Fire and Smoke Dampers – Selection & Application

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Learning Objectives

- What is the difference between a fire damper and a smoke damper?
- Dampers - types of installations
- UL Damper Types and Ratings
- UL Testing and Installation Testing of Dampers
- Where do these dampers go in a building?
  - NFPA Standards
  - Building Codes
- Testing and Maintenance

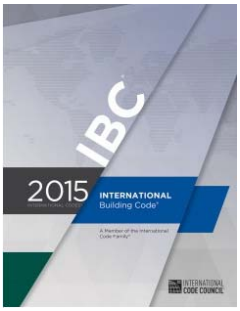
NFPA –National Fire Protection Association

- NFPA80 – Fire Doors & other protective openings
- NFPA90A -
- NFPA105

- ✓ Inspection
- ✓ Testing
- ✓ Maintenance



Building Codes – UL Damper Requirements





https://www.iccsafe.org

FIRE DAMPER TYPES



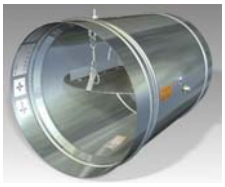
Curtain



Multi-blade



Single blade
Low profile



True round

Fire Dampers

Fire Damper – A Listed device designed to close automatically upon detection of heat and resist the passage of flame.



Fire Damper

A device used to restrict the passage of flame through the duct work of an air system. A fire damper is installed in a fire rated wall or floor and closes automatically to maintain the integrity of that partition.



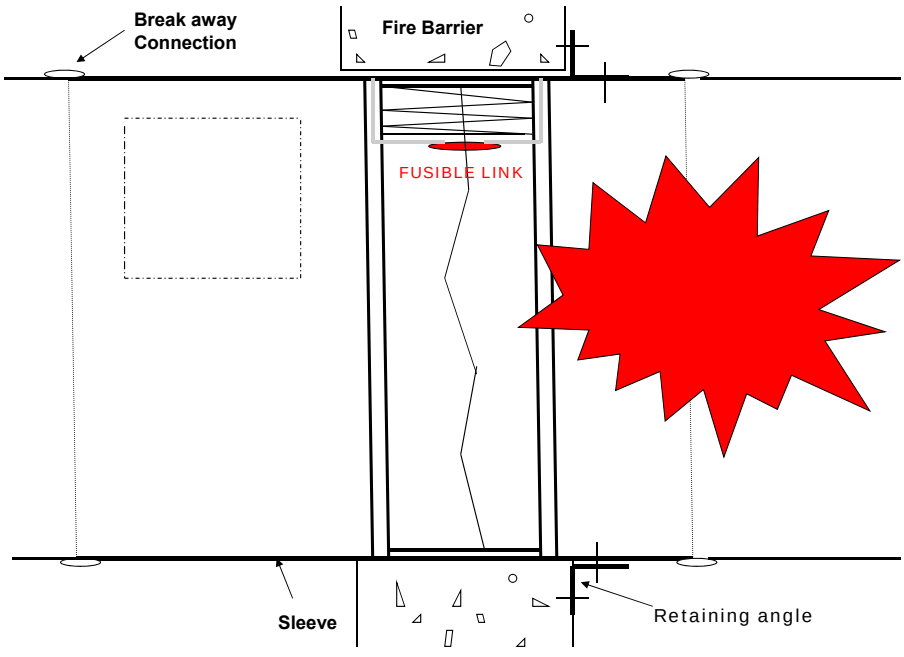


STATIC RATED: For "Fans off" applications

DYNAMIC RATED: For "Fans on" applications

1 ½ Hr : Acceptable for penetrations rated less than 3 hours

3 Hr : Acceptable for penetrations rated 3 hours or greater



Fire Dampers only Stop Fire - Not Smoke!



Stopping Smoke











According to NFPA, fire deaths due to smoke inhalation outnumber deaths due to burns by a 2-to-1 margin … 3-to-1 on death certificates issued prior to 1999

"Even under successful sprinkler suppression, smoke is generated that can still travel through the duct if not properly isolated" – Dr. John Klote

Smoke Dampers

Smoke Damper – A Listed device designed to resist the passage of smoke.







Smoke Damper

A device used to restrict the spread of smoke in an HVAC system which shut down in the event of a fire.

