Conceptual Discussion on Code, Design, and Installation Requirements of Duct Openings of Rated Construction
The Solutions to Damper Problems


- **Engineers**: Show All Dampers. Choose a Basis Of Design and Detail Damper Installations. Specify Installation Instructions be Submitted and Mock-ups be provided. Mock-ups Approved by Engineer, Contractor, Damper Manufacturer.
The Solutions to Damper Problems - Cont

- **Contractors**: Submit Installation Instructions. Sheet Metal and Carpenter (or Mason) Coordinate Framing with Other Trades. Test SD and FSD with FA Contractor.

- **Inspectors**: Verify Construction Docs Show Fire-Resistant Assemblies, and how penetrations will be protected. Inspect Per Mfg Installation Instructions (Obtain From Contractor).
Resources

- www.smacna.org
- www.ul.com
- www.iccsafe.org
- http://www.dos.ny.gov/dcea
  518-474-4073
- manufacturer’s web sites
19 NYCRR Part 1221/1223: Code Requirements

Life safety
Damper Types

- Fire Damper
- Ceiling Radiation Damper
- Corridor Damper (New This Code Cycle)
- Smoke Damper
- Combination Fire/Smoke Damper
Definition Fire Damper §202 of IBC

- A listed (UL Classified) device, installed in ducts and air transfer openings designed to close automatically upon detection of heat and resist the passage of flame... Protecting the opening and maintaining rating of building assemblies.

- Fire dampers are classified as either static (negligible airflow) or dynamic (close with fan running).

- Carry an hourly fire resistance rating of 1-1/2 or 3 hours per Table 717.3.2.1 of IBC.
Ceiling Radiation Damper
Definition

A listed (classified) device installed in a ceiling membrane of a fire-resistance-rated floor/ceiling or roof/ceiling assembly to limit automatically the radiative heat transfer through an air inlet/outlet opening...
Corridor Dampers

- A listed device intended for use where air ducts penetrate or terminate at horizontal openings in the ceiling of the fire-resistance-rated corridors, where the corridor ceiling is permitted to be constructed as required for the corridor walls.

- Must comply with providing for both Both ‘FD’ (UL 555) and ‘SD’ UL 555S Provisions
Smoke Damper Definition

A listed (labeled/classified) device installed in ducts and air transfer openings that is designed to resist the passage of air and smoke. The device is installed to operate automatically, controlled by a smoke detection system, and where required, is capable of being positioned from a remote command station.
Building Components

- §706: Fire Walls
- §707: Fire Barriers
- §708: Fire Partitions
- §709: Smoke Barriers
- §710: Smoke Partitions
- §711: Horizontal Assemblies
- §713: Shafts
Definitions Bldg Components IBC §202

- **Horizontal (Fire Resistant) Assembly**: Horizontal fire resistance-rated assembly, continuity maintained.
- **Fire Barrier**: Fire resistance-rated vertical assembly (generally), continuity maintained.
- **Fire Partition**: Fire resistance-rated vertical assembly, in which openings are protected.
  - Corridor walls or elevator lobbies (exceptions)
  - Separate Dwelling units
  - Separate sleeping rooms
  - Separate tenant spaces in malls
Definitions Cont. – Bldg Components IBC §202

- **Fire Wall**: Extends from foundation through roof, protected openings, allow collapse of structure either side w/o collapse of wall.
- **Smoke Barrier**: Continuous membrane to restrict movement of smoke, vertical or horizontal. 709.3 requires smoke barriers be 1 hour rated.
- **Smoke Partition**: Unrated membrane to restrict smoke movement. Limited use in Code. Only SD in air transfer openings.
Shafts

- Definition §202: Enclosed space extending through one or more stories of a building, connecting vertical openings in successive floors.
- A shaft is essentially a six sided box.
- Shaft may not need top. §713.12 states that if the enclosure does not extend to the underside of the roof deck, the top of the shaft must be enclosed (and protected).
Penetrations - General

- §713.8.1: No penetrations that do not serve the shaft (e.g., elevator hoistways). For exit stairs, see chapter 10.
- §708 - 714: Duct and Air Transfer Openings comply with §717
- In General, if duct penetrating rated assembly not require FD or SD, firestop it
Dryers, Kitchen Hood, & Hazardous Ducts
§717.2.2, 717.5.3 of IBC and Chapter 5 of IMC

