	MODIFIED STARCH DRYING PROJECT – ARGANA – ROMANIA						
	EXPLOSION VENT CALCULATION						
	Project No.	Discipline	Document Type	Plant / Equipment No	Sequence No.	Rev.	
	5204	PR	CL	000	02	00	

EXPLOSION VENTS CALCULATION

00	12.18.2025	Comments	P.S	A.H	A.Z
REV.	**ISSUE**	**PURPOSE OF ISSUE**	**PREPARED**	**CHECKED**	**APPROVED**

TABLE OF CONTENT

1. EXPLOSION VENTS CALCULATION

1.1. INTRODUCTION

A dust explosion risk analysis (often called ATEX risk assessment in Europe or Facility Dust Hazard Assessment - DHA - in US) aims at identifying the areas where an explosion can occur (ATEX zone classification), defines the risk associated with any potential source of ignition, **and propose measures to avoid or mitigate the risk to protect the installation.**
It is mandatory for a factory operator to perform a dust explosion risk assessment and put in place all the measures required to prevent explosions. Sometimes however the residual risk is too high and **explosion mitigation measures must be implemented such as explosion panels on hopper, silos, filters on some conveyors**. This page is explaining how are built explosion panels and propose approximates methods to size them.

1.2. Reference

The vent sizing calculations have been conducted in accordance with the BS EN 14491 standard.

1.3. Summary of Results

Summary of explosion vent calculation is according to below table:

Summary of Explosion Vent Calculation Table

Dryer Position	Required Explosion Vent Area (m2)	Actual Area Of Explosion Vents (m2)
From Feed Material to Cyclones (A to G)	5.46	4.1
Inlet Ducts to cyclones (H)	0.38	0.39
From Cyclones to Fan	6.54	4.10

1.4. Dust Characteristic and Pre-requisites to sizing explosion vents

Knowing the dust explosion properties In order to be able to size an explosion panel allowing to relieve the pressure of a dust explosion, it is necessary to know "how" the dust will explode, that is to say it is required to measure the dust explosion properties of a material.

- **Kst Value:** 200 bar.m/sec
- **Dust Explosion Class:** St 1
- **Max. Explosion Over-Pressure (Pmax):** 8.7 barg
- **Lower Explosion Limit (LEL):** 60 gr/m³
- **Min. Ignition Energy (MIE):** 300 < MIE < 1000 mJ
- **Dust Cloud Ignition Temperature:** 380°C
- **Glow Temperature:** > 280°C
- **Auto-Ignition Temperature:** 175°C
- **Specific Volume Resistance:** 10^8 Ω.m (non-conductive)
- **Burning Number:** BZ4

1.5. Explosion Vent Area (BS EN 14491)

For enclosures, the following formula allow the calculation of the required vent area A. The required vent area can, in practical application, be divided into several smaller areas as long as the total area equals the required vent area:

$$A = B(1 + C \times Log\ L/D)$$

$$B = [3.264 \times 10^{-5} \times Pmax \times Kst \times Preq^{-0.569} + 0.27(Pstat - 0.1)Preq^{-0.5}]V^{0.753})$$

$$C = (-4.305 \times Log(Preq) + 0.758)$$

A: Required Vent Area, m^2
L: Length of the tube or enclosure, m
D: Tube or enclosure diameter, m
Pmax: maximum over pressure, bar, 5<Pmax<10
Kst: Maximum value of the pressure rise per unit time, bar.m/s, 10<Kst<300
Preq.: Maimum over pressure generated by an explosive atmosphere, bar ,0.1<Preq<2
Pstat: Vent Opening Pressure, bar, 0.1<Pstat<1
V: Volume of tube or enclosure, m^3 , 0.1<V<10,000

To calculate the required vent area for the explosion vent, the entire dryer system is divided into several zones, and calculations are performed separately for each zone. These zones include the following sections:

1. From the starch inlet to the cyclone inlets
2. The cyclone assembly

1.5.1. Explosion Vent Area from Feed Material to Cyclones.

The first section—from the starch inlet to the cyclone inlets—is further subdivided into several parts due to changes in pipe diameter in certain areas and the transition from circular to rectangular ducting at the end. To ensure more accurate calculations, this section is divided into 7 segments, with relevant parameters calculated separately for each segment. Finally, the total required vent area is determined.

