an ammonia diffusion system, a leak detection alarm shall be actuated at a value not greater than 8.3 L of water for each 1 kg of ammonia
 - submit the color of the strobes (must be a different color from the Fire Alarm strobes)
 - submit location of the Monitoring System Panel to pre-approved by DFD
 - It is NEVER to be located inside the room that is being protected
- Leak Detection System need on line and monitored as soon a practical. This system is for protecting the lives of not only the public, but construction workers
- Incorporate Leak Detection into the Fire Alarm point-lit graphics panel
 - Leak Detection zone(s)
 - location of the Leak Detection Panel(s)

Testing rules of thumb:

- 1 hrs. minimum for a single zone. Add 45 minutes for each additional zone

Project Status - what must be complete in order for DFD to conduct testing

- Fire Alarm testing is in progress
- When the Fire Alarm Control Panel to be clear of all troubles and ground faults
- When the Leak Detection Panel is clear of all troubles and ground faults
- When the building is done and clean

Pre-testing

- Pretest 100% of all devices - fire alarm & leak detection, their integration & sequence of operations (SOO)
- Point lit graphics 100% pre-tested
- Graphics workstation 100% pre-tested

Trade Participation (be prepared to show proof of State & Municipal licensing)

- 1 Special Systems installer
- 1 Fire Alarm Technician in the Fire Command Center
- 1 General Contractor representative

Equipment required for the day of the test

- Leak Detection equipment/gases required by the Manufacturer. Must provide a minimum of test gases for testing:
 - LO Level Alarm
 - HI Level Alarm

← Indicates DFD's activities during testing. Have all paperwork ready for inspection and all devices/sequences pre-tested.

Paperwork to review with DFD prior to the start testing

- Manufacturer's Testing Requirements
- Leak Detection Permit Card signed off with:
 - Fire Alarm Rough-In "OK to Test"
 - Plumbing Rough-In with "OK to Test"

FIELD INSPECTIONS/VERIFICATIONS

- at Fire Command Center
 - Base Building Fire Alarm Control Panel status:
 - no troubles
 - no ground faults
 - Test Monitoring Panel points monitored by the Base Building Fire Alarm System, as a minimum
 - Supervisory
 - LO level detection (as defined in the approved Deferred Leak Detection Submittal)
 - Trouble
 - Monitoring Panel Ground Fault
 - Monitoring Panel Battery Disconnected
 - Monitoring Panel Loss of AC power
 - Alarm
 - Verify alarm condition properly displays on the Fire Alarm graphics (graphic map and/or workstation)
 - HI level detection (as defined in the approved Deferred Leak Detection Submittal)
 - Must alert the 24 hour monitoring stations to "ROLL HAZMAT"
- At Protected Area/Room
 - Monitoring Panel is located outside of the protected area/room
 - Signage - Signage at each entrance and exit to protected area/room. Horn/Strobe must be located at signage.
 - color of strobe to be per the approved Deferred Leak Detection submittal
 - at each Entrance to the protected room. Signage must state not to enter room without the proper PPE
"DO NOT ENTER WHEN LIGHT IS FLASHING - REFRIGERANT LEAK DETECTED"
 - at each Exit from the protected room. Signage must state to leave the room if Horn/Strobe is active.
 - Horns & Strobes shall be:
 - at each entrance to the protected area/room
 - at each exit from the protected area/room
 - inside the protected area/room to achieve 100% audio and visual coverage
 - Horns shall have a different tone and pattern distinctly different from the fire alarm notification
 - At each sensing location:
 - test for detection of LO level
 - test for detection of HI level
 - if required by the approved Sequence of Operations (SOO), verify that ventilation system STARTS

Computer Room Air Conditioning Units (CRAC) Computer Room Air Handling Units (CRAH)

← Indicates DFD's activities during testing. Have all paperwork ready for inspection and all devices/sequences pre-tested.

