Life-Safety Dampers
Fire, Smoke & Combination Fire - Smoke
Alex Talwar
Background

- Application Engineer II – Commercial Dampers

- 6 years at Greenheck
  - 5 years as Damper Test Lab Supervisor and Product Development Engineer

- Bachelor’s Degree in Engineering Physics (University of Michigan ‘06)

- Member of ASHRAE, NFPA, and Various AMCA Committees
Learning Objectives

- Understand Different Life-Safety Damper Product Types
- Understand Life-Safety Damper Rating Requirements
- Understand Installation Requirements & Options
- Discuss Available Options & Accessories
- Explain Testing & Maintenance Requirements
Damper Selection

• Comply with code requirements
• Design for long term use
• Modification restrictions
Codes & Standards
Required Elements of an “Approved” Life-Safety Damper Installation

1. Rated Barrier
2. Listed Product
3. Installation Requirements
Building Code

International Building Code (IBC)

→ Ch. 7 – Fire & Smoke Protection Features

→ Sec. 717 – Ducts & Air Transfer Openings

• Baseline Requirements:
  • Dampers must be listed & labeled to applicable UL standard
  • Dampers must be installed in accordance with manufacturer’s instructions

• Defines the type of damper required to protect penetrations through each type of rated building element
Code Mandated Applications of Life-Safety Damper

Sections 717.5 – Where Life-Safety Dampers are Required

- 717.5.1 Fire Walls
- 717.5.2 Fire Barriers
- 717.5.3 Shaft Enclosures
- 717.5.4 Fire Partitions (includes corridors)
- 717.5.5 Smoke Barriers
- 717.5.6 Exterior Walls
- 717.5.7 Smoke Partitions
Standards - NFPA

National Fire Protection Association

- Installation, Testing and Maintenance
  - NFPA 80
    - Standard for Fire Doors
  - NFPA 105
    - Standard for Smoke Doors
  - NFPA 90A and 90B
    - Standard for Installation of Air-conditioning and Ventilating Systems
  - NFPA 92
    - Standard for Smoke-Control Systems
Standards - UL

Underwriters Laboratories

• Testing, Evaluation and Certification
  • UL 555 - standard for Fire dampers
  • UL 555S - standard for Smoke dampers
  • UL 555C - standard for Ceiling Radiation dampers

• UL’s “Follow-Up Service” ensures that dampers are built as they were tested
Purposes of Life-Safety Dampers

• Containment
  – Building codes require life-safety dampers to protect duct penetrations thru rated construction
  – Fire and smoke rated construction is used to “compartmentalize” a building into fire & smoke zones to prevent the spread of fire

• Engineered Smoke Control Systems
  – Smoke and Fire Smoke Dampers are often used as part of an engineered smoke control system to evacuate smoke and/or pressurize zones adjacent to the fire
Dampers in an Engineered Smoke Control System
Purpose of Fire Damper

To maintain the fire-resistance rating of fire walls, barriers and partitions when penetrated by air duct or transfer openings.
Hourly Fire Resistance Rating

**IBC table 717.3.2.1**

<table>
<thead>
<tr>
<th>Type of Penetration</th>
<th>Minimum Damper Rating (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 3 hour fire resistance rated assemblies</td>
<td>1½</td>
</tr>
<tr>
<td>3 hour or greater fire resistance rated assemblies</td>
<td>3</td>
</tr>
</tbody>
</table>

- **2 hour assembly rating =** 1.5 hour rated damper
- **3 hour assembly rating =** 3 hour rated damper
- **4 hour assembly rating =** 3 hour rated damper
UL 555 Fire Test
Fire Damper Operation

UL Marking and Application Guide

• Static
  • Used in duct systems or penetrations where the HVAC system is automatically shut down in the event of a fire.

• Dynamic
  • To be used in applications where fan pressure and airflow will be on during a fire incident.
Fire Damper Actuation Temperature

• For Most Fire Dampers this is the Fusible Link Temperature Rating

  • 165°F – standard
    • 160°F minimum per IBC

  • 212°F – max for static applications
    • Helps avoid nuisance trips from heating equipment

  • 286°F

  • 350°F – max for dynamic application
Velocity & Pressure Ratings for Dynamic Fire Dampers

- Operational closure velocity rating
  - **2,000 fpm** (UL555 minimum rating)
  - 3000 fpm
  - 4000 fpm
- Operational closure pressure rating
  - **4-in. wg** (UL555 minimum rating)
  - 6-in. wg
  - 8-in. wg
- Broadest product offering is rated for **2,000 fpm** and **4-in. wg**
Damper Construction

• Two common construction types
  • Curtain
    • Static or Dynamic rating
    • Low cost
  • Multi-blade
    • Typically have Dynamic rating
    • Larger sizes than curtain models
    • Can double as a balancing damper

• Material
  • Galvanized
  • 304 & 316 stainless steel
  * No aluminum models *
  (1,221°F melting point)
Fire Damper Transition Options

