



# OSHA INSTRUCTION

U.S. DEPARTMENT OF LABOR

Occupational Safety and Health Administration

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**DIRECTIVE NUMBER:** CPL 03-00-006

**EFFECTIVE DATE:** October 18, 2007

**SUBJECT:** Combustible Dust National Emphasis Program

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## ABSTRACT

**Purpose:** This instruction contains policies and procedures for inspecting workplaces that create or handle combustible dusts. In some circumstances these dusts may cause a deflagration, other fires, or an explosion. These dusts include, but are not limited to:

- Metal dust such as aluminum and magnesium.
- Wood dust
- Coal and other carbon dusts.
- Plastic dust and additives
- Biosolids
- Other organic dust such as sugar, paper, soap, and dried blood.
- Certain textile materials

**Scope:** This instruction applies OSHA-wide.

**References:** See paragraph III.

**State Plan Impact:** Notice of Intent required. See paragraph VI.

**Action Offices:** National, Regional, and Area Offices.

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By and Under the Authority of

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### **Executive Summary**

OSHA is initiating this National Emphasis Program (NEP) to address the deflagration, other fire, and explosion hazards that may exist at facilities handling combustible dust. A combustible dust hazard study conducted by the U.S. Chemical Safety and Hazard Investigation Board (CSB) found that nearly 280 dust fires and explosions have occurred in U.S. industrial facilities over the past 25 years, resulting in 119 fatalities and over 700 injuries.

The purpose of this NEP is to inspect facilities that generate or handle combustible dusts which pose a deflagration or other fire hazard when suspended in air or some other oxidizing medium over a range of concentrations, regardless of particle size or shape; deflagrations can lead to explosions. Combustible dusts are often either organic or metal dusts that are finely ground into very small particles, fibers, fines, chips, chunks, flakes, or a small mixture of these. Types of dusts include, but are not limited to: metal dust, such as aluminum and magnesium; wood dust; plastic dust; biosolids; organic dust, such as sugar, paper, soap, and dried blood; and dusts from certain textiles. Some industries that handle combustible dusts include: agriculture, chemicals, textiles, forest and furniture products, wastewater treatment, metal processing, paper products, pharmaceuticals, and recycling operations (metal, paper, and plastic).

In situations where the facility being inspected is not a grain handling facility, the lab results indicate that the dust is combustible, and the combustible dust accumulations not contained within dust control systems or other containers, such as storage bins, are extensive enough to pose a deflagration, explosion, or other fire hazard, then citations under 29 CFR 1910.22 (housekeeping) or, where appropriate, 29 CFR 1910.176(c) (housekeeping in storage areas) may generally be issued. Combustible dusts found in grain handling facilities are covered by 29 CFR 1910.272.

For workplaces not covered by 1910.272, but where combustible dust hazards exist within dust control systems or other containers, citations under section 5(a)(1) of the OSH Act (the General Duty Clause) may generally be issued for deflagration, other fire, or explosion hazards. National Fire Protection Association (NFPA) standards (listed in Appendix A of this directive) should be consulted to obtain evidence of hazard recognition and feasible abatement methods. Other standards are applicable to the combustible dust hazard. For example, if the workplace has a *Class II* location, then citations under 29 CFR 1910.307 may be issued to those employers having

electrical equipment not meeting the standard's requirements.

**New Directive: Significant Issues**

This is a new directive describing policies and procedures regarding inspection of facilities that handle combustible dust. This directive does not replace the grain handling facility directive, OSHA Instruction CPL 02-01-004, Inspection of Grain Handling Facilities, 29 CFR 1910.272. In addition, this directive is not intended for inspections of explosives and pyrotechnics manufacturing facilities covered by the Process Safety Management (PSM) standard (1910.119). However, it does not exclude facilities that manufacture or handle other types of combustible dusts (such as ammonium perchlorate) covered under the PSM standard.

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I. Purpose. This instruction contains policies and procedures for inspecting workplaces that handle combustible dusts that are likely to cause dust deflagrations, other fires, or explosions. These dusts include, but are not limited to:

- Metal dust such as aluminum and magnesium.
- Wood dust
- Coal and other carbon dusts
- Plastic dust and additives
- Biosolids
- Other organic dust such as sugar, paper, soap, and dried blood.
- Certain textile materials.

Industries that handle combustible dusts include, but are not limited to:

- Agriculture
- Chemicals
- Textiles
- Forest and furniture products
- Metal processing
- Tire and rubber manufacturing plants
- Paper products
- Pharmaceuticals
- Wastewater treatment
- Recycling operations (metal, paper, and plastic.)
- Coal dust in coal handling and processing facilities.

(Note: OSHA Standard 29 CFR 1910.269(v)(11)(xii) addresses control of ignition sources at coal handling operations in electric power plants. The Mine Safety and Health Administration (MSHA) has authority in some areas involving coal crushing and conveying. See OSHA Instruction CPL 02-01-038 dated June 18, 2003 for additional guidance on authority)

II. Scope. This instruction applies OSHA-wide.

III. References.

- A. OSHA Regional Notice (Region III), Directive Number: 2006 - 556 (CPL 04), Local Emphasis Program for Dust Explosion Prevention, October 1, 2006.
- B. OSHA Instruction CPL 02-00-103, Field Inspection Reference Manual, September 26, 1994.
- C. OSHA Instruction CPL 02-01-004, Inspection of Grain Handling Facilities, 29 CFR 1910.272, November 8, 1996.
- D. OSHA Instruction CPL 02-01-038, Enforcement of the Electric Power Generation, Transmission, and Distribution Standard, June 18, 2003.
- E. Safety and Health Information Bulletin (SHIB)--Improper Installation of Wood Dust Collectors in the Woodworking Industry—May 2, 1997.

- F. SHIB--Combustible Dust in Industry: Preventing and Mitigating the Effects of Fire and Explosions—July 31, 2005.
  - G. 29 CFR 1910.399--Definitions applicable to Subpart S—Electrical.
  - H. NFPA 61, Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities (2002 Edition).
  - I. NFPA 68, Guide for Venting of Deflagrations (2002 Edition).
  - J. NFPA 69, Standard on Explosion Prevention Systems (2002 Edition).
  - K. NFPA 70, National Electrical Code (2005).
  - L. NFPA 77, Recommended Practice on Static Electricity.
  - M. NFPA 86, Standard for Ovens and Furnaces.
  - N. NFPA 120, Standard for Fire Prevention and Control in Coal Mines.
  - O. NFPA 91, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids (2004 Edition).
  - P. NFPA 484, Standard for Combustible Metals (2006 Edition).
  - Q. NFPA 499, Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemicals Process Areas (2004 Edition).
  - R. NFPA 654, Standard for the Prevention of Fires and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids (2006 Edition).
  - S. NFPA 664, Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities (2007 Edition).
  - T. NFPA 2113, Standard on Selection, Care, Use and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire.
  - U. United States Chemical Safety and Hazard Investigation Board (CSB) Combustible Dust Explosion Reports and website.
  - V. ASTM E1226 – 05, Standard Test Method for Pressure and Rate of Pressure Rise for Combustible Dusts.
  - W. ASTM E1515, Standard Test Method for Minimum Explosible Concentration of Combustible Dusts.
  - X. FM Global, Data Sheet No. 7-76, Prevention and Mitigation of Combustible Dust Explosions and Fire (2006 Edition).
  - Y. National Materials Advisory Board (NMAB) 353-3-80, Classification of Combustible Dusts in Accordance with the National Electrical Code.
  - Z. NFPA 85, Boiler and Combustion Systems Hazards Code (2007 Edition).
- IV. Action. OSHA Regional Administrators and Area Directors must use professional judgment when ensuring that the policies and procedures set forth in this directive are followed.
- V. Application. OSHA compliance personnel must use professional judgment when carrying out the procedures contained in this directive when conducting inspections of the facilities selected under this NEP.
- VI. Federal Program Change. This instruction describes a Federal program change, which

establishes a National Emphasis Program (NEP) for inspecting workplaces that handle combustible dusts. State plan participation in this national emphasis effort is strongly encouraged but is not required. State response/notice of intent regarding this directive is required.

The State's response/notice of intent must indicate whether the State will initiate an emphasis program and if so, whether the State's program will be identical to or different from the Federal one. If the State's program differs from the Federal program, its implementing policies and procedures are expected to be at least as effective as those in this instruction and must be available for review. The State may either post its emphasis program on its State plan website and provide the link to OSHA or provide information on how a copy may be obtained. (OSHA will provide summary information on the State response to this instruction on its website.)

