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Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

Sub-Committee of Experts on the Transport of Dangerous Goods

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Listing, classification and packing

Fire suppression devices that contain a pyrotechnic material

Submitted by the Council On Safe Transportation of Hazardous Articles (COSTHA)*

1. COSTHA is submitting this document in support of the discussion on exiting Class 1 for very low hazard energetics. There are several innovative fire suppression safety devices that disperse fine particles of aerosol using an electric match initiator to heat a pyrotechnic material to create a fire suppressing aerosol cloud that is extremely effective at disrupting fires including those involving lithium batteries. Several competent authorities recognize these as UN 3268, Safety devices, Class 9. However, there is no clear indication in the UN Model Regulations on how these devices should be classified. The classification of these devices is sometimes challenging because they contain a small amount of 1.4 explosives (typically UN 0431, Articles pyrotechnic, 1.4G). The explosive device is used to disperse an aerosolized fire suppression material intended to extinguish fires by chemically disrupting the fire.

2. These devices are used in many applications including vehicles, power generation plants, data storage facilities, for energy storage systems, flammable liquid storage cabinets, unit load devices on aircraft, in restaurant frying cabinets and for many other applications (see examples below). Based on statistics from one manufacturer of these fire suppression articles, over 550,000 of these articles have been shipped all over the world without any indication of an accidental discharge nor fire damage caused by any packaged unit. These articles are engineered and manufactured in a manner to prevent accidental actuation, depending on either electronic initiation or intentional physical initiation (removal of safety control and triggering the device). The probability of accidental actuation of the device during transport conditions is functionally nil. Even if the article were actuated due to temperatures above its initiation temperature (above 300 ºC) it would then disperse its fire suppression aerosol, eliminating any existing fire and preventing any fire within a transport vehicle or closed cargo container from spreading or igniting other combustible materials. Considering the ever-expanding world of electric vehicles and commercial and residential energy storage systems, COSTHA envision that the use of these types of fire suppression devices will grow exponentially. They have already been approved for the use for energy storage system fire suppression under standard UL 9540A.

* A/75/6 (Sect.20), para. 20.51

3. The aerosol fire suppression technology is recognized as a distinct fire extinguishing technology from all other fire extinguishing technologies under NFPA 2010, Standard for Fixed Aerosol Fire-Extinguishing Systems. Under NFPA 2010, the specific description for these products is listed as “Condensed Aerosol” agents. A “Condensed Aerosol” is defined as an extinguishing medium consisting of finely divided solid particles, generally less than 10 microns in diameter, and gaseous matter, generated by a combustion process of a solid aerosol-forming compound. The solid fire suppression particles that are dispersed from the article are not combustible “smoke” that results from a typical pyrotechnic combustion or explosion, but alkali metal salts such as potassium carbonate K_2CO_3 and potassium bi-carbonate $KHCO_3$. The aerosol fire suppressant extinguishes flames where the micro-particle solids come into contact with the flame as a total flooding system. The thermal decomposition of the aerosol potassium-based particle disrupts the combustion process forming the flame where the potassium radical is freed from the aerosol particle and bonds with the flame free radicals. This continuous reaction between the cloud of aerosol surrounding the flame, depopulates the available flame free radicals in the combustion process causing the flame to snuff out and extinguish. In other words, this fire suppression agent interferes with the chemical chain reactions that sustain combustion and flame.

4. The fire suppression products that can be considered safety devices are articles as opposed to substances. They are not intended to function with an explosive or pyrotechnic effect and therefore have been approved by the United States Department Of Transportation (DOT) according to DOT-SP 20600 for transport as a Safety Device, UN 3268. The DOT approved them as a safety device based on technical and test data provided and on the basis that they were subjected to the 6(c) tests with no explosion of the device, no fragmentation of device casing or pressure receptacle, and no projection hazard nor thermal effect which would significantly hinder firefighting or emergency response efforts in the immediate vicinity as required by special provision 280.

Special provision 280 states: “This entry applies to safety devices for vehicles, vessels or aircraft, e.g. air bag inflators, air bag modules, seat-belt pretensioners, and pyro mechanical devices, which contain dangerous goods of Class 1 or of other classes, when transported as components parts and if these articles as presented for transport have been tested in accordance with Test Series 6(c) of Part 1 of the Manual of Tests and Criteria, with no explosion of the device, no fragmentation of device casing or pressure receptacle, and no projection hazard nor thermal effect which would significantly hinder fire-fighting or emergency response efforts in the immediate vicinity …”.

5. The German Federal Institute for Materials Research and Testing (BAM) has also classified these types of devices as UN 3268, Safety Device, Class 9 (see BAM Process no: 2.6/1857/19).

6. These fire suppression devices are currently being used in freight containers containing lithium batteries under the entry “UN 3536, Lithium Batteries Installed in Cargo Transport Unit, Class 9”. Special provision 389 which applies to this entry states that “Dangerous Goods necessary for the safe and proper transport of the cargo transport unit (e.g. fire extinguishing systems and air conditioning systems) shall be properly secured to or installed in the cargo transport unit and are not otherwise subject to these regulations. It is noted that these devices are installed in vehicles where they are also not subject to these regulations.