FIELD INSPECTIONS/VERIFICATIONS

CRAC/CRAH - ONLY tested by DFD IF CONNECTED TO THE FIRE ALARM SYSTEM:

- verify that the integral CRAC smoke detector reports to the Base Building FACP as a Supervisory
- verify fire alarm shutdown

Note, EPOs are not tested since they are not associated with the Fire Alarm System

Smoke Control

Pre-planning

- Smoke Control requires a Deferred Submittal in order to obtain a Smoke Control Permit
- refer to the Denver Amendments for the specifics of what must be submitted (see Appendix 4 of this Testing Guide)
- verify Fire Alarm Smoke Control Sequence matches Smoke Control Engineer's Sequence
- Verify that Firefighter Smoke Control Panel (FSCP) matches the DFD approved panel
- Comply with all Smoke Control REVIEW COMMENTS and RESPONSES from the Deferred Smoke Control Permit

Testing rules of thumb:

- 4 hrs. for most highrise buildings (after hours - no one is to be in the building except for the smoke control testing team)

Project Status - what must be complete in order for DFD to conduct testing

- ENTIRE Building Envelope is 100% Complete (roof, cap flashing, exterior doors, windows, caulking).
- Building Construction
 - All Smoke Control Zone dividing walls/floors are complete (seal all openings between the floors and smoke zones)
 - Stair doors, Smoke Zone Boundary doors & Area of Refuge (AOR) doors are installed and operational with all hardware (closers, astragals, brushes, smoke seal, door bottoms, etc.)
 - Ceilings are installed
- Elevators have been completed tested and signed off per the ELEVATOR section of this Testing Guide
- Stairwells are 100% Complete - basement to roof, door hardware and finishes (paint and flooring)
- HVAC Installation is 100% Complete
- BAS Installation is 100% Complete and in AUTO
- Electrical Systems:
 - Electrical Installation is 100% complete
 - Electrical SOO has been tested
 - Life Safety Generator has been tested and complies with requirement for power restoration within 10 seconds
- Fire Protection System is 100% Complete and Tested/Signed-Off by Fire Department

- Fire Alarm System is 100% Complete and Tested by Fire Department (formal signoff dependent on successful completion of the Smoke Control Testing)
- Smoke Control has been configured and pretested by the Construction Team per the Sequence of Operation (SOO) approved by DFD in the Deferred Smoke Control Permit
- Smoke Control Engineer of Record has tested the system and determined that is in conformance with the Approved Deferred Smoke Control Permit and the Denver Amendments. The Smoke Control Engineer of Record issue a 72 hour letter to DFD to test the Smoke Control System

Smoke Control Configuration & Pre-testing - (Perform in the order listed!)

- Perform vendor startup of all Smoke Control equipment.
- Complete all control/interlock wiring for fire alarm to control equipment in a smoke event (VFDs, Starters, Controllers, Dampers, etc.)
- Verify proper "FAILED" position of all dampers:
 - all environmental dampers at the building envelope associated with Smoke Control (hoistway pressurization, stairwell pressurization, smoke control/exhaust) shall fail OPEN
 - all fire/smoke dampers and/or smoke dampers between smoke control zones typically fail CLOSED
 - understand your specific Smoke Control Sequence of Operations (SOO) to determine how dampers fail
- Verify Firefighters Smoke Control Panel matches the APPROVED Deferred Smoke Control Permit
- Verify the Fire Alarm System and/or the Firefighters Smoke Control Panel (FSCP) have positive control of all smoke control equipment by testing every switch (toggle or rotary) and verify indicator light reports proper equipment configuration
 - stair pressurization fans and associated dampers (environmental, fire/smoke dampers & smoke dampers)
 - hoistway pressurization fans (environmental, fire/smoke dampers & smoke dampers)
 - smoke control/exhaust fans (environmental, fire/smoke dampers & smoke dampers)
 - fire/smoke dampers and smoke dampers
 - mechanical equipment that the smoke control system overrides or re-configures
 - air handling units
 - fan coil units
 - makeup air units
 - outside air units

- verify all fault conditions properly report to the Firefighters Smoke Control Panel
 - loss of power to fans (hoistway, stair, smoke control/exhaust) and dampers
 - belt breakage detection for fans (hoistway, stair, smoke control/exhaust). Remove the belts and start the fan.
 - failure for fan to run (hoistway, stair, smoke control/exhaust)
 - locked rotor of fan (hoistway, stair, smoke control/exhaust)
 - incorrect damper position (shut off power to damper actuators)
 - fan ON/OFF light illumination
 - ON - if motor is rotating
 - OFF - if motor is NOT rotating

verify garage exhaust fans can be controlled from the Firefighters Smoke Control Panel.

With Building Automation in AUTO, adjust all door closers on doors associated with smoke control to achieve an OPENING force of not more than 12lbs.

