

Strengthening Combustible Dust Safety in Workplace

Applying Explosion Protection in Waste Management, Chemical, and Pharmaceutical Plants

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Applying explosion safety in accordance with the WSH Guideline

Figure 5: DHA flowchart (Figure 5 is adapted from SS 667 : 2020 with permission from Enterprise Singapore.)

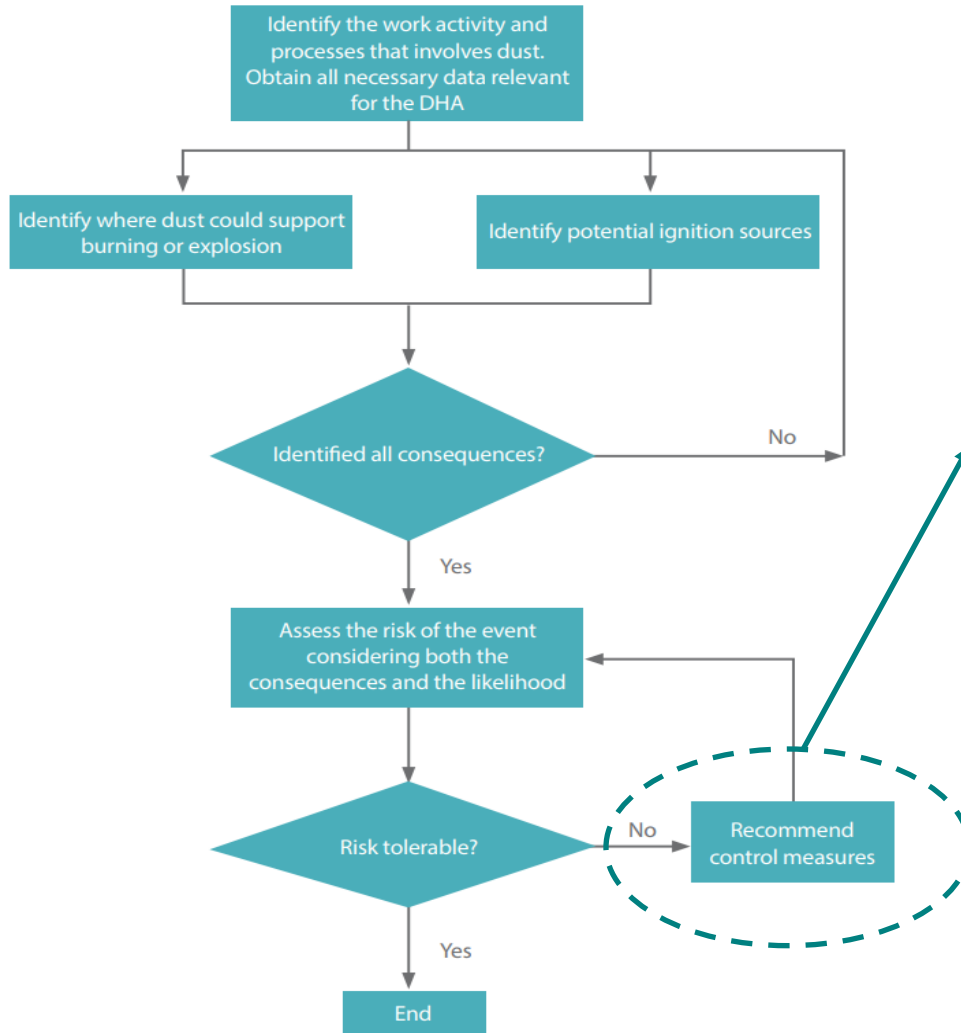


Figure 6: Hierarchy of Control

Elimination	For e.g., removing the use of combustible dust in processes.
Substitution	For e.g., replace material in powder form to paste/ slurry form.
Engineering Controls	For e.g., use of local exhaust ventilation to prevent accumulation of combustible dust.
Admin Controls	For e.g., regular cleaning of the workplace to prevent dust accumulation.
PPE	For e.g., fire retardant clothing, static dissipative safety shoes and dust respirator.

