Approved: L.Marculescu

Checked: A.Boscornea

Prepared: V.Florea

Modernization of the modified starch production plant

TECHNICAL MEMORANDUM – HAZARDOUS AREA CLASSIFICATION - DRYER

Project Phase : DDE

Project No.: 2215PJ

Client : Agrana Starke Austria

Owner: AGFD Tandarei

Site Location : Tandarei

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1. GENERAL INFORMATION

1.1. DOCUMENT SCOPE

The document displays the premises which formed the basis of preparation of the following documents:

- Zoning Plans for Environments with Explosion Hazard for modified starch plant.
- 2215PJ-UE114-DR4-001

1.2. INTRODUCTION – TECHNOLOGICAL PROCESS DESCRIPTION

The technological assembly consists of several zones of interest for hazardous area classification, namely, Starch Dryer 4.

The methodology used for determining the type, extent, radius, and length of hazardous zones is based on the requirements of, SR EN 60079-10-2/2020 (Combustible dust atmospheres – Classification of areas), and SR EN 1127-1/2019 (Explosion prevention and protection – Basic concepts and methodology). These standards define the criteria for assessing emission sources, ventilation effectiveness, and the resulting hazardous area dimensions.

The purpose of this hazardous area classification is to ensure full compliance with the European ATEX Directive, specifically Directive 2014/34/EU (equipment intended for use in potentially explosive atmospheres) and Directive 1999/92/EC (minimum safety requirements for workplaces with explosion risks). The classification provides the foundation for selecting ATEX-certified electrical and mechanical equipment, establishing operational safety measures, and ensuring that the installation meets all applicable European regulatory requirements for explosion protection.

2. PROCESS AREAS DESCRIPTION

2.1. STARCH DRYER 4

2.1.1. CENTRIFUGATION OF STARCH MILK

The drying of starch milk takes place in the DR4 building. The first step in this process is centrifugation in the peeler centrifuge S6000. This is gravity-fed from a high-level buffer tank B6000 equipped with agitator R6000. Tank B6000 is fed from the secondary buffer tank B5700 with pump P5700, with continuous recirculation back to tank B5700 to avoid settling of solids from the modified starch milk. The centrifuge S6000 reduces the water content in the starch milk by centrifugation, resulting in a starch cake that is discharged into a wet product bunker B6200, which is equipped with R6201 mixer, then in a set of mixing conveyors H6202, H6207, H6203, which discharge the starch cake into the disintegrator H6204. The water removed in the centrifugation process, called filtrate, is discharged into a buffer tank B6002 with agitation (R6002), from where it is further pumped with pump P6002 into the HWC feed tank B5710 for solids recovery. The centrifuge S6000 requires periodic washing after a certain number of centrifugation cycles. This procedure is carried out automatically, and the water is discharged into the existing wastewater collection system.

2.1.2. DRYING OF STARCH MILK

The drying of the starch cake obtained by centrifugation is done in a flash dryer (drying unit 6500). The drying unit consists of a steam air heating and treatment unit (F6500, W6501, F6502, W6503A+B, W6504-1..6, T6505, F6506 … F6511, V6515), and a disintegrator (H6204) that breaks and feeds the starch cake into the hot air stream from the air heating and treatment unit. Once introduced through the disintegrator into the hot air stream, the starch ascends through a drying column where it dries and enters the cyclone system where the dust is separated at the top of the cyclones and extracted with the V6515 fan, to then be eliminated in the atmosphere with a concentration of solid particles in accordance with the norms in force. At the base of the cyclones, the starch accumulates as a product in the collection hoppers (B6506 .. B6511).

2.1.3. FINAL PROCESSING OF DRIED STARCH

From the collection hoppers (B6506 … B6511), the starch is further discharged into the dry starch receiving silo B6512 and dosed with the rotary valve H6514 into the conveyor H6513, and then into a

scale (A6310) to record the product quantity. After weighing, the starch is discharged into the hopper A6324 of the rotary valve H6311 and is dosed into a fluidization cone H6320 (fluidized by compressed air injection) to prepare the starch for pneumatic transport to the product silo.

The fluidization cone is equipped with a cartridge filter to remove the remaining dust particles. At the base of the fluidization cone H6320 and a rotary valve H6321 connected to a pneumatic conveying system (blower V6540) that pushes the finished starch toward the existing starch storage silos.

2.1.4. CONDENSATE COLLECTION

The condensate collection tank B6450 in the DR4 section collects condensate generated by the air heating unit. From the condensate collection tank B6450, it is pumped with pumps P6451 and P6452 into existing condensate collection system.

3. GENERAL DATA – HAZARDOUS AREAS CLASSIFICATION

The classification of hazardous areas is done in accordance with SR EN 60079-10-1&2, 2020 edition.

Installations that convey flammable materials are designed so that the probability of the simultaneous presence of an inflammable atmosphere and an ignition source is practically reduced to zero. The classification of explosion hazard zones is used to identify those areas, equipment, or workspaces where flammable and/or explosive atmospheres could occur. For example, in cases where the probability of an flammable atmosphere occurring is high and cannot be reduced, the equipment and machinery in that area will be protected to minimize the likelihood of an ignition source appearing.

An explosion hazard zone is defined as a three-dimensional space where an explosive atmosphere can occur with a frequency that requires special precautions regarding the type and mode of use of electrical equipment or other ignition sources.

For explosive dust/air mixtures, the classification is as follows:

- Zone 20 – An area in which, during normal operation, combustible dust, in the form of a cloud, is constantly or frequently present in sufficient quantities to produce an explosive concentration of combustible dust in mixture with air, and/or in which layers of dust can form with excessive and uncontrolled thickness.
- Zone 21 – An area not classified as Zone 20, in which, during normal operation, combustible dust, in the form of a cloud, is likely to occur in sufficient quantities to be capable of producing an explosive concentration of combustible dust in mixture with air.
- Zone 22 – An area not classified as Zone 21, in which dust clouds can rarely be formed and persist for short periods, or in which accumulations or layers of combustible dust can be present under abnormal conditions and can generate flammable dust/air mixtures.

Explosion hazard zones are marked on a site plan. Unmarked areas are considered free from explosion hazard or safe.

The analysis of the classification of explosion hazard zones considers events characterized as possible under normal or abnormal operating conditions. The analysis of the classification of explosion hazard zones does not consider:

- Large releases of gases/vapors from process vents into collection pipes or flare systems.
- Releases of gases/vapors through rupture discs in collection pipes or flare systems. The favorable resolution of these cases relies on the proper functioning of the ESD protection system.

