Keeping Smoke and Fire Containment Systems Reliable

by James Shea, Globe Technologies

The National Fire Protection Association (NFPA) reports that in 2017 there were 499,000 structure fires. Seventy-two percent of these fires occurred in residential occupancies, leaving a remaining 139,720 in occupancies other than residential. While property damage resulting from these fires was in the billions of dollars, the focus of this article is protection of life safety in commercial and industrial occupancies, many of which contain sophisticated smoke mitigation and fire suppression systems. The non-residential structure fires accounted for 782 deaths or one person for every 179 fires. Every two hours and forty minutes a civilian perishes as a result of a fire incident. The risk of injury, death and fire loss remains unchanged and constant where a fire occurs. These statistics include a 40 percent increase in fires in places of assembly, 38 percent increase in educational facilities, 27 percent increase in institutional facilities, 13 percent increase in stores and offices, and a 2 percent increase in storage facilities inside of a structure.[1]

You often hear people talk about death and injury as a result of a fire incident. Too many people assume these tragic events occur in some horrific manner of human life disintegrating as a result of exposures to temperatures that a person just cannot endure. What most don't talk about is that the overwhelming majority of death and injury from fire is a result of smoke inhalation. A burning of the human body from the inside out resulting in inflaming the lungs and airways, causing swelling and blocking oxygen. The effects of which can be instant death or a more painful, prolonged, but inevitable event. Smoke inhalation mortality increases by up to 20 percent over that predicted by age or extent of burns alone.[4]

The fact is, smoke inhalation is the number-one cause of death in structure-related fires.[2] There are studies and reports regarding this fact across the nation, continent, and world. Smoke kills! More than the fire itself. According to a study of death certificates in 1999, smoke inhalation was determined to be the overwhelming leading cause[3] and accounts for as high as 80 percent of all fire-related deaths.[4]

Despite this number-one cause of death in fires, smoke containment systems such as mechanical fire dampers, smoke vents, fire doors, and other life safety systems designed to contain smoke have less stringent safety inspection and maintenance requirements than other installed life safety systems including fire alarm systems, commercial cooking fire protection systems, and special hazard systems.

Fusible links, of which Globe is a major manufacturer, operate as an integral part of these life-preserving smoke containment systems. Despite this, fusible links present one area where the codes governing smoke containment are less stringent. How did we get here, and how can things change?

The NFPA, through a consensus-based program, authors and publishes fire codes as well as nationally recognized standards. These standards are typically adopted by the code world as the basis for their national, state, and local fire codes and become written into the perspective codes.

Some of these standards such as NFPA 13, 17, 17A, 33, 34, and 96, where links are installed in conjunction with fire suppression systems, contain requirements within the standard for fusible links to be periodically removed and discarded. This change-out requirement is identified within the standard as occurring semi-annually, annually, or "more frequently," dependent on the application and potential risk of degradation of the fusible link.

The replacement requirements of fusible links in these systems are a direct result of the industry's efforts to maintain the integrity of the suppression systems, given education and understanding of potential risks associated with retaining fusible links in their installed environments indefinitely. Reports of fire suppression system failures in both fire and non-fire related cases prompted the understanding and knowledge of how these links were impacted by their installed environment and what factors may warrant a change-out program.

Economic impact is considered, based on the relatively low cost of replacement links and the importance of replacement thus maintaining the integrity of the links as well as the support of manufacturer warranties. The nuisance costs for replacement, rather than removal and re-install, far outweigh risk of failure of a link to operate as designed, tested, and approved in a catastrophic occurrence.

When it comes to smoke containment systems, current trade organizations, in cooperation with damper manufacturers, have written documents as guidelines for safety and maintenance inspections on smoke and combination fire/smoke dampers. These guidelines use the codes and standards as minimum safety requirements. These guidelines have been widely accepted, resulting in their adoption by the industry.

Unfortunately, not all standards have caught up with those as listed above, and standards associated with fire and smoke dampers, fire doors, and smoke hatches such as NFPA 80, 90A, 90B, and 105 are not consistent with their counterparts. In these documents the requirements for link removal exists, however there remains allowance for service personnel to place the link back into service within these life safety systems after a visual inspection is completed.

