Protecting Employees from the Effects of Dust Explosions and Fires in the Die Casting Industry

INTRODUCTION

This paper discusses the prevention and/or control of fires and explosions when working around die casting facilities producing white metal castings. Topics included are:

- Key Facts You Should Know
- Emergency Plans and Procedures
- Clothing Fires
- Housekeeping
- Control of Ignition Sources
- Control of Combustible Materials
- Removal of combustible metal waste
- Inspection and Maintenance
- Fire Extinguishing Agents
- Controlling Metal Fires
- Fire Fighting Organization
- Automatic Sprinkler Protection

The intent is to assist in implementing work practices and procedures necessary for dust explosion and fire safety at the plant. The practices and procedures discussed here are adapted from NFPA 484 - Standard for Combustible Metals, 2006 Edition. Some of the practices and procedures that are of greatest concern are appropriate housekeeping, fugitive dust control and safe handling of fine particles.

This document has been prepared as part of the North American Die Casting Association course on combustible dust in the die casting Industry.

KEY FACTS YOU SHOULD KNOW

This section presents some key information regarding combustible metal and dust operations – the materials used in the die casting industry. Some of this information is unusual and not widely known. Health and safety depends on the recognition of actual or potential hazards of combustible metals, particularly metal dusts; the control or removal of these hazards; and, training of employees on safe working procedures. Important guidance on health and safety is found in NFPA 484 Standard for Combustible metals. Everyone working with combustible die casting metals, (particularly in the form of dusts and fines) needs to know some key facts. Emergency response and preparedness are especially important.

Containers for molten metal must be cleaned and dried prior to receiving the molten material. Metal pieces charged into liquid molten metal must be clean and dry. Water wet containers and charge pieces can cause a molten metal explosion

When combustible metals burn, an intense, extremely hot, orange or orange and white flame is produced. This is accompanied by a large volume of white and gray smoke. If the burning metal has been contaminated with water, fire will be more intense.

Water and Other Common Fire Extinguishing Media

Water does not mix with burning combustible metals. The intensity of the burning will break the water into oxygen and hydrogen and greatly increase the heat and energy being released by the fire. Explosions have been produced by applying water to burning combustible metal. Carbon dioxide has a similar effect in that it breaks down into carbon and oxygen. Most combustible metals will burn in 100% carbon dioxide. Halon type and other halogenated extinguishing agents may decompose into hazardous products and are not suitable for use on die casting metal fires. Dry chemical extinguishers may be used on burning flammable or combustible liquids are mixed with combustible metal but have not started the metal to burn.

Fines, Chips and Ingots

Dusts, fines and powders produced from die casting metals may cause explosions. If these materials are in a confined space, the concentration of particles may be higher and more likely to explode. Chips and turnings ignite with a very hot flame. If they are coated with cutting oil or other petroleum product, there may be a tendency to ignite spontaneously. Heavy wall die castings, thick bars and ingots are difficult to ignite or may not ignite at all. If ordinary combustibles are burning and heat up these heavy materials, especially magnesium alloys, the heavy items may participate in the fire in a spectacular fashion.

Burning combustible metals produce an unusual amount of heat. Such a fire may cause water to come out of concrete (the water of hydration in the concrete) or even rocks. This water may cause increased burning, burst the materials and cause pieces of rock or concrete to be thrown about. Asphalt paving material can be involved in the fire because of the intense heat given off.

Fires in die casting metals cannot be directly extinguished. They may be controlled and separated from the oxygen in air, cease burning and cool. In die casting metal fires, this is done by applying dry extinguishing agents to completely cover the burning materials.

Combustible metal dusts, and fines create unique hazards. If they contain or are contacted by moisture, they can produce hydrogen, a flammable gas; oxygen, an oxidizer and heat. This can cause an explosion or fire.