The classification of explosion hazard zones depends on the ventilation of areas where sources that can lead to the presence of an inflammable atmosphere exist. A source is defined as a point or surface from which flammable gases, vapors, or liquids are released into the atmosphere. In this regard, three types of releases are defined based on their frequency of occurrence and duration:

- Continuous source: A release is continuous or long-lasting if its duration exceeds 1000 hours per year. Example: atmosphere inside a hydrocarbon tank.
- Primary source: A release that occurs periodically or occasionally during normal operation. The cumulative duration of its occurrence within a year ranges from 10 to 1000 hours. Example: sample extraction points.

- Secondary source: A release that does not normally occur during normal operation or occurs infrequently and for short periods. The cumulative duration of its occurrence within a year is less than 10 hours. Examples include:
    - Pump, compressor, and valve seals where no release of flammable substances is expected during normal operation.
    - Flanges, gaskets, and pipe fittings where no release of flammable substances is expected during normal operation.
    - Sample extraction points from which no release of flammable substances into the atmosphere is expected during normal operation.
    - Relief valves, vent openings, and other openings from which no release of flammable substances is expected during normal operation.

”Type of source” and ”zone” are not synonymous. The types of zones depend on the ventilation level in the analyzed area. For example:

- Zone 0 is determined by continuous sources.
- Zone 1 is determined by primary sources.
- Zone 2 is determined by secondary sources.

For explosive dust/air mixtures:

- Zone 20 is determined by continuous sources.
- Zone 21 is determined by primary sources.
- Zone 22 is determined by secondary sources.

The analysis for the classification of explosion hazard zones categorizes fluids in two stages:

1. The Combustible Fluid Class is established based on the flashpoint and handling or storage temperature.

- Class 0: Liquefied gaseous hydrocarbons;
- Class I: Liquids with a flashpoint below 28°C;
- Class II: Liquids with a flashpoint between 28 and 55°C;
- Class III: Liquids with a flashpoint between 55 and 100°C;
    - Class IIIa: Handled/stored below the flashpoint;
    - Class IIIb: Handled/stored above the flashpoint;
- Class IV: Liquids with a flashpoint above 100°C;
    - Class IVa: Handled/stored below the flashpoint;
    - Class IVb: Handled/stored above the flashpoint;

2. The category is established based on the class and indicates the fluid's tendency to form explosive mixtures with air. This is a determining factor for establishing the extent of the explosion hazard zone. The explosion hazard zone's extent represents the greatest horizontal distance determined by a source. The extent is not solely determined through a fully deterministic analysis; it is also estimated based on design experience.

Dust exists in technological spaces in two forms: suspended dust and deposited dust.

For the classification of industrial spaces with explosion hazard, a concept similar to that used for flammable gases and vapors is adopted when forming atmospheres of combustible dust (powder) to provide an indication of the risk of fire and/or explosion in the presence of an ignition source.

Additionally, unlike flammable gases and vapors, combustible dust doesn't necessarily need to be evacuated through ventilation or diffusion after the emission ceases. This aspect has implications in zone classification, which differs from that for flammable gases and vapors. If clouds of dust, highly diluted and therefore non-explosive, are continuously generated or over extended periods, thick layers of dust gradually form. Starting from these layers of dust, rapid air movements can generate dust clouds, creating explosive mixtures of dust/air. A deposit of smoldering dust, if disturbed, can thus ignite the dust cloud.

Zone classification is a method of analysis and classification of the environment in installations or factories, based on the probability of occurrence of explosive dust atmoshperes and layers of

combustible dust. This will facilitate the correct selection of electrical equipment intended for safe use in such an environment, considering the characteristics of the dust.

For the classification of areas, the nature of the dust and the installations used must be clearly specified and the following steps must be completed:

- The first step is to identify the characteristics of the dust, for example particle size, humidity, cloud and layer ignition temperatures and resistivity.
- The second stage is the identification of places where dust or sources of dust release may be present.
- The third stage is the determination of the probability of occurrence of a release from these sources and consequently the probability of the occurrence of explosive dust atmospheres in different parts of the installation.
- The fourth stage is the identification of the possibility of the formation of potentially dangerous dust layers.

Depending on the probability of formation of potentially explosive dust atmosphere and potentially dangerous dust layers, the areas can be designated according to table 2.

Zone 20:

Inside the handling and production equipment of powdery products where explosive dust atmospheres are present permanently or frequently. Inside an enclosure containing dust where excessive and uncontrollable layers of dust can form.

Zone 21:

Inside handling equipment for powdery products where an explosive dust atmosphere is likely to occur. The zone extends outside the equipment, originating from a release source and dependent on various parameters such as dust quantities, airflow rate, particle size, and product moisture content. This zone should be easily extended; typically, a typical release source will not create an explosive dust atmosphere extending more than 1m around the source (e.g., an open viewport) and extends vertically to the ground or the level of a solid floor.

Zone 22:

In most cases, the extent of Zone 22 can be defined by evaluating secondary release sources in relation to the environment that causes the formation of an explosive dust atmosphere. For example, where dust dispersion is limited by mechanical structures (e.g., walls), their surfaces can be considered as the boundary of the zone. If layers of dust accumulate outside in Zone 22, then classifying the area delimited by Zone 22 would require extending it, considering the extent of the layer and any disruption to the layer that produces a dust cloud. Therefore, the basic elements for determining the type of hazardous zones are identifying the release source and determining the degree of release.

3.1. REFERENCE DOCUMENTS FOR HAZARDOUS AREA CLASSIFICATION FOR EXPLOSION PROTECTION – ROMANIAN

SR EN 60079-10/2020 „Aparatura electrică pentru atmosfere explozive gazoase. Partea 10: Clasificarea ariilor periculoase.”

SR EN 60079-10-1:2020 - Atmosfere explozive. Partea 10-1: Clasificarea ariilor. Atmosfere explozive gazoase.

SR EN 1127-1: 2019 - Atmosfere explozive. Prevenirea exploziilor şi protecţia la explozii. Partea 1. Concepte fundamentale şi metodologie.

Îndreptar departamental de zonare a mediilor cu pericol de explozii şi măsuri de prevenire a acestora – MIP 1987.

Normativ departamental pentru proiectarea şi executarea construcţiilor şi instalațiilor din punct de vedere al prevenirii incendiilor în industria chimică + MICh – 1979.

NP 099-04 - Normativ pentru proiectarea, executarea, verificarea şi exploatarea instalaţiilor electrice în zone cu pericol de explozie.

3.2. DETERMINATION OF EXPLOSION HAZARD ZONES

Within the technological system, flammable substances are transported, handled, and processed. In practice, in most cases where flammable materials are used, it is difficult to ensure that an explosive atmosphere cannot form or that the electrical equipment used in environments where an explosive atmosphere is or could be present will never generate an ignition source. This situation requires special precautions in the selection, construction, installation, and operation of electrical materials used in installations where, under normal operating conditions, an explosive atmosphere may exist or be produced, for the purpose of safety in operation.

