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Wood Products Safety Summit 2019

Dust Hazards & Explosion Protection
Dust Testing & Case Studies

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- Founded in 1945, Fike are world leaders in explosion protection, and pressure relief.
- In business for over 74 years
- Fike Canada Inc, was founded in 1985 in Burlington, ON
- Leaders in technology, research and testing worldwide

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Dust Explosibility Testing

A wide range of explosibility tests are designed to assist companies in identifying and mitigating costly explosion hazards. Testing laboratories are staffed with highly trained technicians, engineers, and combustion scientists. To assure proper execution and interpretation of the results, tests are conducted in accordance with ASTM E1226 standards.

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NFPA-68 2018 Current Edition

Para 6.1.2

"For Dusts, Kst & Pmax values shall be determined …per ASTM E 1226"

Para 8.1.2.2

"When the actual material is available, the Kst shall be verified by test" (Collect finest dust from Dust Collector Bags)

Appendix F.2:

"The user is cautioned that test data on the flammability characteristics of dusts are sample specific."

Why Testing?

Material explosibility testing is vital for safe plant design, safe operating parameters, and safe handling procedures. Testing can be conducted in both small- and large-scale explosion test vessels, designed and constructed to provide accurate data that is scalable to industrial equipment volumes: • Information regarding explosibility parameters of Pmax and KST • Explosibility limits of fuel, oxidant, or ignition energy • Performance of many tests at elevated temperatures and/or pressures to simulate customer operating conditions • Verify and document PMax - KST values required to comply with NFPA standards

Particle Size and Shape

-Particle Size and Shape has the greatest impact on explosibility parameters like Pmax and Kst.

-Nearly all dust samples will contain some amount of fine particles which are more easily ignited.

-Combustion will also propagate more rapidly through fine particles than larger particles.

-ASTM standards recommend the testing of particles $< 75\mu m$ (200 mesh).

-Dust samples can be tested “as received” provided the particles are small enough to properly disperse in the test apparatus (typically $< 425\mu m$).

-Samples containing fine particles should be sieved to determine the worst case scenario.

Moisture Analysis

Typically, the sample will be dried prior to testing if the moisture content is >5%.

If this greater moisture content is representative of the process, the sample can be tested as provided, as long as it can be dispersed into a dust cloud within the test apparatus.

Prior arrangements should be made for testing samples at higher moisture contents >5%, >10%, >15%, or >20%.

Additional Tests

Explosibility Screening – Kst and Pmax Values
Minimum Explosible Concentration MEC
Limiting Oxygen Concentration LOC
Minimum Autoignition Temperature MAIT
Minimum Ignition Energy MIE
Minimum Dust Layer Ignition Temp.
Percent Combustible Material PCM
Particle Size Analysis PSA

