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COMBUSTABLE DUST STANDARD

SPECIFICATION NO. XXX.XXX

Revision 0

July 11, 2024

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**Introduction -** ALINVEST is committed to controlling the hazards associated with combustible dust in our operating plants. We are currently focusing our efforts on testing to identify combustible dust hazards, cleaning operations to limit risk, and ultimately engineering solutions to mitigate the risks associated with this hazard.

This standard is a collaborative document that included participants from HSE, Loss Prevention, Engineering, as well as third party experts from numerous sectors. It is a living document that will be updated periodically as additional information becomes available See [Attachment 9](#Attachment9) – “Revision Request form”.

We encourage all of our managers and employees to strive to understand the risks and concerns associated with combustible dust as we work toward our vision of: "No Risk of a Secondary Explosion”

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1. **Purpose** [**(Back to TOC)**](#TOC)This standard summarizes the minimum requirements, as well as best practices, related to managing combustible dust hazards at facilities worldwide.

This document provides the necessary information to enable ALINVEST employees worldwide to recognize combustible dust hazards and the potential for dust fires and explosions. The standard identifies appropriate preventive and protective measures as well as actions necessary to manage the risks associated with combustible dust.

1. **Application of Standard** [**(Back to TOC)**](#TOC)
   1. This standard applies to all ALINVEST operations worldwide as well as joint ownerships.
   2. This standard is applicable to all operations with combustible dusts. These operations include but are not limited to those described in section 4.1.
   3. This standard applies to the design and installation of all new equipment. Upgrades to existing equipment shall be prioritized based upon documented process hazard analysis (PHA), see section 9, at each facility.
   4. This standard applies to ALINVEST employees, contract employees and outside contractors involved in cleaning combustible dust deposits, regardless of which party is performing the cleaning operation.
   5. This standard applies to all metal dusts as each are considered to be combustible and potentially explosible. The words “combustible” and “explosible” are often used interchangeably. The differentiation between the two centers around suspension and confinement of the dust. Therefore, all requirements of this Standard must be met; unless a specific dust is proven to be non-combustible by means of recognized testing procedures. This standard only uses the term “combustible” to characterize combustible and explosible dusts.
   6. This standard details the fire and explosion prevention measures that shall be provided to prevent explosions and fires related to combustible dust. Where statutory regulations conflict with this Standard, the stricter of the two requirements shall apply. Where the requirements of this Standard exceeds, but does not conflict with local statutory regulations, the installation or operation shall meet both sets of requirements.
   7. For most combustible dusts, a deposit less than 1 mm deep evenly distributed over the whole floor area is sufficient, if raised into suspension, to fill completely a room of normal height with an explosive dust/air mixture
   8. Applicable reference standards are provided at the end of this document, see section 12.0.
2. **General Information** [**(Back to TOC)**](#TOC)
   1. During aluminum fabricating operations, aluminum fines and combustible dust may be generated during shredding, scalping, grinding, sawing, cutting, sanding, scratch brushing, melting, dross handling, furnace operation, conveying, etc. activities. Some of the dusts generated by these activities may be fine enough to be potentially combustible.
   2. Aluminum and other metals (e.g. copper, chromium and manganese), as well as plastics, coal and cellulose materials, when sufficiently granulated, may be combustible.



**CD  
Explosion**

**CD  
Flash Fire**

**CD  
Fire**

- **Fires** are typically high frequency / low severity events with limited exposure to employees

- **Flash fires** are medium frequency / medium severity events with significant exposure to employees in the immediate area of the flash fire.

- **Explosions** are low frequency / high severity events with significant exposure to employees in the general area.

* 1. **Fires -** Combustible dust and fines represent a general fire risk at our facilities that needs to be addressed. For combustible dust / fines to ignite, we only need fuel (Combustible dust / fines), oxygen (always available) and heat (Exposure fire, hot work, hot surface, etc.). Hot surface ignition point testing (MIT – ASTM 2021, see 6.5.1.4) can be used to determine the minimum temperature at which a layer of material will ignite from a heated surface. The finer the material and the thicker the layer, the less energy is needed to ignite this material. These are typically high probability / low severity events but if not quickly addressed can result in a high severity events.
  2. **Deflagration (Flash Fire)** poses a significant hazard. When combustible dust is dispersed in air or distributed along a surface, with or without confinement, a flash fire can occur in the presence of an ignition source. The resulting fire can burn personnel and damage equipment.
  3. **Dust Explosion -** Under certain conditions, these same dusts can result in an explosion, with extremely violent and destructive results. While a layer of combustible dust on a horizontal surface can readily burn or cause a flash fire, the following critical parameters must be met for a dust explosion to occur:   
     1. **Particle Size:** “Dust” has different definitions in terms of particle size from one scientific body to another. For purposes of this Standard, “dust” refers to any material smaller than 420 microns. The smaller the particle size and the higher the surface area to mass ratio, the greater the risk of ignition and the more violent the explosion. Agglomerates of combustible materials that have lengths that are large compared to their diameter (and will not usually pass through a 420 μm sieve) can still pose a deflagration hazard. Therefore, any particle that has a surface area to volume ratio greater than that of a 420 μm diameter sphere shall also be considered a combustible dust. Dust particles smaller than 75 microns present the most serious hazard.
     2. **Dust Concentration:** The dust must be suspended in air at the point of ignition for an explosion to occur. The dust to air ratio must be above the Minimum Explosible Concentration (MEC).
     3. **Oxygen Level:** The oxygen level must be greater than the limiting oxygen concentration (LOC) for explosions involving combustible dust to occur. For example, the LOC of aluminum is 2% with carbon dioxide and 5% with nitrogen. Usually, there is no oxygen control during aluminum fabricating operations. Therefore, the LOC is readily exceeded in most aluminum fabrication and recycling operations.
     4. **Ignition Source:** The ignition source must have sufficient energy and temperature to initiate combustion. Combustible dusts have relatively low Minimum Ignition Energy (MIE) levels, often between 10 and 100 milli-joules, although this varies with the particle size and concentration. Potential sources of ignition are hot surfaces; flames and hot gases; mechanically generated sparks; electrical apparatus; stray electrical currents, cathodic corrosion protection; static electricity; lightning; electromagnetic fields in the frequency range from 9 kHz to 300 GHz; electromagnetic radiation in the frequency range from 300 GHz to 3 x 106 GHz or wavelength range from 1000μm to 0.1 μm (optical spectrum); ionizing radiation; ultrasonics; adiabatic compression, shock waves, gas flows Electrostatic discharge energy is typically 20 mJ. The MIE of almost any ignition source can initiate an explosion, provided all other critical parameters are met.
     5. **Confinement:** Confinement keeps dust particles in proximity after suspension – allowing sufficiently rapid heat transfer to continue propagation. Without confinement, a propagating explosion is not possible, though a large and very dangerous fireball may occur. Removing either the suspension or the confinement elements prevents an explosion, although a fire may still occur, because the elements of the fire triangle (fuel, oxygen and ignition) exist.
  4. ****Fuel, ignition, oxygen, suspension, and confinement form the five sides of the dust explosion pentagon (see Figure 1). As with all other fires, a dust fire occurs when fuel (the combustible dust) is exposed to heat (an ignition source) in the presence of oxygen (air). Removing any one of these elements of the fire triangle eliminates the possibility of a fire. A dust explosion requires the simultaneous presence of two additional elements: dust dispersion and confinement. Suspended dust burns more rapidly, and confinement allows for pressure buildup.

**Figure 1**

* + 1. Dust explosions typically involve two events:  
       1. **Primary Event -** A small, primary explosion, initiates the process. The resultant pressure wave then dislodges and suspends a much larger amount of material, which may have accumulated on nearby horizontal surfaces.
       2. **Secondary Event -** The resulting dust cloud from the primary event is then ignited by either the original ignition source or the established burning of the primary event. This secondary explosion is often catastrophic due to the much larger volume of dust (fuel) involved.

1. **Combustible Dust Training** [**(Back to TOC)**](#TOC)
   1. If a combustible dust hazard is present at an ALINVEST plant all workers shall be provided with general hazard training on combustible dust on initial employment, new assignment at the facility, when equipment is introduced for the first time or changed, when new technology is introduced and refreshed annually.
   2. If a combustible dust hazard is present at an ALINVEST facility, all visitors shall be provided general hazard training on combustible dust prior to entering the plant site.
   3. All workers (ALINVEST employees and contract employees) working at an ALINVEST plant within a known combustible dust hazard area shall be provided with combustible dust hazard training related to safety, specific hazards, housekeeping and operational issues in the work area on initial employment, after new assignment at the facility, when work equipment is introduced for the first time, when new technology is introduced and refreshed annually.
   4. Training shall be given by a competent person. Records shall be kept including the date, time, who attended and scope of the training.  
      1. All personnel, ALINVEST employees and/or contract personnel, involved in cleaning combustible dust must be knowledgeable of, and experienced in, the hazards associated with combustible dust including precautions necessary to prevent dust explosions.   
         1. Vacuum truck owners must assure that operators and other assigned personnel are trained and qualified for their assigned duties. Owners must provide documentation of training (date, time, scope of training, and attendance) specific to individuals performing tasks at ALINVEST plants.
      2. In addition to the general HSE requirements of the plant, all personnel involved in clean-up or work in areas with combustible dust shall receive training in the following areas:
2. Physical properties and hazards of combustible dust
3. Identification and removal of potential ignition sources
4. Clean-up methods and procedures to be used
5. Clean-up equipment to be used
6. Personal protective equipment to be used
   1. Specific training for electricians performing ground / bond continuity verification. **Each plant shall train emergency response personnel in the safe methods for fighting fires that involve or potentially could involve combustible dust. See section 8.5 and** [**Attachment 4**](#Attachment4)**.**
7. **Dust Sample Collecting and Testing** [**(Back to TOC)**](#TOC)
   1. If dust is present at an ALINVEST facility, sampling and testing shall be performed to determine if a combustible dust hazard exists.
   2. Testing shall be performed by a laboratory accredited using the internationally accepted criteria for competence identified in ISO/IEC 17025:2005, “General Requirements for the Competence of Testing and Calibration Laboratories” (as updated). The Corporate Manager, Property Conservation, shall pre-approve all test labs used to determine if a dust is combustible.
   3. **Sample Collection**
      1. Collection of samples shall represent a “worst case” scenario.
      2. Each site shall develop a sampling strategy and protocol to ensure that samples are collected in all areas where combustible dust is present. The following shall be considered in developing the sampling strategy:

1. Samples shall be taken from all processes that produce dust, e.g. UBC processing; remelt and casting; hot mill scalping; scalper chip handling and processing; alloying molten metal; aluminum sheet/foil scrap chopping, shredding and handling; ingot sawing; etc.

1. Samples shall be taken from horizontal surfaces on and around the process identified.
2. Samples shall be taken from various heights on the equipment and in the building. Note: lighter, small particle size dust tends to collect higher in the structure.
3. Samples shall be taken from recessed or hidden areas where dusts may have collected,
4. Samples shall be taken from worst case process situations when possible. For example, higher magnesium content has been shown to have higher energy potential.
5. The sampling strategy shall also include taking samples from inside bins, hoppers, baghouses, cyclones, ductwork, etc. used to store, collect and convey materials.   
   * 1. Samples shall be taken and promptly submitted to the testing lab as dust tends to oxidize over time.
   1. **Combustible Dust Testing**
      1. An initial explosion screening test shall be performed to determine if the dust is combustible. The dust is considered to be combustible if the initial test indicates such.
      2. Semi-annual testing over a period of two years shall be performed to validate that a specific dust is non-combustible. Retesting can be stopped if three consecutive tests indicate that a specific dust is not combustible.
      3. Re-sampling and retesting shall be conducted anytime a previously tested production process has changed including changes in raw materials. Plants shall incorporate combustible dust considerations as part of the plant specific Management of Change (MOC) process to trigger the need for re-sampling and retesting dust.
      4. The explosibility classification screening test shall serve as the basis to determine if a fugitive dust, metal powder, metal dust, or alloys of these materials, is capable of initiating or sustaining an explosion when suspended as a dust cloud. See section 6.5.1.1
      5. Metal dusts, regardless of the alloy, generated from the following processes shall be deemed to be generically combustible, unless testing as described in section 6.5.1determines otherwise:
6. Hot mill ingot scalping;

1. Metal powders used in alloying molten metal;
2. Aluminum sheet and foil scrap chopping, slitting, shredding or balling.
3. Aluminum ingot sheet and billet sawing;
4. Aluminum scrap processing, including UBCs.
5. Other Aluminum machining/finishing operations.
   * 1. Dust mixtures regardless of composition, shall be tested to determine their explosibility, See section 6.5.1.
     2. Results of all tests shall be input directly to the “Combustible Dust - Test Results Listing” on the Insurance and Risk Management web portal by each plant within 30 days of report receipt.

* 1. **Testing Methods**
     1. The tests listed below are performed to determine if a dust is combustible and to obtain parameters for equipment design changes related to mitigation activities. The explosion screening test is required, at a minimum.   
        1. **Go / No-Go Testing** - An initial explosion screening test shall be performed to determine if the dust is combustible (Modified Hartmann Tube Apparatus). The dust is considered to be combustible if the initial test indicates such. If the dust sample is found to be non-combustible during the initial screening, more thorough testing methods shall be applied (ASTM E1226 – 20 liter sphere test) to validate that the dust is non-combustible.
        2. **Explosion Severity Test -** The explosion severity test is conducted to determine the explosion severity of a dust cloud under specified conditions. It is the single most important factor in evaluating the hazard of a dust, and principally determines the destructiveness of a deflagration. This test serves to identify the maximum explosion pressure (Pmax), maximum speed of the explosion ((dP/dt)max) and explosion index (Kst). These values are needed to determine the design of explosion control measures (deflagration vents, explosion suppression systems, etc.). This explosion severity test is performed in accordance with ASTM E 1226, BS 6713-3, ISO 6184-1or VDI 3673.
        3. **Minimum Explosible Concentration (MEC)** - The MEC test determines the smallest concentration of material in the air that can give rise to flame propagation upon ignition when in the form of a dust cloud. MEC is used to help establish the maximum concentration allowed in process dusts and the maximum allowed layer thickness. The MEC test shall be performed in accordance with ASTM E1515, ISO 618411, BS 6713-1, or other equivalent recognized standards.
        4. **Minimum Ignition Temperature Test (MIT)**. The MIT is used to determine if a hot surface, such as a furnace or duct, can ignite the dust layer. The MIT test shall be in accordance with ASTM E2021 (for dust layer), ASTM E 1491 (for dust cloud), ROI5624, or IEC1241-2-1.   
             