From the above statement, the significant importance of knowing the types of zones in which different components of the installation containing flammable substances are categorized is evident. The classification of hazardous explosion zones within the technological assembly has been carried out through the hazard source method, which analyzes and identifies each point from which flammable substances can be released in a quantity sufficient to allow the formation of an explosive mixture.

Thus, the following have been performed:

a) Identification of sources of release of flammable gases, vapors, liquids, or dusts. In this regard, the following have been taken into consideration:

- The type of equipment containing flammable products (open system or closed system).
- Possible sources of release of flammable substances from the respective equipment, for example: flanged joints, seals, connections, ventilation and drainage points, etc.
- Frequency and duration of release under normal operation.

b) Highlighting the properties of substances present in each of the machines or equipment in the installation, such as: flashpoint, working temperature, explosion group, maximum surface temperature class. Also taken into account were: location (outdoors, indoors, in shed-type structures, etc.), ventilation system (natural or artificial). These data are presented in the Hazardous Area Classification Data Sheet - Part I, II.

c) Analysis of other factors affecting the type and/or extent of the hazardous area, for example: relative density of flammable substances in relation to air, explosion limits, installation elevation, etc.

As per the provisions of the regulations used in the development of the documentation, catastrophic events that could occur in the installation, such as the rupture of a technological apparatus or a large diameter pipe, have not been considered. These are verified during each general review of the technological assembly by the Control Installations department.

Within the technological assembly, hazardous areas are classified as follows: Zone 20, Zone 21, Zone 22; explosion hazard; T200°C; explosion groups IIIB.

4. TECHNOLOGICAL DATA

4.1. NAME OF THE TECHNOLOGICAL PROCESS, ACTIVITY PROFILE, LAYOUT, NUMBER OF THE AREA CLASSIFICATION PLAN WITH EXPLOSION HAZARD

Unit name technology origin	Activity profile	Name and number of the area classification plan with explosion hazard
DR4	Modified Starch centrifugation, Modified Starch drying, Filtrate collection and transport, product weighing, Steam Condensate collection	Explosion hazard Area classification plan no. 2215PJ-UE135-DR4-001

4.2. SOURCES OF RELEASE OF FLAMMABLE GASES, VAPORS, OR LIQUIDS, DEGREE OF SOURCES FOR THE MAIN TYPES OF MACHINERY OR EQUIPMENT

The type of pollutants emitted depends on the degree of ventilation and the availability of ventilation. The influence of ventilation on the zone type, according to SR EN 60079-10, is presented in Table 1, below.

Table 1. Designation of hazardous areas for explosive dust atmospheres and potentially hazardous dust layers

Grade of release	Dust clouds	Dust layers of controlled thickness	
		Disturbed frequently	Disturbed seldom
Continuous	20	21	22
Primary	21	21	22
Secondary	22	21	22

In Table 3, both sources of release of flammable materials within the installation and their release levels are highlighted.

These assessments are presented in the Hazardous Area Classification Datasheet - Part II, in which:

C - continuous release grade;

P - primary release grade;

S - secondary release level;

N - natural ventilation;

A - artificial ventilation;

Ventilation level: strong, moderate, weak;

Ventilation availability: very good, good, and mediocre.

Table 2. Sources of release

*Equipment that does not generate an Ex zone is excluded from the following table

Item no.	Equipment	Equipment description	Equipment Target	Sources of release		Observations
				Source identification	Grade of release	
1.	Silos, Bunkers, Cyclones, Dryer, Tank, Weighing Systems	Closed system with valves, flanged joints, ventilation, sealing	Cyclone - removal of dust from enclosed spaces and fine product extraction from dryers Dryer – Starch, Storage Tanks	- nozzles - seals - ventilation - leaks	S S P P	- abnormal leaks due to seal deterioration; - release of small amounts of products during room ventilation and inside ventilation equipment;
2.	Conveyors, Mills,	Closed system with valves, flanged joints, ventilation, drainage, sealing and Motors	Conveyors - product transportation (dewatered or dried) Mills – fine product milling or grinding	- nozzles - seals - ventilation - leaks	S S P P	- abnormal leaks due to mechanical seal deterioration;
3.	Product transfer system, Fittings,	Closed system with valves, flanged joints, ventilation,	Product transfer	- nozzles - seals	S S	- release of small quantities of product;

Item no.	Equipment	Equipment description	Equipment Target	Sources of release		Observations
				Source identification	Grade of release	
	Rotary valves	drainage, sealing				
4.	Exhaust stack/pipe	Ventilation	Air exhaust Vent	- nozzles	P	-continuous leakage;

Table 3. Assessment of characteristics of dust releases

Required characteristic parameters for dust hazardous area classification	Dust leaks	
	Characteristic parameter values of dusts conveyed in the process plant	
Parameter name	Source 1	U.M.
Flammable substance	Cornstarch fine dust	-
Conductive/non-conductive	Non-conductive	-
Moisture content percentage	12	%
Average particle size	18.6-30.1	µm
Auto-Ignition Temperature	175	°C
Glow Temperature	310	°C
Ignition temperature (Dust cloud)	420	°C
Minimum explosive concentration	60	g/m^3
Maximum explosion pressure	8.6	barg
Minimum ignition energy	300 - 1000	mJ
Deflagration index of a dust cloud, K_{St}	144	bar·m/s
St Class	St 1	-
Specific volume resistance	> 10^8 (non conductive)	
Burning number	BZ 3	
Explosion group and temperature class	IIIBT200°C	-

Based on the properties of substances with a risk of forming an explosive atmosphere mentioned in table 3, the placement of hazardous explosive zones shall be carried out according to figures 10-12.

Additional considerations based on key parameters in the table above are mentioned as follows:

- Specific volume resistance values indicate that Dusts are not electrically conductive, therefore design in IP 55/56 in zone 22 is sufficient.
- Burning Number value of 3 for starch indicates that no stable glow nests are to be expected and as such, are not likely to be transported over long distances within the dryer.