Source: WSH Guidelines – Combustible Dust 2025 Figure 5 and 6



Applying explosion safety in accordance with the WSH Guideline – 4.3.3 Engineering Control Measures

Explosion Prevention Measures

Goal: **Reliably** prevent explosions from happening

A. Prevention of Hazardous Explosive Atmospheres

e.g. cleaning & housekeeping, inerting, dust capture (aspiration), leakage control, and etc.

B. Prevention of Ignition Sources

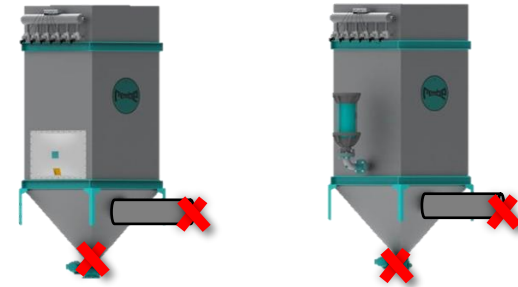
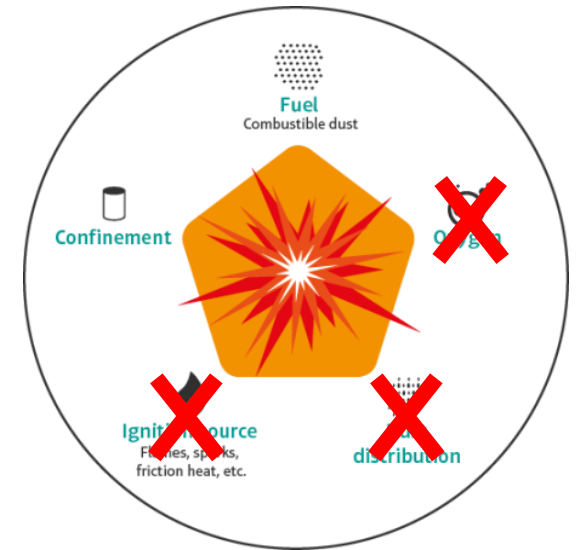
e.g. hazardous area classification to select suitable electrical devices, electrostatic bonding & grounding, surface temperature control, operational permits, and etc.

Explosion Protection

Goal: **Reduce** the effects of explosions to a safe level

C. Mitigation Measures

e.g. explosion resistant design, explosion venting, explosion suppression, explosion isolation



Case Study 1: Explosion Protection in a Waste Management Plant

Overview of Case

Material: Dried Organic Sludge

Process: Dried Sludge unloaded by truck and conveyed for storage in silos prior to being used as fuel for boilers

