

Air-Material Separators

Don't Let Them Hurt You!

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J.M.Cholin Consultants, Inc.

2011 NFPA Dust Symposium

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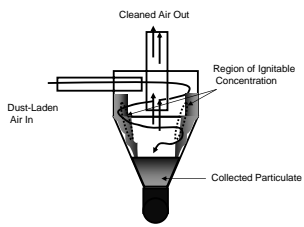
Air-Material Separators

- Types
 - Cyclones
 - Bag Houses and Dust Collectors
 - Enclosureless Dust Collectors
 - Wet Dust Collectors, Scrubbers, etc.
- Systems
 - Positive Pressure
 - Negative Pressure

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Cyclones

- Separate material from air on the basis of material momentum.



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Cyclones

- Cyclones can also burn.
- Rarely do cyclone fires pose a threat to personnel or other equipment, unless.....
 - The cleaned air is returned to the facility (more on that later)
 - Some one tries to fight the fire (let it burn out!)

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Bag Houses and Dust Collectors

- Term “bag house” and “dust collector” used interchangeably by many users.
- Separate dry material from the conveying air
- Use filter media as a separation method

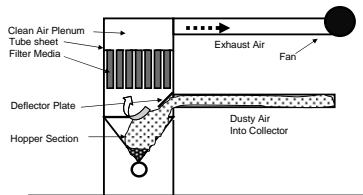
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Typical Pendant Bag Dust Collector

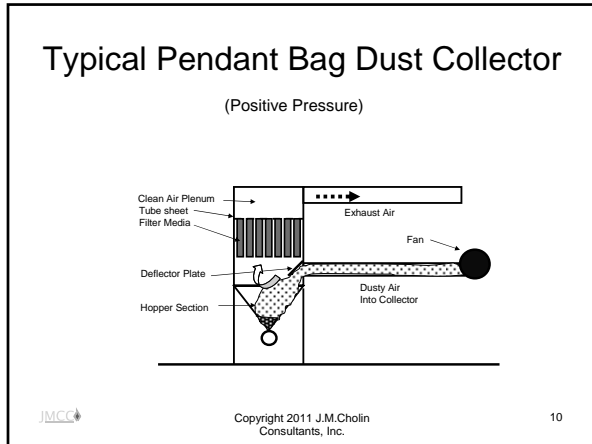
(Negative Pressure)



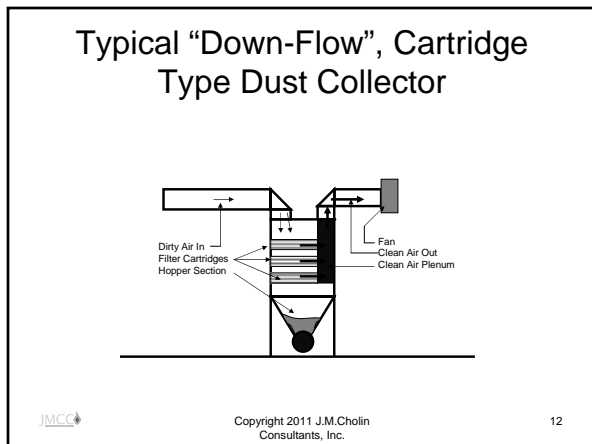
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Typical "Down-Flow", Cartridge Type Dust Collector



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Dust Collector Operation

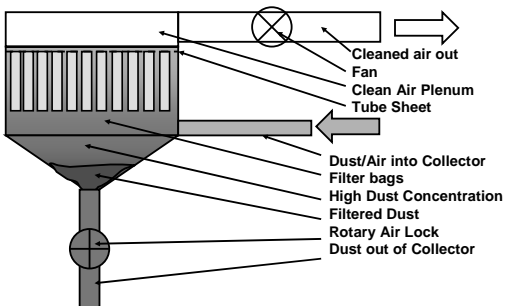
- Moving air is used to pick-up and transport a particulate through ducts.
- When the conveyance air stream passes into the dust collector, bag-house, cyclone or other air/material separator the dust falls out of suspension and the concentration increases to levels above the MEC!
- Generally, air/material separators should be considered potential deflagration sites.

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Dust Collector Anatomy



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Dust Collector Operation

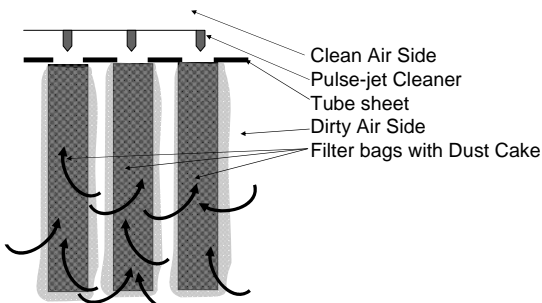
- After operating for a while the filter bags become caked with dust.
- Accumulated dust reduces air flow and conveyance efficiency.
- Most dust collectors have automatic bag cleaning to shake or blow the dust down to the bottom bin.