For those equipment types not falling within the categories mentioned in figures 6-7, the placement of hazardous explosive zones shall be determined individually for each case, following the specific zoning plans for each area analyzed within the project. The hazardous area boundary distance values shall adhere to the following criteria, as per standard SR EN 60079-2 + General best practices:

Table 4. EX protection zone classification for outdoor and installation areas of starch dryer

Area/Equipment	Zone explanation	Zone Considered
General dryer installation area	Good cleaning condition is considered permanently	Zone free

Area/Equipment	Zone explanation	Zone Considered
Manhole door, maintenance openings	Temporary Zone of 1 meter around opening is considered when opened and if no position switch is used zone is escalated to 21.	22
Exposed areas	Surrounding area of open solids manipulation, such as big bags, an area of radius of 0.5 meters is considered at contour down to the ground	22
Rotary Sling	Generally wet material is present; malfunctions and material deposition can generate occasional explosive atmospheres.	22
Flash dryer, drying Column	Typical zone 21 up to 50% of height and zone 20 for the rest of the column. However, due to the size of the and overall geometry of the duct, deposition is possible on lower parts, as such the presence of permanent explosive mixtures is considered, especially in the end part of the dryer where the material is stirred due to the path change, and dust is generated continuously.	20
Separation cyclones after drying column	Permanently explosive mixtures are considered during operation of the dryer.	20
Ducting after cyclones	Explosive atmosphere formation is considered in the event of cyclone blockage or cyclone failure.	22
Extraction Fan/Exhaust air ducting	Explosive atmosphere formation is considered in the event of blockage or cyclone failure.	22
Product collection screw conveyor and collection bunker under cyclones, In-line weigher, fluidizing bed,	Dried Solid material is vertically discharged and perturbed, Explosive atmosphere formation is considered continuous.	20
Intermediary screw conveyors	The equipment is generally filled with material in operation and low turbulence is expected. Occasional explosive mixtures are present.	21
Rotary valves	Equipment is used as an isolation device and is generally filled with material in operation with low turbulence. Occasional explosive mixtures are present. A 0.5 m radius zone 22 external to the rotary valve is considered due to flanged connections.	21 22
Vibrating or rotating sieves	The equipment is generally filled with material in operation and low turbulence is expected due to conveying. Occasional explosive mixtures are present.	21
Bag Loading Stations	If equipped with an aspirated filtration system, a 1 m zone 22 will be considered around the feeding point. Otherwise a zone 21 of 1 m around feeding point with an extension of 1 m as zone 22 will be considered.	21 22
Compensators	For compensators that are in contact with product that are properly installed and located in ventilated rooms, a 0.5 m 22 external zone is considered for occasional leakage. Internal zone considered as 20.	20 22

Area/Equipment	Zone explanation	Zone Considered
Explosion Vents (Outside)	Typically a zone 21 of up to 20 m straight is considered in the direction of venting (flame ball radius). Considering dust layer deposition only, the zone generated laterally (lateral spread) is considered relevant. Considering typical values used in industry and parameters of the dried starch a zone 22 lateral spread of 5 m from EVP is considered and a zone 22 rebound zone of 2 m behind the EVP opening direction	22
Flameless Explosion Vents (Inside)	Flameless EVP do not produce a flame jet and as such zone 21 is not considered. A Zone 22 area of up to 1 m radially around the flameless vent is considered. This zone accounts for localized release of hot gases, limited dust disturbance, and elevated surface temperatures on the flameless vent housing. A Zone 22 rebound zone of 1 m behind the flameless vent housing is considered.	22
Exhaust Stack	The exhaust stack normally designed to discharge clean or filtered air. Under correct operation, the probability of an explosive dust atmosphere forming at the outlet is very low, corresponding to a secondary release condition, 1 m Zone 22 around Outlet, Zone 22 inside stack	22

Table 3 presents the situations imposed by the aforementioned hazard sources (pumps, tanks, unloading trucks, pipelines, and vents) in accordance with the explanatory figures that follow:

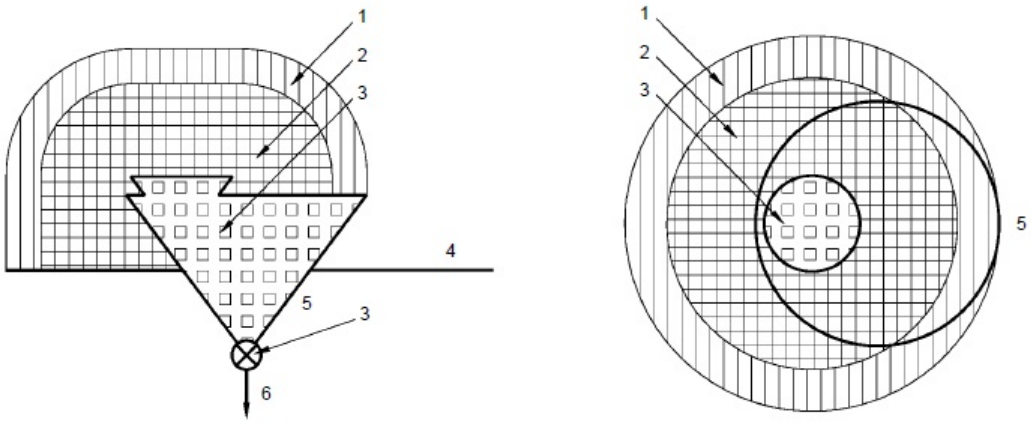

Fig. 1. Bag emptying point without suctiont ventilation, inside the building

1 - Zone 22; 2 - Zone 21, 3 - Zone 20, 4 - floor,

5 - bag unloading bunker, 6 - to processing through a rotary valve

Zone 20 Inside the bunker, considering that during normal operation, an explosive mixture of dust/air is frequently or continuously present, and excessive and uncontrollable layers of dust are formed or present.

Zone 21 An open access hatch is a primary release source; the occurrence of an explosive mixture of dust/air is likely. Consequently, a Zone 21 area must be defined around this access hatch, with a width of 1 meter from the edge and downward to the floor.

Zone 22 Due to atmospheric agents, Zone 22 will be limited to a maximum of 1 meter around the boundary of Zone 21.

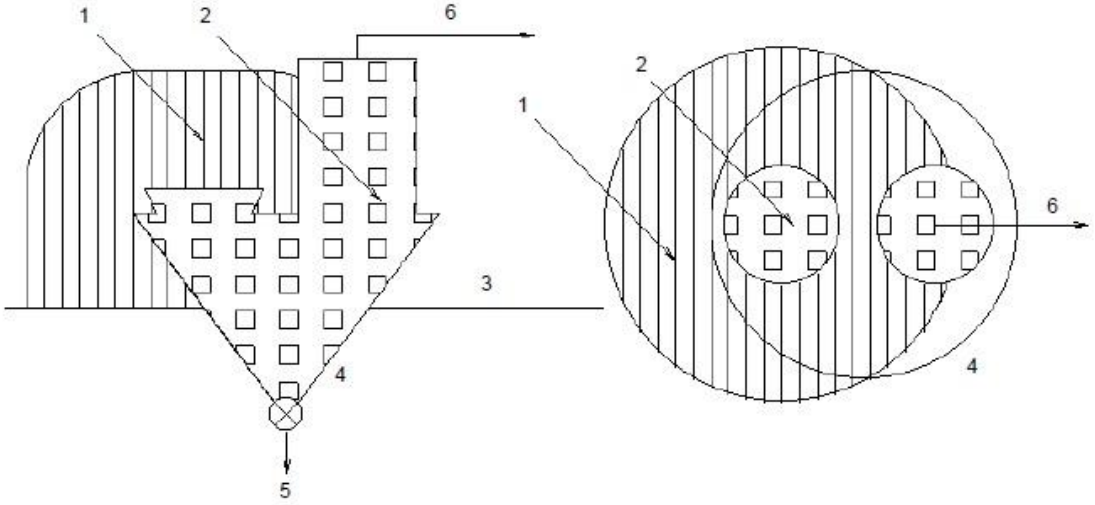

Fig. 2. Bag emptying point located indoors, with suction ventilation

1 - Zone 22; 2 - Zone 20, 3 - Floor, 4 - Bag unloading bunker,

5 - To processing through a rotary valve, 6 - To extraction

Zone 20 Inside the bunker, considering that during normal operation, an explosive mixture of dust/air is frequently present, and excessive and uncontrollable layers of dust are formed or present.

