
expofuego
CHILE 2023
CONGRESO INTERNACIONAL
DE PROTECCIÓN CONTRA INCENDIO

expofuego
CHILE 2023

Explosión de Polvos Combustibles: Riesgos Industriales y Normativa Asociada

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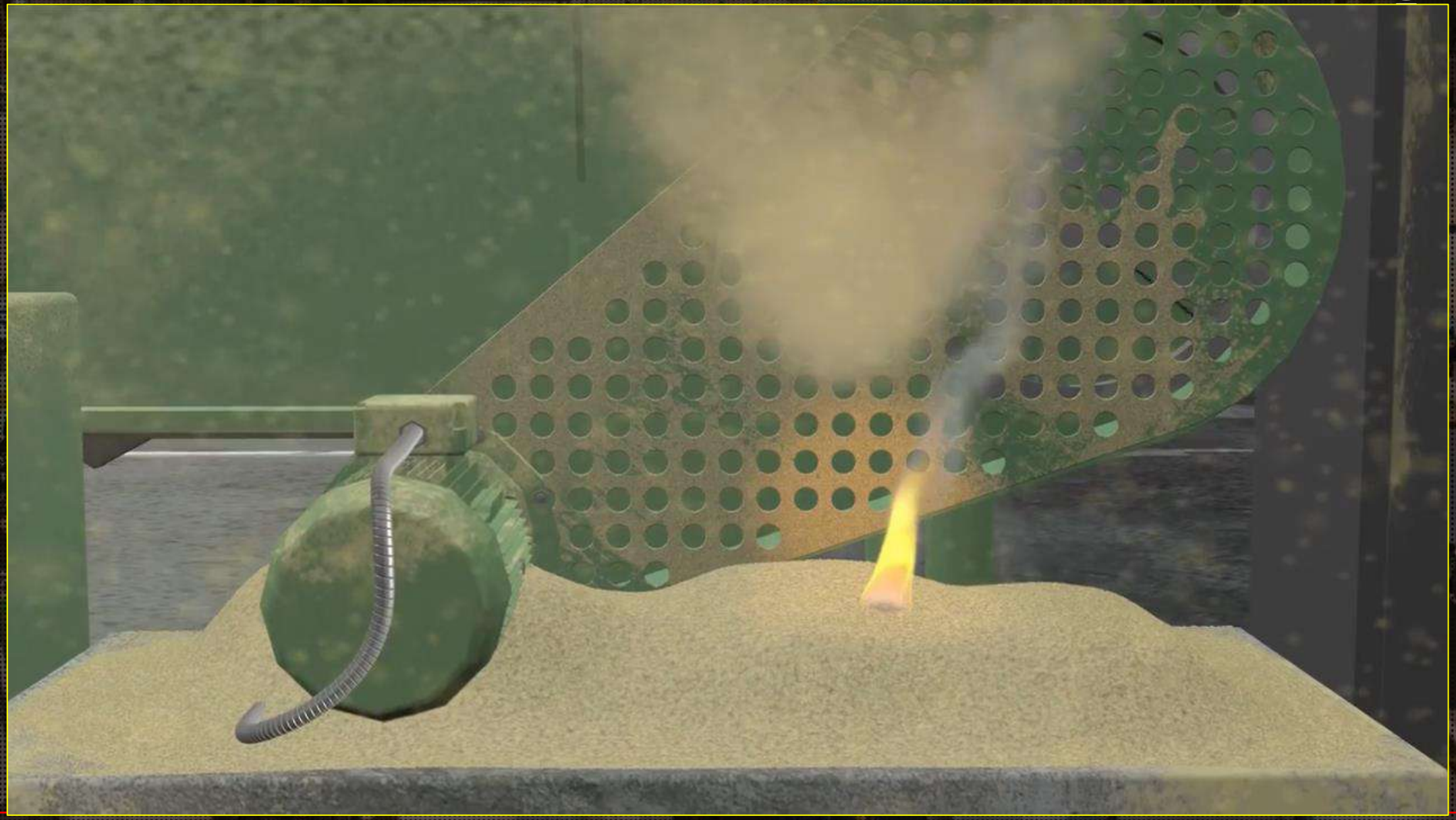
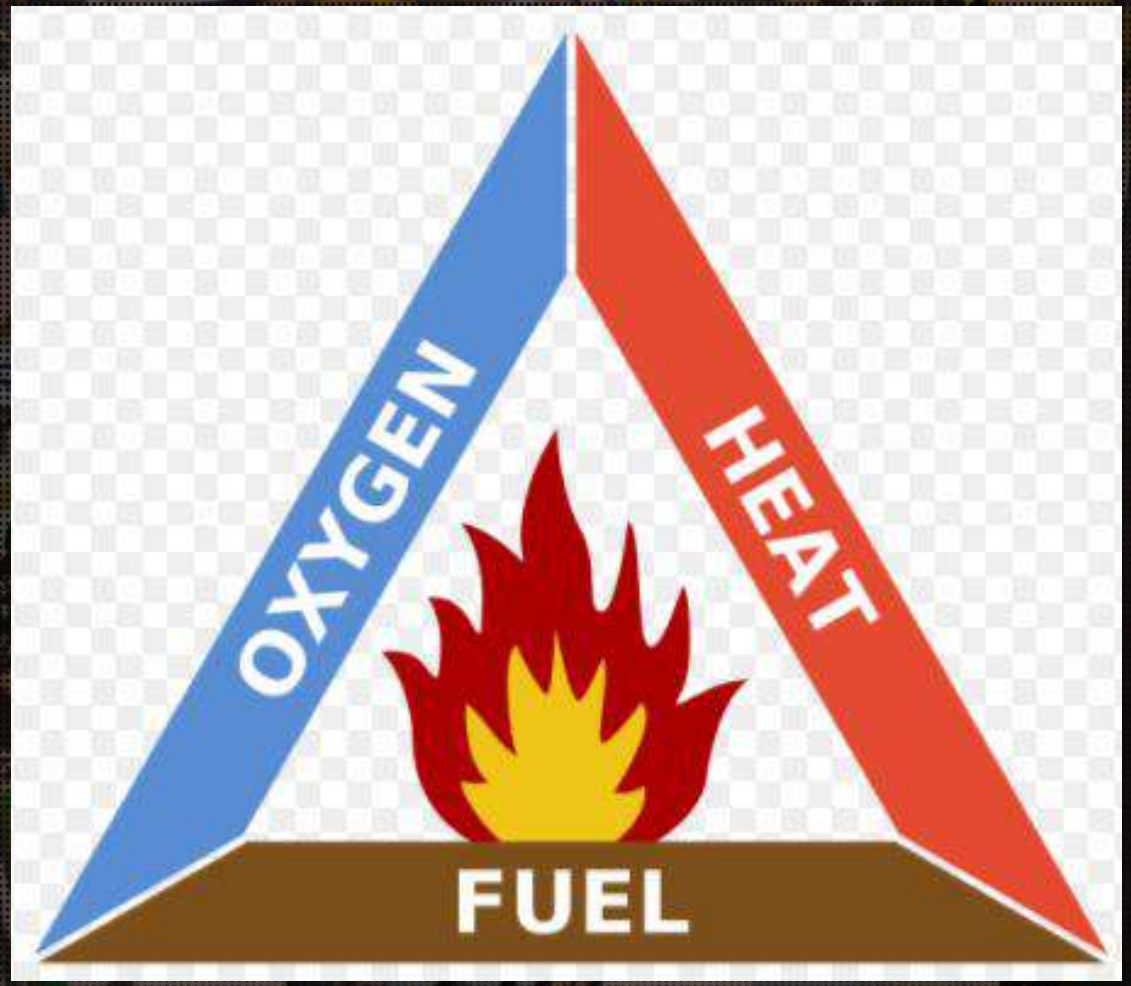
Video- SAWMILL