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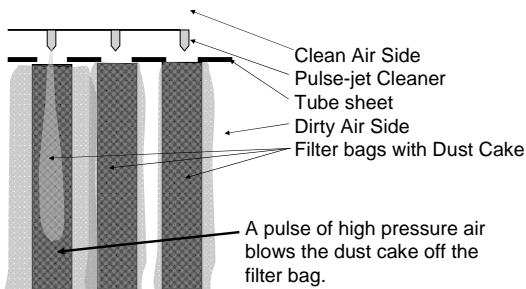
Dust Collector Operation



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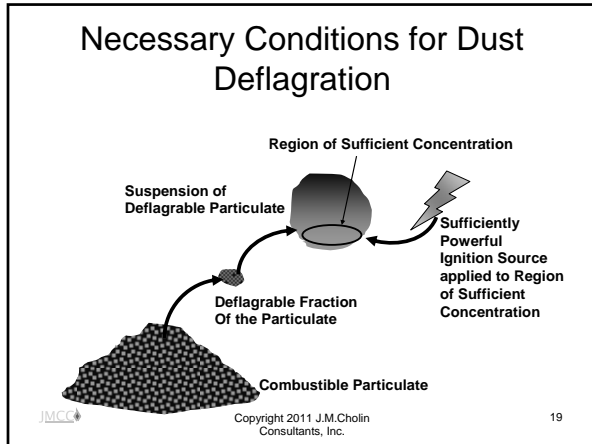
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Dust Collector Operation



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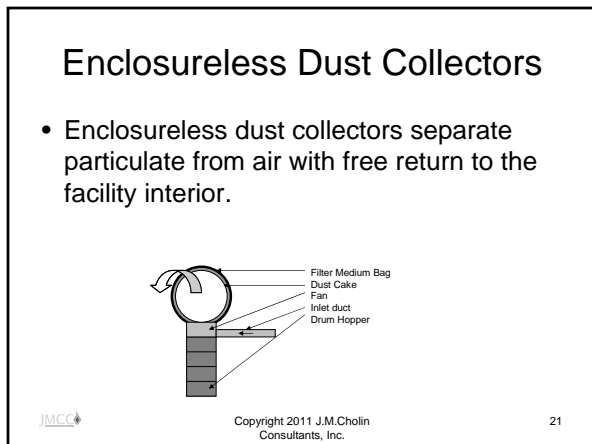
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Dust Collector

- The operation of the bag cleaning feature produces a dust cloud within the dust collector.
- If burning material is present or introduced into the dust collector during the operation of the bag or filter element cleaning cycle a deflagration can result from.

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Enclosureless Dust Collectors



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Protection FROM the Air-Material Separator

- Prevention of Ignition
- Management of Fire
- Management of Deflagration

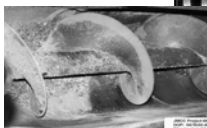
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Prevention of Ignition

- Ignition is often from process equipment
 - Mills,
 - Grinders,
 - Hogs,
 - Cutters,
 - Conveyors
 - Fans




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Prevention of Ignition

- Process Equipment Maintenance
 - Keep bearings lubricated
 - Keep cutters sharp
 - Keep mills balanced
 - Keep fans balanced
- Prevent Ingress of Tramp Materials