Zone 21 If the suction ventilation system is malfunctioning or inadequate, the opening becomes a primary release source, leading to a Zone 21, with a width of 1 meter around the edge of the feeding inlet.

Zone 22 In well-designed suction ventilation systems, any dust release will be aspirated indoors. The feeding inlet can thus be defined as a secondary release source, leading to a Zone 22, with a width of 1 meter around the edge of the feeding inlet.

Emptying the bags will result in a dust release during handling. Consequently, an area with a width of 2 meters around the feeding inlet must be designated as Zone 22. If cleanliness maintenance is poor, a larger area of the room may become dusty, and it should be appropriately classified.

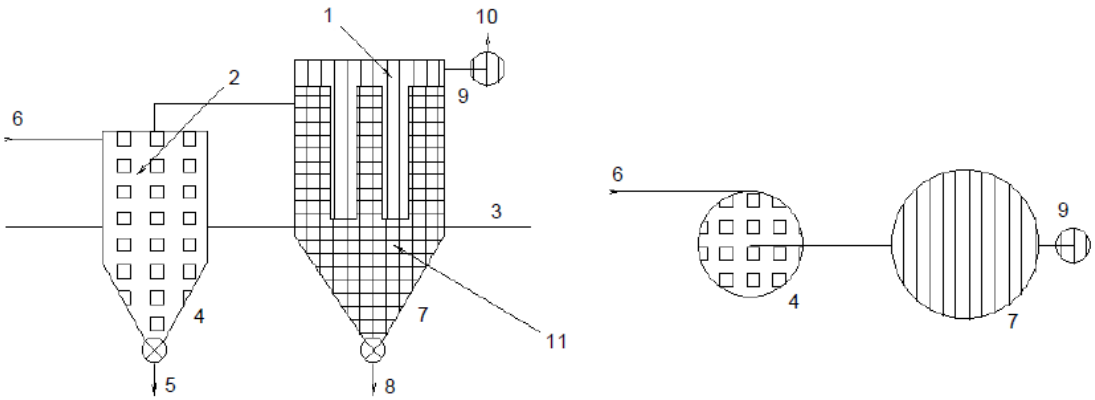

Fig. 3. Cyclone and filter: discharge to the outside of the room

1 - Zone 22, 2 - Zone 20, 3 - Floor, 4 - Cyclone, 5 - To silo,

6 - Inlet, 7 - Filter, 8 - To fine particle storage, 9 - To extraction fan,

10 - To outlet, 11 - Zone 21

Zone 20 Inside the cyclone, filter, and ducts, as during normal operation explosive dust/air mixtures are constantly present.

Zone 21 There is a Zone 21 on the dirty side of the filter only if small quantities of dust are not collected by the cyclone during normal operation.

Zone 22 Dust can be released onto the clean side of the filter through sudden leaks (source with a secondary degree of release) with high concentrations or continuously, in very small concentrations.

The situation is similar for the downstream ducts of the filter, the fan, and around the discharge outlet. An area with a width of 1 m around the edges of the discharge outlet will be classified as Zone 22.

The filter's discharge outlet, when releasing very small quantities of dust into the room, can lead to the formation of dust layers inside the room over time. Therefore, the entire room must be classified as Zone 22. Most of the room can be classified as a non-hazardous area, only if proper cleaning is maintained at regular intervals to limit the thickness of the dust layer.

The explosion pressure relief duct and outlet can have leaks or rupture (slight overpressure is possible) and in this case, constitute a Zone 22 (rupture or leakage).

4.3. NON-ELECTRICAL IGNITION SOURCES AND PROTECTION MEASURES

The designed machinery and equipment take into consideration the elimination of mechanical ignition sources by ensuring that dynamic machinery is installed to avoid vibrations, noises, and other abnormal behaviors during operation. Additionally, proper cooling water for bearings or appropriate lubrication oils are provided in accordance with the manufacturer's instructions.

Static electricity generated by the flow of organic fluids in the absence of grounding of machinery and pipelines can lead to sparks inside them. The operating manual presents the procedures for startup, normal operation, shutdown, accidental shutdowns, as well as during maintenance and repairs. By adhering to the operating instructions presented in the facility's operating regulations, mechanical ignition sources are avoided.

However, during accidental operation, situations may arise if the instructions and operating standards are not followed, leading to potential ignition sources as presented in Table 9.

Table 5. Examples of Ignition Sources

Item no.	Name of mechanical ignition source	Protective measures
0	1	2
1	Overheating of electrically operated rotating equipment (pumps, agitators, etc.)	Continuous monitoring of equipment operation and ensuring proper lubrication
2	Use of improper tools in the work area during maintenance, inspections, and repairs	Use of tools that do not produce sparks
3	Wearing footwear with metal accessories by operating personnel and maintenance workers	Use of protective equipment made of materials suitable for the working area
4	Access of untrained individuals with potential ignition sources (matches, cigarettes, etc.)	Instruction and training before accessing the workplace

Protective systems in accordance with Law 319/2006 on occupational health and safety, Government Decision 1058/2006 on minimum requirements for improving the safety and health protection of workers who may be exposed to a potential risk due to explosive atmospheres, and Government Decision 752/2004 refer to devices designed for the immediate cessation of incipient explosions and/or for limiting the effective range of an explosion, which are placed on the market separately for use as standalone systems.

The protective systems used for technical equipment placed and used in potentially explosive atmospheres are:

Protective system	Technical Equipment
Grounding	Machinery and Piping
Explosion Vents	Dried Solids conveying
Spark Detectors	Dried Solids conveying

DATA REGARDING PROCESS EQUIPMENT AND STORED OR CONVEYED PRODUCTS (FROM THE PERSPECTIVE OF EXPLOSION HAZARD)

These data are presented further in:

- Data sheet for the classification of hazardous areas - Part I, according to SR EN 60079-10/2016, including the list of equipment and data regarding the equipment and stored/conveyed products from the perspective of explosion hazard. This data is extracted from Annex 4 of the Departmental Guide for zoning of environments with explosion hazard and preventive measures.

