	Combustible Dust Program	Rev B
	Form 1500-ALL-EHS-P-0021	

Combustible Dust Program

1. PURPOSE

The presence of metallic dusts presents a potential explosion and fire hazard. If dust is suspended in air in the right concentration, under certain conditions, it can become explosible. This document establishes requirements and procedures to control combustible dust accumulation and minimize dust generation for storage, transfers and operations through routine housekeeping, preventive maintenance, and special cleaning.

2. SCOPE


This procedure establishes housekeeping, preventive maintenance, and training requirements for VulcanForms facilities that utilize metallic powders that have the potential to produce combustible dust. Appendix A lists these areas.

3. DEFINITIONS

- 3.1. **Combustible dust:** Any combustible solid material that presents a fire or explosion hazard when suspended in air.
- 3.2. **Explosible:** Capable of being exploded.
- 3.3. **Housekeeping:** Routine cleaning and organizing of the workplace.
- 3.4. **Intrinsically Safe:** Equipment and wiring which is incapable of releasing sufficient electrical or thermal energy to cause ignition of a specific hazardous atmospheric mixture in its most easily ignited concentration.
- 3.5. **Job Safety Analysis (JSA):** Technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between worker, task, tools and work environment. After identification of uncontrolled hazards, steps are taken to eliminate or reduce them to an acceptable risk level.
- 3.6. **Metallic Powders:** Metal powders (usually in the 40-60 μm size range) like titanium alloys, Nickle/Iron alloys and aluminum alloys. For this procedure, these metal powders are considered a form of combustible dust.
- 3.7. **Personal Protective Equipment (PPE):** Equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses.
- 3.8. **Preventive maintenance:** Maintenance that is regularly performed on a piece of equipment to lessen the likelihood of it failing.

4. RESPONSIBILITIES

- 4.1. The EH&S Department shall:
 - 4.1.1. Coordinate necessary sample collection and testing.
 - 4.1.2. Assist departments in developing work instructions, JSA's and policies for minimizing dust generation from operations, storage and disposal of metallic powders.
 - 4.1.3. Develop training for affected employees.
 - 4.1.4. Review and, if necessary, revise the Combustible Dust Program every three years.

	Combustible Dust Program	Rev B
	Form 1500-ALL-EHS-P-0021	

5. DEPARTMENTAL REQUIREMENTS


5.1. Powder accumulates in or on:

- 5.1.1. In printers on machine parts and equipment surfaces.
- 5.1.2. Machine filter cartridge system cleaning
- 5.1.3. Explosion proof vacuum systems cleaning
- 5.1.4. Build plates and shroud after process, before cleaning
- 5.1.5. Waste containers
- 5.1.6. Downdraft and other cleaning operations
- 5.1.7. Transfer operations of power from smaller containers to feed hoppers
- 5.1.8. Lab operations during cutting and destructive sampling

The most effective way of minimizing combustible dust hazards is to prevent its buildup.

5.2. Departments that work with powder shall:

- 5.2.1. With EH&S their facilities to identify where hazards are present.
- 5.2.2. Establish a site-specific schedule based on their equipment and operations.
- 5.2.3. Train their employees appropriately to perform required cleaning.
- 5.2.4. Develop work instructions, JSA's as needed, to address and eliminate dust buildup(see example in Appendix B). The plan shall:
 - 5.2.4.1. Step by step instructions to manage powder manipulation to prevent dust generation
 - 5.2.4.2. Assign responsibility for cleaning specific areas to shift employees. This may include vacuuming, wiping down and disposal of waste materials.
- 5.2.5. Ensure that electrical panels, junction boxes and fittings are free of any powder.
- 5.2.6. Provide proper cleaning tools and ensure they are kept in working condition. In hazardous (classified) locations, all tools (vacuum, powered hand tools) or other equipment (hammers, screwdrivers, wrenches) shall meet area's electrical classification. When worn out, tools shall be replaced immediately.
- 5.2.7. Conduct a JSA, if needed to identify hazards and controls.
- 5.2.8. Enforce PPE requirements set by EH&S. PPE shall be available and associated training is provided to all employees assigned to perform cleaning tasks and to others who may be in the area where powder is being used.
 - 5.2.8.1. Appendix D PPE requirements for possible contact with powder
- 5.2.9. Compressed air-nitrogen-argon shall not be used for cleaning clothes.
- 5.2.10. Compressed nitrogen or argon can be used for cleaning contaminated build plates and shrouds ONLY on a controlled downdraft table or media blast with grounding, bonding and ventilation is used to control powder and minimize dust cloud thus reducing the risk of a fire/explosion.
- 5.2.11. Ensure items are grounded and bonded to minimize static electricity discharge.
- 5.2.12. Ensure Control of Hazardous energy sources are at a zero state when doing maintenance and repair during operations.