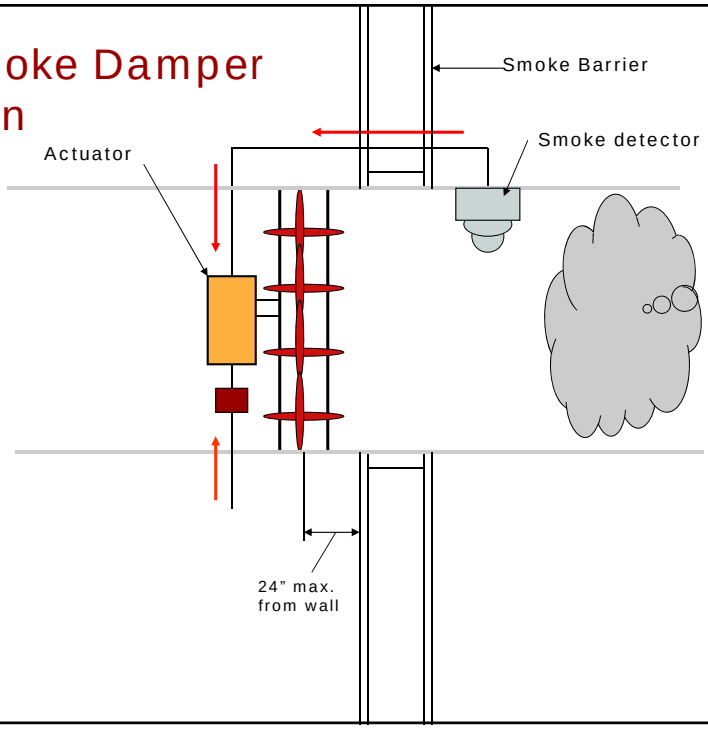


Leakage Class I – 4 cfm @ 1" w.g. (20.3 L/s/m^2 @ 250pa)
Leakage Class II – 10 cfm @ 1" w.g. (50.8 L/s/m^2 @ 250pa)
Leakage Class III – 40 cfm @ 1" w.g. (203 L/s/m^2 @ 250pa)

Velocity Ratings start at 2000 fpm @ 4" w.g. (10.2m/s @ 1000pa) and increase at 1000 fpm (5.1 m/s) and at 2" w.g (500pa).

Temperature Rating 250°F or 350°F (121°C or 177°C)

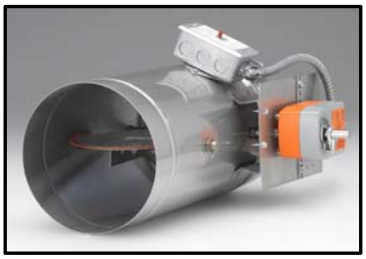
Typical Smoke Damper Application



Combination Fire/Smoke Dampers

Combination Fire/Smoke Damper – A Listed device designed to close automatically upon detection of heat and resist the passage of flame and smoke.





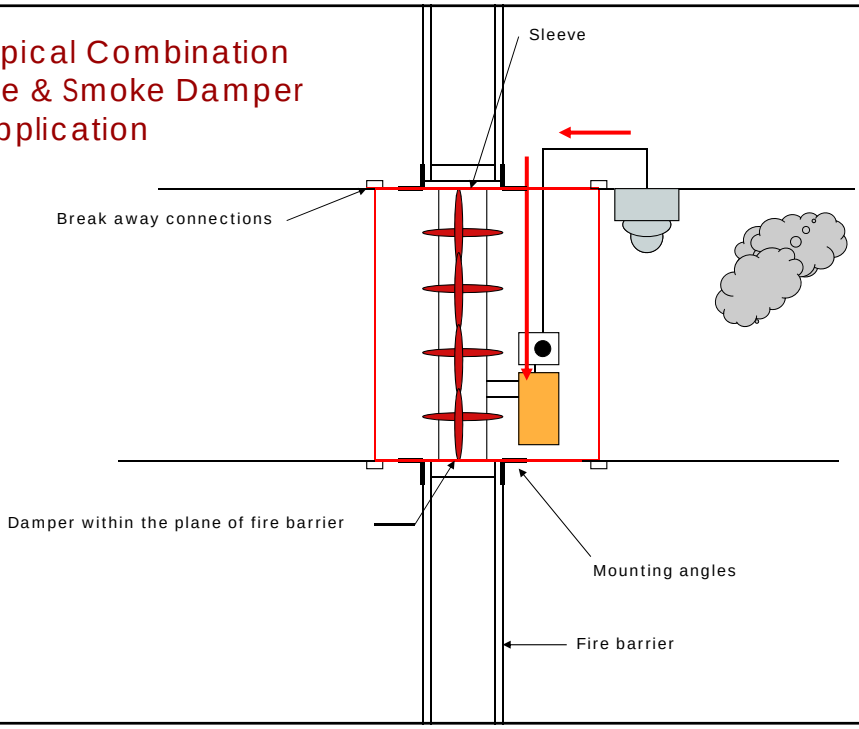


Combination Fire/Smoke Damper

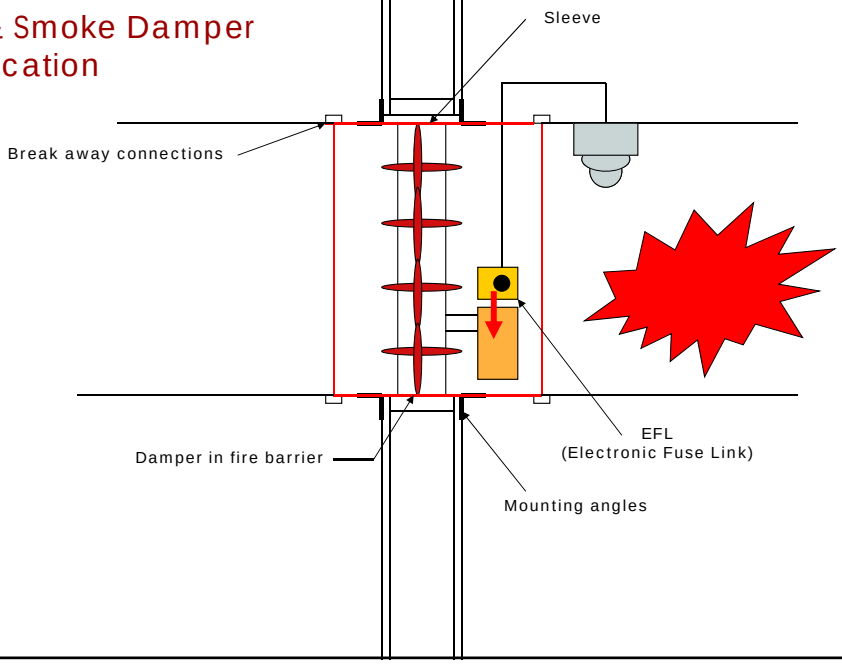
A device which functions as both a fire damper, and a smoke smoke damper.