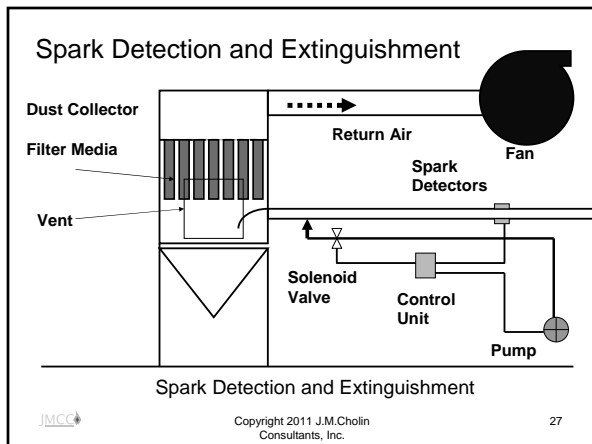


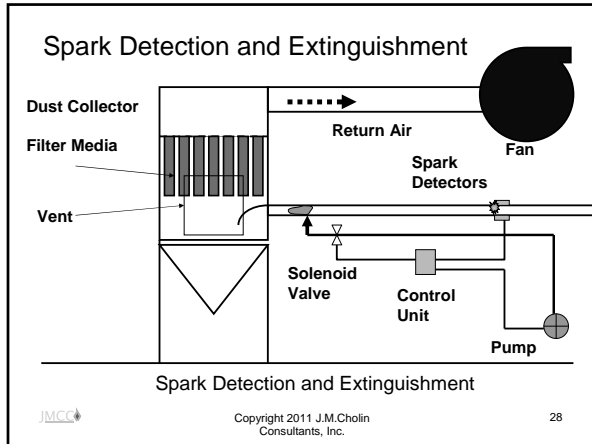
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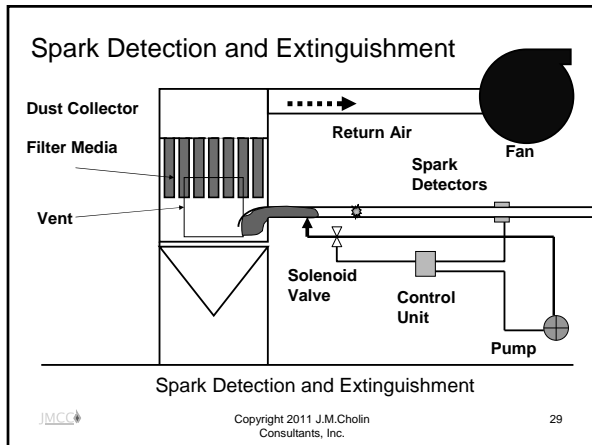
Pre-Deflagration Detection and Control of Ignition Sources

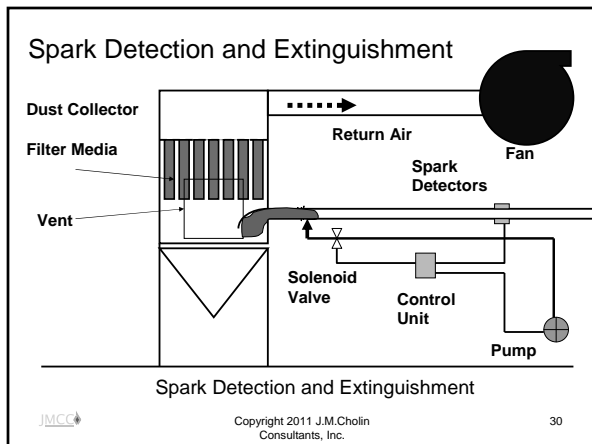
- Includes spark detection and extinguishing systems.
- Includes gas sensing systems.
- Designed in accordance with Chapter 9 of NFPA 69-2008
 - For spark detection and extinguishing systems also refer to NFPA 72 and NFPA 15.

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Spark Detection and Extinguishing Systems

- Spark Detection and Extinguishing systems are permitted as a means to **reduce the frequency** of deflagrations.
- Spark Detection and Extinguishing systems **cannot be used in lieu** of other explosion prevention strategies.
- Spark Detection and Extinguishing systems cannot be used:
 - in processes that contain flammable gases.
 - on transport ducts where the concentration exceeds the MEC.
 - to quench deflagrations

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Spark Detection and Extinguishing Systems

- Design of the detection is governed by NFPA 72, Section 5.8.
- Design of the extinguishment is governed by NFPA 15.
- Distance between detectors and extinguishment per manufacturer's instructions is based upon:
 - Conveyance system speed
 - Response time of detection
 - Response time of valve
 - Time required to establish water spray pattern

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Managing Dust Collector Fires

- Many (if not most) dust collector explosions start off as dust collector fires.
- The facility and occupants must be protected from the effects of a dust collector fire.



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Managing Dust Collector Fires

- Locate Air-Material Separators a safe distance away from buildings and other exposures.
- If cleaned air is returned to the facility, equip the Air-Material Separator with return air diversion.
- Provide automatic fire protection if asset value of AMS warrants it.

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Return Air Diversion

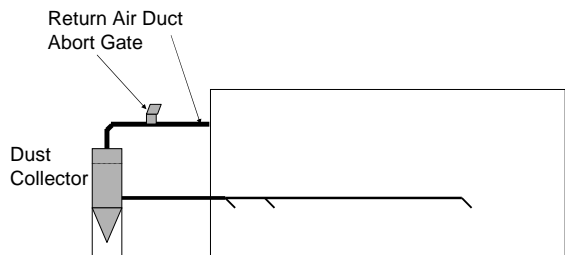
- Return Air Diversion prevents smoke, combustion product gases and flame from entering the occupied space.
- Pneumatic conveying system air CANNOT be returned to the building interior if automatic return air diversion is not in place. [61, 654, 664]

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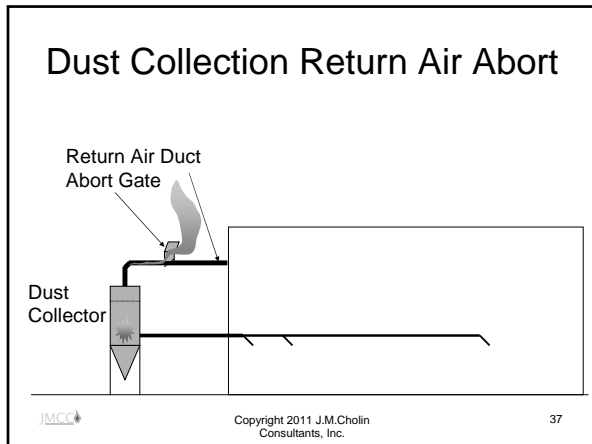
Dust Collection With Return Air Abort