Data sheet for the classification of hazardous areas - Part II, according to SR EN 60079-10/2020, containing the list of emission sources, including the degree of emission sources for the main types of equipment or machinery:

4.4. DATA SHEET FOR CLASSIFICATION OF HAZARDOUS AREAS – PART I: LIST OF FLAMMABLE MATERIALS AND THEIR CHARACTERISTICS

FLAMMABLE SOLIDS

Item no.	Flammable material		Moisture percentage	Average particle size	Ignition temperature (Cloud)	Minimum explosion concentration	Maximum explosion pressure	Minimum ignition energy	Deflagration index, KSt	Explosion group and temperature class	Other relevant information and observations
	Name	Composition	%	µm	°C	g/m3	barg	mJ			
STARCH DRYER AREA – DR4											
1	Cornstarch fine dust	Dust layer	<12	30.1	420	60	8.6	300-1000	144	IIIBT200°C	Ignition temperature considered for Dust-Air suspension

4.5. DATA SHEET FOR THE CLASSIFICATION OF HAZARDOUS AREAS – PART II: LIST OF RELEASE SOURCES

Item no.	Release source		Flammable material					Ventilation			Hazardous area				
	Description	Layout Location	Release grade	Reference (Table 2)	Operating temperature and pressure		State	Type	Degree	Availability	Zone type 20-21-22	Zone extent, m		Drawing reference	Other relevant information and observations
					°C	barg						Vertical	Horizontal		
DR4 Area – Dryer Building															
1	H6204 Rotary Sling Manholes with position switch	DR4 Building, Ground level	S	Table 8	10-40	Atm	S	A	Medium	Fair	22	Zone 22, 1 m around each manhole, Zone 22 inside equipment	Zone 22, 1 m around each manhoel, Zone 22 inside equipment	2215PJ-UE114-DR4-001	
2	T6505 Drying Column Compensators and manholes with position switch Explosion Vents on outside elements	DR4 Building Inside/Outside From Ground level to +36 m	S	Table 8	160-175	Low vacuum	S+G	N/A	Medium	Fair	20 22	Zone 22, 1 m around each manhole, Zone 22, 0.5 m around each compensator, Zone 20 inside Zone 22 5 m around Explosion vents Zone 22 2 m behind Explosion vents	Zone 22, 1 m around each manhole, Zone 22, 0.5 m around each compensator, Zone 20 inside Zone 22 5 m around Explosion vents Zone 22 2 m behind Explosion vents	2215PJ-UE114-DR4-001	
3	F6506-F6511 Separation Cyclones Explosion Vents on top elements	DR4 Building Inside/Outside From +22.6 m level to +29.3 m	S	Table 8	160-175	Low vacuum	S+G	N/A	Medium	Fair	20 22	Zone 20 inside Zone 22 5 m around Explosion vents Zone 22 2 m behind Explosion vents	Zone 20 inside Zone 22 5 m around Explosion vents Zone 22 2 m behind Explosion vents	2215PJ-UE114-DR4-001	
4	B6506-B6511 Separation cyclones individual collection bunkers With manholes, no position sensors	DR4 Building Inside/Outside From +22.6 m level to +29.3 m	S	Table 8	60-80	Atm	S	A	Medium	Fair	20 21	Zone 21, 1 m around each manhole, Zone 20 inside	Zone 21, 1 m around each manhole, Zone 20 inside	2215PJ-UE114-DR4-001	

Item no.	Release source		Flammable material					Ventilation			Hazardous area				
	Description	Layout Location	Release grade	Reference (Table 2)	Operating temperature and pressure		State	Type	Degree	Availability	Zone type 20-21-22	Zone extent, m		Drawing reference	Other relevant information and observations
					°C	barg						Vertical	Horizontal		
5	B6512 Collection bunker under cyclones Manhole with position switch Flameless Explosion Vents	DR4 Building Inside +14.8 m	S	Table 8	60-80	Atm	S	A	Medium	Fair	20 21	Zone 22, 1 m around each manhole, Zone 20 inside Zone 22 1 m radius around EVP,	Zone 22, 1 m around each manhole, Zone 20 inside Zone 22 1 m radius behind EVP,	2215PJ-UE114-DR4-001	
6	H6514 Rotary Discharge vlave Flanged connections	DR4 Building Inside +13.3m	S	Table 8	60-80	Atm	S	A	Medium	Fair	21 22	Zone 21 inside Zone 22 0.5 m around flanged connections	Zone 21 inside Zone 22 0.5 m around flanged connections	2215PJ-UE114-DR4-001	
7	H6513 Product collection screw conveyor Manhole with position sensor Flanged Connections	DR4 Building Inside +12.9m	S	Table 8	60-80	Atm	S	A	Medium	Fair	20 22	Zone 22, 1 m around each manhole, Zone 20 inside equipment Zone 22 0.5 m around flanged connections	Zone 22, 1 m around each manhoel, Zone 20 inside equipment Zone 22 0.5 m around flanged connections	2215PJ-UE114-DR4-001	According to equipment spec Flanged connections are used
8	V6515 Extraction fan with exhaust duct Manholes with no position sensor Compensators Flanged connections	DR4 Building Inside +16.56m	S	Table 8	160-175	Low vacuum	S+G	A	Medium	Fair	22	Zone 22 inside equipment Zone 22 0.5 m around flanged connections Zone 22 0.5 m around Compensators Zone 22, 1 m around each manhole,	Zone 22 inside equipment Zone 22 0.5 m around flanged connections Zone 22 0.5 m around Compensators Zone 22, 1 m around each manhole,	2215PJ-UE114-DR4-001	Manhole zone generated reduced to 22 due to the fact the inside zone of the equipment is also 22
9	Exhaust Stack of dryer With exhaust shielding	DR4 Building Outside +35.85m	S	Table 8	160-175	Atm	S+G	N	Medium	Fair	22	Zone 22, 1 m around exhaust Outlet Zone 22 inside equipment	Zone 22, 1 m around exhaust Outlet Zone 22 inside equipment	2215PJ-UE114-DR4-001	
10	A6310 In-line Weigher Flanged connections Rotating	DR4 Building Inside +5.1m	S	Table 8	60-80	Atm	S	A	Medium	Fair	20 22	Zone 20 inside equipment Zone 22 0.5 m around flanged connections	Zone 20 inside equipment Zone 22 0.5 m around flanged connections	2215PJ-UE114-DR4-001	