- stair doors
- smoke control zone boundary doors
- exterior exit doors

Determine the extent of STACK EFFECT on the building (the taller the building, the greater stack effect will be). With the Building Automation in AUTO:

- measure the differential pressure from the ground floor to the exterior
- measure the differential pressure from the top most floor (penthouse/mechanical room) to the exterior
- subtract the two numbers to determine stack effect. If this number is around 0.10" wc, configuring smoke control may be a real challenge

With Building Automation in AUTO, establish early stairwell and hoistway fan speeds

START WITH FANS AT 12HZ AND WORK UP FROM THERE TO AVOID DAMAGE TO EQUIPMENT, DOORS, THE BUILDING OR PEOPLE.

The goal is to adjust the vertical pressurization fans to obtain the following criteria throughout the building (from basement to penthouse):

- typically the goal is a MINIMUM of 0.05" wc across all stairwell and hoistway doors(the stairwell/hoistway is positive)
- a MAXIMUM door opening force of 15 lbs.

Reset Fire Alarm Panel

These fan speeds may adjust during smoke exhaust balance, but they will provide a good starting point and better understanding for how the building is reacting.

Adjust Smoke Control/Exhaust Fan(s) to achieve:

a MINIMUM of 0.05" wc across all hoistway doors (the hoistway is positive).

a MINIMUM of 0.05" wc across all stairwell doors (the stairwell is positive).

a MAXUMIM door opening force of 30 lbs.

Smoke Exhaust Rates (Per 2019 Denver Amendments 909.10.1.8)

40% of design rate during incident (sealed floor except one stairway)

80% of design rate in post fire conditions (salvage and overhaul operations)

Start with the smoke control zone that is most remote of the Smoke Control/Exhaust Fan

activate an initiating device to put the zone in smoke control

START WITH FANS AT 20HZ AND WORK UP FROM THERE TO AVOID DAMAGE TO EQUIPMENT, DOORS, THE BUILDING OR PEOPLE.

reset Fire Alarm Panel

lock in Smoke Control Fan VFD Hz setting

Repeat for the smoke zone closest to the Smoke Control/Exhaust Fan and verify compliance with criteria.

Make adjustments to Smoke Control/Exhaust Fan Hz setting as needed.

Repeat for the all other smoke zones and verify compliance with criteria.

Make adjustments to Smoke Control/Exhaust Fan Hz setting as needed.

Expect to see significant differences in differential pressures and door pulls where the building is unique, such as:

the floor(s) above the parking garage

the floor(s) below the roof

the floor(s) with exits to the exterior

Vertical Pressurization

Verify door opening forces are ≤ 30 lbs after smoke exhaust balance

Verify proper smoke control programming and verify repeatability

Verify pull stations only put the building into vertical pressurization

Verify each smoke detector initiates smoke control for the proper Smoke Control Zone

Verify each waterflow switch initiates smoke control for the proper Smoke Control Zone

- Kill normal power to the building. Verify:
 - emergency generator is online and has re-energized the building in less than 10 seconds
 - from the Firefighters Smoke Control Panel, operate all equipment fans, dampers, etc. to assure that all Smoke Control Equipment operates on emergency power
- Demonstrate the Smoke Control system functionality to the Smoke Control Engineer of Record
- Smoke Control Engineer of Record to issue "72 hour Letter" to DFD requesting testing of the Smoke Control System

Trade Participation (be prepared to show proof of State & Municipal licensing)

- 1 electrician to put building on emergency power
- 1 fire alarm install technician in the field testing devices
- 1 fire alarm technician operating the FACP & graphics (if applicable) in the FCC
- 1 fire protection fitter to trip flow switches and/or OPEN inspector test stations
- 2 mechanical technicians with tools to remove belts for testing belt breakage detection settings
- 1 TAB specialist to take differential pressure reading and airflow readings
- 1 VFD technician to make adjustments to the VFDs

Equipment required for the day of the test

- Door Pressure Gauge
- Manometer (differential air pressure)
- Anemometer (air velocity)
- Smoke Machine
- Test Pole for Testing Smoke Detectors
- Heat Gun for Testing Heat Detectors
- Key to Flow Switch covers
- Ladders as Applicable for Access (as needed)
- Radios for Communication
- Keys and Cardkeys for access throughout the building

← Indicates DFD's activities during testing. Have all paperwork ready for inspection and all devices/sequences pre-tested.