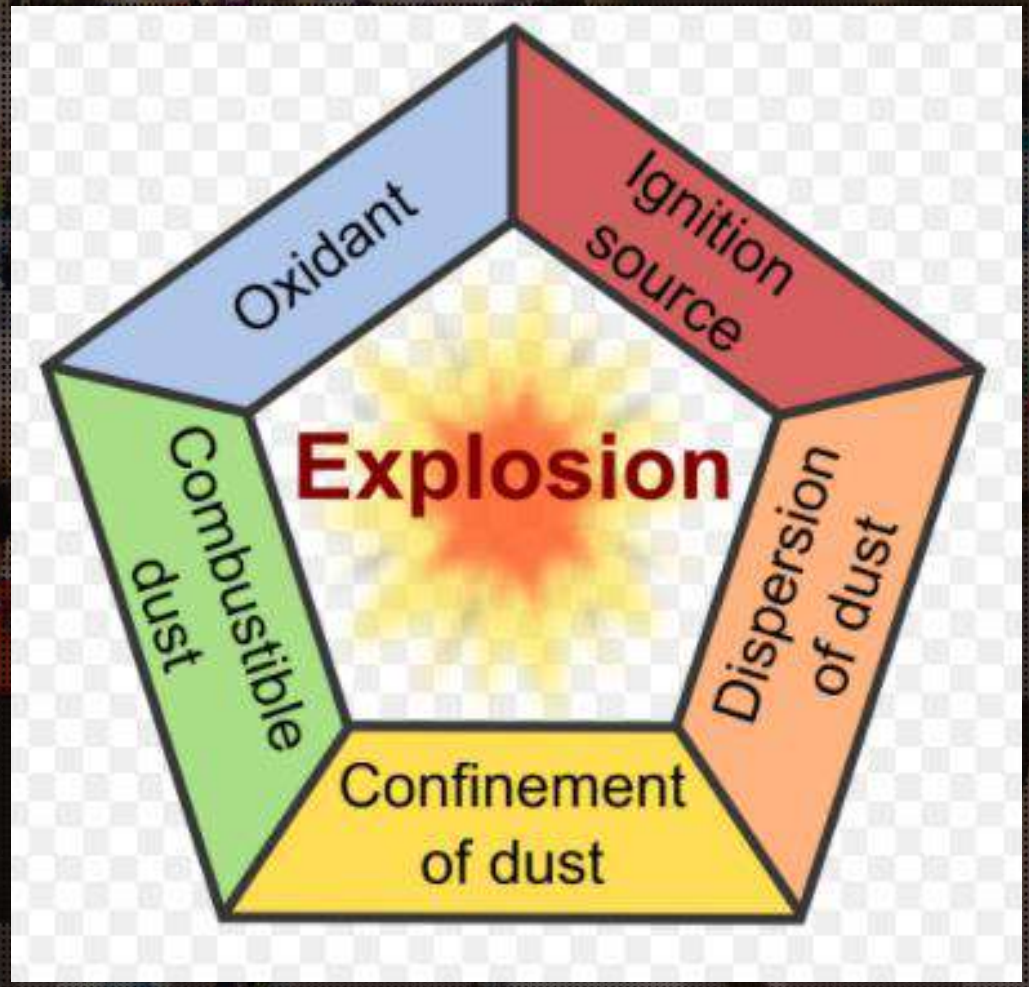


Fuego vs Explosiones Polvos combustibles

Fire Triangle



Explosion Pentagon



Fuego vs Explosiones Polvos combustibles

Fire Triangle ***Explosion Pentagon***

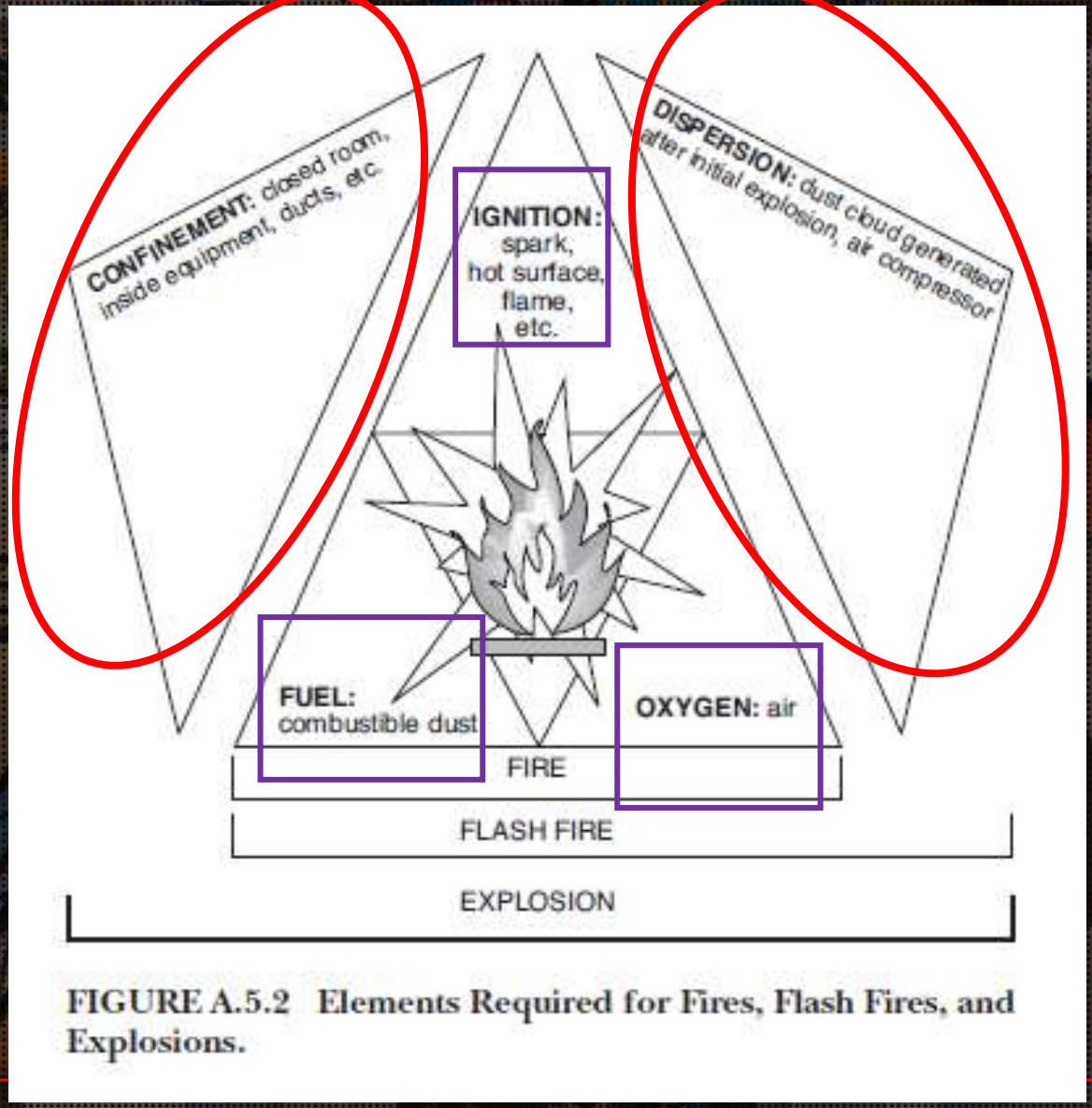


FIGURE A.5.2 Elements Required for Fires, Flash Fires, and Explosions.

Definiciones Asociadas

Deflagración. Propagación de una zona de combustión a una velocidad inferior a la del sonido en el medio no reactivo. [**68,** 2007]

Riesgo de Deflagración. Un riesgo determinado por la presencia de cualquiera de la dos condiciones siguientes: (1) Está presente polvo combustible de madera como una capa sobre superficies encaradas hacia arriba con un espesor superior al permitido en la Sección 4.7 o (2) el polvo combustible de madera está suspendido en el aire a una concentración que excede el 25 por ciento de la MEC en condiciones normales de trabajo.

Concentración Mínima Explosiva (MEC). La concentración mínima de un polvo combustible suspendido en aire, medida en masa por unidad de volumen, que es capaz de deflagrar. [654, 2006]

Explosión. Reventón o ruptura de un cerramiento o recipiente debido al desarrollo de una presión interna procedente de una deflagración.

Riesgo de Explosión. Un recinto de cualquier tipo, incluyendo también silos, colectores de polvo, transportadores cerrados, cubos, bunquers, locales y edificios, donde existe un riesgo de deflagración.

Definiciones Asociadas

Polvo de Madera Deflagrable. Partículas de madera que propagarán un frente de llama, lo que supone un riesgo de incendio o explosión, cuando están suspendidas en aire o en un medio oxidante específico por encima de un rango de concentraciones, independientemente del tamaño o forma de la partícula; partículas de madera con una masa media de 500 micras o Menor

Polvo de Madera Seco No Deflagrable. Partículas de madera con un diámetro medio mayor de 500 micras con un contenido de humedad menor 25 por ciento (base mojada).

Riesgos de Polvos Combustibles

Combustible dust poses two types of hazard:

- Fire
- Explosion

Tipos de polvos combustible

- Productos de Madera
- Alimentos
- Metales
- Químicos/Farmacéuticos
- Celulosa y Papel
- Plásticos
- Gomas
- Textiles
- Etc

Combustible dusts are present in many industries.

- Woodworking
- Food
- Metals
- Chemical/pharmaceutical
- Pulp/paper
- Mineral

No two

Tipos de polvos combustible

Ignición de Polvos Combustibles

Ignition occurs when sufficient energy is applied to a portion of the combustible dust layer or cloud.

Combustion begins when the temperature of that portion is increased to the autoignition temperature (AIT)

Ignitability is usually characterized by measuring:

- Minimum ignition energy (MIE)
- Minimum ignition temperature (MIT)