Safety values: $K_{st} = 110 \text{ bar.m/s}$, $P_{max} = 8 \text{ bar}$

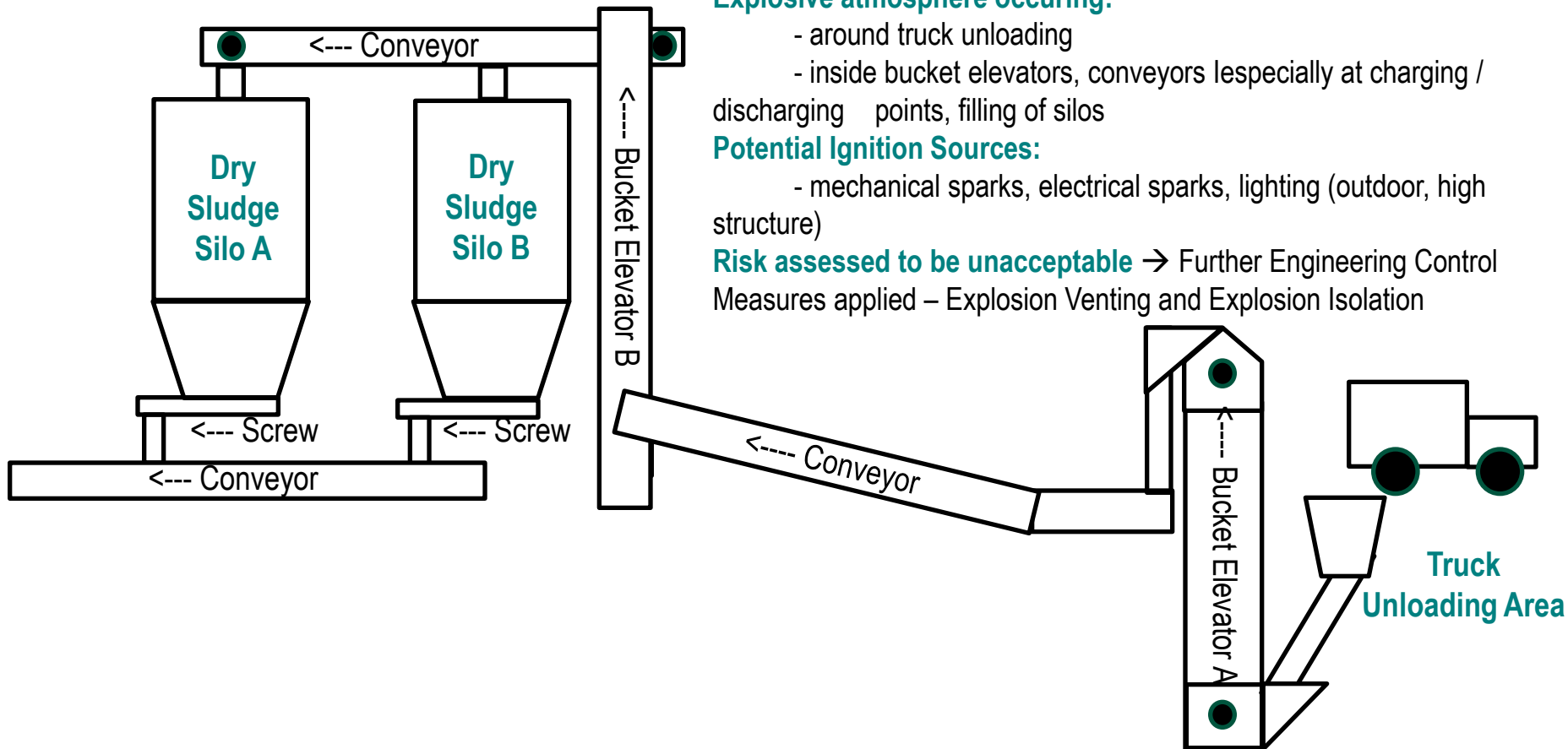
Explosive atmosphere occurring:

- around truck unloading
- inside bucket elevators, conveyors (especially at charging / discharging points, filling of silos)

