How to properly Specifying Life-Safety Dampers

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Life-Safety Dampers seem like pretty straight forward products. You select a fire damper if you want to stop the spread of fire, a smoke damper if you want to stop the spread of smoke, and a combination fire smoke damper if you are trying to stop the spread of both. ***Specifying the proper damper for a given application can literally be the difference between life and death.*** The purpose of this paper is to explain how to properly specify life-safety dampers to maximize their benefit to building owners and occupants.

What Makes a Damper a "Life-Safety" Damper?

The term "life-safety damper" is a catch-all phrase used to describe fire dampers, smoke dampers and combination fire smoke dampers. The use of these products is mandated by building codes and specified by engineers to protect both lives and property. However, in general life-safety dampers have two purposes. The first is to protect duct and air transfer openings in fire and smoke rated walls and floors. In these applications the damper's purpose is simply to contain the fire and/or smoke in the zone it originated in. The second purpose of life-safety dampers is to be used as part of an engineered smoke control system. Smoke control systems are designed to maintain tenable conditions in egress areas as occupants exit a building and to allow emergency response personnel to rescue occupants and control the fire. Smoke and combination fire smoke dampers are often critical components of these systems.

The below **Figures 1 and 2** will help to explain how fire smoke dampers can be used as part of a smoke control system. Figure 1 shows a three story building with a supply shaft and an exhaust shaft. Under normal conditions all of the dampers are open to allow the space to be ventilated and the air to be conditioned. However, in the event of a fire once smoke is detected and the zone of the fire's origin is identified the building's smoke control system takes control of the dampers. As figure 2 shows, the dampers are used to create a positive pressure in the smoke zones outside the zone of origin and a negative pressure in the zone of origin. This not only prevents smoke from entering the other smoke compartments, but also exhausts smoke from the zone of origin giving occupants within that zone the best opportunity to escape from the building.

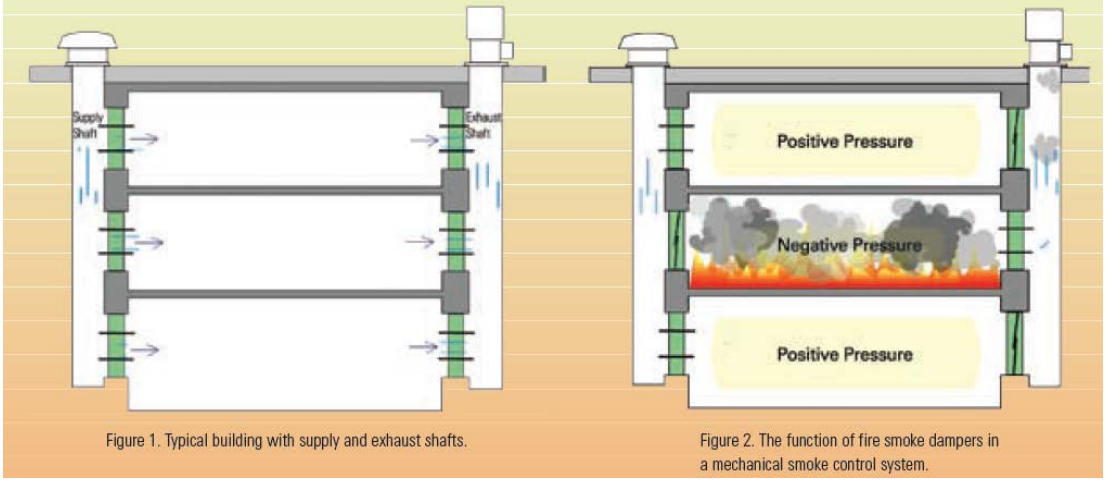


Figure 1. Typical building with supply and exhaust shafts.

Figure 2. The function of fire smoke dampers in a mechanical smoke control system.

Life-Safety Damper Test Standards

In this white paper we will look into the standards published by Underwriters Laboratories (UL). UL publishes two standards for life-safety dampers: *Fire Dampers – UL 555 and Smoke Dampers – UL 555S*. These standards contain many tests that result in important ratings that need to be part of a proper life-safety damper specification. Once the product is certified, it's ready to be installed in any building.

Fire Dampers

The first and most basic rating that a fire or fire smoke damper receives is its hourly fire resistance rating. Dampers can be tested for either 1 ½ hours or 3 hours. Both the International Building Code (IBC) and NFPA's Life Safety Code (NFPA 101) require duct and air transfer opening penetrations through fire resistance-rated assemblies of less than 3 hours to be protected by 1 ½ hour rated fire dampers. Penetrations through fire-resistance rated assemblies rated for 3 hours or more are to be protected by 3 hour rated dampers.

Next, the temperature of a damper's closure device must be selected. On fire dampers designed without an actuator the closure device is typically a fusible link. Fire and fire smoke dampers designed to operate with an actuator usually use a bimetallic disc type thermostat as the closure device. When the rated temperature of the thermostat is reached electrical power, or air pressure in the case of a pneumatic actuator, is cut to the actuator. This causes the actuator's built-in spring to close the damper.

When the rated temperature of the primary closure device is reached the damper will close. Dampers with two closure devices also require position indication switches (discussed below) that tells the smoke control system whether the damper is open or closed.

