UnitedEnertech

THE ENERTECH EDGE

Fire & Air: The Damper Series

By Kent Maune

Fire Dampers: History, Function, and Limitations of Fusible Link Designs

1.0 Introduction

Fire dampers are a critical component of a building's passive fire protection system. Installed in HVAC ductwork, they prevent the spread of flame through fire-rated walls, floors, and partitions. While their function has remained the same for decades, the design, materials, and actuation methods have evolved significantly to meet modern life safety and performance requirements.

This paper reviews the origin and development of fire dampers, explains the operating principles of fusible link designs, and discusses their practical limitations in contemporary HVAC systems.

2.0 Historical Background

Fire dampers became part of recognized building protection systems in **1939**, when the **National Board of Fire Underwriters** acknowledged the effectiveness of automatic HVAC dampers and fans in containing fire and smoke.

The **first fire damper patent** appeared in **1953**, followed by **Underwriters Laboratories'** publication of **UL 555, Standard for Safety for Fire Dampers**, in **1966**. UL 555 established the performance and fire endurance testing requirements still used as the foundation for damper qualification today.

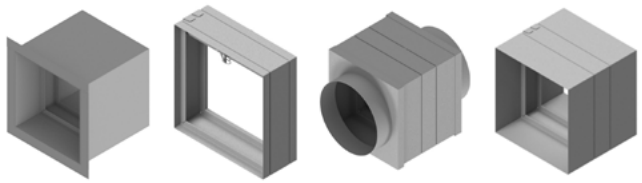
The modern **curtain-style fire damper** design was developed in **1964** and remains the most common configuration in use.

3.0 Curtain-Style Fire Damper with Fusible Link Latch

A curtain-style fire damper consists of a galvanized sheet of metal folded, or "curtained," at the top of the frame. A **fusible link** secures the curtain in the open position until heat from a fire activates it.

- **Open Position:** The curtain is folded and held by the fusible link and a retaining mechanism.
- **Closed Position:** When the link melts, the latch releases, allowing gravity (for Static dampers) or a spring (for Dynamic or horizontal dampers) to pull the curtain closed over the duct opening.

This simple mechanical concept provides reliable passive closure, but it lacks the responsiveness and control required for modern dynamic systems.



4.0 Fusible Links and Fuse Rods

A **fusible link** or **fuse rod** is two pieces of metal soldered together with heat-sensitive metal element designed to melt at a specified temperature, typically 165°F (74°C).

When the link melts, it releases the damper's blades or curtain assembly, allowing closure to prevent the spread of fire through ductwork.

5.0 Multi-Blade Fire Dampers with Fusible Rods

In the 1970s, innovations in multi-blade damper technology introduced configurations such as **3-Vee** and **airfoil-shaped blades**. These designs improved airflow efficiency and could serve dual purposes such as both **fire dampers** and **volume control dampers** when fitted with a hand quadrant or actuator.

Operating principles:

- **Open Position**: The damper is held open by an auxiliary shaft (jackshaft) connected to the blades through a fusible rod. A spring exerts closing tension, while a spring-loaded blade lock and secondary fuse link maintain the open position.

- **Closed Position**: When the fusible rod separates, the spring closes the blades, and the blade lock holds the damper shut during a fire.

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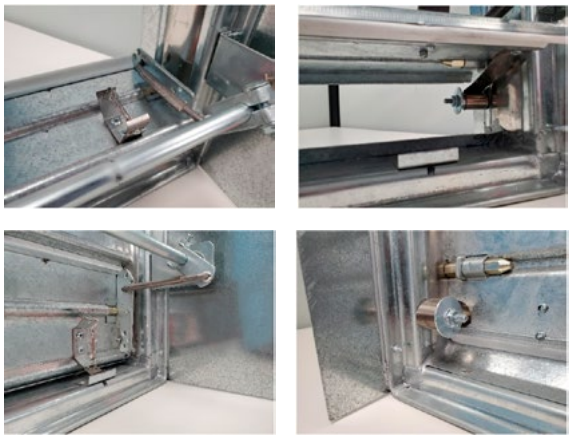
Multi-Blade Fire Dampers with Fusible Rods



6.0 Limitations of Fusible Link Fire Dampers

6.1 Delayed Response to Smoke

Fusible links respond only to **temperature**, not smoke causing delayed closure.

- **Thermal-only detection**: Fires often produce large volumes of smoke well before ambient temperatures reach the melting point of the link, allowing toxic gases to spread through the duct system.

- **Smoke management limitations**: Fusible link dampers cannot participate in coordinated smoke control strategies such as stairwell pressurization or zoned smoke exhaust.

6.2 Single-Use and Manual Reset

Fusible links are **single-use components** that must be replaced after activation.

- Once melted, a qualified technician must install a new link to reset the damper.
- Many fire dampers are installed in concealed or difficult-to-access locations, complicating inspection and maintenance.
- When doing maintenance, a manual replacement process is time-consuming and impractical in large facilities containing hundreds of dampers.

6.3 Mechanical and Environmental Susceptibility

Fusible link assemblies can degrade due to environmental or mechanical factors, including:

- **Vibration fatigue:** Continuous vibration from fans or equipment can weaken or fracture metal components.
- **Contamination**: Accumulation of grease, dust, or debris can insulate the link, altering its heat response.
- **Corrosion**: Exposure to moisture or chemicals can cause premature failure or delayed activation.
- **False activation**: In high-temperature environments (e.g., boiler rooms, gas heat, or kitchens), standard fusible links may melt unintentionally, requiring higher-rated alternatives.

6.4 Lack of Remote Monitoring

Traditional fusible link dampers lack integration with building monitoring systems.

- **No feedback capability:** Fire alarm or building automation systems cannot determine if a fusible link has released or if the damper has closed.
- **Manual verification required:** Only visual inspection can confirm damper position, which is impractical for continuous monitoring and impossible during a fire event.

6.5 Unsuitability for Dynamic Systems

Static fire dampers are designed for use in HVAC systems that **shut down during a fire**.

- Fusible link mechanisms are not tested or rated to close against airflow pressure.
- Modern buildings frequently rely on **dynamic fire dampers**, which use **actuators** and are tested under airflow and pressure to **UL 555 dynamic closure requirements**.

7.0 Conclusion

Fusible link fire dampers have served as a proven and reliable method of fire containment for decades. However, their limitations—including single-use operation, lack of smoke response, and inability to integrate with modern control systems—make them less suitable for contemporary buildings that require active smoke management and continuous system monitoring.

For these applications, **actuated (motorized) dynamic fire dampers or combination fire smoke dampers** provide superior performance, faster response, and compliance with current life safety and building automation standards.

“Fusible link fire dampers have served as a proven and reliable method of fire containment for decades. But smoke is the biggest harm to occupants during a fire event.”

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