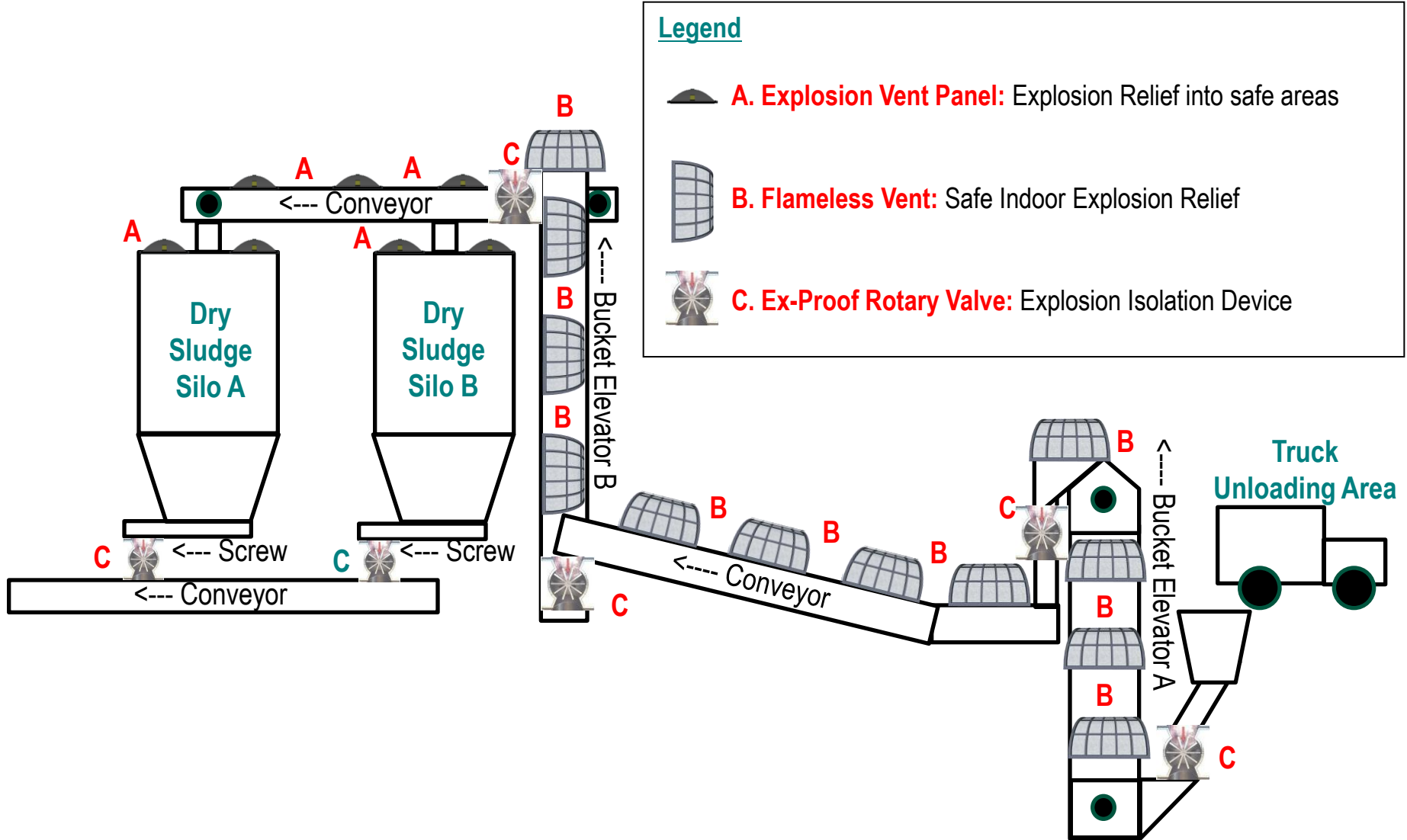
Potential Ignition Sources:

- mechanical sparks, electrical sparks, lighting (outdoor, high structure)

Risk assessed to be unacceptable → Further Engineering Control Measures applied – Explosion Venting and Explosion Isolation



Case Study 1: Explosion Protection in a Waste Management Plant



Case Study 1: Explosion Protection in a Waste Management Plant

EN 14491:2012 Dust

SAMPLE CALCULATION ONLY!

Vessel Characteristics

NOT ACTUAL

V (Volume)	50.12	m ³
L/D (Length/Diameter)	2.45	
Pred,max (Reduced expl. overpressure)	0.4	bar
Pstat (Static activation overpressure)	0.1	bar
Pinitial (Process over / under pressure)	0	bar

Product Data

Non Metallic Dust

Pmax (Max. explosion overpressure)	8	bar
KSt (Dust explosion constant)	100	m ² bar/s
Portion of solvents	0	%

Vent

Duct Length	0	m
M (Mass of vent)	0.5	kg/m ²
Ef (Efficiency of venting device)	100	%
Vent area (Geometric)	1.64	m ²
Position	Top (Top venting allows VDI 3673 if du...)	

Bucket Elevator Explosion Protection in acc. with NFPA 68

Kst value of product between 100 to 150 bar.m/s
Pred of elevator, Pred = 0.2 barg