Thermite Reactions

Magnesium, aluminum (or a similar light metal or alloy) dust, not oxidized, can react in contact with rusty iron and produce heat in what is called a thermite reaction. Specially made tools are used to avoid this and friction sparking. Thermite reactions can be an ignition source. Thermite sparking was identified as a hazard in coal mines in the 1940s. Articles made from light alloys that accidentally hit, or were dropped on, steel structures or machinery caused a spark. Magnesium and iron powder mixtures have been used to demonstrate this reaction in chemistry labs, a spectacular show.

Equipment to Remove Containers

Storage areas for containers of combustible metal are to be equipped with material handling equipment that would enable a container to be removed from the area quickly and efficiently in and emergency.

Hydrogen from Moist Particles

Stored die casting metal dusts, chips and particles that contain moisture can produce hydrogen gas. A significant amount of hydrogen produced in the storage area can produce a Class I, Group B hazardous location. Ignition sources must be excluded and good ventilation provided.

Flammable and Combustible Liquids

Use of flammable and combustible liquids must comply with OSHA 29 CFR 1910.106 and NFPA 30. Consider:

- Spray finishing;
- Open containers;
- Spills;
- Use around ignition sources;
- Lack of ventilation.

High capacity hydraulic systems (greater than 50 gallons), must use hydraulic oil with a flashpoint exceeding 200° F. These systems are often used in powering and controlling heavy grinders, forging equipment and large milling machines. High pressure spray leaks can easily catch fire. Any spray finishing using flammable or combustible liquids must meet the requirements of OSHA 29 CFR 1910.106 and NFPA 33

EMERGENCY PLANS AND PROCEDURES

Every employee needs to know the emergency procedures to be used in the event of combustible metal fires or explosions at the die casting plant. Basic issues are the ability to evacuate and/or to actively respond to emergencies.

Emergency Response

A careful assessment (“size-up”) of the situation is important to anyone attempting to act on or suppress a combustible metal fire. This is an important question. “Can the fire be isolated and safely allowed to burn out?” Small and incipient fires may be contained using Class D extinguishing agents. Large fires can be difficult, even impossible to extinguish. They must be allowed to burn out.

Only an organized, trained and properly equipped fire brigade or department should attempt to respond to a large combustible metal fire. All others must evacuate the area. Knowledge and familiarity with the products involved are critical to safety. The state of the material and the quantities involved (or potentially involved) are keys to the type response, e.g.: chips, fines, dust, light or heavy castings, ingots; Remember – dusts and fines have the potential to explode if airborne in the presence of an ignition source. If a fire is burning in a collector or other closed container, the potential for an explosion must be considered.
A fire involving a large amount of product can be dangerous, especially within a building. Responders need to know that extreme caution is necessary. Heat and smoke can build up more rapidly than fires in ordinary combustibles. Large fires are often impossible to extinguish and must be allowed to burn out. Isolate the burning material as much as possible if this can be done safely.

Water in contact with molten metal will cause hydrogen explosions and throw material about. Water may be used with care on products and exposures that are not involved in the fire. Appropriate drainage must be available to prevent water from contacting burning material.

If the fire has been extinguished, the temperature of burned products must be allowed to cool. A “flare-up” may occur if the burned material is disturbed prior to complete oxidation and self extinguishment.

Emergency Preparedness

A comprehensive emergency preparedness program is necessary wherever combustible metals are processed, handled, used or stored. Safety experts have identified the need for a plan including specific actions to take in the event of a combustible metals fire and coordination

of the plan between plant management and everyone who will be responding to an emergency. OSHA regulations related to emergency plans are listed at 29 CFR 1910.38 & 1910.120.

All employees in areas where combustible metals are handled need training regarding the following:

- The hazards of their working area;
- What they need to do in case of fire or explosion;
- The location and operation of:
    - Electrical switches and alarms;
    - First-aid equipment;
    - Safety equipment; and,
    - Fire extinguishing equipment.
- Permissible ways of fighting incipient combustible metal fires and for isolating fires;
- Hazards of causing dust clouds;
- The dangers of applying liquids to incipient metal fires;
- Safe and proper evacuation of the work area;
- Equipment operation, start-up, shut-down and how to respond to upsets;
- Need for and function of relevant fire and explosion protection systems; and,
- Details of the emergency response plan.