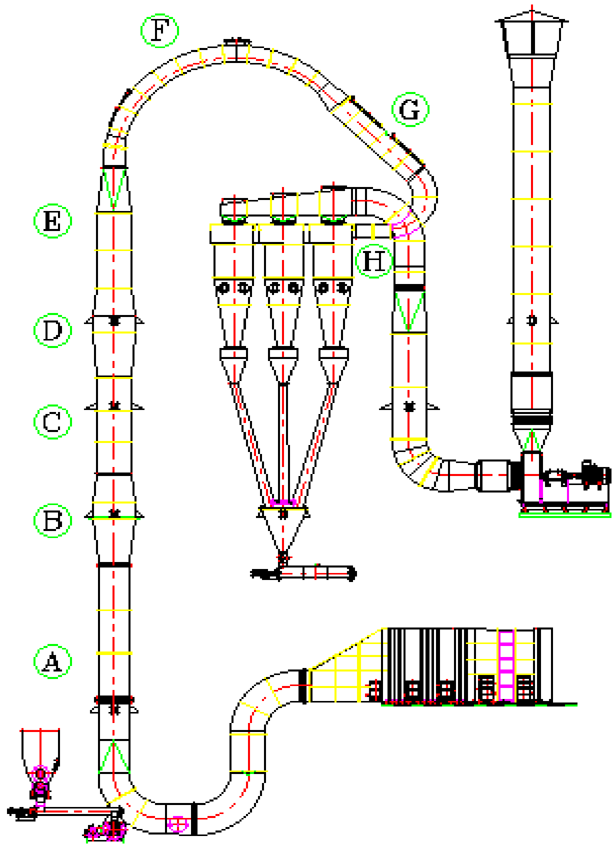


Figure 1- Flash Dryer Areas

Table 1 – Ducts Explosion Vent Area Calculation

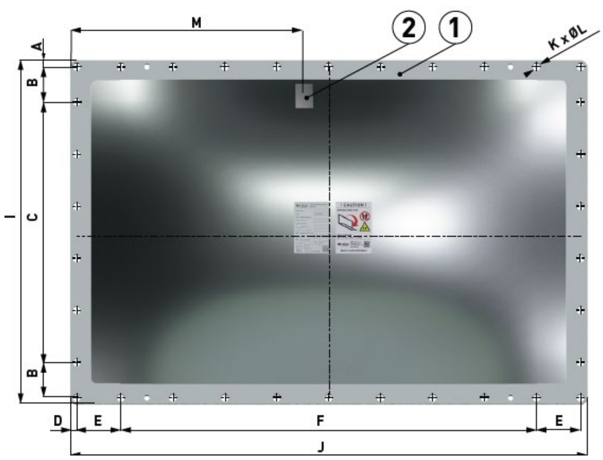
Position	Length(m)	Dim. /Dia.	De	L/De	Volume	Preq.	Pmax	Kst	Pstat.	B	C	A (Vent Area)
A	9.5	1.3	1.3	7.31	12.60	0.75	8.7	200	0.1	0.451	1.296	0.956
B	4	1730/1300	1.58	2.53	7.84	0.75	8.7	200	0.1	0.315	1.296	0.480
C	4.5	1.4	1.4	3.21	6.92	0.75	8.7	200	0.1	0.287	1.296	0.476
D	4	1730/1400	1.60	2.50	8.04	0.75	8.7	200	0.1	0.321	1.296	0.487
E	5.6	1.4	1.4	4.00	8.62	0.75	8.7	200	0.1	0.339	1.296	0.603
F	11.8	0.75x1.37	1.15	10.26	12.25	0.75	8.7	200	0.1	0.441	1.296	1.020
G	9	0.95x1.37	1.29	6.98	11.76	0.75	8.7	200	0.1	0.428	1.296	0.896
SUM	Total Area for Explosion Vents From A to G											4.917