	Combustible Dust Program	Rev B
	Form 1500-ALL-EHS-P-0021	

5.3. INSPECTIONS AND EQUIPMENT MAINTENANCE


- 5.3.1. Develop an inspection schedule. The schedule shall address:
 - 5.3.1.1. Dust producing equipment.
 - 5.3.1.2. Printers
 - 5.3.1.3. Transfer of powders
- 5.3.2. Dust collecting equipment.
 - 5.3.2.1. Vacuums
 - 5.3.2.2. Cleaning of print plates and associated shrouds
 - 5.3.2.3. Downdraft tables and media blast equipment
- 5.3.3. Interior surfaces (exhaust ductwork, vents, etc.) cleaning.
 - 5.3.3.1. Printers
 - 5.3.3.2. Ampro systems
 - 5.3.3.3. Downdraft tables and media blast equipment
 - 5.3.3.4. Parts taken out of printers
- 5.4. Maintain powder operations and collecting equipment to limit the generation and escape of dust during operation.
- 5.5. Maintain proper seals on any collection equipment or containers.

6. TRAINING

- 6.1. All employees exposed to areas with powder that could generate combustible dust shall complete the following training:
 - 6.1.1. Working with powders training program upon hire, (1500-ALL-EHS-TR-0019) and then once every three years.
 - 6.1.2. Respirator training program upon hire, (1500-ALL-EHS-TR-0015). review training annually.
 - 6.1.3. Control of Hazardous Energy sources on hire (1500-ALL-EHS-TR-0001), review training annually.
- 6.2. Employees working at heights (ladders, harness, lifts) to clean printers, handle repairs and maintenance shall complete the following training initially and every three years thereafter:
 - 6.2.1. Ladder safety (1500-ALL-EHS-TR-0012).
 - 6.2.2. Working from heights (1500-ALL-EHS-TR-0006).
 - 6.2.3. Aerial Lift-Scissors Lift – Fork truck all need operator training. Only “Authorized Operators” can operate equipment they are authorized for.

7. STORAGE OF METAL POWDER

- 7.1. Titanium Alloy Powder – all powder not hooked up or ready to be hooked up to a specific printer will be stored in the raw material area of the site.
 - 7.1.1. Virgin Powder – 7.5 kg containers
 - 7.1.1.1. 7.5 kg Containers will be stored in raw material area inside grounded flammable storage cabinets
 - 7.1.1.2. Cabinets will be marked with safety label supplied by EH&S
 - 7.1.1.3.
 - 7.1.2. Transferred Powder – 7.5 kg containers to Feed Hooper (~375 kg/50 containers)
 - 7.1.2.1. Transfer operations will follow work instruction (1500-ALL-EHS-WI-0003)

	Combustible Dust Program	Rev B
	Form 1500-ALL-EHS-P-0021	

RE

V A) for proper setup grounding and cleanup.


- 7.1.2.2. Loaded Feed hopper will have safety label supplied by EH&S and other associated paperwork for QMS.
- 7.1.2.3. Feed hoppers are stored In raw materials area of the plant and go directly to printer and hooked up as a supply at the printer when needed.
- 7.1.3. Reclaim Powder – in feed hopper
 - 7.1.3.1. Loaded Feed hopper will have safety label supplied by EH&S and other associated paperwork for QMS.
 - 7.1.3.2. Feed hoppers are stored In raw materials area of plant and go directly to printer and hooked up as a supply at the printer when needed.
- 7.2. Inconel Powder (nickel / iron alloy)
 - 7.2.1. Powder comes from manufacture in stainless steel sealed Feed Hoppers. (~800kg per feed hopper)
 - 7.2.2. Feed hopper will have safety label supplied by EH&S and other associated paperwork for QMS.
 - 7.2.3. Feed hoppers are stored in raw materials area of plant and go directly to printer and hooked up as a supply at the printer as needed.