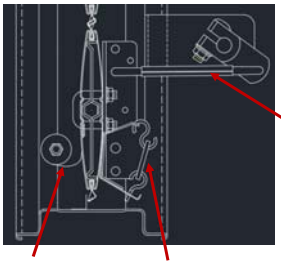
Typical Combination Fire & Smoke Damper Application



Typical Combination Fire & Smoke Damper Application



Typical Electronic Fuse link for Fire Smoke Dampers



1970's and 1980's Design



1990's to Current Design

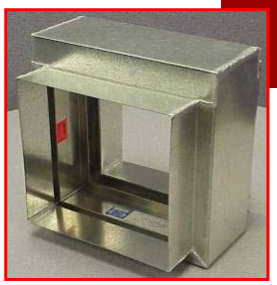
Fire Damper / FSD STYLES



B style



BC Style



C style – Most Free Area



R style – Round Duct

O style – Oval Duct



Underwriters Laboratories Testing

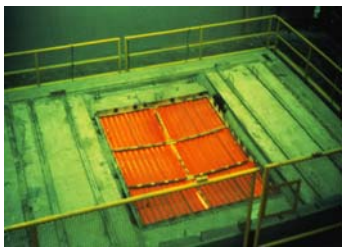
UL555 - *Fire Dampers*

UL555S - *Smoke Dampers*

UL555C - *Ceiling Dampers*

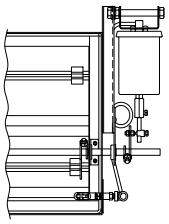
UL555 Fire Dampers

- **Fire Test**
  - Flame Exposure
  - $1^1/_2$ (1700°F or 927°C) or 3 (1900°F or 1038°C) Hour
- **Hose Stream Test**
  - Explosive Forces
- **Dynamic Closure Test**
  - Pressure & Velocity & Temp
    - Minimum 2400 fpm (2000 fpm) and 250°F.
    - Minimum 12.1 m/s (10.2m/s) and 121°C.
- **Cycle Test - Salt Spray**
  - Operation Reliability and Gunking Test



UL555S Smoke Dampers

- **Elevated Temperature Test**
  - Damper/Actuator Assembly
  - Factory-mtd Actuator
  - Heat Exposure 250°F/121°C, 350°F/177°C
- **Leakage Test**
  - Class I, II, III
  - Heated Air
- **Operation Test**
  - Pressure & Velocity & Temp
- **Cycle Test and Salt Spray**
  - Operation Reliability
    - 20,000 - Two Position
    - 100,000 - Modulating



Smoke Damper Ratings

- **Leakage Rating**
  - Class I - 8 cfm @ 4" w.g. (40.6L/s/m^2 @1000pa)
  - Class II - 20 cfm @ 4" w.g. (102L/s/m^2 @1000pa)
- **Elevated Temperature Rating**
  - Minimum 250°F/121°C
  - Maximum 350°F/177°C
- **Air Velocity**
  - Minimum 2000 fpm/ 10.2m/s
  - 1000 fpm/5.1m/s increments
- **Static Pressure**
  - Minimum 4" w.g/1000pa.
  - 2" w.g/500pa increments

Underwriters Laboratories

FIRE TEST VIDEO



Underwriters Laboratories

Dynamic Heated Airflow TEST VIDEO

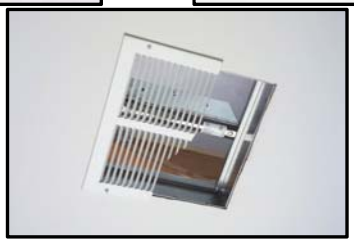


Ceiling Radiation Dampers

Ceiling Radiation Damper – A Listed device installed in a ceiling membrane of a fire-resistance-rated floor/ceiling or roof/ceiling assembly to limit the radiative heat transfer.







NFPA

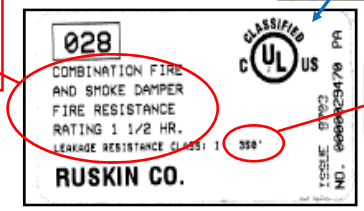
UL CERTIFICATION

- The label certifies the product meets stringent testing and performance requirements
  - Covered by UL's Follow Up Service



Indicates Damper Type & Rating/s

Assembly Temp.