The total vent area is calculated from “A” to “G” with an efficiency factor of 0.9 applied to each vent, ensuring a safety margin is incorporated into the calculations. Based on past experience, the hazardous zone in the first section begins where the material has lost most of its moisture. Therefore, explosion vents are installed in the upper part of this section up to the cyclone’s inlets. The number of vents planned for the first section is 4. Thus, the total calculated vent area is divided by 4 to determine the area and diameter of each individual vent.

$$E\ (Efficiancy) = 0.9$$

$$A = Required\ Area(Total\ Vent\ Area) = \frac{4.917}{0.9} = 5.46\ m^2$$

Type Of Explosion Vent:
1020x1020
Vent Area = 1.01 m^2
Quantity : 5.46/1.01=5.4 ~6
Required Quantity = 6



The calculations were performed for 3+1 vents; however, at the end of the duct where the main channel splits into two branches, an explosion vent is installed on each branch. For H position (Inlet of Cyclones) explosion vent area is calculated separately:

Table 2 – Ducts Explosion Vent for "H" section

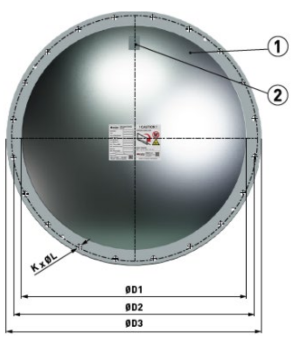
Position	Length(m)	Width(m)	Height(m)	De	L/De	Volume	Preq.	Pmax	Kst	Pstat.	B	C	A (Vent Area)
H1	1.76	1.27	0.88	1.19	1.48	1.97	0.75	8.7	200	0.1	0.111	1.296	0.136
H2	0.82	0.63	0.88	0.84	0.98	0.45	0.75	8.7	200	0.1	0.037	1.296	0.036
H3	0.848	0.31	0.88	0.59	1.44	0.23	0.75	8.7	200	0.1	0.022	1.296	0.027
H4	1.43	0.31	0.88	0.59	2.43	0.39	0.75	8.7	200	0.1	0.033	1.296	0.049
H5	2.64	0.31	0.88	0.59	4.48	0.72	0.75	8.7	200	0.1	0.052	1.296	0.096
SUM													**0.345**

$E\ (Efficiancy) = 0.9$

$A(Total\ Vent\ Area) = \frac{0.345}{0.9} = 0.38\ m^2$

Vent Type: DN750

Area: 0.41 m^2



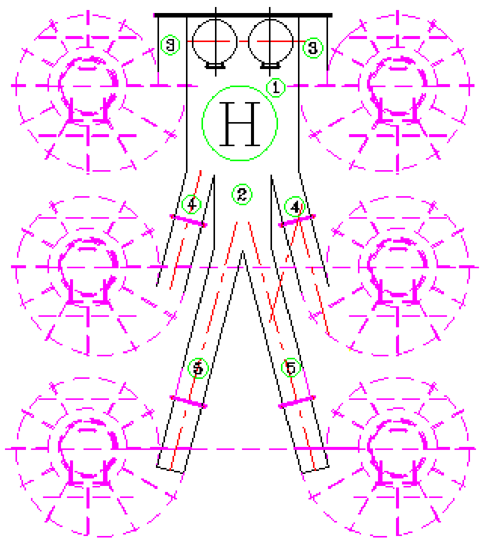


Figure 2- "H" section – Cyclones Inlet Area

1.5.2. Explosion Vent Area on Cyclones & Outlet Duct

The Explosion vent area calculation was performed for Cyclones and outlet duct separately, there are 6 explosion vents on top of the cyclone's outlet pipe, total area of vents shall be greater than required explosion vent area for cyclones and outlet duct:

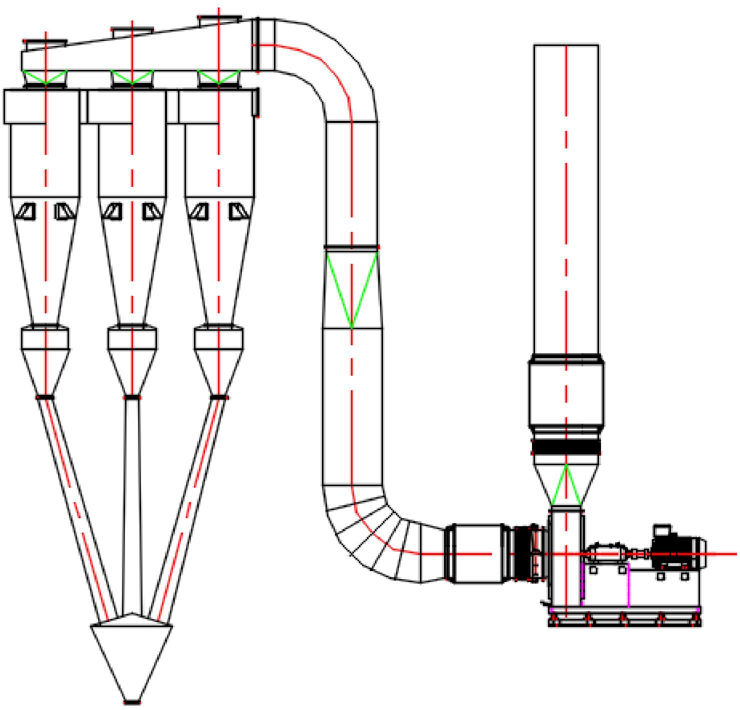


Figure 3-– Cyclones & Outlet Duct

a. Explosion Vent Area on Cyclones

There are six cyclones to which the inlet air, along with the dried starch, is directed. The separation of air from the starch takes place within these units. The explosion vent, based on process conditions and Annex "B" of BS EN14491 standard, is installed at the highest point of cyclone. The calculation of the required explosion vent area is as follows:

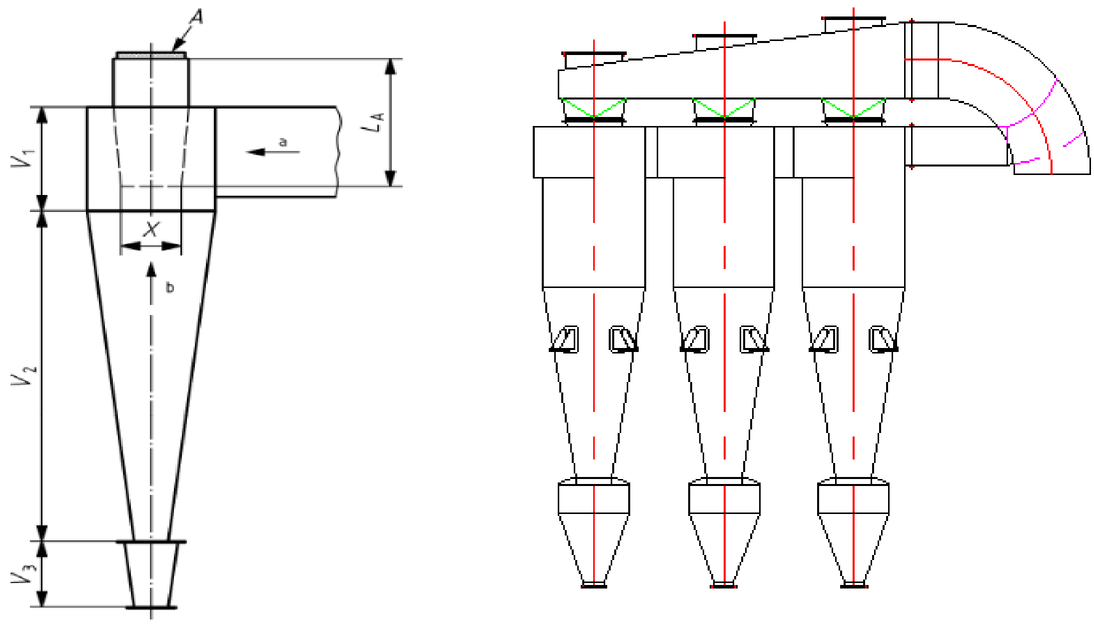


Figure 4 -Cyclones Schematic

$$A = B(1 + C \times Log\ LA/X)$$

$$B = [3.264 \times 10^{-5} \times Pmax \times Kst \times Preq^{-0.569} + 0.27(Pstat - 0.1)Preq^{-0.5}]V^{0.753}$$