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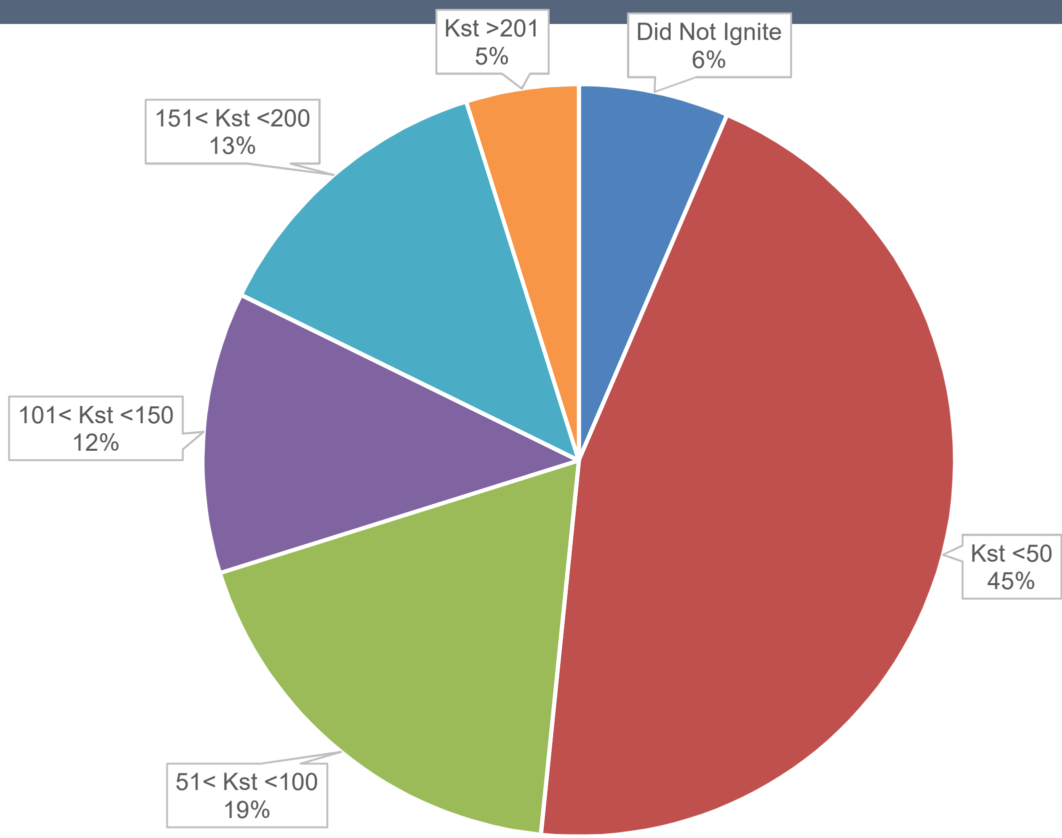
WOOD DUST TESTING

124 Wood Dust samples tested since 2010

- Various types from various industries (Pellet Plants, MDF, OSB, Particle Board, Sawmills, etc)
  - 15% received at 5% moisture or less
  - 50% received above 5% and less than 10% moisture
  - 10% received above 10% and less than 15%
  - 25% received above 15% moisture
- 70% of samples dried to 5% or below per ASTM E1226 procedure
- 25% of samples not dried (tested as received) ignited with Kst values above 50bar*m/s
- 20% of samples not dried (tested as received) did NOT ignite
  - In each case sample contained small % of dust (425um or less)



124 Wood Dust Samples

CASE STUDIES

Cyclone

- Venting
- Suppression

Metering Bin

- Venting
- Suppression

CYCLONES

Explosion Venting

Typically difficult to apply explosion venting due to following:
Vents are applied to top of Cyclon
Generally not much available space to install vents
Generally have a short straight wall body and a tall hopper

- This leads to long L/D ratios (NFPA 68, 2018 – Section 6.4)
  - As L/D ratio increases, final vent area increases
  - Adds more difficulty to installing vents on top of Cyclone
  - If L/D ratio exceeds 6, vent must be applied at multiple elevations – NOT PRACTICAL FOR CYCLONES

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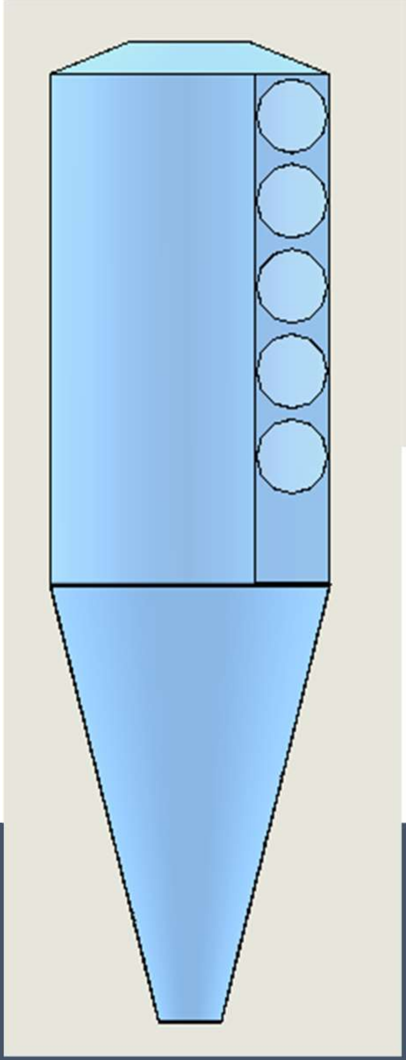
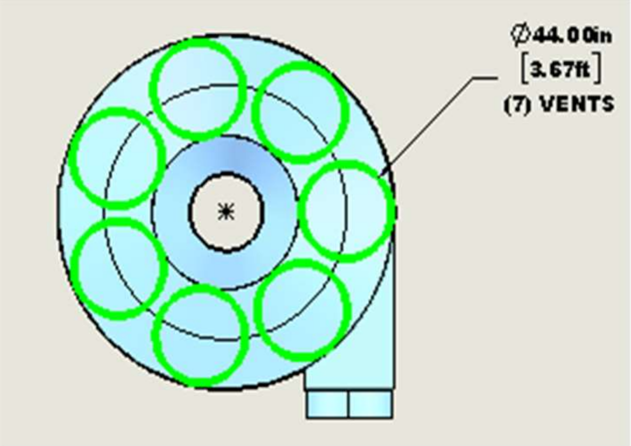
Volume - 7268ft3
L/D - 3.18
Wood Dust
Kst - 140bar*m/s
Pmax - 7.0barg
Pred - 4.06psig
Pstat - 0.73psig