The assignment of appropriate IMIS identifier codes for State Emphasis Programs should be coordinated with the Directorate of Information Technology and the Regional Administrator.

- VII. Background. Dust deflagration, other fire, and explosion hazards in the industries noted in Section I, Purpose, are covered by several OSHA standards and the general duty clause. A chemical dust deflagration occurs when the right concentration of finely divided chemical dust suspended in air is exposed to a sufficient source of ignition to cause ignition (combustion) of the dust. If the deflagration is in a confined area, an explosion potential exists. These materials can also cause other fires. Combustible dust is often either organic or metal dust that is finely ground into very small particles. The actual quantity of dust that may accumulate in an affected area may vary, depending upon air movement, particle size, or any number of other factors.

OSHA is initiating this NEP to address the deflagration, other fire, and explosion hazards associated with most combustible dusts. It is issued in response to a number of combustible dust accidents which have resulted in deaths and serious injuries.

In 1999, a primary explosion of natural gas in an idle power boiler followed by a secondary explosion of disturbed coal dust in the facility caused six fatalities and fourteen serious injuries in a Michigan electrical power generation facility. (See Safety and Health Information Bulletin: Potential for Natural Gas and Coal Dust Explosions in Electrical Power Generating Facilities.)

In May 2002, an explosion occurred at Rouse Polymerics International, Inc., a rubber fabricating plant, in Vicksburg, Mississippi, which injured eleven employees, five of whom later died of severe burns. The explosion occurred when highly combustible rubber dust that had been allowed to accumulate ignited.

On January 29, 2003, an explosion and fire destroyed the West Pharmaceutical Services plant in Kinston, North Carolina, causing six deaths, dozens of injuries, and hundreds of

job losses. The facility produced rubber stoppers and other products for medical use. The fuel for the explosion was a fine plastic powder, which accumulated above a suspended ceiling over a manufacturing area at the plant and ignited.

On February 20, 2003, an explosion and fire damaged the CTA Acoustics manufacturing plant in Corbin, Kentucky, fatally injuring seven employees. The facility produced fiberglass insulation for the automotive industry. The resin involved was a phenolic binder used in producing fiberglass mats.

On the evening of October 29, 2003, a series of explosions severely burned three employees, one fatally, and caused property damage to the Hayes Lemmerz manufacturing plant in Huntington, Indiana. One of the severely burned men subsequently died. The Hayes Lemmerz plant manufactures cast aluminum automotive wheels, and the explosions were fueled by accumulated aluminum dust, a combustible byproduct of the wheel production process.

These explosions -- in Michigan, Mississippi, North Carolina, Kentucky, and Indiana -- resulted in the loss of 25 lives and caused numerous injuries and substantial property losses.

In opening a daylong public hearing on the combustible dust hazard on June 22, 2005, the United States Chemical Safety and Hazard Investigation Board (CSB) declared that chemical dust explosions in the United States are a "serious industrial safety problem." In November 2006, CSB issued a Combustible Dust Hazard Study Report that revealed the occurrence of nearly 280 dust fires and explosions in U.S. industrial facilities over the past 25 years, resulting in approximately 119 fatalities and over 700 injuries. In that report CSB made five recommendations to OSHA, one of which urged OSHA to conduct a special emphasis program targeting industries particularly at risk for dust explosions, such as aluminum casting, plastics, pharmaceuticals, and wood products. Details on this study and other CSB reports can be found at <http://www.csb.gov>.

## VIII. Definitions.

The following is a partial listing of definitions based on NFPA standards and 29 CFR 1910.399, the definitions provision of Subpart S—Electrical, that relate to combustible dust.

- A. Class II locations. Class II locations are those that are hazardous because of the presence of combustible dust. The following are Class II locations where the combustible dust atmospheres are present:

*Group E.* Atmospheres containing combustible metal dusts, including aluminum, magnesium, and their commercial alloys, and other combustible dusts whose particle size, abrasiveness, and conductivity present similar hazards in the use of electrical equipment.



*Group F.* Atmospheres containing combustible carbonaceous dusts that have more than 8 percent total entrapped volatiles (see ASTM D 3175, *Standard Test Method for Volatile Matter in the Analysis Sample of Coal and Coke*, for coal and coke dusts) or that have been sensitized by other materials so that they present an explosion hazard. Coal, carbon black, charcoal, and coke dusts are examples of carbonaceous dusts.

*Group G.* Atmospheres containing other combustible dusts, including flour, grain, wood flour, plastic and chemicals.

- B. *Combustible dust.* A combustible particulate solid that presents a fire or deflagration hazard when suspended in air or some other oxidizing medium over a range of concentrations, regardless of particle size or shape.
- C. *Combustible Particulate Solid.* Any combustible solid material composed of distinct particles or pieces, regardless of size, shape, or chemical composition.
- D. *Hybrid Mixture.* A mixture of a flammable gas with either a combustible dust or a combustible mist.
- E. *Deflagration.* Propagation of a combustion zone at a speed that is less than the speed of sound in the unreacted medium.
- F. *Deflagration Isolation.* A method employing equipment and procedures that interrupts the propagation of a deflagration of a flame front, past a predetermined point.
- G. *Deflagration Suppression.* The technique of detecting and arresting combustion in a confined space while the combustion is still in its incipient stage, thus preventing the development of pressures that could result in an explosion.
- H. *Detonation.* Propagation of a combustion zone at a velocity that is greater than the speed of sound in the unreacted medium.
- I. *Dust-ignitionproof.* Equipment enclosed in a manner that excludes dusts and does not permit arcs, sparks, or heat otherwise generated or liberated inside of the enclosure to cause ignition of exterior accumulations or atmospheric suspensions of a specified dust on or in the vicinity of the enclosure.
- J. *Dusttight.* Enclosures constructed so that dust will not enter under specified test conditions.
- K. *Explosion.* The bursting or rupture of an enclosure or a container due to the development of internal pressure from deflagration.

- L. Minimum Explosible Concentration (MEC). The minimum concentration of combustible dust suspended in air, measured in mass per unit volume that will support a deflagration.

IX. Program Procedures.

- A. Inspection Scheduling. Inspections conducted under this NEP will focus on general industry facilities where employees may be exposed to potential combustible dust hazards.
1. Using the most recently available Dunn and Bradstreet employer list, the Office of Statistical Analysis (OSA) will prepare a master list of establishments in the SIC/NAICS codes listed in Appendix D of this Instruction, which represents industries with an OSHA inspection history of combustible dust hazards. OSA will then provide to each Area Office a list of establishments in these SIC/NAICS codes within the Area Office's geographical jurisdiction.
  2. Based on its familiarity with local industries, each Area Office will then make appropriate additions and deletions to its list. See OSHA Instruction CPL 02-00-025 (CPL 2.25I)-Scheduling Systems for Programmed Inspections.
    - Other facilities with a known a pattern of combustible dust hazards (with SICs/NAICS other than the ones listed in Appendix D) may be added, in alphabetical order, to the bottom of the list. The Area Office shall document the basis for any such addition.
    - Area Offices shall delete from the master list any facilities not likely to have combustible dust hazards, documenting the basis for such determinations.
    - Area Offices shall delete from the master list any establishments known to be out of business, documenting the basis for such determinations.
    - Area Offices may delete any establishment that has received an inspection addressing combustible dust hazards within the previous five Fiscal Years, provided either that no citations were issued for combustible dust hazards or that a citation(s) was issued but a follow-up inspection documented tangible appropriate and effective efforts to abate the serious hazards cited or OSHA received abatement verification that the dust hazards have been abated. An establishment with a pending contest of a citation

related to combustible dust hazards will not be deleted, but the inspection will be deferred during the contest.

3. After additions and deletions have been made, each establishment on the resulting establishment list will be assigned a sequential number, starting at the top of the list with number one. A random number table (RNT) (see CPL 02-00-025) will then be applied. Inspections will be scheduled in the order called for by the RNT.
4. Each Area Office shall conduct at least one NEP inspection from this list in each Fiscal Year.
5. Area Offices will ensure that they schedule and conduct enforcement activities following the guidelines set forth in CPL 02-00-051, Enforcement Exemptions and Limitations under the Appropriations Act, using the NAICS codes found in the current Appendix A of CPL 02-00-051.
6. The establishment list generated under this NEP must be maintained in the Regional/Area Offices for a period of three years. (See OSHA Instruction ADM 03-01-005, OSHA Compliance Records.)

