ARCADIA FIRE DEPARTMENT
STANDARD OPERATING GUIDELINE

COMBUSTIBLE METAL FIRES

Number:	***140***
Revision Date:	***12/05/2012***
File Name:	***High Rise***

Review Date: ***03/25/2017***

Approved: _____
Michael E. Lang, Fire Chief

PURPOSE

To provide a guideline to Department personnel involved in the handling of a combustible metal fire.

If not properly identified and handled, combustible metal fires present a unique and dangerous hazards to firefighters.

Combustible metals such as magnesium, titanium, zirconium, tantalum, lithium and sodium are becoming more prevalent in use, shipment and are being recycled much more frequently. Many new products are now being made from these materials including vehicles, increasing the quantities of these metals existing and traveling through the City.

RESPONSIBILITY

Fire Prevention Bureau will apprise fire suppression personnel of all commercial occupancies that handle, manufacture or store, 100 pounds or more of any type of combustible metals, and that these occupancies have the appropriate extinguishing agent on site to control the amount of combustible metals they handle, manufacture or store.

It shall be the responsibility of all Department personnel to follow these guidelines in the handling of combustible metal fires to insure the safety of firefighters and citizens and to protect exposed structures.

It shall be the responsibility of company officers to familiarize themselves and their crew with this guideline and to pre-fire plan any/all structures containing 100 pounds or more of combustible metal.

SCOPE

Combustible metals fall into four categories:

1. Alkali Metals: Alkali metals are water reactive under non-fire and fire conditions. Applying water to alkali metals will result in fire and extreme reactions. Alkali metals include lithium, sodium, rubidium, cesium, radium and potassium.
2. Alkali Earth, Transitional and Other Metals: Alkali earth, transitional and other metals in non-fire situations do not present the same hazards as alkali metals, however, when burning Alkali earth, transitional and other metals can become extremely dangerous if water is utilized an as extinguishing agent. Alkali earth metals include magnesium, beryllium, calcium and strontium; Transitional metals include titanium, hafnium, niobium, tantalum and zirconium. Other metals include aluminum powder and flakes.

Most metals in the form of powders, dusts and chips will ignite and burn. Powders and dusts are by far the greatest concern; they have a greater surface area and a high explosion potential should they become airborne in a natural environment or during attempts to extinguish a fire. As a rule, larger products of combustible metals such as bars, ingots, heavy castings and thick plates are virtually impossible to ignite; in most cases, they will self-extinguish when the heat source is removed. Aluminum powders have the highest inherent explosive power of all combustible metal dusts.

Combustible metal fires can produce extreme temperatures ranging from 5,000°F to 8,500°F. These temperatures result in the dissociation of water to its basic elements of hydrogen and oxygen. In a basic sense, 100 gallons of water that is applied to a combustible metal fire is the same as applying the hydrogen equivalency of 42 gallons of gasoline to a combustible metal fire. Application of carbon dioxide has similar results with the dissociation of carbon and oxygen.

These temperatures present extreme hazards to Department personnel entering a structure where a combustible metal fire may be burning, due to rapid heat buildup and fire spread characteristics. The temperatures encountered with a combustible metal fire will far exceed those for which personal protective gear are designed for.

Combustible metal fires can produce flames of blue-green, orange-to-white in color and smoke can be white or grayish in color, if only the combustible metal is involved. Smoke will also appear to be exiting the structure at a much higher velocity than in a normal structure fire because of the high burning temperatures of combustible metals.

Fires involving large quantities of combustible metals are impossible to extinguish and are extremely difficult to contain if not caught in the incipient stage and controlled with a Class D extinguishing agent appropriate for the metal involved. In most cases, the heat generated by a metal fire will make it impossible to apply an appropriate agent to control the fire once it is beyond the incipient stage.

PROCEDURE

1. Size-Up; a proper size-up and identification of the materials involved, the physical state of the product, chips, powder, fines, dust, etc.; and the quantity of the product involved or potentially involved.

2. Ensure control of utilities to affected areas.

3. Obtain Material Safety Data Sheets for the involved products and, if available, contact those familiar with the product hazards.

4. Fire involving large quantities of product within structures can result in rapid heat build-up and smoke generation, beyond that which is normally encountered in fires involving ordinary combustibles. Fire beyond the incipient stage within structures can place personnel at extreme risk.

5. If fires can be safely isolated, the best course of action is to allow them to burn out.

6. Uninvolved product, with the exception of alkali metals, and exposures can be protected by hose streams if adequate precautions are taken. It is extremely important that care is taken to prevent runoff from hose streams coming in contact with burning material or molten product.

7. Extreme caution needs to be taken for fires involving combustible metal powders, dusts, and fines. This is the most hazardous form of combustible metals. Explosions are possible with these products, especially if product becomes airborne with an ignition source.

8. Small and incipient fires may be contained utilizing Class D extinguishing agents, dry sand, or dry salt. Refer to Attachment A for the list of compatible extinguishing agents for combustible metal fires.

9. Most fires involving combustible metals can only be extinguished by providing an inert atmosphere of argon or helium, if those products are dry.