Final Vent Area = 70ft2
(7) 44in Dia explosion vents





Very little space to fit explosion vents on top.
Vents installed in high flow area

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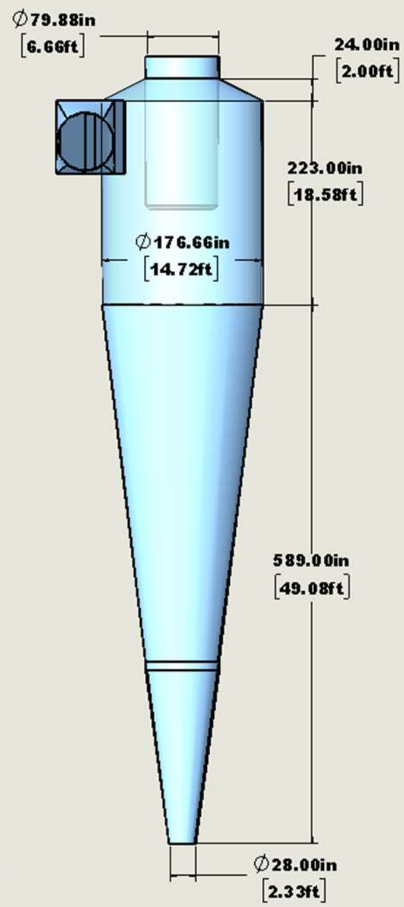


VOLUME CALCULATIONS

TOP = 0.2618 * h * (D1^2 + D1*D2 + D2^2) * Quantity
TOP = 0.2618 * 2.00 * (6.66^2 + 6.66*14.72 + 14.72^2) * 1.00
TOP = 188.01 ft^3

STRAIGHT = 0.7854 * D^2 * h * Quantity
STRAIGHT = 0.7854 * 14.72^2 * 18.58 * 1
STRAIGHT = 3,161.93 ft^3

HOPPER = 0.2618 * h * (D1^2 + D1*D2 + D2^2) * Quantity
HOPPER = 0.2618 * 49.08 * (14.72^2 + 14.72*2.33 + 2.33^2) * 1.00
HOPPER = 3,294.58 ft^3

EFFECTIVE VOLUME(Veff) = TOP + STRAIGHT + HOPPER
EFFECTIVE VOLUME(Veff) = (188.01) + (3,161.93) + (3,294.58)
EFFECTIVE VOLUME(Veff) = 6,644.52 ft^3

L/D CALCULATION

TOTAL FLAME PATH(H) = 2.00 + 18.58 + 49.08
TOTAL FLAME PATH(H) = 69.66 ft

EFFECTIVE AREA (Aeff) = Veff / H
EFFECTIVE AREA (Aeff) = 6,644.52 / 69.66
EFFECTIVE AREA (Aeff) = 95.39 ft^2

HYDRAYLIC DIA. (Dhe) = (4 * Aeff / pi)^0.5
HYDRAYLIC DIA. (Dhe) = (4 * 95.39/ pi)^0.5
HYDRAYLIC DIA. (Dhe) = 11.02 ft