**B. Scheduling and Resource Allocation.**

1. Some establishments selected for inspection under this NEP also may be selected under the current Site-Specific Targeting (SST) Plan. Whenever possible, NEP inspections should be conducted concurrently with SST inspections. If this is not possible, the SST plan inspections have priority and are to be conducted prior to NEP inspections. Refer to OSHA Notice CPL 07-03 (CPL 02), Site-Specific Targeting 2007 (SST-07), or subsequent implementing directive for later years.
2. If a formal complaint or referral is received related to a facility handling combustible dust, the complaint or referral item(s) shall be investigated in accordance with OSHA Instruction CPL 02-00-140, Complaint Policies and Procedures, and an inspection as required by this NEP should be conducted if the Area Director determines that the facility has not already been inspected as per this instruction and resources are available to conduct the NEP inspection.
3. If a nonformal complaint is received related to a facility handling combustible dust, and if an inspection is conducted to investigate the complaint based on the criteria contained in OSHA Instruction CPL 02-00-140, then an inspection as required by this NEP should be conducted if the Area Director determines that the facility has not already been inspected

under this instruction and resources are available to conduct the NEP inspection.

4. Responses to accidents and catastrophes at facilities handling combustible dust shall follow the guidelines contained in CPL 02-00-137, Fatality/Catastrophe Investigation Procedures, in addition to the guidelines contained in this instruction. If a fatality or catastrophe investigation arises at a facility due to a combustible dust deflagration or explosion, the accident shall be investigated and an inspection as required under this NEP shall be conducted.

C. Opening Conference.

During the opening conference and after a preliminary walkaround of the facility, if the CSHO determines that the employer's operation does not have combustible dust explosion, deflagration, or other fire hazards, then the CSHO may terminate the inspection, or contact the Area Office on whether to continue the inspection. Additionally, if the CSHO determines that the facility has undergone an OSHA consultation visit in the past three years and verifies (through a basic walkaround and evaluation of any changes made by the employer) that the combustible dust explosion hazards have sufficiently been addressed by the employer, then the CSHO shall normally terminate the inspection.

During the opening conference, if the CSHO determines that the facility being inspected is covered under the grain handling standard (1910.272), then the CSHO shall not use the guidance provided in this instruction, but instead, shall use the guidance provided in OSHA Instruction, CPL 02-01-004, Inspection of Grain Handling Facilities, 29 CFR 1910.272, November 8, 1996.

D. Inspection Resources.

1. When possible, only CSHOs trained in recognizing the hazards associated with combustible dust shall be assigned to conduct inspections under this NEP. A training course offered by the OSHA Training Institute (OTI) in recognizing combustible dust explosion hazards may be one source of such training. The training at OTI covers various topics, including engineering controls and methodologies in preventing combustible dust deflagration, other fire, and explosion hazards. In addition the training covers several NFPA documents referenced in Section III of this directive, including NFPA 654, NFPA 68, and NFPA 69. (Note: CSHOs knowledgeable in recognition and control of combustible dust hazards and familiar with NFPA provisions need not undergo the training at OTI). The Regional Administrators will ensure that an appropriate number of CSHOs trained in combustible dust hazard recognition are available for inspections under this NEP.

2. If appropriate, the Area Director in coordination with the Regional Office shall decide as soon as practicable whether or not expert services from outside the Agency (such as expert witnesses) will be needed to support a combustible dust case properly. If so, such services shall be involved at the earliest date practical.
3. To support inspections under this NEP, each Regional Office library shall have industry reference documents available for CSHOs to use as a resource to support research and enforcement activities during the inspection. However, Area Offices that conduct a larger number of inspections under this NEP should have these industry reference documents in their own libraries.

At a minimum, each Regional Office shall have available for CSHOs the hard copies of the latest editions of the following documents (listed in Section III, References of this instruction):

- a. NFPA 654, Standard for the Prevention of Fires and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids.
- b. NFPA 484, Standard for Combustible Metals, Metal Powders, and Metal Dusts.
- c. NFPA 664, Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities.
- c. NFPA 68, Guide for Venting of Deflagrations.
- d. NFPA 85: Boiler and Combustion Systems Hazards Code
- e. NFPA 69, Standard on Explosion Prevention Systems.
- f. NFPA 499, Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.
- g. FM Global Safety Data pamphlet FM 7-76

Note: The NFPA documents are available online in readable format, without charge, at:

[http://www.nfpa.org/aboutthecodes/list\\_of\\_codes\\_and\\_standards.asp](http://www.nfpa.org/aboutthecodes/list_of_codes_and_standards.asp)

At the above web address, the following steps will allow in accessing a NFPA standard only in readable format: 1) select the standard, 2) click “Preview this Document”, 3) agree to the disclaimer, and 4) open the standard.

4. CSHOs’ Safety and Health.

CSHOs shall take appropriate precautionary measures for the particular hazards presented in facilities with combustible dust hazards.

- a. Personal Protective Equipment (PPE): In addition to the normally required personal protective equipment, CSHOs shall wear non-spark-producing clothing such as natural fiber (e.g., cotton). It is also recommended that CSHOs be provided with flame-resistant clothing as appropriate.
- b. Equipment: Cameras and video cameras shall be appropriate (for example, intrinsically safe) for the work environment. However, if such cameras are not available, then CSHOs shall take photographs or videos (using a telephoto feature) from locations within the plant that are not hazardous (classified) locations. Additionally, CSHOs shall take written statements from employees, and if possible from employers, regarding the hazardous conditions, including the alleged violative conditions (such as dust accumulations over 1/32 inch, explosion vents not directed to safe locations away from the employees working in the area, etc.)
- c. Use safe practices when collecting samples, such as not generating a dust cloud while collecting a sample and using the right tools in collecting the samples. Additionally, if a means of safe access is not available, sample(s) should not be collected.
- d. Equipment for collecting dust samples may include the following:
  - Natural bristle hand brushes for collecting settled dust.
  - Non-sparking, conductive dust pans (aluminum), for collecting settled dust.
  - Non-spark producing sample container.
  - Non-spark producing funnel for filling sample containers.
  - Non-spark producing scoops for removing dust from cyclone containers or other ventilation equipment.
- e. Care shall be taken to ensure integrity of the sample.

E. Inspection and Citation Procedures.

1. CSHOs should recognize that the following criteria must be met before a deflagration can occur:
  - a. The dust has to be combustible.
  - b. The dust has to be dispersed in air or another oxidant, and the concentration of this dispersed dust is at or above the minimum explosible concentration (MEC).
  - c. There is an ignition source, such as an electrostatic discharge, spark, glowing ember, hot surface, friction heat, or a flame that can ignite the dispersed combustible mixture that is at or above the MEC.
2. CSHOs should recognize that the following criteria must be met before an explosion can occur:
  - a. The above criteria for deflagration must be present.
  - b. The combustible mixture is dispersed within a confined enclosure (and the confined enclosure does not contain sufficient deflagration venting capacity to safely release the pressures) such as a vessel, storage bin, ductwork, room or building. It must be noted that a small deflagration can disturb and suspend the combustible dust, which could then serve as the fuel for a secondary (and often more damaging) deflagration or explosion.
3. CSHOs should be able to recognize the following conditions that may indicate that a potential dust deflagration, other fire, or explosion hazard exists:
  - a. Plant History of Fires: The plant has a history of fires involving combustible dusts.
  - b. Material Safety Data Sheets (MSDS): The MSDS may indicate that a particular dust is combustible and can cause explosions, deflagrations, or other fires. However, do not use MSDSs as a sole source of information because this information is often excluded from MSDSs.
  - c. Dust Accumulations: Annex D of NFPA 654 contains guidance on dust layer characterization and precautions. It indicates that immediate cleaning is warranted whenever a dust layer of 1/32-

inch thickness accumulates over a surface area of at least 5% of the floor area of the facility or any given room. The 5% factor should not be used if the floor area exceeds 20,000 ft<sup>2</sup>, in which case a 1,000 ft<sup>2</sup> layer of dust is the upper limit. Accumulations on overhead beams, joists, ducts, the tops of equipment, and other surfaces should be included when determining the dust coverage area. Even vertical surfaces should be included if the dust is adhering to them. Rough calculations show that the available surface area of bar joists is approximately 5 % of the floor area and the equivalent surface area for steel beams can be as high as 10%. The material in Annex D is an idealized approach based on certain assumptions, including uniformity of the dust layer covering the surfaces, a bulk density of 75 lb/ ft<sup>3</sup>, a dust concentration of 0.35 oz/ ft<sup>3</sup>, and a dust cloud height of 10 ft. Additionally, FM Data Sheet 7-76 contains a formula to determine the dust thickness that may create an explosion hazard in a room, when some of these variables differ.

d. CSHOs should observe areas of the plant for dust accumulations of greater than 1/32 of an inch (approximately equal to the thickness of a typical paper clip). Likely areas of dust accumulations within a plant are:

- structural members
- conduit and pipe racks
- cable trays
- floors
- above ceiling
- on and around equipment (leaks around dust collectors and ductwork.)

e. If CSHOs find that there are potential combustible dust hazards, dust samples must be safely collected. CSHOs shall use means of access to upper levels of a facility only when this can be done safely. Dust samples shall be submitted to OSHA's Salt Lake Technical Center (SLTC) for analysis. Locations from which to collect separate samples:

- "High spaces" such as roof beams, open web beams, tops of pipes and ductwork, and other horizontal surfaces located as high in the overhead as possible. Note: These are the preferred locations; however, if a means of safe access is not available, sample(s) should not be collected.