           Note: MIT of a dust layer is usually lower than the MIT of a dust cloud therefore ASTM E 2021 is the preferred test. Standard tests assume a layer thickness of 5-7mm.
        5. **Conductivity Testing (Volume Resistivity and Charge Relaxation Time Tests) –** Plants are only required to perform the conductivity portion of this test protocol. ASTM D 257 or equivalent regional standard shall be used.
  2. **Shipping requirements**
     1. All dust samples shall be packaged (Double bagged in sturdy container) and shipped with applicable MSDS
     2. Shipping shall follow all local and regional legal and other applicable requirements.

1. **Combustible Dust Cleaning** [**(Back to TOC)**](#TOC)
   1. The requirements in this section shall be incorporated into plant specific housekeeping programs for areas that have combustible dust risks.
   2. The frequency and scope of combustible dusts clean-up shall be such as to minimize the accumulation and associated risk of explosions, flash fires, and surface fires. An accumulation in excess of 0.8 mm (1/32 inch) thickness is considered a high dust explosion risk. If underlying surface color is not visible, the dust layer is assumed to exceed 0.8 mm (1/32 inch), corrective actions shall be taken and dust cleaning shall be initiated.
   3. Generation Rate Testing  
      1. Combustible dust generation rate testing shall be performed to determine the frequency of cleaning operation. A building explosion hazard is present if any one of the following conditions exist:
2. The fugitive combustible dust escapes and accumulation is greater than 0.8 mm (1/32 inch).
3. The dust layer exceeds 5% of the floor area or exceeds 1,000 square feet.
4. The cleaning frequency is insufficient to keep dust accumulations from exceeding 0.8 mm (1/32 inch).   
   * 1. A fire hazard would be present in an area where the underlying surface temperature exceeds the MIT of a dust layer. See section 6.5.1.4
     2. For the purposes of the Process Hazard Analysis (PHA), see section 9.1 and work prioritization, dust accumulation rate shall be determined for all combustible dust producing processes as follows:
5. A container, such as an aluminum pie pan, shall be left over time to collect dust.
6. The container shall be weighed empty, and re-weighed after sampling period to determine accumulation rate.
7. Cleaning frequency plans shall be based on generation rates for each combustible dust hazard area.
8. Generation rate shall be determined at enough locations to identify the highest accumulation locations. This data shall be used to establish priority of engineering controls and other improvements.
9. Generation rate testing shall be used to validate equipment or process changes to determine new cleaning frequency and future improvement needs.



Example - Generation Rating Testing Station at Recycle

* 1. **Personal Protective Equipment (PPE)**
     1. **Clothing**
        1. PPE/clothing (shirts, long pants and gloves made of flame-retardant material) worn shall be intended for use in environments known to contain combustible dusts Clothing shall be fire resistant (FR) - NFPA 2112 – “Flame-Resistant Garments for Protection of Industrial Personnel against Flash Fire”, or equivalent standard. The current approved ALINVEST molten metal, molten metal electrical, and electrical duty uniforms meet this requirement Additionally, due to the inherent properties of cotton and the weight of the fabric, the ALINVEST General Duty 100% cotton uniforms provides protection against electrostatic generation/discharge and are considered FR clothing suitable for cleaning of combustible dusts.

* + - 1. Non-Flame Retardant disposable coveralls (e.g., Tyvek or similar synthetic fiber coveralls) and other non-flame retardant disposable garments shall not be worn by personnel engaged in cleaning of combustible dust.
    1. **Other PPE**
       1. Individuals shall use respiratory, hearing, eye, foot and head protection as required by the applicable ALINVEST HSE Directives for the area in the plant in which the cleanup is being performed.
       2. Particulate masks if used shall be made of flame resistant materials or rated as flame retardant. Example:  
            
          **Example - 3M - 8515 N95 Particulate Disposable Respirator** - The 8515 provides comfortable respiratory protection from particles. The fiber media and protective layers of this respirator are **flame resistant per ASTM D2859**.
       3. For PPE related to fighting fires involving or potentially involving combustible dust, see section 8.5
  1. **Combustible Dust Cleaning Methods**
     1. Applicable fall protection, confined space entry and hazardous energy control procedures as required by ALINVEST HSE Directives shall be in place prior to start of cleaning operations. Several concerns that may need to be addressed are:
        1. Control of ignition sources
        2. Location of ventilation supply fans
        3. Likely hood of ventilation air to disturb a combustible dust in the confined space
        4. Wetting of Aluminum dust (Generation of hydrogen in the confined space).
        5. Likely hood of fall protection equipment rope disturbing a combustible dust.
     2. **Hand Clean-up**
        1. Hand cleaning of dust is the preferred method of cleaning. In general, daily hand cleaning activities are not likely to generate a dust cloud that would result in an explosive atmosphere.
        2. To prevent ignition sources (sparks or static) while hand cleaning, personnel shall use conductive, non-sparking scoops and receptacles for holding the material. Brooms or brushes with natural fiber bristles shall be used.
        3. Hand cleaning shall be stopped immediately if an opaque cloud of dust is generated. Hand cleaning or other cleaning may resume when the dust cloud has dissipated.
        4. Compressed air or blowers shall not be used to blow-down or dislodge combustible dusts during cleaning without special precaution being taken. If compressed air is used the pressure shall be 103 kPa (15 PSI) or less and only after other cleaning methods have been used to eliminate the majority of the dust buildup. If a dust cloud can be formed, all ignition sources within 16 M (50 Ft) of the operation must be removed.
        5. Best Practice is to provide signs at all compressed air connections installed in a Combustible Dust area, that reads as follows:

“Use of Compressed Air to Clean Combustible Dust

is Strictly Forbidden as it Could Result

in an Easily Ignitable Dust Cloud”

* + - 1. High velocity oscillating fans can be used to prevent the accumulation of combustible dust on the structure or equipment if continuously used and dust cloud hazard is not created.   
           
         Note: For areas where existing accumulations exceed 0.8 mm (1/32 inch), including periods of extended fan shutdown, cleaning shall be performed prior to fan start-up.
      2. High pressure water hoses shall not be used to blow-down or dislodge combustible dusts during cleaning.
    1. **Vacuum Clean-up**
       1. Vacuum cleaning can be a safe alternative to hand cleaning if the vacuum cleaning equipment utilized is specifically designed for use with combustibledust. The equipment must also be maintained and operated according to the manufacturer’s instructions to be used for cleaning combustible dust. See section 7.6.2 and 7.6.3
       2. Vacuum cleaning equipment that is not specifically designed for clean-up of combustible dust shall not be used. Only vacuum cleaners containing no ignition sources shall be used.
       3. When using a portable vacuum to clean manganese dust the collection hopper shall be emptied after each use. Vacuum trucks shall not be used to vacuum manganese dust. Any volume of manganese dust greater than 1” thick, over a square foot area, shall require hand cleaning.
    2. **Cleanup Procedures**
       1. **ALINVEST Responsible Person (OCRP) -** AN ALINVEST employee shall be designated as the “ALINVEST Responsible Person” (OCRP) for all cleaning operations related to combustible dust. The OCRP shall be responsible for ensuring all requirements of this standard and applicable ALINVEST HSE Directives are met for the duration of the clean-up operations. The OCRP shall be the only ALINVEST employee allowed to issue and approve combustible dust clean-up work permits.
       2. **Permit to Work**
          1. Clean-up of combustible dusts shall be regulated by a permit to work system in accordance with ALINVEST HSE Directives for General Work Permits. A permit shall be required for all clean-up work performed by contractors. For the recommended permit see [Attachment 1](#Attachment1) and [Attachment 2](#Attachment2). Modifications to align the permit with the scope of cleaning activity are allowed, and must be approved by ALINVEST’ Corporate Manager, Property Conservation.
          2. A combustible dust clean-up permit shall be updated or reissued when any member of the crew performing the clean-up changes, any condition changes (example: grounding change), or at a minimum every twenty-four (24) hours.
          3. A permit is **not** required for daily hand cleaning / housekeeping activities on the shop floor which may involve combustible dust that does not create a risk for a dust cloud. In all cases where mechanical cleanup (vacuuming) is performed, a permit is required.
       3. **Preparation - Hazard Identification and Communication**
          1. The OCRP shall determine if the dust to be cleaned is combustible in accordance with the requirements of section 6.4 and 6.5.
          2. If the dust is determined to be combustible, the OCRP shall implement the clean-up procedures required in this Standard.
          3. The OCRP shall communicate to all persons involved in the clean-up, the hazards of the dust to be cleaned up and the precautions to be taken.

* + - 1. **Cleanup Procedures**
         1. The OCRP shall evaluate the cleaning task(s) to be performed and select the appropriate method: hand cleaning or vacuum cleaning.
         2. The OCRP shall ensure that the work area has been inspected and that a Work Permit (see [Attachment 1](#Attachment1) and Attachment 2) is issued.
         3. The OCRP shall ensure that all needed equipment for either hand cleaning and/or vacuum cleaning is:

1. at the work area prior to the start of cleaning,
2. equipment meets the requirements in this Standard
3. that no unauthorized equipment is present.   
   * + - 1. Prior to vacuuming with either portable vacuum units or vacuum trucks, all equipment shall be checked to ensure it is in good working order and consistent with this standard.
         2. Portable vacuum units and vacuum trucks shall be bonded from the suction point to the vacuum equipment collection hopper and then grounded to the building’s grounding system using the grounding cable required in section 7.6.2.7 (i) and 7.6.3.1 (iii), whenever the unit or truck is in use.
         3. The grounding cable shall be securely attached at each end to prevent it from coming loose during vacuuming operations.
         4. The effectiveness of the grounding of portable vacuum units and vacuum trucks, and the electrical continuity of the vacuum hoses and resistance readings shall be verified and documented by an ALINVEST Electrician prior to starting work. The continuity to ground must be rechecked by the ALINVEST Electrician each and every time the vacuum equipment is relocated and / or a new ground attachment is made.
         5. Vacuum trucks shall be placed at a safe distance from the actual cleaning work so as to not be an ignition source.
         6. Care must be taken to assure that the materials being cleaned are compatible with residual materials in the vacuum equipment. This is to avoid the potential for mixing of these materials and creating fire/explosion, heat, toxic gases/vapors, etc. hazards. Vacuum equipment shall be inspected for residual materials and cleaned if necessary to eliminate the hazards of unsafe mixing of materials prior to use.
         7. The OCRP shall periodically check the cleanup operations to ensure on-going compliance with the requirements of this Standard.
         8. Disposal of dust must be in accordance with regional, state and local environmental regulations and ALINVEST HSE requirements. Hydrogen gas can be generated when aluminum dust gets wet. Aluminum shall be kept dry to ensure explosive concentrations of hydrogen are not generated. If aluminum dust gets damp or wet during cleanup or during the use of wet scrubbers and vacuums, precautions shall be taken to prevent hydrogen gas buildup.
       1. **Control of Ignition Sources** 
          1. All equipment creating sparks or using open flames in the proximity of cleaning 16 m (50 ft.) radius shall be identified on the permit to address the risk of fire or spark from coming into contact with the cleaning operation. Shut down or isolation of spark, flame or other known ignition sources shall be accomplished prior to the start of work when a dust cloud is likely to be created as a result of the cleaning operation. If it is impractical to remove all ignition sources such as a continuous operating furnace, additional precautions shall be taken to ensure a dust cloud is not created.
          2. Mobile equipment shall be restricted in the vicinity 16 m (50 ft.) radius of combustible dust cleaning operations when a dust cloud may be present.
          3. Mobile floor sweepers (dry) shall not be used to clean-up combustibledust unless they are specifically rated for combustible dust.   
               
             Note: This is due to the potential of generating a dust cloud in a confined space within the sweeper or in the general area in the presence of unknown ignition sources. These units can also generate static charges if non-natural bristle brushes are used.
          4. Mobil floor scrubbers (wet) shall not be used for sweeping combustible dusts from floors unless the unit is rated for combustible dust, or the hazard of flammable gas build-up is addressed.
          5. Smoking shall be permitted only in designated areas. See the plant’s smoking policy.
   1. **Combustible Dust Cleaning Tools & Equipment**
      1. **Vacuum Cleanup Equipment General Requirements**
         1. Only portable vacuum cleaners and vacuum trucks specifically designed for use with combustible dust may be used.
         2. Vacuum cleaning equipment must be maintained and operated in accordance with the manufacturer’s instructions and this standard.
      2. **Portable Vacuums**
         1. Portable vacuums shall be certified for use with the type of combustible dust to be vacuumed. The certification shall be by a recognized testing laboratory. Only those units rated for conductive combustible dust and those units rated for non-conductive dust or equal, shall be used (similar to DX and EX rating requirement for industrial trucks)
         2. In addition, vacuum cleaners used for cleaning of combustible dust in the United States shall meet the following standards:
4. Portable vacuum equipment for use with conductive combustible dusts shall be certified for use in Class II, Group E in accordance with the National Electric Code – NFPA 70.
5. Portable vacuum equipment for use carbonaceous dust shall be certified for use in Class II, Group F in accordance with the National Electric Code – NFPA 70. Coal, carbon black, charcoal and coke dusts are examples of carbonaceous dusts.
6. Portable vacuum equipment for use with non-conductive combustible dust shall be certified for use in Class II, Group G in accordance with the National Electric Code – NFPA 70.   
   * + 1. Vacuum cleaners used for cleaning of combustible dust in Canada shall meet the following Canadian Standards Association (CSA) standards:
7. Class 1618.01 Cleaning Machines - For Hazardous Locations.
8. Class 1618.81 Cleaning Machines - For Hazardous Locations (CERTIFIED TO U.S. STANDARDS Class II, Group E)  
   * + 1. Portable vacuum equipment for use in the European Community shall meet the requirements of ATEX 100a (Equipment Directive 1994/9/EC) and ATEX137 (Workplace Directive 1999/92/EC), and related European Standards for equipment design.
       2. Portable vacuums certified by testing laboratories outside Canada, the United States and the European Community shall meet comparable local standards for combustible, conductive Combustible dusts.
       3. In countries where there is no applicable local regulation or certification standard equivalent to those listed above, portable vacuum equipment meeting the requirements of sections 7.6.2.2, 7.6.2.3 or 7.6.2.4 shall be imported and used.
       4. Regardless of the country of origin, all portable vacuum cleaners for use with combustibledust shall contain the following features:
9. In addition to the grounding provided by power cables or compressed air supply hoses, a separate, permanently attached, grounding cable shall be provided on the portable vacuum unit.
10. All metal components of the vacuum unit against which vacuumed material may come in contact shall be stainless steel grade 304 or 316, aluminum or other non-ferrous, non-sparking, metal.
11. All individual components of the vacuum cleaner, including but not limited to the container, filters, hoses, nozzles and associated fittings, and the fully assembled vacuum cleaner unit shall be conductive and bonded for electrical continuity so as to prevent the buildup of static charges, The resistance shall be less than 10ohm in a continuous ground path.
12. Portable vacuum cleaners may be electric or pneumatic (air operated) and subject to the certification requirements in this Subsection.
13. Portable vacuum cleaners may be either the dry or wet type. Sites shall select the correct unit based on hazard(s) present.   
    * 1. **Vacuum Trucks**
         1. Large truck mounted vacuum cleaners have been used in industry for general cleaning. These units are generally not designed nor intended for use with combustible dust. As a result, there have been fires and/or explosions associated with vacuum trucks being used to clean-up combustible dust. There are no standards for certifying vacuum trucks for combustible dust. Vacuum trucks used to clean-up combustible dust shall have specific features that limit explosion risks:
14. The truck collection hopper, dump tube in the hopper and metal components of the cyclone shall be made entirely of stainless steel grade 304 or 316.
15. All individual components in the dust collection path of the vacuum truck and associated fittings of the fully assembled unit shall be conductive and bonded for electrical continuity so as to prevent the buildup of electrostatic charges. The resistance of the truck components shall be less than 10 ohms in a continuous path to ground.
16. The vacuum truck shall be equipped with a permanently attached grounding cable. See [Attachment 7](#Attachment7) for OHM measurement diagram.
17. The truck shall be equipped with a continuous ground monitoring system that shall stop the vacuuming operation immediately if the ground connection is interrupted. This function must be verified and documented before each use on the cleaning permit.
18. Hoses used for vacuuming, from the pick-up point to the collection hopper inlet, shall be designed to be “static conductive” or “static dissipative”, certified by the manufacturer and equipped with metallic conductor imbedded in the hose. Sections of hose shall be connected with non-ferrous metal couplings that are electrically conductive and bonded to the metallic conductor of the vacuum hose. The hose system shall be conductive from the pickup point to the collection hopper. The resistance shall be less than 100 ohms in a continuous path to ground.   
    * + 1. Vacuum truck owners / operators are responsible for complying with federal, state and local regulations regarding the construction, maintenance and operation of vacuum trucks.
      1. **Hand Cleaning Tools**   
         1. All tools (shovels, scoops, and receptacles) shall be constructed with conductive and non-sparking material (aluminum, stainless steel, etc.) when cleaning-up combustible dust.
         2. Brooms or brushes with natural fiber bristles shall be used.
         3. Tools not meeting the requirements of this section shall be removed from the work area.

