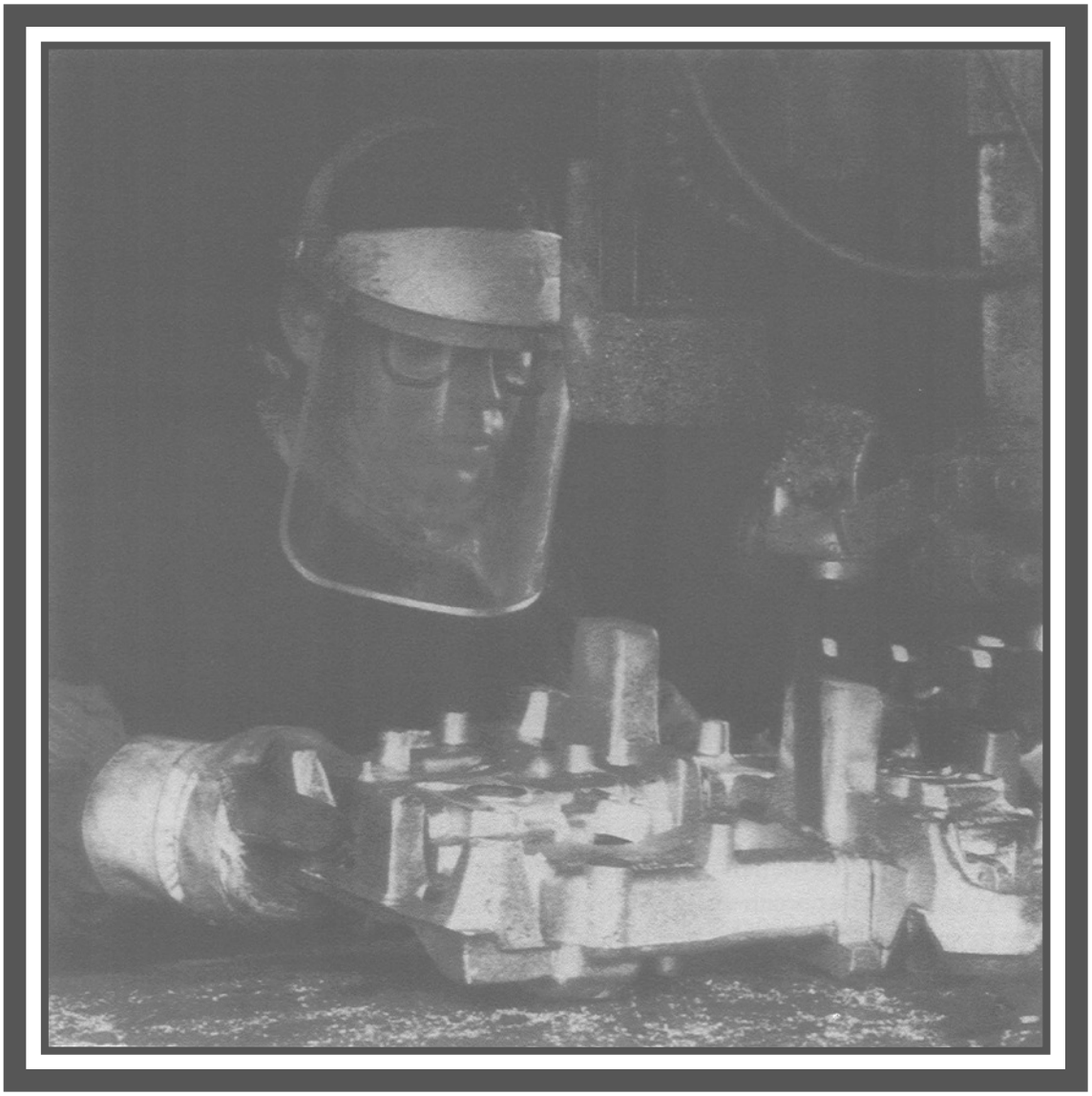
Guidelines for Handling Aluminum Fines Generated During Various Aluminum Fabricating Operations