Item no.	Release source		Flammable material					Ventilation			Hazardous area				
	Description	Layout Location	Release grade	Reference (Table 2)	Operating temperature and pressure		State	Type	Degree	Availability	Zone type 20-21-22	Zone extent, m		Drawing reference	Other relevant information and observations
					°C	barg						Vertical	Horizontal		
11	H6311 Rotary Discharge vlave Flanged connections	DR4 Building Inside +2m	S	Table 8	60-80	Atm	S	A	Medium	Fair	21 22	Zone 21 inside Zone 22 0.5 m around flanged connections	Zone 21 inside Zone 22 0.5 m around flanged connections	2215PJ-UE114-DR4-001	
12	H6320 Fluidizing Bed Flanged connections	DR4 Building Inside +1.5m	S	Table 8	60-80	Atm	S	A	Medium	Fair	20 22	Zone 20 inside Zone 22 0.5 m around flanged connections	Zone 20 inside Zone 22 0.5 m around flanged connections	2215PJ-UE114-DR4-001	
13	H6321 Rotary Discharge vlave Flanged connections	DR4 Building Inside +2m	S	Table 8	60-80	Atm	S	A	Medium	Fair	21 22	Zone 21 inside Zone 22 0.5 m around flanged connections	Zone 21 inside Zone 22 0.5 m around flanged connections	2215PJ-UE114-DR4-001	
14	F6321 Aspirated filter for fluidizing bed Flanged connection	DR4 Building Inside +2m	P	Fig. 12	60-80	Atm	S+G	A	Medium	Fair	21 22	Zone 21 inside filter cartridges Zone 22 on clean side Zone 22 inside fan	Zone 21 inside filter cartridges Zone 22 on clean side Zone 22 inside fan	2215PJ-UE114-DR4-001	Due to low volume of filter no additional zone extension is considered at fan outlet.

5. GENERAL REQUIREMENTS FOR THE SELECTION AND INSTALLATION OF ELECTRICAL EQUIPMENT IN HAZARDOUS AREA

In accordance with the identified Ex zones on the zoning plan, the equipment will be equipped with electric drives in explosion-proof protection. Additionally, all electrical equipment, devices used for automation and/or processing of electrical signals in hazardous areas, as indicated by the zoning plan, will have the appropriate type of protection both in terms of the hazardous area classification and the ATEX category.

The classification of the equipment (please refer to the equipment data sheets) shall comply with Directive 94/9/EC / HG 752/2004+461/2006, respectively, Group II equipment intended for use in places which may be exposed to explosive atmospheres, other than mines, Category 2, capable of operating according to the functional parameters established by the manufacturer and ensuring a high level of protection to function in areas where explosive atmospheres caused by gases, vapors, or mists (G) are likely to occur. The electrical equipment must be marked on the main part, in a visible location, and must include the following information:

- manufacturer's name or registered trademark;
- identification of the specific type provided by the manufacturer;
- the Ex symbol indicating that the electrical equipment complies with one or more types of protection;
- the symbol for each type of protection used;
- the group symbol, if the specific standard for the considered type of protection requires it;
- temperature class;
- a serial number;
- name or trademark of the certificate issuer;
- marking of the "X" symbol, if it is necessary to indicate special conditions for safe use;
- any additional marking prescribed for special conditions of safe use;
- any additional marking prescribed in specific standards.

5.1. CHOOSING ELECTRICAL EQUIPMENT IN HAZARDOUS AREAS

The equipment intended to be installed in classified areas is chosen in such a way as to reduce the probability of explosions caused by arcs, sparks, or hot surfaces generated during normal operation, as well as under specified fault conditions.

The electrical equipment and electrical cables that are intended to be installed in hazardous areas will be selected, installed, and verified based on the following criteria:

- classification of hazardous area;
- ignition temperature of conveyed gases or vapors;
- classification of gases and vapors;
- external influences.

Electrical installations and equipment in hazardous explosive atmosphere zones must comply with all requirements from the applicable standards and regulations.

Electrical equipment for potentially explosive atmospheres must adhere to the provisions of SR EN 60079-0:2020 and the specific standards of the protection type or types that formed the basis for the construction of the respective equipment.

For measurement and control equipment, except analyzers, only the "Ex i" type of protection shall be used.

In the design of electrical installations, the following considerations will be taken into account in addition to the requirements for installations in non-hazardous areas:

- implementation of an appropriate grounding scheme;
- potential equalization;
- reduction of static electricity effects to a safe level;
- reduction of lightning strike effects to a safe level.
- reducing the electromagnetic radiation effects to a safe level;

- providing means for disconnecting the electrical power supply to the hazardous area.
- Depending on the presence of the ignition source and the potentially explosive atmosphere, the types of protection are:
- types of protection that allow direct contact between the ignition source and the hazardous atmosphere (flameproof enclosure "d", intrinsic safety "i", non-incendive "nC")
- types of protection that do not allow direct contact between the ignition source and the hazardous atmosphere (oil immersion "o", pressurized enclosure "p", encapsulation in sand "q")
- types of protection that, by design, attempt to eliminate the ignition source under specified conditions (increased safety "e", non-incendive "nA")

Classification also represents a hierarchy of the level of security provided, where the type of protection in point 1 is the highest, and the type in point 3 is the lowest.

Electrical equipment shall be accompanied by the following documents:

- declaration of CE conformity;
- a CE type examination certificate issued by an authorized testing laboratory, bearing the certification mark.

5.2. CONCLUSIONS

The hazardous area classification presented in this document has been developed in accordance with the methodologies defined in, SR EN 60079-10-2/2020, and SR EN 1127-1/2019, which establish the principles for identifying emission sources, assessing ventilation, and determining the radius and extent of hazardous zones. The objective of this classification is to ensure full alignment with the requirements of the European ATEX Directive, including Directive 2014/34/EU for equipment and Directive 1999/92/EC for workplace safety. This evaluation provides the necessary foundation for selecting compliant equipment, establishing appropriate protective measures, and ensuring safe operation of the installation in environments where explosive atmospheres may occur. The analysis considered the physical and chemical properties of the flammable substances present, the technological configuration, ventilation availability, the type and grade of release sources, and the potential for both gas/vapor and dust-air explosive atmospheres.

The main conclusions are defined as follows:

- The identified explosion-hazard zones are consistent with the emission-source-based classification methodology and accurately represent the risks associated with the DR4 area.
- All zone types (20/21/22 for dusts) were determined using validated algorithms and graphical methods from the applicable standards.
- Most emission sources in the installation are secondary grade, typically originating from mechanical seals, flanged joints, hose connections, and rotating equipment. Consequently, Zone 22 designations predominate around transfer points.
- Primary emission sources are limited to equipment such as:
    - equipment within the starch drying system where dust clouds form as part of the normal process.
- These lead to Zone 21/Zone 22 (dust) classifications where appropriate.
- Dust-explosion hazard areas are primarily concentrated in the DR4 drying section, consistent with the characteristics of starch dust and adipic acid powder.
- Zone 20 is present inside cyclones, filters, and the drying column.
- Zone 21 and Zone 22 arise outside manholes, compensators, ducts, and around explosion-vent panels.
- Ventilation effectiveness is generally assessed as medium, with good availability in most buildings.
- The zone extents have been determined conservatively, considering both normal and abnormal operating scenarios.
- Temperature classes and explosion groups required for electrical equipment were established in accordance with the auto-ignition temperatures of the flammable dusts present. This

ensures that electrical surfaces cannot reach ignition temperatures under normal or fault conditions.