1. **Operations** [**(Back to TOC)**](#TOC)
   1. **PPE and Hazard Assessments**
      1. Job hazard assessments shall incorporate combustible dust hazards and risks into the assessment and risk reduction plan.
      2. Any plant employees engaged in an activity that could result in generation of a combustible dust cloud shall have PPE consistent with section 7.4.
      3. For personnel involved in cleaning operations see section 7.4
   2. **Contingency Plans (Business Recovery Plans)**
      1. Where dust collection systems are critical for facility production, a written contingency plan shall be developed and implemented to address the following:  
         1. Each plant shall maintain a supply of bags and 10% of the cages in stock or readily available, sufficient to replace all the bags in the largest dust collector or in the largest compartment of a subdivided dust collector.
         2. Each plant shall evaluate each system for critical spare parts and long lead item needs. These items shall be maintained on site or readily available with short lead time.
   3. **Control of Ignition Sources**
      1. When working inside baghouses or within three feet of any opening (i.e., door, hatch) containing suspended combustible dust, all power tools (i.e.-drop cords, drills, impact wrenches, etc.) shall be explosion proof, class II, division I.
      2. Hot work operations in areas handling Combustible dust or wetted sludge shall comply with NVLFPES 16. Hot work shall not be initiated if the formation of a dust cloud combustible gas mixture in air is likely (cleaning operation, etc.) in an area within a 16 m (50 ft.) radius.
      3. Areas with combustible dust deposits shall be cleaned in accordance with this standard prior to initiating hot work out to a 16 m (50 ft.) radius. NVLFPES 16 – Hot work, states that areas with Combustible Dust deposits require process owner approval prior to performing hot work. It is a best practice to post plant areas with combustible dust / Hot work sign:

**Combustible Dust Hazard Area**

Process Owner Approval Required

Prior to Performing Hot Work

* + 1. For process equipment with a surface temperature greater than the MIT (See section 6.5.1.4) of the collecting dust, the accumulation shall be minimized to the greatest extent practical. Note – This is required because there is a high frequency of fires related to these types of processes.
    2. Known process fire risks (Hydraulic fluids, HTM fluids, Combustible conveyor belts, combustible insulation, etc.) that have the potential of exposing combustible dust deposits shall be evaluated to identify corrective actions which limit the fire risk to the greatest extent practical.
    3. Non-sparking tools shall be used to make repairs or adjustments on or around any machinery or apparatus where a combustible dust cloud is likely.
    4. Do not locate portable fans and blowers in the dust collection system, within the dust stream or in any other area where use of such equipment could result in the suspension of combustible dust.
    5. Bonding and grounding shall be provided for all equipment handling combustible dusts including ducts and buildings in accordance with NFPA 70, National Electrical Code, or equivalent regional standard. Duct expansion joints, slide gates or other moving equipment must also be bonded to less than 106 ohm in a continuous ground path. Ground connections shall be less than10 ohms.
    6. Accumulations of combustible dust on surfaces and in containers shall be managed at all times to limit risk. Note - Some combustible dusts (Manganese, aluminum) can heat and auto-ignite under the right conditions. Key risk factors are thickness of dust layer, MIT (See section 6.5.1.4), humidity / moisture content, length of time dust is present, etc.
    7. At no time should extraneous organic or other combustible material be introduced to our recycling streams or directly to a molten metal furnace. The introduction of this material will produce sparks and embers that could make their way through the ducts to a dust collector.
  1. **Plant Signage Requirements**
     1. All plant areas where dust has been tested and found to be combustible shall be provided with general area hazard warning signs notify all employees of the potential risk. See [Attachment 3](#Attachment3)
     2. Whenever Class A, Class B or Class C fire extinguishers are located in a combustible metal dust area, they shall be provided with a label marked “Not for use on fires involving metal dust”.
     3. All signs shall be durable and permanently attached to process equipment and building structure both at access points to enclosure and rooms and also within rooms.
     4. All signs shall be mounted in a location that is easily visible and can be accessed for clearing.
  2. **Manual Fire Fighting.**
     1. Qualified personnel at each operating plant with combustible dust hazards shall decide, in advance, if it is better to attempt to fight a dust fire, or simply allow it to burn itself out, if a dust fire were to occur. This decision shall be documented and a pre-plan shall be developed in conjunction with local fire department personnel, see [Attachment 4](#Attachment4) and [Attachment 5](#Attachment5) for standard preplan.
     2. **Heating Material –** Heating material is defined as a layer of Dust or other material that is heated from an external heat source or exothermic reaction prior to open flaming. Employees responding to heating material where the total area is less than .22 Sq. m (2 Sq. ft.) and material in on a flat horizontal surface not likely to fall and disturb other material in the area, shall   
        1. Wear fire retardant clothing
        2. Limit activities to safely (Do Not Create a Dust cloud) moving non-involved material away from the heating material, then
        3. Apply dry sand, dry powder fire extinguisher, etc. to further isolate the heating material, See Section 8.5.5
        4. Wait for material to fully cool prior to clean-up operation.
        5. If heating material spreads outside the limits defined in 8.5.2 or involves combustible dust in a the vertical plain or has the potential to fall or other wise move and potentially cause

a dust cloud to form, “Stop”, evacuate the area and call the fire brigade or local fire department.

* + 1. Fires and Explosions - Employees responding to combustible dust fires or fires that could potentially involve Combustible Dust shall wear full bunker gear including SCBA



* + 1. Firefighting activities shall be limited to the scope of the emergency response plan / organization / command structure as well as the scope of training / PPE provided to emergency responders.
    2. **Dry sand and powder extinguishing agents**
       1. Utilization of dry sand is the preferred method for manual firefighting or for dealing with heating material. Firefighting pre-plan shall address such issue as sand transportation to fire site and application of the sand in the immediate area of the fire and possibly from a remote distance due to radiant heat concerns associated with larger fires.
       2. An incipient fire, smoldering or heating material shall be ringed with a dam of dry sand, preferably less than 20 mesh, dry inert granular material, dry flux salt, or a listed Class D extinguishing powder in accordance with the manufacturer’s instructions. Application of dry extinguishing agent shall be conducted in such a manner so as to avoid any disturbance of the combustible dust, which could cause a dust cloud.
       3. The extinguishing agent shall be stored in such a manner that it remains clean and dry.
       4. The dry extinguishing agent shall be carefully applied with a non-sparking metal scoop or shovel, applied from a listed Class D fire extinguisher equipped with a low-velocity nozzle or by other remote means (conveyor, slide, etc.) in a manner that does not disturb the burning dust.
       5. The dry extinguishing agent is generally applied by ringing and then covering the burning dust with a layer of powder at least 38 mm (1-1⁄2 in.) deep. The powder shall be applied with minimum disturbance to the burning dust.
    3. **Use of Water and Hose Stations**
       1. Low velocity spray water shall only be used as a last alternative when other methods of control have failed and the fire shows evidence of involving a significant amount of other combustible materials or of burning out of control. And then, only a low velocity spray or fog nozzle shall be used to prevent formation of a combustible dust cloud.
       2. In areas with aluminum dust, application of water is likely to generate Hydrogen gas so the area shall be well ventilated prior to application of water.
       3. After extinguishment is confirmed and dust has cooled, the area shall be immediately cleaned of all wetted powder, paste or slurry. Ventilation shall continue to be provided during cleanup to avoid concentrations of hydrogen gas.

1. **Management of Change, ATEX and Process Hazards Analysis** [**(Back to TOC)**](#TOC)
   1. Each operating plant with combustible dust hazards shall maintain a Process Hazards Analysis (PHA) that identifies the hazards and prioritizes the activities to reduce risk. The specific risks arising from explosive atmospheres shall be assessed, taking into account, but not limited to:

The likelihood that explosive atmospheres will occur

The likelihood that ignition sources will be present,

The likelihood that electrostatic discharges, will be present or occur

Installations, substances used, processes, and their possible interactions and the scale of the anticipated effects.

Explosion risks shall be assessed overall

* 1. PHAs shall be approved by ALINVEST’ Corporate Manager, Property Conservation for new construction and by the plant engineering manager for all existing facilities. PHAs shall be updated as a result of process changes and maintained current at all times. At a minimum the PHA shall be updated every 3 years. For European plants, see Section 9.4, The ATEX[[1]](#footnote-1)[[2]](#endnote-1) documentation shall satisfy this requirement.
  2. Projects that will result in work being performed in plant areas where combustible dust is present, shall have a PHA performed to assess all risks related to combustible dust, introduction of ignition sources and confinement during demolition, construction and start-up and testing. This task should be listed as part of the project scope and schedule.
  3. For plants in the EU, where the combustible dust can generate explosive atmosphere, the site must ensure that an explosion protection document (ATEX) in accordance with ATEX Directives 94/9/EC and 1999/92/EC is written and kept up to date, See [Attachment 8](#Attachment8) for ATEX documentation summary.   
     1. This document must at least demonstrate or identify the following:  
        1. Demonstrate that the explosion risks have been determined and assessed;
        2. Demonstrate that adequate measures will be taken to attain the aims of the Council Directive;
        3. Identify those places which have been classified as Combustible Dust zones;
        4. Identify those places where the minimum requirements set out in Annex II of the Directive will apply;
        5. Demonstrate that the workplace and work equipment, including warning devices, are designed, operated and maintained with due regard for safety;
        6. Demonstrate that, in accordance with Council Directive 89/655/EEC, arrangements have been made for the safe use of work equipment.
     2. The explosion protection document shall be completed prior to the commencement of work and be revised when the workplace, work equipment or organization of the work undergoes significant changes, extensions or conversions.
     3. The explosion protection document is intended to provide an overview of the results of the risk assessment and the related technical and organizational protective measures established for the plant and working environment.
     4. The document must be tailored to conditions at the site. It shall be well-structured and easy to read, with enough detail for the reader to grasp the content and scope of the review.
     5. For additional information on the scope and structure of the ATEX document see Attachment 6 and Directive 1999 / 92 / EC of the European Parliament and the council of December 16, 1999.
  4. When making changes that could affect the creation, generation, cleaning or maintenance of combustible dust, a thorough risk assessment shall be completed. The purpose of this risk assessment is to determine the potential effects that changes may have on the current condition. If an assessment identifies an area of increased risk, an action plans to mitigate these risks to the greatest extent possible shall be developed, documented and implemented.
  5. Plant based written procedures to manage change to process materials, technology, equipment, procedures, and facilities related to combustible dust shall be established and implemented at each operating plant. Plant based management-of-change procedures shall ensure that the following issues are addressed prior to implementing any changes involving combustible dust:  
     1. The technical basis for the proposed change
     2. The safety and health implication.
     3. Whether the change is permanent or temporary
     4. Modifications to operating and maintenance procedures
     5. Modifications to Employee training requirements
     6. Authorization requirements for the proposed change(HSE, Property Conservation, Insurance TSP, etc.)
  6. ALINVEST MOC procedure as defined in the ALINVEST Global Operating System clearly defines the need to assess, plan for and mitigate risks, during changes that involve combustible dusts. Please refer to this Performance Standard, any site specific procedures or site specific tools that may be needed for further instructions and directions related to implementing changes involving combustible dusts.
  7. Where the change requires new or changes to existing dust control equipment or systems, the ALINVEST Insurance Technical Service Provider (TSP) engineer or Corporate Manager, Property Conservation shall be involved in the risk assessment process and shall review related drawings for loss prevention concerns.