CLOTHING FIRES

Special flame retardant, antistatic clothing should be used for dusty jobs. Molten metal jobs also create the need for suitable heat resistant clothing and equipment. A major concern is that every employee must know what to do in the event his or her clothing starts on fire. Every employee must know the basic stop, drop, and roll procedure:

- Stop to slow down the supply of oxygen feeding the fire;
- Drop to remove the face and breathing zone from rising column of flames and superheated gases; and,
- Roll to press oxygen away from flames.

Strategically placed fire blankets are very helpful in suppressing clothing fires. Personal deluge showers must not be placed in dry powder or combustible dust areas.

Employees working with combustible die casting metal dusts need protection from clothing fires. Anti-static and flame retardant clothing is necessary for some jobs, e.g.: bagging or loading dusts, work with collector bags or at bag house doors or openings. Wear cotton, not silk or wool.

Employees working with molten die casting alloys also need flame retardant (FR) that will shed molten alloy. Clothing treated with “phosphate” or “ammonia cure” flame retardant often used in the iron and steel industries should not be worn. The lower temperature of molten die casting metal does not allow the metal to run off the clothing as well as molten iron or steel and may result in burn injuries.

HOUSEKEEPING

Housekeeping is known to be critical to safety and the prevention of dust explosions in the die casting industry. Dangerous accumulations must be prevented through systematic cleaning.

Combustible metal dust must not be allowed to accumulate on the floor, ledges or other horizontal surfaces. Develop a cleaning system for all parts of the building that contain dust producing equipment. Look for the finest dust in the high places, on roof joists and beams, above suspended ceilings and on top of equipment. Include roof members and structures, pipes, conduits and similar items, machines and equipment, ceilings, floors and walls. Walls and other vertical surfaces with dusts adhering to them are a significant problem. Dust from vertical surfaces can be most easily be dislodged and become airborne into a dangerous cloud.

A competent person must assess the entire cleaning process to make sure that cleaning methods minimize the probability of a fire or explosion. Cleaning must be planned, systematic, effective and safe. Remove all chips and powder sweepings to an identified safe area for storage and/or disposal. Develop an appreciation of level of dust from “a small acceptable amount” through “ready for cleaning” to “too much dust”

Do not blow down surfaces with compressed air. Never generate a dangerous cloud of small particles in the air. The purpose is to avoid generating clouds of hazardous dust and to prevent excess oxygen at and within any dust cloud. It can suspend the smallest particles in the air for a long time. They can later be deposited on the highest surfaces, ready to be suspended and explode.
If cleaning is not possible any other way (e.g.: a narrow channel on a piece of equipment) the force of a gas stream might be used. Careful safety precautions must be implemented including:

- All equipment must be shut down;
- Any ignition sources are to be removed or eliminated;
- Collect as much dust as possible by vacuum;
- In general, low pressure inert gas is to be used to blow out the dust; and
- Provide inert gas and air outlets with non-matching fittings to prevent an interchange of gases.

When moving bulk accumulations of fine combustible metals, use a natural fiber push broom and a spark resistant scoop or shovel. Gently sweep particles down. Use vacuum cleaning equipment only after removing bulk materials with a brush and scoop. Use vacuums for small amounts of residual material. It is important to use conductive, spark resistant scoops and brooms or brushes with natural fiber bristles for the removal of bulk material.

Industry experts have identified dry collection systems as likely to be associated with a fire or explosion when used to collect magnesium dusts. If a dry collection system is used, it must be located outside and safely away from buildings or people. At least 50 ft (approximately 15 m) clearance is required. Any bag system must be of the anti-static type with ground wires. Pulse type cleaning arrangements are preferred. An alarm system that monitors pressure drop and temperature should be used. A wet collection system is preferred and considered much safer.