10. Water in contact with molten combustible metals will result in violent steam and hydrogen explosions and reactions. Control of domestic and fire protection water systems must be considered in fires involving a structure to prevent water contact with burning material.

11. Large fires are impossible to extinguish. The best approach is to isolate the material as much as possible if it can be done safely. Protect exposures with water streams if adequate drainage is present to prevent contact of water with the burning material. Let the fire burn out naturally to minimize hazards to personnel and losses to exposures.

12. In most cases, combustible metal fires will burn quickly and begin to develop an oxide crust that will limit open burning of the product. It is extremely important that the crust is not disturbed until the metal has completely oxidized to the point of extinguishment. Depending on the size of the fire, this can take 24-hours or longer.

13. Even though there may not be any signs of external burning, the metal can remain extremely hot and continue to present thermal injury risk to department personnel, and risks associated with water application if the oxidized crust is disrupted prior to complete extinguishment.

14. Thermal Imaging Cameras can assist with determining if the burning material has cooled to the point of complete extinguishment.

15. Consider Fire or Health Haz-Mat teams, there is a potential for this type of incident to develop into a hazardous materials incident.

UNUSUAL HAZARDS OF COMBUSTIBLE METALS

1. Water applied to a burning combustible metal will result in an increase in burning intensity.

2. Application of carbon dioxide has similar effects as water; the carbon dioxide adds to the intensity of the burning. Most combustible metals will ignite and burn in 100-percent carbon dioxide atmospheres.

3. Dry chemical extinguishers have no effect on combustible metal fires.

4. Halogenated extinguishing agents have no effect on combustible metal fires, with the decomposition of the products producing hazardous byproducts.

5. A primary metal fire displays intense orange-to-white, or blue-green flames and may be associated with a heavy production of white or grayish smoke.

6. When water is applied to burning combustible metal, it actually disassociates to basic compounds of oxygen and hydrogen. Similar results occur with carbon dioxide.

7. Dusts, fines and powders of combustible metals present an explosion hazard, especially in confined spaces.

8. Turnings and chips of combustible metals can ignite and burn with intensity, especially if they are coated with petroleum based oils. There have been instances of spontaneous combustion.

9. The larger the product, the lower the likelihood of ignition. Bars, ingots, heavy castings and thick plates are virtually impossible to ignite and, in most cases, will self-extinguish when the heat source is removed.

10. Burning combustible metals can extract moisture from concrete and similar products that can intensify burning and cause spalling and explosion of the products. Burning metal will destroy asphalt and extract moisture from rock.

11. Fire involving combustible metals cannot be extinguished, they can only be controlled, unless they are placed in an inert atmosphere of argon or helium. Fire involving large quantities should be allowed to cool for at least 24-hours prior to being disturbed to prevent re-ignition. Fire will oxidize the metal.

12. Combustible metal fines and powders that are stored and contain moisture can produce hydrogen gas.

ATTACHMENT A

Appropriate Extinguishing Agents for Combustible Metals

Table 3. Combustible Metal Fire Extinguishing Agents Quick Reference Guide

Extinguishing Agent	Alkali Metals (Potassium, NaK, Sodium)	Alkali Metals (Lithium)	Aluminum	Magnesium	Niobium	Tantalum	Titanium	Zirconium
Coke (Carbon Micro-spheroids)	YES	YES	YES	YES	YES	YES	YES	YES
Met-L-X	YES	NO	YES	YES	YES	YES	YES	YES
Lith-X	YES	YES	NO	NO	NO	NO	NO	NO
Copper Powder	YES	YES	YES*	NO	NO	NO	NO	NO
Dry Flux	YES	YES	YES	YES	NO	NO	NO	NO
Dry Sand	YES	YES	YES	YES	YES	YES	YES	YES
Dry Lithium Chloride	YES	YES	NO	NO	NO	NO	YES	YES
Dry Soda Ash	YES	YES	YES	YES	NO	NO	YES	YES
Dry Sodium Chloride	YES	YES	YES	YES	YES	YES	YES	YES
Water	NO	NO	NO	NO	NO	NO	NO	NO
Foam	NO	NO	NO**	NO	NO	NO	NO	NO
Argon	YES	YES	YES	YES	YES	YES	YES	YES
CO_2	NO	NO	NO	NO	NO	NO	NO	NO
Nitrogen	YES	NO	NO	NO	NO	NO	NO	NO
Halon	NO	NO	NO	NO	NO	NO	NO	NO
Halon Replacements	NO	NO	NO	NO	NO	NO	NO	NO

NOTE: When combustible metals are blended with other materials, the extinguishing agent used should be compatible with the combustible metal.

Green text indicates the preferred extinguishing agents, blue indicates acceptable agents.

*Copper powder can be used on aluminum fires but requires large quantities to be effective.

**Aqueous film-forming foam (AFFF) has been shown to be effective on aluminum paste fires in the incipient stage where a Class B solvent is the primary fuel.

Source: Based on NFPA 484, *Standard for Combustible Metals, Metal Powders, and Metal Dusts*, Table A.13.3.3. Used with permission.