Paperwork to review with DFD prior to the start testing

- Licenses of Fire Alarm installers
- Signoff for all Fire Protection, Fire Alarm, and Elevator Testing Performed by DFD
- Project Record Set of Deferred Smoke Control Submittal
- Smoke Control Engineer of Record "72 hour Letter" and test results
- Document showing Air Changes per Hour (ACH) and equivalent CFM for each Smoke Control Zone

FIELD INSPECTIONS/VERIFICATIONS

- Exact Testing/Verification is at DFD Fire Protection Engineer's Discretion
- Loss of Power will be simulated one or more times throughout the test to verify system operates correctly without normal power
- Testing Example is Developed Around High Rises
- Verify Conformance with Applicable Codes and Denver Amendments Prior to Verifying System Readiness

- Verify Equipment Operation (These can be performed at the beginning of the test, prior to the building being totally clear of personnel not associated with smoke controls testing (the public and/or construction workers not associated with smoke control))
 - Verify All Smoke Control Fans match the DFD Approved Deferred Smoke Control Submittal
 - Verify All Smoke Control Fans Report Correctly to FACP and FSCP
 - Verify ON/OFF Status Lights Operate Correctly
 - Verify Fault Lights Operate Correctly (Mimic Fault Conditions - Broken Belt, Locked Rotor, etc.)
 - Verify Fan Reaches Desired Operating State within 75 seconds
 - Verify All Smoke Control Dampers Match Approved Smoke Control Submittal
 - Verify Fire/Smoke Dampers Carry Correct Minimum Temperature Rating
 - Exhaust Path Dampers - 250 deg F
 - Isolation Dampers - 165 deg F

- Verify All FSCP Dampers Operate Correctly and Report Correctly to the FSCP
- Verify OPEN/CLOSED Status Lights Operate Correctly and Match Actual Blade Position
- Verify Failed Position is Per Smoke Control Submittal (Drop Power to Damper)
- Verify Fault Light Operates Correctly (Incorrect Position, No Power, etc.)
- Verify Damper Travels to Desired Position within 60 seconds

Test Vertical Pressurization (Stairways and Hoistways)

- Activate Vertical Pressurization with Pull Station
- Test for Door Opening Force at all doors associated with Smoke Control
Stairway doors/Elevator doors/Elevator Lobby doors/Area of Refuge doors, Exterior doors)
 - Door Opening Force Must be < 30 lbs.
 - Elevator doors must OPEN
- RESET Fire Alarm Control Panel (FACP)

Test Smoke Control

- Activate a Smoke Detector or Flow Switch for a Smoke Control Zone (usually each level is a zone)
- Test for Differential Pressure and Door Opening Force at all doors associated with Smoke Control
Stairway doors/Elevator doors/Elevator Lobby doors/Area of Refuge doors, Exterior doors)
 - Door Differential Pressure Must be > +0.05 in wc
 - Door Opening Force Must be < 30 lbs.
 - Elevator doors must OPEN
- Test Smoke Exhaust Rate
 - Measure Exhaust CFM from Floor for Incident and Post Fire Conditions
 - 40% of design rate during incident (sealed floor except one stairway)
 - 80% of design rate in post fire conditions (salvage and overhaul operations)
- Activate a Pull Station on Another Level Not in Alarm
- Verify Pull Station Registers on FACP, but Smoke Control configuration remains the same

- Activate Smoke Detector or Smoke Zone Flow Switch for Another Smoke Control Zone
- Verify System Stays in Smoke Control for the 1st Smoke Control Zone that was put in ALARM
- Verify System configures for 2nd Smoke Control Zone that was put in ALARM
- Test for Differential Pressure and Door Opening Force at Stairway Doors
 - Door Differential Pressure Must be $> +0.05$ in wc
 - Door Opening Force Must be < 30 lbs.
- Test for Differential Pressure and Door Opening Force at all doors associated with Smoke Control (Stairway doors/Elevator doors/Elevator Lobby doors/Area of Refuge doors, Exterior doors)
 - Door Differential Pressure Must be $> +0.05$ in wc
 - Door Opening Force Must be < 30 lbs.
 - Elevator doors must OPEN
- With the System Still in Smoke Control
 - Manually Operate Dampers/Fans Safely (not to damage ductwork/system) from the FSCP
 - Verify Dampers/Fans Respond to FSCP Commands and Display Correct State/Run Status
- RESET Fire Alarm Control Panel (FACP)

Tests will be performed at a minimum of three locations. Typically:

- once in the top third of the building
- once in the middle third of the building
- once in the lower third of the building