1. **Maintenance** [**(Back to TOC)**](#TOC)
   1. General  
      1. This section outlines the necessary steps to maintain function and performance of the equipment relative to combustible dust hazards.
      2. Each operating plant must have a preventive maintenance program that encompasses the necessary PMs with appropriate frequencies for all process equipment that can generate, liberate or accumulate a combustible dust.
      3. When creating PMs, the following are the basic functional failures to consider for each program with respect to combustible dust.   
         1. Process is creating more dust
         2. Dust is escaping the process
         3. Protective equipment is not functioning properly.
      4. For known combustible dust equipment areas, PMs shall include:  
         1. Cleaning accumulations in or around work area. See section 7.0
         2. Ignition source control. See section 7.5.4.5
         3. Proper tool selection. See section 7.6
         4. Proper PPE. See section 7.4
   2. Building Maintenance   
      1. The building and structure must be maintained in such a way to minimize the ability of combustible dust to collect on the structure in confined areas to the point that dust poses a fire and explosion hazard.
      2. Ridge vents  
         1. All ridge vents shall have PMs established for the periodic cleaning of combustible dust to ensure dust building up is maintained below 0.8 mm (1/32 inch).
         2. Cleaning shall be accomplished in accordance with section 7.0
      3. Pressure relief structures / panels  
         1. Quarterly visual inspection shall be made to ensure nothing is obstructing the operational path of pressure relieving components.
         2. Annual inspection of critical components (actuation releases, hinges, hangars, retaining cable and chains, etc.) to ensure proper function of pressure relieving components and that they are capable of safely serving their intended purpose.
      4. Electrical Equipment
         1. Classified electrical equipment enclosure seals shall be annually verified.
         2. Enclosure shall be checked monthly to ensure doors are maintained closed.
         3. Particulate filters shall be changed out routinely, based upon plant experience.
      5. Building features used to limit the build-up of combustible dust to 0.8 mm (1/32 in.) between cleaning operations, see section 7.0  
         1. Annual PMs shall be established to review building features to ensure building components are in place to prevent the excessive buildup of combustible dust on the structure. Examples: Installed sloped surfaces, dust management enclosures, concealed space cover plates, etc.
         2. Annual PMs shall be in place to review concealed spaces and other areas where combustible dust can accumulate out of sight of employees on the plant floor. Examples are: Elevated horizontal surfaces, above drop ceiling, ventilation systems, etc.
   3. Process Equipment Maintenance  
      1. General
      2. The process equipment listed in this section has known combustible dust failure modes associated with them.
      3. Debaler   
         1. Incoming quality of inputs is an important consideration for the reliability of this asset. Incoming material shall be inspected for quality considerations, as well as incoming tramp materials.
         2. PMs shall focus on visual inspection of seal condition, housing and door condition. Recommended frequency of these checks is daily.
         3. Recommended best practice is to pre-condition (clean) scrap prior to introduction to plant processes.
      4. Shredder  
         1. Operational checks shall include density control measures. PMs shall include daily observation of the housing and door seals. Measures shall be in place to monitor hammer and grate, or knife conditions.
         2. In-feed and discharge flow rates to the shredder or debalers shall be electronically monitored to ensure that the residency time of material in the shredder does not create fine particulate / combustible dust that could then be subject to fire or an explosion.
         3. Care needs to be taken to avoid enclosing the shredder. Where the shredder is fully enclosed an explosive event can occur, therefore explosion venting of a fully enclosed shredder would be required.
         4. Having an adequate ventilation flow rate (See Section 11.4.6.1) to limit the dust concentration below the MEC (See Section 6.5.1.3) in the shredder and related duct work is required.
      5. Air Knife  
         1. PMs shall include air flow monitoring and monthly validation. The gap setting shall be verified monthly, and with product changes. Air flow screens shall be visually checked monthly.
         2. Recommended best practice is to install differential pressure monitors to automatically detect a problem instead of relying on periodic testing.
      6. Size Separation  
         1. PMs on this asset shall focus on visual inspection for leaks daily. Dust capture hoods shall be inspected for proper function monthly, and annual flow monitoring of the dust capture system.
         2. Recommended best practice is to install size separation equipment that includes dust removal, such as a trammel.
      7. Conveyors  
         1. Best practice is to install fully enclosed conveyors with adequate dust capture design.
         2. Best practice is to install fire retardant belting on all conveyors. It is mandatory the fire retardant belting be installed in close proximity to the decoater, at the entry and exit end of the shedder and for bucket elevators.
         3. Horizontal conveyor (Pre-shred, post-shred and post-decoater conveyors)  
            1. Material spillage, belt slippage and dust liberation are the failure modes for this asset.
            2. PMs shall include daily visual observation on condition of side guards and conveyor shape. PMs shall also be in place to maintain or verify proper conveyance speed.
            3. Where covers and/or dust collection hoods exist, visual inspection each shift shall verify that these components are in place and that they are capable of serving their intended purpose.
            4. Best practice is to install a belt type conveyor instead of a vibratory conveyor.
         4. Vertical conveyor (Bucket elevators, pleated conveyors, etc.)  
            1. Bucket elevators have a history of combustible dust incidents. When material spillage and dust liberation happen inside the typical enclosed environment, the only component needed for a dust explosion is an ignition source. Hence, much of the maintenance effort for this asset shall focus on ignition source identification. Mechanical components such as rollers and bearings create ignition sources when they fail. Belt slippage could also be a source of ignition.
            2. PMs shall also include those mentioned in section 10.3.7.2.
            3. Daily visual observations of mechanical linkages and bucket condition.
            4. Validation of the feed rate shall be performed annually to avoid overcharging. Motor amperage monitoring and thermography shall also be included.
            5. Explosion suppression shall be installed on bucket elevators which are fully enclosed.
      8. Decoater or Delaquering Kiln  
         1. PMs shall include visual monitoring of the access doors, seals, and areas where dust may escape. Monitoring for high internal pressure shall be included to trigger corrective action.
         2. Best practice is to install a fully enclosed rotating delaquering kiln.
      9. Melting or Holding Furnaces  
         1. PMs shall focus on visual inspection and housekeeping of hooding or capture equipment to ensure combustible dust is not accumulating on ledges inside or outside of the hoods.
         2. Best practice is to design a hood without ledges inside or outside that would allow combustible dust accumulation.
      10. Manganese Injectors (powder alloy injectors)  
          1. The main combustible dust failure modes are operational leaks, spillage, and accumulations of combustible dust on equipment.
          2. PMs shall include frequent seal inspections and visual inspection of conveyance lines and housekeeping for accumulations of combustible dust on the equipment. Grounding and bonding must be verified monthly.
      11. Degasser  
          1. Monthly maintenance PMs shall include visual inspection for enclosure damage and leaks, damage to fan or gate. PMs shall include checks for rotor imbalance. Quarterly duct inspection is required to determine if removal of combustible dust accumulation inside the duct is necessary.
   4. Dust Collector System Maintenance  
      1. General  
         1. Dust Collection systems typically have five major components: 1) Hoods; 2) Ducts; 3) Filters; 4) Fan/Motor and 5) Exhaust.
         2. Visual presence of dust or increased cleaning frequencies is an indication of functional failure of the dust collection system. There may be many contributors to this failure, critical concerns are discussed below.
         3. Flow verification and air flow balancing is required to maintain the function of this system. This shall be documented annually by a competent industrial ventilation resource. The minimum requirement is 1372 mpm (4500 fpm) velocity at all points through the system that conveys combustible dust.
      2. Hoods  
         1. PMs shall include visual inspection for condition of hood and curtains. Inspection shall also include the connecting duct as well as any attached dampers. Annual flow validation shall be conducted and documented. Damper set points shall be marked and visually inspected monthly to ensure they are correct.
      3. Ductwork  
         1. Maintenance PMs shall include visual inspection to ensure access doors, hatches and seals are in good condition and serving their intended function. Internal visual inspection shall be conducted semi-annually to ensure accumulation is not occurring inside the ducts. Annual bonding and grounding validation must be performed. Flow rates and damper set points shall also be validated annually.
      4. Filters   
         1. Air-Material Separators  
            1. Cyclone

Monthly PMs shall include visual checks to ensure the structure, access doors, and seals are in good condition. Internal inspections shall be done quarterly to identify bridging and material accumulation problems.

Best practice is to install replaceable plates at key wear points. Wear plates shall be inspected annually.

* + - * 1. Drop out box

Monthly PMs shall include visual checks to ensure the structure, access doors, and seals are in good condition.

Recommended best practice is to install spark detection and suppression systems.

* + - 1. Baghouse  
         1. For the function of removing dust and fumes, PMs shall focus tasks to identify the following possible failure modes:

High differential pressure (DP) / Plugged filter.

Broken bag or bleed through

Lower DP or plugged line

Plugging or blinding of filter element concerns shall be addressed as follows.

PMs shall include calibration and annual cleaning (blowing out) of the pressure taps.

Recommended practice is use of surge valves to clean out pressure taps and tubing.

Recommended practice is to convert continuous cleaning to on demand cleaning.

Hopper level indicators must be checked frequently. Annual PM to ensure bag break detection system is working properly shall also be included.

* + - * 1. For the function of keeping the enclosures and hoods at negative pressure:

Monthly PMs shall include visual inspection for structural breaches in housing as well as listening for whistling sounds.

Annual PMs shall include bearing and tolerance checks on screw conveyor and mechanical components at material discharge.

Best practice recommendation is to install rotary valves instead of double dump valves.

* + - * 1. For the function of keeping the exhaust clean:

Annual PMs for broken bag detection and daily visual emission checks shall be accomplished.

Monthly PM shall include visual inspection of seals and listening for air leaks. Quarterly tactile checks are recommended to ensure seals are still pliable. Ultrasound can be used effectively to identify leaking seals.

Quarterly PM to verify proper header pressure gauge functionality for the cleaning system. Annual PM for inspection of the cleaning mechanism. Recommended practice is to install water separator before the distribution header.

For the air supply, Quarterly PMs shall include a tactile inspection of diaphragm, as well as listening for whistling.

* + - * 1. For the function of safely holding the collected material:

Quarterly visual checks and inspection PMs for deflagration vents and isolation systems must be included, as well as annual inspection by a certified inspector. OEM can typically serve this function.

The fire suppression system shall have PMs based on applicable NFPA codes and standards or other regional equivalent standards.

* + 1. Motor and Fan  
       1. PMs shall include detection for higher amperage loading and drop in differential pressure. Differential pressure measurements shall be included in monthly PMs, and annual calibration is required for these devices.
       2. Quarterly vibration PMs shall be included. Annual PM for fan performance comparison against design capacity and visual fan blade inspections shall be included.
       3. Annual PM for oil analysis on bearings shall be included. Quarterly usage of thermography is recommended to identify pending failures.
    2. Exhaust Stack  
       1. Daily PMs shall include exhaust inspection for visible emissions.
       2. Annual PMs shall include checks for structural integrity.

1. **Building, Process Equipment, and Exhaust System Design, Construction and Installation** [**(Back to TOC)**](#TOC)
   1. This section contains general principles for the safe design of combustible dust handling systems. All system installations and modifications shall undergo a formal Management of Change (MOC) process to ensure risks have been identified and controlled, see section 9.6.
   2. **Building Design and Construction**  
      1. The construction of the building where combustible dust is likely to be present shall be designed to the following requirements:
2. Provide damage-limiting construction for buildings or rooms that have fugitive emissions or accumulations of combustible dust exceeding the level specified in section 7.3.1.
3. Construction details of both pressure-relieving walls and pressure–resistant walls shall be in accordance with NFPA 68, Standard for Explosion Protection by Deflagration Venting or similar regional regulations.
4. Explosion vents shall not be directed towards critical facilities or where personnel are likely to be present.
5. Building materials including insulation shall be non-combustible throughout and all walls shall be non-load bearing.
6. Do not use explosion vents in the roof to provide explosion-relief in geographical areas where snowfall or icing occurs. In these locales, explosion vents in the walls is the preferred location for explosion vents.
7. Interior surfaces where dust accumulations can occur shall be designed and constructed in a manner to facilitate cleaning and to minimize combustible dust accumulation. Where surfaces on which dust can collect are unavoidable, they shall be covered by smooth concrete, plaster, or non-combustible mastic fillet having a minimum slope of 60 degrees to the horizontal.
8. For sound proof enclosures, the inner surface shall be smooth and not likely to hold or collect dust (Perforated sheet is a good example of a surface likely to hold dust). Where fibrous insulating materials are used a vapor barrier shall be provided to prevent dust from contaminating the fibers. All materials of construction shall be non-combustible.
9. Spaces inaccessible to housekeeping shall be sealed to prevent dust accumulation. Provisions shall be made for periodic inspection and cleaning of these spaces.
10. New interior walls erected for the purpose of limiting fire spread shall have a minimum 2-hour fire resistance rating and wall penetrations shall be sealed with fire rated materials.
11. In geographic areas where lightning is a common occurrence consideration shall be given for installation of appropriate lightning protection. Best practice is to complete the Lightening Risk Assessment in NFPA 780 (Standard for the Installation of Lightning Protection Systems).  
    1. **Process Equipment Design and Installation**
       1. **Equipment** **Protection**
          1. Where hydraulic systems are installed in or near (within 15m (50ft)) of combustible dust hazard areas, the hydraulic power unit shall be installed in a 2 hour fire rated enclosure and protected by automatic sprinklers.
          2. In potential combustible dust exposure areas, combustible materials of construction shall be limited to the greatest extent practical.
          3. The design of explosion protection for equipment shall be in accordance with both NFPA 68 and NFPA 69. Facilities located in Europe shall be in accordance with ATEX Directives 94/9/EC and 1999/92/EC and relevant EN standard (e.g. EN 14491, Dust explosion venting protective systems, etc.). List of relevant EN standard can be found in the reference section.
          4. All equipment with an explosion hazard shall be provided with explosion protection using either venting, suppression, containment, or a suitable combination of these. Deflagration venting shall be designed so projectiles are not created.
          5. Where an explosion hazard exists, isolation devices shall be provided to prevent deflagration propagation between pieces of equipment connected by ductwork. Deflagration isolation protection for interconnected enclosures can be eliminated, based on a documented Process Hazard Analysis (PHA), see section 9.1.
          6. The following are examples of acceptable explosion isolation:
12. Chemical isolation systems - Extinguishing barriers;
13. Mechanical isolation systems;   
    1. Rotary air locks (i.e., rotary valves, star valves);
    2. Rapid-action valves (gate or butterfly type);
    3. High speed abort gates - Product barrier choke;
    4. Double-dump valves; and
    5. Rapid-action valves (float type) – Quick acting shut-off valves (explosion insolation valves);
    6. Flame front diverter – Explosion diverters  
       1. **Dust Collection Systems**
          1. **All process equipment (Slitters, edge trimmers, stamping, laser cutters, etc.) where the process produces a combustible dust shall be provided with dust collection systems. The purpose of this system is to collect all fugitive dust related to this process.**
          2. **De-dusting Technology - Use of dedusting technology can limit our combustible dust exposure in downstream duct work and dust collection systems.**
             1. **De-dusting technology shall be provided for all new scalper related chip collection and transport systems.**
             2. **De-dusting technology shall be evaluated for use in other systems to determine if it would be effective in the removal of dust without creating other process concerns.**

****Examples of a De-duster

* + 1. **Electrical Equipment and Installations**
       1. Electrical installations in areas or on equipment where combustible dust is handled shall be in accordance with National Fire Protection Association Standard 70, National Electrical Code, when not in conflict with regional regulations. Plants located in Europe shall be in accordance with ATEX Directive 94/9/EC. Also see section 9.3
       2. Areas of combustible dust hazards must be classified in accordance with NFPA 499 or similar regional regulation. The key to the classification of electrical equipment in the facility will be the adequacy of the combustible dust removal systems. Assuming room explosion hazards do not exist, see section 7.2, or ignitable dust clouds are not generated as part of the process, general electrical equipment will be unclassified. Classified electrical equipment will be required as follows:  
          1. Determination must be made through testing to determine if the dust is conductive. Conductive dusts are classified as Group E and require a higher level of protection. For non-conductive dusts the classification is Group G. The applicable test is ASTM D 257, See section 6.5.1.5. the following is a summary of related group classifications:

1. Group E - Atmospheres containing combustible metal dusts regardless of resistivity or other combustible dusts of similarly hazardous characteristics having resistivity of less than 102 ohm-centimeter (magnesium, aluminum, bronze powder, etc.)
2. Group F - Atmospheres containing carbon black, charcoal, coal, coke dusts that have more than 8% total volatile material ( coal and coke dusts per ASTM 3175-82) or atmospheres containing these dusts sensitized by other materials so that they present an explosion hazard and having resistivity greater than 102 ohm-centimeter but equal to or less than 108 ohm-centimeter.
3. Group G - Atmospheres containing combustible dusts (flour, starch, pulverized sugar and cocoa, dairy powders, dried hay, etc.) having resistivity of less than 108 ohm-centimeter or greater.
   * + - 1. Areas located inside any processing equipment that generates aluminum fines/dust, must be classified Class II (Group E or Group G), Division 1 (IEC Zone 20).
         2. Areas within a 3 ft. radius of any openings capable of creating a dust cloud (such as conveyor openings) of process equipment generating combustible dust must be classified Class II (Group E or Group G), Division 1 (IEC Zone 21).
         3. For equipment enclosures, such as de-bailers or shredders, the area within the enclosures must be classified Class II (Group E or Group G), Division 1 (IEC Zone 21). See section 11.3.3.2.3 for hatches and openings.
   1. **Exhaust System Design and Installation**
      1. New silos, dust collectors, cyclones handling combustible dust with a total volume of greater than 8 Ft3 (0.23M3), shall be located outdoors. For existing equipment located inside buildings, The Process Hazard Analysis (PHA), See section 9.1 shall address changes necessary to minimize the risk until mitigating activities are completed.
      2. Deflagration Venting  
         1. Where a collector, silo, or cyclone is used for dust collection or a material storage silo is used, deflagration venting (i.e., blow out panels) shall be installed to protect surrounding personnel, process equipment and main structures. Use the following calculations to estimate the axial (length) and lateral (width) distances of the projected flame from the deflagration vent(s). The area must be clear of personnel and obstructions to the vent. See figure 1 - section 11.4.2.2
         2. Axial Distance from Deflagration vent(s)

D=10\*[V/n]1/3

Where:

* + - n = number of vents
    - D = distance of clearance (meters)
    - 10 = Metal dust factor
    - V = volume of enclosure (m3)

Lateral Distance from Deflagration vent(s) L=(½)\*D

Where

* + - D = distance of clearance (meters)
    - L= Vertical and Horizontal clearance (meters)

|  |  |
| --- | --- |
| Figure 1 - Vented Explosion of Corn Starch Dust (Courtesy Fike)  Figure 1 - Vented Explosion of Corn Starch Dust (Courtesy Fike)   |  | | --- | |  | |

* + - 1. To minimize exposure to personnel, the area within the projected flame range (D and 2L) of deflagration venting on a collector, silo, or cyclone shall be restricted to people operating or maintaining the system.
      2. For explosion relief panels for process equipment where the dust being collected is characterize 300 and/or Pmax of greater than 9 bar, the sizing and configuration of explosion relief venting shall be defined by the explosion relief vent manufacturer.

* + 1. **Dry Type Collectors (baghouses, cartridge filters, etc.)**
       1. Loss history demonstrates that dry type dust collectors, specifically fabric and filter media type dust collectors, are the leading type of equipment to experience fires and explosions.
       2. Where a large collection capacity is needed and a fabric bag filter is used, the following steps shall be taken to reduce exposure to downtime related to fires and explosions:

1. Provide a multiple number of small dry type collectors;
2. Subdivide large collectors equipped with combustible bags into compartments containing not more than approximately 300 bags per compartment.
3. Partitions shall have a minimum of 30 minutes fire resistance if fixed fire protection is not provided. One method is to use two 5/8 inch sheets of gypsum board sandwiched by 18 gauge steel sheeting.   
   * + 1. **Fire and Explosion Protection Features For Dry Type Collectors**
          1. Sprinkler or Water Spray Protection for dry type collectors

A manual sprinkler system or manual water spray system shall be provided for protection inside dry type collectors,

For improved protection install the systems in section 11.4.4.2.1 as an automatic system.

Automatic sprinkler systems and water spray systems shall be designed and installed in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems and NFPA 15, Standard for Water Spray Fixed Systems.

Where water based systems are used, venting of the dry type collectors may be required to vent hydrogen gas.

* + - * 1. The Requirements for special hazard fire extinguishing systems (Gaseous Protection) shall be as follows:

1. Gaseous protection shall not be permitted for dry type collectors handling dry pure aluminum dusts.
2. Gaseous protection systems shall be permitted for equipment where both dry pure aluminum and other combustible dusts are present only if the Process Hazard Analysis (PHA), see section 9.1, indicates that such protection systems could reduce the risk to life and/or damage to property. CO2 is the most recommended gaseous agent. However, other agents, such as nitrogen or argon, may also be used.
3. The gaseous protection system shall be activated by an infrared or heat detection system.
4. The gaseous protection shall be designed as total-flooding and requires isolation of the dry type collectors from the rest of the process in order to maintain effective agent concentration. Second discharge capability shall be provided.
5. For dry type collectors collecting combustible materials, such as paper and plastics, and where there is no isolation between the bag compartment and the collection bin/box, gaseous protection shall not be used; as it is not effective for these types of combustibles due to the potential for smoldering, deep seated, fires.
6. CO2 protection shall be designed, installed and maintained in accordance with NFPA 12, Carbon Dioxide Extinguishing Systems or similar regional regulation.
7. For other inert gases, protection shall be in accordance with NFPA 69 and FM Global Data Sheet 7-59, “Inerting and Purging of Tanks, Process Vessels and Equipment” or similar regional regulation.
8. Halogenated fire protection systems (such as Halon) shall not be used.   
   * + - 1. Where the likelihood of sparks or embers travelling from a process to dry type collectors is high, one or more of the following shall be implemented:
9. Install high speed infrared detectors in the duct between the process and the collector. Interlock the detector to actuate a spark suppression system in the duct or to actuate a diverter valve and isolation of the collector Spark/ember detection and extinguishing systems. These systems shall be designed, installed, and maintained in accordance with NFPA 69, Standard of Explosion Prevention Systems, and NFPA 72, National Fire Alarm Code, or equivalent regional standard;
10. Install a spark –arrester or settling chamber in the duct between the process and the dry type collectors;
11. Where feasible, increase the length of the duct between the process and the dry type collectors;
12. Install other equipment known in industry proven to suppress sparks and prevent them from entering dry type collectors.
13. Use Nomex, P84 or Teflon coated polyester bags  
    * + - 1. Inlet and outlet temperature monitors shall be provided for over temperature protection for bags. Alarms shall be monitored in a constantly attended location and shall initiate at no more than 25 degrees F above the normal operating temperature of the dry type collectors. A shut down sequence shall be initiated at 50 degrees F above normal operating temperature with interlocks to shut down the following:
14. Exhaust Fan Motor
15. Close fire dampers to isolate the dry type collectors and ensure that any fire cannot propagate.
16. Rotary valves in order to prevent burning material from being transferred out of the dry type collectors.
17. A tempering air damper shall be provided and interlocked with the air temperature monitors to maintain the dry type collector’s air temperature lower than the bag ratings.
18. Shutdown pulse jet system  
    * + - 1. During normal operation, the combustible material collected in the dry type collectors shall be discharged continuously via rotary valve, flap valve or any other air lock equipment that ensures isolation between the bag filter compartment and the collection container.
        1. **Other Features to address fires and explosions**  
           1. Electrostatic precipitators shall not be used due to the risk of static electrical charge build-up.
           2. The preferred dry type collectors are a high-efficiency cyclone–type collector unless it cannot meet environmental regulations.
           3. All new dry type collectors (bag filter, cartridge, etc.) shall be installed outside and at least 15 meters (50 feet) from any critical building or operation. Explosion relief panels shall be installed directly on the dry type collectors. See section 11.4.2
           4. Dry type collectors shall not be located on the roof due to limited access for fire protection personnel. If this is not feasible, the roof shall be non-combustible, automatic fire protection shall be provided for the collector and rapid access, such as stairs, shall be provided for firefighting personnel.
           5. For existing equipment located inside, the preferred method is to relocate the equipment outside. If this is not feasible, the dry type collectors shall be equipped with explosion vent(s) to vent the explosion outside the building via a short vent duct. The design / location of explosion venting shall take into account the possibility of personnel in the vicinity, see section 11.4.2. See NFPA 68 or other equivalent standard for other design requirements. These requirements shall include:

The duct shall direct explosion pressure and gasses outside the building to a safe area

The duct should have a cross sectional area greater than the vent itself.

The vent calculation shall take into account the flow restriction effects of the duct on the vent.

* + - * 1. In situations where dry type collectors are being used for the collection of combustible dust, the dust could be rendered inert by mixing it with a non-combustible dust (known as “phlegmatization”). An explosion screening test, see section 6.5.1.1 shall be conducted to determine whether or not a mixture is explosible. This shall be considered in the Process Hazard Analysis (PHA) – See section 9.1.
        2. Explosion venting for dry type collectors shall be in accordance with NFPA 68. The facilities located in Europe shall be in accordance with EN 14491, Dust Explosion Venting Protective Systems.
        3. The dry type collectors shall be designed and maintained so that internal cleanliness is ensured. The accumulation of material inside any area of the collector, other than in the discharge containers designed for that purpose, shall not be permitted.
        4. As a minimum, alarms shall be provided to indicate “rotary valve malfunction” and “discharge level full”.
        5. Discharge containers must be grounded and bonded. This can be accomplished by use of Flexible Intermediate Bulk Containers (FIBCs) type C.
        6. Do not locate fans and blowers in dust collection systems within the dust stream. For negative pressure systems (preferred), locate the fan on the clean side of the dry type collectors. For positive pressure systems, locate the blower upstream of the dust injection point. Venturi systems meet this requirement because the fan is not located in the exhaust airstream.
        7. The air exhausted from a dust collection system shall not be recycled into a building for new construction. For existing systems the Process Hazards analysis (PHA), see section 8. 1 shall require the following, until mitigating activities are complete:

1. The filter efficiency must be 99.9% at 10 Microns.
2. Transmission of energy from a fire or explosion are prevented (explosion isolation) from entering a building.

* + 1. **Wet Type Dust Collectors**
       1. Measures shall be taken in order to minimize the risk and severity of wet type dust collector fires and explosions.   
          1. If the wet scrubber is installed inside the building, the exhaust vent shall be terminated outside the building.
          2. Where possible, use non-combustible material for collector construction.
          3. Provide interlocks to prevent operation of the unit in the event the water flow system is not operational.
          4. The liquid level shall be maintained above the level of sludge, or arrange for sludge to be continuously drained and disposed of properly.
          5. Chambers of collectors handling dusts shall be vented to the atmosphere. A one inch (1”) diameter hole in the top of each section of the collector will serve to dissipate hydrogen formed during shutdown.
          6. The exhaust fan shall be located on the collector’s clean air side.
          7. The scrubber exhaust fan shall run three to four minutes before the process begins in order to ensure that any hydrogen will be purged. Any area where wet aluminum residue may collect needs to be ventilated to release hydrogen gas.
          8. The dust collector shall be inspected and cleaned frequently to prevent buildup of combustible dusts on the interior surfaces of the ducts and exhaust fans, including on the surfaces of fan blades.
          9. A vibration switch shall be provided in the exhaust fan to detect abnormal dust build up on the fan blades. Very fine wet aluminum dusts from the scrubber can coat the fan blades’ surface over time, and pieces of this coating can release. Any friction between the fan blades and pieces of this coating can create a spark, resulting in a subsequent explosion. Annual inspection is required to prevent build-up on fan blades.
          10. Sludge shall be removed from the wet scrubber at least once each day, or more frequently if conditions warrant.
          11. Procedures shall be established for the handling and storage of sludge. At a minimum the procedure shall address the following:

Quick removal of sludge from the plant to an outside location

Storage of sludge outside away from other building and hazardous areas.

Establish “hold time” (i.e. 14 days) requirements to allow for chemical reaction to be fully completed prior to final disposal or further processing.

* + - * 1. The collector sump shall be ventilated at all times. When the collector is not in operation, the sump shall be automatically ventilated by an independent blower or by an unimpeded gravity vent in order to exhaust any hydrogen generated by an aluminum-water reaction.
        2. The covered, vented metal containers shall be used to transport the collected sludge for disposal.
        3. Containers shall not hold more than 50 lb. (23 kg) each.
      1. Sprinkler or Water Spray Protection  
         1. A manual sprinkler system or manual water spray system shall be provided for protection inside wet collectors of combustible construction, as well as those with combustible linings or packing materials.
         2. For improved protection install the systems in section 11.4.4.2.1 as an automatic system.
         3. Automatic sprinkler systems and water spray systems shall be designed and installed in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems and NFPA 15, Standard for Water Spray Fixed Systems.
    1. **Ducts** **and** **Hoods**
       1. Air velocity in ducts shall be maintained throughout the conveying system at a minimum of 1,372 mpm (4,500 fpm) to prevent the accumulation of dust at any point, and to pick up any dust that can drop out during system stoppages.
       2. Clean out ports shall be included in the design such that the entire system can be inspected and cleaned as necessary to prevent the buildup of dust in the duct system. Clean out ports shall be designed and located so they don’t create a dust collection point. Dead end runs shall not be installed.
       3. The dust-to-air ratio throughout the duct shall be held below a concentration of 25% of the MEC. If processing generates concentrations exceeding these safe limits, provide protection for the explosion hazard in accordance with section 11.3.1**.**
       4. Hoods and pick-up ducts shall be placed at each transfer point for conveyors handling combustible dust. This is critical for fully enclosed conveying systems.
       5. Where product pickup is likely, register collars shall be installed directly above the hood to allow the face velocity to be adjusted to prevent product pick up. This will allow the air flow in the duct to remain at a minimum of 1,372 mpm (4,500 fpm) to prevent the accumulation of dust at any point in the system.