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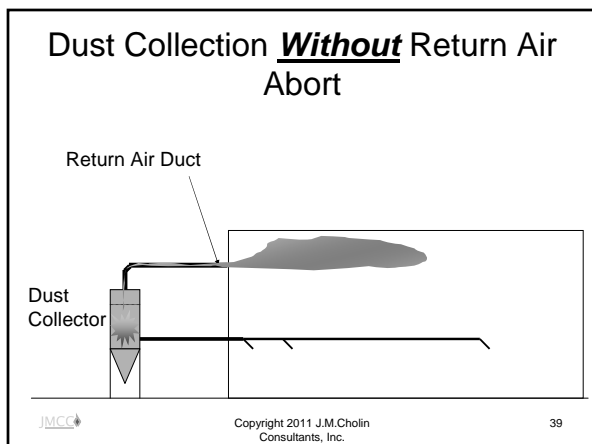
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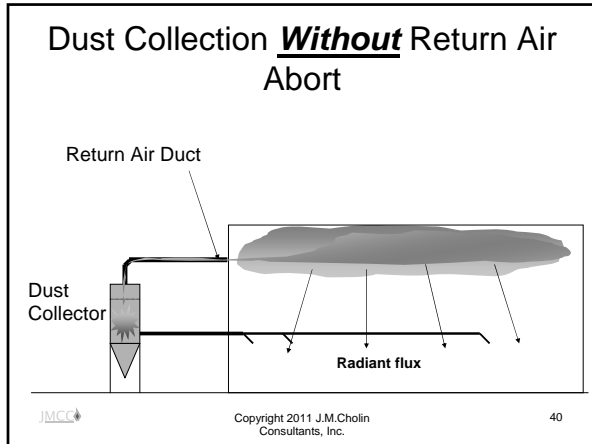


Dust Collection Return Air Abort

- The diversion of return air to building exterior is usually implemented with spark detection and a fast-acting abort gate.

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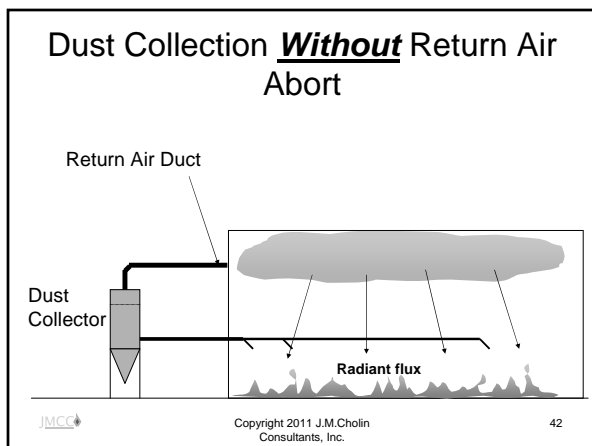
Without Return Air Abort

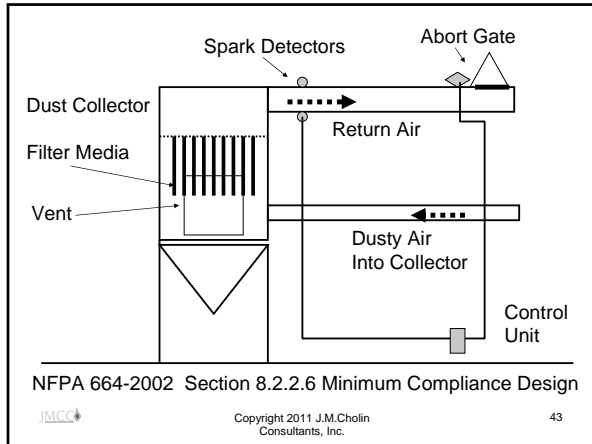
- As the flame and hot gases fill the space beneath the ceiling/roof deck sprinkler heads begin fusing.
- Often more heads fuse than the riser is designed to support.
- The excessive demand deprives entire facility of required delivered density and fires are not controlled.