Ignición Polvos combustibles

Fuentes de Ignición comunes

Thermal

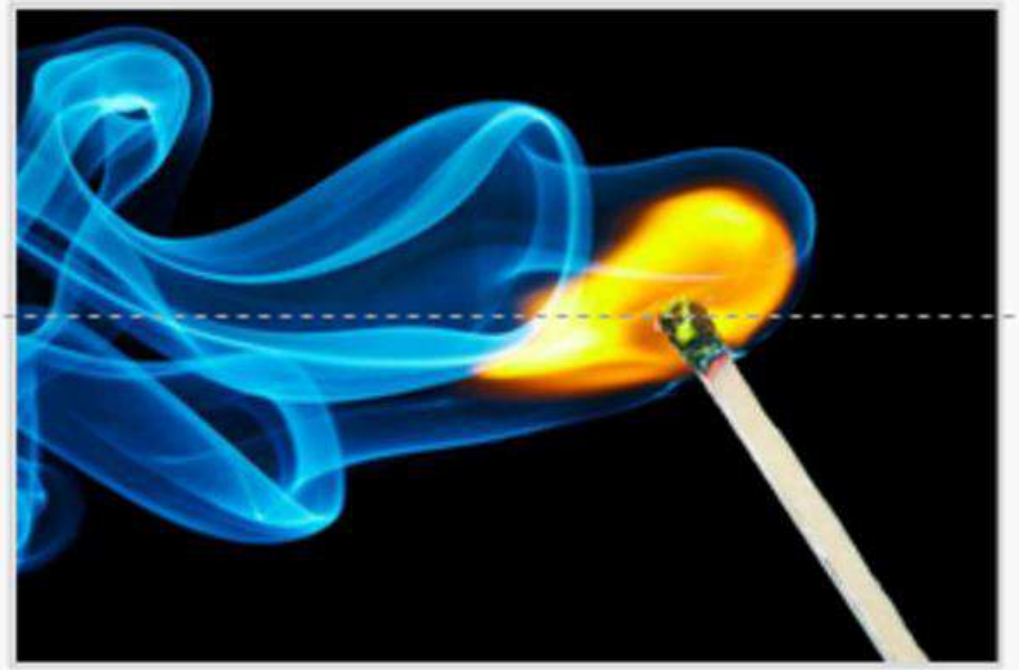
Electrical

Mechanical

Chemical

Thermal

- Hot surfaces
- Flames
- Spontaneous combustion



Fuentes de Ignición comunes

Thermal

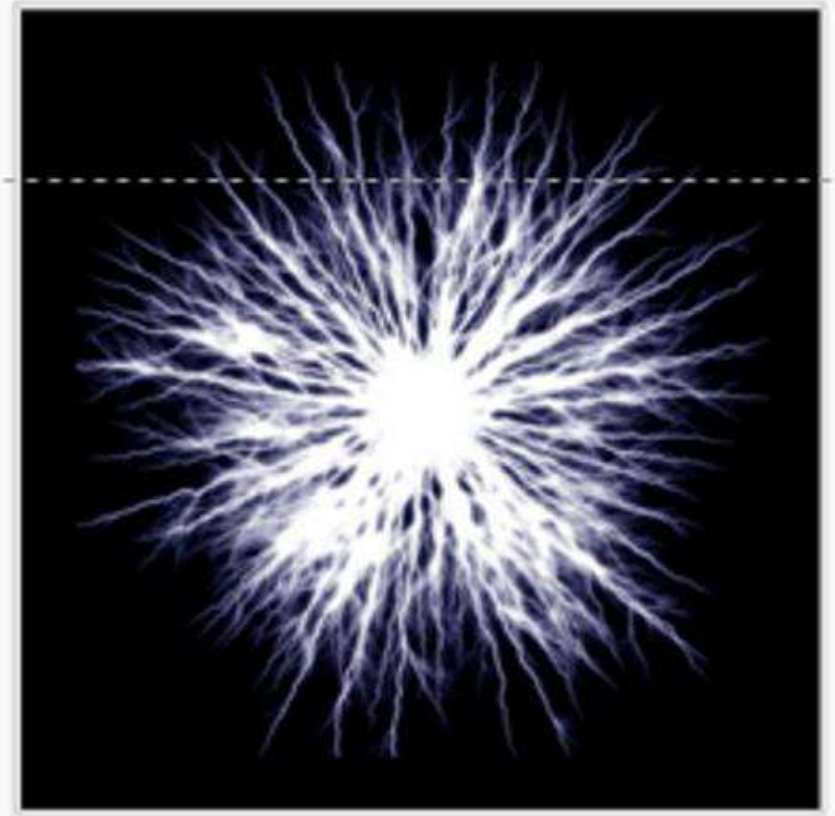
Electrical

Mechanical

Chemical

Electrical

- AC or DC electrical equipment faults
- Static electricity
- Lightning



Fuentes de Ignición comunes

- Thermal
- Electrical
- Mechanical
- Chemical

Mechanical

- Frictional heating
- Grinding sparks
- Impact sparks

Explosion Prevention

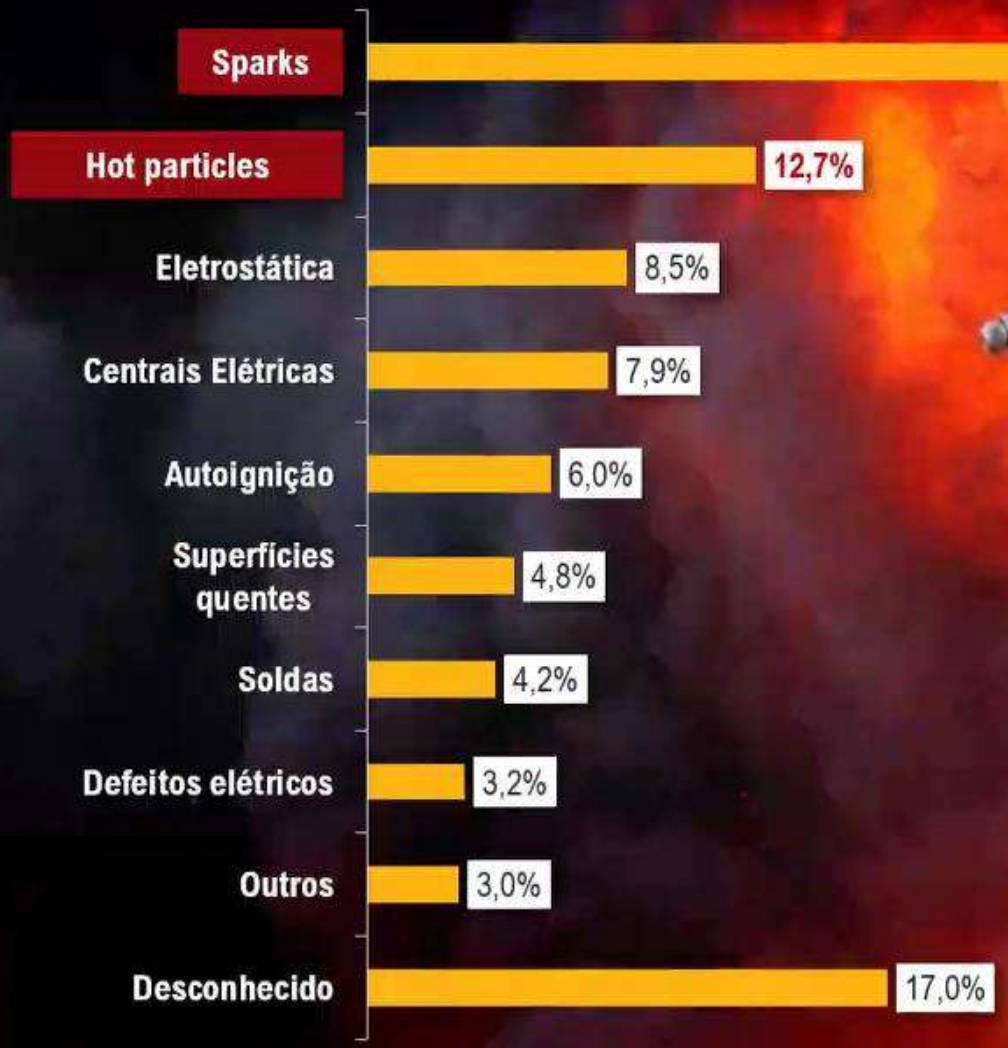
Ignition Source Identification & Control

Process Friction

- Moving Parts (Friction Contact)
  - Maintenance, Misalignment/contact protection
  - Spark Detection
- Moving Parts (Bearings, Drives etc.)
  - Maintenance, lubrication program
  - Vibration and temperature monitoring

Locations and equipment most affected by fire and explosion

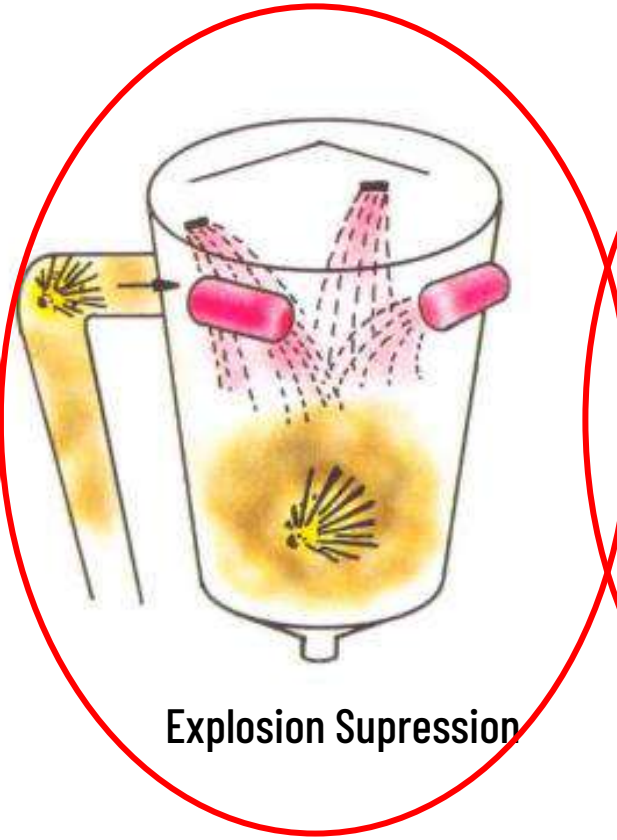
45% of fires are caused by hot particles



Principios de Protección Contra Explosiones

Explosion Protection Principles

Explosion Proof



Explosion Supression

Explosion Venting

Alivio Explosiones (Explosion Venting) -Ruptura Equipo

Alivio de explosiones- Ventana certificada

Alivio Explosiones (Explosion Venting) –Area de Venteo

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8.2.2 Equation 8.2.2 shall be used to calculate the minimum necessary vent area, A_{v0}:

$$A_{v0} = 1 \cdot 10^{-4} \cdot \left(1 + 1.54 \cdot P_{stat}^{4/3}\right) \cdot K_{St} \cdot V^{3/4} \cdot \sqrt{\frac{P_{max}}{P_{red}} - 1} \qquad (8.2.2)$$

where:

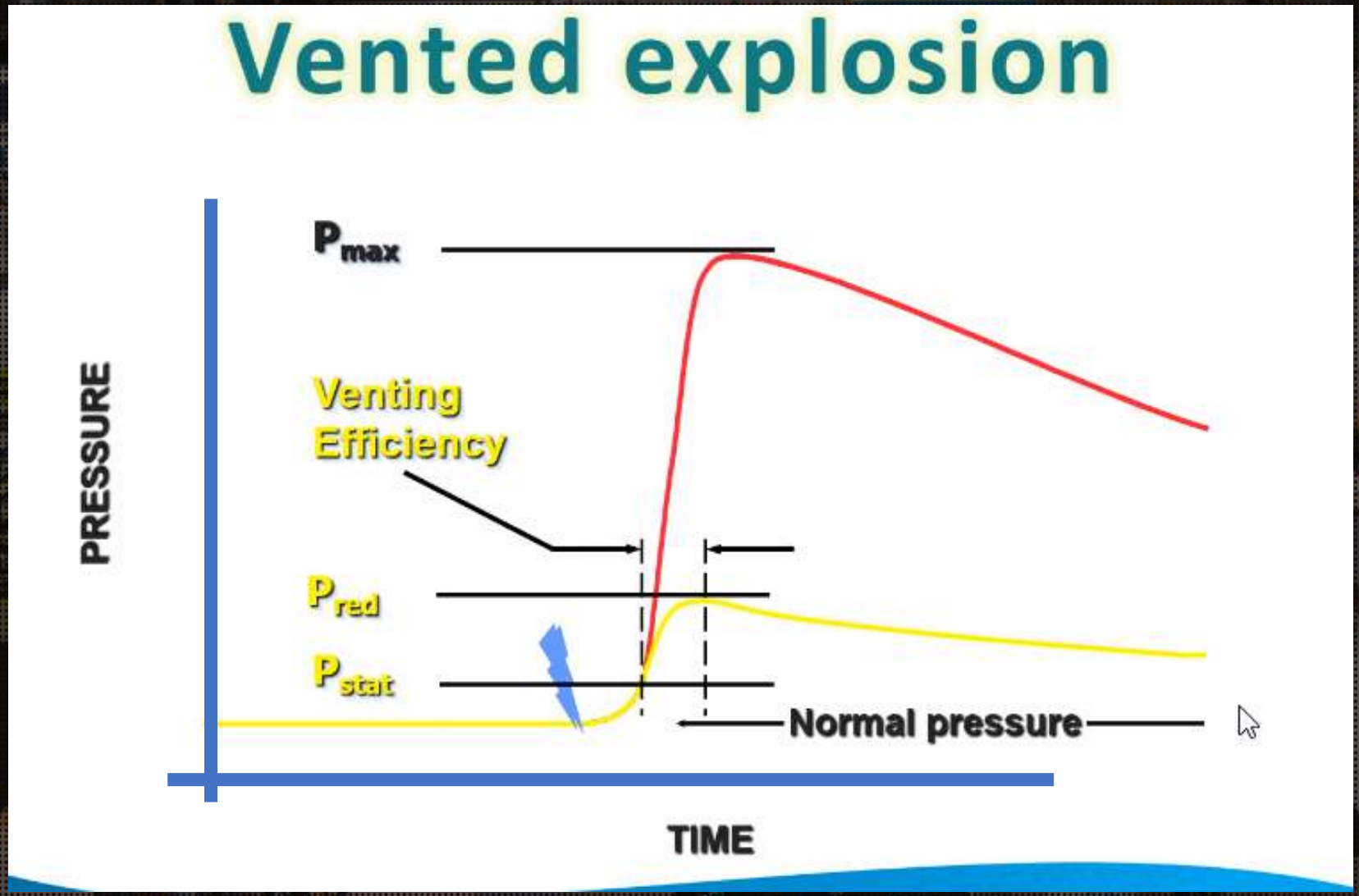
A_{v0} = vent area (m^2)
P_{stat} = nominal static burst pressure of the vent (bar)
K_{St} = deflagration index (bar-m/s)
V = enclosure volume (m^3)
P_{max} = maximum pressure of a deflagration (bar-g)
P_{red} = reduced pressure after deflagration venting (bar)

[115]

NFPA® 68

Standard on Explosion Protection by Deflagration Venting

Alivio Explosiones (Explosion Venting) -Ruptura Equipo



Alivio Explosiones (Explosion Venting) -Ruptura Equipo

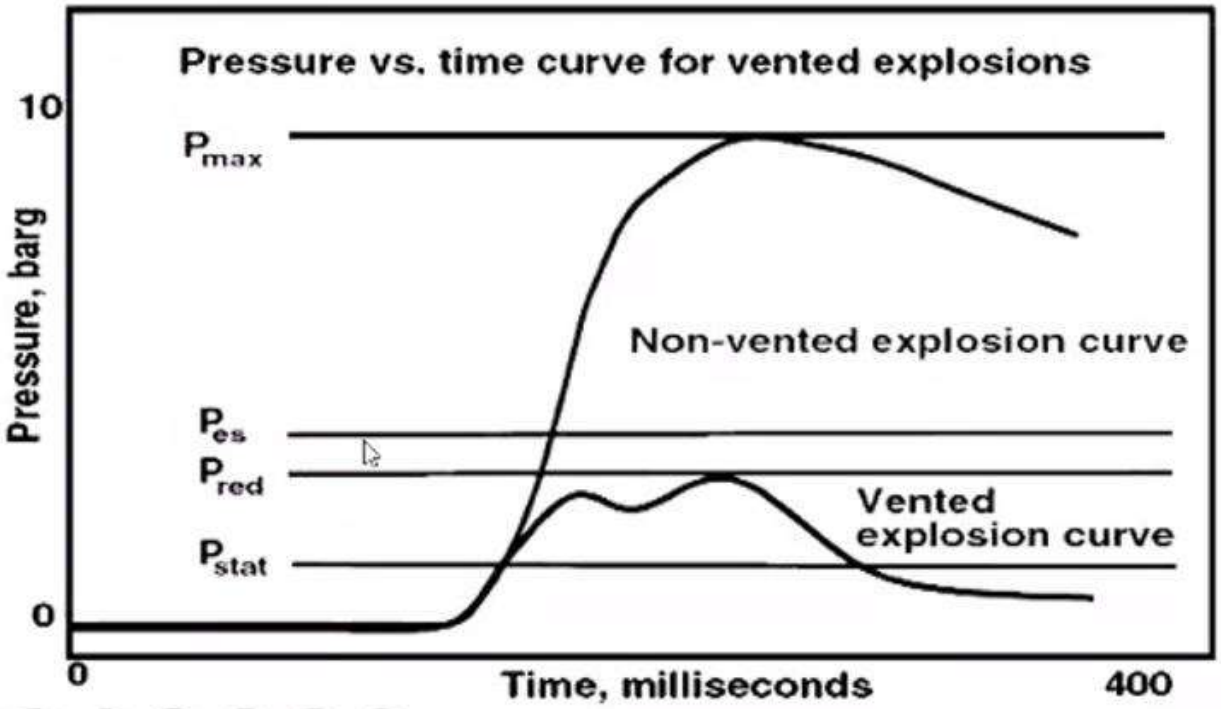
Kst Value – Maximum pressure rise (dp/dt) during an explosion in an enclosed vessel. Kst measures the relative explosive severity compared with other dusts. To find the Kst values of combustible dust, please visit: **www.dguv.de/ifa/en/gestis/expl/index.jsp**