  
  
 Example of register collar

* + - 1. Special care shall be taken for the accumulation or buildup of moisture in the dust collection system. The reaction of aluminum with water produces hydrogen, which is highly flammable. Dust deposits in ducts shall be removed on a regular basis. Addition or disconnection of branch ducts in existing systems shall not be permitted without appropriate engineering studies, proper MOC process and duct redesign. Note: Moisture concerns are likely where ducts leave buildings due to condensation in duct work
      2. Where the conveying duct is exposed to weather or moisture, it shall be moisture-tight.
      3. The hood is one of the most important aspects of a ventilation system and can have a major impact on transfer velocity. Hooding shall be properly maintained after installation to ensure proper system performance.
      4. Where an air-material separator, such as a cyclone, is used as part of the process, and the material is not collected within the vessel, the cyclone shall be located outside unless The documented Process Hazard Analysis (PHA), see section 9.1, confirms there is no risk of a combustible dust explosion through testing of dust and design of equipment.
    1. **Manual Fire Fighting – Hose Stations and Fire Extinguishers**
       1. **Where manual firefighting is included in the firefighting pre-plan for fighting a combustible dust fire, the hose stations shall be strategically placed to ensure they are accessible for use on process equipment and the structure.**
       2. **Fire extinguishers shall be located throughout all combustible dust hazard areas. Only appropriate extinguishers shall be located in Combustible Dust hazard areas.**
       3. **The installation of manual firefighting equipment shall match the emergency response team’s capability, training provided to team members and the firefighting pre-plan (see** [Attachment 4](#Attachment3) and 5**).**
    2. **Sprinkler or Water Spray Protection- General**
       1. Automatic sprinklers or water spray protection shall not be permitted for the bag collector handling dry pure aluminum dusts. For the purpose of this standard, pure aluminum dust includes operational dusts from processing aluminum ingot and sheet. Examples are scalping, slitting, sawing, milling and machining.
       2. Automatic sprinklers or water spray systems shall be permitted for equipment where both dry pure aluminum and other combustible dusts are present only if the Process Hazard Analysis (PHA), see section 9.1, indicates that such protection systems could reduce the risk to life and/or damage to property.   
          1. The hazard associated with aluminum dust in contact with water shall be considered in this selection.
          2. Where installed, automatic sprinkler systems and water spray systems shall be designed and installed in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems and NFPA 15, Standard for Water Spray Fixed Systems or similar regional regulation. Note:The operation of dry pipe systems and deluge systems installed in combustible dust hazard areas could dislodge dust on the structure or the piping network as a result of air discharge or the shaking of the piping.
          3. Provide rupture disks, hatches attached with springs, or other reliable drainage devices where it is possible to accumulate enough water from hose streams or sprinklers to result in structural damage to the collector.
          4. All rotary valves shall be interlocked to stop operating on actuation of the collectors’ extinguishing system.
          5. All fans on the exhaust system shall be interlocked to shut down on actuation of the sprinkler system.
          6. Where valves / fire dampers are installed they shall be interlocked to close in the event a fire is detected.
          7. On high - high temperature and operation of heat detection, or water flow, the pulse jet system shall be interlocked to shutdown.
          8. Critical alarm conditions or operation of fire protection systems, operation of isolation systems, etc. shall be annunciated at the main control panel and other manned locations to ensure operations personnel are notified of alarm conditions.

1. **References** [**(Back to TOC)**](#TOC)
   1. **The following standards should be consulted for information on combustible dust:**
      1. **Occupational Safety and Health Administration OSHA**
2. CPL-03-00-008 Combustible Dust National Emphasis Program (03/08)
3. SHIB 07-31-2005 Safety and Health Information Bulletin
4. 1910. 22 Housekeeping
5. 1910. 38 Emergency action plans
6. 1910. 39 Fire prevention plans
7. 1910. 94 Ventilation
8. 1910. 145 Specification for accident prevention signs
9. 1910. 157 Portable fire extinguishers
10. 1910. 178 Powered industrial trucks
11. 1910. 258 Welding, cutting and brazing
12. 1910. 269 Electric Power Generation, Transmission and Distribution (coal handling)
13. 1910. 272 Grain Handling Facilities
14. 1910. 307 Hazardous Locations
15. 1910. 1200 Hazard Communication  
      
    * 1. **National Fire Protection Association**
16. NFPA 12, Standard for Carbon dioxide extinguishing systems:
17. NFPA 13, Standard for the Installation of Sprinkler Systems;
18. NFPA 15, Standard for Water Spray Fixed Systems;  
    NFPA 51B, standard for fire prevention during welding, cutting and other hot work:
19. NFPA 68, Standard on Explosion Protection by Deflagration Venting;
20. NFPA 69, Standard on Explosion Prevention Systems;
21. NFPA 70, National Electric Code;
22. NFPA 72, National Fire Alarm Code;
23. NFPA 77, Recommendation Practices on Static Electricity;
24. NFPA 484, Standard for Combustible Metal Dust;
25. NFPA 499, recommended practice for the classification of combustible dusts and of hazardous locations for electrical installations in chemical process areas:
26. NFPA 505, Industrial Trucks
27. NFPA 654, Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids;
28. NFPA 780, Standard for the Installation of Lightning Protection Systems
29. NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems:
30. NFPA 2112, Standard on Flame Resistant Garments for Protection of Industrial Personnel Against Flash Fires  
      
    * 1. **European Standards**
31. DIRECTIVE 1999/92/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres
32. ATEX Directives 94/9/EC and 1999/91/EC (for facilities located in EC countries);
33. EN 1127-1 Explosive atmospheres - explosion prevention and protection - Part 1: Basic concepts and methodology;
34. EN 12874 Flame arresters - Performance requirements, test methods and limits for use;
35. prEN 13237-1 Potentially explosive atmospheres - explosion prevention and protection - Part 1: Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres;
36. EN 13463-1 Non-electrical equipment for potentially explosive atmospheres - Part 1: Basic method and requirements;
37. prEN 13463-2 Non-electrical equipment intended for use in potentially explosive atmospheres - Part 2: Protection by flow restricting enclosure "fr";
38. prEN 13463-5 Non-electrical equipment intended for use in potentially explosive atmospheres - Part 5: Protection by constructional safety;
39. prEN 13463-8 Non-electrical equipment for potentially explosive atmospheres - Part 8: Protection by liquid immersion "k";
40. prEN 13821 Determination of minimum ignition energy of dust/air mixtures;
41. prEN 13980 Potentially explosive atmospheres - Application of quality systems;
42. prEN 14034-1 Determination of explosion characteristics of dust clouds - Part 1: Determination of the maximum explosion pressure;
43. prEN 14034-2, Determination of explosion characteristics of dust clouds — Part 2: Determination of the minimum rate of explosion pressure rise (dp/dt)max of dust clouds
44. prEN 14034-3, Determination of explosion characteristics of dust clouds — Part 3: Determination of the lower explosion limit LEL of dust clouds
45. prEN 14034-4 Determination of explosion characteristics of dust clouds - Part 4: Determination of limiting oxygen concentration of dust clouds;
46. prEN 14373 Explosion suppression systems
47. prEN 14460 Explosion resistant equipment
48. prEN 14491 Dust explosion venting protective systems
49. prEN 14797 Explosion venting devices
50. EN 15089, Explosion Isolation Systems (for facilities located in EC countries)
51. EN 60079-0:2009 [Explosive atmospheres. Equipment. General requirements](http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030134571)
52. EN 61241-0:2006 Electrical apparatus for use in the presence of combustible dust. General requirements
53. EN 61241-1:2004 Electrical apparatus for use in the presence of combustible dust. Protection by enclosures "tD"
54. EN 61241-2-2:1996 Electrical apparatus for use in the presence of combustible dust. Test methods. Method for determining the electrical resistivity of dust in layers
55. EN 61241-4:2006 Electrical apparatus for use in the presence of combustible dust. Type of protection "pD"
56. EN 61241-10:2004 Electrical apparatus for use in the presence of combustible dust. Classification of areas where combustible dusts are or may be present
57. EN 61241-11:2006 Electrical apparatus for use in the presence of combustible dust. Protection by intrinsic safety "iD"
58. EN 61241-14:2004 Electrical apparatus for use in the presence of combustible dust. Selection and installation
59. EN 61241-17:2005 Electrical apparatus for use in the presence of combustible dust. Inspection and maintenance of electrical installations in hazardous areas (other than mines)
60. EN 61241-18:2004 Electrical apparatus for use in the presence of combustible dust. Protection by encapsulation 'mD'
61. CEN/TR 15281:2006 Guidance on Inerting for the Prevention of Explosions
62. CLC/TR 50404 Electrostatics - Code of practice for the avoidance of hazards due to static electricity   
      
    * 1. **FM Global**
63. FM Global Data Sheet 1-44, Damage Limiting Construction;
64. FM Global Data Sheet 5-07, National Electric Code;
65. FM Global Data Sheet 5-08, Static Electricity;
66. FM Global Data Sheet 7-17, Explosion Mitigation Systems;
67. FM Global Data Sheet 7-59, Inerting and Purging of Tanks, Process Vessels and Equipment;
68. FM Global Data Sheet 7-64, Aluminum Industry;
69. FM Global Data Sheet 7-73, Dust Collectors and Collection Systems;
70. FM Global Data Sheet 7-76, Prevention and Mitigation of Combustible Dust Explosions and Fires;
71. FM Global Data Sheet 7-78, Industrial Exhaust Systems;  
    * 1. **ASTM Standards**
72. ASTM D257 ‐ "Standard Test Methods for DC Resistance or Conductance of Insulating Materials."
73. ASTM E1226 ‐ "Standard Test Method for Pressure and Rate of Pressure Rise for Combustible Dusts"
74. ASTM E1491 ‐ "Minimum Auto ignition Temperature (MAIT) of Dust Clouds”
75. ASTM E1515 ‐ "Minimum Explosible Concentration (MEC) of Combustible Dusts"
76. ASTM E2019 ‐ "Standard Test Method for Minimum Ignition Energy of a Dust Cloud in Air"
77. ASTM E2021 ‐ "Test Method for Hot‐ Surface Ignition Temperature of Dust Layers"
78. ASTM E2079 – “Standard Test Methods for Limiting Oxygen (Oxidant) Concentration in Gases and Vapors”  
      
    * 1. **Other Standards**
79. Industrial Ventilation – A Manual of Recommended Practice for Design, 27th Edition, 2010 (ACGIH Publication);
80. Industrial Ventilation – A Manual of Recommended Practice for Operation and Maintenance, 2010 (ACGIH Publication);
81. The Aluminum Association – Guidelines for Handling Aluminum Fines Generated During Various Aluminum Fabricating Operations.

1. **Attachments** [**(Back to TOC)**](#TOC)
2. [Attachment 1 – Combustible Dust Cleaning Permit](#Attachment1)
3. Attachment 2 – Combustible Dust - Small Vacuum and Hand Cleaning Permit
4. [Attachment 3 – Example of Explosive Dust Sign and European Warning Sign](#Attachment2)
5. [Attachment 4 – ALINVEST Standard Fire Fighting Preplan – Combustible Dust](#Attachment3)
6. [Attachment 5 – ALINVEST Standard Heating Material Preplan](#Attachment4)
7. [Attachment 6 - Combustible Dust – Project Review Check List](#Attachment5)
8. [Attachment 7 – Summary of Vacuum Truck Bonding and Grounding](#Attachment6)
9. [Attachment 8 – ATEX Documentation Summary for European Plant](#Attachment7)
10. [Attachment 9 – Revision Request Form](#Attachment8)

**Attachment 1 – Combustible Dust - Vacuum Truck Cleaning Permit** [**(Back to TOC)**](#TOC)

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**ALINVEST**

**COMBUSTIBLE DUST CLEAN-UP PERMIT**

* A permit is not required for daily hand cleaning/housekeeping activities on the shop floor which may involve combustible dust that does not create a risk for a dust cloud. In cases where mechanical cleanup (vacuuming) is performed, a permit is required.
* A permit is required for all other combustible dust clean-up work, whether performed by employees or contractors.
* A new permit shall be issued every twenty-four (24) hours or when there is a change in the job leader of the crew performing the work.
* When the grounding connection of the vacuum equipment being used is changed, an electrician must re-verify and sign permit.
* Document shall be displayed in the area where work is being performed and turned in to the responsible party at permit expiration.

**Job Description (describe in detail):**

**Task:**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**Description/Location:**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Date:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Start Time:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**Finish Time:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Personnel:** (please list all personnel covered by this permit)

“I fully understand the hazards associated with clean-up of the dust described above and agree to comply with the ALINVEST cleanup requirements given to me by the ALINVEST Responsible Person. I have been trained in the compliance and risks of combustible/explosible dust cleanup in order to do and/or manage the work safely. ”

**Name Alinvest Name Alinvest**

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**Cleaning Method(s) (check all that apply)**

\_\_\_\_ Hand Cleaning \_\_\_\_ Portable Vacuum Cleaning \_\_\_\_ Vacuum Truck Cleaning \_\_\_\_ Other

**Permit Roles**

***ALINVEST*** *– ALINVEST Employee responsibility*

***Job Leader*** *– ALINVEST Employee or Contractor responsibility – (job dependent)*

***Contractor*** *– Contractor’s responsibility*

**[Page 2 of 3]**

***Initial all items when verified. Mark N/A if does not apply.***

**Pre-Job Inspection**

\_\_\_ **ALINVEST** - The Permit Issuer (ALINVEST Responsible Person) has personally inspected the work area.

\_\_\_ **ALINVEST** - All tramp materials (loose nuts/bolts, spent parts, tools, trash, debris, etc.) have been removed from the work area.

\_\_\_ **ALINVEST** - Potential ignition sources (open flames, hot work, smoking, etc.) have been removed from the area.

\_\_\_ **ALINVEST** - All unnecessary mobile equipment has been restricted from the area.

\_\_\_ **Job Leader** **-** All personnel assigned to the cleaning operation have been trained and are qualified for their assigned tasks.

\_\_\_ **ALINVEST** - All employees have flame resistant garments (trousers, long-sleeve shirts and gloves) and safety glasses when performing Combustible dust cleanup in all areas except areas containing molten metal. All ALINVEST uniforms meet this requirement (ref. Section 7.4.1.1). Additionally, areas with molten metal must meet molten metal PPE requirements.

\_\_\_ **Job Leader -** Only natural fiber brushes and brooms are available for cleaning.

\_\_\_ **Job Leader -** Only conductive, non-sparking scoops and shovels are available for cleaning.

\_\_\_ **Job Leader -** Only conductive, non-sparking containers are available for cleaning.

**ALINVEST**

**COMBUSTIBLE DUST CLEAN-UP PERMIT**

\_\_\_ **Job Leader -** Only certified portable vacuum cleaners are available for the cleaning. (NFPA Class II Group E)

\_\_\_ **Job Leader -** Only the conductive vacuum hose supplied by the vacuum cleaning manufacturer is available for cleaning.

\_\_\_ **Job Leader -** A grounding cable has been connected to the portable vacuum cleaner and to ground.

\_\_\_ **ALINVEST –** An electrician has confirmed continuity to ground for the grounding cable (< 10 ohms) and vacuum hose (< 106 ohms). \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ohms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date

\_\_\_ **ALINVEST –** An electrician has re-confirmed continuity to ground each time the portable vacuum cleaner was relocated

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ohms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Electrician

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ohms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Electrician

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ohms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Electrician

\_\_\_ **Contractor -** Only vacuum trucks designed to clean combustible/explosible dust are to be used for cleaning.

