How to be Sure Your Dust Collector Design and Installation are NFPA Compliant

Presented by:

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Who is the NFPA?

- National Fire Protection Association
- Nonprofit international organization
- More than 81,000 members
- 300 codes and standards
- Earned accreditation from the American National Standards Institute (ANSI)
NFPA 68

- “Should” changed to “SHALL” to show mandatory provisions for compliance
- Non-mandatory Annexes are included for informational purposes only

“This standard applies to the design, location, installation, maintenance, and use of devices and systems that vent the combustion gases and pressures resulting from a deflagration within an enclosure so that structural and mechanical damage is minimized.”
Enforcement of NFPA Standards

• NFPA:
  – Has no enforcement capabilities
  – Does not police or verify compliance
  – Defers to “Authority Having Jurisdiction” (AHJ)
    • Fire chief, fire marshal, insurance official, company safety compliance officer, an organization such as OSHA
Applicable NFPA Standards

- **NFPA 77** – *Recommended Practice on Static Electricity*, 2007 Edition
NFPA 68

Definitions:

Deflagration – “Propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium.”

• explosions
• fires

\( P_{\text{max}} \) (Maximum Pressure) – “The maximum pressure developed in a contained deflagration of an optimum mixture.”

• a function of the material being combusted
• “determined in approximately spherical calibrated test vessels of at least 20 L capacity...”
Definitions (cont’d):

$K_{st}$ – “The deflagration index of a dust cloud.”

- $K_{st}$ “shall be computed from the maximum rate of pressure rise attained by combustion in a closed...approximately spherical calibrated test vessel of at least 20 L capacity...”
- Published lists of example values are available for certain materials, but variations in characteristics, such as particle size and moisture content, of seemingly identical materials can produce varied results.

NOTE: NFPA 68 states “where the actual material is available, the $K_{st}$ shall be verified by test”.

Definitions (cont’d):

Enclosure Length-to-Diameter ratio (L/D)

If $L/D \leq 2$, Equation 8.2.2 is used to calculate the minimum necessary vent area

If $2 < L/D \leq 6$, Equation 8.2.3 is used to calculate the minimum necessary vent area

For unusual shapes, the effective hydraulic diameter is used
Definitions (cont’d):

$P_{\text{red}}$ (Reduced Pressure) – “The maximum pressure developed in a vented enclosure during a vented deflagration.”

“$P_{\text{red}}$ shall not exceed two-thirds of the ultimate strength for the vented enclosure, provided deformation of the equipment can be tolerated.”

– 2/3 Ultimate strength of the vessel
  • Less required vent area (lower costs)
  • Potential for permanent deformation of equipment

“Where deformation cannot be tolerated, $P_{\text{red}}$ shall not exceed two-thirds of the yield strength for the vented enclosure.”

– 2/3 Yield strength of the vessel
  • More vent area required (higher costs)
  • Permanent deformation of equipment from deflagration unlikely
Determining $P_{\text{red}}$

Decide if the enclosure design pressure selection will be based on $2/3$ of the ultimate strength or $2/3$ of the yield strength.

Identify weakest point of design by either:

- Performing actual test explosions, or
- Finite Element Analysis (FEA)
Determining $P_{\text{red}}$ Utilizing FEA
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Determining $P_{\text{red}}$ Utilizing FEA
Validating FEA Results by Performing Actual Test Deflagrations
Dust Collector Venting Alternatives

Alternative Arrangement 1

• **Condition 1**
  Spacing between the bags ≤ radius of the bag
  and
  all of the venting is located **below** the bottom of the bags

  – “…the vent area shall be permitted to be calculated on the basis of the volume below the lower end of the bags” (lower housing and hopper)
  – yields the smallest volume and thereby reduces the required vent area
  – filter housing must be taller or the bag length shorter to provide the space beneath the bags required for the vent(s)
Venting Alternative Arrangement 1

\[ S < r, \text{ See 8.7.1(1)(a).} \]

\[ S > r, \text{ See 8.7.1(1)(b).} \]
Dust Collector Venting Alternatives

Alternative Arrangement 1

- **Condition 2**
  - Spacing between the bags > radius of the bag and all of the venting is located below the bottom of the bags
Venting Alternative Arrangement 1

Condition 2

• “…the vent area shall be permitted to be calculated on the basis of the dirty side only; that is, calculate the volume below the tube sheet, and subtract out the volume occupied by the bags.”