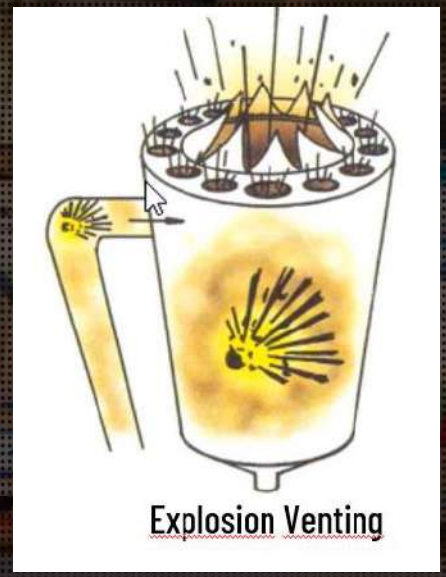
Pmax – The maximum pressure developed in a contained deflagration of an optimum mixture

Pred – The maximum pressure developed in a vented enclosure during a vented deflagration

Pstat - Pressure that activates a vent opening when the pressure is increased slowly

Pes - The enclosure design pressure sufficient to resist Pred





Alivio Explosiones (Explosion Venting) –Presión Reducida (Pred)

- **Pred: 2/3 enclosure yield strength → No deformation**
- **Pred: 2/3 enclosure ultimate strength → Deformation Tolerated**

FM Global Datasheet 7-76

2.3.3.3 For calculations of vent area where **equipment design strength data is not available**, use the following values of Pred (maximum allowable pressure) for normally constructed equipment with an assumption that *some vessel deformation may occur* in a safely vented explosion:

A. Weak rectangular vessels (e.g., bag-type dust collector): 0.2 barg (2.9 psig)

B. Cylindrical vessels (e.g., cyclone. or strong (reinforced) **rectangular vessels: 0.3 barg (4.4 psig).**

Explosion Venting

Alivio Explosiones (Explosion Venting) –Presión Reducida (Pred)

6.3.1.3.2 Given a P_{mawp}, P_{red} shall be selected based on the following conditions as defined by Equation 6.3.1.3.2a or Equation 6.3.1.3.2b:

(1) Permanent deformation, but not rupture, of the enclosure can be accepted:

$$P_{red} \leq \left(\frac{2}{3}\right) \cdot F_u \cdot P_{mawp} \qquad (6.3.1.3.2$$

(2) Permanent deformation of the enclosure cannot be accepted:

$$P_{red} \leq \left(\frac{2}{3}\right) \cdot F_y \cdot P_{mawp} \qquad (6.3.1.3.2$$

where:

P_{red} = maximum pressure developed in a vented enclosure [bar (psi)]

F_u = ratio of ultimate stress of the enclosure to the allowable stress of the enclosure per the ASME *Boiler and Pressure Vessel Code*

P_{mawp} = enclosure design pressure [bar (psi)] according to ASME *Boiler and Pressure Vessel Code*

F_y = ratio of the yield stress of the enclosure to the allowable stress of the materials of construction of the enclosure per the ASME *Boiler and Pressure*

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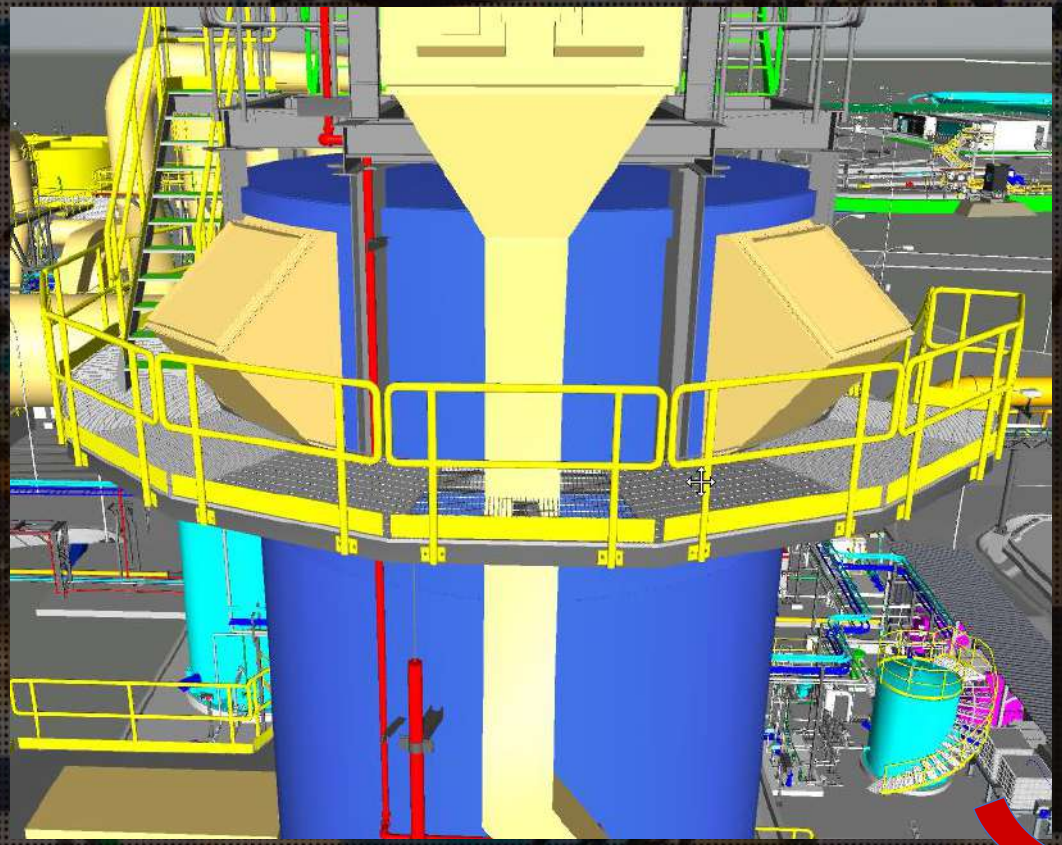
Standard on Explosion Protection by Deflagration Venting

Alivio Explosiones (Explosion Venting) –Deflexion



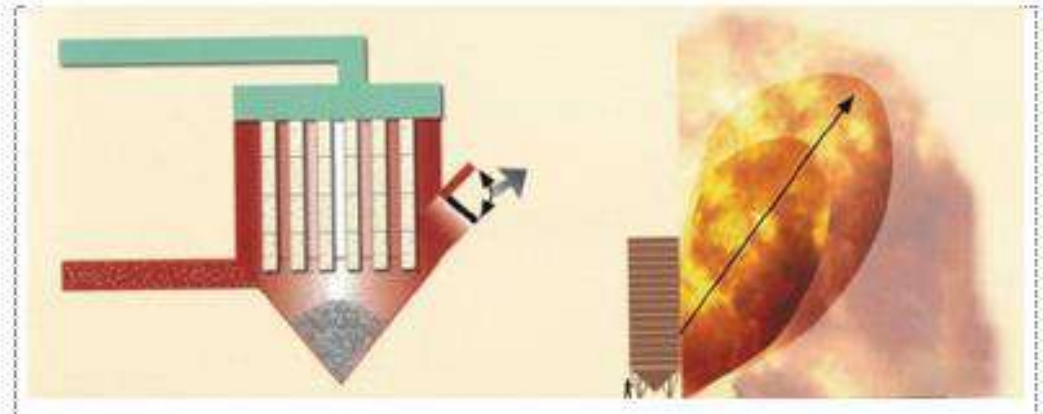
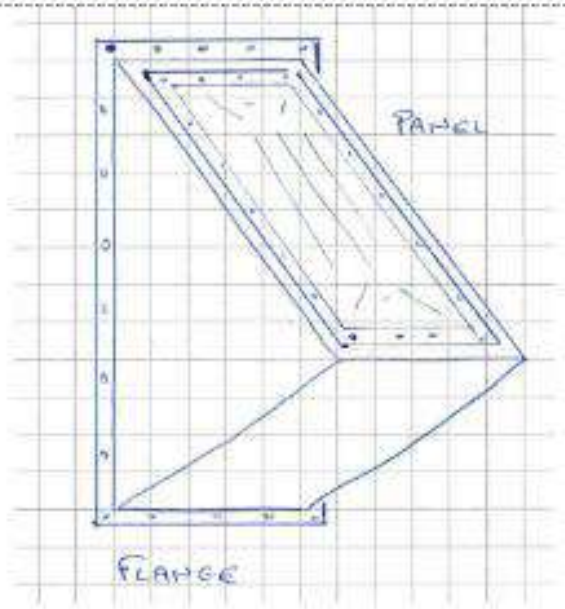
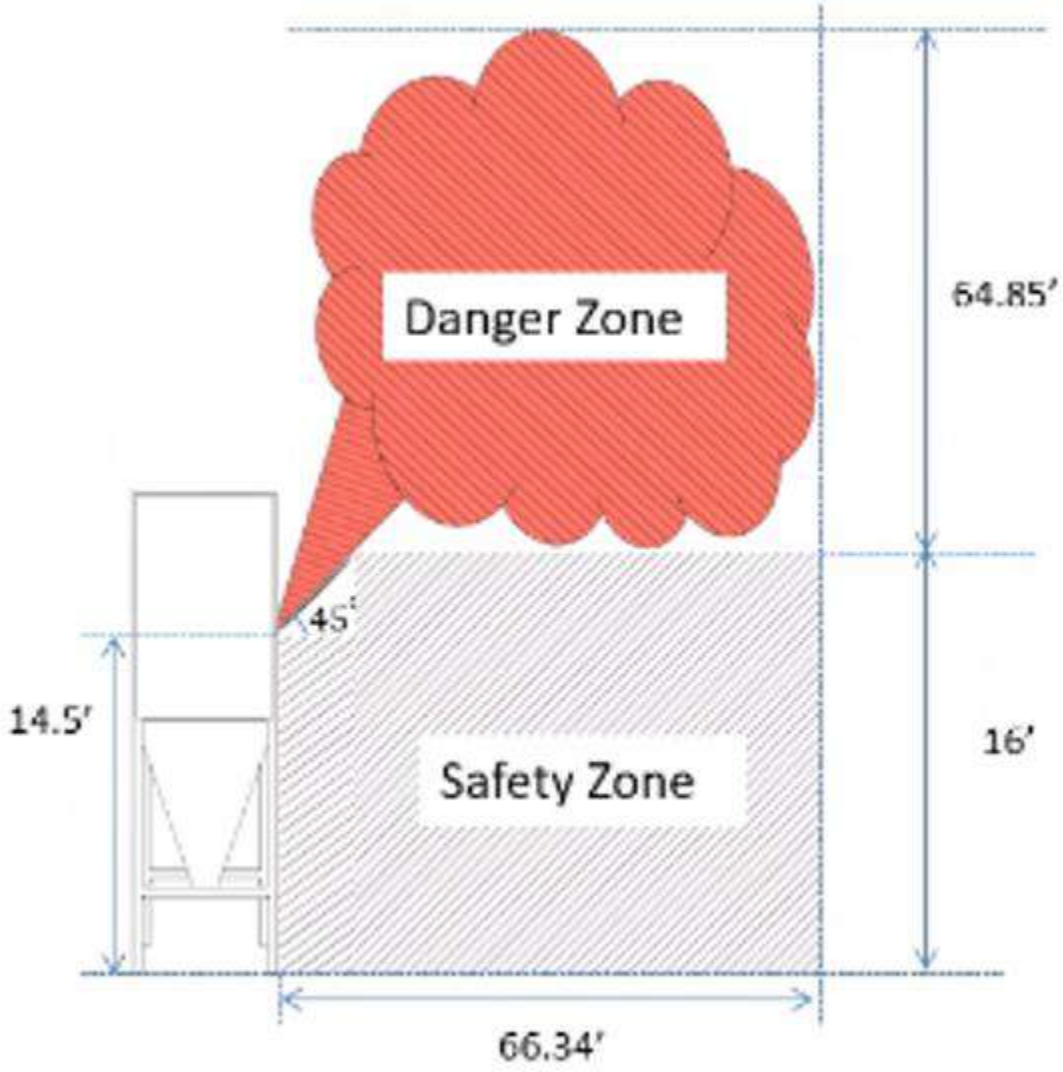