- Demonstrate the Smoke Control Weekly Self-Test

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APPENDIX N SHOP DRAWING AND SYSTEM GRAPHIC REQUIREMENTS FOR PERMIT APPLICATION

N103.5 Building plans for graphic map. Plans shall be of durable construction, easily readable in normal lighting, protected by a smooth, transparent, plastic surface and shall include every building level including mezzanines and roofs. Plans shall contain the following information as applicable:

1. Building name
2. Building address
3. Construction type(s)
4. Scale
5. North orientation arrow
6. **“You Are Here”** in contrasting and bold font
7. Latest date plans were drawn/ revised
8. Floor plans
9. Concealed spaces below floors and above ceilings; e.g., crawl spaces and attics
10. Site plan
11. Adjacent streets
12. Local fire hydrants
13. Major uses, e.g., kitchens, restaurant, offices, Gymnasium, parking, etc.
14. Areas of emergency function, e.g., areas of refuge, fire command center
15. Utility areas, e.g., electrical/telephone rooms/closets, water entry
16. All stair enclosures with distinct designation for each, matching floor signage
17. All elevators with distinct designation for each and associated machine rooms
18. All trash/linen chutes
19. All utility shafts including HVAC and light wells
20. All interior and exterior utility (communication, electricity, gas, water, etc.) shutoff locations
21. Locations of hazardous materials such as:
 - a. Control areas
 - b. Fuel storage
 - c. Battery rooms
 - d. Medical gas rooms

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- e. Emergency and standby power equipment locations
 - f. Fuel fill location
 - g. Identify fuel type and tank size
- 22. Sprinkler zones
 - 23. All control valve locations including elevators and paint booths
 - 24. Standpipe outlet locations
 - 25. Special suppression systems; e.g., FM-200; UL-300; pre-action
 - 26. Specialized fire protection equipment; e.g., water tanks
 - 27. Fire pump location
 - 28. Fuel fill location for diesel pumps
 - 29. Identify fuel type and tank size as applicable
 - 30. Fire department connections
 - 31. Pump test headers
 - 32. Wall hydrants as applicable
 - 33. Smoke control zones
 - 34. Fire-resistance-rated construction, fire walls, fire barriers, fire partitions, smoke barriers, smoke partitions
 - 35. All initiating devices including water flow
 - 36. Fire alarm zones
 - 37. NAC power extender locations
 - 38. Roof plan
 - a. Access
 - b. Vents
 - c. Occupied areas
 - 39. Stamp and signature of a professional engineer licensed by the State of Colorado
 - 40. Control areas in accordance with Section 5003.8.3 of the *International Fire Code*
 - 41. Other features required by the *fire code official*

2019 DENVER AMENDMENTS TO THE 2018 INTERNATIONAL FIRE CODE

SECTION 508 FIRE COMMAND CENTER

Section 508.1 General is replaced as follows:

508.1 Fire command center (FCC). Where required by Section 907 or 909, buildings shall be provided with an FCC in accordance with this section. No piping, ducts or equipment foreign to required fire operations shall be permitted to enter, pass through or be installed within the FCC. Scale drawings of the FCC showing the location of all equipment and features, in plan and elevation views, shall be submitted for approval prior to installation.

Section 508.1.1 Location and access is replaced as follows:

508.1.1 Location and access. The FCC shall:

1. Be on the ground floor, and
2. Have a secured entrance directly accessible to and in immediate proximity of the main building entrance.
3. Have access within the building to all fire service access elevators.

Exception: Unless otherwise approved by the fire code official.

Section 508.1.2 Separation is replaced as follows:

508.1.2 Separation. To meet the system survivability requirements of NFPA 72, the FCC shall be separated from the remainder of the building by not less than a 2-hour fire barrier constructed in accordance with Section 707 of the *International Building Code* or a horizontal assembly in accordance with Section 711 of the *International Building Code* or both.

Section 508.1.6 Required features is replaced as follows:

508.1.6 Required features. The FCC shall contain the following:

1. Emergency voice/alarm communication system unit in accordance with Section 907.5.2.2.
2. Fire Department communication system in accordance with Section 907.2.12.2.
3. Fire alarm control unit and annunciator in accordance with Sections 907.1.5 and 907.6.4.1.
4. Elevator status/control panel in accordance with Section 907.2.12.7.
5. Firefighter's smoke control panel in accordance with Section 909.8.
6. Manual controls for simultaneously unlocking stairway and refuge area doors in accordance with Section 1010.1.9.12 of the *International Building Code*.
7. Emergency generator status panel in accordance with Section 907.2.12.8.
8. Telephone with controlled access to a public telephone network.
9. Fire pump remote status panel in accordance with Section 907.2.12.9.