• filter housing must be taller or the bag length shorter to provide the space beneath the bags required for the vent(s)
Dust Collector Venting Alternatives

Alternative Arrangement 2:

- Bottom of vent(s) above bottom of bags
- Loss of filter bag area
- Restrain remaining bags, or verify by test that bags are rigid enough to remain in place during venting
- Operational concerns about bag wear from restraint
- Increased vent area required; volume between bags included in calculation, volume of bags excluded
Dust Collector Venting Alternatives

Alternative Arrangement 3:

• Bottom of vent(s) below bottom of bags
• Increased vent area required; volume between and inside bags included in calculation
Risks Associated with Fireball

- “Measures shall be taken to reduce the risk to personnel and equipment from the effects of fireball temperature and pressure.”
- NFPA 68 provides equations to calculate both the axial distance of the fireball and the external pressure.
- A blast deflector plate can be used to reduce the axial hazard distance to 50% of the calculated value.
Effects of Panel Inertia

The mass of the vent panel can result in an incremental increase in the minimum necessary vent area.

7.2.2.5.2\textsuperscript{a} The vent area determined by Equation 7.2.2 shall be adjusted for vent mass when the vent mass exceeds $M_T$ as calculated in Equation 7.2.2.5.2:

$$M_T = \left[ 6.67 \cdot (P_{c_{at}})^{0.8} \cdot (n)^{0.9} \cdot \left( \frac{V}{K_G} \right)^{1.67} \right]$$  \hspace{1cm} (7.2.2.5.2)

where:
- $M_T$ = threshold mass (kg/m\textsuperscript{2})
- $P_{c_{at}}$ = bar
- $n$ = number of panels
- $V > 1$ m\textsuperscript{3}
- $K_G \leq 130$

7.2.2.6 If $M > M_T$, the vent area shall be increased by adding the calculated area, $\Delta A$, from Equation 7.2.2.6:

$$\Delta A = A_c \cdot (0.0075) \cdot M^{0.6} \cdot \frac{K_G^{0.6}}{K_G^{0.6}} \cdot V \cdot P_{c_{at}}^{0.2}$$ \hspace{1cm} (7.2.2.6)

where:
- $A_c$ = vent area calculated by Equation 7.2.2
- $M$ = mass of vent panel (kg/m\textsuperscript{2})

7.2.2.7 If $K_G$ is less than 75 bar-m/sec, $K_G = 75$ shall be used in Equation 7.2.2.6.
Effects of Vent Discharge Ducts

- If it is necessary to locate a dust collector with deflagration vents inside of a building, a vent duct shall be used to direct vented material from the dust collector to the outdoors.

- “A vent duct shall have a cross sectional area at least as great as that of the vent itself, but shall be limited to no more than 150% of the vent itself at any point in the vent duct.”

- “Vent area calculations shall include the effects of vent ducts.”

- The equation to calculate the effect of vent ducts has a solution that is iterative, requiring a trial and error process (or the goal seek button in Excel).

- Vent ducts “shall be of noncombustible construction and shall be strong enough to withstand the expected $P_{\text{red}}$.”

- Bends in the vent duct are now allowed, but “support calculations shall include reaction forces based on the expected $P_{\text{red}}$.”
Flame-arresting and Particulate-retention Vent Systems

• An alternative approach that eliminates the need for vent ducts and satisfies the mandate to reduce the risk from the effects of a fireball involves the use of flame-arresting and particulate-retention vent systems.
NFPA 68 provides equations to determine the reaction force, the duration of the reaction force, and the total impulse that a structure supporting a vented enclosure experiences during deflagration venting.