Portable vacuum cleaners have been the source of fires. Only those units labeled as appropriate for combustible metal dust areas are to be used. It is worth repeating, portable vacuum cleaners and vacuum collection systems must be approved for handling combustible metal dusts.

There are hazards associated with vacuum cleaning. Particles are concentrated into a small space and contacting each other. They are moving at high speed through the air, rubbing against the molecules of the air. They are contacting duct work and equipment. All of this generates electrostatic charges that may be energetic enough to be an ignition source. A special engineering analysis and review must be provided for the design, installation, maintenance and use of vacuum systems.

Clean up any spilled oils or other liquids that will burn promptly. They are a slip and fall hazards as well.

Keep incompatible materials separated. Do not allow water, moisture oxidizing agents, halocarbons, halogens or acid chlorides to contact magnesium. These materials should be kept away from other finely divided alloys as well. Make sure that supplies are stored in order; aisles are wide enough and not obstructed. This will enable inspections to be carried out and any incompatible materials to be kept separated.

In die casting shops, it is acceptable for combustible metal waste sweepings to contain small amounts of ordinary combustible materials.

Conduct frequent inspections, as often as needed. Make sure there is no accumulation of combustible metal, chips, powder or dust. These materials are to be cleaned on a daily basis and not allowed to accumulate. Making and retaining records relating to the housekeeping inspections is important. Potential ignition sources of equipment that must operate during the cleaning program must be

identified. Action must be taken to isolate, eliminate or minimize any identified hazards.

CONTROL OF IGNITION SOURCES

Some of the ignition sources that must be controlled at die casting facilities are: Smoking; Sparking tools and equipment used around metal dust; Static electricity; and, Friction and bearings.

Hot Work

NFPA 484 defines Hot Work as work involving burning, spark producing, welding or similar operations capable of producing fires or explosions. For example, the use of cutting torches to dismantle dust collectors is extremely hazardous if they are not free of combustible dust. This practice has often been associated with fires and explosions and has frequently been cited and fined by OSHA.

When performing hot work, it is very important to comply with NFPA 51B regarding fire prevention during welding, cutting and other hot work. OSHA has a very similar list of rules and safe practices identified in the regulations as 29 CFR 1910.252 regarding welding, cutting, and brazing.

A hot work permit system must be established and used in any area containing combustible metals or combustible metal turnings, dust and fines. This includes all areas – production, storage, handling and processing or disposal areas. Hot work procedures, approved by qualified persons, must be used. A hot work permit system involves addressing the issues listed below:

- Relocate the hot work operation, if possible.
- Clean up the hot work area.
- Cover any remaining combustible with fire safe shields or barriers.
- Protection equipment must be available, in service and ready. Combustibles within 35 feet must be protected
- Management must authorize the hot work.
- Inspect to be certain precautions are adequate.
- Implement a special watch for fires and keep the watch in service for at least 30 minutes after completion,

A simple form of written permit adapted from one edition of NFPA 51B is attached to this document as “Attachment A”. An appropriate form must be prepared and signed by at least two persons, the permit authorizing official and the permit supervisor. The supervisor may serve as the fire watcher as well. A great deal of useful information is available in NFPA 51B . . . Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,

2009 Edition. Each individual plant must adapt its hot work permit system to address any hazards at the facility.
Essential to every plan is a fire watcher who guards against small fires during the work and for thirty minutes thereafter. The supervisor is to verify hot work safety prior to beginning work. Before any welding, cutting, open flame or other hot work is performed, the area must be cleaned and any combustible metals or combustible metal dust, powder, fines, or sponge removed.

A hot work permit is not required for any hot work processes that are a routine part of the production process. This work must be done in a safe area as demonstrated by a hazard analysis.