The final key decision point that needs to go into properly specifying a fire damper is if the damper is to be static or dynamic rated. Static rated dampers have not been tested to close against airflow. Thus static dampers should only be used in HVAC systems that are designed to shut-down immediate upon detection of fire or smoke. Dynamic rated dampers on the other hand are tested and rated to close

against airflow. The minimum velocity rating that UL 555 allows a dynamic fire damper to be rated to is 2,000 fpm (10.2 m/s). To achieve this minimum velocity rating a damper is tested for its ability to close against a full-open velocity 2,400 fpm (12.2 m/s). Dampers can be rated above 2,000 fpm (10.2 m/s) in increments of 1,000 fpm (5.1 m/s). Regardless of the rated velocity the same 400 fpm (2.0 m/s) safety factor is applied during the test. Similarly, dynamic fire dampers are assigned a rated pressure. This is the pressure they are designed to withstand when the damper is in the full closed position. The minimum pressure rating is 4" wc (1.0 kPa). Higher pressure ratings can be achieved in increments of 2" wc (0.5 kPa). During this testing a safety factor is applied such that the damper is tested at a pressure 0.5" wc (0.125 kPa) above the rated pressure. So for a dynamic fire damper to achieve a rating of 6.0" wc (1.5 kPa) it is tested to 6.5" wc (1.625 kPa).

Smoke Dampers

All smoke dampers are rated to close against airflow. Note that combination fire smoke dampers must meet the requirements of both fire dampers and smoke dampers so when smoke dampers are referenced in this section the requirement applies to fire smoke dampers as well. The operation of smoke dampers is accomplished by use of an electric or pneumatic actuator. Because the actuator is the operating mechanism for smoke dampers all of the ratings that a smoke damper carries are for the damper and actuator together as an assembly. Thus UL 555S requires actuators to come factory mounted from the damper manufacturer. They cannot be installed in the field.

UL 555S classified smoke damper and actuator assemblies also carry an operational temperature rating. The minimum operational temperature rating is 250°F (121°C). For smoke control systems that require smoke dampers to remain operational above 250°F (121°C) damper and actuator assemblies can be specified with a 350°F (177°C) operational temperature rating.

As discussed above, it is often desirable for a smoke or fire smoke damper to be able to communicate its current position (i.e. open or closed). This is accomplished by way of "position indication switches". Position indication can either be built into the damper's actuator (often referred to as limit switches or auxiliary switches) or they can be a separate switch package that is mounted by the damper manufacturer.

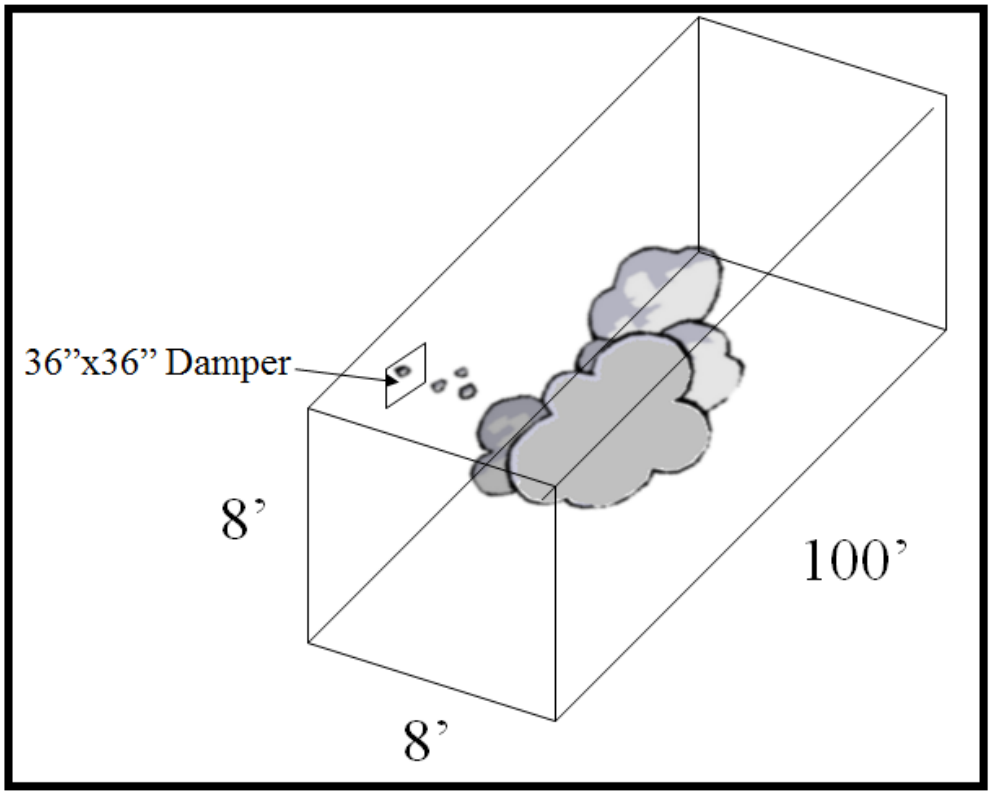
The final rating that a smoke damper receives is a leakage rating. UL 555S has three leakage classifications. As shown in the table below these leakage classifications define the maximum allowable leakage through a damper at the damper's rated pressure.

Table 1

Maximum Allowable Leakage cfm/ft^2 (L/s/m^2)		
Classification	**4" wc (1 kPa)**	**8" wc (2 kPa)**
I	8 (41)	11 (57)
II	20 (102)	28 (144)
III	80 (406)	112 (574)

The selected leakage class has a significant impact on the performance of the damper. The example below shows the impact of selecting a class I damper verses a class II, or III damper in terms of the time required to fill an 8'x8'x100' hallway serviced by a 36"x36" damper full of smoke.

- With a Class I Damper: 89 minutes
- With a Class II Damper: 36 minutes
- With a Class III Damper: 9 minutes



Summary of Specification Requirements for Fire, Smoke, and Combination Fire Smoke Dampers

As we've discussed there are many aspects of a damper's performance that must be taken into consideration when specifying these products. We need to make sure when specifying dampers for any building we need to think on the above points. We should know the type of applications, Certifications with the leakage class ratings.