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10. Building as-built construction plans indicating typical floor and roof plans, detailing the building core, means of egress, fire protection system drawings, firefighting equipment, fire department access, interior generator and utility shut-off locations. These drawings shall be protected from damage and immediately accessible to the fire department. A storage rack to support these drawing shall be provided.
 11. Building site plan with “North” orientation, local street intersection, fire hydrants, Fire Department connections, building entries, exterior generator and fuel locations and exterior utility shut-off locations.
 12. Work table 3’ x 5’ and chair.
 13. Public address system equipment, where specifically required by other sections of this code.
 14. A key vault *approved* by the fire department to house keys to access mechanical and electrical equipment.
 15. Two-way communication required by Sections 1009.6.5, 1009.8, 1010.1.9.13.7 Item 3(b), and 3008.6.6 of the *International Building Code* and two-way communication system required for elevator communication in accordance with ASME A17.1.
 16. Multi-level lighting control. Separately switched lamps or dimming control is acceptable. Dimming of fluorescent fixtures shall be by EMI/RFI shielded devices.
 17. Mass Notification System (MNS) equipment.
 18. Heating/cooling zone or system.
- 508.1.7 Heating/cooling zone or system for FCC.** A separate heating/cooling zone or system operating continually shall be provided for the Fire Command Center.

2019 DENVER AMENDMENTS TO THE 2018 INTERNATIONAL FIRE CODE

While Appendix N of the Denver Amendments provides the requirements for SHOP DRAWING AND SYSTEM GRAPHICS REQUIREMENTS FOR PERMIT APPLICATION, this Table of Contents is helpful for assembling a complete Deferred Smoke Control Submittal for submission to

DFD

Deferred Smoke Control Submittal Table of Contents

updated 6-March-2021

1. Code reference used as Basis of Design
 - a. Administrative Modifications
 - b. Board of Appeals decisions
 - c. Smoke Control Rational Analysis, if available

2. Who are the responsible contractors:
 - a. General Contractor
 - b. Mechanical Contractor
 - c. Electrical Contractor
 - d. Fire Alarm Contractor
 - e. Fire Protection Contractor
 - f. Building Automation Contractor, if applicable

3. What licensed contractor will the Smoke Control Permit be issued to?

4. Plans identifying each smoke control zone, including:
 - a. vertical section
 - b. horizontal section
 - c. narrative of the smoke control sequence of operations (from the contract documents)
 - d. locations of the VFDs/motor starters associated Smoke Control
 - must be in secure, conditioned 1-hour rated room
 - cannot be located inside the zone that is being protected

5. Listing of smoke control equipment associated with each respective smoke control zone
 - a. Smoke Control Equipment (Fans) associated with each zone
 - b. Fire Smoke Damper (FSD) Schedule
 - c. Verification that all Smoke Control Equipment (excluding parking garage fans) are on Emergency (Backup Generator) Power.

6. Coordination & certification that sprinkler zones, smoke control and fire alarm/detection zones match.
 - a. Fire Sprinkler deferred submittal shop drawings, for reference
 - b. Fire Alarm deferred submittal shop drawings, for reference
 - i. This must show all smoke control equipment and interfaces

7. Coordinated fire alarm/smoke control design that provide a fault if you are not moving air (belt breakage detection). This can be done different ways:
 1. internal to the VFD and displays as a fault (typical of ABB drive)
 2. add CT (current) switch that is monitored by the fire alarm system (typical of non-ABB drive)

8. Documents (shop drawings/wiring diagrams) showing Smoke Control equipment wired by other than the Fire Alarm Contractor
 - a. Stairwell and Hoistway Pressurization and Smoke Exhaust - differential pressure control
 - i. VFD
 - ii. differential pressure sensor
 - iii. tubing/piping
 - iv. Other devices/equipment
 - b. Equipment that is dual use - Building Automation and Smoke Control
 - i. If this equipment is on the Firefighter's Smoke Control Panel, this must be specifically called out.