- Equipment and floors where dust has accumulated.
  - The interior (i.e., bins and/or bags) of a dust collector.
  - Within ductwork.
4. SLTC Tests. The following are a series of tests which may be performed at SLTC to determine the explosibility and combustibility parameters of the dust samples submitted.  
Details on these tests are found in Appendix E.
- Percent through 40 mesh
  - Percent moisture content
  - Percent combustible material
  - Percent combustible dust
  - Metal dusts will include resistivity
  - Minimum explosive concentration (MEC)
  - Minimum ignition energy (MIE)
  - Class II test
  - Sample weight
  - Maximum normalized rate of pressure rise (dP/dt) – Kst Test
  - Minimum ignition temperature
5. Sampling & Analytical Methods.
- Air sampling is not necessary.
  - Bulk samples in 1-liter plastic bottles are preferred, because several tests are conducted at SLTC. Obtain samples from several locations so that the amount can be collected in a 1-liter plastic bottle. These bottles may be obtained from the SLTC or locally purchased.
  - Affix an official sample identification seal (OSHA 21) on the container. To seal the bottle correctly apply one end of the seal to the center of the lid. Then run the seal to the edge of the lid and as far down the side of the bottle as it will reach.
  - It is preferred that these sample materials not be collected in plastic bags because they cannot be sealed tightly enough to prevent sample leakage or moisture loss. Also, these bags have a bellows effect which can make the dust airborne when handling the samples.

- CSHOs should take precautions not to contaminate the sample material. The presence of some contaminants in a sample may result in the tests' underreporting of the explosiveness of the dust being handled at the facility.
- Document the description of the operation in block 18 of the OSHA 91A form, and indicate the tests to be done on block 30 of the OSHA 91A as follows:
  - When requesting analyses for fire or explosion hazards that may result from housekeeping or 5(a)(1) violations, write Kst.
  - When requesting analyses for Class II hazardous locations, write "Potential Class II Dust". This test must be done to support a citation for Class II hazardous (classified) locations, 1910.307. (Note: This test only applies to electrical ignition sources in Class II locations.)
- Because of the resource intensive nature of the tests, SLTC requires the Area Director's concurrence for all combustibility and explosibility testing.
- Place the prepared materials and required identification papers (including an MSDS) in a box, and ship them to SLTC, following the shipping instructions provided by the shipping company or the U.S. Postal Service. (Note: Normally, no special DOT shipping requirements apply; however, when shipping metal dusts (especially when dusts involve aluminum or magnesium), CSHOs should verify with the shipping company whether any special shipping requirements apply.)

6. Lab results. Lab results may contain some of the results listed below, but not all, depending on particular tests that are performed:

- Mesh size
- Moisture content
- Percent combustible dust
- Sample weight
- Explosion severity
- Kst Value
- MEC
- Resistivity for metal dusts

7. Dust collectors, ductwork, and other containers. CSHOs should also pay attention to the dust collectors and ductwork, as well as other containers, because they maintain a cloud of finely divided particles suspended in air. Because they maintain a cloud of combustible dust, CSHOs should determine whether the plant has a sound ignition control program that prevents introduction of ignition sources (including sparks from electrostatic discharge, open flames, or other similar sources) into them. Additionally, housekeeping problems may be exacerbated by the inefficient operation of dust collectors. As noted in NFPA 654, Annex D.2, dust collectors generally operate most effectively between limited pressure drops of between 3 inches to 5 inches of water. If the employer does not have a hot work permit system that addresses hot work on and around collection points and ductwork or in areas where hazardous levels of dust accumulations may occur, the CSHO should recommend that such a system be adopted expeditiously and rigorously implemented. In section 5(a)(1) cases a hot work permit system may be noted as a feasible abatement method. For chemicals covered by 29 CFR 1910.119 (PSM), the standard requires a hot work permit system. See 29 CFR 1910.119(k).
8. CSHOs must gather information about the employer's efforts to abate the combustible dust hazard. This information will be helpful in determining some violations, as well as the employer's good faith, a penalty factor. CSHOs should look at dust collectors, ductwork, associated equipment, and containers, like mixers or storage bins. The following information may be gathered during the course of the inspection:
- Explosion prevention and mitigation controls such as the isolation or segregation of dust-generating processes, building damage-limiting construction, explosion venting for dust-processing areas; process equipment relief (see NFPA 68), and process isolation and explosion suppression (see based NFPA 69).
  - The dimensions of the room as well as the areas of the dust accumulations of greater than 1/32-inch depth.
  - The design information on the dust collection systems, along with model numbers and serial numbers (located on the side of the equipment along with the manufacturer and phone numbers).
  - Size (volume) of dust collectors (Note: Dust collectors are referred to as "air-material separators" in NFPA 654).

- Warning signs or alerts on the equipment referencing combustible dust.
- Any sources of ignition in the area, such as welding, fork truck traffic, etc.
- Information on whether the electrical equipment in the area is designed for use in a hazardous (classified) location. (Note: Do not open electrical boxes or disconnect electrical cords. Opening them could cause an electrical arc, especially in an area with metal dust.)

NOTE: Because of its spark-producing potential, no equipment, including cameras with electronic flashes or electrical equipment, shall be used in hazardous (classified) locations of the facilities, unless the equipment is intrinsically safe, approved, or safe, as defined in 29 CFR 1910.307(b), for use in these types of areas.

9. Citations.

- a. Grain Handling Standard Violations. For violations at grain handling facilities, citations under 1910.272 shall be issued. (See OSHA Instruction CPL 02-01-004, Inspection of Grain Handling Facilities, 29 CFR 1910.272).
- b. Ventilation Standard Violations. If the facility's operations are covered by 1910.94, *Ventilation*, then any violations of the standard shall be cited. Paragraph (a) of the standard covers abrasive blasting; paragraph (b), grinding, polishing, and buffing operations;
- c. Housekeeping Violations. If the facility being inspected under this NEP is not a grain handling facility, the surface dust accumulations (**i.e., dust accumulations outside the dust collection system or other containers, such as mixers**) are over 1/32- inch deep, and such depth covers an area of at least 5% of the total area of the room, with an upper limit of 1000 ft<sup>2</sup>, then citations for violations of 29 CFR 1910.22 (housekeeping) shall be issued. The standard provides in pertinent part: "(a) *Housekeeping.* (1) All places of employment, passageways ... and service rooms shall be kept clean... (2) The floor of every workroom shall be maintained in a clean...condition."
  - Citations for violations of 1910.22(a)(1) shall be issued when

the conditions as set forth in the first sentence of this subparagraph c. exist in places of employment (except floors of workrooms and storage areas), passageways, and service rooms.

- Citations for 1910.22(a)(2) shall be issued when the conditions set forth in the first sentence of this subparagraph c. exist on the floors of workrooms.

However, small amounts of dust accumulations in isolated spots of the floor or other areas would not normally be classified as a violation of the housekeeping requirement under this NEP. In order to substantiate housekeeping violations, CSHOs shall take representative measurements. Thickness measurements must be made at several locations within the sampling area to determine whether the thickness is at least 1/32 inch in height. For a large area, a paint brush and dustpan can be used. For a small area, a high-volume pump pulling through a filtered cassette may be used to collect the sample. As a part of determining whether the housekeeping violation is serious, the CSHO should determine whether the dust is combustible or can cause deflagration by submitting the sample to SLTC and obtaining its analyses. In addition, the CSHO should also document the heat and ignition sources.

