Combustible Dust Issues

Dust Collector Requirements

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Combustible Dust – Impact on Collectors

- Rules or Requirements Discussed by Customers
- What areas of the collectors are impacted by the requirements?
- What Requirements Apply and When?
  - New collectors?
  - Existing collectors?

DUST COLLECTORS AND COMBUSTIBLE DUST STRATEGIES

- Who Owns a “Combustible Dust Strategy?”
- Thoughts on “Strategy of Use”

Compliance Strategy Components

DUST CONTROL
PROTECTION
PREVENTION
IGNITION CONTROL

Do you have combustible materials?

- Are there any tests on combustible materials?
- Does the process experience fires?
- Has the process experienced fires?

Options for combustible materials:

- Options for combustible materials may not be appropriate for your collector.

Materials may not be combustible:

- Certify combustibility and verify material properties.
- Document process hazard assessment and suggest options to consider during collector selection.

Donelson Test will include options to support combustible material risk management strategies.

Additional options may be provided by others.
Key Point

Exceptions to codes may be possible, as long as the AHJ approves!

Key Point to think about

- Inlet Isolation
- Hopper Outlet Isolation
- Air Outlet Isolation

Commonly Referenced NFPA Dust Collection Standards

- 68 – Standard for Explosion Protection by Deflagration Venting – 2007
- 77 – Recommended Practice on Static Electricity - 2007
- 484 – Standard for Combustible Metals - 2009
- 499 – Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas - 2008
  (Upcoming - 2011)

Other Requirements

- What have you run across?

International Mechanical Code - 2009

Chapter 5 – Exhaust Systems

- Section 510 – Hazardous Exhaust Systems
- Section 511 – Dust, Stock, and Refuse Conveying Systems
International Fire Code – Chapter 13

Combustible Dust-Producing Operations

Factory Mutual – Property Loss Prevention Data Sheets

General Industry Data Sheets

- 7-6 Causes and Effects of Fires and Explosions, 2006
- 7-73 Dust Collectors and Collection Systems, 2008
- 7-76 Prevention and Mitigation of Combustible Dust Explosion and Fire, 2009

Industry Specific Property Loss Prevention Data Sheets

- 7-4 Paper Machines and Pulp Dryers, 2009
- 7-10 Wood Processing and Woodworking Facilities, 2000
- 7-43 Loss Prevention in Chemical Plants, 2009
- 7-75 Grain Storage and Milling, 2006

Code & Standard Requirement Impacts

Collector Type
Collector Location
Collector Options
Accessories
Operation & Servicing

Impact – Terms Used

- Mechanical
  - Drop Out Boxes & Cyclones
- Wet - Precipitators
- Media – Dry Dust Collectors
- Electrostatic – ESP & Media

Type – Metal's NFPA 484

Aluminum – Chapter 6
- Dry-type dust collectors shall be located outside of buildings.
- Electrostatic collectors shall not be used.

Magnesium – Chapter 7
- Either a wet-type collector or a cyclone collector and blower located outdoors.

Titanium – Chapter 10
- Connected to liquid precipitation separators,…
- Dry-type cyclone dust collectors shall be located outside of buildings.

Metals not covered by other chapters – Chapter 12
- Dry-type cyclone dust collectors shall be located outside of buildings.

Type – Wood NFPA 664

Enclosureless Collector - An air–material separator designed and used to remove dust from the transport air possessing ALL of the following.

(1) The filtration is accomplished by passing dust-laden air through filter media, collecting the dust on the inside of the filter media, and allowing cleaned air to exit to the surrounding area.
(2) The filter medium is not enclosed or in a container.
(3) The filter medium is not mechanically shaken or pressure-pulsed.
(4) The filter medium is under positive pressure.
(5) Removal of the collected dust is not continuous or mechanical.

Note: Can be indoors and explosion venting not required

But…….
**664 Enclosureless Collector**

**Limitations**
- No more than 5,000 CFM capacity each
- No closer than 20 ft to an egress, normally occupied area, or other collectors.
- Wood only!

