Rolling Stock Fire Suppression

WHITE PAPER

Stat-X® Aerosol Fire Suppression

Active Fire Suppression for Rolling Stock — Is There a Perfect Solution?

In Issue One 2023 of Railway-News, an article—of the same name—raised the following question: “When Will Rail Authorities Start Addressing Active Fire Suppression for Rolling Stock?” Therein, the need for rail safety organizations to include active fire suppression on rolling stock was emphasized. As tragic evidence of that need, the article highlighted the Kaprun Disaster in Austria that killed 155 people.

While fatal rail fire incidents are not commonplace, the Kaprun Disaster was not exactly an anomaly either. In 2002, a fire in a sleeping car in France killed twelve people while they slept. Incidents such as this and the Kaprun Disaster clearly indicate a need for active fire suppression. But what type of fire suppression systems should rail authorities consider? And is there a single type of system that can be used for all of the fire risks on all types of rolling stock?

Before delving into possible solutions, it is first important to understand the types of fire risks that exist across the varied types of rolling stock traveling today on the world’s rail network. Those in the rail business understand that rolling stock is anything but universal.

Depending on where you are, you may find rolling stock that is powered by diesel-electric or purely electric. Also operating today are trains with motive power supplied by hydrogen fuel cells and those with large-scale battery energy storage systems (BESS). In addition to the variables in motive power, passenger or freight trains carry a wide variety of things that will burn along with the means to ignite them. Each of these carries with it unique risks and hazards that must be considered and managed.

- **Diesel-Electric**

  The diesel engine and its fuel load represent the primary risk. A fuel leak that contacts the heated engine block or exhaust manifold is a probable source of fire. Secondly, there are myriad electrical components, wiring, and traction motors that all can be a competent ignition source.

- **Purely Electric**

  Lacking the diesel prime mover and its significant fuel load, purely electric rolling stock depend on large amounts of electrical energy that pass into the train to drive the traction motors. All the electrical components, including transformers, rectifiers, inverters, and traction motors pose a risk of fire.

- **Hydrogen**

  Rolling stock powered by hydrogen fuel cells are becoming more prevalent on global rails and may even be poised to supersede diesel-electric as a source of motive power for rolling stock. While hydrogen is extremely flammable, its properties are well understood because of its widespread use in industry, and it is a very stable fuel. Hydrogen fuel cells convert hydrogen to electricity which drives the traction motors. So, the risk from a “hydrogen train” approximates that of an electric train.

- **Battery**

  With the success of electric vehicles (EVs) on the highway, battery-powered rolling stock is also being seen in some locations. Battery power intended as a supplement to a diesel-electric locomotive exists to improve fuel efficiency. So, a “battery train” carries all the fire risks of a diesel-electric train. In addition, there multiple racks of lithium-ion BESS. As our experience with EVs suggests, lithium-ion BESS carry a considerable fire risk. Once they begin to fail, the event can rapidly cascade into a thermal runaway that

deflagrates and spreads the fire in dramatic fashion. BESS are particularly vulnerable during charging as this video filmed at an EV charging station in China demonstrates.

- **Passenger Compartments**

  The fire load in passenger compartments consists of the furnishings and luggage brought onboard by passengers. Ignition sources in passenger compartments are primarily electric, which includes heaters. As with the Kaprun Disaster, heaters are a common fire cause.

So, with these myriad fire risks, how do rail authorities protect crew and passengers? And is there a perfect solution that protects against them all? As rolling stock is comprised of individual cars that are continuously linked and unlinked, this rules out legacy fire suppression systems that depend on a central system location that pipes the agent out to the source of the fire—including water-based, gaseous / clean agents, and dry chemical systems.

Additionally, the system must be universal and able to extinguish multiple classes of fire. It should be designed to extinguish Class A (ordinary combustibles), Class B (flammable liquids), and Class C (electrical) fires. Furthermore, the agent must be safe to use in normally occupied areas and should pose no environmental or long-term health risks.

These are severe constraints, and when taken in total, they effectively eliminate most agents and systems on the market today. But there is an agent and delivery system that meets every one of these requirements: condensed aerosol. Condensed aerosol units require no piping and can be installed remotely at the individual fire risks. Upon discharge, the units totally flood the space and are effective against Class A (surface), B, and C fires. Further, the agent remains suspended for several minutes to provide reflash protection. Some condensed aerosols have even been tested and proven effective at minimizing the propagation of thermal runaway in lithium-ion BESS fire scenarios.

In addition to their effectiveness, condensed aerosol units are safe for use where personnel are present. They do not displace oxygen and have zero atmospheric life or persistence. Persistence is a real health issue facing many firefighting foams and some clean agents and has been linked to water contamination. Additionally, condensed aerosol units have zero global warming or ozone depletion potential—additional problems facing a number of clean agents currently in use, many of which are seeing their production curtailed by environmental regulatory agencies.

When rail authorities finally begin considering active fire suppression on rolling stock, they will need to consider of all the challenges described herein. While in the past, these challenges may have appeared insurmountable, in today's world, they are not. There is a perfect solution. And the time for making rolling stock a safer form of travel is now. Rail authorities have no good excuse to do otherwise.

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