Type A: Blades in Airstream
Type B: Blades Out of Airstream
Type C: 100% Free Area
Type CO: 100% Free Area
Type R: High Free Area
Type CR: 100% Free Area
True Round Life-Safety Dampers

DFDR-510  
True Round  
Dynamic Fire Damper

FSDR-510  
True Round  
Fire Smoke Damper

Retaining Plate  
Included with the Damper

The Opening in the Wall  
Does Not Have to be Round!
Fire and Fire Smoke Damper Installation
Curtain dampers are only listed and labeled to be mounted in the orientation they were ordered for.
Fire Damper Installation Requirements

Mounting Orientations – Multi-Blade Fire Dampers

“Most” multi-blade fire dampers are approved to be mounted vertically or horizontally

Traditional models: Blades must be horizontal

Only models specifically tested for vertical blade mounting may be mounted with their blades running vertically
Fire and Fire Smoke Damper Installation

Wall or Floor Opening Dimensions

Dampers must be ordered to fill the full opening.

You can not order multiple dampers to fill a single opening!
Fire and Fire Smoke Damper Installation

Horizontal Installations

Fire and Fire Smoke dampers are only approved to be installed horizontally in concrete floors

**Exceptions**

1. Tunnel Corridor Ceilings (model CFSD)
2. UL Design I503
Fire and Fire Smoke Damper Installation

Design I503: Horizontal Non-Concrete Barrier

An Innovative Solution to a Common Construction Challenge

Note: Design I503 is a non-load bearing barrier
Horizontal Non-Concrete Installation

UL Design I503
Installation Requirements
Fire and Fire Smoke Dampers

Framing of Opening

- Double vertical studs required for dampers over 36”x36”
- Damper opening in wood stud walls must be lined with sheet rock
- Openings in steel stud walls do not need to be lined
Traditional Installation
Fire and Fire Smoke Dampers

- The centerline of the damper frame must be in the plane of the wall/floor
- Requires annular space between the damper sleeve and wall opening
- Retaining Angle Installation
  - Angles must be fastened to the sleeve (not to the barrier)
Traditional Installation
Fire and Fire Smoke Dampers

Approved Duct to Sleeve Breakaway Connections

Transverse Joints

Manufactured Flange Systems

TDC/TDF
UL 555 Duct Impact Test

Greenheck Connect-All Breakaway Test
UL 555 Duct Impact Test
UL 555 Duct Impact Test
Installation Requirements
Fire and Fire Smoke Dampers
Alternative Installation Methods

Single Side Installation

- No annular space requirements
- Angles must be attached to both the sleeve and the barrier
- Allowable damper sizes:
  - Vertical Mount:
    - 80”x50”
    - 50”x80”
    - 40”x100”
  - Horizontal Mount
    - 144”x96”

* Larger assemblies and 3 hour ratings require angles on both sides of barrier
Alternative Installation Methods

Out-Of-Wall Installations

Only valid for specific models that were tested outside the plane of the rated barrier.

Commonly used in shaft walls installations where there is no external access to the actuator.
Alternative Installation Methods

3 Sided Retaining Angle Installation Method

- The retaining angle may be omitted from any of the four sides
- UL approved
Recap of Fire Damper Specification Criteria

Specification Requirements

- Hourly Fire Rating
- Actuation Temperature
- Dynamic vs. Static
  - Velocity / Pressure Ratings
- Mounting Orientation
- Be Conscious of Size Limitations
- Installation Options
UL 555S Classifications

• Velocity and pressure rating
  • Tested to performance values
dynamic fire dampers

• Leakage class
  • I (8 cfm/sq. ft @ 4 in. wg)
  • II (20 cfm/sq. ft @ 4 in. wg) *
  • III (80 cfm/sq. ft @ 4 in. wg)

• Elevated temperature rating
  • 250° F
  • 350° F

* IBC 717.3.2.2: Smoke damper leakage ratings shall be Class I or II.
**Amount of Time to Fill a Room With Smoke**
*Based on Leakage Class*

<table>
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<tr>
<th>Leakage Class</th>
<th>Length of Time</th>
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<tr>
<td>I</td>
<td>100 minutes</td>
</tr>
<tr>
<td>II</td>
<td>40 minutes</td>
</tr>
<tr>
<td>III</td>
<td>10 minutes</td>
</tr>
</tbody>
</table>

24”W x 24”H damper at maximum rated pressure

3200 FT³ space
Smoke Damper Installation

• Installation
  • Centerline of blades must be within 24 inches of a rated smoke barrier
  • Can be installed directly in ductwork or in sleeve/barrier like fire damper
  • No annular space requirement

• Actuation (per IBC 717.3.3.2)
  • Listed smoke detector within 5 feet of damper
  • Total-coverage smoke detection system
Smoke Damper Construction

• Configured like a control damper
  • Multi-blade
    • 3V or Airfoil blade
  • Round