LENGTH / DIAMETER (L/D) = H / Dhe
LENGTH / DIAMETER (L/D) = 69.66 / 11.02
LENGTH / DIAMETER (L/D) = 6.32

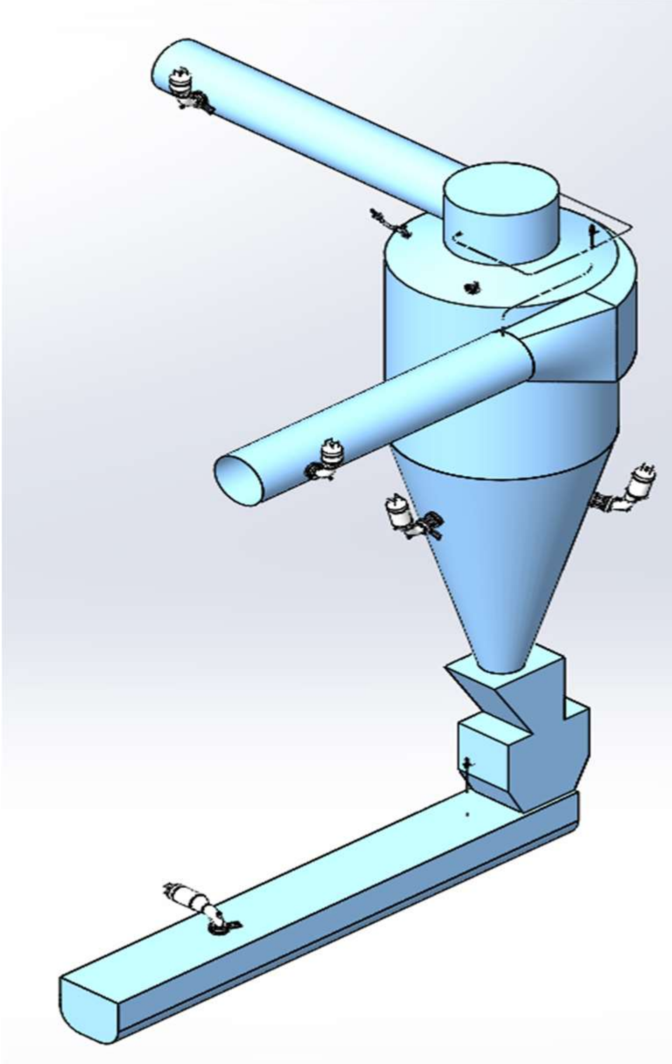
Explosion Suppression

Explosion is detected and suppressed within Cyclone

Suppressant containers installed on hopper away from high velocity areas

Meets NFPA 69 Standard