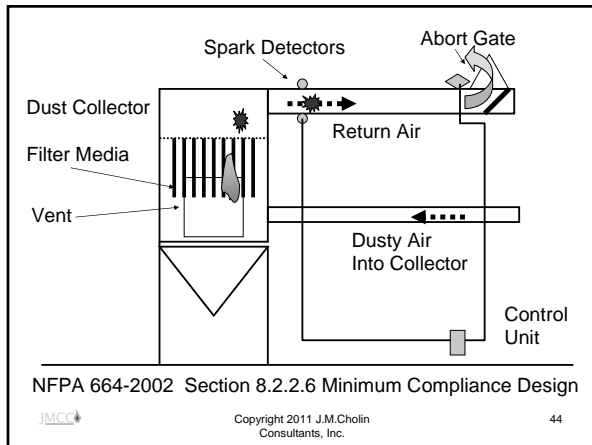
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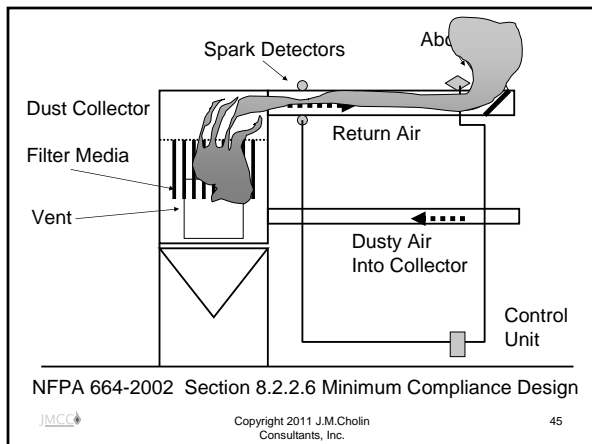
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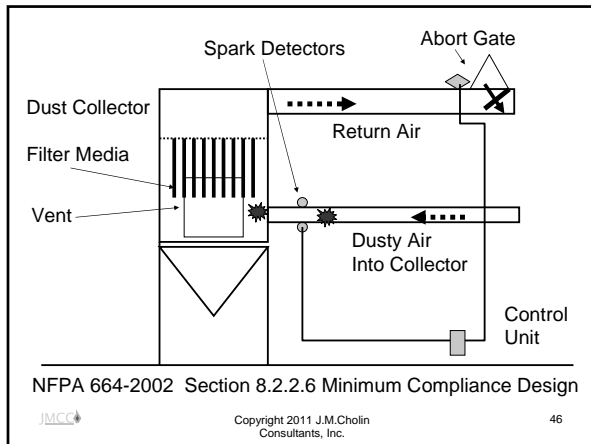
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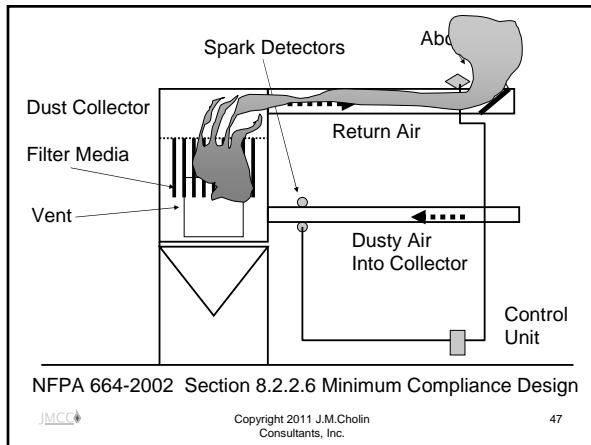












Return Air Diversion

- Upon actuation of the return air spark detection the automatic bag cleaning should be shut-down.
- DO NOT shut down the air movement as this can:
 - cause a deflagration and explosion,
 - Allow fire extension up-stream into the facility.
- If fire expands the sprinklers in the D/C will fuse and dissipate the heat generated by the fire.

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Managing Dust Collector Deflagrations

- Prevention of Ignition (Good Luck!)
 - Spark Detection and Extinguishment
- Deflagration Management
 - Deflagration Relief Venting
 - Deflagration Isolation
 - Deflagration Suppression



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Deflagration Relief Venting



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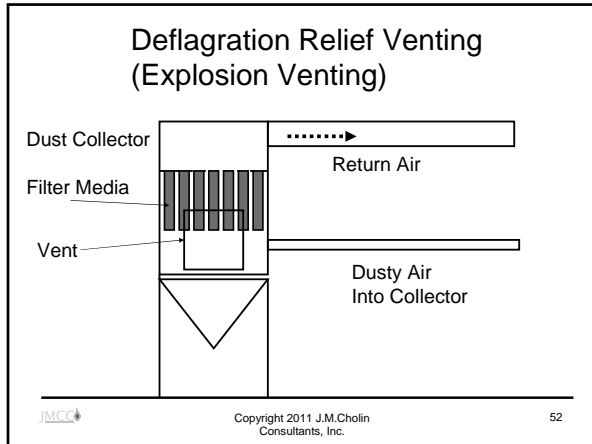
Deflagration Relief Venting