Device description and operation

7. The device can **ONLY** be initiated when incorporated into a complete system. The device is started in two possible ways:

(a) Electric match. An electric match is placed in the centre of the "pellet" and is electrically ignited from a monitoring control box or panel. Typically, the control panel interprets the signal from a fire detection device (flame, smoke, or heat), and then initiates the electric match.

Figure 1: Typical aerosol generator components

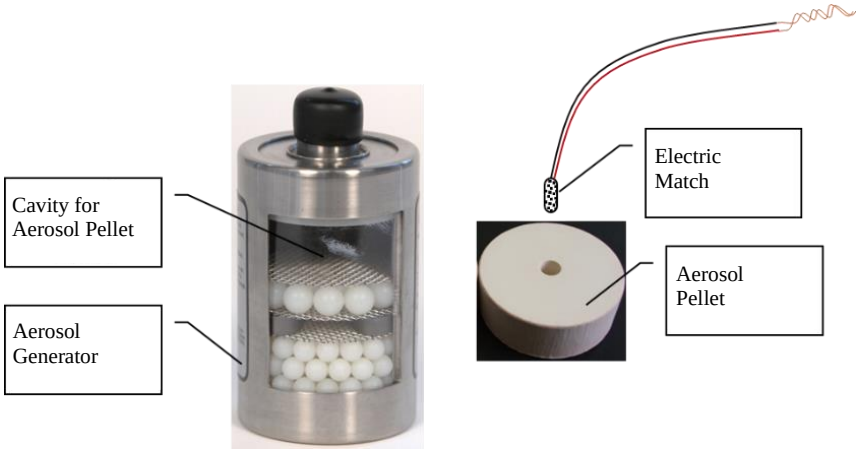
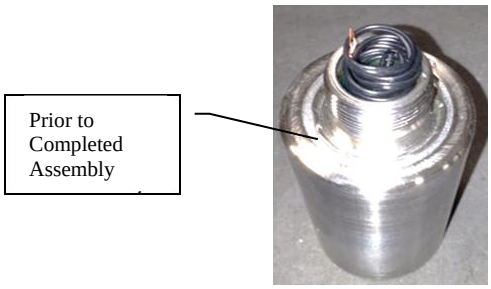


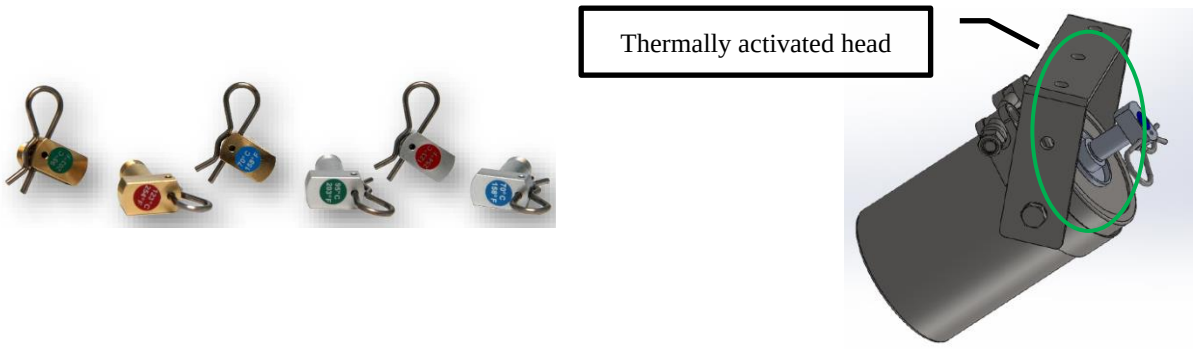
Figure 1 shows the typical components that make up the aerosol generator. The electric match is installed through the top of the unit, resting inside the aerosol pellet. The electric match is shorted and stored under the protective cap for shipment, shown in Figure 2. It cannot be accessed by any electrical charge during shipment. In this scenario, the largest electric match contains approximately 4.4 grams of explosive, contained powder.

Figure 2:
E-match installed: lead wires coiled and shorted prior to installing protective cap



(b) Thermal activation head. Thermally actuated units activate ONLY using a thermally activated head, installed on the top of the unit. These units have slightly different interior components, allowing activation using a spring-loaded impact, after the thermally sensitive material has melted. The pin strikes a small bag containing explosive powder, that initiates the aerosol forming reaction. The largest thermally activated units contain approximately 3.0 grams of explosive, contained powder inside the bag. The thermally activated head, and the aerosol generator unit are ALWAYS shipped separately. Figure 3 shows the thermally activated head both alone (as shipped) and installed on the generator (as installed).

Figure 3: Picture of various thermal head units. Diagram of how the thermal activation unit is installed on the aerosol generator, AT THE TIME of installation



8. Based upon the type of fire suppression employed by these devices, they are particularly effective in suppressing fires caused by lithium batteries. The aerosol produced by the actuation of the device reacts with the combustion free radicals, creating stable molecules that interrupt the fire reaction pathway and puts the fire out.

9. Due to the minute probability of actuation in transport, the high rate of effectiveness in fire suppression in varying environments and their non-toxic emissions, these types of fire suppression devices are utilized in myriad vehicle and non-vehicle applications. Additionally, these types of devices are highly effective in suppressing lithium battery fires, which would otherwise require flooding with copious amounts of water.