Smoking

Smoking matches or lighters are not allowed in areas where combustible metal sponge, chips, or powder is used, stored, handled or present. Smoking is only allowed in appropriate, safe designated areas at die casting plants. When smoking is allowed in any area of the plant, no smoking signs must be posted. Where smoking is prohibited, it may be a good idea to post no smoking signs in combustible metal areas in all cases.

Spark Resistant Tools

When making repairs or adjustments in areas where combustible metals cannot be moved away, spark resistant tools are to be used. Spark resistant tools are made from materials that will not generate impact sparks when they are used. Standards for these tools are listed in Air Movement Control Association Standard No. 99-1408-86. Risks of ignition by equipment and tools must be assessed in combustible metal areas.

Tools must be electrically conductive and made of spark resistant materials. Aluminum or magnesium cannot be used as a non-sparking material where it may strike, or come in contact with, rusted iron or steel. This contact can generate a spark, known as a thermite reaction.

Static Electricity

Prevent accumulations of electrostatic energy. Bond and ground the building structure and all equipment with permanent ground wires. Equipment that may be moved, including tools made of metal, must be bonded and grounded to a good earth ground prior to use. Failure to do this has been frequently cited and fined by OSHA.

The bonding and grounding program must include bearings and the belting of drive systems and conveyors. Belts must be anti-static and conductive type.

If non-conductive equipment components create discontinuity to ground, suitable bonding jumpers must be used to bridge any gaps. Where bonding jumpers are used, the connecting wires must be verified as conductive.

Friction and Bearing

Install and maintain equipment to minimize the possibility of friction sparks. Appropriate clearances must be provided to prevent rubbing and frictional heating. This type of heating may be a source of ignition and must be minimized. Bearings must be sealed type or shielded against dust. If shielded, exposed bearings are used; they must be kept properly lubricated. Localized frictional heating of bearings may cause hot spots and a fire hazard.

CONTROL OF COMBUSTIBLE MATERIALS

Control flammable and combustible liquids and oils, wood, paper and metal waste is important in preventing the fire control problems of combustible metals and dusts from being increased and complicated.

Use of flammable and combustible liquids must comply with OSHA 29 CFR 1910.106 and NFPA 30. High capacity hydraulic systems (greater than 50 gallons), must use hydraulic oil with a flashpoint exceeding 200° F. These systems are often used in powering and controlling heavy grinders, forging equipment and large milling machines. High pressure spray leaks can easily catch fire. Any spray finishing using flammable or combustible liquids must meet the requirements of OSHA 29 CFR 1910.106 and NFPA 33.

Wood, paper, and other materials that will burn, must not be allowed to accumulate in processing areas. If these items are necessary for the process they must be stored in designated safe places. The same containers used for collection of combustible metal waste must not be used to receive combustible waste products.

REMOVAL OF COMBUSTIBLE METAL WASTE

Chips, fines, and other waste caused by cutting, machining, or grinding as well as swarf, paste, powder, dust and sweepings are to be collected into closed top metal containers and removed from the processing area at least daily. Be sure to separate combustible metal waste materials from metal scraps and ordinary combustible material. Swarf is a mixture of grinding chips, abrasive wheel particles and cutting fluid. This material is produced by grinding operations.

INSPECTION AND MAINTENANCE

It is important to implement a properly functioning inspection, testing and maintenance program. This will allow the systems, processes and equipment to perform in the way they were intended. In addition process changes must not increase hazards at the plant.

The plant inspection and maintenance program must include the following:

- Fire protection provided for equipment must comply with NFPA and other codes and standards.
- Inspect all dust control equipment. Make sure that it is properly installed and functioning.
- Check electrical grounding of the equipment.
- Determine if any dust is leaking from ducts and other equipment.
- Identify any housekeeping practices that could create a hazard.
- Look for potential ignition sources, and require the removal of any built up deposits of dust.
- Make certain that all equipment items, including any interlocks, are functioning properly.
- Be certain to check that grounding and bonding systems provide appropriate continuity to ground.
- If static dissipative footwear is worn and conductive floors are used, be sure that they meet resistivity standards through testing.