- No dampers installed in dryer & Kitchen ducts
- No dampers in hazardous exhaust ducts. Hazard Defined in NFPA 704
- Still must maintain rating
  - Fyre Wrap
  - Shafts and rate room(s)
  - One story – steel not aluminum
Shaft Penetrations - §717.5.3

- **Shaft penetrations require FSDs**
- **Exceptions for Fire and/or Smoke**
  - No FSD for smoke control. (engineered design) Exception typical for all penetrations of rated assemblies
  - No FSD kitchen or cloths dryer exhaust. Still maintain rated assemblies.
  - No FSD for parking garage with conditions
Shafts - §717.5.3 Continued

- Exceptions Continued
  - No FD for subduct
  - No SD for subducts in B or R Occupancies, continuous exhaust fan at top, serves Kitchen, cloth dryer, bathroom or toilet room.
  - No FD if tested per ASTM E119 or UL 263. Firestop mfg has small size ducts. Still need SD.
Shafts - Horizontal Assemblies

- 717.6: Provide a shaft if penetrate a rated floor, floor/ceiling, or ceiling membrane of roof/ceiling assembly.

- Exception per 717.6.1: Not I-2 or I-3, floor/ceiling assembly, 1 floor (two stories), fire damper at floor line. The shaft is still required for I-2 & I-3 Occupancies.

- Can go three stories or less w/o FD for only very specific conditions of dwelling or sleeping units.
Shafts - Horizontal Assemblies Continued

- 717.6.3: **Non-Rated floors**, other than individual dwelling unit:
  - Shaft
  - 2 stories (1 floor penetration), annual space filled with **approved** material.
  - <=3 stories, FD at each floor
Membrane Penetrations §717.6.2

- Protect penetration of rated floor/ceiling or roof/ceiling with:
  - Shaft
  - Ceiling Radiation Damper at ceiling line where:
    - Duct penetrates ceiling of assembly
    - Diffuser w/o duct penetrates ceiling of assembly
Fire Walls - 717.5.1

- 706.1.1 & 706.11: No penetrations of Fire Wall (Party Wall) at lot line. Provide FD when penetrating Fire Wall not at lot line.
- 717.5.1.1: SD where Fire Wall serves as horizontal exit. See Chapter 10 (Exits)
Fire Barriers

- 717.5.2: Provide fire dampers. If used as horizontal exit, provide SD.
- Exceptions for FD provision:
  - ASTM E 119 or UL 263
  - Smoke control system
  - Ducted HVAC System
    - Not H occupancy
    - 1 hour or less
    - NFPA 13 or 13 R sprinkler system throughout
Fire Partitions

- 717.5.4 – Provide fire damper. Exceptions for Non-‘H’ Occupancies:
  - Corridor walls in sprinklered building (NFPA 13 or 13R)
  - Tenant Partitions in malls where partition is not required to go to underside of deck.
  - Duct penetration in sprinkled bldg & complies with:
    - Duct opening maximum 100 square inches
    - 0.0217 “ (+- 26 gauge) thick steel duct
    - No corridor opening
    - Above ceiling
    - No wall register in rated wall
    - Min. 12” long sleeve
Corridors - 717.5.4.1

- **Corridor Damper** at ceiling penetration, where Corridor Fire Partition does not go to deck and ceiling is same construction rating as wall.
- **Ceiling Radiation Damper** at ceiling membrane penetration.
- **SD** at corridor enclosure penetration required to have smoke and draft control doors (716.5.3). Exceptions:
  - Smoke control system
  - 0.019” (+- 28 gauge) steel duct and no opening in corridor
Smoke Barrier

- 717.5.5 – Smoke damper where duct or air transfer opening penetrates a smoke barrier
- Exception: Opening in steel duct limited to a single smoke compartment, or, I-2 with exceptions
Smoke Damper Activation

717.3.3.2 – One of the following:

- Duct detector w/in 5’ of damper & fan shut-down
- Damper above smoke barrier doors, spot-type detector listed for releasing service on either side (both) of door
- Transfer opening in wall, spot type detector within 5’ of damper
- Corridor wall – smoke detection in corridor
- Total-coverage system, control by system (NFPA 72)
Installation

- **717.2 - Install in accordance with ... the manufacturer’s installation instructions and listing**
  - 717.3 - Labeled dampers 555, 555S, 555C
  - 717.4 – Access: Inspection and Maintenance
  - 717.4 – Identification (signage)
    - Smoke Damper
    - Fire Damper
Damper Assembly