The Aluminum Association



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SCOPE

This brochure discusses the potential problems involved in various aspects of aluminum fabricating which generate fine aluminum particles. It also discusses methods of particle collection and handling designed to reduce the risk of fire or explosion. The information is similar, in general, to that presented in National Fire Protection Association Standard No. 484 "Standard for Combustible Metals." However, it is not written to displace any aspect of the Standard, but rather to support and perhaps supplement it. In addition, it is not meant to cover aluminum powder and paste products. These are discussed in The Aluminum Association brochure No. TR-2 "Recommendations for Storage and Handling of Aluminum Powders and Paste."

INTRODUCTION

Fines and how they are generated

During fabricating operations, aluminum fines may be generated by such activities as grinding, sawing, cutting, sanding or scratch brushing and at least some of them will be fine enough to be potentially explosible. The term "dust" or "powder" is frequently used to describe such particles. It is difficult to be specific about dimensions, but if all the particles are *larger* than 500 microns, an explosion will probably not be sustained. It is more likely, however, that a mixture of coarser and finer material will be generated, and if the material is 420 microns (40 mesh) or finer, then it has the potential for explosion.

Finer particles burn readily when their ignition point is reached, and tend to ignite the coarser particles as well. In the case of aluminum, an explosion can result if ignition occurs while the particles are suspended in air as a dust cloud, since the burning extends from one particle to another with extreme speed.

Examples of potential sources of ignition are open flames, welding equipment and cutting torches, matches and cigarettes, faulty electrical equipment and static electrical discharges. Such conditions must be avoided in areas where dust producing operations are carried out.

Measuring the hazard and how it may change

The degree of hazard involved in any given operation can be determined by laboratory explosibility testing conducted by qualified personnel. The tests to be performed are outlined in NFPA 484 "Standard for Combustible Metals". The results of the tests will determine the applicability of NFPA 484 to the facility. NFPA 484 applies to any facility that processes, handles or stores any metal that is in a form that is capable of combustion or explosion. If any changes are made in the process which generates the fines, fresh samples should always be tested for re-determination of the minimum explosive concentration and ignition energy. Changes in speed, alloy, lubricant or abrasive used may cause finer particles to develop and thus increase the potential hazard.

General criteria for an aluminum dust explosion

Several conditions must be met before a dust explosion can take place:

1. The dust has to be combustible.
2. It must be suspended in air.
3. It must be fine enough to propagate flame
4. The concentration of the suspended dust must be within the explosible range
5. An ignition source contacting the dust suspension must have enough energy to initiate flame propagation, that is, combustion of the particles.
6. Enough oxygen or other oxidizer must be available to support and sustain combustion of the dust suspension.

What must be done

Dust collection systems must be installed which will safely capture potentially explosive aluminum fines. They may be of the wet or dry type, and must be so arranged that enclosures or exhaust hoods will provide efficient pick up of the fines from the machine or other equipment from which they are generated. The fines must either fall or be projected into the hoods or enclosures in the direction of the air flow. Fines will then be transported through ducting to the collector itself by means of positive air flow created by an exhaust fan.

DUST COLLECTION AND DISPOSAL

Either dry-type or wet-type dust collectors may be used and the following recommendations apply to both.

The hoods, enclosures, duct work and collectors should be constructed of rustproof and non-sparking metal.

To ensure the ductwork is as short as possible, each dust producing machine area should have a separate pick up hood or enclosure connected to its own dust collector located outside the building. Dust collection systems handling aluminum or aluminum alloy dusts should be dedicated for that use only. If the collection system is to be used for the collection of dusts of other metals, the system should be disassembled and thoroughly cleaned prior to and after use for dusts of other metals.

Metallic dusts from grinding, sawing or cutting should be picked up by one collection system, while dusts from buffing and polishing should be picked up by a different system. This will prevent the mixing of explosive and flammable dusts.