The inspection program must provide a complete inspection of the operating area. It must be done frequently enough to meet the needs of the plant. The program will verify that equipment remains in good condition and that work practices are appropriate to assure safety. To prevent dust hazards from developing, quarterly inspections are needed, as a minimum.

Inspectors need to know all the work practices used in the area. They must be competent in performing the job of inspecting the area and making sure that it is safe.

Records and files must be established for all findings and recommendations. This is important to document the safety program and make sure that any recommendations are acted upon, followed up and resolved in a systematic way.

An important part of good maintenance is systematic management of any changes. Review Operating and maintenance procedures at least annually and whenever there are process changes. Management of process changes is an important part of good maintenance. MOC includes all modifications to equipment, procedures, raw materials, and processing. “Replacements in kind” or same to same replacements are an exception. Some examples are:

- Increasing the operating temperature molten metal heats;
- Implementing a new way of cleaning dust;
- Removing a dust collector.

FIRE EXTINGUISHING AGENTS

It is important to remember the meaning of the markings on fire extinguishers, e.g.: ABC and so on. Class A extinguishers are meant to be used on wood and paper fires. Water and/or ABC dry chemical are often used on these fires. Class B fires are often seen in the news and on TV. Class B fires involve liquids and gases. Dry chemical extinguishers and foam are often used on fires of this type. A class C fire involves energized electrical current. The first thing done is shut off the power if possible. A construction crane contacting a power line and bursting into flames is an example of this type fire. Class K fires involve vegetable cooking oil in commercial deep fat fryers, i.e.: in the Kitchen. It requires use of specially marked Class K kitchen fire extinguishers because of the unusual burning characteristics of vegetable oil.

Fires involving combustible metals (e.g.: magnesium and aluminum) are Class D fires. Alloys of these materials are used in die casting facilities and are included in this class of fire.

The material used to extinguish or suppress a fire is called an extinguishing agent. Regarding magnesium and aluminum alloy materials, only those agents listed by a NRTL (a nationally recognized testing laboratory accepted by OSHA) as suitable for Class D fires, are to be used on burning combustible metal fires. The “Fire Extinguishing Agents” chart (Attachment B) is adapted from a similar chart referenced in NFPA 484. That chart does not address Zinc alloys but MSDS sheets have identified Met-L-X, Dry sand and dry sodium chloride as appropriate agents.

Experts agree that it is dangerous to use some extinguishing agents on fires involving the metal alloys used in the die casting industry. They either do not work or produce a hazardous reaction when contacting combustible metals. These materials should not be used on fires in die cast metal alloys:

- Lith-X;
- Copper powder;
- Dry lithium chloride;
- Water;
- Foam;
- Carbon dioxide
- Nitrogen;
- Halon and Halon replacement materials.

Extinguishers and extinguishing materials must be conveniently located and within easy access in the event of a fire. OSHA 29 CFR 1910.157 (d)(6) requires portable fire extinguishers or other containers of Class D extinguishing agent to be placed so that the travel distance from the combustible metal working area to any extinguishing agent is 75 feet (22.9 m) or less. Portable fire extinguishers for

Class D hazards are required in those combustible metal working areas where combustible metal dusts, flakes, shavings, or similarly sized products are generated at least once every two weeks or more often.

Containers for extinguishing agents that are applied by hand must be kept tightly covered to keep the agent dry. If the agent is wet, it is not effective and is dangerous to use. Containers must be checked frequently to assure that the agent is dry. Weekly is recommended.