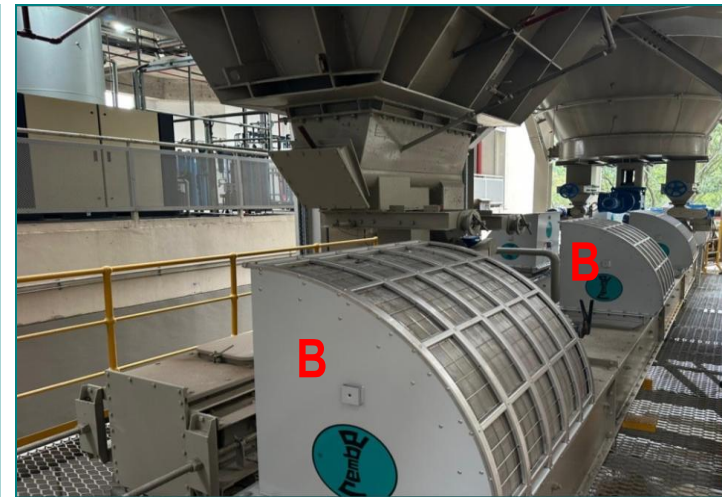
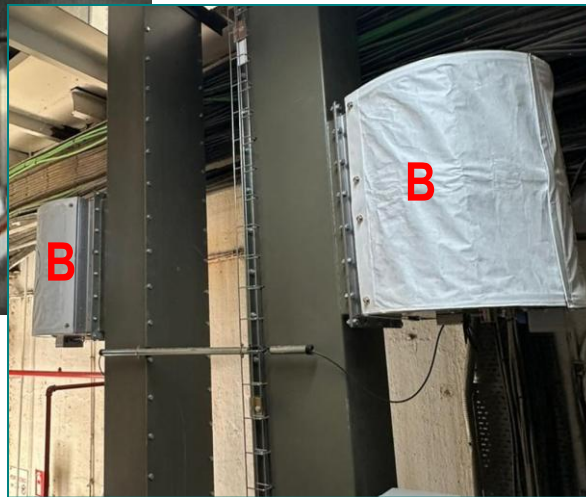
- Explosion Venting on the Head (venting device to be calculated accordingly)
- Explosion Venting on each Leg, every 3 meters (venting device to have vent area at least equivalent to cross sectional area of the leg)

Source: NFPA 68 Table 8.8.3.3 Additional Vent Spacing

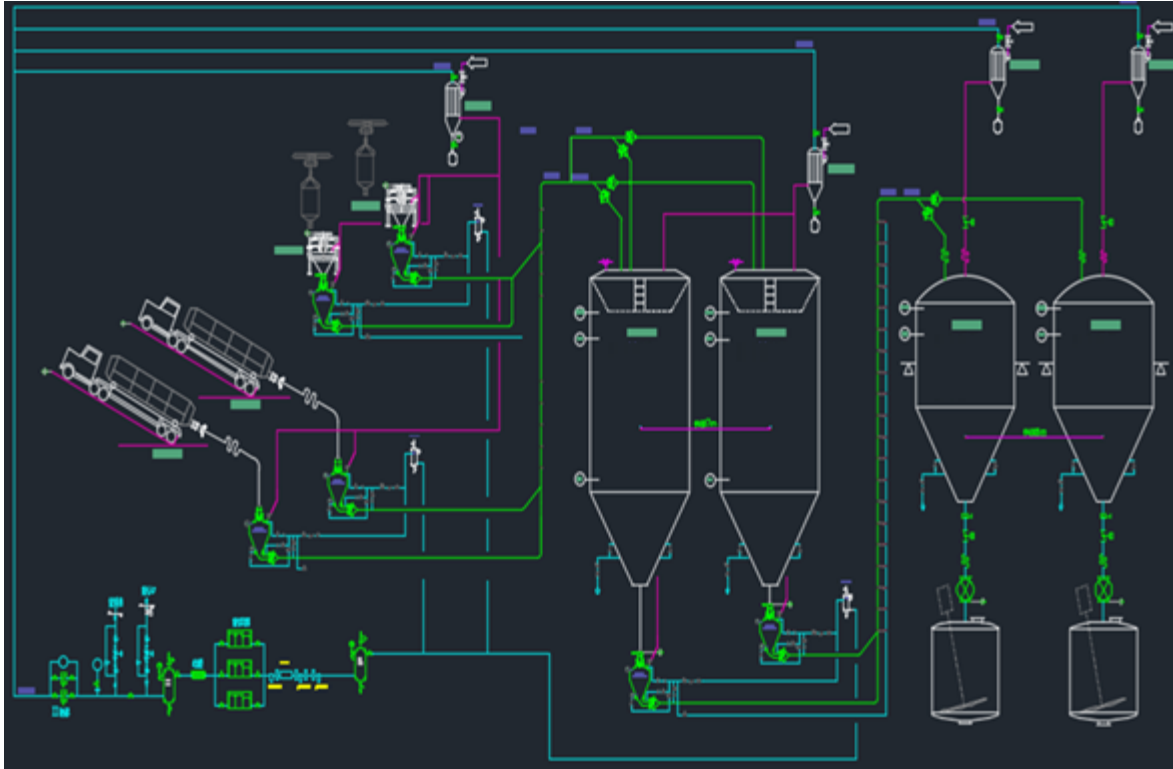


Case Study 1: Explosion Protection in a Waste Management Plant **SAMPLE INSTALLATION PICTURES**