Underwriters Laboratories

Where are the Dampers?
Code Location Requirements

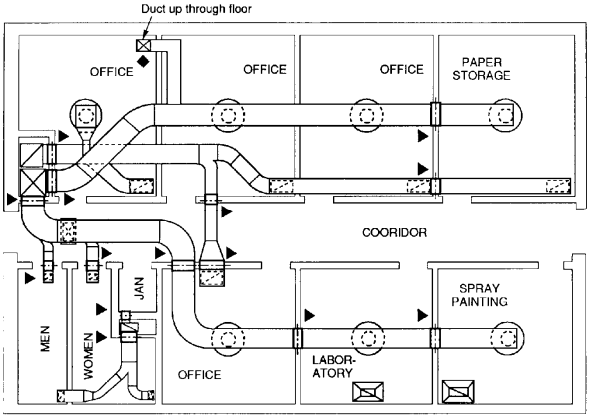
- Occupancy Separation Walls
- Horizontal Exit Walls
- Shaft Enclosures
- Building Exterior
- Smoke Barriers
- Floor/Roof Ceiling Assemblies
- Atrium Enclosure Elements
- Elevator Lobbies
- Areas of Refuge



Occupancy Separations

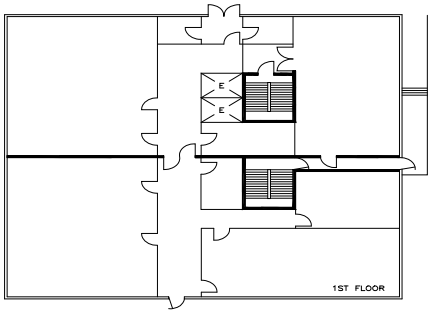
- All structures are classified with respect to occupancy.

- Assembly
- Business
- Educational
- Factory
- Institutional



Horizontal Exit Walls

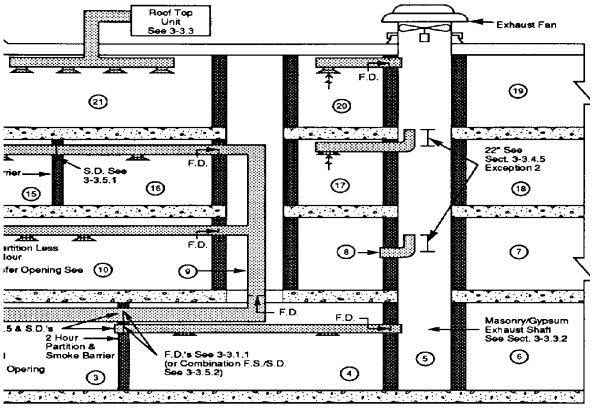
- A horizontal exit wall is part of the means of egress.
- It divides a floor in to at least 2



Health Care Facilities
&
Correctional Facilities

Shaft

- An enclosed interior space extending through one or more stories to accommodate mechanical equipment
- Shafts may or may not run the full height of a building

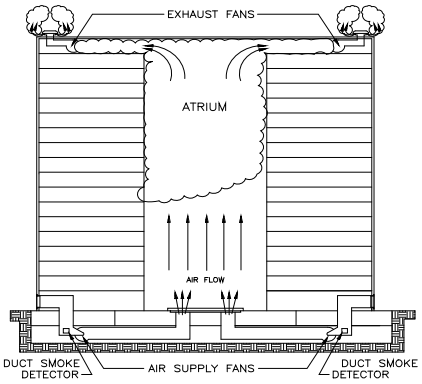




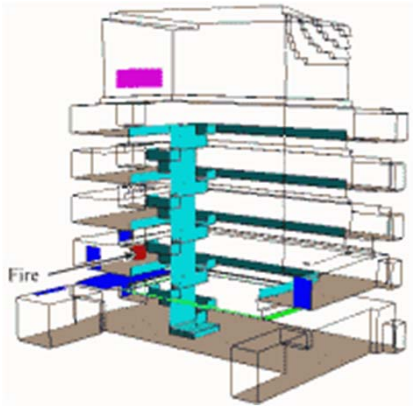
Fire smoke dampers at shaft wall openings

Atrium Enclosure

- A floor opening or series of floor openings that is covered at the top.



Atrium CFD Model



Building Exterior –

based on distance from adjacent building



EXTERIOR WALLS (SECTION 705)

EXTERIOR WALL OPENINGS – Based on Fire Separation Distance

TABLE 705.8
MAXIMUM AREA OF EXTERIOR WALL OPENINGS BASED ON
FIRE SEPARATION DISTANCE AND DEGREE OF OPENING PROTECTION

FIRE SEPARATION DISTANCE (feet)	DEGREE OF OPENING PROTECTION	ALLOWABLE AREA[a]
0 to less than 3[b, c, k]	Unprotected, Nonsprinklered (UP, NS)	Not Permitted[k]
	Unprotected, Sprinklered (UP, S)[i]	Not Permitted[k]
	Protected (P)	Not Permitted[k]
3 to less than 5[d, e]	Unprotected, Nonsprinklered (UP, NS)	Not Permitted
	Unprotected, Sprinklered (UP, S)[i]	15%
	Protected (P)	15%
5 to less than 10[e, f, j]	Unprotected, Nonsprinklered (UP, NS)	10%[h]
	Unprotected, Sprinklered (UP, S)[i]	25%
	Protected (P)	25%

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EXTERIOR WALLS (SECTION 705)

- Fire-Resistance Rating
  - Occupancy
  - Construction type
  - Distance from other structures
- Ducts/ Air Transfer openings are protected and shall comply with section 716
- FIRE DAMPER required

705.10 Duct and Transfer Openings

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Louver & Fire Damper in exterior wall



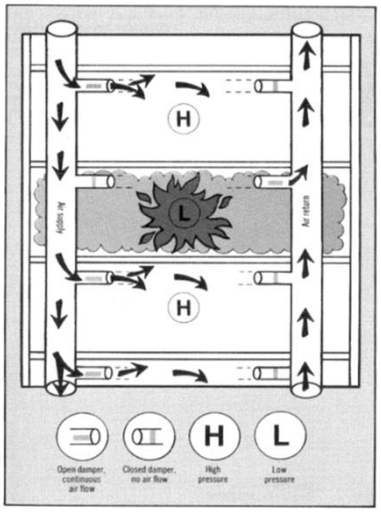
Key Factors:

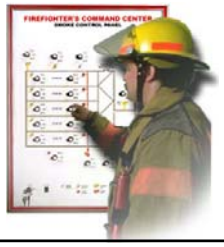
- Wall opening size?
- Wall depth?
- Damper model?
- Louver model
- Hourly rating?



