Session 13:

Fundamentals of Area Classification Studies

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1 Introduction

An accurate area classification study is of the utmost importance for selecting suitable explosion protected equipment by providing enough information and to ensure that the correct level of protection is afforded to render the plant safe without making everyday operations impractical.

The methodology as described in SANS 10108:2014 “The classification of hazardous locations and the selection of equipment for use in such locations” were used as basis for this paper.

2 Case study one – Surface gas or vapor handling plant (Gas Groups IIA; IIB and IIC)

In practice, the following 8 steps can be followed.

a. List the flammable materials.

A good starting point in obtaining this information is with the MSDSs (Material Safety Data Sheets) of materials present on the plant.

b. Select those present in significant quantities.

No.	Material	Composition	Relative density (air=1)	Flash point (°C)	LEL % (v/v)	UEL % (v/v)	Boiling Point (°C)	Vapour pressure at operating T (kPa)	Auto-ignition temperature (°C)	Material group[2]	Temperature Class[3] (°C)
1	Ethyl acetate	EA (COO-CH2-CH3.	>1	-4	2.2	11.5	77	-	460	IIA	T1
2	Pentanes	(Include Cyclopentane and mixed isomers).	>1	-40	2.2	7.8	36	57.9kPa (20°C)	258	IIA	T3
3	Sasol Natural gas	Mixture of Butane and Propane.	>1	Gas	5	17	-	-	537	IIA	T1
4	Paraffin	Kerosene as defined by SANS60079-20.	>1	38	0.70	5.0	-	-	210	IIA	T3

Enough information on flammable materials is provided in the example above to enable the reader of the final assessment report to select the equipment according to the gas group and temperature class of these materials as well as additional information to allow traceability of the material data and even guidance on the explosive concentrations to help with using gas sensors.

c. Determine sources of release.

The sources of release will typically be liquid surfaces, vents, sample points, pump shaft seals, spillage containment areas, material transfer points, etc.

The accurate identification of these will enable us to determine an accurate and specific zone around each release point.

d. Determine grades of release.

This section is calculated purely on how frequent explosive atmospheres are likely to be present. For the example of a spray booth that is frequently used, the spray gun nozzle will constitute a primary grade source of release and depending on the spray direction to a primary or secondary grade source release in the extraction ventilation system. The grade of the release will have the greatest influence on determining the Zone around the source of release.

As a guide the following relationship can be used:

Frequency of formation of explosive atmosphere	Total duration of explosive atmosphere
Continuous	>1 000 hours per year
Normal conditions (Primary)	>10 ≤1 000 hours per year
Abnormal conditions (Secondary)	>1 ≤10 hours per year (or from >0.1, in some literature)

e. Determine zones (0/1/2); i.e. areas where explosive atmospheres occur.

There is, in most cases, under unrestricted 'open air' conditions a direct relationship between the grade of release and the zone classification to which it gives rise;

- Continuous grade normally leads to Zone 0.
- Primary grade normally leads to Zone 1.
- Secondary grade normally leads to Zone 2.

This relationship is also described as:

Zone	Frequency of formation of explosive atmosphere	Total duration of explosive atmosphere
Zone 0	Continuous	>1 000 hours per year
Zone 1	Normal conditions (Primary)	>10 ≤1 000 hours per year
Zone 2	Abnormal conditions (Secondary)	>1 ≤10 hours per year (or from >0.1, in some literature)

The level of ventilation and its ability to dilute the flammable mixture is then considered to determine if the Zoning should be amended to a lower or higher Zone.

f. Size and Shape Zones.

This can be determined by using the direct examples such as the examples in SANS10108 or by calculating the volumes from suitable Standard documents. Equivalent release hole size diameters can for example be successfully used to calculate the extent of a zone around a pump shaft seal or vent diameter.

It is also advisable to recommend at this stage what measures can be taken to reduce the zones. Like to render areas zone 2 instead of zone 1 by employing additional ventilation or using deflection walls. This can significantly reduce the burden on maintenance and allow additional explosion protection techniques to be used in the area.

g. Rationalize, i.e. merge overlapping areas with the same zones and simplification of the zones.