\_\_\_ **Contractor -** Only certified static conductive and static dissipative vacuum hose is to be used for cleaning.

\_\_\_ **Contractor -** Vacuum truck operators and other personnel have been trained and are qualified to safely operate the vacuum truck.

\_\_\_ **Contractor -** Vacuum truck operators and other personnel are familiar with the hazards associated with the dusts to be cleaned.

\_\_\_ **ALINVEST -** The vacuum truck has been inspected for residual materials that may be incompatible with the dusts to be cleaned. A visual inspection should be performed on the inside of the vacuum truck tank.

\_\_\_ **ALINVEST -** The vacuum truck has been placed in a safe position to avoid becoming an ignition source during cleaning.

\_\_\_ **ALINVEST -** The vacuum truck is attached to ground via a grounding cable.

\_\_\_ **ALINVEST –** An electrician has verified electrical continuity of the grounding cable (< 10 ohms) and vacuum hose (< 106 ohms).

\_\_\_ **ALINVEST -**The vacuum truck operator has demonstrated that the ground verification system will shut the vacuum system off if continuity to ground is lost.

**[Page 3 of 3]**

**Post Job Performance**

|  |  |  |
| --- | --- | --- |
| **Cleaned Area** | **Cleaning Method** | **Estimated lbs. Removed** |
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|  |  |  |
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**Comments**

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**All requirements of the ALINVEST 28 Engineering Standard regarding cleanup of combustible dusts have been met and all explosion and fire risks have been identified and adequately controlled.**

**ALINVEST Responsible Person** (Print Name): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Signature):\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_ Time: \_\_\_\_\_\_\_\_\_\_\_

*(Permit expires 24 hrs after this date and time or upon job completion whichever is sooner. Document is to be retained by ALINVEST Responsible Person in designated location).*

**Attachment 2 – Combustible Dust - Small Vacuum and Hand Cleaning Permit** [**(Back to TOC)**](#TOC)

**[Page 1]**

**ALINVEST**

**COMBUSTIBLE DUST CLEAN-UP PERMIT p. 1 of 2**

* A permit is not required for daily hand cleaning / housekeeping activities on the shop floor which may involve combustible dust that does not create a risk for a dust cloud. In cases where mechanical cleanup (vacuuming) is performed, a permit is required.
* A permit is required for all other combustible dust clean-up work, whether performed by employees or contractors.
* A new permit shall be issued every twenty-four (24) hours or when there is a change in the job leader of the crew performing the work.
* When the grounding connection of the vacuum equipment being used is changed, an electrician must re-verify and sign permit.
* Document shall be displayed in the area where work is being performed and turned in to the responsible party at permit expiration.

**Job Description (describe in detail):**

**Task:**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**Description/Location:**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Date:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Start Time:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**Finish Time:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Personnel:** (please list all personnel covered by this permit)

“I fully understand the hazards associated with clean-up of the dust described above and agree to comply with the ALINVEST cleanup requirements given to me by the ALINVEST Responsible Person. I have been trained in the compliance and risks of combustible / explosible dust cleanup in order to do and/or manage the work safely. ”

**Name Alinvest Name Alinvest**

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**Cleaning Method(s) (check all that apply)**

\_\_\_\_ Hand Cleaning \_\_\_\_ Portable Vacuum Cleaning \_\_\_\_ Other

**Permit Roles**

***ALINVEST*** *– ALINVEST Employee responsibility*

***Job Leader*** *– ALINVEST Employee or Contractor responsibility – (job dependent)*

***Contractor*** *– Contractor’s responsibility*

***Initial all items when verified. Mark N/A if does not apply.***

**Pre-Job Inspection**

\_\_\_ **ALINVEST** - The Permit Issuer (ALINVEST Responsible Person) has personally inspected the work area.

\_\_\_ **ALINVEST** - All tramp materials (loose nuts/bolts, spent parts, tools, trash, debris, etc.) have been removed from the work area.

\_\_\_ **ALINVEST** - Potential ignition sources (open flames, hot work, smoking, etc.) have been removed from the area.

\_\_\_ **ALINVEST** - All unnecessary mobile equipment has been restricted from the area.

\_\_\_ **Job Leader** **-** All personnel assigned to the cleaning operation have been trained and are qualified for their assigned tasks.

\_\_\_ **ALINVEST** - All employees have flame resistant garments (trousers, long-sleeve shirts and gloves) and safety glasses when performing Combustible dust cleanup in all areas except areas containing molten metal. All ALINVEST uniforms meet this requirement (ref. Section 7.4.1.1). Additionally, areas with molten metal must meet molten metal PPE requirements.

\_\_\_ **Job Leader -** Only natural fiber brushes and brooms are available for cleaning.

\_\_\_ **Job Leader -** Only conductive, non-sparking scoops and shovels are available for cleaning.

\_\_\_ **Job Leader -** Only conductive, non-sparking containers are available for cleaning.

**ALINVEST**

**COMBUSTIBLE DUST CLEAN-UP PERMIT p. 2 of 2**

\_\_\_ **Job Leader -** Only certified portable vacuum cleaners are available for the cleaning. (NFPA Class II Group E)

\_\_\_ **Job Leader -** Only the conductive vacuum hose supplied by the vacuum cleaning manufacturer is available for cleaning.

\_\_\_ **Job Leader -** A grounding cable has been connected to the portable vacuum cleaner and to ground.

\_\_\_ **ALINVEST –** An electrician has confirmed continuity to ground for the grounding cable (< 10 ohms) and vacuum hose (< 106 ohms). \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ohms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date

\_\_\_ **ALINVEST –** An electrician has re-confirmed continuity to ground each time the portable vacuum cleaner was relocated

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ohms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Electrician

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ohms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Electrician

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ohms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Electrician

**Post Job Performance**

|  |  |  |
| --- | --- | --- |
| **Cleaned Area** | **Cleaning Method** | **Estimated lbs. Removed** |
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|  |  |  |
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**Comments**

|  |
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**All requirements of the ALINVEST 28 Engineering Standard regarding cleanup of combustible dusts have been met and all explosion and fire risks have been identified and adequately controlled.**

**ALINVEST Responsible Person** (Print Name): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Signature):\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_ Time: \_\_\_\_\_\_\_\_\_\_\_

*(Permit expires 24 hrs after this date and time or upon job completion whichever is sooner. Document is to be retained by ALINVEST Responsible Person in designated location).*

**Attachment 3** [**(Back to TOC)**](#TOC)



In Europe the points of entry to places where *hazardous explosive atmospheres* may occur in such quantities as to endanger the health and safety of workers must be marked by the employer with the following warning sign:



**Attachment 4** [**(Back to TOC)**](#TOC)

**ALINVEST Standard Fire Fighting Preplan – Combustible Dust**

**Purpose:**

To provide operational guidelines on appropriate fire control methods when encountering combustible dust fires which include aluminum dust and fines that may present a fire and explosion hazard. For Heating Material see Attachment 5

**Applicable Resources Documents**

* + - OSHA 3644-04, Dated 2013 - Firefighting Precautions at Facilities with Combustible Dust

**Overview:**

Most fires involving combustible dust cannot be extinguished using ABC fire extinguishers and water. In most cases, the fire is controlled by application of Flux Salt, Dry Sand, or Class D extinguishing agents. The temperature of the material involved can remain extremely hot, and the fire can flare up again if the product is disturbed prior to the oxidation of the product and self-extinguishment.

Water in contact with some combustible dusts could result in the generation of Hydrogen. Actions need to be taken to ensure water does not contact combustible dusts unless the area is ventilated to the point hydrogen will not accumulate in a building or in any other way become confined. Extreme care needs to be exercised when using water to protect exposures.

Large fires are impossible to extinguish. The best approach is to isolate 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 and adequate ventilation is provided. Let the fire burn out naturally to minimize hazards to personnel and losses to exposures.

Fires involving combustible dusts need to be approached with extreme caution to ensure a dust cloud is not formed as a result of firefighting activities. Combustible dust suspended in air can result in primary and more destructive, secondary explosions.

OSHA 3644-04 should be used as a general guide in establishing Incident Action Plan (IAP) to respond to combustible dust related fire incidences.

**Procedure:**

* When encountering combustible dust fires **full protective gear** is required. This includes **Full Turnout gear and SCBA**. Thermal risk is present and fire can result in dust on fire falling down through a structure.

  
Example of Turnout Gear

* Set up **Incident Command Post** and identify necessary resources.
* **Secure the area** and evacuate all personnel from combustible dust hazard areas and adjacent areas. Only trained personnel should attempt to fight combustible dust fires. Firefighting should not be attempted until all personnel have been evacuated. Note – Operation of dry pipe sprinkler systems or water deluge systems will discharge air in advance of water flow or the piping network could shake. This could dislodge dust and create a dust cloud. If the area of the fire is protected by one of these systems manual firefighting should not commence until these systems have activated with water discharging from the systems.
* Ensure control of utilities (**water, gas, power sources**).
* Identify the material involved and quantity as well as the **physical state of the product**, e.g. Chips, power, fines, dust etc.
* Obtain any necessary **Material Safety Data Sheets** for any involved products and contact any personnel that may be knowledgeable of the area for information.
* To control a Combustible Dust fire, use the proper extinguishing agent. Attempt to smoother the fire with **Flux Salt, Dry Sand, or Class D extinguishing** **agent.** Isolate the fire from non-burning material if possible and let it burn its self out. DO NOT create a dust cloud while attempting to create a fire break or while smothering the burning material.
* **Water should only be used as a last resort when other methods of control have failed and the fire shows evidence of burning out of control. Use only low velocity spray or fog pattern to prevent a dust cloud explosion. Before this extinguishment method is initiated, all firefighting personnel should be evacuated from the area. This method of control can be effective, however it can intensify the fire if applied improperly. The generation of hydrogen is also possible so ventilation of any enclosure needs be established prior to the use of water.**
* **If a dust cloud forms as a result of firefighting activity, explosion or other reason immediately evacuate all fire fighters from the area or building to a safe distance.**

**Special Precautions and Additional Information**

1. **Large fires are impossible to extinguish. Isolate the material if possible; protect exposures with water streams if adequate drainage is present to prevent contact of water with the burning material.**
2. **Water contact combustible metal fines and powders can produce Hydrogen gas when exposed to water.**
3. **Use extreme caution when dealing with fires involving combustible metal powders, dust, and fines.** Explosions are possible, especially if the product becomes airborne and in the presence of an available ignition source.
4. When using your agent of choice to contain a combustible dust fire, **scoop the agent very carefully on and around the edges of the fire to contain and isolate burning material. The extinguishing agent should be applied with minimum disturbance to the burning dust.** Combustible dust fires can result in an explosion if it is suspended in air. The secondary explosion may be more violent than the original explosion.
5. **When creating fire breaks in combustible dust a few inches make a lot of difference in isolating dust from material that is already involved in a fire.** Move away from the fire 8 to 10 inches if possible and create an isolation trench about 2-3 inches wide if possible. To keep from disturbing the dust, the none burning dust can be pushed slowly toward the fire and then slowly away from the fire, to establish the trench and get down to the bare surface. If needed, Class D agent, salt, or sand can be applied in the trench. Allowing the Fire to completely burn out before attempting to remove unburned material (decreases the chance the fire will spread). A metal bucket should be used when cleaning up charred dust because it may still be hot to the touch. Note this activity shall be assumed to be manual firefighting activity and full bunker gear and SCBA is required (See previous picture).
6. Depending on the thickness of the burning dust and the surface the dust is on, i.e. steel, the fire may result in some expansion, warping, and/or failing of the structure due to high temperature of the fire. **Use extreme caution when attempting to create fire breaks or otherwise contain combustible dust fires.**
7. For all baghouse fires emergency responders should **verify that the pulse jet system for bag cleaning is turned off**. This will prevent the dust being dispersed off the bags (Creation of a dust cloud).
8. **Fires involving the baghouses with Nitrogen systems** will set off a temperature alarm causing the fans to cease operation and the Fire dampers will close and valves will prevent the material from transferring out of the collector. The nitrogen system will provide nitrogen to the enclosure displacing the oxygen to help extinguish the fire.
9. **Fires involving baghouses with water based extinguishing systems (Manual or Automatic).** Once a fire in a protected baghouse has been confirmed, operate the manual protection system or confirm automatic systems have actuated and that fire dampers have operated. Then move to a safe distance and cool any exposures. Note: If baghouse was not designed to handle the weight of the water discharged, water system operation could result in the structural failure of the baghouse. Note: During several baghouse fires the manual deluge system has failed to fully extinguish the fire so once the fire stabilizes, the fire brigade may need to manually extinguish the fire or protect exposures and wait for all combustibles to be consumed.  
     
   For hot baghouses with Lime or sodium Bicarbonate injection systems the introduction of water may result in spontaneous heating of the material. It is recommended that the baghouse be emptied of this material as quickly as possible and that large amount of water are used to cool this material or that it be isolated and spread out to allow it to fully react prior to disposal.
10. **Fires in unprotected baghouses** should be fought by leaving the fan operating (Shutting the fan down will increase the temperature in the baghouse and increase the chance of a combustible dust explosion) This will ensure that material coating the bags remains in place and does not create a dust cloud in the baghouse.
11. **Fires involving large quantities of combustible dust** within a structure can result in rapid heat buildup and smoke generation. Use extreme caution. In some cases it may be best to allow the fire to burn out & protect exposures.
12. **Fires involving vacuum trucks** if applicable, need to be addressed by the preplan to ensure that the emergency response is coordinated. The plan also needs to identify where the truck should go to dump the load to limit the damage to the truck and exposure to the plant.
13. **Do not use any other extinguishing agents** that are not listed in this procedure as they can produce hazardous by-products and / or violent explosions.

**Attachment 5** [**(Back to TOC)**](#TOC)

**ALINVEST Standard “Heating Material” Preplan**

**Purpose**

To provide operational guidelines on appropriate methods and limitation when encountering heating material that may contain combustible dust and other combustible material. This document also defines when activities exceed the scope of this preplan and need to be transitioned to the Combustible Dust “Fire Fighting” preplan – See Attachment 4.

Note: Heating material is defined as a layer of Dust or other material that is heated from an external heat source or exothermic reaction prior to open flaming.

**Overview**

Employees responding to heating material where the total area is less than .22 Sq. m (2 Sq. ft.) and material in on a flat horizontal surface not likely to fall and disturb other material in the area:

* + - All responders shall Wear fire retardant clothing
    - Responders shall limit activities to moving non-involved material away from the heating material, then
    - Apply dry sand, dry powder fire extinguisher, etc. to further isolate the heating material, then
    - Wait for material to fully cool prior to clean-up operation.