To prevent a build up of static electrical charges, the entire system should be thoroughly grounded, including the machine generating the dust, the conveying ductwork and the collector. Detailed guidelines are given in National Fire Protection Association Standard No. 77, “Recommended Practice on Static Electricity.”

It is important that both the coarser and finer particles be moved efficiently to the dust collector and therefore a minimum velocity of 4500 f.p.m. should be maintained in the conveying ductwork.

The concentration of aluminum fines in the air in the ductwork should be safety below the lower explosive limit. This is reported by the former U.S. Bureau of Mines to be 0.040 oz. per cu. ft. (Report of Investigation RI-6516, Explosibility of Metal Powders).

The environmental aspects of plant disposal are beyond the scope of this brochure. However, aluminum fines may be recycled through companies that process aluminum scrap and/or aluminum dross. Contact The Aluminum Association for names and addresses of these firms.

Dry type dust collectors

Dry dust collectors should be located outside the building so that potential damage to equipment or injury to personnel is minimized.

Electrostatic collectors (precipitators) should not be used due to the high risk of static electrical charge build up. Special consideration should by given to the hazards associated with the use of fabric or filter media collectors (bag Houses). Installation of these devices should be in accordance with National Fire Protection Association Standard No. 484.

High collection efficiency cyclone collectors should be used.

Ducts should have a minimum number of bends so that free airflow can be maintained at all times. They should be of rustproof and non-sparking metal with smooth interior surfaces and lap joints facing the direction of air flow. There should be no configurations of any kind which might allow accumulation of dust.

As outlined in National Fire Protection Association Standard No. 68, "Guide for Venting of Deflagrations," collectors should have explosion vents installed to release an explosion pressure wave. They should be positioned so that a blast will not be directed toward personnel or other buildings which may bum or be structurally damaged.

There should be at least regular daily removal of the dust from the collectors, and more often if required by the amount accumulated. It should be handled very carefully to prevent dust clouds from forming, and be discharged into metal containers which can be tightly covered immediately.

Before making repairs, the entire system should be emptied and cleaned by trained, authorized employees, and the ducting capped off.

Wet type dust collectors

A roto-clone type collector should be considered.

It should be a high efficiency type (dust collection efficiency of at least 99.5%).

It is important that the air stream containing the dust be thoroughly scrubbed by the wet collector liquid so that the particles are trapped efficiently. Otherwise damp, fine particles may agglomerate and form a sludge on the interior of the exhaust vent.

If an exhaust vent is used, it should be straight and of minimum length. It should be able to withstand an internal explosion pressure of at least 100 psi, as recommended in NFPA Standard No. 484.

The exhaust vent should have regular inspections and be cleaned frequently enough to prevent the buildup of a combustible cake of metal dust on its inner wall.

Tests should be conducted to determine whether the collector's efficiency is high enough to prevent a buildup of metal dust sludge on the inner wall of the exhaust duct. If it is, then the cleaned exhaust air may be able to be returned to the work area. Check local and state regulations about permission to do so.

Parts moving at high speed should not be allowed to contact dust particles. The exhaust fan pulling the air stream and dust into the collector should be located on the collector's clean air side.

The scrubber exhaust fan should run three to four minutes before the process begins, so that there will be positive ventilation in the collector area and any hydrogen present will be purged.

Interlocks should prevent the process from beginning to operate unless the exhaust is functioning and there is enough water in the scrubber. If already operating, the process should shut down if the water pressure should fail.

The scrubber exhaust fan should operate for at least two hours after the process has stopped.

The sump should be automatically ventilated when the collector is shut down so that any hydrogen produced by

an aluminum-water reaction will be exhausted. Another blower may be used, or an unimpeded gravity vent, which should be designed to open automatically when the dust collector is not operating.

Sludge should be removed from the wet collector at least once each day.

FIRE PREVENTION AND FIRE PROTECTION

Sources of Ignition

These may include, but are not limited to, cutting torches, welding activity, gas fired heating equipment, malfunctioning equipment, cigarettes and matches, glowing electrical elements and static electrical discharges. NFPA 484_requires that where aluminum dust is generated, all electrical equipment and wiring should be in accordance with the "National Electrical Code," NFPA 70.