**Collector Type – Grain NFPA 61**

Cyclones with a 30 in. diameter or less (no FB sections) used as air-material separators shall be allowed to be placed inside buildings without explosion protection when the following conditions are present:

1. The room, building, or other enclosure is not a Class I, Division 1 or 2 or Class II, Division 1 area as defined by Article 500 of NFPA 70, National Electrical Code.
2. The material being processed has a minimum ignition energy of more than 10 mJ.
3. The system is a closed process, excluding cleaning vacuum systems.
4. The material being processed has a Kst of less than 200 bar\-m/sec.

**Impact – Collector Size**

- Single Use
- Centralized (Manifold Ducts)

**Impact – Size**

664 Wood:
- The capacity of the system shall be calculated on the basis of all hoods and other openings connected to the system being open or equipped with means to ensure minimum conveying velocity in all sections of the system.

654 Combustible Dust:
- The rate of airflow at each hood or other pickup point shall be designed so as to convey and control the material.
- All ductwork shall be sized to provide the air volume and air velocity necessary to keep the duct interior clean and free of residual materials.

**Size – Central vs Dedicated – NFPA Interpretation**

**NFPA 654 – Combustible Dusts**

Manifolding of dust collection ducts to air-material separators shall not be permitted. (NFPA 654 7.13.1.4)

**Exceptions:**
- Dust collection ducts from a single piece of equipment or from multiple pieces of equipment interconnected on the same process stream shall be permitted to be manifolded.
- Dust collection ducts from non-associated pieces of equipment shall be permitted to be manifolded provided that each duct is equipped with an isolation device prior to manifolding.
- Dust collection ducts for centralized vacuum cleaning systems shall be permitted to be manifolded.

**Manifolded**
Non-Manifolded

Centralized vs Dedicated

Aluminum – NFPA 484
- Grinding operations shall not be served by the same dust collection system as buffing and polishing operations.
- Dust collection systems shall be dedicated to the collection of aluminum or aluminum alloy dust only. **WHY?**

Grain – NFPA 61
- Dust collection systems for one or more hammer mills or pulverizer mills shall not be manifolded with other types of machinery
- Each department in starch manufacturing and handling (i.e., starch drying, grinding, dextrine cooking) shall have a separate dust collection system

Location – Outdoors (OSHA NEP)

Although alternatives to out-of-doors locations are permitted, allowing indoor locations under special circumstances, **outdoor locations are highly recommended.** It is **not advisable to locate dust collectors on the roofs of buildings.**

How do the Requirements Impact Location?
- **Outside**
- Inside if…….
- **Proximity of other Collectors**

Location – Indoors IF

- Deemed to have **no fire or deflagration hazard**
- **A fire hazard only** & protected in accordance with …
- Equipped with listed deflagration suppression system
- Equipped with deflagration relief vents with relief duct extending to safe areas outside the building & the collector meets the strength requirement of …
- When equipped with deflagration relief vents exhausting through listed flame-quenching devices and the collector meets the strength requirement of …

664 Location – Proximity Issues

Industry, Wood – Enclosureless Collectors
- At least **20 feet** from other collectors.
- At least **20 feet** from any means of egress or area routinely occupied by personnel.
Engineering Data Requirements

- Collector Model
- Location – City, State
- Elevation (above grade)
- Clearance below the hopper flange
- Inlet Size
- K_{st}
- P_{max}
- Duct Length
- Accessories
- Airflow
- Hopper Type

Collector Options

- Hopper & Legs –or– Bin Vent
- Media Selection
- Bonding & Grounding
- Housing Reinforcements

Collector Options: Hopper

61 Grain
- Bin vent dust collectors directly mounted without a hopper on a tank or bin, whose primary function is to filter air displaced during filling or blending operations and return dust directly to the bin, shall be permitted inside or outside of buildings without explosion protection. Filters that return air to inside of buildings shall be capable of a minimum efficiency of 99.9 percent at 10 microns.
- Take-away: Sell CPV!