Class A:B:C dry chemical and B:C dry chemical extinguishers may be used on any ordinary combustible materials in the area but are never to be used on combustible metals. They must be marked “Not for Use on Combustible-Metal Fires”. Carbon dioxide used as an expellant in an extinguisher or as the actual extinguishing gas is hazardous around combustible metals. Only materials that are compatible with combustible metals may be used.

CONTROLLING METAL FIRES

Control of combustible metal fires requires careful planning and training. Small or incipient fires must be assessed in contrast to large or advanced fires. The effects of water use in a class D environment must be considered as well.

Experts define an incipient fire as a small fire. It is in the beginning stage and small enough to be safely suppressed without wearing special protective clothing or breathing apparatus. It is not small if you need thermal protective clothing or SCBA Breathing apparatus or must crawl on the ground or floor to stay below smoke or heat. Properly trained employees who understand the hazards of combustible metals may isolate and contain combustible metal fires in the incipient stage. An incipient fire may be controlled or extinguished using small extinguishers and hand scoops of relatively small amounts of dry extinguishing agent.

Careful plans must be prepared and include specific actions to take in the event of a combustible metal fire. These plans must include specifying what the limits are regarding attempts to extinguish combustible metal fires. Industrial fire brigade requirements are discussed in detail in NFPA 600.

Water must not be applied to combustible metal fires or molten metal. Water intensifies by the fire supplying oxygen and generating hydrogen. Water may become trapped under molten or burning metal and cause a steam explosion. In addition, water in contact with combustible metals (e.g.: molten metal or finely divided particles) may generate heat, hydrogen and oxygen. This can be extremely hazardous. The role of water is to protect, cool and/or extinguish other materials, structures or equipment located away from the burning combustible metal. Water is not to be used on burning or molten metal.

A fire in a significant quantity of burning combustible metal may grow large and dangerous. This type of fire is extremely hot and burning molten metal can be thrown about. If small particles are present, they can become suspended in air and explode. Fires in combustible metals that have developed beyond the incipient stage are to be fought by professional fire fighters and/or specially trained fire brigade members only. These fire crews are required to complete rigorous training and education. They must work according to established plans within an appropriate incident command system. Special protective “turn-out” gear is required for these fires.

Metal fire fighting beyond the incipient stage requires eye protection that includes attention to radiant light from metal fire; protective clothing intended for metal fire fighting with heavy quilted lining and aluminized coating or equivalent; and self contained breathing apparatus.

Most companies have the policy encouraging and trained, capable employee to attempt to suppress a small or incipient fire. Employees dressed in ordinary work clothing, (i.e.: employees who are not part of a specialized, trained and equipped fire brigade) must not attempt to suppress a large combustible metal fire. These employees must be restricted to attempting suppression of incipient fires only.

Dealing with combustible metal fires involves knowing the answer to this question: Can the fire can safely be suppressed, extinguished, isolated or contained, given existing plans and resources? Proper training and information will allow employees to know the answer to this question.

Fire fighter should not cause a cloud of combustible metal particles to form in attempting to control a fire, small or large. It is critical to avoid this. An ignition source is present and an explosion could result. It is also a problem to move, carry or disturb a pan of metal chips, turnings or other small particles. Spreading the fire or causing an explosion is a possible result. A person trained and skilled in metal fire fighting may do this in special circumstances if the risk is low and there is a greater hazard to not moving the burning material to a safe area. If it can be done safely, drums or tote bins of burning materials should be moved outside, away from buildings, personnel, processing equipment and materials. This should be done as rapidly as possible.

Small metal fires are suppressed in a series of steps. First, surround them with a dam or ring of dry sand, dry non-reactive material or listed Class D extinguishing agent according to the manufacturer’s instructions. When applying agent to the fire, be certain that nothing is done to allow a cloud of metal dust to form. Failure to do this could result in an explosion. Do not use a pressurized extinguishing agent on combustible metal chip, dust or powder fire, unless it can be done without spreading the burning fuel or forming a dust cloud. Class D extinguishing agents listed or approved by a NRTL or an equivalent extinguishing agent are to be used when attempting to suppress combustible metal fires.