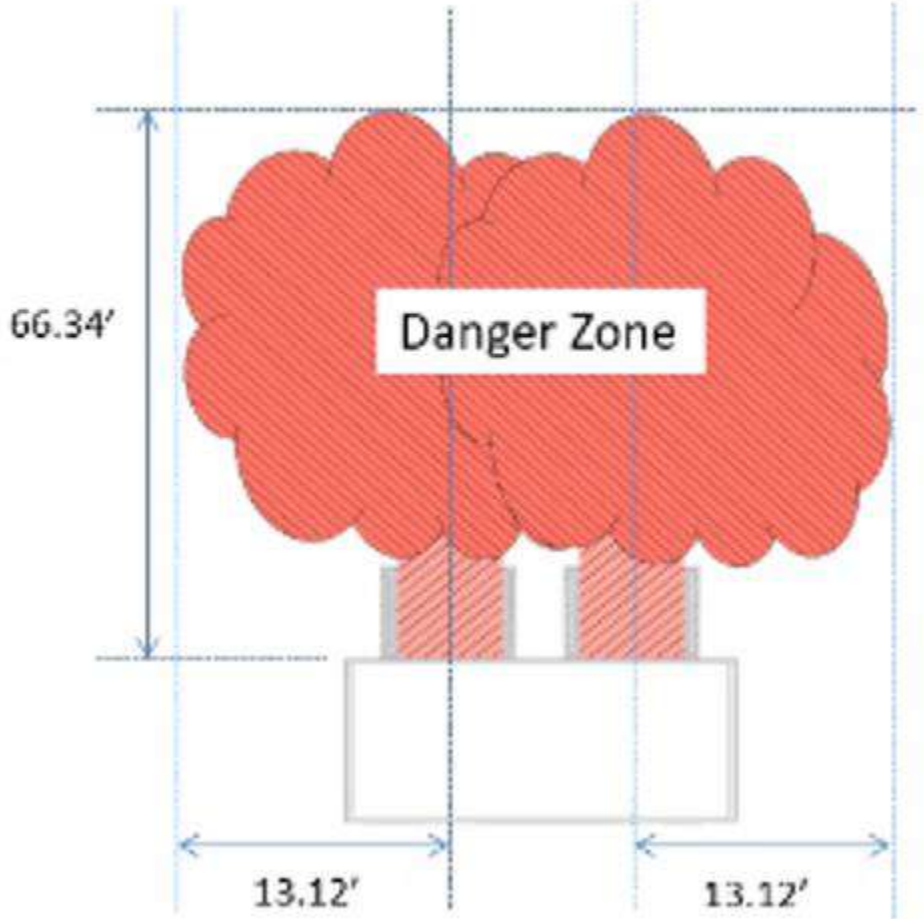
Imagen 10.Esquema de venteo orientado



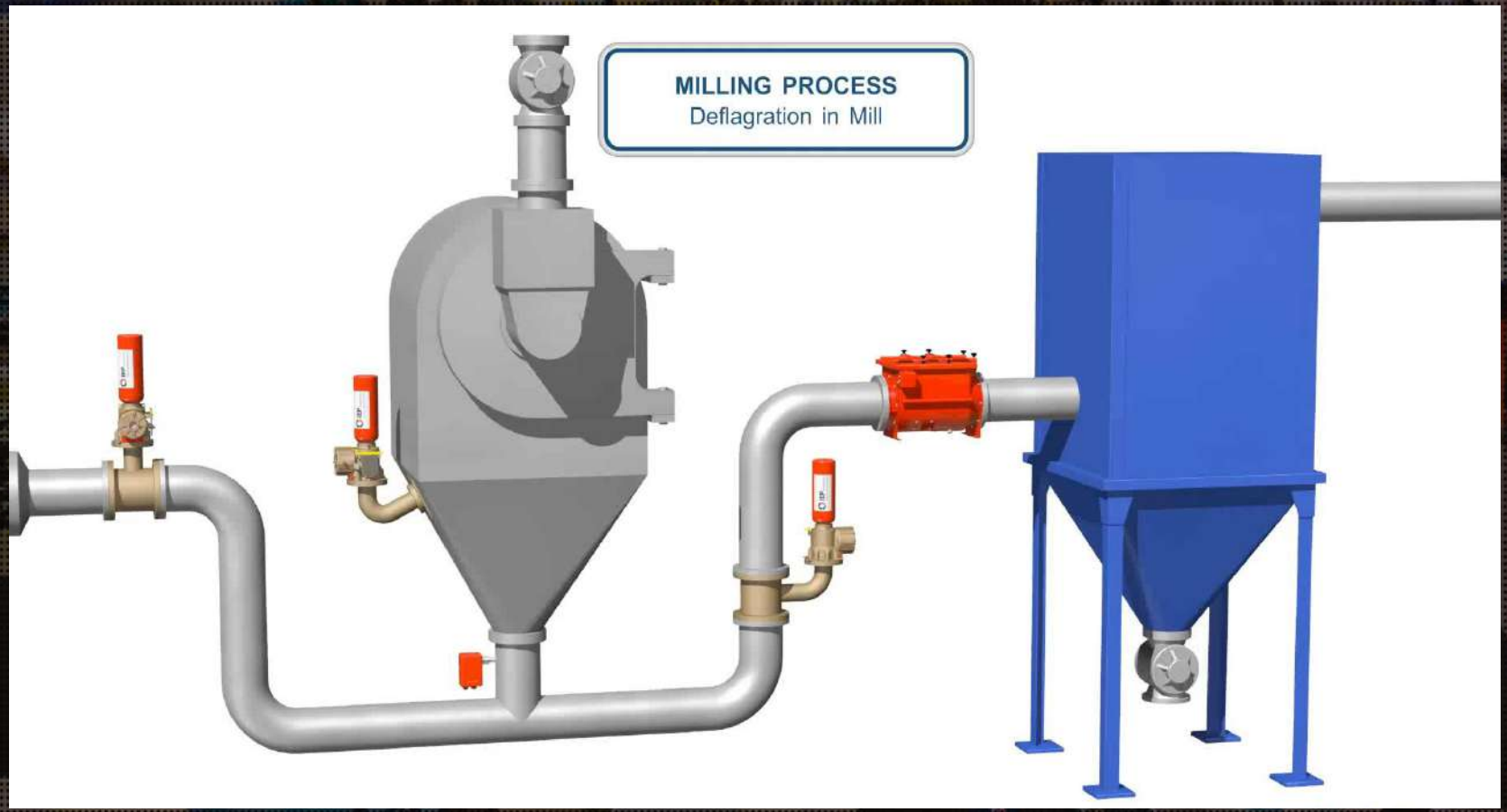
Alivio Explosiones (Explosion Venting) –Deflexion