Collector Options: Media

484 Aluminum: Dust-collecting filter medium shall be designed to be conductive so as to dissipate static electric charges.
- Available Torit-Tex CD
- Epitropic

654 Combustible Dust: Filter media shall be permitted to be constructed of combustible material.

Collector Construction

664 Wood: The collection equipment shall be designed and constructed entirely of noncombustible material suitable for the use intended. (no plastic)

Exception: Filter bags and explosion vent diaphragms fabricated from combustible material shall be permitted.

Collector Options: Bonding

654 Combustible Dust
- Bonding and grounding with a resistance of less than 1.0x10^6 ohms to ground shall be provided for conductive components.
- Available: Ground Test Documentation

484 Metals - Aluminum
- All components of dust collection systems shall be electrically bonded and grounded.
- Available: Ground Test Documentation
Collector Options: Reinforcing – no vents and no suppression

**NFPA 69 Chapter 13: Containment**

- …specifying the design pressure of a vessel and its appurtenances so they are capable of withstanding the maximum pressures resulting from an internal deflagration.
- R, is the ratio of the maximum deflagration pressure, in absolute pressure units, to the maximum initial pressure, in consistent absolute pressure units.

*Sometimes referenced as “10 bar” construction

**Generally not feasible for Dust Collectors**

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**Technical Data Sheet**

**DFO 2-4 & DFO 3-6 COLLECTOR TECHNICAL DATA SHEET**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>SHT WT (LBS)</th>
<th>CART</th>
<th>CART WT (LBS)</th>
<th>CART Vol. (CFM)</th>
<th>CART QTY</th>
<th>COLLECTOR</th>
<th>COLLECTOR Vol. (CFM)</th>
<th>COLLECTOR QTY</th>
<th>DIMENSIONS (IN)</th>
<th>EXPLOSION VENTS (A, B)</th>
<th>VENT AREA (SQF)</th>
<th>VENT PRESSURE (BAR)</th>
<th>VENT MATERIAL</th>
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<tr>
<td>DFO 2-4</td>
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<td>4</td>
<td>750</td>
<td>55</td>
<td>4</td>
<td>119</td>
<td>95</td>
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<td>3</td>
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<tr>
<td>DFO 3-6</td>
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<td>3</td>
<td>3</td>
<td>3</td>
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<td>3</td>
</tr>
</tbody>
</table>

(A) Contact Home Office for explosion vent information. LD > 2 for the DFO which lowers the Kst value accordingly. Calculations based on NFPA 68 2017. Assumed standard hopper, enclosure strength of 10 bar. For deflagrations, no deflagrations. Deflagration vent size based on max.

(B) Contact Home Office for details on flange adapters.

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**Technical Data Sheet Notes**

- Fire Suppression
- Deflagration Vents
- Flameless Vent
- Explosion Suppression
- Isolation Devices
  - Inlet, Outlet, & Hopper Discharge

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**Collector Accessories**

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**NFPA Key Parameters**

\[
A_v = 1 \times 10^{-4} \left( 1 \times 1.54 P_{rad}^{1/3} K_{st}^{3/4} \right) \left( \frac{P_{max}}{P_{red}} - 1 \right)
\]

- \(A_v\) = Vent Area [m²]
- \(P_{rad}\) = Burst pressure of vent [bar]
- \(K_{st}\) = Maximum Rate [bar-m/sec]
- \(V\) = Volume of enclosure [m³]
- \(P_{red}\) = Reduced pressure after venting [bar]
- \(P_{max}\) = Maximum Pressure [bar]
**Pred Values for Various Products**

- CPC: 0.18 bar (72" water)
- DFT: 0.40 bar (160" water)
- DFO Small: 0.35 bar
- DFO Med-Large: 0.40 bar
- MBW: 0.34 bar
- MBT: 0.24 bar
- UMA: 0.35 bar
- TG-Series: Varies
- Dalamatic: Varies

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**Impact – Vent Location**

Volumes used to determine required vent area

**Impact – Vent Location**

6.4.3.3 The effective volume of the enclosure, $V_{eff}$, shall be determined based on the volume of that part of the enclosure through which the flame can pass as it travels along the maximum flame length, $H$.