9. Manufacturers' specification sheets (from the product data submittal package approved by the Mechanical Engineer) for all equipment and devices associated with the smoke control system including, but not limited to the following:
 - a. Mechanical Equipment Used for Smoke Control
 - i. Roof Top Units
 - ii. Air Handlers
 - iii. Fans
 - iv. Pressurization Fans (Stairwell and Hoistway)
 - v. Smoke Exhaust Fans
 - vi. Parking Garage exhaust fans

- b. Show that all mechanical equipment is UL864 rated for smoke control, specifically:
 - i. Designed to operate at 250 degree F
 - ii. Minimum number of drive belt is 1.5x the number required (2 minimum)
 - c. Fire Smoke Dampers (FSD)
 - i. Damper
 - 1. UL 555S rated for smoke dampers
 - 2. Proper thermocouple rating
 - AHJ specific – range from 165 to 250 degree F operating temperature.
 - DFD requires 250 degree F for all FSDs in the smoke exhaust path.
 - ii. Actuator
 - 1. Positive indication end switches (based on blade position, not shaft position) both OPEN and CLOSE
 - use of actuator end switches is unacceptable
 - 2. Operating Temperature/Ambient Temperature Range of actuator much coordinate with actual actuator installation location
 - actuators exposed to outside temperatures must have an ambient temperature range of -22 degrees F to 122 degrees F, not the ambient temperatur range of 32 degree F to 122 degree F.
 - iii. Provide Fire/Smoke Damper (FSD) Matrix with the following:
 - 1. FSD ID
 - 2. Failed position (OPEN or CLOSED)
 - 3. Power source - panelboard/circuit
 - (must be on Emergency Power)
 - 4. Closure temperature (thermocouple)
 - 250 degrees for Smoke Exhaust
 - 165 degrees for all other
 - d. Variable Frequency Drives
 - i. Rated for smoke control – UL864
 - e. Misc. Devices/Equipment Used
 - i. Differential pressure sensors
 - ii. Other devices/equipment
10. Detailed description of the required Owner’s weekly self-testing criteria per Section 909.12. Provide plans/procedures for complying with the self-test intervals. The weekly self test printed reports must be maintained on site in the fire command center.

11. Firefighters Smoke Control Panel Graphic
 - Include Toggle switch for release of Access Doors, if required
12. Smoke Control Sequence of Operations (SOO) Matrix
13. Final acceptance testing plan indicating system testing per 909.18, Acceptance Testing.
 - a. As defined by the Mechanical EOR and detailed on the Contract Documents
 - b. Refer to 909.18, Acceptance Testing.
14. Fire Alarm Product Data
 - a. Must be a UL864 Compliant system
 - b. This should be the same product data that was approved in the Deferred Fire Alarm Submittal
15. Provide copies of the Mechanical & Electrical Drawings that were permitted that this Deferred Smoke Control Submittal is based on

NOTES:

1. The Deferred Smoke Control submittal does not necessarily need to be in the above order, but all information must be provided.
2. Drawings and documents shall be professionally sealed by each responsible engineer (mechanical, electrical and changes to the the design via RFIs)
3. Highlight pertinent information regarding the smoke control system:
 - a. Certifications – UL864, UL555S
 - b. Smoke Control Over-ride contacts
 - c. Temperature ratings – FSD actuators, thermocouples, etc
 - d. Misc. - number of belts provided for fans (1.5x required)
4. Provide any and all information to demonstrate that the smoke control system has been coordinated with all trades and the end result will be a functioning smoke control system.

Project Summary Information for DFD Testing

Project Information	
Name:	
Address:	

Project Team	
Owner:	
General Contractor:	
Developer:	

Key Subcontractors	
Fire Protection	
Electrical/Fire Alarm	
Mechanical/Controls	
Elevators	

Permit Information	
Commercial Construction Permit Log #	
Fire Suppression Permit Log #	
Fire Alarm and Signaling Permit Log #	
Smoke Control Permit Log #	
Generator Permit Log #	