The supporting structure of the dust collector must “be strong enough to withstand any reaction forces that develop as a result of operation of the vent”.
Suppression Concept (NFPA 69)

– The heat of combustion develops pressure.

– Upon pressure detection, sufficient suppressant agent is dispersed into the protected volume.

– Flame is quenched which prevents any further pressure increase.

– Flame, pressure and unburned mixture are contained inside the vessel.
Explosion Isolation (NFPA 69 and 654)

– Prevent explosion propagation through ductwork

– Explosion isolation devices:
  Chokes
  Rotary valves
  Automatic fast-acting valve systems
  Flame front diverters
  Chemical isolation (suppression) systems
Maintaining NFPA Compliance

Documentation
Inspection
Maintenance
Record Keeping and Training
NFPA 68

Required Documentation:

(1) Manufacturer’s data sheets and instruction manuals
(2) Design calculations
(3) General specifications
(4) Vent closure specifications
(5) End user inspection/maintenance forms
(6) User documentation of conformity with applicable standards
(7) Vent closure identification
(8) Combustible material properties test report
(9) Copy of vent identification label
(10) Process plan view
(11) Process elevation view
(12) Vent relief (pressure and fireball) path
(13) Proximity of personnel to vent relief path
(14) Mechanical installation details
(15) Electrical supervision (if provided) installation details
(16) Vent restraint installation and design documentation (if required)
(17) Process interlocks (if provided)
(18) Event deflagration isolation requirements (if required)
(19) Employee training requirements
Maintaining NFPA Compliance

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Vent closures shall be inspected at least annually:

1. The opening is free and clear of any obstructions on both sides.
2. The discharged material and fireball pathway does not extend into an area normally occupied by personnel or critical process equipment.
3. The closure has been properly installed according to manufacturer’s instructions.
4. The closure is not corroded or mechanically damaged.
5. The closure is clearly identified with manufacturer’s information.
6. The closure is clearly labeled as an explosion relief device.
7. The closure has no damage and is protected from the accumulation of water, snow, ice, or debris after any act of nature.
8. The closure has not been painted or coated other than by manufacturer.
9. The closure has no buildup of deposits on the inside surfaces or between layers of the vent.
10. The closure has not been tampered with.
11. The closure shows no fatigue and has not released.
12. The closure hinges (if provided) are lubricated and operate freely.
13. The closure restraints (if provided) are in place and operational.
14. The closure seals, tamper indicators, or vent rupture indicators (e.g., breakwire switches), if provided, are in place.
15. The flame-arresting and particulate-retention device is being maintained, is clean, and is unobstructed in accordance with the manufacturer’s listing.
16. The closure has no conditions that would hinder its operation.
Maintaining NFPA Compliance

Documentation
Inspection
Maintenance
Record Keeping and Training
Maintenance

– Vent closure maintenance shall be performed after every act of nature or process upset condition to ensure that the closure has not been physically damaged and there are no obstructions including but not limited to snow, ice, water, mud, or process material that could lessen or impair the efficiency of the vent closure.

– An inspection shall be performed after every process maintenance turnaround.

– If process material has a tendency to adhere to the vent closure, the vent closure shall be cleaned periodically to maintain vent efficiency.

– Process interlocks, if provided, shall be verified.

– Known potential ignition sources shall be inspected and maintained.

– Records shall be kept of any maintenance and repairs performed.
Maintaining NFPA Compliance

Documentation
Inspection
Maintenance
Record Keeping and Training
Record Keeping and Training

1. The records of inspections and any maintenance and repairs performed shall be retained for a minimum of 3 years.

2. Initial and refresher training shall be provided and training records maintained for employees who are involved in operating, maintaining, and supervising facilities that utilize devices for venting of deflagrations.
OSHA’s “Combustible Dust National Emphasis Program (Reissued)”

“The purpose of this NEP is to inspect facilities that create or handle combustible dusts which can cause intense burning or other fire hazards when suspended in air, and can lead to explosions.”