ONLY



Case Study 2: Explosion Protection in a Petrochemical Plant



Overview of Case

Material: LDPE raw material

Process: LDPE raw material unloaded by trucks / big bags and transferred for storage in silos, and for further processing

Safety values: $K_{st} = 156 \text{ bar.m/s}$, $P_{max} = 8 \text{ bar}$, Resistive dust

Explosive atmosphere occurring:

- filling of silos, hoppers
- inside dust collection systems

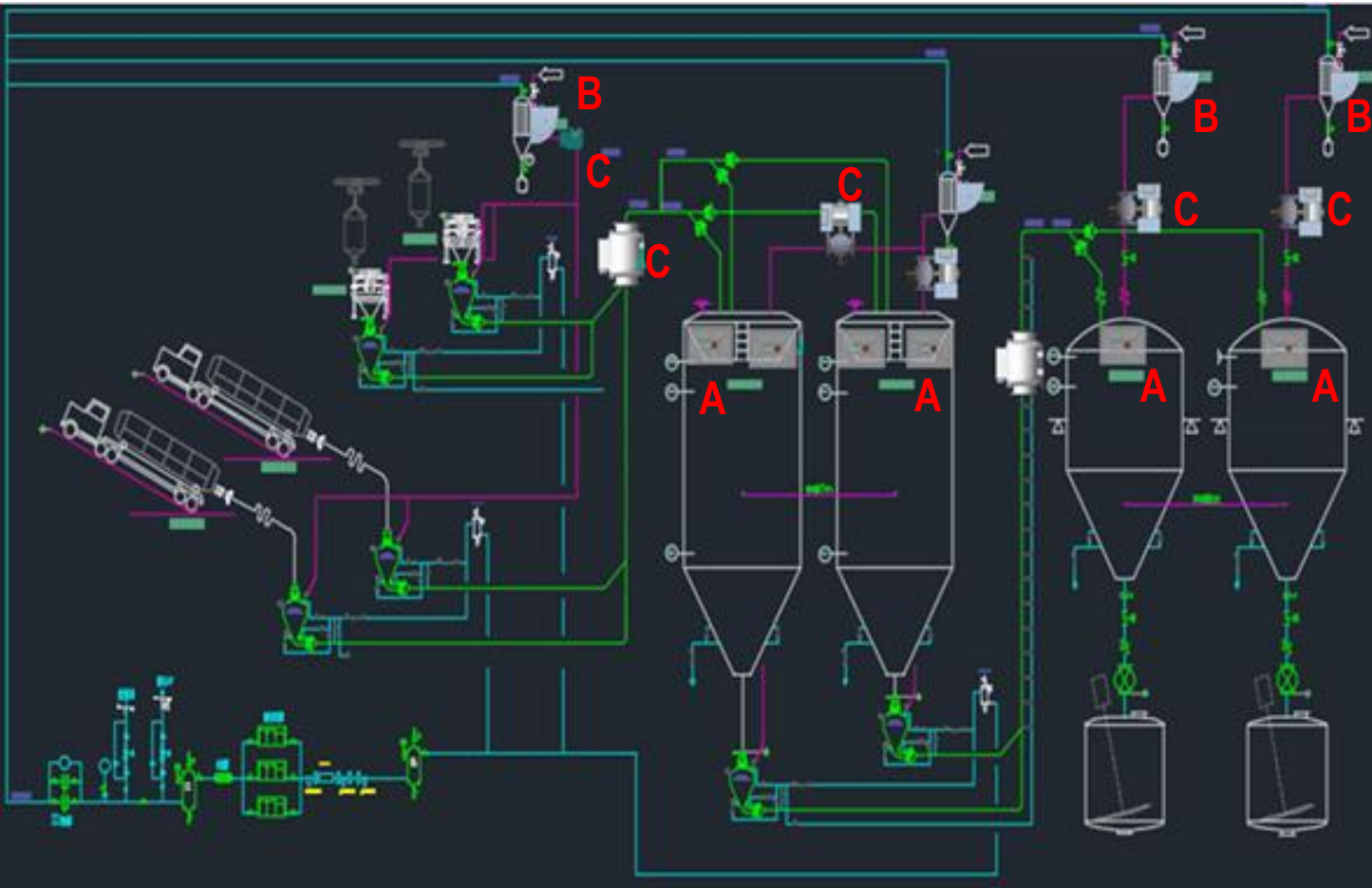
Potential Ignition Sources:

- mechanical sparks
- electrical sparks
- lighting (outdoor – high structure)
- electrostatic discharges

Risk assessed to be unacceptable → Further Engineering Control Measures applied – Explosion Venting and Explosion Isolation



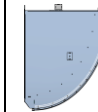
Case Study 2: Explosion Protection in a Petrochemical Plant



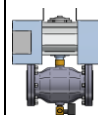
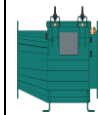
Legend



A. Explosion Vent Panel: Explosion Relief into safe areas



B. Flameless Vent: Safe Indoor Explosion Relief



C. Quench and Flap Valve: Explosion Isolation Devices

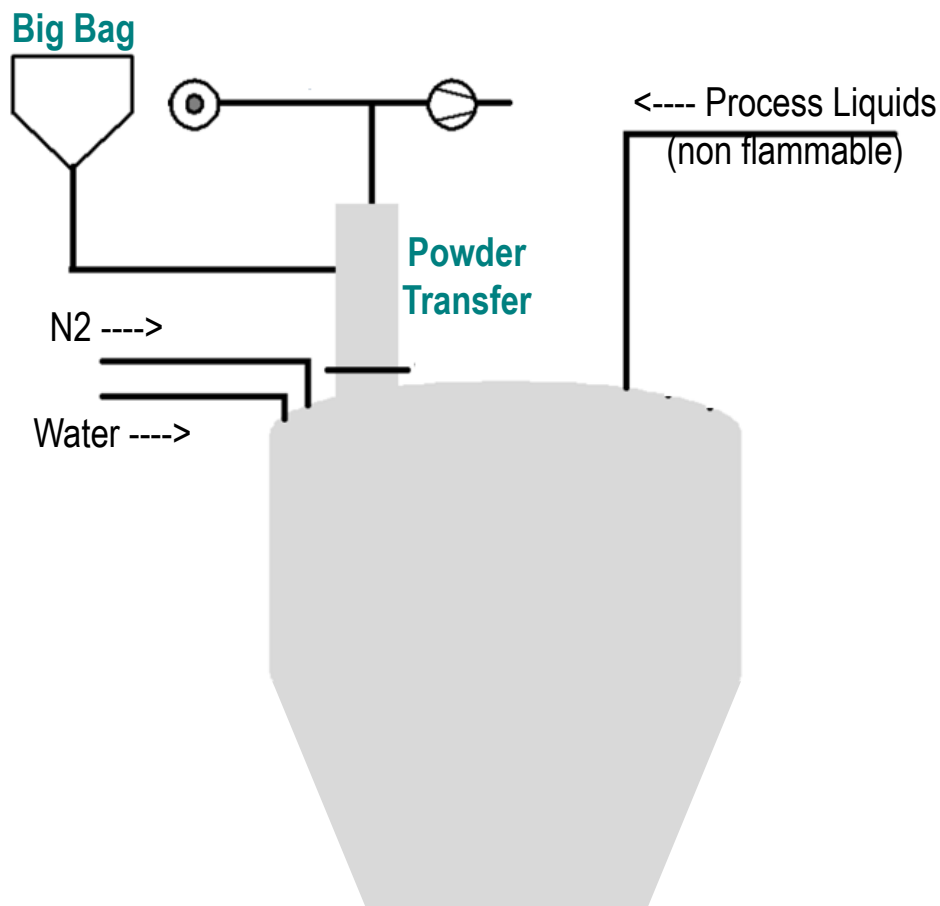


Case Study 2: Explosion Protection in a Petrochemical Plant

SAMPLE INSTALLATION PICTURES ONLY



Case Study 3: Explosion Protection in a Pharmaceutical Plant



Overview of Case

Material: Pharmaceutical Powder

Process: Pharmaceutical Powder in grounded big bag transferred into an agitation vessel via Powder Transfer System under suction from vacuum pump using process control of valves, and N2 purging (non-SIL)

