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Risk Control Services: Fire Protection

Fire protection systems for metal fires

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Standard recommendations based on recognized international standards and good practices are proposed. Moreover, very good NFPA (National Fire Protection Association) and FM Global Property Loss Prevention Data Sheets on these subjects exist. Since there is no need to reinvent the wheel, readers are referred to those references when relevant.

- NFPA free viewing at http://www.nfpa.org/
- FM Global Data Sheets free viewing and download available when registered at http://www.fmglobal.com/

Note that these materials are periodically revised and updated. Please monitor the above websites for updates and/or revisions.

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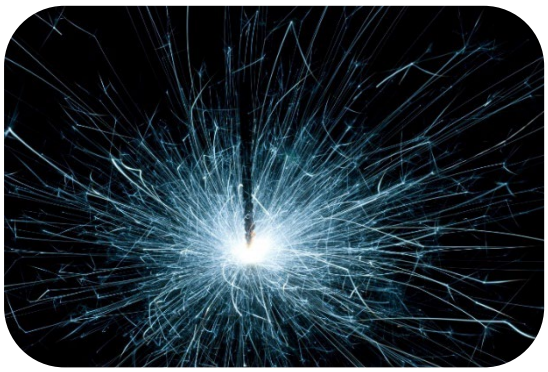
Most metals are combustible to a varying degree, depending on the physical conditions. Many also undergo dangerous reactions with water, acids, and certain other chemicals. Some are subject to spontaneous heating and ignition. A few are radioactive. The hazard of an individual metal or alloy can vary widely depending on the particle size and shape that is present. A large piece of a metal can be difficult to ignite. But ignition is very easy when metals are in finely divided forms such as powders, dusts, chips and lathe turnings. Molten metals can be especially hazardous. The hazards of combustible metals require special extinguishing agents. Not all agents are effective on all metals.



Acknowledgments:

- Franck Orset (FPO) Fire Prevention Engineer

Technical Documents:

- NFPA 484 – Standard for Combustible Metals

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These fires can be difficult to extinguish and mishandling them can cause explosions and spread fire over large areas

1. Metal fires

Because most burning metals react violently with water and decomposes it into hydrogen (additional fuel and explosion hazard) and oxygen (oxidizing agent contributing to the fire), sprinkler systems are normally not recommended with metal fires.

In powder form, they present severe dust explosion possibilities. Some are pyrophoric and ignite spontaneously when dispersed in air, burn readily in pure nitrogen or carbon dioxide gas, and explode on contact with oxidizing agents. Some heat spontaneously in air and must be stored and handled under a nonreactive liquid or gas. Chips and other fine particles from sawing, drilling, or turning operations ignite easily, and special care is needed to prevent ignition of chips and of combustible coolants by the friction of machining.

aluminum granules

crumpled aluminum

titanium granules

metal dust

Magnesium Fire Starter

The alkali metals sodium, potassium, lithium, rubidium and cesium are the most reactive class of metals. They are highly combustible, react with water to generate hydrogen, and are easily ignited.

2. Extinguishing Agents

The following agents should not be used as extinguishing agents on combustible metal fires because of possible adverse reactions or ineffectiveness:

- Water
- Foams
- Halon
- Carbon dioxide
- Nitrogen
- Halocarbon clean agents

Automatic sprinkler protection should not be permitted in areas where combustible, pyrophoric and/or alkali metals are produced or handled unless the following elements are considered:

- Sprinkler systems could be installed in areas where combustibles other than combustible metals in molten form or in a state that could cause immediate explosive reaction with water create a more severe hazard than the metals.
- The hazards analysis has considered the possibility of fires and explosions involving both combustible metals and the other combustibles
- The special hazards associated with metals in a combustible form and in contact with water is considered in the selection, design and installation of automatic sprinkler systems

Note that sprinkler protection can be considered with iron and steel, but not when blending and melting operations are present.

2.1 Fire Extinguishing Agent selection table

Extinguishing agent	Alkali metals (Calcium, NaK, Sodium)	Lithium	Aluminium	Iron & steel	Magnesium	Niobium	Tantalum	Titanium	Zirconium & Hafnium
Coke (carbon microspheroids)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Met-L-X	Yes (1)	No	Yes (1)	Yes	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)
Lith-X	Yes (1)	Yes (1)	No	No	No	No	No	No	No
Copper powder	Yes (1)	Yes (1)	Yes	No	No	No	No	No	No
Dry flux	Yes	Yes	Yes (1)	No	Yes (1)	No	No	No	No
Dry sand	Yes	Yes	Yes (1)	Yes	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)
Dry lithium chloride	Yes	Yes	No	No	No	No	No	Yes	Yes
Dry soda ash	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes
Dry sodium chloride	Yes	Yes	Yes (1)	No	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)
Water	No	No	No (2)	Yes	No	No	No	No	No
Foam	No	No	No	Yes	No	No	No	No	No
Argon	Yes (1)	Yes	No	Yes	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)
CO_2	No	No	No	No	No	No	No	No	No
Nitrogen	Yes (1)	No	No	Yes	No	No	No	No	No
Halon	No	No	No	No	No	No	No	No	No
Hydrocarbon clean agent	No	No	No	No	No	No	No	No	No

(1) Preferred extinguishing agent
(2) Aqueous film forming foam (AFFF) has been shown to be effective on aluminium paste fires in the incipient stage where a class B solvent is the primary fuel.

2.2 Combustible metal fire extinguishing agents quick reference chart (NFPA 484)

Halogenated extinguishing agents must never be used on a burning metal as the resulting chemical reaction can be explosive.

Carbon dioxide is also ineffective as the metal fire will react with the molecule and produce oxygen (oxidizer) and carbon (combustible element), thus increasing the fire.

Class B extinguishing agents will usually greatly accelerate combustible metal fires and can cause burning metal to explode.

Nitrogen can be considered as an extinguishing agent for iron, steel and many alkali metals. But gaseous nitrogen is not a suitable agent for lithium.

Experience has shown that sodium chloride is one of the most effective chemicals for containing fires involving combustible metals powder.

Dry sodium chloride or other dry chemical compounds suitable for extinguishing or containing combustible-metal fires can be used as substitutes for class D fire extinguishers.

The use of fine, dry sand is also an approved method of isolating incipient fires in combustible metal dusts.

2.3 Specific Cases

Note the specific case of Thorium, Uranium and Plutonium, that represents an additional adverse effect of radioactive contamination.

When the fire is in an enclosed space, it can be smothered by introducing argon (preferred extinguishing agent) or helium.

Small fires can be controlled with dry powdered graphite or G-1 powder, by the technique of excluding air from the burning metal with the powder.

Halogenated extinguishing agents (carbon tetrachloride, trichloroethane, halons and many halon replacements), must never be used on a burning metal as the resulting chemical reaction can be explosive.

Carbon dioxide is also ineffective as the metal fire will react with the molecule and produce oxygen (oxidizer) and carbon (combustible element), thus increasing the fire.

Nitrogen is also normally not recommended.

The generation of steam when applying water is likely to spread contamination throughout the area of the fire and beyond.

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