$$C = (-4.305 \times Log(Preq) + 0.758)$$

A: Required Vent Area, m^2
LA: Length of the tube or enclosure, m
X: Outlet Pipe diameter, m
Pmax: maximum over pressure, bar, 5<Pmax<10
Kst: Maximum value of the pressure rise per unit time, bar.m/s, 10<Kst<300
Preq.: Pressure after explosion that structure could be resistance without damage, bar ,0.1<Preq<2
Pstat: Vent Opening Pressure, bar, 0.1<Pstat<1
V: Volume of tube or enclosure, m^3 , 0.1<V<10,000 = V1+V2+V3

Table 3- Cyclones Explosion Vent Area

Equipment	L_A(m)	X	De	L_A/X	Volume	Preq.	Pmax	Kst	Pstat.	B	C	A (Vent Area)
Cyclone	1	0.87	1.3	1.15	8.95	0.75	8.7	200	0.1	0.349	1.296	**0.376**

$$E\ (Efficiancy) = 0.9$$

$$A(Vent\ Area) = \frac{0.376}{0.9} = 0.417\ m^2$$

$$Q\ (Quantity\ of\ Cyclones) = 6$$

$$A'(Total\ Required\ Area\ for\ Cyclones\ ) = 6 \times 0.417 = 2.5\ m^2$$

b. Explosion Vent Area on Outlet Duct

For Outlet Duct, the following formula allow the calculation of the required vent area A. The required vent area can, in practical application, be divided into several smaller areas as long as the total area equals the required vent area:

$$A = B(1 + C \times Log\ L/D)$$

$$B = [3.264 \times 10^{-5} \times Pmax \times Kst \times Preq^{-0.569} + 0.27(Pstat - 0.1)Preq^{-0.5}]V^{0.753})$$

$$C = (-4.305 \times Log(Preq) + 0.758)$$

A: Required Vent Area, m^2
L: Length of the tube or enclosure, m
D: Tube or enclosure diameter, m
Pmax: maximum over pressure, bar, 5<Pmax<10
Kst: Maximum value of the pressure rise per unit time, bar.m/s, 10<Kst<300
Preq.: Maimum over pressure generated by an explosive atmosphere, bar ,0.1<Preq<2
Pstat: Vent Opening Pressure, bar, 0.1<Pstat<1
V: Volume of tube or enclosure, m^3 , 0.1<V<10,000

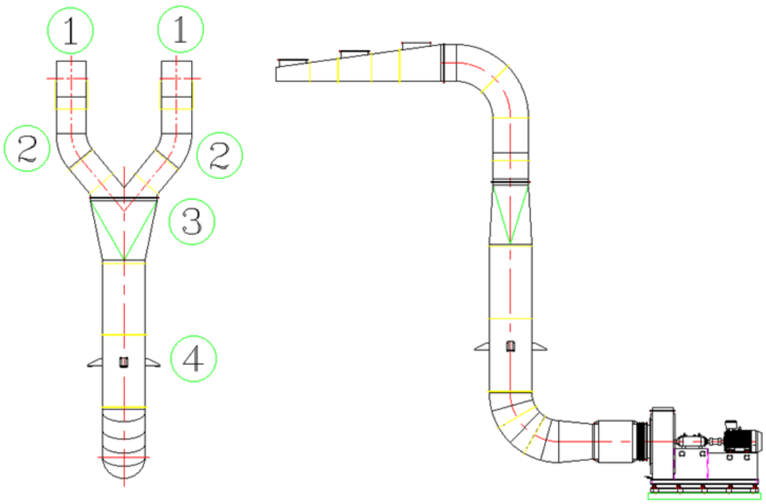


Figure 5 -Outlet Duct

Table 4- Outlet Duct Explosion Vent Area

Position	Length(m)	Width(m)	Average Height(m)	De	L/De	Volume	Preq.	Pmax	Kst	Pstat.	B	C	A (Vent Area) m2
1	5.45	1	0.83	1.03	5.30	4.52	0.75	8.7	200	0.1	0.208	1.296	0.404
1	5.45	1	0.83	1.03	5.30	4.52	0.75	8.7	200	0.1	0.208	1.296	0.404
2	5.73	1	1.2	1.24	4.63	6.88	0.75	8.7	200	0.1	0.286	1.296	0.532
2	5.73	1	1.2	1.24	4.63	6.88	0.75	8.7	200	0.1	0.286	1.296	0.532
3	1.95	1.3	1.8	1.73	1.13	4.56	0.75	8.7	200	0.1	0.210	1.296	0.224
4	7.5	-	-	1.40	5.36	11.54	0.75	8.7	200	0.1	0.422	1.296	0.820
SUM													**2.92**