Isolation Containers installed on inlets and outlets



Metering Bins

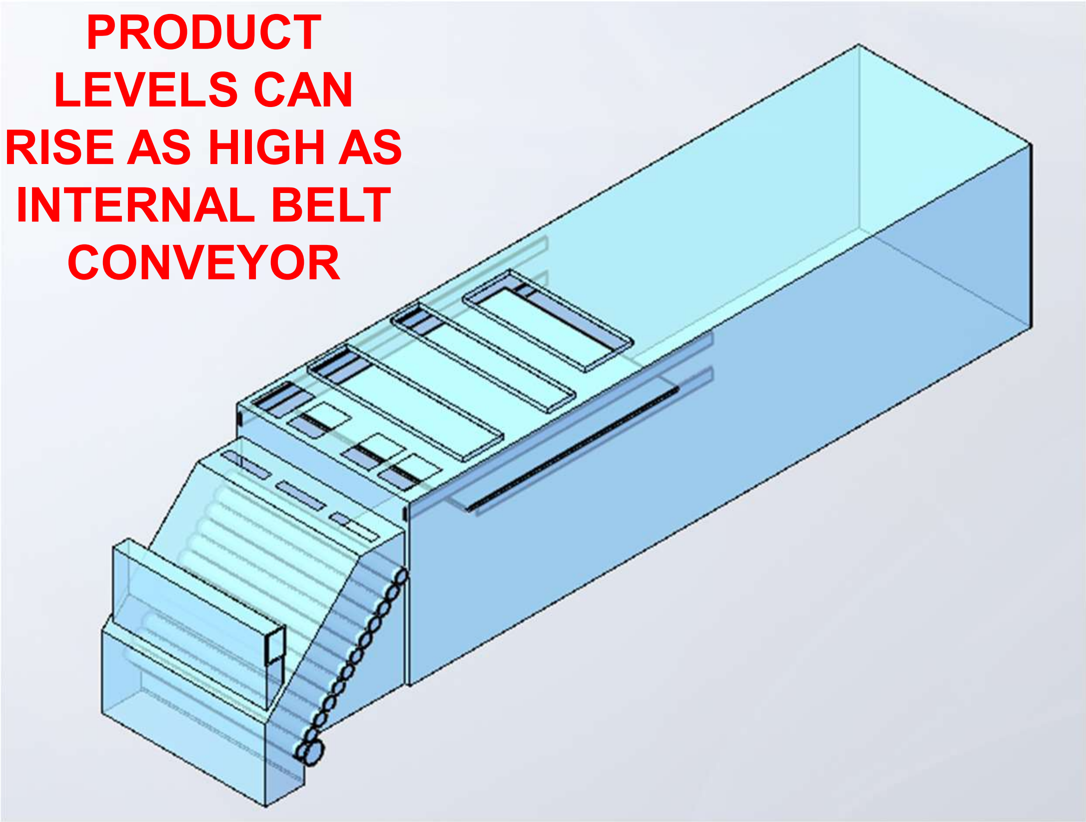
Typically difficult to apply Explosion Venting due to following:

Variable fill levels

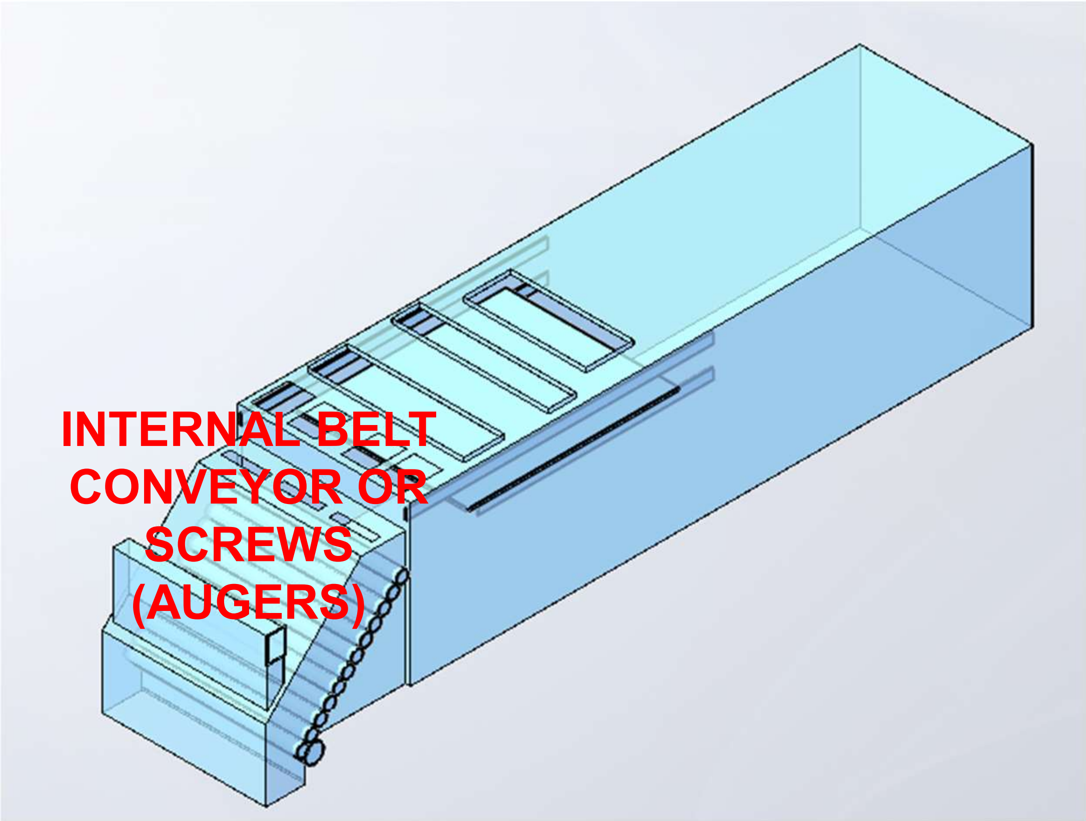
Installing vents on top of the bins are most practical location to avoid product blocking vent openings