All equipment used in the dust generating process must be thoroughly grounded to remove static electricity. "Recommended Practice on Static Electricity," NFPA 77, should be followed.

Inspection and cleaning of all electrical equipment must be done regularly and frequently (at least weekly). Ground connections should be checked visually on a daily basis by the operators.

Should sparks develop in any part of the operation, all equipment must be shut down immediately to determine the source and take corrective action.

All flammable solvents should be handled in accordance with NFPA 30, "Flammable and Combustible Liquids Code."

If maintenance is planned and welding or cutting is required, all machinery, ductwork and collectors must be shut down, emptied and cleaned, and all aluminum dust removed from the area and properly disposed of. The interior surfaces of all equipment must be carefully inspected to check for possible accumulations of fine powder, particularly at elbows, welded joints, etc. These surfaces must be wiped clean.

Employees must be trained to understand the possible hazards involved and to react to an incident intelligently.

All activities involving sparks or open flames must be constantly supervised and welding or burning permits should be issued.

All of these recommendations also apply when gun-type power operated tools are to be used. In addition, when the work has been completed, no cartridges or charges should be left in the area, since they might discharge when the equipment begins operations again.

Housekeeping

Good housekeeping must be carefully carried out in the entire operating area at all times. Dust accumulations must not be allowed to build up on floors, piping, ductwork, conduit, exposed building structural members or walls. Ductwork interiors must be checked often and cleaned as required. Excessive accumulations of combustible dusts have been found to be a major contributing factor to secondary explosions.

Cleaning tools must be a soft natural fiber brush or squeegee with non-sparking, conductive scoops used to pick up the collected material. Synthetic fiber bristle brushes and plastic or other nonconductive scoops must not be used, since they tend to accumulate strong static charges.

Standard commercial industrial vacuum cleaners must not be used during cleaning. Vacuum cleaning systems, designed and certified for use with Group E combustible dusts may be used, with limitations (see NFPA 484).

Controlling an aluminum powder fire

When aluminum fines are involved in a fire, only Class D extinguishing agents should be used. The dry powder discharged from some portable extinguishers does so under some pressure and could create an aluminum dust cloud. Therefore, it is important to try to direct the stream of powder above the fire and allow the powder to settle by gravity onto the burning material.

In addition, fine dry sand, preferably finer than 20 mesh, and other approved dry powders, are effective materials for isolating an aluminum fines fire. A plentiful supply should be easily available in the operating area and stored in covered bins or drums. Long handled shovels should be available at each bin or drum, and should be constructed of non-sparking metal. The shovels can be used to safely lay the sand or powder around the edge or perimeter of the fire.