8. POWDER USAGE AT PRINTER

- 8.1. All powder is fed from feed hopper to the Ampro System
 - 8.1.3. Ampro system is always to be used with an inert (argon) gas to minimize potential combustion of the powder as it moves through the feed hopper to the screening process in the Ampro to the top powder container on the printer.
 - 8.1.4. When printing, argon gas is in the build area at ~25ppm of O₂, the balance of the atmosphere in the chamber is assumed to be argon gas.
 - 8.1.5. When print is completed:
 - 8.1.5.7. Argon is purged from the inner print chamber
 - 8.1.5.8. O₂ level is checked prior to entry
 - O₂ level must be >20.5% to enter
 - 8.1.3.8. Exclusion zone for non-protected employees is the mouth of doorway of the outer chamber.
 - 8.1.3.9. Proper PPE requirements must be met when entering a dirty machine
 - 3M Versaflow NIOSH Filter system
 - Tyvek DuPont deluxe coveralls / Nitrile Gloves or
 - Tyvek coveralls are disposed of at end of shift
 - Fire Retardant Coveralls
 - Booties
 - Hood
 - Nitrile gloves

9. DOWNSTREAM PROCESSING

- 9.1. When transporting volume to downdraft table, take precautions (plastic) to eliminate powder spillage, during transport.
- 9.2. After placing volume on downdraft table, make sure all bonding and grounding cables are in place for every step of the operation.
- 9.3. Persons working on the downdraft table must be in full PPE as per 8.1.3.8
 - 9.3.3. Exclusion zone for other workers is at 6' from volume and build/tooling plate

	Combustible Dust Program	Rev B
	Form 1500-ALL-EHS-P-0021	

10. WASTE DISPOSAL

- 10.1. All powder waste shall be disposed of in the proper waste stream at the hazardous waste storage area at the site.
- 10.2. Proper PPE (as per 8.1.3.8) shall be used when disposing of waste that may become contain or has been contaminated with powder.
 - 10.2.3. Ruwac Vacuum waste
 - 10.2.4. Protective suits, gloves
 - 10.2.5. Wipes
 - 10.2.6. Waste hoses from powder carrying devices
 - 10.2.7. Filters from filter carts
 - 10.2.8. Water from downdraft, media blast or cleaning stations.
 - 10.2.9. Residue from cut up samples from metals lab
 - 10.2.10. Any powder spills from any process or location

11. PROGRAM EVALUATION

- 11.1. EH&S shall review the Combustible Dust Program every three years unless additions, subtractions or updates or equipment changes are made.

12. RESOURCES

- 12.1. NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids
- 12.2. NFPA 484, Standard for Combustible Metals
- 12.3. 29 CFR 1910.22 Housekeeping
- 12.4. 29 CFR 1910.307 Hazardous Locations
- 12.5. 29 CFR 1910.1200 Hazard Communication
- 12.6. General Duty Clause, Section 5(a)(1) of the Occupational Safety and Health Act (Employers must keep workplaces free from recognized hazards likely to cause death or serious physical harm)..

13.0 Revision Log

VERSION	DATE	REVISION DESCRIPTION	APPROVALS
A	11.11.21	1 st Issue	L. Maglin K. Wyman
B	3/2/22	Update site locations and add other policy updates	L. Maglin K. Wyman

Appendix A Powder Areas

Site	Location	Hazard
Vulcan One	Printer Production area	Powder management
Vulcan One	Raw material area	Powder management
Vulcan One	Metals Lab	Powder management
Vulcan One	Downdraft, media blast, cleaning area	Powder management
Vulcan One	Hazardous Waste area	Powder management
Vulcan One	Metals Lab	Powder management
Burlington HQ	Metals Lab	Powder management
Burlington HQ	Printer Production R&D area	Powder management
Burlington HQ	Downdraft, media blast, cleaning area	Powder management
Burlington HQ	Raw material area	Powder management
Burlington HQ	Hazardous Waste area	Powder management