**If heating material spreads outside the limits defined above or involves combustible dust in the vertical plain or has the potential to fall or other wise move and potentially cause a dust cloud to form, the responders shall “Stop”, evacuate the area and call the fire brigade or local fire department and transition to the “Combustible Dust Fire Preplan”.**

**Activities**

**Use of dry sand and powder extinguishing agents**

* + - Utilization of dry sand is the preferred method for dealing with heating material. The plant specific pre-plan shall address such issues as sand transportation to site and application of the sand in the immediate area of the heating material and possibly from a remote distance due to radiant heat concerns.
    - Smoldering or heating material shall be ringed with a dam of dry sand, preferably less than 20 mesh, dry inert granular material, dry flux salt, or a listed Class D extinguishing powder in accordance with the manufacturer’s instructions. Application of dry extinguishing agent shall be conducted in such a manner so as to avoid any disturbance of the combustible dust, which could cause a dust cloud.
    - The dry extinguishing agent shall be stored in such a manner that it remains clean and dry.
    - The dry extinguishing agent shall be carefully applied with a non-sparking metal scoop or shovel, applied from a listed Class D fire extinguisher equipped with a low-velocity nozzle or by other remote means (conveyor, slide, etc.) in a manner that does not disturb the burning dust.
    - The dry extinguishing agent is generally applied by ringing and then covering the burning dust with a layer of powder at least 38 mm (1-1⁄2 in.) deep. The powder shall be applied with minimum disturbance to the burning dust.

**Attachment 6** [**(Back to TOC)**](#TOC)

**Combustible Dust - Project Review Check List**

The listing below is a “shopping list” of protection features that:

* Have been used to protect existing ALINVEST dust collection systems and baghouses or
* are required by NFPA codes or
* are recommended by equipment manufacturers or
* are listed in the ALINVEST combustible dust standard.

Each new dust collection system needs to be reviewed to determine which of these features should be included to address Life safety, explosion, fire and general loss prevention concerns.

**Hot Dust Collection Systems (>100oC)**

**Explosion Prevention**

* Explosion Isolation systems (Chemical or mechanical)
* Explosion relief panels / Deflagration venting
* Design air flow for < 25% MEC

**Fire Protection**

* Detection
  1. heat detection
  2. Flame detection
* Prevention of Ignition sources
  1. Passive spark arrestors
  2. Long duct runs
  3. Bonding and grounding
  4. Proper hazardous location electrical equipment
  5. Lightning protection
* Suppression
  1. Manual or automatic deluge (Hydrogen generation – venting may be required)
  2. Spark suppression systems
  3. Nitrogen or CO2 suppression / inerting systems

**General Loss Prevention**

* Spatial separation from other critical structures or buildings 16M (50ft min. )
* Modular design
* Inlet / outlet fire dampers (for each cell)
* Locate outside of building
* Dilution air vents (tempering air Vents)
* Evaporative water spray cooling system
* Automatic shutdown on high temperature
* Lime injection (if required to address environmental concern)
* Inlet / outlet temperature monitoring
* Surface temperature of baghouse
* Discharge chokes (augers, rotary valves)
* Induced draft fans
* 1372 mpm (4500 fpm) (duct conveying velocity
* Nomex / P84 / Teflon coated polyester, etc. bags
* Heavy wall duct work inside buildings (100 PSI internal pressure)
* Use conductive waste bags (Supper sacks C) Note: A and B are non-conductive and should not be used)

**Cold Dust Collection Systems(< 100oC)**

**Explosion Prevention**

* Explosion Isolation systems (Chemical or mechanical)
  1. Chemical isolation systems;
  2. Mechanical isolation systems

1. Rotary air locks (i.e., rotary valves, star valves);
2. Rapid-action valves (gate or butterfly type);
3. High speed abort gates;
4. Double-dump valves;
5. Rapid-action valves (float type);
6. Flame front diverter

* Explosion relief panels / Deflagration venting

Design air flow for < 25% MEC

**Fire Protection**

* Detection
  1. heat detection
  2. Flame detection
* Prevention of Ignition sources
  1. Passive spark arrestors
  2. Long duct runs
  3. Bonding and grounding
  4. Proper hazardous electrical equipment
  5. Lightning protection
* Suppression
  1. Manual or automatic deluge (Hydrogen generation – venting may be required)
  2. Automatic sprinklers (Hydrogen generation – venting may be required)
  3. Spark suppression systems
  4. CO2 suppression / inerting systems

**General Loss Prevention**

* Spatial separation from other critical structures or buildings 16M (50ft min. )\
* Modular design
* Inlet / outlet fire dampers (for each cell)
* Locate outside of building
* Automatic shutdown on high temperature
* Inlet / outlet temperature monitoring
* Surface temperature of baghouse
* Discharge chokes (augers, rotary valves)
* Induced draft fans
* 1372 mpm (4500 fpm) conveying velocity (use of register collars)
* Nomex / P84 / Teflon coated polyester, etc. bags
* Heavy wall duct work inside buildings (100 PSI internal pressure)
* Use conductive waste bags (Supper sacks C) Note: A and B are non-conductive and should not be used)

**Saws / Scalper Cyclones / Hoppers / Edge Ballers**

**Explosion Prevention**

* Explosion Isolation systems (Chemical or mechanical)
  1. Chemical isolation systems;
  2. Mechanical isolation systems

1. Rotary air locks (i.e., rotary valves, star valves);
2. Rapid-action valves (gate or butterfly type);
3. High speed abort gates;
4. Double-dump valves;
5. Rapid-action valves (float type);
6. Flame front diverter

* Explosion relief panels / Deflagration venting
* Design air flow for < 25% MEC

**Fire Protection**

* Detection
  1. heat detection
  2. Flame detection
* Prevention of Ignition sources
  1. Passive spark arrestors
  2. Long duct runs
  3. Bonding and grounding
  4. Proper hazardous electrical equipment
  5. Lightning protection
* Suppression
  1. Manual or automatic deluge (Hydrogen generation – venting may be required)
  2. Automatic sprinklers (Hydrogen generation – venting may be required)
  3. Spark suppression systems
  4. CO2 suppression / inerting systems

**General Loss Prevention**

* Spatial separation from other critical structures or buildings 16M (50ft min.)
* Modular design
* Inlet / outlet fire dampers (for each cell)
* Locate outside of building
* indoor material hoppers/collectors < .227 m3 (8ft3), (or less than a 208 L (55 gal) drum) – Dirty side)
* Automatic shutdown on high temperature
* Inlet / outlet temperature monitoring
* Surface temperature of baghouse
* Discharge chokes (augers, rotary valves)
* Wet collectors
* Induced draft fans
* 1372 mpm (4500 fpm) conveying velocity (use of register collars)
* Nomex / P84 / Teflon coated polyester, etc. bags
* Heavy wall duct work inside buildings (6.9 Bar (100 PSI) internal pressure)
* Low velocity oil spray at collection bin (used on saw at Greensboro)
* Use conductive waste bags (Supper sacks C) Note: A and B are non-conductive and should not be used)

**Attachment 7** [**(Back to TOC)**](#TOC)

**Vacuum Truck Diagram and Static Conductive Hose Information**



Note: Truck diagram shown with static conductive hose with bonded metal braid or auxiliary ground conductor.

**Static conductive hose without bonded metal braid or auxiliary ground conductor test method.**

The resistance of conductive hoses can only be determined with a test instrument specifically designed for measuring insulation resistance. This requires a nominal open circuit DC voltage of 500 volts. The instrument should provide an accuracy of +/- 10%. The test should not dissipate more than 3 watts of power into the hose specimen to prevent errors associated with test temperature. The dissipating power shall be determined by the square of the applied voltage divided by the resistance of the measurement (ohms law).

In order to perform the test with sufficient contact with the hose inner core, metallic end fittings (permanent or temporary) must be applied to hose and clamped to assure contact.

If a conductive hose braid is present, care should be taken to isolate from the end fittings for the test which could potentially cause false readings of hose resistivity. The hose assembly must also be isolated from ground to perform this test. The insulation resistance shall be less than 1 Meg-ohm.

**Static conductive hose with bonded metal braid or auxiliary ground conductor test method**.

It is sometimes customary to bond the hose reinforcement to the end connectors or to include an internal/external wire or cable to the hose assembly. This will change the resistance of the assembly based on the conductive ability of the conductor whether it is metallic, carbon fiber, etc. If this conductor is metallic, a suitable ohmmeter with an accuracy of +/- 10 % should be used to determine conductivity. Consult hose manufacturer for information on non-metallic conductors. The insulation resistance for an individual assembly with metallic conductor shall be less than 10 ohm.

**Documentation:**

Each hose assembly shall have a serial number applied and the above test data recorded.

**Attachment 8** [**(Back to TOC)**](#TOC)

**ATEX Documentation Summary for European Plants**

For sites in the EU, where the combustible dust can generate explosive atmosphere, the site must ensure that an explosion protection document is drawn up and kept up to date.

This document must at least demonstrate:

* That the explosion risks have been determined and assessed;
* That adequate measures will be taken to attain the aims of the Directive;
* Those places which have been classified into zones;
* Those places where the minimum requirements set out in Annex II to the Directive will apply;
* That the workplace and work equipment, including warning devices, are designed, operated and maintained with due regard for safety;
* That in accordance with Council Directive 89/655/EEC, arrangements have been made for the safe use of work equipment.

The explosion protection document must be drawn up prior to the commencement of work and be revised when the workplace, work equipment or organization of the work undergoes significant changes, extensions or conversions.

**Implementation**  
  
The explosion protection document is intended to provide an overview of the results of the risk assessment and the consequent technical and organizational protective measures for a plant and its working environment.  
  
The document must be tailored to conditions in the site. It should as far as possible be well-structured and easy to read and the degree of detail should be such as to allow a general grasp of its content. The amount of documentation should therefore not be excessive. When necessary, the document should be produced in a form that allows additions, e.g. as a loose-leaf collection. This is particularly recommended for larger plants or where the plant engineering is frequently changed.

**Specimen layout for an explosion protection document**

**Description of the workplace and working areas:**  
  
The workplace is divided into working areas. The explosion protection document describes the working areas at risk from explosive atmospheres.  
  
The description may contain, e.g. the name of the establishment, type of plant, building/room designation and persons in charge, number of workers employed.  
  
Documentation of the buildings and topography may be in graphic form, e.g. site and layout plans, including plans of escape and rescue routes.

**Description of the process steps and/or activities:**  
  
The process should be described in a brief text, perhaps accompanied by a flowchart. This description should contain all information that is important for explosion protection. It should cover the operational steps including startup and shutdown, an overview of design and operational data (e.g. temperature, pressure, volume, throughput, rotational speed, work equipment), the nature and extent of cleaning if relevant, and possibly details of space ventilation.

**Description of the substances used / safety parameters:**  
  
This should in particular indicate what substances form the explosive atmosphere and under what process conditions it arises. At this point, it is useful to list the safety parameters relevant to explosion protection

**Results of the risk analysis:**  
  
This section should indicate where hazardous explosive atmospheres may arise, possibly distinguishing between the inside of items of plant and their surroundings. Startup and shutdown, cleaning and malfunctions must be taken into account as well as normal operation. The procedure for process or product changes must also be addressed where appropriate. The hazardous places (zones) can be described by means of a text and also represented graphically as a zone plan.  
  
The explosion hazards should also be described at this point. It is useful to state the procedure followed in identifying the explosion risks.

**Explosion protection measures taken:**  
  
This section is based on the risk assessment and describes the resulting explosion protection measures. The principle underlying the protective measures should be stated, e.g. "Avoidance of effective ignition sources". It is useful to distinguish between technical and organizational measures.  
  
**Technical measures:**

* Prevention As the explosion protection strategy for the plant is based, fully or in part, on preventive measures - avoidance of explosive atmospheres or of ignition sources - the way in which these measures are implemented must be described in detail.
* Mitigation As the plant will be protected by mitigation measures, their nature, manner of operation and location must be described.
* Process Control Engineering (PCE) measures If PCE measures are part of the explosion protection strategy, their nature, manner of operation and location must be described.

**Organizational measures:**  
  
The organizational measures must also be described in the explosion protection document. The explosion protection document must demonstrate:

* what operating instructions have been produced for a workplace or activity;
* what steps are taken to ensure competence of the persons employed;
* the content and frequency of training (and the participants);
* any rules for the use of mobile work equipment in hazardous places;
* what steps are taken to ensure that workers wear only suitable protective clothing;
* whether a permit-to-work system is in place and, if so, how it is organized;
* how maintenance, inspection and checking are organized;
* how the hazardous places are marked.

If forms relating to these points are available, specimens can be attached to the explosion protection document. A list of mobile work equipment authorized for use in hazardous places should be attached. The level of detail should depend on the type and size of the operation, and the degree of risk involved.

**Implementation of the explosion protection measures**  
  
The explosion protection document should indicate who is responsible for carrying out particular measures or who has been or will be appointed (e.g. to produce and update the explosion protection document itself). It should also state when the measures have to be taken and how their effectiveness is to be checked.

**Coordination of the explosion protection measures**  
  
Where workers from several undertakings are present at the same workplace, each employer is responsible for all matters coming under his control. The employer responsible for the workplace must coordinate the implementation of all the explosion protection measures and state in his explosion protection document the aim of that coordination and the measures and procedures for implementing it.

**Annex to the explosion protection document**  
  
The annex may contain e.g. EC type-examination certificates, EC certificates of conformity, safety datasheets, operating instructions for plant or equipment. Servicing plans relevant to explosion protection may also be included.

**Attachment 9 [(Back to TOC)](#TOC)**

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| **ALINVEST FIRE PROTECTION STANDARD**  **REVISION REQUEST FORM** |
| **Directions:**  Fill in the form and mail to: ALINVEST Risk Management, Corporate Manager, Property Conservation – E-mail from to: (Fill in with risk manager email address)  **NAME:** \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_ **DATE**: \_\_\_\_\_\_\_\_\_\_\_\_\_  **PHONE**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  **E-MAIL:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| **STANDARD #:**  **STANDARD TITLE:**  **SECTIONS AFFECTED**:  **REVISION:**  **REASON FOR REVISION:** |
| RISK MANAGEMENT RESPONSE: DATE: |

1. The **ATEX directive** consists of two [EU](http://en.wikipedia.org/wiki/EU) [directives](http://en.wikipedia.org/wiki/Directive_(European_Union)) describing what equipment and work environment is allowed in an environment with an [explosive](http://en.wikipedia.org/wiki/Explosive) [atmosphere](http://en.wikipedia.org/wiki/Atmosphere). ATEX derives its name from the [French](http://en.wikipedia.org/wiki/French_language) title of the 94/9/EC directive: *Appareils destinés à être utilisés en* ***AT****mosphères* ***EX****plosives* [↑](#footnote-ref-1)
2. [**(Back to TOC)**](#TOC) [↑](#endnote-ref-1)