Figure 5-1 from SMACNA Fire Damper Guide - Used with Permission
UL555
Fire Damper Test Standard

- **Fire Test** (ASTM E 119)
  - Flame Exposure
  - 1 1/2 (1700°) or 3 (1900°) Hour
- **Hose Stream Test**
  - Explosive Forces
- **Dynamic Closure Test**
  - Pressure & Velocity & Temp
  - Not for fan off dampers
- **Cycle Test**
- **Salt Spray Test**
  - ASTM B117
- **Duct Impact Test**
UL555S
Smoke Damper - Including:

- **Temp Degradation Test**
- **Leakage Test**
  - Class I, II, III
- **Operation Test**
  - Pressure 4” w.g. & Velocity 2000FPM min & Temp 250°F
  - Increments 2” w.g. & 1000FPM & 100 °F
- **Cycle Test**
  - Operation Reliability
    - 20,000 - Two Position
    - 100,000 - Cycle Test
- **Salt Spray Test**
Smoke Dampers - The Pressure Drop Dilemma

ALBERT L. ENGELHART
TPF, Mechanical Testing, Inc.

One project our firm completed recently, we ended up with a system that had almost twice the static pressure and broke horsepower than the original design. Investigation by the building owner, engineer, and our technician found that the static pressure drops across the smoke dampers were the major source of the problem.

In this particular system, the exhaust fan was located in the mechanical room with ductwork going to two floors. The longest duct run on this system had four smoke dampers installed before reaching the end exhaust register. One of these smoke dampers was in a 24\" x 12\" duct with a design of 1,985 CFM and a velocity of 495 FPM. Referencing the manufacturer's pressure drop data (Figure 1), this should give us a pressure drop for the damper of between 0.90\" and 0.12\" w.g., depending on the manufacturer. However, when we measured the pressure drop across the smoke dampers, it was 0.51\" w.g. This is over five times what it should have been reading.

Next, we checked the duct work and found that the actual opening for this damper was 21\" x 5\", or a free area of only 0.91 square feet. To obtain the design of 1,985 CFM, we would now need a velocity of 728 FPM. If we again look at the manufacturer's pressure drop data (Figure 1), we can see that, at this velocity, we do indeed have a pressure drop of between 0.40\" and 0.50\" w.g.

Consequently, when there are multiple smoke dampers in the same duct line, we need to anticipate that the actual system may be significantly different than its original design. Once we discovered this problem, we were careful in our plan and specification reviews to check other manufacturer's data. None of the data that we have reviewed to date reference anything other than 100% open duct free area.

We believe that the HVAC designer needs to be aware of this condition and be extremely careful when using smoke dampers in small ducts.

![Figure 1: AMCA S80.19 Laboratory method of testing fans for rating](image-url)
Maintenance and Testing

- General maintenance of Property Maintenance Code. No specifics in PMC, IBC, IMC, IFC
- Where NFPA 101 applies:

  - NFPA 101 → NFPA 90A → NFPA 80 → NFPA 105
Maintenance and Testing Cont

- Dampers to be inspected and tested one year after installation
- Dampers to be Tested every 4 years, except hospitals which is 6 years as indicated in next slide
- Operational test after installation for dynamic FDs and FSDs
ASHE Guidance-CMS Waiver Requirement for Extending Damper Testing to Six Years

DEPARTMENT OF HEALTH & HUMAN SERVICES Centers for Medicare & Medicaid Services
7500 Security Boulevard, Mail Stop S2–12–25 Baltimore, Maryland 21244–1850
Center for Medicaid and State Operations/Survey and Certification Group

DATE: TO:
FROM: SUBJECT:
October 30, 2009
State Survey Agency Directors State Fire Authorities
Director
Survey and Certification Group
Waiver to Allow Hospitals to Use the NFPA 6-Year Damper Testing Interval
Ref: S&C-10-04-LSC

Memorandum Summary

• Option for Damper Testing Interval: This memorandum permits hospitals to apply the NFPA 6-year testing interval for fire and smoke dampers in hospital heating and ventilating systems, so long as the hospital's testing system conforms to the testing requirements under the 2007 edition of NFPA 80 and NFPA 105.

• Categorical Waiver: Hospitals may operate under the damper testing cycle of the NFPA 2007 edition without special application to CMS.