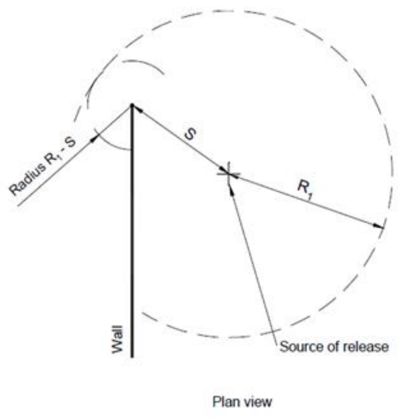
Representation of the assessment:

In an aim to provide enough information to select the appropriate equipment but also to capture enough information to make the assessment traceable the data is presented in a table form as shown below. Most of the information can however be ignored by the end-user who only needs to select and inspect equipment installed in the zoned areas (such information is stressed in **Bold**).

Equipment		SOR	Grade of release (C/P/S)	Flammable Material				Ventilation			Hazardous Area			Reference
ID	Item			Material No. (Gas Group; Temp. Class)	P (kPag)	T (°C)	State (S/A/B /C/G(i)/G(ii))	Type (N/A)	Degree (Open-air/ Adq/ Inadq)	Availa= bility (G/F/P)	Zone	Horiz (m)	Vert (m)	
Booth A and B														
1	**Spray gun**	**Spray gun nozzle.**	P	**1 (IIA; T3)**	5 000 (assumed maximum for spray gun)	Amb	C	N	A	G	**1**	**5** **Extend to include the interior of the booth.** **Use figure 6.2 below to extend beyond openings in the walls.**	**5**	IP 15 Table C9 with nozzle release hole size equivalent of 2mm.
2	**Spray gun**	**Spray gun nozzle.**	S	**1 (IIA; T3)**	5 000 (assumed maximum for spray gun)	Amb	C	N	A	G	**2**	**Interior of the extraction ventilation system.**		IP 15 Table C9 with nozzle release hole size equivalent of 2mm, (dilution from ventilation expected).

Interior of room where zoning is interrupted by the walls, also refer to figure 6.2 (below) for openings in such walls, R1 is the zoning as indicated in the tables above.

IP 15 Figure 6.2.



Notes:
1. R_1 is the hazard radius obtained from Chapter 5.
2. The wall should extend to at least the full vertical height of the hazardous area if it is to be used as a deflection wall.
3. S is the shortest distance from the source to the edge of the retaining wall.

Figure 6.2 Extent of hazardous area around wall producing sheltered area

h. Determine Equipment Protection Level (EPL).

A direct correlation exists between the EPL and the Zonings. For above example (under g.) an EPL of Gb would normally be acceptable in all the indicated zones due to the fact that poor discipline might lead to a more frequent explosive atmosphere being present in the indicated Zone 2 area and also to simplify the stock keeping of backup electrical equipment.

Zone	Minimum Equipment Protection Level (EPL)
0	Ga
1	Gb
2	Gc
20	Da
21	Db
22	Dc

Alternatively, the EPL is determined using the *risk-based method*.

3 Examples of the "old" approach to area classification.

Usually most of the report will consist of general standards and definitions. Very often plants are/were also over classified with large "block" type zoning that led to huge cost implications and impractical arrangements such as zones extending into roads or nearby parking areas originally not considered safe areas. Far too often zones are so conservatively large that burner systems end up in zoned areas.

The following is an example of this outdated type of classification:

APPENDIX A

HAZARDOUS AREA CLASSIFICATIONS

1	Ammonia Bulk Store	Safe Area (comply To OHSAct)
2	Ammonia/Caustic/Acid off Loading bay	Safe Area (comply To OHSAct)
3	Chemical make-up Tank Room	Safe Area (comply To OHSAct)
4	Battery rooms	Zone 2
5	Diesel/Fuel oil/Dirty oil bulk storage tankes	Zone 2
6	FRF/ Turbine Lube Oil room	Safe Area (comply To OHSAct)
7	Fuel Oil Pumps	Safe Area (comply To OHSAct)
8	Generator seal oil Plant	Zone 2
9	H2 Detraining Tanks	Zone 2
10	H2 Plant	Zone 2
11	Laboratory (Damp cupboards)	Zone 1
12	Lab Gas Store	Zone 2
13	LP Gas Storage Tank	Safe Area (comply To OHSAct)
14	Milling Plant/ Cable Racks/ Coal Plant	Zone 22
15	Oil Store	Safe Area (comply To OHSAct)
16	Paint store	Zone 2
17	Petrol Pump Station	Zone 1/ Zone 2
18	Spray Booth	No Spray booth (Zone 1)
19	Unit Diesel Generator Supply Tank	Zone 2
20	Unit H2 Distribution	Zone 2
21	Sewage Plant	Not classified
22	Diesel tanks (coal stock yard & Ash disposal)	Not classified

Please feel free to try and select equipment such as a level transmitter to be used <u>inside</u> the diesel tank as described under line 19 above. In addition the pages leading up to this “Annex A” did not contain much useful information.