In coal-handling operations located in electric power generation, transmission, and distribution facilities, 29 CFR 1910.22 shall not be cited for coal dust accumulations; rather 29 CFR 1910.269(v)(11)(vii) shall be cited. See subparagraph IX.E.9.f.

NOTE: This NEP should not be construed to interfere with the application of 1910.22 or other housekeeping standards to the uncleanliness of workplaces unrelated to the combustible dust hazard.

- d. Housekeeping violations in storage areas. 1910.176(c) shall be cited for housekeeping violations in storage areas. The standard provides in pertinent part: “(c) *Housekeeping.* Storage areas shall be kept free from accumulation of materials that constitute hazards from ...fire, explosion...” The criteria for the dust hazard applicable to 1910.22(a) violations under this NEP apply in determining 1910.176(c) violations. The CSHO must document whether a reasonable person would recognize a combustible dust hazard under the circumstances. NFPA standards may be relied upon in this regard. See, e.g., NFPA 654 (2006), Standard for the

Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids. The CSHO must also document feasible abatement methods. See, e.g., NFPA 654.

e. Section 5(a)(1) (general duty clause) violations. A citation under section 5(a)(1) of the OSH Act (the general duty clause) may be issued for deflagration, explosion or other fire hazards that may be caused from combustible **dust within a dust collection system or other containers, such as mixers.** The NFPA standards, which represent the opinions of experts familiar with combustible dust hazards, are useful in providing evidence of industry recognition of the hazard. See, e.g., NFPA 654 (2006), Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids. (See *Kelly Springfield Tire Co., Inc. v. Donovan*, 729 F.2d 317 (5<sup>th</sup> Cir. 1984) (recognition of combustible dust hazard based on testimony of expert employed by dust collection equipment manufacturer.) CSHOs should also search for articles dealing with the combustible dust hazard in publications dealing with the employer's industry. CSHOs shall also look at the employer's safety manuals or other instructions to determine whether there is employer recognition of the combustible dust hazard. However, if such articles or employer documents are unavailable, CSHOs may rely upon the NFPA standards for evidence of recognition of the hazard. For evidence of feasible means of abatement, CSHOs should consult relevant NFPA standards. The essence of a 5(a)(1) citation is the hazard. A separate 5(a)(1) citation shall not be issued for a failure to use a particular abatement method. The Regional Solicitor's Office should be consulted prior to issuing Section 5(a)(1) citations.

- However, when inspecting bakery equipment in a bakery covered under 1910.263, general duty clause citations shall not be issued for fire and explosion hazards in connection with sugar and spice pulverizers, covered under 1910.263(k)(2).
- Additionally, general duty clause citations shall not be issued with respect to explosion hazards from blower collection and exhaust systems in sawmill operations covered under 1910.265(c)(20)(i).

5(a)(1) citations may be issued for deflagration and explosion hazards if SLTC finds Kst values of the submitted dust sample to be greater than zero. 5(a)(1) citations may also be issued for other fire hazards if SLTC determines that the dust is combustible. (See

Appendix E.5 for more details on combustible dust tests, including the Kst test and its associated values relative to degree of explosion). General duty clause citations can only be issued if all elements of a 5(a)(1) violation can be documented. As a part of 5(a)(1) documentation, the CSHO should also document the heat and ignition sources.

The following are some conditions for which a general duty clause citation (See Appendix C for sample citations) may be issued:

- Problems related to dust collectors, e.g., dust collection equipment located inside the building (however, there are some exceptions) and dust collectors returning air back inside the building.
- Ductwork-related problems, e.g., the ductwork not being grounded and ductwork not constructed of metal.
- Improperly designed deflagration venting (venting to areas where employees are likely to be exposed to explosion/deflagration hazards).
- Processing and material handling equipment, such as, mixers, blenders, pulverizers, mills, dryers, ovens, filters, dust collectors, pneumatic conveyors, and screw conveyors, not protected by deflagration suppression systems .
- Equipment connected by pipes and ducts not protected by deflagration isolation systems, such as flame arresters, flame front diverters, spark detection, spark extinguishing equipment, and rotary valves.

(Note: If all the elements of a 5(a)(1) violation cannot be documented for the hazards noted during an inspection, then a Hazard Alert letter shall be issued to the employer for such hazards.)

- f. Housekeeping violations at coal-handling operations covered under 1910.269. If violations of 1910.269(v)(11)(xii) (sources of ignition not eliminated or controlled where coal-handling operations may produce a combustible atmosphere from fuel sources) are identified during an inspection of a coal-fired power plant, that provision shall be cited, not 1910.22 or section 5(a)(1).
- g. Personal Protective Equipment (PPE) Violations. Citations under

1910.132(a) (the general requirement to provide and assure the use of protective equipment, including *protective clothing*) may be issued, if an employee exposure to potential burn injuries can be documented. For example, if employees are not wearing protective clothing, such as flame-resistant clothing, in areas of the plant (e.g., bagging areas) where employees may be exposed to potential flash fire hazards, then citations under 1910.132(a) may be issued. A citation may be issued whether or not an accident precipitated the inspection.

The CSHO shall document whether a reasonable person familiar with the circumstances would recognize hazards from combustible dust. NFPA standards may be used for this documentation. The CSHO shall also document whether there are feasible types of personal protective equipment to deal with these hazards. It has been recognized as industry practice to require flame-resistant clothing when employees may be exposed to flash fire hazards. National Fire Protection Association (NFPA) 2113, *Standard on Selection, Care, Use and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire* is a national consensus standard which applies to, among others, chemical, refining, and terminal facilities with flash fire hazards. Among other provisions, NFPA 2113 has requirements for when flame-resistant clothing must be used by industrial personnel exposed to flash fire hazards. See Chapter 4 of NFPA 1123 for a discussion on selection of flame-resistant clothing.

- h. Process Safety Management. If the dust in question appears on the list of Highly Hazardous Chemicals (Appendix A to 29 CFR 1910.119) and is present in quantities greater than or equal to the listed threshold quantity, the PSM standard will apply. Citations under 1910.119 shall be issued for PSM violations.
- i. Electrical Violations. If the laboratory analysis indicates that the submitted dust meets the criteria for Class II (See Class II Test methodology in Appendix E), and if the location where the dust was present falls under any of the Class II location definitions, then 29 CFR 1910.307 will apply. See the Class II definition in 29 CFR 1910.399. However, if violations involving Class I or III locations are found in the course of conducting an inspection under this NEP, citations shall be issued. See the Class I and III definitions in 29 CFR 1910.399.

Equipment, wiring methods, and installations of equipment in hazardous (classified) locations shall be: 1) intrinsically safe, 2)



approved for the hazardous (classified) location, or 3) safe for the hazardous (classified) location. The meaning of these terms is spelled out in 29 CFR 1910.307(b).

If the employer chooses the third option of providing equipment that is "safe for the hazardous location," then the employer must demonstrate that the equipment is of a type and design that will provide protection from the hazards involved. Compliance with the guidelines contained in the National Electrical Code (NEC) constitutes one means, but not the only means, of demonstrating that the electrical equipment is safe for the hazardous location.

Citations issued for electrical violations must be adequately documented in the case file. Such documentation must include the location and type of potential electrical ignition sources, the type and condition of electrical equipment located in the area, and information indicating that the equipment is not approved or safe for the location. (See NEC and NFPA 499 for more details.)

- j. Powered Industrial Trucks. For powered industrial truck violations, citations shall be issued under 1910.178(c)(2)(ii) and (vi)-(ix) and 1910.178(m)(11).
- k. Welding, cutting, and brazing. For violations involving welding, cutting, and brazing operations, 1910.252 (general welding and cutting) (see, in particular, (a)(2)(vi)(C), prohibiting cutting and welding in explosive atmospheres, including mixtures of flammable dusts with air), 1910.253 (oxygen-fuel gas welding and cutting) (see, in particular, (c)(2)(ii) and (iv), and (f)(5)(i)(B)), and 1910.254 (arc welding) (see, in particular, (b)(2)(F)) shall be used.
- l. Warning Sign Violations. If safety instruction signs are missing on equipment, or at the entrance to places where explosive atmospheres may occur, then citations under 29 CFR 1910.145(c)(3) shall be issued.
- m. Hazard communication violations. The hazard communication standard, 29 CFR 1910.1200, requires all employers to provide information to their employees about the hazardous chemicals to which they are exposed, by means of a hazard communication program, labels and other forms of warning, material safety data sheets, and information and training. See "hazardous chemicals" definition in 29 CFR 1910.1200(c), which addresses physical hazards. The definition of physical hazards includes flammable solids (see the definition in .1200(c)), and employers who do not

follow the requirements of this standard shall be cited with respect to chemicals which in the course of normal conditions of use could become combustible dusts.