• Construction
  • Blade and jamb seals
  • Aluminum models available
    • Extruded blades and frame
  • No sleeve requirement
  • Larger max. listed sizes than fire and fire-smoke dampers
Fire/Smoke Damper Actuators

• Mounting
  • Must be factory installed per UL
  • Internal or external location

• Operation
  • Always spring return

• Testing requirement
  • 20,000 cycles – two position
  • + 100,000 repositions – modulating
Fire/Smoke Damper Actuators

• Electric
  • Two position
  • Modulating / Balancing
• Power connection
  • 24 VAC
  • 120 VAC
    • Transformer required on 208V, 277V, 460V
• Pneumatic
  • 20-25 psi supply
  • 60-80 psi supply
Purpose of Fire / Smoke Damper

• Provide the same level of protection as individual fire and smoke dampers
• Fire rating – UL555 certified
• Leakage rating – UL555S certified
  • Always supplied with factory mounted actuator
• Always dynamically rated
Fire/Smoke Damper Closure Devices

- **RRL**
  - Electric thermal switch
- **RRL/OCI**
  - RRL + open / close indication
- **TOR**
  - Secondary override temp. for smoke control applications
- **Fusible Link**
  - Often used for fail open operation
- **PRV**
  - Pneumatic relief valve
Ceiling Radiation Dampers
Ceiling Radiation Dampers

When are they used?

To protect opening penetrations in the ceiling membrane of fire-resistive rated floor/ceiling and roof/ceiling assemblies
Ceiling dampers that only carry a UL 555C classification can only be used if assemblies that were tested with a generic hinged-door-type damper
Ceiling Radiation Dampers

UL Fire Resistance Directory

**UL Category Code:** BXUV
Ceiling Radiation Dampers

When can I use them?

Only in Floor/Ceiling or Roof/Ceiling Assemblies that were tested with HVAC Penetrations Protected by a Ceiling Damper

If the UL 263 test wasn’t conducted with ceiling dampers, then ceiling dampers can not be installed in those assemblies in the field!
Ceiling Radiation Dampers

When can I use them?

Application 1: In UL rated floor ceiling assemblies that were tested with a generic “hinge-door-type” damper

9. Damper — No. 16 MSG galv steel, sized to overlap duct outlet by 1 in. min. Protected on both surfaces with 1/16 in. thick ceramic fiber paper and held open with Fusible Link (Bearing the UL Listing Mark).
Ceiling Radiation Dampers

When can I use them?

**Application 2:** In UL floor/ceiling assemblies tested with specific ceiling damper models (i.e. proprietary designs)
Ceiling Radiation Dampers

“Proprietary” Nature of Floor/Ceiling Designs

- The original test assembly may be the same
- But if a damper manufacturer sponsored the test then they control whose products can be listed in the design
Operational Test and Inspection
International Fire Code (IFC)
Requires fire dampers to be maintained in accordance with NFPA 80 & smoke dampers to be maintained in accordance with NFPA 105
Operational Testing

NFPA 80 & 105

• Operational test:
  • NFPA 80 – Fire Dampers
    • “After the installation of a damper is completed, an operational test shall be conducted.”
  • NFPA 105 – Smoke Dampers
    • “An operational test shall be conducted after the building’s HVAC system has been balanced.”
Periodic Testing and Maintenance
Periodic Testing

**IFC / NFPA 80 & 105**

- **Frequency**
  - “Each damper shall be tested and inspected 1 year after installation.”
  - “The test and inspection frequency shall then be every 4 years, except in buildings containing a hospital, where the frequency shall be every 6 years.”
Periodic Testing

IFC / NFPA 80 – Fire Dampers with Fusible Links

• Remove fusible link, allow damper to close, return to open position, reinstall fusible link, verify damper is unobstructed

IFC / NFPA 80 & 105 – Smoke & Combination Fire Smoke

• Traditional test method requires visual confirmation of damper operation

• 2019 editions of NFPA standards now allow for remote testing
  • Damper position indication (OCI or actuator end switch) can provide confirmation of damper operation
Commonly Specified Features
Commonly Specified Features

Position Indication

On-Blade

Actuator auxiliary switches
Commonly Specified Features

- Modulating fire-smoke actuator
  - Eliminates the need for additional control or automatic balance dampers
  - Position control signal provided by local devices or building control system
  - On-board controls override position signal to close damper during fire event
Commonly Specified Features

Test Stations

- Local
  - Momentary Test Switch
    - Damper mounted

- Remote
  - Wall mounted test panels
    - Various configurations
      - Testing and position indication
      - Position indication only
Commonly Specified Features

Factory Mounted and Wired Smoke Detectors

Flow Sampling

No Flow
Commonly Specified Features

Automatic Balancing Dampers

ABD-FD
Installation Time Savers

- Factory provided accessories
  - Retaining angles
  - Quick connect breakaway
  - Access doors
Thank you for your time

Questions?

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