After due consideration of State survey agency findings and conclusions of the National Fire Protection Association (NFPA), we are issuing a categorical waiver pursuant to 42 CFR 482.41(b)(2) to permit a testing interval of 6 years rather than 4 years for the maintenance testing of fire and smoke dampers in hospital heating and ventilating systems, so long as the hospital’s testing system conforms to the requirements under 2007 edition of NFPA 80: Standard for Fire Doors and Other Opening Protectives and the 2007 edition of NFPA 105: Standard for the Installation of Smoke Door Assemblies. The 6-year testing interval shall commence on the date of the last documented damper test.

While the 1999 edition of NFPA 80: Standard for the Installation of Air-Conditioning and Ventilating Systems specified a 4-year testing cycle, the NFPA more recently determined that an increase to a 6-year interval did not lower the fire protection of hospitals but could instead lower the incidence of infections that may be spread when the ventilation system was shut down and restarted at shorter time intervals. There is also some indication of cost savings to institutions when maintaining these dampers on a longer time interval.

Under this categorical waiver, a hospital that conforms to the above requirements will not need to apply in advance for a waiver nor will it need to wait until being cited for a deficiency in order to apply for a waiver. At the time of a CMS onsite life-safety code survey, the hospital must notify the survey team that it has elected to operate under this categorical waiver and is in conformance with the testing requirements of the above-cited 2007 NFPA edition. The survey team will note this attestation in its records and apply the 2007 testing cycle requirements in the course of its survey.
Typical Design Issues

- Improperly shown construction fire resistance rating and smoke barriers
- Corridors (smoke/draft doors) not identified
- Damper location not shown
- Damper types incorrectly shown
- Dampers not detailed
Typical Design Issues Cont.

- Picture framing in stud walls not detailed on M or A drawings
- Lack of Coordination with E trade designer regarding smoke damper activation (power/smoke detectors)
- No mock-ups specified
- No labeling/identification specified
Typical Construction Issues

- No submitted installation instructions, include ‘hidden’ MFG supplements
- Dampers not installed per Installation Instructions
  - Damper Retaining Angles (placement/overlap of structure)
  - Interstitial Space around sleeve (gap/thermal expansion)
  - Using intumescent caulk
  - Out of Plane of wall/floor
  - Arrow on damper “UP”
Case Studies
Case Study
Case Study
Case Study
Case Study
Case Study
Case Study
Summary

- Fire Walls – Penetrating is a bad idea.
- Fire Partitions and Fire Barriers – Provide a FD unless meet an exception. Considerable leeway with fully sprinklered building
- Smoke Barriers – SD, with exception
- Shafts FSDs, unless meet exception
- Corridors with S&DC doors – SD, with exception
Summary Cont.

- Know The Current Code Requirements
- Some considerations - occupancy, extent of sprinklers, extent of smoke detection, type of barrier/partition
- Show dampers per 717 of Code. **Detail Dampers**
- Install per manufacturer’s **installation instructions**
- Mock-ups w/ Engineer, Mfg Rep, Contractor (sheet metal, carpenter, mason) Approval
Learning Assessment

- Standards UL555 and UL555S require dampers be installed in accordance with which of the following?
  A. NFPA 90A
  B. International Fire Code
  C. Manufacturer’s Installation Instructions
  D. ASHRAE Fundamentals

- Standard UL555 mandates what tests be performed on fire dampers?
  A. Fire/flame test for 1.5 or 3 hours
  B. Hose Stream test
  C. Cycle testing after salt spray exposure
  D. All of the above
Learning Assessment

- When a duct penetrates shaft, at the second story of a five story shaft, what type of opening protective is required?
  - A. Fire Damper
  - B. Smoke damper
  - C. Fire/Smoke Damper
  - D. None is required

- A Smoke damper is generally required where a duct penetrates a corridor wall that requires smoke and draft control doors.
  - A. True
  - B. False
Learning Assessment

In stud wall construction, structural picture framing is required around fire damper sleeves with a gap between the sleeve and the framing because:

A. It gives the Code inspectors something to complain about
B. It provides the sheet metal subcontractor something to talk about with the carpenter over coffee
C. Damper manufacturers create inappropriate requirements
D. Retaining angles overlap the picture framing to keep it in the wall in order to pass the UL555 test. Gaps are generally required due to thermal expansion of the damper assembly in a fire.
Thanks For Your Time

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Questions?