There are several reasons this does not make good life safety sense and why these links should follow the same protocols of that of the other standards. The status of a fusible link's operational function as approved and listed cannot be reasonably ascertained through a "visual inspection." More specifically:

1. Service providers performing maintenance and inspections are not skilled in understanding what warrants a good link from a bad one simply by performing a visual check of the link.
2. Fusible links can become damaged upon removal. Such damage to the metal alloy can be naked to the human eye and only detected upon examination under a microscope.
3. Fusible links installed in these applications typically are those with lower set-point temperatures. Metal solder and alloy at lower set-point temperatures is softer and more brittle and thus more susceptible to physical damage than those with higher set-point temperatures.

4. No guidelines or instructions for inspection are identified in the standards beyond noting if the visual inspection reveals that the link “appears damaged.”
5. No guidelines as to acceptable appearance are addressed anywhere within the standards.
6. Fusible links (thermal releasing devices) as a component in a fire protection or fire/smoke containment system are always under a load condition. This load can vary over the life cycle of the product and degrade the link over time.
7. Ambient air temperature fluctuations can cause the alloy or solder to change states, thus affecting the reliability of the fusible link to operate as intended when called upon.
8. Links installed in smoke/fire dampers, fire doors, and smoke hatches exposed to fluctuations in ambient air temperatures can cause alloys or solders to crack or partially melt and then re-form, changing the characteristics and temperature set-points and response times of fusible links.
9. Fusible links not properly stored and maintained can be exposed to environmental changes that impact the link in operating as intended.
10. Fusible links in the “installed” application (field) may be susceptible to chemical or environmental conditions that impact the ability of the link to operate as intended.
11. Fusible links are an approved and listed device. They are tested and approved to UL 33, *Heat Responsive Links for the Fire Protection Service*. They are warrantied for a period of one year from date of installation. Links installed in life safety systems for periods greater than one year no longer are supported by the link manufacturer.

For all these reasons, and to ensure the integrity of life safety systems, fusible links regardless of where they are installed must be inspected, maintained, and replaced on a regular basis. Standards such as NFPA 80, 90A, 90B, and 105 need to adopt language similar to that of their counterparts in NFPA 13, 17, 17A, 33, 34, and 96, with reciprocity to be maintained and communicated amongst them. National fire codes including the International Building Code, International Mechanical Code, International Fire Code, Uniform Fire Code, and the Life Safety Code need to adopt language similar to the revised standards or continue to reference the standards as amended within their codes. State legislation needs to be drafted and proposed to include adoption of these higher standards into their state fire codes with enforcement mandated.

In Conclusion

There is documented proof that fire deaths and injuries remain constant in the United States, North America, and the world, and smoke inhalation continues to be the number-one cause of all fire-related deaths and injuries. Improvement of our installed life safety systems through proper inspection, testing, and maintenance can only help support efforts to prevent catastrophic losses due to smoke and fire propagation.

There is a lack of knowledge relating to fusible links in the service industry. It is not reasonable to assume a service provider can identify a damaged link versus an operational link through a visual “naked eye” inspection. Link storage amongst service providers is not monitored or controlled and varies from one provider to another, resulting in potential damage happening even prior to installation.

Manufacturer warranties do not cover links installed in applications for periods greater than one year. Therefore, the links lose any support from the manufacturer who best understands the volatility associated with an installed link, how a link is tested and approved, and best practices for safe and effective usage.

The life safety benefit far outweighs the economic impact and supports a replacement program for fusible links.

Many occupancies now offer a “defend in place” response to fire conditions. This response includes evacuation to safe zones within the occupancy. Occupancies such as high-rise buildings, healthcare facilities, senior living centers, universities and educational facilities, all rely on our life safety systems for this strategy. Failure of the smoke containment systems in the affected zones can and will result in catastrophic injury and loss of life in occupancies whose evacuation plans include a “defend in place” strategy.

Only through an effort to encourage legislation and code changes, along with enforcement, can we ensure that human lives are safe from the risk of smoke inhalation, injury, or death due to propagation from the fire zone to other safe zones within an occupancy.

References:

1. NFPA, “Fire Loss in the United States in 2017”
2. Source: National Fire Protection Association
3. Ciottone's Disaster Medicine (Second Edition), 2016
4. Richard E. Wolfe, MD

About the Author

James M. Shea is vice president of Globe Technologies. He has thirty-nine years working in the fire protection industry. He previously worked on NFPA technical committees for 10, 17, 17A, 33, 34, and 96. He is the current ANSI / IKECA Consensus Body Chair.