- n. Egress violations. Citations for violations of Subpart E –Means of Egress, Part 1910, particularly 29 CFR 1910.33-37, shall be issued where violations of these provisions are found.
- o. Fire protection violations. Citations for violations of 29 CFR 1910.156 (fire brigades) and 1910.157 (portable fire extinguishers) shall be issued where violations of these standards are found. 1910.156 only applies in the context of this NEP if the employer has a fire brigade or industrial fire department. The fire extinguisher provisions of 1910.157 do not apply where the employer requires the evacuation of employees in the event of fire, has an emergency action plan meeting the requirements of 1910.38, and has a fire prevention plan meeting the requirements of 1910.39.
- p. Bakery equipment violations. Citations for violations of 29 CFR 1910.263(k)(2) shall be issued for fire and explosion hazards in sugar and spice pulverizers.
- q. Sawmill violations. Citations for violations of 29 CFR 1910.265(c)(20)(i) shall be issued in connection with defects in the design, construction, and maintenance of blower collecting and exhaust systems.
- r. Agriculture. The only provisions discussed in this NEP which may be cited in connection with agricultural operations are the hazard communication standard (see 29 CFR 1928.21) and the general duty clause. Industries in SIC 0723, Crop Preparation Services for Market, Except Cotton Ginning, listed in Appendix D, are engaged in agricultural operations.

Because 29 CFR 1910.22(a) and 29 CFR 1910.176(c) do not apply to agricultural operations, the general duty clause may apply to hazards associated with surface dust accumulations outside and within dust collection systems and other containers.

F. Program Evaluation.

IMIS case files coded “DUSTEXPL” can be retrieved for program evaluation purposes by the Directorate of Evaluation and Analysis (DEA) based on agency

evaluation priorities. Case files will be requested from the Areas Offices by DEA as needed.

G. Outreach.

The Office of Communications and the OSHA Training Institute in conjunction with the Directorate of Enforcement Programs will develop combustible dust information and training materials. This information will be made available to the Regional Offices for distribution to the Area Offices, Consultation Program offices, and state plan offices. Area and Regional Offices are encouraged to develop outreach programs that will support their enforcement efforts. Suggested outreach products and activities include the following:

1. Letters and news releases announcing implementation of the Combustible Dust National Emphasis Program.
2. Seminars on combustible dust topics, tailored for specific audiences, such as employers, employee groups, local trade unions, apprentice programs, and equipment manufacturers. Local fire department staff may be invited to participate.
3. Partnerships and alliances, such as those involving employers within the same industry (e.g., foundries) to share successes and technical information concerning effective means of controlling or eliminating potential dust explosion hazards at their facilities.

H. IMIS Coding Instructions.

1. All enforcement activities (inspections, complaints, accidents and referrals) and compliance assistance (OSHA 55) conducted under this NEP must be coded with the NEP code "DUSTEXPL" entered in the appropriate NEP field/item number on the respective forms.
2. All consultation activities (form 20, 30 and 66) conducted in response to this NEP must include "DUSTEXPL" in the National Emphasis Field on the forms as well.

X. Appendices. The following appendices are provided as guidance for the inspection of facilities handling combustible dust.

Appendix A: NFPA Publications Relevant to Combustible Dust Hazard Controls.

Appendix B: Sample Questions.

Appendix C: Sample Citations.

Appendix D: Industries that May have Combustible Dusts.

Appendix E: Combustible Dust Tests Conducted at SLTC.

**Appendix A**  
**NFPA Publications Relevant to Combustible Dust Hazard Controls**

NFPA Number	Title	Current Edition
61	Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities	2002
68	Guide for Venting of Deflagrations	2002
69	Standard on Explosion Prevention Systems	2002
70	National Electrical Code	2005
77	Recommended Practice on Static Electricity	2000
85	Boiler and Combustion Systems Hazards Code	2007
86	Standard for Ovens and Furnaces	2007
91	Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids	2004
484	Standard for Combustible Metals	2006
499	Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas	2004
654	Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids	2006
655	Standard for Prevention of Sulfur Fires and Explosions	2007
664	Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities	2007

## Appendix B

**Sample questions CSHOs may use during the course of an inspection.  
(CSHOs may refer to appropriate NFPA standards in developing additional questions.)**

What types of combustible dust does the facility have?

(Note: Please see Table 4.5.2 of NFPA 499 and Table 1 in NMAB 353-3 for additional information on the various types of dust along with their properties)

Does the facility have a housekeeping program with regular cleaning frequencies established for floors and horizontal surfaces, such as ducts, pipes, hoods, ledges, and beams, to minimize dust accumulations within operating areas of the facility? Under the housekeeping program, is the dust on floors, structural members, and other surfaces removed concurrently with operations? Is there dust accumulation of 1/32 inch thick, or greater? For housekeeping violations, what are the dimensions of the room and the dimensions of the area covered with the dust?

Are the dust-containing systems (ducts and dust collectors) designed in a manner that fugitive dusts are not allowed to accumulate in the work area?

Are dust collectors greater than 8 cubic feet in volume located inside of buildings?

If dust explosion hazards exist in rooms, buildings, or other enclosures, do such areas have explosion relief venting distributed over the exterior walls of buildings and enclosures? Is such venting directed to a safe location away from employees?

Does the facility have isolation devices to prevent deflagration propagation between pieces of equipment connected by ductwork?

Does the facility have an ignition control program, such as grounding and bonding and other methods, for dissipating any electrostatic charge that could be generated while transporting the dust through the ductwork?

Does the facility have separator devices to remove foreign materials capable of igniting combustible dusts?

Are electrically- powered cleaning devices, such as sweepers or vacuum cleaners used in dusty areas, approved for the hazard classification, as required under 1910.307(b)?

Is smoking permitted only in safe designated areas?

Are areas where smoking is prohibited posted with “No Smoking” signs?

Is the exhaust from the dust collectors recycled?

Does the dust collector system have spark detection and explosion/deflagration suppression

systems? (There are other alternative measures.)

Are all components of the dust collection system constructed of noncombustible materials?

Are ducts designed to maintain sufficient velocity to ensure the transport of both coarse and fine particles?

Are duct systems, dust collectors, and dust-producing machinery bonded and grounded to minimize accumulation of static electrical charge?

Is metal ductwork used?

In areas where a hazardous quantity of dust accumulates or is present in suspension in the air, does all electrical wiring and equipment comply with 1910.307(b) requirements?

Does the facility allow hot work only in safe, designated areas?

Are bulk storage containers constructed of noncombustible materials?

Does the company use methods to dissipate static electricity, such as by bonding and grounding?

Are employees who are involved in operating, maintaining, and supervising facilities that handle combustible dust trained in the hazards of the combustible dust?

Are MSDSs for the chemicals which could become combustible dust under normal operations available to employees?

## **Appendix C Sample Citations**

### **The General Duty Clause Violations**

Section 5(a)(1) of the Occupational Safety and Health Act of 1970: The employer did not furnish employment and a place of employment which were free from recognized hazards that were causing or likely to cause death or serious physical harm, including severe burns, to employees in that employees were exposed to dust explosion, deflagration, or other fire hazards from dust collectors being located inside a building .

- (a) SMK Building - There was a dust collector located at the number 1 conveyor system which was located inside the SMK building.
- (b) Day Bin Building - There was a large dust collector system located in the Day Bin Building that collected dust from the day bins.

AMONG OTHER METHODS, A FEASIBLE ABATEMENT METHOD TO CORRECT THIS HAZARD IS TO RELOCATE THE DUST COLLECTION SYSTEMS OUTSIDE THE BUILDINGS.