Smoke Control Systems

- Zoned Smoke Control
  - Strategically located fire and smoke dampers open or close to channel HVAC air into selected areas - creating
  - high and low pressures





Area of Refuge

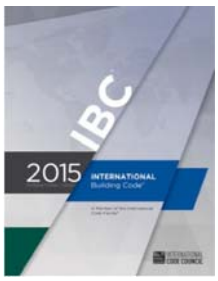
- Part of the total egress process
- Temporary use
- Safe staging area while emergencies are assessed

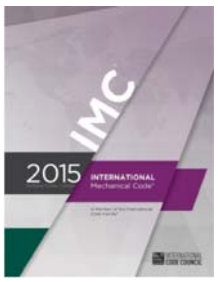
Building Codes

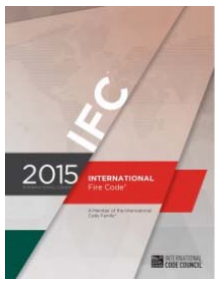
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- IBC Chapter 7
- IMC
- IFC

Why are UL Dampers used?

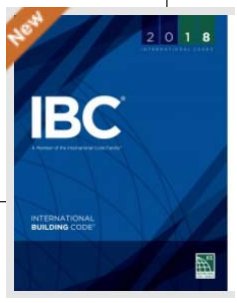






IBC Chapters That Affect The Construction and Ratings

- **IBC Chapter 3**
  "Use and Occupancy Classification"
- **IBC Chapter 4**
  "Special Use and Occupancy"
- **IBC Chapter 9**
  "Fire Protection System"



Occupancy

Occupancy Classification	
Description	***Group(s)***
Assembly	*A-1, A-2, A-3, A-4 and A-5*
Business	*B*
Educational	*E*
Factory and Industrial	*F-1 and F-2*
High Hazard	*H-1, H-2, H-3, H-4 and H-5*
Institutional	*I-1, I-2, I-3 and I-4*
Mercantile	*M*
Residential	*R-1, R-2, R-3, R-3.1 and R-4*
Storage	*S-1 and S-2*
Utility and Miscellaneous	*U*

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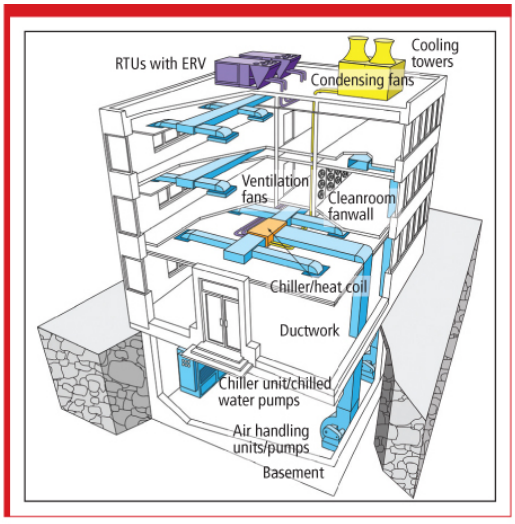
DUCT & AIR TRANSFER OPENING

Chapter 717 – Follows NFPA

- Fire Dampers
- Smoke Dampers
- Combination Fire/Smoke Dampers
- Ceiling Radiation Dampers

ICC INTERNATIONAL CODE COUNCIL

SHAFT ENCLOSURES (SECTION 713)



ICC INTERNATIONAL CODE COUNCIL

SHAFT ENCLOSURES (SECTION 713)

Ducts/ Air Transfer openings are protected and shall comply with Section 716

- Combination Fire/Smoke Damper Required
- SMOKE DAMPER required (exceptions)

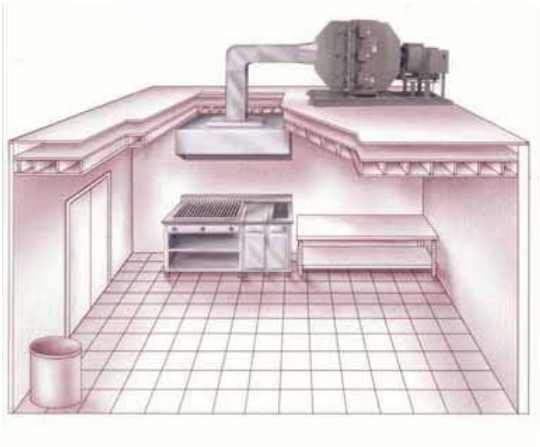
  Smoke damper are available for either "Fail Open" or "Fail Closed" operation does not interfere with approved mechanical smoke control system.