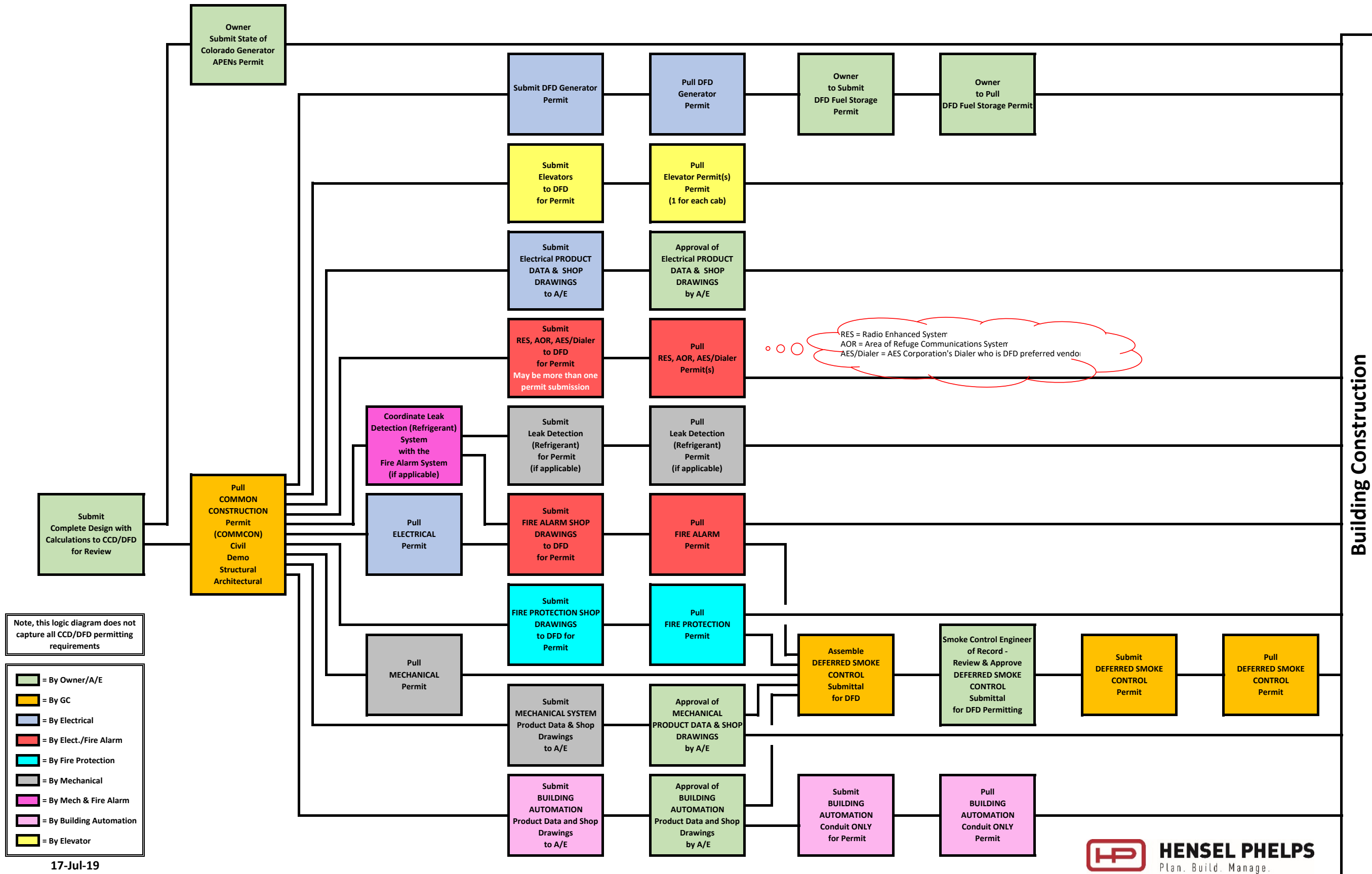
Project Overview - type of building, use, # of stories, etc.

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Type of Testing	Device Counts	
Fire Pump, PRVs & Generator	Pressure Reducing Valves (PRV)	
	Fire pumps	
	Jockey Pumps	
	Generators	
Flows, Tamperers & Dry Systems	Number of Stairwells	
	Number of Standpipes	
	Wet Systems	
	Dry-Pipe Systems	
	Pull Stations	
	Smoke Detectors	
	Duct Detectors	
	Heat Detectors	
	Beam Detectors	
	CO Detectors	
Area of Refuge Phones		
Firefighter Phone Jacks		
Kitchen Hoods		
Clean Agent Systems		
VESDA Systems		
Leak Detection Systems		
Fire Alarm Devices		

Type of Testing	Device Counts	
Elevators, Elevator Recall & Elevator Phones	Elevator Cabs	
	Total Number of Elevator Stops	
	Stair Pressurization Fans	
Smoke Control	Hoistway Pressurization Fans	
	Smoke Exhaust/Control Fans	
	Smoke Control Zones	
Life Safety		

CCD/DFD Permitting Logic Diagram



17-Jul-19



Denver Fire Department TCO/CO Sign-Off Logic Diagram