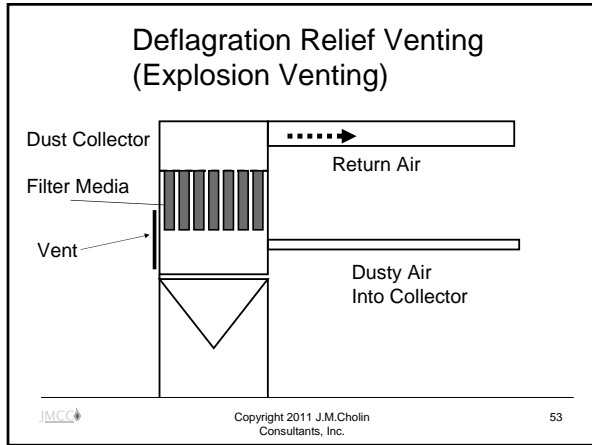
- The vent size is determined by the volume of the containment vessel and the K_{st} of the dust, using calculations per NFPA 68.
- The K_{st} of the dust depends upon the particle size and chemical composition of the dust. It is determined by test per ASTM E1226.

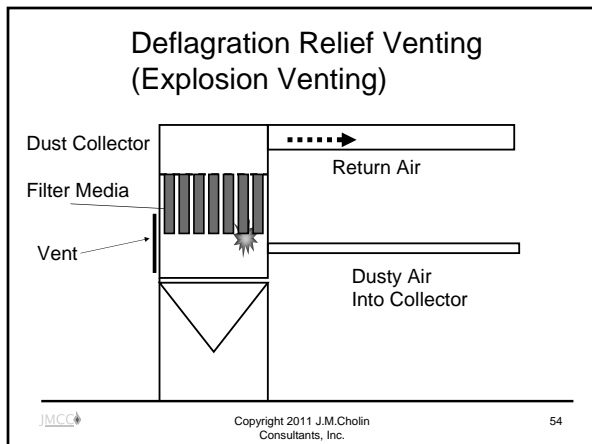


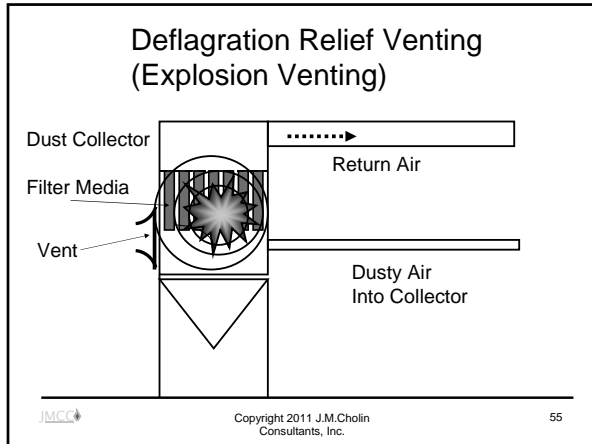
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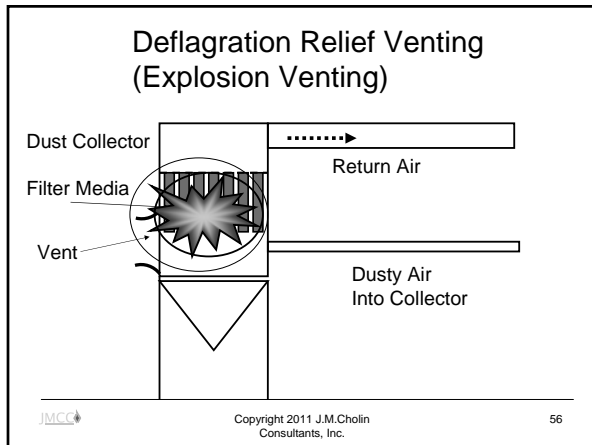
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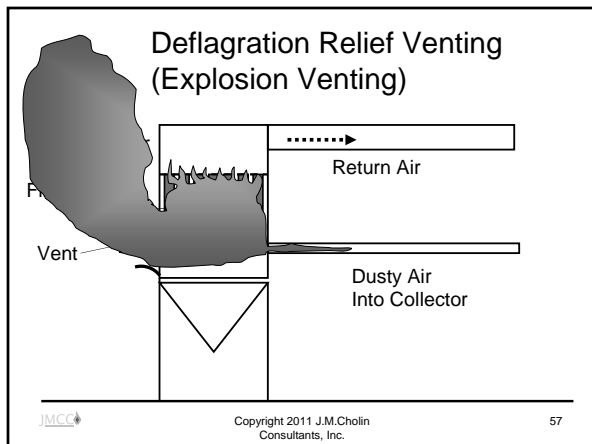












Deflagration Relief Venting

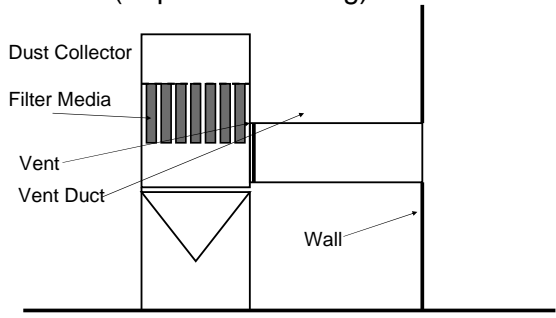
- If the dust collector is located within the building the deflagration relief vents must be ducted to the outside with short straight ducts of sufficient size.
- NFPA 68 provides the design parameters for vent ducts.
- When vents are ducted they must be of larger cross-sectional area .