Alivio Explosiones (Explosion Venting) –Deflexión

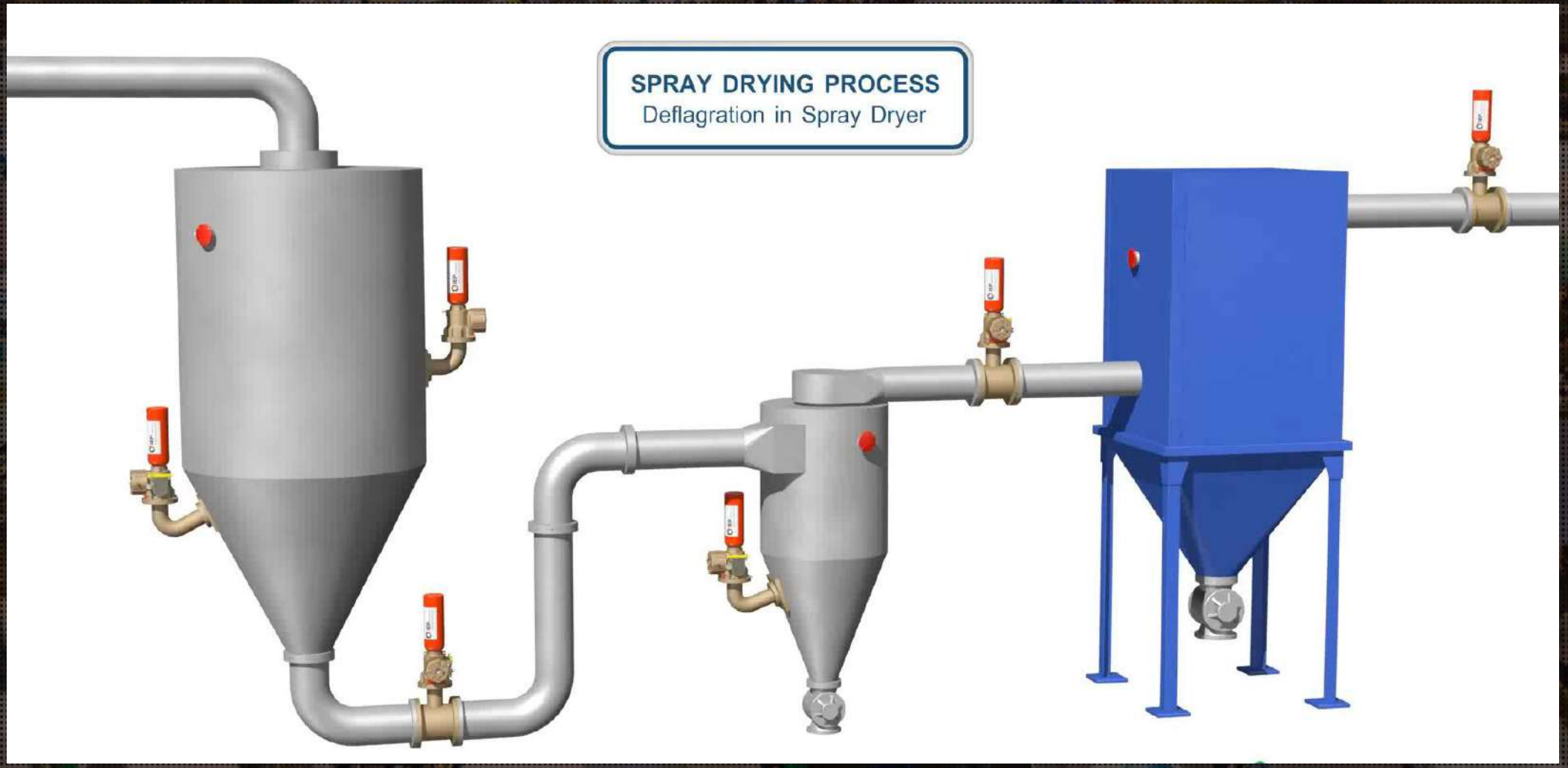


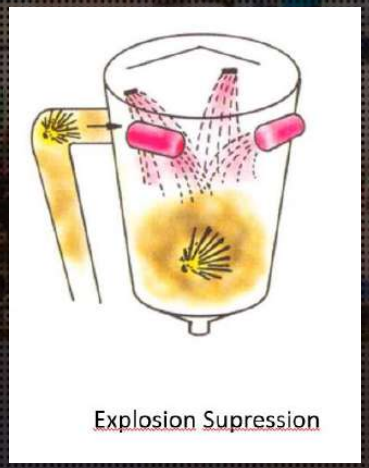


Supresión de Explosiones



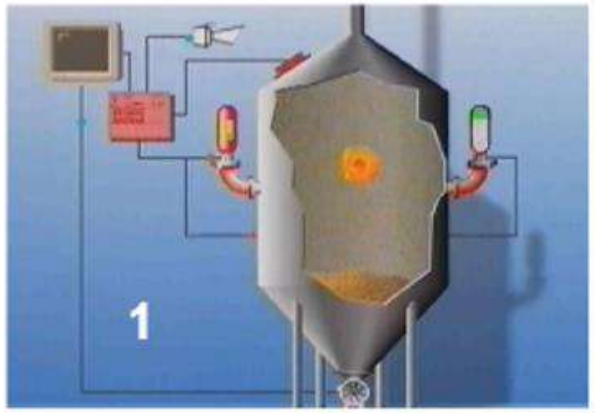
Supresión de Explosiones

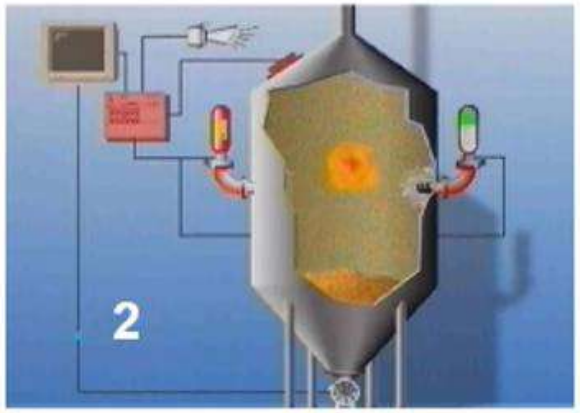


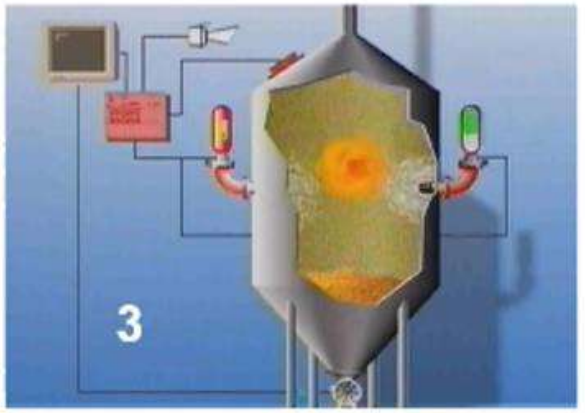


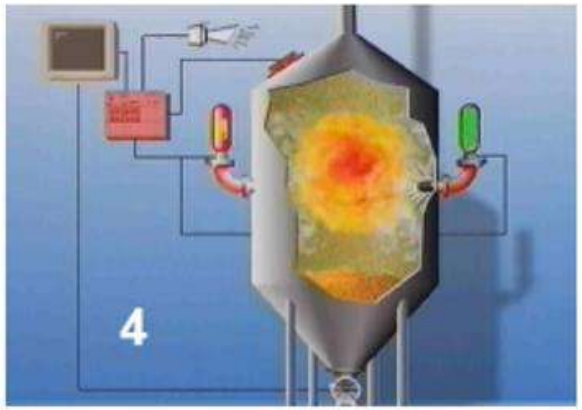
Supresión de Explosiones

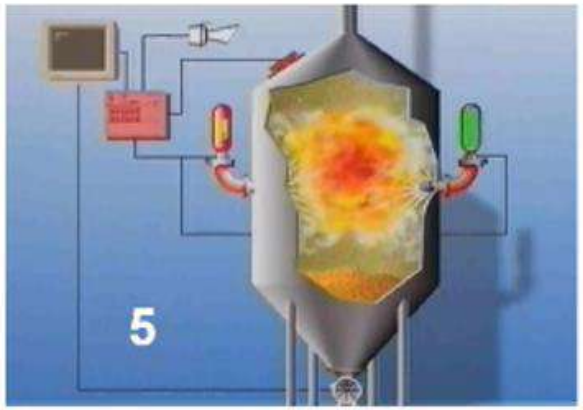
Supresión de Explosiones

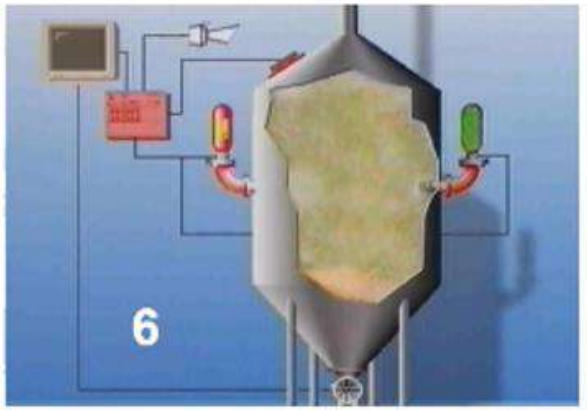


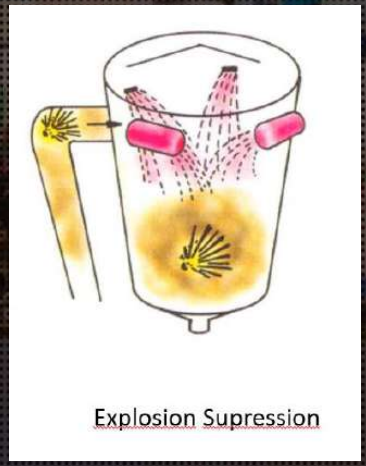






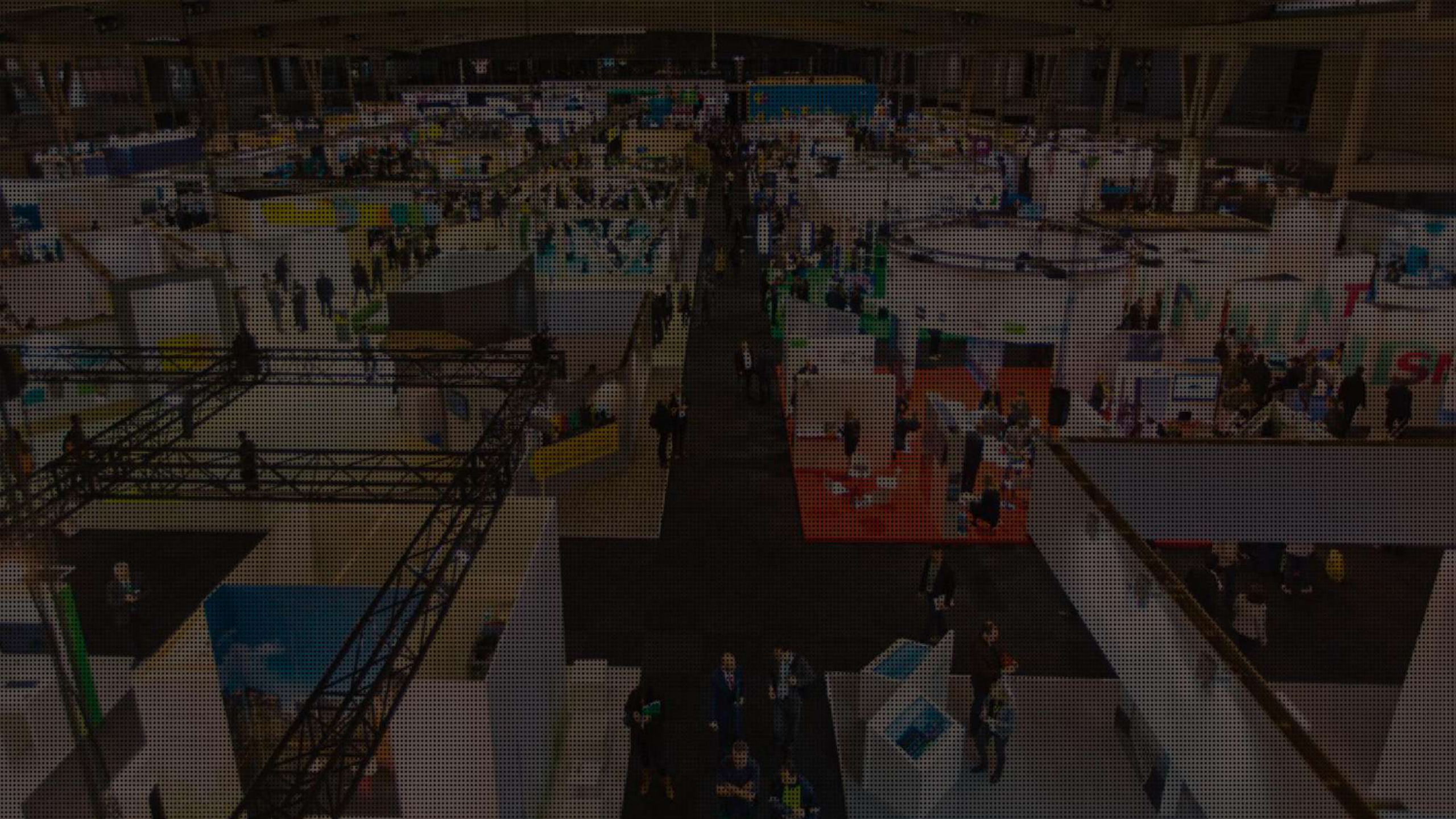






Explosion Supression

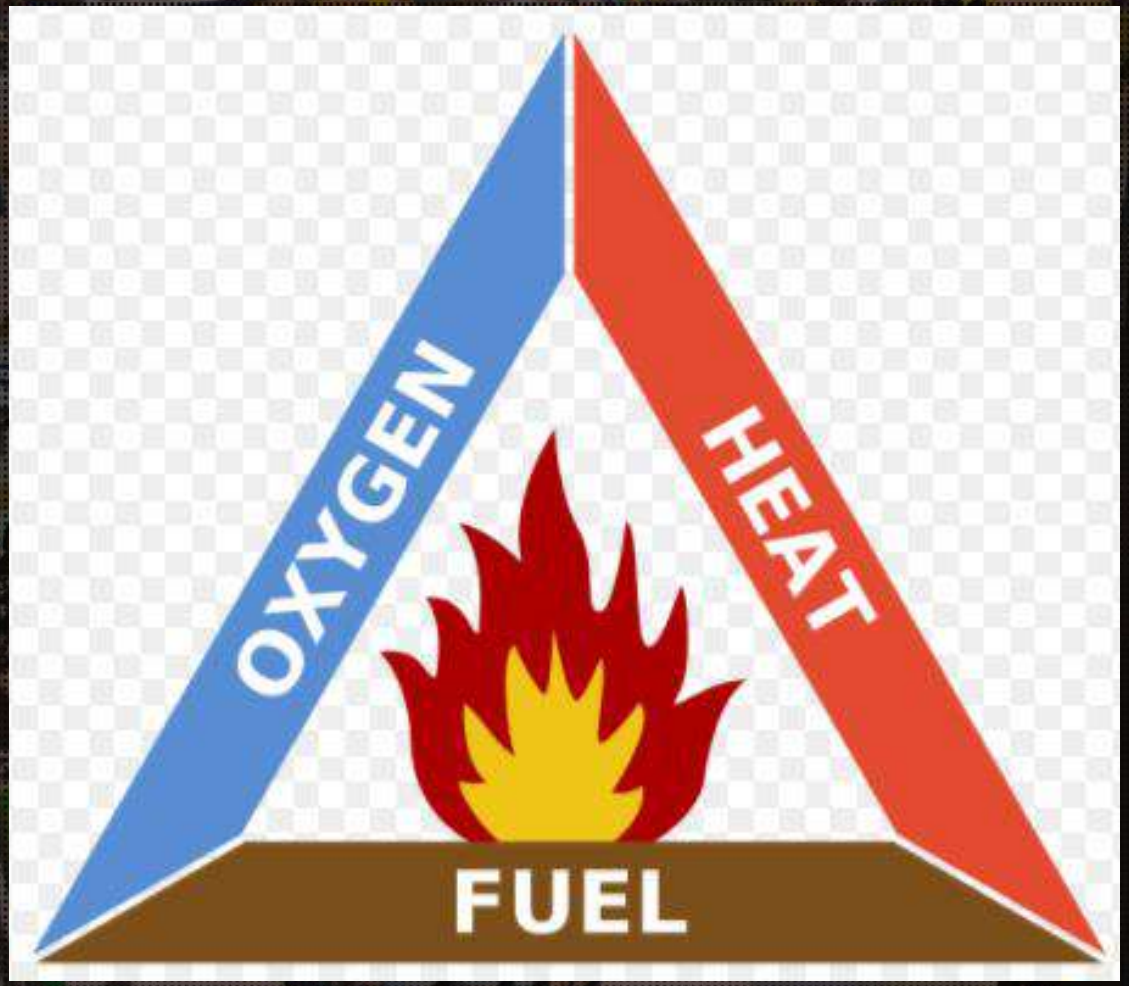
Supresión de Explosiones-Filtro de Mangas