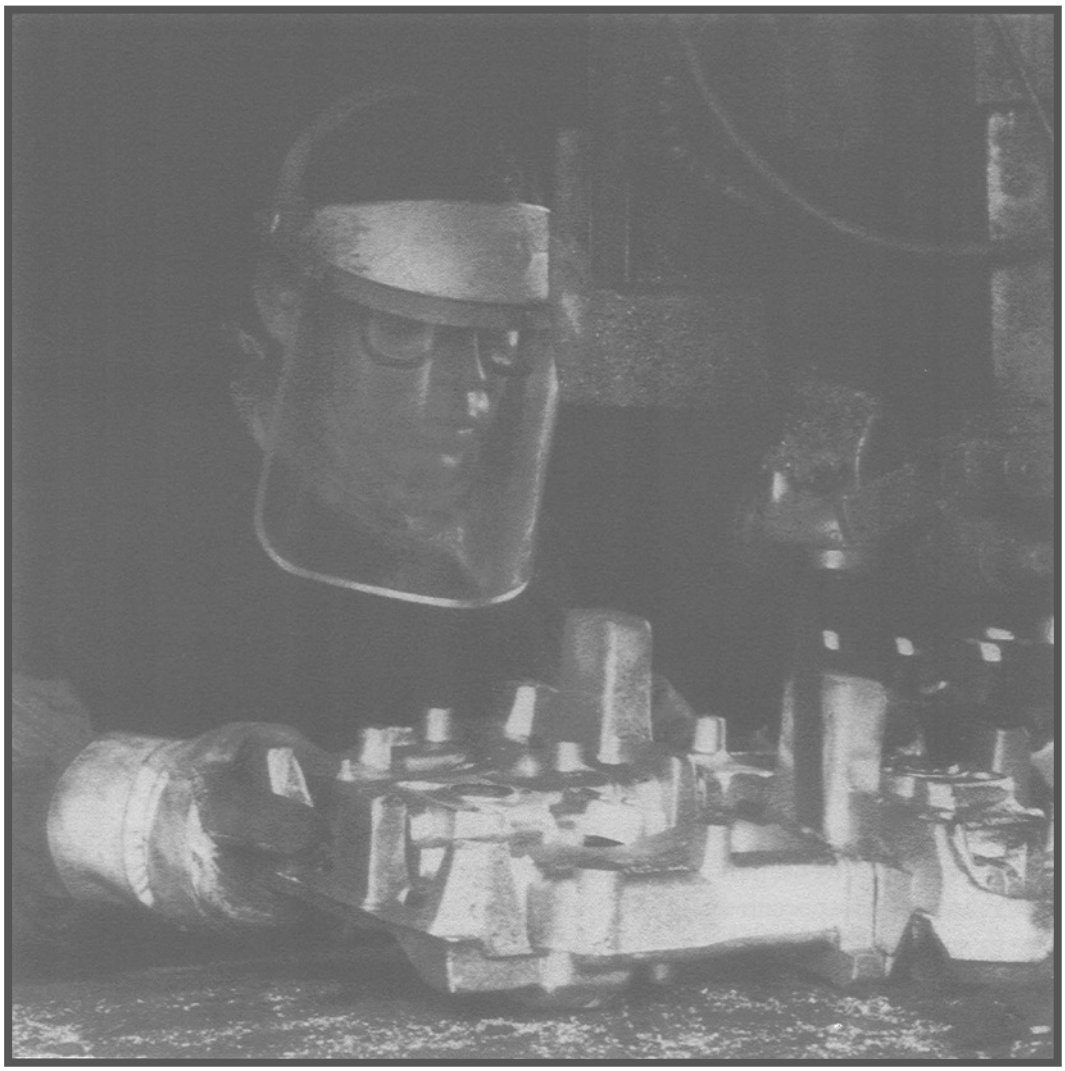
Aluminum fines can form explosible or combustible mixtures with various chlorinated or brominated hydrocarbons such as carbon tetrachloride, methyl chloride, and mixtures of carbon tetrachloride and chloroform. Therefore, halogenated extinguishing agents such as Halon should not be used in aluminum powder fires.

A water stream should not be used, since its impact on the fire may cause the formation of an explosible aluminum dust cloud. In addition, water will react with the aluminum fines to form flammable hydrogen gas.

Qualified supervisory personnel should decide in advance whether it is better to attempt to fight the fire or to withdraw to a safe location and allow it to bum itself out.

Professional or volunteer fire fighters from outside the plant cannot be expected to be trained for the specific fire and life safety hazards associated with combustible dust fires. In the interest of their own safety, fire fighters should be directed by the plant's safety or fire fighting officer.

REFERENCES

1. **M. Jacobson, Austin R. Cooper, John Nagy, Explosibility of Metal Powders, in U.S. Bureau of Mines Report of Investigation No. 6516**
2. **National Fire Protection Association, No. 68, Guide for Venting of Deflagrations**
3. **National Fire Protection Association, No. 70, National Electrical Code**
4. **National Fire Protection Association, No. 77, Recommended Practice on Static Electricity**
5. **National Fire Protection Association, No. 484, Standard for Combustible Metals**

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