### **Housekeeping Violations**

- 1) 29 CFR 1910.22(a)(1): Place(s) of employment were not kept clean
  - (a) Grinding and Polishing Area - The area where aluminum polishing and grinding were performed had explosive aluminum dust located on the pipes in the ceiling, the roof structure, and masonry walls on or about December 17, 200X.
- 2) 29 CFR 1910.22(a)(2): The floor of a workroom was not maintained in a clean condition.
  - (a) Grinding and Polishing Area – Explosive dust was on floor of the area where aluminum polishing and grinding were performed on or about May 7, 200X.

### **Electrical Violations**

- 1) 29 CFR 1910.307(b): Electrical equipment in hazardous (classified) locations was not intrinsically safe, approved for the hazardous (classified) location, or safe for the hazardous (classified) location:
  - (a) Robot Polishing and Grinding Area - Open motor fans, electrical outlet boxes, breaker panels, disconnect switches, normal lighting snap switches, overhead lighting, robot control panels, stand belt grinders, and portable radios in a Class II, Division 1 location, were not intrinsically safe, approved for a Class II, Division I, location, or safe for a Class II, Division I, location, on or about December 24, 200X.
  - (b) Half Round Area - Electrical equipment including, but not limited to, overhead lights, circuit breaker panels, disconnect switches and outlets, in Class II, Division I locations, was not intrinsically safe, approved for a Class II, Division I, or safe for a Class II, Division I, location, on or about January 11, 200X.
- 2) 29 CFR 1910.307(b): Electrical equipment in a hazardous (classified) location was not intrinsically safe, approved for the hazardous (classified) location, or safe for the hazardous (classified) location:
  - (a) Mixing Department - A vacuum used in a Class II, Division 1 location was not intrinsically safe,



approved for a Class II, Division I, location, or safe for a Class II, Division 1, location.

## Appendix C (Contd.)

### Personal Protective Equipment Violations

29 CFR 1910.132(a): Protective equipment was not used when necessary when a hazard of processes or environment capable of causing injury or impairment of the body through physical contact was encountered:

- (a) Aluminum Grinding and Polishing Area - Employees did not wear easily removable flame-retardant and non-static-generating clothing in an area where combustible aluminum dust was present on or about November 16, 200X.

AMONG OTHER METHODS, ONE FEASIBLE ABATEMENT METHOD TO CORRECT THIS HAZARD IS TO REQUIRE EMPLOYEES TO WEAR FLAME- RESISTANT, NON-STATIC-GENERATING CLOTHING, INCLUDING SAFETY SHOES THAT ARE STATIC-DISSIPATING, IN THIS AREA.

## Appendix D

### Industries that May have Combustible Dusts

SICS	Industry	NAICS
0723	Crop Preparation Services for Market, Except Cotton Ginning	115114, 115111
2052	Fresh cookies, crackers, pretzels, and similar "dry" bakery products.	311821
2062	Refining purchased raw cane sugar and sugar syrup.	311312
2087	Flavoring extracts, syrups, powders, and related products, not elsewhere classified.	311930
2099	Prepared foods and miscellaneous food specialties, not elsewhere classified.	311212
2221	Broadwoven Fabric Mills, Manmade Fiber and Silk	313210
2262	Finishers of Broadwoven Fabrics of Manmade Fiber and Silk	313311
2299	Textile Goods, Not Elsewhere Classified	313111
2421	Sawmills and Planing Mills, General	321113
2431	Millwork	321911
2434	Wood Kitchen Cabinets	33711
2439	Structural Wood Members, Not Elsewhere Classified	321213,321214
2452	Prefabricated Wood Buildings and Components	321992
2493	Reconstituted Wood Products	321219
2499	Wood Products, Not Elsewhere Classified	321920, 321219
2511	Wood Household Furniture, Except Upholstered	337122
2591	Drapery Hardware and Window Blinds and Shades	337920
2819	Industrial Inorganic Chemicals, Not Elsewhere Classified	325188, 325998, 331311
2821	Plastic Materials, Synthetic Resins, and Nonvulcanizable Elastomers	325211
2823	Cellulosic Manmade Fibers	325221
2834	Pharmaceutical Preparations	325412
2841	Soap and Other Detergents, Except Specialty Cleaners	325611

<b>SICS</b>	<b>Industry</b>	<b>NAICS</b>
2851	Paints, Varnishes, Lacquers, Enamels, and Allied Products	32551
2861	Gum and Wood Chemicals	325191
2899	Chemicals and Chemical Preparations, Not Elsewhere Classified	325510, 325998
3011	Tires And Inner Tubes	326211
3061	Molded, Extruded, and Lathe-Cut Mechanical Rubber Goods	326291
3069	Fabricated Rubber Products, Not Elsewhere Classified	326299
3081	Unsupported Plastics Film and Sheet	326113
3082	Unsupported Plastics Profile Shapes	326121
3086	Plastics Foam Products	326140, 326150
3087	Custom Compounding of Purchased Plastics Resins	325991
3089	Plastics Products, Not Elsewhere Classified	326199
3291	Abrasive Products	327910
3313	Alumina and Aluminum Production and Processing	331312
3334	Primary Production of Aluminum	331312
3341	Secondary Smelting and Refining of Nonferrous Metals	331314
3354	Aluminum Extruded Products	331316
3363	Aluminum Die-Castings	331521
3365	Aluminum Foundries	331524
3369	Nonferrous Foundries, Except Aluminum and Copper	331528
3398	Metal Heat Treating	332811
3441	Metal Cans	332431
3469	Metal Stampings, Not Elsewhere Classified	332116
3471	Electroplating, Plating, Polishing, Anodizing, and Coloring	332813
3479	Coating, Engraving, and Allied Services, Not Elsewhere Classified	332812
3496	Miscellaneous Fabricated Wire Products	332618
3499	Fabricated Metal Products, Not Elsewhere Classified	332999
3548	Lighting Equipment, Not Elsewhere Classified	335129
3644	Noncurrent-Carrying Wiring Devices	335932

<b>SICS</b>	<b>Industry</b>	<b>NAICS</b>
3714	Motor Vehicle Parts and Accessories	336322
3761	Guided Missiles and Space Vehicles	336414
3799	Transportation Equipment, Not Elsewhere Classified	333924
3995	Burial Caskets	339995
3999	Manufacturing Industries, Not Elsewhere Classified	321999, 325998, 326199
4221	Farm product warehousing and storage	493130
4911	Electric Services Establishments engaged in the generation, transmission, and/or distribution of electric energy for sale.	221112
4952	Sanitary treatment facilities.	221320
4953	Refuse Systems	562920
5093	Scrap and waste materials	423930
5162	Plastics materials and basic forms and shapes	424610

## Appendix E

### Combustible Dust Tests Conducted at SLTC

- 1. Percent through 40 Mesh.** An aliquot of the "as received" material is sieved through a 40 mesh (425  $\mu\text{m}$ ) US Standard Testing Sieve. The percent which goes through the sieve is determined using the following steps:

- a. Weigh a dust aliquot; sieve through 40 mesh.
- b. Weigh the material passed through the 40 mesh sieve.
- c. Calculate the percentage that passes through a 40 mesh via:

$$\% \text{ through 40 mesh} = \frac{\text{Grams through 40 mesh} (100)}{\text{Total "as received" aliquot weight}}$$

- 2. Percent Moisture Content.** Moisture content is another factor which may have an effect on dust explosibility and is an initial determination made on an aliquot of all dust samples that are received at the OSHA Salt Lake Technical Center laboratory. Moisture in dust particles raises the ignition temperature. Dusts having more than 5% moisture are dried prior to performing explosibility tests. Drying sample materials to (or less than) the 5% moisture content level is a standardized test protocol. The moisture content of the sieved material is determined by measuring the weight loss after drying. This test method must be modified when the materials being tested would be degraded at 75°C. Percent moisture content is determined as follows.

- a. Weigh crucibles and aliquots of material which passed through a 40 mesh sieve.
- b. Dry for twenty-four hours in a drying oven set at 75°C. Then reweigh the material.
- c. Calculate the moisture content as:

$$\% \text{ Moisture Content} = \frac{(\text{Wet Sample Weight} - \text{Dry Sample Weight})(100)}{\text{Wet Sample Weight}}$$

Note: "Moisture in dust particles raises the ignition temperature of the dust because of the heat absorbed during heating and vaporization of the moisture. The moisture in the air surrounding a dust particle has no significant effect on the course of a deflagration once ignition has occurred. There is however, a direct relationship between moisture content and minimum energy required for ignition, minimum explosive concentration, maximum pressure, and maximum rate of pressure rise. For example, the ignition temperature of cornstarch may increase as much as 122°F, with an increase of moisture content from 1.6 percent to 12.5 percent. As a practical matter, however, moisture content cannot be considered an effective explosion preventive, since most ignition sources provide more

than enough heat to vaporize the moisture and to ignite the dust. In order for moisture to prevent ignition of dust by common sources, the dust would have to be so damp that a cloud could not be formed.” (Source: Fire Protection Handbook, 19<sup>th</sup> Edition).