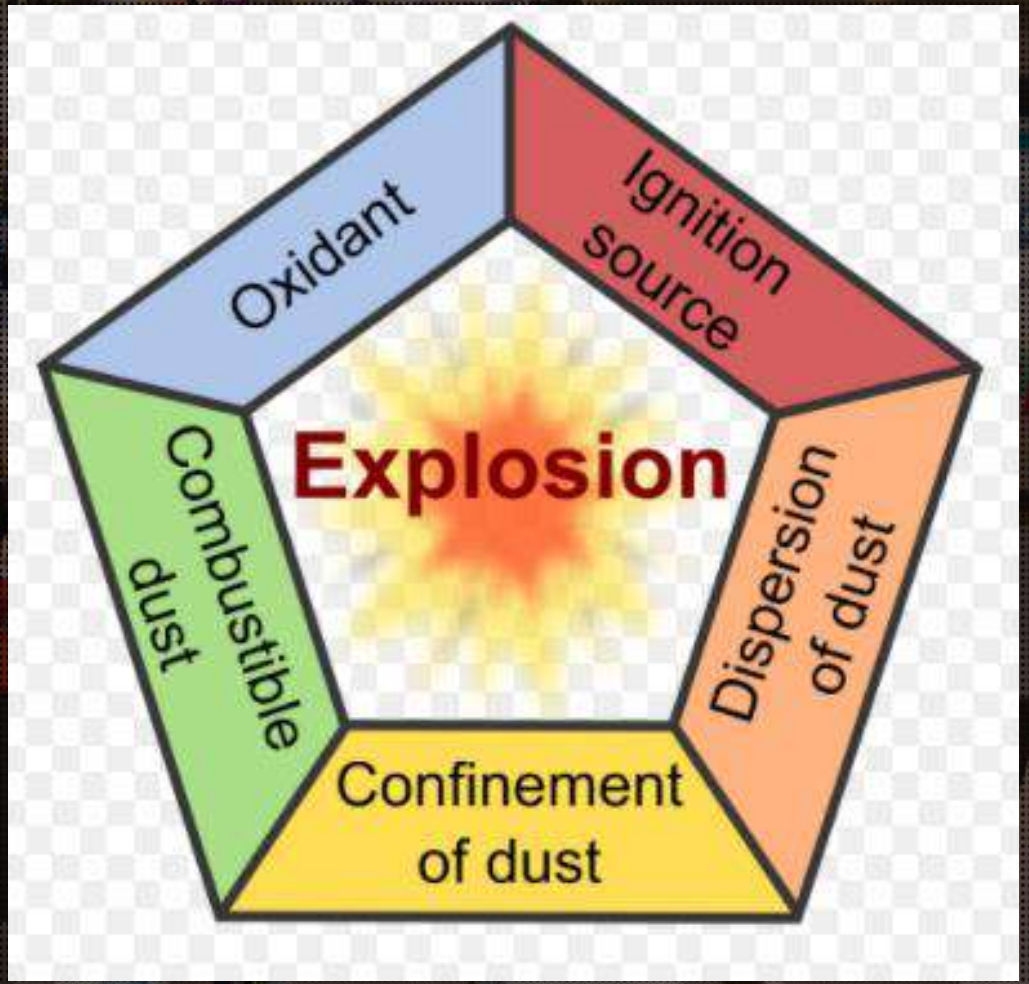
Detección de Chispas

Detección de Chispas- Eliminar la fuente de ignicion

Fire Triangle



Explosion Pentagon



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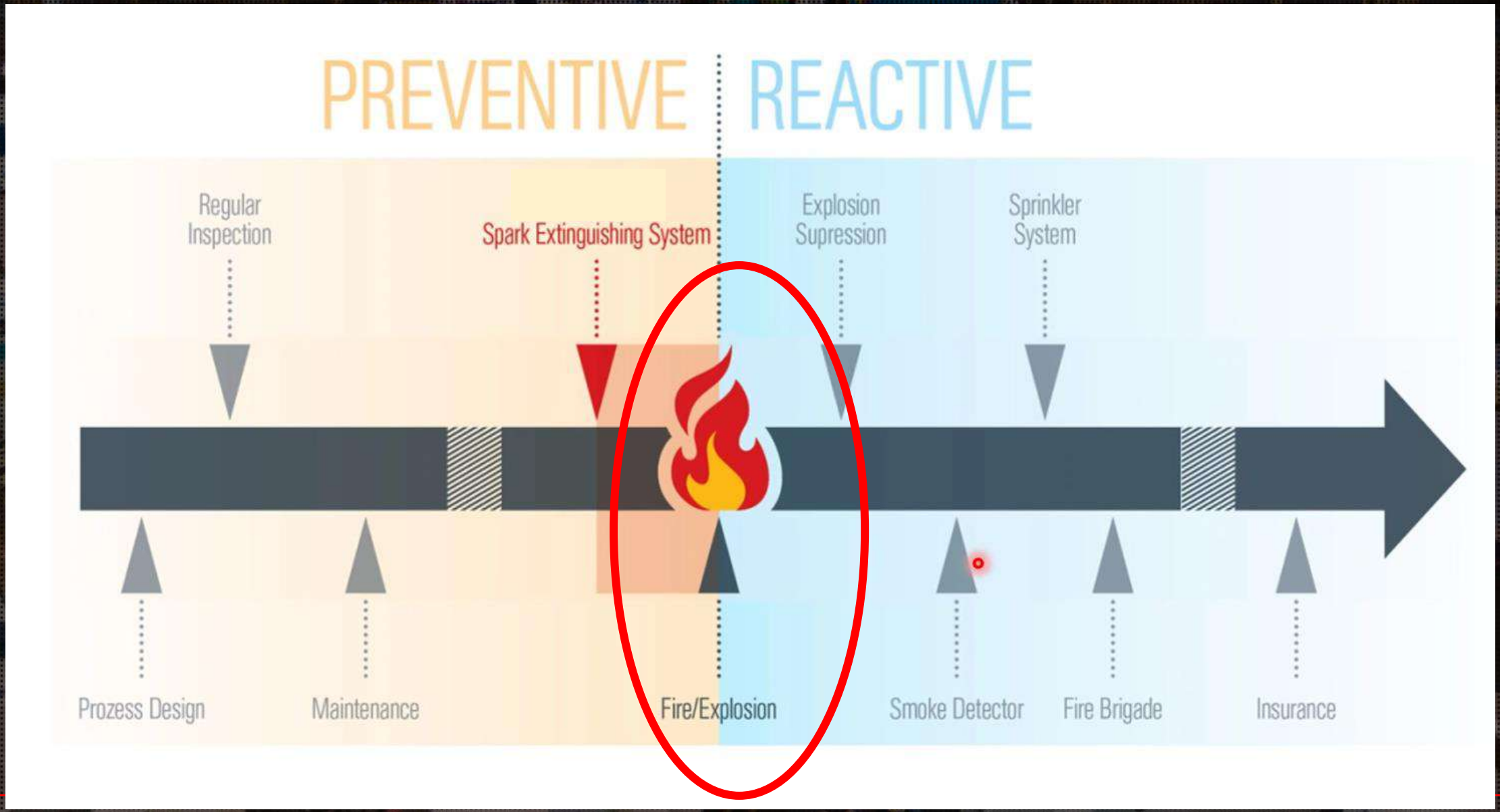