4 Case study two – Surface flammable dust handling plant (Material Groups IIIA; IIIB and IIIC)

For ***dust*** explosive atmospheres, typical examples as well as sources of release are considered.

a. List of flammable materials

The MSDS will normally have little information on flammability and explosivity. SANS10108 can be used to obtain typical values but cardinal properties to find are:

a. Is the dust flammable (silica is not!)

b. What is the cloud ignition temperature?

c. What is the smouldering temperature?

d. Is it conductive or non-conductive.

b. Select the flammables present in significant quantities

For example:

No.	Material	Composition	Relative density (air=1)	Flash point (°C)	LEL % (v/v)	UEL % (v/v)	Boiling Point (°C)	Vapour pressure at operating T (kPa)	Auto-ignition temperature of dust cloud (T_{cl} in °C)	Material group	Dust smoulder temperature, (T_{5mm} in ˚C)
1	Bituminous coal (typical)	Dust particles	>1	-	-	-	-	-	580	IIIC	225

c. Determine sources of release and determine grades of release

Pointer: Dust must be in suspension (must form dust clouds) to explode.

Examples are a mill interior, a pneumatic transport system (internal), a dust extraction system (internal) or a bag filling operation (external).

The lower explosive limit/concentration for dust-air mixtures is generally between 30 and 40 g/m3. A useful rule of thumb is that a dust cloud is explosive if a 40W incandescent lamp is invisible to the eye at a range of 3m. Loosely translated, this means that the dust cloud is dense enough to prevent normal human operation in the area.

Clearly in the photos below there is dust present on the plant but does it get suspended to form explosive atmospheres or should the maintenance and housekeeping be upgraded? To get to the answer we have to assess the process at the plant and one can use this as a guide that if a 40W light is invisible over 10m there is likely to be an explosive atmosphere...If not the area should not be zoned but treated as a fire hazard. In the past very often these areas were zoned a Zone 22 or Zone 21 with dire consequences.

The inside of the transfer equipment in this photo should be considered to be a Zone 21 or even 20 depending on the frequency of use and particle size of the dust.

d. Determine zones (20/21/22) and the size and shape of zones

Pointer: Unlike gases, the zones for dusts are best determined following the "Cremora" rule: If the dust clouds are inside, it is a Zone 20. If the dust clouds are outside, it is a Zone 21. If there are dust layers on top of equipment that may be suspended (or rather that could get suspended) due to known disturbances, it is Zone 22. Note that this is a broad approach and not a hard-and-fast rule.

If one take a simple typical grain silo complex for example:

Grain is offloaded into a hopper, transferred by closed chain conveyers to a bucket elevator and ultimately into the silos.

i. Offloading can suspend a fair amount of dust but the 40W "rule" (guide) does NORMALLY not apply outside the intake hopper therefore Zone 21 is expected inside the hopper only with a Zone 22 in the immediate surroundings (but normally not very far).

ii. The closed transfer system is expected to suspend dust for extensive periods in enough quantities therefore Zone 20 or 21 is assigned for the interior of transfer equipment and the inside of the Silo.

iii. The tunnels and rooms where the transfer equipment is housed can be a Zone 22 if dust layers form that is frequently disturbed but if proper housekeeping is introduced this can be rendered a fire hazard or even a safe area in most cases.

5 Conclusions

An incorrect area classification can have a huge financial impact on a company causing the company to incur unnecessary costs and causing the company to make incorrect "upgrades". In addition, an incorrect area classification can render a plant unsafe by allowing unprotected equipment to enter explosive atmospheres.

The area classification assessment report, together with an accurate area classification drawing, is by far the most important starting point towards successful explosion prevention. However, it is unfortunately too often neglected, left for incompetent individuals to do or even misused by especially electrical contractors, for financial gain.

6 References

a. SANS 10108:2014 "The classification of hazardous locations and the selection of equipment for use in such locations".

b. Edition 3: 2005 of Part 15 of the IP Model Code of Safe Practice in the Petroleum Industry, "Area Classification Code for Installations Handling Flammable Fluids", IP 15 for short.