$$E\ (Efficiancy) = 0.9$$

$$A(Explosion\ Vent\ Area\ for\ Outlet\ Duct\ to\ Fan) = \frac{2.92}{0.9} = 3.2\ m^2$$

c. Explosion Vent Area from Cyclone's outlet Ducts to Hopper & Hopper

For Ducts from cyclones to hopper and hopper, the following formula allows the calculation of the required vent area A. The required vent area can, in practical application, be divided into several smaller areas as long as the total area equals the required vent area:

$$A = B(1 + C \times Log\ L/D)$$

$$B = [3.264 \times 10^{-5} \times Pmax \times Kst \times Preq^{-0.569} + 0.27(Pstat - 0.1)Preq^{-0.5}]V^{0.753})$$

$$C = (-4.305 \times Log(Preq) + 0.758)$$

A: Required Vent Area, m^2
L: Length of the tube or enclosure, m
D: Tube or enclosure diameter, m
Pmax: maximum over pressure, bar, 5<Pmax<10
Kst: Maximum value of the pressure rise per unit time, bar.m/s, 10<Kst<300
Preq.: Maimum over pressure generated by an explosive atmosphere, bar ,0.1<Preq<2
Pstat: Vent Opening Pressure, bar, 0.1<Pstat<1
V: Volume of tube or enclosure, m^3 , 0.1<V<10,000

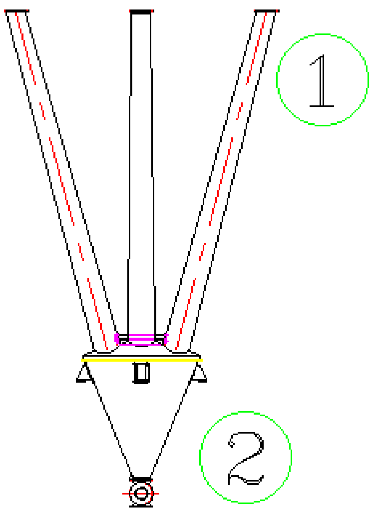


Figure 5 -Outlet Duct

Table 4- Outlet Duct Explosion Vent Area

'osition	Length(m)	De	Qty	L/De	Volume	Preq.	Pmax	Kst	Pstat.	B	C	A (Vent Area)
1	5.7	0.4	6	14.25	4.30	0.75	8.7	200	0.1	0.200	1.29586	0.500
2	2.3	1.38	1.00	1.67	3.42	0.75	8.7	200	0.1	0.169	1.29586	0.218
SUM												0.718

$$E\ (Efficiancy) = 0.9$$

$$A(Total\ Vent\ Area) = \frac{0718}{0.9} = 0.795\ m^2$$

d. Total Area Required for Cyclones and Outlet Duct

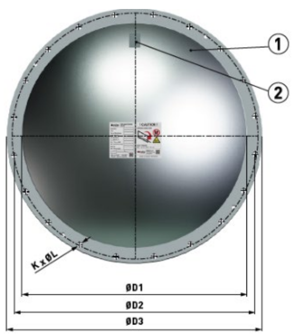
$$A"(Total\ Required\ Area\ for\ Cyclones\ and\ Outlet\ = 2.5\ m^2\ + 3.2\ \ m^2 + \ \ 0.795\ m^2$$

$$A"\ = 6.5\ m^2$$

Vent Type: DN 1000

Vent Area: 0.72 m^2

Vent Quantity (DN 1000) = 6.5/0.72= 9



If we select DN900

Vent Type: DN 900

Vent Area: 0.57 m^2

Vent Quantity (DN900) = 6.5/0.57 = 11.4 ~12