Once a fire has been extinguished and a crust is formed by the extinguishing agent, don't disturb the crust until the residue has cooled to room temperature. Protect residues from water and other materials that could cause an adverse reaction.

Appropriate extinguishers, compatible with any hazards in the area, must be provided and available in combustible metal scrap storage areas.

An incipient (small) fire in solvent or oil coated alloy dust, chips or turnings may be fought with a class B extinguisher and then treated as a combustible metal fire, covered in, allowed to cool and disposed of in covered metal containers. Make certain it is a solvent or oil fire before using Class B extinguishing agents. Combustible metal fires emit an intensity of light not present in Class B fires. Using extinguishers intended for use on Class B fires may be dangerous on a burning combustible metal fire.

FIRE FIGHTING ORGANIZATION

Combustible metal fire fighting and control requires training. Personnel who have not been trained must be evacuated from the area. Training programs need to emphasize the various different types of fires that may occur in the area; extinguishing agents that are appropriate for use; and, fire fighting techniques. Train everyone who will be fighting combustible metal fires in extinguishing test fires at a safe location away from buildings. The plant fire fighting organization must comply with 29 CFR 1910.156 and NFPA 600 on fire brigades. Training for combustible metal fire fighters must address the types of fires and other events that may occur; fire fighting techniques; appropriate agents to be used; prevention of dust explosions during a response; and, how things can go wrong and what to do about it.

All fire fighting activities are to be conducted under the direction of a unified incident command system that includes qualified plant safety officers. Any local fire department personnel should be given the opportunity to participate in a practice and familiarization drill each year, in the interest of their own safety.

AUTOMATIC SPRINKLER PROTECTION

Sprinkler protection is desirable to protect against fires at facilities and greatly assists in protecting personnel from fire. It should be noted however: Sprinklers provide no protection from explosions. Combustible metals in plant present special problems. Sprinklers should not be used in areas where the only significant fire potential results from combustible metals or molten metal. It must be determined if other combustibles present a greater hazard.

Automatic fire sprinklers are not suitable for use where combustible metals are used or handled in die casting plants unless other combustibles create a more severe hazard. A systematic hazard analysis process must be used to determine

the hazard. This must include an evaluation of the possibility that fires and explosions could involve both combustible metal dust and ordinary combustibles. Melt shop and molten metal areas must be included in this analysis. If it is determined that a sprinkler system is necessary, the system is required to meet the requirements of OSHA 29 CFR 1910.158 and NFPA 13 on sprinkler systems.

Magnesium contacting water causes hydrogen and oxygen to be generated and produces heat. It may cause an explosion. It is possible that significant amounts of hydrogen may accumulate and explode. In addition, molten metal is likely to be thrown and splashed around. Any Sprinkler system design and installation must address these possibilities. It is extremely important to provide an excellent evacuation program for any combustible metals area that is protected by an automatic sprinkler system.

Stored light castings, especially those with thin metal sections, may produce a significant metal fire. The design of all the fire protection arrangements must consider this problem including the detection, alarm and suppression systems and the use of fast acting response sprinkler heads. Sprinkler systems are to be used to protect light casting storage areas where the volume of storage exceeds approximately 1000 ft^3 or 28 m^3. Also provide sprinklers where magnesium castings are packed in combustible crates or packaging or where other combustible storage is located within 30 ft or 9 m of the castings.

SUMMARY

This paper discussed the prevention and/or control of fires and explosions when working around die casting facilities producing white metal castings. The intent was to assist in implementing work practices and procedures necessary for dust explosion and fire safety at the plant. The practices and procedures discussed here were adapted from NFPA 484 - Standard for Combustible Metals, 2006 Ed., Chapter 13. Practices and procedures that are of greatest concern were indicated to be appropriate housekeeping, fugitive dust control and safe handling of fine particles.