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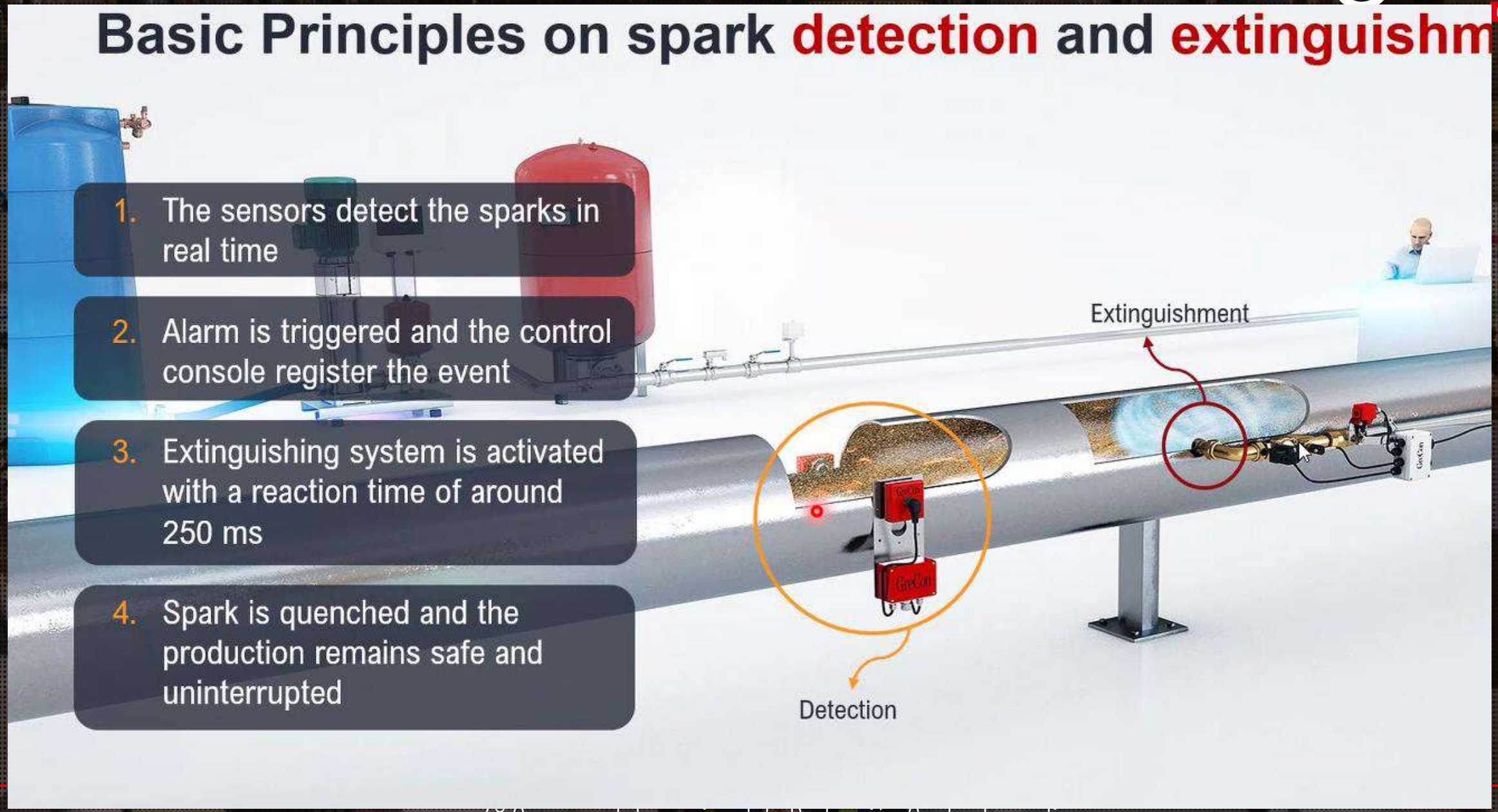
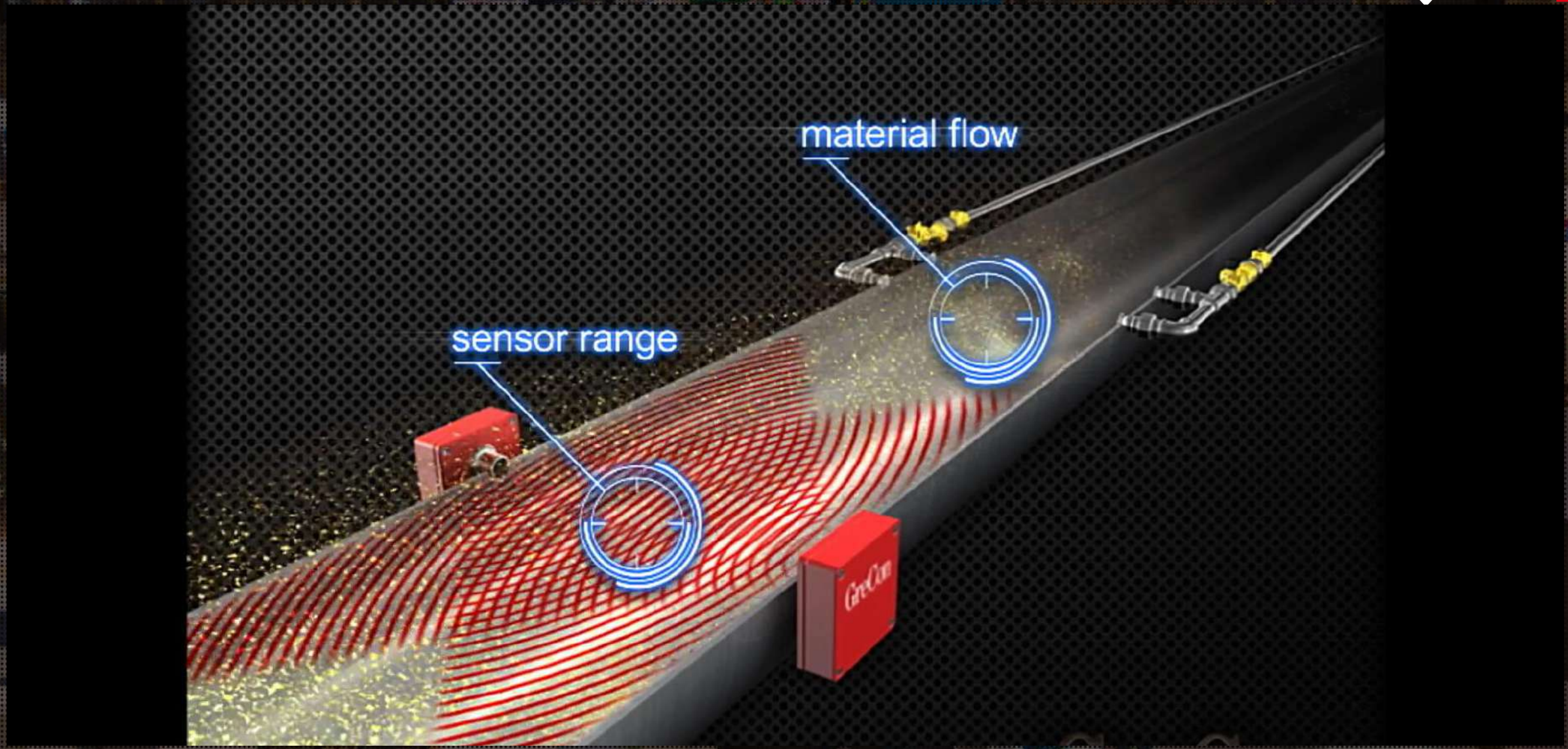
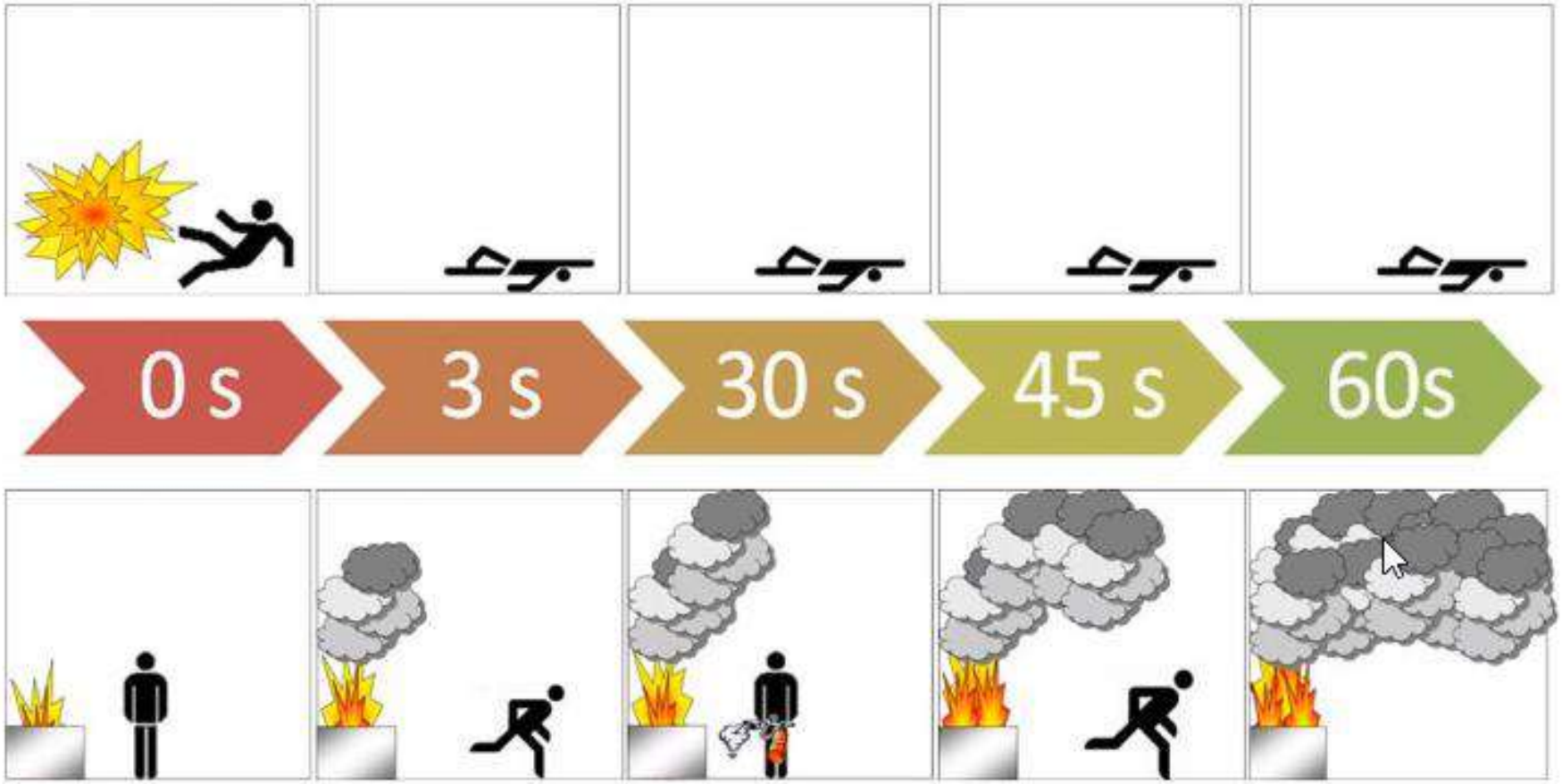


Detección de Chispas

Detección de Chispas Sistema Neumatico-Video



Note: Fire Protection Is Not Explosion Protection



Eventos ASOCIADOS

EXPLOSION SECUNDARIA MOLINO PLANTA AGLOMERADO

FALLA EN DESCNASO BUJE

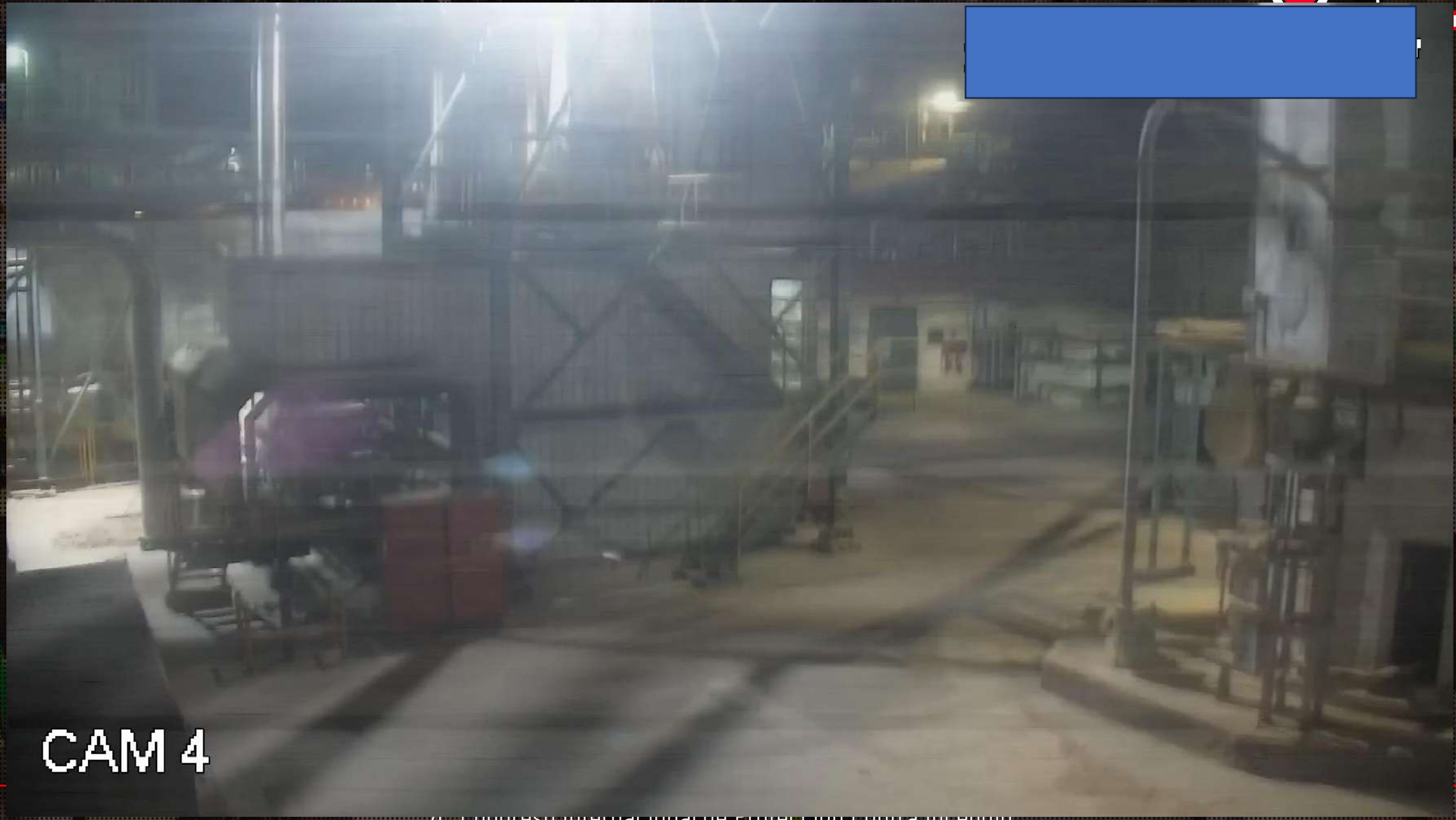
FALLA EN DESCNASO BUJE

Atasco de Sellos desprendidos de Válvula rotatoria

Atasco de Sellos desprendidos de Válvula rotatoria

TRABAJO EN CALEINTE PARA MENSUAL DE MANTENCION

BRAZAS PROVENIENTE DE DUCTO DE SECADO



Imperial Sugar Dust explosion-2008

Applicable NFPA Regulations

NFPA 652: Standard on the Fundamentals of Combustible Dust, 2019 Edition

NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids, 2020 Edition

NFPA 68: Standard on Explosion Protection by Deflagration Venting, 2018 Edition

NFPA 69: Standard on Explosion Prevention Systems, 2019 Edition

Applicable NFPA Regulations

NFPA 61: Standard for the Prevention of Fire and Dust Explosions in Agricultural and Food Processing Facilities, 2020 Edition

NFPA 484: Standard for Combustible Metals, 2019 Edition

NFPA 655: Standard for Prevention of Sulfur Fires and Explosions, 2017 Edition

NFPA 664: Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities, 2020 Edition

3-5 years → "NFPA 660" Consolidated standard

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