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Deflagration Relief Venting (Explosion Venting)



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Deflagration Vents

- Each vent closure is rated for its static release pressure, P_{stat} .
- Vent closures for high-strength enclosures such as dust collectors, cyclones, bins, bunkers
 - P_{stat} is determined by testing.
 - Testing should include both the vent closure and the enclosure or vessel.

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Deflagration Vents

- Vent closures must be capable of withstanding worst-case wind loads and maximum and minimum temperatures.
- Re-closing vent assemblies must be capable of withstanding vacuum forces that can occur subsequent to a deflagration.

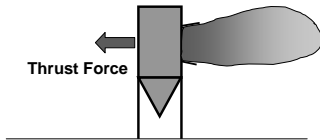
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Reaction Forces

- A vented deflagration produces thrust like a jet engine.
- A vented vessel or enclosure must be braced to withstand the thrust.



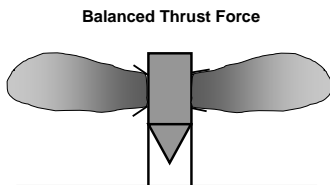
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Reaction Forces

- Where possible use symmetric vents on opposite sides to balance thrust.

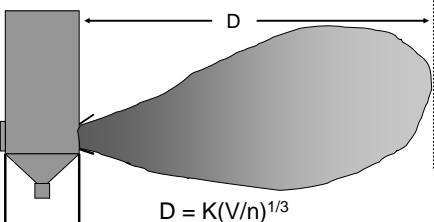


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Vented Flame Extension



$D = K(V/n)^{1/3}$

D = Flame extension distance
V = Enclosure Volume
n = Number of evenly distributed vents
K = 10 for metal dusts, 8 for other dusts

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Deflagration Isolation

- The isolation system prevents the propagation of the deflagration along conveyance ducts from one vessel or compartment to another.
- Designed in accordance with Chapter 11 of NFPA 69-2008

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Deflagration Control by Active Isolation

- Commonly used Isolation methods include:
 - Chemical Isolation
 - Fast-Acting Valves
 - Explosion Flap Valve a.k.a Back-Flash Preventer
 - Actuated Pinch Valves and others

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Chemical Isolation Systems

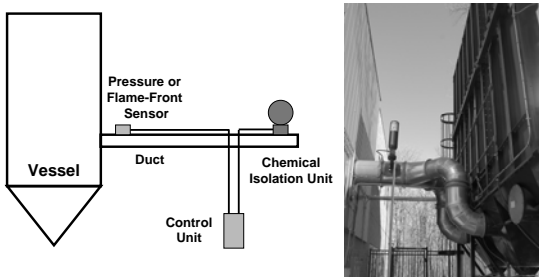
- Used to prevent deflagrations from propagating from one vessel to the next.
- Detect deflagration flame or pressure and discharge extinguishing agent into duct.
- Duct must be able to withstand the pressure of the suppressed deflagration.

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Chemical Isolation Systems



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Fast-Acting Valves

- Fast-acting valves are used to close-off ducts or pipes upon the occurrence of a pressure increment from a deflagration.
- Must be tested for use with the combustible in question.
- Spacing between sensor and valve is based upon flame-speed and system response time.
- The duct must be able to withstand the pressure of the deflagration.

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Fast-Acting Valves

Pressure or Flame-Front Sensor

Duct

Vessel

Control Unit

Fast-acting Valve

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Back-Flash Preventers

- The Back-Flash Preventers assembly must be capable of withstanding the anticipated deflagration pressures.
- Where diversions is provided:
 - Maximum opening pressure of 100 mbar.
 - Diversion of flame front must be to a safe, outside location.
 - Diverters shall be tested to verify capability.