Safety values: Dust Class ST2, MIE Dust Cloud <5mJ, Resistive powder likely to be charged even in grounded systems

Explosive atmosphere occurring:

- during charging of powder only into agitation vessel, and failure of process control valves / vacuum pump

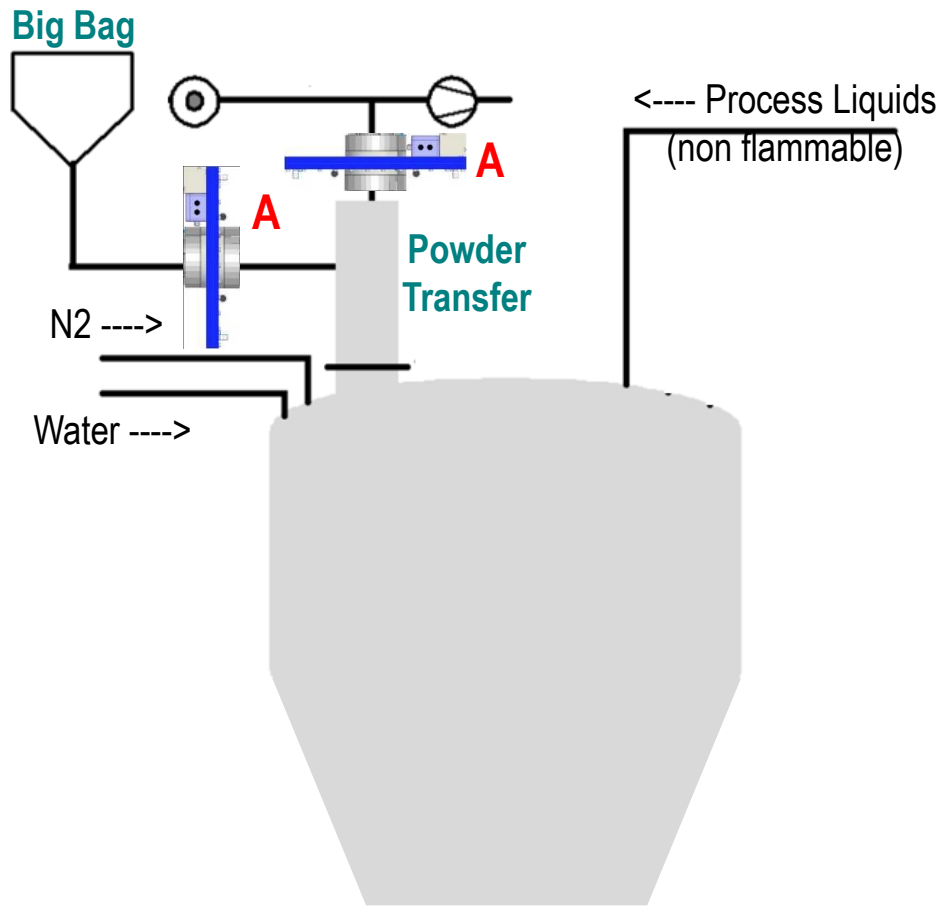
Potential Ignition Sources:

- electrostatic discharges, electrical sparks, and etc.

Risk assessed to be unacceptable → Further control measures applied - Explosion Resistant Design of Agitation Vessel (10 bar) and Explosion Isolation of inlet pipes



Case Study 3: Explosion Protection in a Pharmaceutical Plant



Legend



A. Slide Valve: Explosion Isolation Device withstanding 10bar of explosion pressure



Case Study 3: Explosion Protection in a Pharmaceutical Plant

**SAMPLE INSTALLATION PICTURES
ONLY**