713.10 Duct and Transfer Openings

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SHAFT ENCLOSURES (SECTION 713)

- FIRE DAMPER required (exceptions)



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FIRE PARTITIONS (SECTION 708)

- Fire Partitions are used for:
  - Walls Separating Dwelling Units
  - Walls Separating Sleeping Units
  - Walls Separating Tenant Spaces
    - Covered Malls
  - Corridor Walls
  - Elevator Lobby Separation

708.9 Duct and Transfer Openings

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Access and Identification

Access

- Provided with an approved means of access
- Large enough to permit inspection, and maintenance
- Access shall not affect the integrity of fire resistance-rated assemblies



Identification

- Access points shall be permanently identified on the exterior by a label
- Letters not less than 0.5 inch in height reading:
  - FIRE/SMOKE DAMPER
  - SMOKE DAMPER
  - FIRE DAMPER

SECTION 717.4 Access and Identification
NFPA80 (19.2.3) and 105 (7.3.1)

Installation

- the manufacturer's installation instructions and the dampers' listing

- Damper Testing
  - Fire Damper UL555
  - Smoke Damper UL555S
  - Combination Fire/Smoke Damper UL555 & UL555S
  - Ceiling Radiation Damper UL555C

FIRE PROTECTIVE SYSTEMS

Chapter 909
Smoke Control Systems

Mechanical or Passive Smoke Control Systems
Design and, Installation and acceptance testing

909.10.4 Automatic Dampers

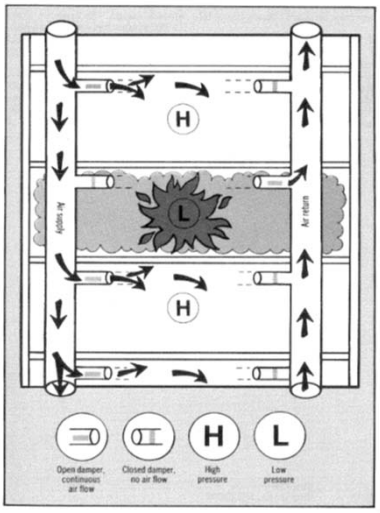
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Smoke Control Systems

Passive Smoke Control
Close upon detection of smoke

- *Engineered Smoke Control*

  Strategically located fire and smoke dampers open or close to channel HVAC air into selected areas - creating high and low pressures



Smoke Control Systems Section 909

- **Special Inspection and Testing Requirements Section 909.3**
  - shall undergo special inspections and tests sufficient to verify the proper commissioning of smoke control design in its final installation condition.
- **Ducts and Air Transfer Openings Section 909.5.2.1**
  - Listed Ducts and air transfer openings are to be protected with a minimum Class II, 250°F/121°C smoke damper complying with Section 716.
- **Equipment Section 909.10**
  - Equipment including, but not limited to, fans, ducts, automatic dampers and balance dampers, shall be suitable for its intended use, suitable for the probable exposure temperature that the rational analysis indicates and as approved by the fire code official.
  - (Fail Open or Fail Closed)

Smoke Control Systems Section 909

- **Automatic Dampers Section 909.10.4**
  - Automatic dampers, regardless of purpose for which they are installed within the smoke control system, shall be listed and conform to the requirements of approved, recognized standards.
- **Smoke Control Systems Section 909.16.1**
  - Status indicators shall be provided for all smoke control equipment
    - **Fans, dampers - normal status –** WHITE
    - **Fans, dampers - off or closed status –** RED
    - **Fans, dampers - on or open status –** GREEN
    - **Fan, dampers - fault status –** YELLOW/AMBER

Smoke Control Systems Section 909

- **Smoke Control Panel Section 909.16.2**
  - OPEN-AUTO-CLOSE control over individual dampers relating to smoke control
  - also controlled from other sources within the building
- **Acceptance Testing Section 909.18**
  - Devices, equipment, components and sequences shall be individually tested
  - Dampers shall be tested for function in their installed condition. 909.18.3
- **Identification and Documentation Section 909.18.9**
  - Devices shall have an approved identifying tag or mark on them consistent with the other required documentation and shall be dated indicating the last time they were successfully tested and by whom.

INTERNATIONAL FIRE Code (IFC)

Chapter 7

- **Smoke Barriers and Smoke Partitions**
  - Section 703.1.2
  - Damper maintained per NFPA 105
- **Fire Walls, Fire Barriers and Fire Partition**
  - Section 703.1.3
  - Dampers maintained per NFPA 80

ICC INTERNATIONAL CODE COUNCIL

Building Codes – UL Damper

Requirements/ Fire & Smoke Protection Features

SECTION	WALL TYPE	REFERENCED FROM	TYPE OF DAMPER
717.5.1 (IMC 607.5.1)	Fire walls	706.11	Fire damper
717.5.1.1 (IMC 607.5.1.1)	Fire wall – Horizontal exits	706.11	Fire damper, Smoke damper
717.5.2 (IMC 607.5.2)	Fire barriers	707.10	Fire damper
717.5.2.1 (IMC 607.5.2.1)	Fire barriers – Horizontal exits	707.10	Fire damper, Smoke damper
717.5.3 (IMC 607.5.5)	Shaft enclosures	713.10	Fire damper, Smoke damper
717.5.4 (IMC 607.5.3)	Fire partitions	708.9	Fire damper
717.5.4.1 (IMC 607.5.3 and 607.5.4)	Fire partitions – Corridors	708.9	Fire damper, Smoke damper
717.5.5 (IMC 607.5.4)	Smoke barriers	709.8	Smoke damper
717.5.6 (IMC 607.5.6)	Exterior walls	705.10	Fire damper
717.5.7 (IMC 607.5.7)	Smoke partitions	710.8	Smoke damper