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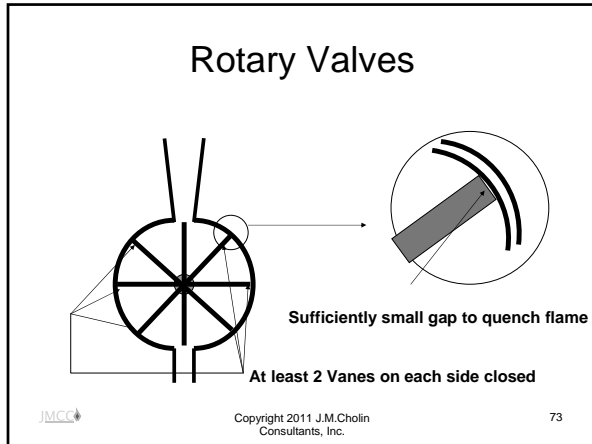
Rotary Valves

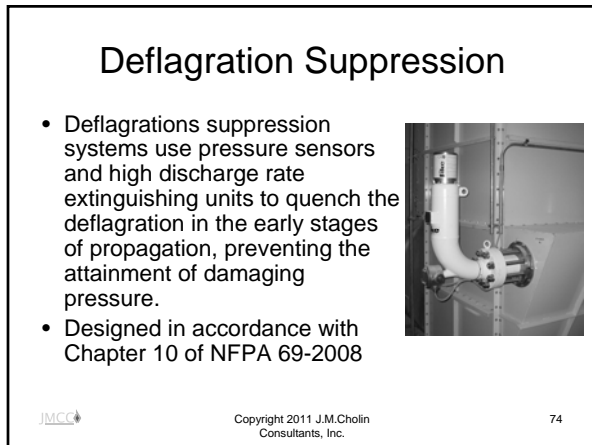
- Rotary valves are often called rotary air-locks.
- Not all rotary valves are suitable for deflagration isolation.
- Only permissible for isolation of dust deflagration hazards.

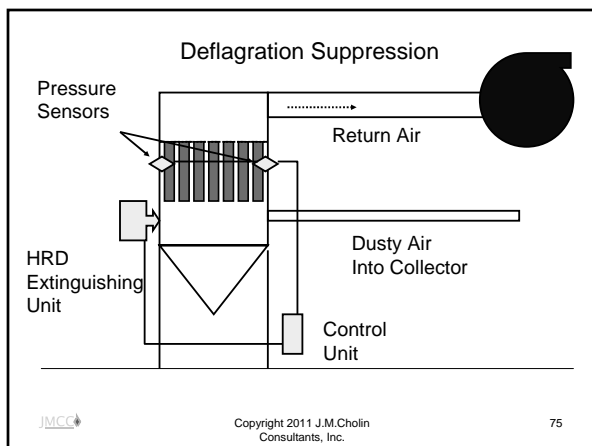
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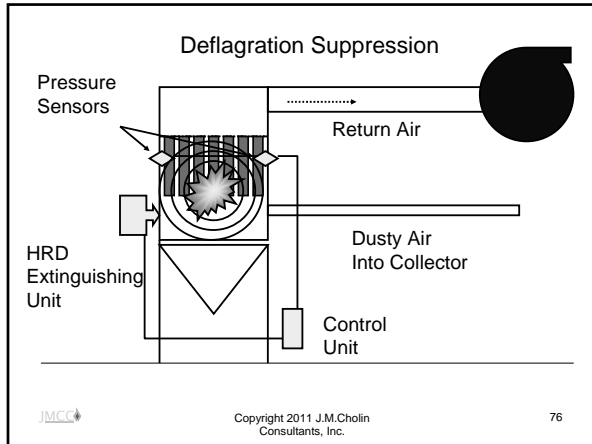
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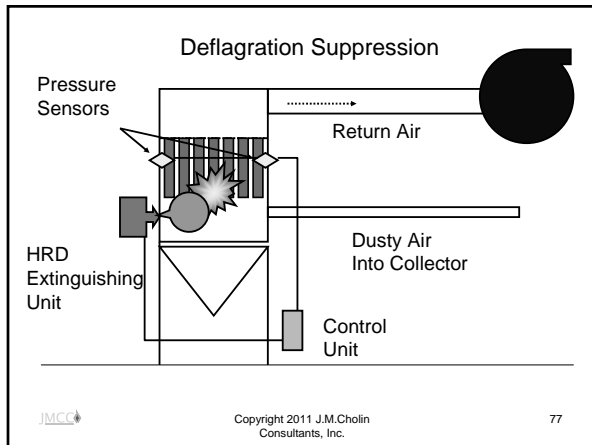
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Deflagration Suppression

- Reaction times are generally in the 30 to 40 millisecond time domain.
- Pressure sensors are generally calibrated to 0.5 psi above ambient.
- Extreme care should be used when Deflagration Suppression is used on vessels also equipped with Deflagration Relief Vents.

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Deflagration Suppression

- Deflagration suppression systems are custom-designed for the particular compartment to be protected.
- Each make has limitations on the quantity of agent and distance it can be projected within the time-frame of the developing deflagration.
- Any change to the vessel or compartment necessitates a review of the system to verify that it will still meet the design objectives.


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“Protected” from the Air-Material Separator

- From Fire:
 - Return Air Diversion
- From Deflagration
 - Deflagration venting and isolation
 - OR
 - Deflagration Suppression and isolation

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“Protected” from the Air-Material Separator



BackFlash Preventer
Deflagration Vent
Flame Diverter
Abort Gate
Rotary Valve

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Thank You

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