Various internal structures such as rollers and belt conveyors obstruct the free vent path through the bin and to the explosion vents

An explosion originating at the underside of an internal belt conveyor will encounter a restricted path to the explosion vent delaying the release



Product would build-up and prevent explosion vents from rupturing properly if vents were installed anywhere other than the top of the bins.



INTERNAL BELT CONVEYOR OR SCREW (AUGERS) WOULD PREVENT AN EXPLOSION ORIGINATING IN THIS VOLUME FROM FLOWING FREELY TO THE EXPLOSION VENTS INSTALLED ON TOP

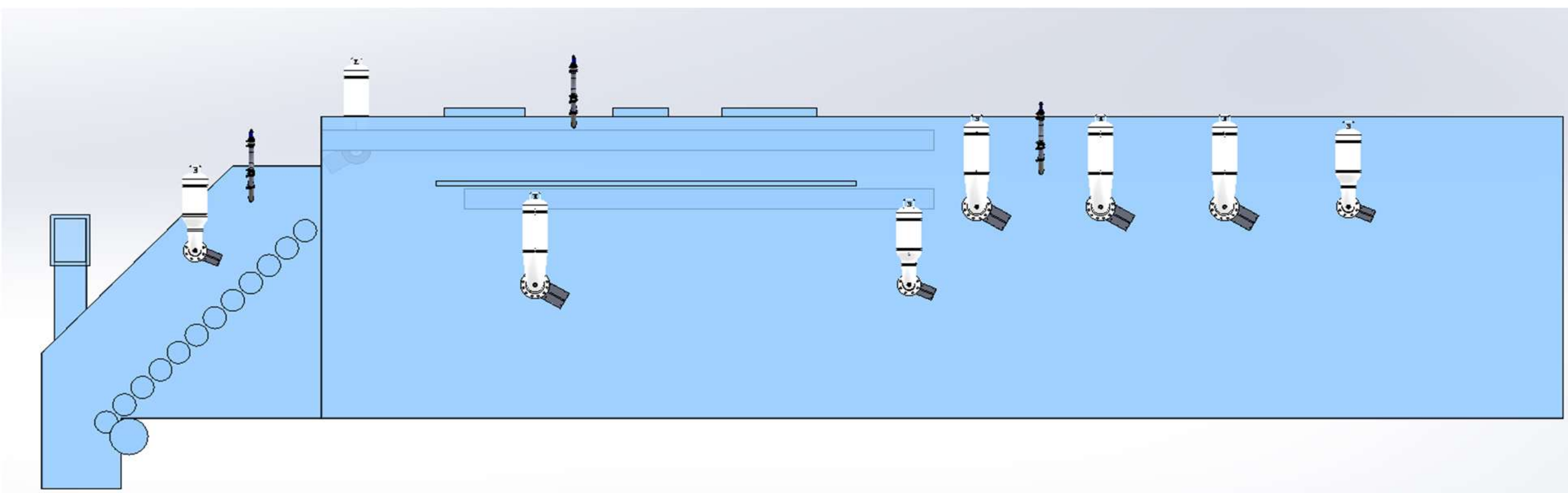
ROLLERS AND FULL PRODUCT LEVELS WOULD PREVENT AN EXPLOSION ORIGINATING IN THIS VOLUME FROM FLOWING FREELY TO THE EXPLOSION VENTS INSTALLED ON TOP

Explosion Suppression

Explosion is detected and suppressed within Bin

Pressure detectors and Suppressant containers installed at various locations to ensure proper detection and suppression of deflagration regardless of fill levels and ignition location

Meets NFPA 69 Standard



Thank You!

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