- Protection measures integrated into the design—including grounding, bonding, static-control systems, mechanical protection, explosion vents, spark detection, and use of certified Ex electrical equipment—are adequate to mitigate ignition risks and prevent escalation.

The document provides a reliable basis for:

- selection of ATEX-certified equipment;
- preparation of safety and compliance documentation;
- operational safety planning.

5.3. RECOMMENDATIONS

5.3.1. GENERAL RECOMMENDATIONS

Any of the hazards caused by the presence of dust layers should be considered separately from those caused by the formation of dust clouds.

Three risks are posed by the presence of dust layers:

1. The shockwave from a primary explosion inside a building might entrain the dust layers, forming dust clouds that can lead to secondary explosions, which are more destructive than the primary event. **Dust layers should be consistently controlled to mitigate this risk**.
2. Dust layers could be ignited by heat radiation from equipment over which layers have accumulated, potentially leading to a slow-burning process.
3. Even a thin layer of dust can be entrained into a dust cloud, ignite, and cause an explosion.

These risks depend on the properties of the dust and the thickness of the layers, influenced by the level of cleanliness. The potential of a dust layer to cause ignition can be controlled through **proper equipment selection** and **cleaning effectiveness**.

Changes to the dust layer's condition (e.g., moisture absorption) can reduce or eliminate the potential of entraining a dust layer into a dust cloud. In such cases, the risk of secondary explosion diminishes, and any fire risk might remain the same or be similarly reduced.

However, the cleaning frequency alone is not enough to determine whether a layer contains enough dust to pose an explosion risk. The rate of dust deposition has various effects. For instance, a secondary release source with a high deposition rate can create a dangerous layer much faster than a primary release source with a low deposition rate. Thus, both cleaning frequency and effectiveness are vital.

Three levels of cleanliness can be described:

- **Good**: Dust layer thickness is maintained at a negligible or non-existent level, regardless of release grade. In this case, the risk of an explosive dust cloud arising from deposited dust layers and the associated fire risk have been eliminated.
- **Acceptable**: Dust layers are not negligible but are short-lived (usually less than a work shift). The dust is removed, preventing the possibility of ignition.
- **Poor**: Dust layers are not negligible and persist for a prolonged period (usually more than a work shift). The risk of ignition and secondary explosion is significant.

Therefore, prevention of a poor level of cleanliness is essential, combined with conditions that could lead to the formation of a dust cloud from a dust layer.

5.3.2. SPECIFIC RECOMMENDATIONS AND MEASURES UNDERTAKEN

The following additional measures have been undertaken with the purpose of reducing explosive atmosphere zone extents:

- Segregation of Peeler centrifuge, Peeler centrifuge feed vessel and centrifuge backwash tank from the dry area of the dryer installation through a physical wall in DR4 building.
- Segregation of pneumatic transport blower, air cooler and condensate collection vessel from the dry area of the dryer installation through a physical wall in DR4 building.

The following recommendations are given to be considered for implementation but are not mandatory:

- The compensator on the main dryer column should be relocated above or below the centrifuge level if possible.
- Cleaning manholes for B6506-B6511 should be equipped with position sensors.
- Chemical barriers may be installed as an additional protection measure between cyclones and extraction fan or directly on the cyclones. However evaluation must be done by a certified chemical barrier supplier.
- Optimization of acces manholes to dryer for lance cleaning to maintain the good cleanability rating mentioned on chapter 5.3 as long as possible.

5.4. DESIGN CODE REFERENCES

The main normative references applicable to the design, construction, verification, and operation of electrical installations in hazardous areas are as follows:

- Legea 319/2006 a securității și sănătății în muncă actualizată în 19.03.2012 prin legea 51/2012, actualizată în 24.10.2012 prin legea 187/2012, actualizată în 20.07.2018 prin legea 198/2018;
- NP 099-04 Normativ pentru proiectarea, executarea, verificarea și exploatarea instalațiilor electrice în zone cu pericol de explozie;
- SR EN 60079-0:2020 Atmosfere explozive. Partea 0: Echipamente. Cerințe generale;
- SR EN 60079-2:2020 Atmosfere explozive. Partea 2: Protecţia echipamentului prin carcasă presurizată "p", destinat utilizării în atmosfere explozive gazoase sau atmosfere explozive cu praf.
- SR EN 60079-14:2024 Atmosfere explozive. Partea 14: Proiectarea, alegerea și construcția instalațiilor electrice;
- SR EN 60079-14:2024/AC:2016 Atmosfere explozive. Partea 14: Proiectarea, alegerea și construcția instalațiilor electrice – erata modifică paragrafele 9.3.1, 16.2.2 și 16.2.4.3 din SR EN 60079-14:2024 ;
- SR EN 60079-17/2024 Atmosfere explozive. Partea 17: Inspecția și întreținerea instalațiilor electrice;
- NP I7/2011 Normativ pentru proiectarea și executarea instalațiilor electrice la consumatori cu tensiuni până la 1000Vc.a. și 1500Vc.c;
- NFPA 652:2019 Standard on the fundamentals of combustible dust
- Legea 163/2016 privind calitatea în construcții;
- Legea 440/2002 privind calitatea lucrărilor de montaj pentru utilaje, echipamente și instalații tehnologice industriale.
- SR EN 60079-10/2020 „Aparatura electrică pentru atmosfere explozive gazoase. Partea 10: Clasificarea ariilor periculoase.”
- SR EN 60079-10-1:2020 - Atmosfere explozive. Partea 10-1: Clasificarea ariilor. Atmosfere explozive gazoase.
- SR EN 1127-1: 2019 - Atmosfere explozive. Prevenirea exploziilor şi protecţia la explozii. Partea 1. Concepte fundamentale şi metodologie.
- Îndreptar departamental de zonare a mediilor cu pericol de explozii şi măsuri de prevenire a acestora – MIP 1987.
- Normativ departamental pentru proiectarea şi executarea construcţiilor şi instalațiilor din punct de vedere al prevenirii incendiilor în industria chimică + MICh – 1979.

6. ANNEX A

Symbols and Units of Measurement:

LFL Lower Flammability Limit (vol/vol);

EVP Explosion Venting Panel