**3. Percent Combustible Material.** Percent combustible material is determined as follows:

- a. Weigh crucibles and aliquots of material which passed through a 40 mesh sieve.
- b. Place ash samples, uncovered, for one hour at 600°C in a muffle furnace. Then reweigh the residue.
- c. Calculate the combustible material as:

$$\% \text{ Combustible Material} = \frac{(\text{Wet Sample Weight} - \text{Ash Weight})(100)}{\text{Wet Sample Weight}}$$

**4. Percent Combustible Dust.** Percent combustible dust is the product of the percent of material which went through a 40 mesh sieve and the percent combustible material. This is calculated as follows:

$$\% \text{ combustible dust} = (\% \text{ through } 40 \text{ mesh})(\% \text{ combustible material})$$

(Be aware of the distinction between combustible material and combustible dust.)

**5. Maximum Normalized Rate of Pressure rise (dP/dt) – K<sub>st</sub> test**

K<sub>st</sub> is the Deflagration Index for dusts, and the K<sub>st</sub> test results provide an indication of the severity of a dust explosion. The larger the value for K<sub>st</sub>, the more severe is the explosion (See Table below). K<sub>st</sub> is essentially the maximum rate of pressure rise generated when dust is tested in a confined enclosure. K<sub>st</sub> provides the best “single number” estimate of the anticipated behavior of a dust deflagration.

Dust explosion class	K <sub>st</sub> (bar.m/s)	Characteristic
St 0	0	No explosion
St 1	>0 and ≤200	Weak explosion
St 2	>200 and ≤300	Strong explosion
St 3	>300	Very strong explosion

Approximately 300 grams of "as received" sample material are needed for the K<sub>st</sub> test. In this test, dust is suspended in the 20-liter explosibility testing chamber (shown in Figure 1) and is ignited using a chemical igniter. The 20-liter explosibility testing chamber determines maximum pressure and rate of pressure rise if the sample explodes. These parameters are used to determine the maximum normalized rate of pressure rise (K<sub>st</sub>). K<sub>st</sub> is calculated with the following formula:

$$K_{st} = (dP/dt)_{\max} V^{1/3}$$

where:

$(dP/dt)_{\max}$  = the maximum rate of pressure rise

V = the volume of the testing chamber:

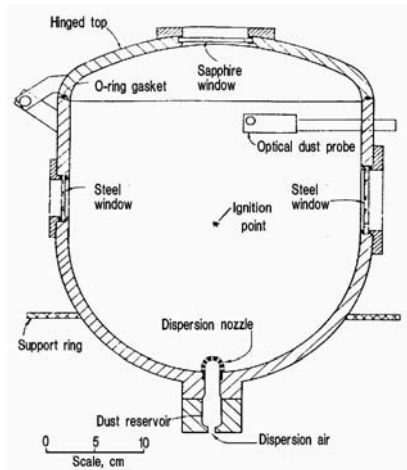
The test involves the following steps:

- a) The sample dust is suspended in a 20-liter explosion chamber. (Use 2500 J Sobbe igniters if using the Bureau of Mines test chamber.)
- b) The dust is tested "as received" (except drying, if the moisture content is greater than 5%).
- c) Test at three to five dust concentrations, from 500 g/m<sup>3</sup> to about 2500 g/m<sup>3</sup>, plotting the found maximum normalized dp/dt values versus dust concentration, and reporting the highest value from the plateau of the plot.

**6. Minimum Explosible Concentration.** Minimum explosible concentration (MEC) of the sample is determined by suspending the sample in a 20-liter explosibility testing chamber and ignited with a 2500-joule chemical igniter. MEC is the lower concentration limit of explosibility for the dust. This limit is determined using test material that has been sieved through a 40-mesh sieve (425 μm particle size), dried, suspended in a 20-liter explosibility testing chamber. Approximately 200 grams of material with a particle size of 425 μm or less are needed for the MEC tests. Some analytical details include:

- a. Use test material that has been sieved through 40-mesh screen.
- b. Use material which has been either dried in an oven at 75°C overnight (if the moisture content is greater than 5%) or kept in a desiccator.
- c. Use 2500 J igniters.
- d. Plot both the dp/dt and pressure ratio versus concentration. The minimum explosible concentration is where the K<sub>st</sub> is greater than or equal to 1.5 and the pressure ratio is greater than or equal to 2.





**Figure 1: 20-Liter Explosibility Test Chamber**

## 7. Class II Test

National Materials Advisory Board (NMAB) 353-3-80, *Classification of Combustible Dusts in Accordance with the National Electrical Code*, defines dusts having Ignition Sensitivity (IS) greater than or equal to 0.2 or Explosion Severity (ES) greater than or equal to 0.5 to be appreciable explosion hazards requiring electrical equipment suitable for Class II locations. This document is listed as a reference document in Appendix A to Subpart S of 29 CFR 1910. Dusts whose explosibility parameters fall below these limits are generally considered to be weak explosion hazards and need only general purpose electrical equipment.

Approximately 1 liter bulk volume with particle size less than 75  $\mu\text{m}$  (200 mesh) are necessary to determine the Class II dust classification. SLTC will only characterize a sample sufficiently to prove (or disprove) that the sample meets the definition for Class II dusts, based on results of the E.S or the I.S.

E.S. tests are made by suspending dust in a Hartmann stainless steel explosion chamber and igniting it with an electrical spark. If the sample explodes, the maximum pressure and rate of pressure rise developed by the explosion are recorded. ES is the product of the maximum explosion pressure and the maximum rate of pressure rise, normalized to Pittsburgh coal dust. Mathematically it is defined as:

$$E.S. = \frac{(PxR)_{\text{Sample}}}{(PxR)_{\text{Pittsburgh Coal}}}$$

Where

P = Maximum Explosion Pressure  
R = Maximum Rate of Pressure Rise

The I.S. is the product of the minimum ignition temperature, minimum ignition energy, and the minimum explosion concentration normalized to Pittsburgh coal dust. It is expressed mathematically as:

$$I.S. = \frac{(TxExC)Pittsburgh\ Coal}{(TxExC) Sample}$$

Where T = Minimum Ignition Temperature  
E = Minimum Ignition Energy  
C = Minimum

If E.S. is greater than or equal to 0.5 further tests are suspended and the sample is reported to be a Class II dust. If no explosion occurs the Class II dust testing will be terminated.

## 8. Resistivity.

The resistivity or specific resistance is defined as the electrical resistance of a material of unit cross section and of unit length. Resistivity must be measured under conditions comparable to those to which the dust is present in the workplace. The test for resistivity must be conducted at the highest voltage to which the dust is exposed, to assure that high resistivity surface coatings don't break down when subjected to a voltage gradient in the equipment that may be higher than that used in these analyses. If the sample is combustible and conductive, then a Class II, Division 1 location is specified.

Based on the classification of dusts using the NMAB 353-3-80 resistivity guidelines, explosible dusts are classified into Groups E, F, and G through the values of electrical resistivity as follows:

Group E,  $\rho \leq 10^2$  ohm-cm  
Group F,  $10^2 < \rho \leq 10^8$  ohm-cm  
Group G,  $\rho > 10^8$  ohm-cm

According to the definition for a Class II, Division 1 location as found in 1910.399, the electrical conductive nature of the dust is one of the criteria to determine if it is necessary that equipment in a dust location be approved for Class II, Division 1 location. Where group E dusts are present in hazardous quantities, there are only Division 1 locations. The NEC does not recognize any Division 2 locations for such dusts. (See NFPA 499 or NEC).

**9. Minimum Ignition Energy (MIE).**

The minimum ignition energy (MIE) of the sample is determined by suspending the sample in a Hartmann Lucite explosion chamber. To determine the MIE, the energy of the electrical spark used to ignite the dust is varied until the MIE is determined.

**10. Minimum Ignition Temperature (MIT).**

Minimum ignition temperature (MIT) is determined by using the Godbert-Greenwald furnace. Dust is discharged through this furnace at various temperatures. The lowest temperature that ignites the dust is considered to be the MIT.