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**Impact – Hopper Height**

20% drop with 11° change height and volume

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**Impact - Vent Ducts**

6.8.1 If it is necessary to locate enclosures with deflagration vents inside of buildings, vent ducts shall be used to direct vented material from the enclosure to the outdoors.

6.8.2 A vent duct shall have a cross section at least as great as that of the vent itself.

6.8.3 Vent area calculations shall include the effects of vent ducts. (See Sections 7.4 and 8.5 for gases and dusts, respectively.)

6.8.4 Vent ducts and nozzles with total lengths of less than one hydraulic diameter shall not require a correction to increase the vent area.

6.8.5 Ducts that are used to direct vented gases from the vent to the outside of a building shall be of noncombustible construction and shall be strong enough to withstand the expected Pred.

6.8.5.1 When vent ducts include bends, the support calculations shall include reaction forces based on the expected Pred.
**Take Away – Collector Inside**

- Direct vents outside
- Get as close to wall as possible
- Make vents of non-combustible material
- Ducts need to be match collector strength
- If collector located one HD or less no correction for vent area

**Impact - Vent Ducts**

Q: What is a “Hydraulic Diameter”?  
A: Commonly used term when handling flow in noncircular tubes  
\[
D_H = \frac{4A}{P}
\]

For a rectangular ducts the equation becomes:  
\[
D_H = \frac{4A}{P} = \frac{4LW}{2(L+W)} \text{ or } \frac{2LW}{L+W}
\]

**Example Impact - Vent Ducts**

**Other Impacts – Collector Operation**

- Vents for Positive Pressure  
- Vents and Downtime Pulsing  
- Discharge of Vents
  - “Safe Location”  
  - Deflectors  
  - Weather Covers  
- Multi-mod collectors that have different vent configurations will be analyzed with the worst case configuration

**Vent Discharge**

- Deflagration venting shall be arranged to avoid ignition of adjacent property.  
- Deflagration venting shall be arranged to avoid blast damage to adjacent property.  
- Deflagration venting shall be arranged to avoid projectile damage to adjacent property.

**Vent Discharge – Fireball**

\[
D = K \left( \frac{V}{n} \right)^{1/3}
\]

- \( D \) = axial distance (front) from the vent [m]  
- \( K \) = flame length factor  
  - 10 for metal dusts  
  - 8 for chemical & agricultural dusts  
- \( V \) = volume of vented enclosure [m³]  
- \( n \) = number of evenly distributed vents
**Vent Discharge - Deflector**

Shall not be used for enclosure volume greater than 20 m³ (6’x6’x15’)

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**Collector Accessories**

- Fire Suppression Components
- Flameless Vents
- Explosion Suppression System Components
- Isolation Devices
  - Inlet, Outlet, & Hopper Discharge
- Sprinklers
  - Apply on combustible dusts except….
- Spark Abatement Systems
- Spark cooler for thermally generated dusts

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**Other Accessories - Isolation**

- Inlet
- Outlet / Return Air
- Hopper Discharge

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**Hopper Discharge RAL Requirements**

- Housing must meet $P_{red}$ of collector
- Designed for $K_{sl}$ and $P_{max}$
- Valve must be certified and tested
- Valve must be at least 6 vane
- 2 vanes in contact at all times
- Body of RAL must be metal
- Bearings must be exterior
- Vanes .007-.008” clearance

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**Impact - Operational**

**Service Interval**

484 Aluminum: Dust shall be removed from dry collectors at least once each day and at more frequent intervals if conditions warrant.

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**Returned Air Restrictions**

Air can only be returned if the system prevents the return of

- dust (Filter must provide an efficiency of at least 99.9% @ 10micron)
- energy from a fire or explosion into the building.
- No metals, no gases
Questions?