“As a result of a recent catastrophic accident involving combustible dust at a sugar refinery plant, OSHA is intensifying its enforcement activities at facilities where combustible dust hazards are known to exist.”

Found on OSHA’s new combustible dust safety and health website: http://www.osha.gov/dsg/combustibledust/index.html
Imperial Sugar Refinery Explosion on 2/7/2008
Petition from Worker Organizations

“We want OSHA to issue comprehensive combustible dust standards and we fully back the Committee on Education and Labor in their request to Secretary of Labor Elaine Chao for answers and action based on the CSB investigations and recommendations.”
Sugar Plant Blast Puts Heat on OSHA's Rulemaking

"I see such an incredible lack of urgency on the part of your agency to protect workers that it is astounding," Rep. George Miller (D-Calif.), who heads the House Education and Labor Committee, told OSHA director Edwin G. Foulke Jr.

- Cindy Skrzycki, Business Columnist for The Washington Post
H.R. 5522: Worker Protection Against Combustible Dust Explosions and Fires Act of 2008

To require the Secretary of Labor to issue interim and final occupational safety and health standards regarding worker exposure to combustible dust, and for other purposes.

Overview


Text: Summary | Full Text

Cost: less than $1 per American in fiscal year 2009.

Status:
- Introduced: Mar 4, 2008
- Reported by Committee: Apr 9, 2008
- Passed House: Apr 30, 2008
- Voted on in Senate: (did not occur)
- Signed by President: (did not occur)

This bill never became law. This bill was proposed in a previous session of Congress. Sessions of Congress last two years, and at the end of each session all proposed bills and resolutions that haven't passed are cleared from the books. Members often reintroduce bills that did not come up for debate under a new number in the next session.

Last Action: May 1, 2008: Received in the Senate and Read twice and referred to the Committee on Health, Education, Labor, and Pensions.
OSHA National News Release

U.S. Department of Labor
OSHA, Office of Communications

National News Release: 09-475-NAT
April 29, 2009
Contact: Diana Pettersen
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U.S. Department of Labor’s OSHA announces rulemaking on combustible dust hazards

WASHINGTON - The U.S. Department of Labor’s Occupational Safety and Health Administration (OSHA) is initiating a comprehensive rulemaking on combustible dust hazards.

OSHA will issue an Advanced Notice of Proposed Rulemaking and convene related stakeholder meetings to evaluate possible regulatory methods, and request data and comments on issues related to combustible dust such as hazard recognition, assessment, communication, defining combustible dust and other concerns.

Since 1950, more than 130 workers have been killed and more than 750 injured in combustible dust explosions. These include 14 people who were killed in a dust explosion Feb. 7, 2000, at an Imperial Sugar Co. plant in Georgia and three workers who were burned in April 2009 in an Illinois pet food plant dust explosion.

“Over the years, combustible dust explosions have caused many deaths and devastating injuries that could have been prevented,” said Secretary of Labor Hilda L. Solis. “OSHA is reinvigorating the regulatory process to ensure workers receive the protection they need while also ensuring that employers have the tools needed to make their workplaces safer.

Combustible dusts are solids finely ground into fine particles, fibers, chips, chunks or flakes that can cause a fire or explosion when suspended in air under certain conditions. Types of dusts include metal (aluminum and magnesium), wood, plastic or rubber, coal, flour, sugar and paper, among others.

In 2008, the U.S. Chemical Safety Board (CSB) recommended that OSHA issue a combustible dust standard. OSHA received additional support for a combustible dust standard from the CSB during a congressional hearing in 2008 when the board said a new standard, combined with enforcement and education, could save workers’ lives.


Under the Occupational Safety and Health Act of 1970, employers are responsible for...
Retroactivity of NFPA Standards

NFPA 68:
Section 1.5.1.1 – “...the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard.” (December 20, 2006)

Exceptions:
“In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.” (Section 1.5.1.2)

or

“When major replacement or renovation of existing facilities is planned, provisions of this standard shall apply.” (Section 1.5.3)
Thank you for the opportunity to speak with you today

Should you have any questions please visit our website at

www.kice.com

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