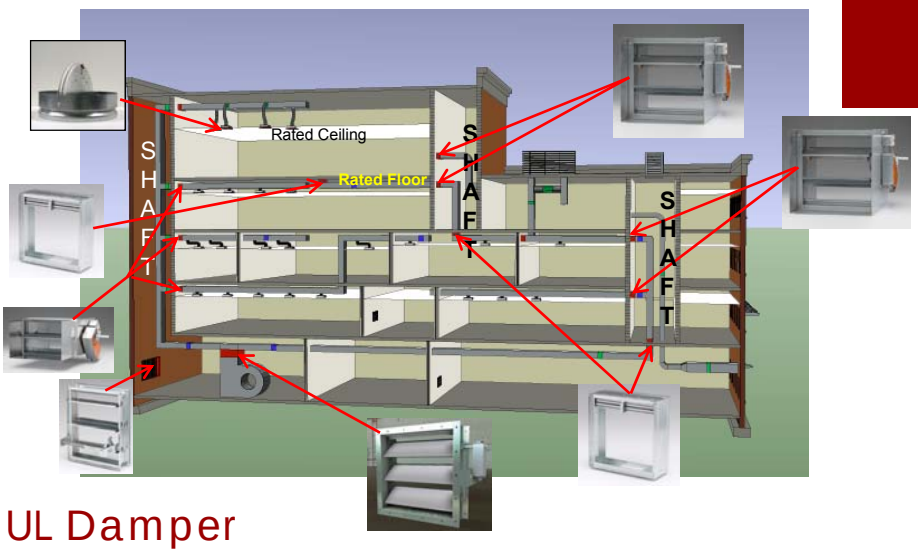
717.6	Horizontal Assemblies	CFD/ Fire Damper	





IBC TABLE 717.3.2.1
FIRE DAMPER RATING (IMC TABLE 607.3.2.1)

TYPE OF PENETRATION	MINIMUM DAMPER RATING (hours)
Less than 3-hour fire-resistance-rated assemblies	1.5
3-hour or greater fire-resistance-rated assemblies	3

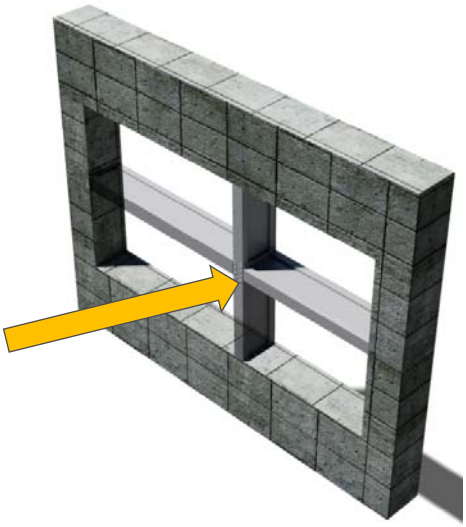


UL Damper Applications

Oversized Opening

- Maximum UL damper size
- Sub-dividing the opening

AHJ to approve materials & method for subdividing the opening

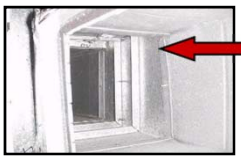


Operational, Testing and Maintenance

When should Fire/Smoke dampers be tested?

All the following information is a summary of the IBC (International Building Code) 2009, UL, NFPA 72, NFPA 80, NFPA90A, NFPA92A & B and NFPA105.

Acceptance Testing and Maintenance



Screws in damper track



Fuselink missing



When Should The Dampers be Tested?

- NFPA80 and NFPA 105

- 19.3 **Operational Test**
  - 19.3.1 After Installation of a damper is complete, An operational test shall be conducted.
  - 19.3.1.2 When equipped with a smoke detection activation, the smoke detector shall be activated in accordance with NFPA 4
  - 19.3.1.5 All indicating devices shall be verified to work and reporting to the intended location

First Test

When should Fire and Combination Fire Smoke dampers be tested?

- Each damper should be tested and inspected 1 year after installation
  - This test is to verify that the damper has no interference due to rust, bent, misaligned or damaged parts during the construction phase of the building





When Should The Dampers be Tested?

- NFPA90A
  - **Chapter 7 – Acceptance Testing (Commissioning)**
    - 7.2 All dampers shall be tested 1 year after installation and/or prior to **Occupancy**.
  - NFPA80
  - **19.4– Acceptance Testing (Commissioning)**
    - 19.4.4 Dynamic damper are to be tested under normal operating conditions.

Second Test

When Should The Dampers be Tested?

- NFPA80 and NFPA 105
  - 19.5 **Periodic Testing**
    - 19.5.1.1 – The test and inspection frequency shall be every 4 years.
      - Except in buildings containing a hospital, where the frequency shall be every 6 years.

Third Test

Documentation

PREVENT Life Safety

FIRE DAMPER INSPECTION

Inspected by: Johnny Smith Job #: 16-XXXX

Floor: 1st Floor Facility: ABC Hospital

Damper #	Inspect Type (M / V)	Damper Type (FD / FSD / SD)	Exercised (Y / N)	Passed (Y / N)	Inspection Date	Repair Date	Repairs made / Notes / Date checked (ex: replace fusible link, fixed screw)	Actuator Type	Damper Replacement Dimensions
1- 028	Mechanical	FSD-E	Yes	Yes	5/11/16				
1- 029	Mechanical	FSD-E	Yes	Yes	5/11/16				
1- 030	Visual		No	No	5/11/16		No Duct Access		
1- 031	Mechanical	FD	Yes	Yes	5/11/16				
1- 032	Mechanical	FD	Yes	Yes	5/11/16				
1- 033	Mechanical	FSD-E	Yes	Yes	5/11/16				
1- 034	Mechanical	FD	Yes	Yes	5/11/16				
1- 035	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 036	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 037	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 038	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 039	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 040	Visual		No	No	5/12/16		No Duct Access		
1- 041	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 042	Mechanical	FD	Yes	Yes	5/12/16				
1- 043	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 044	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 045	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 046	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 047	Mechanical	FD	Yes	Yes	5/12/16				
1- 048	Mechanical	FD	Yes	Yes	5/12/16				
1- 049	Mechanical	FD	Yes	Yes	5/12/16				
1- 050	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 051	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 052	Mechanical	FSD-E	Yes	Yes	5/12/16				
1- 053	Mechanical	FD	Yes	Yes	5/12/16				
1- 054	Mechanical	FSD-E	Yes	Yes	5/12/16				

NFPA90A 2015 Edition

5.4 Fire Dampers, Smoke Dampers, and Ceiling Dampers.





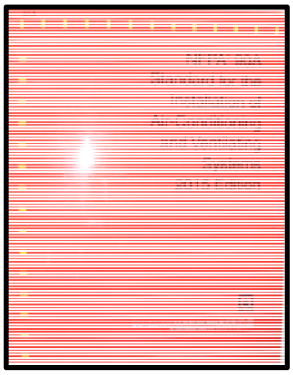




NFPA

NFPA90A 2015 Edition

Standards for the Installation of Air-Conditioning and ventilating Systems



Damper Installation

NFPA 90A 2015
Section 5.4.7 Installation

Fire , Smoke, Combination Fire Smoke and Ceiling Dampers shall be installed in accordance with the condition the listing.

In Accordance with Damper Manufacture Installation Instructions

Plans and Review

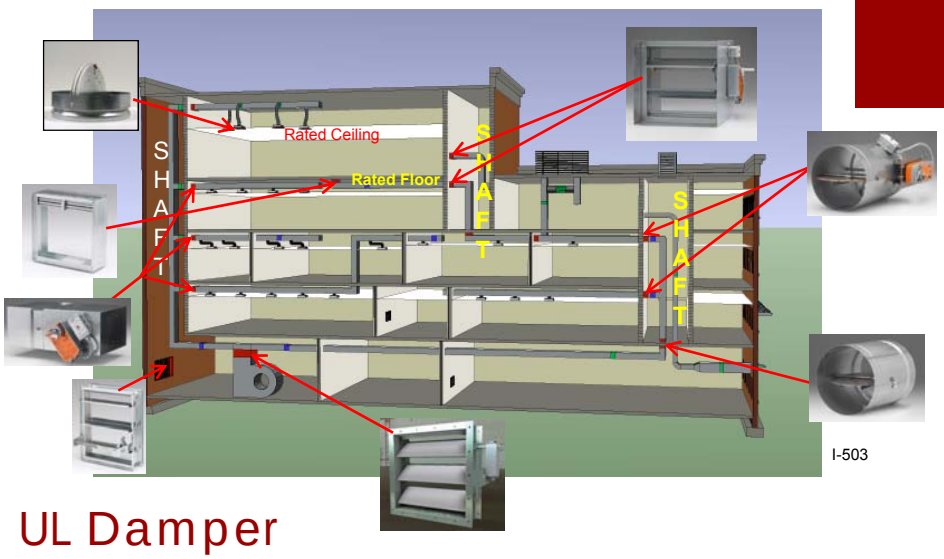
NFPA 90A2015
Section 5.4.6 Damper Location and Information

5.4.6.1 The locations and mounting arrangement of all fire, smoke, ceiling and combination fire smoke dampers: **"Shall be shown on the drawings of the air duct systems."**

Plans and Review

NFPA 90A2015
Section 5.4.6 Damper Location and Information

5.4.6.2 Dampers required to close in airflow **"shall have the calculated airflow at their location shown on drawings of the air duct system".**



UL Damper Applications

Plans and Review

NFPA 90A
Section 5.4.6 Damper Location and Information

5.4.6.1 The locations and mounting arrangement of all fire, smoke, ceiling and combination fire smoke dampers: **"Shall be shown on the drawings of the air duct systems."**

Plans and Review

NFPA 90A
Section 5.4.6 Damper Location and Information

5.4.6.2 Dampers required to close in airflow "shall have the calculated airflow at their location shown on drawings of the air duct system".

In Summary …

- Follow Building codes, NFPA and logical Engineering safety practices
- UL-approved smoke dampers and combination fire-smoke dampers stop smoke – fire dampers do not
- NFPA90A, 92A/B and 105 should be in your engineering library
- UL testing includes proper installation methods
- Commission and test dampers before occupancy
- Consult your manufacturer's catalog/website for UL installation guidelines
- Keep your Buildings SAFE!!!