Hazardous Area Classification

Introduction

Fire, **Explosions** and **Environmental Pollution** are the most serious “unpredictable "issues affecting life and business losses in the hydrocarbon and chemical industries today.

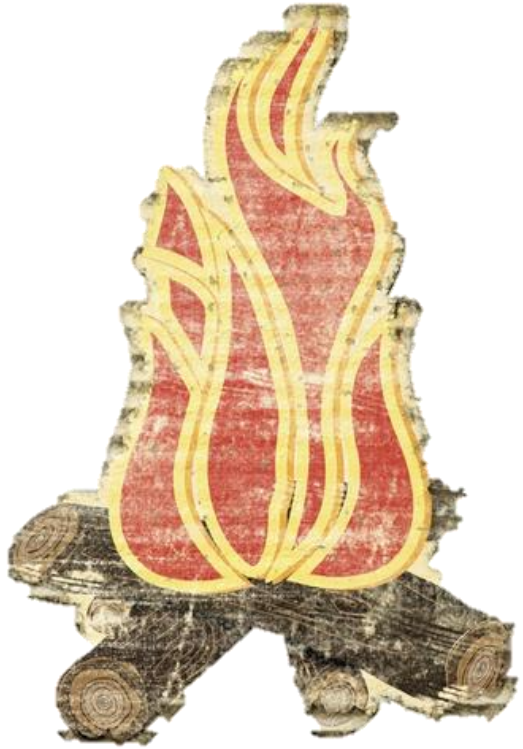
Fire and Explosion Fundamentals

- What is Fire?
- Flammable Hazardous Material
- Fire Triangle and Fire Tetrahedron
- What is an Explosion?
- Properties of Hazardous Materials

What is Fire?

Fire

Is a rapid oxidation process which is a chemical reaction resulting in the evolution of heat and light.



Flammable or hazardous material

- Flammable Material can be **gas , vapor , liquid or solid** that can react continuously with **oxygen** and may result in fire or explosion.

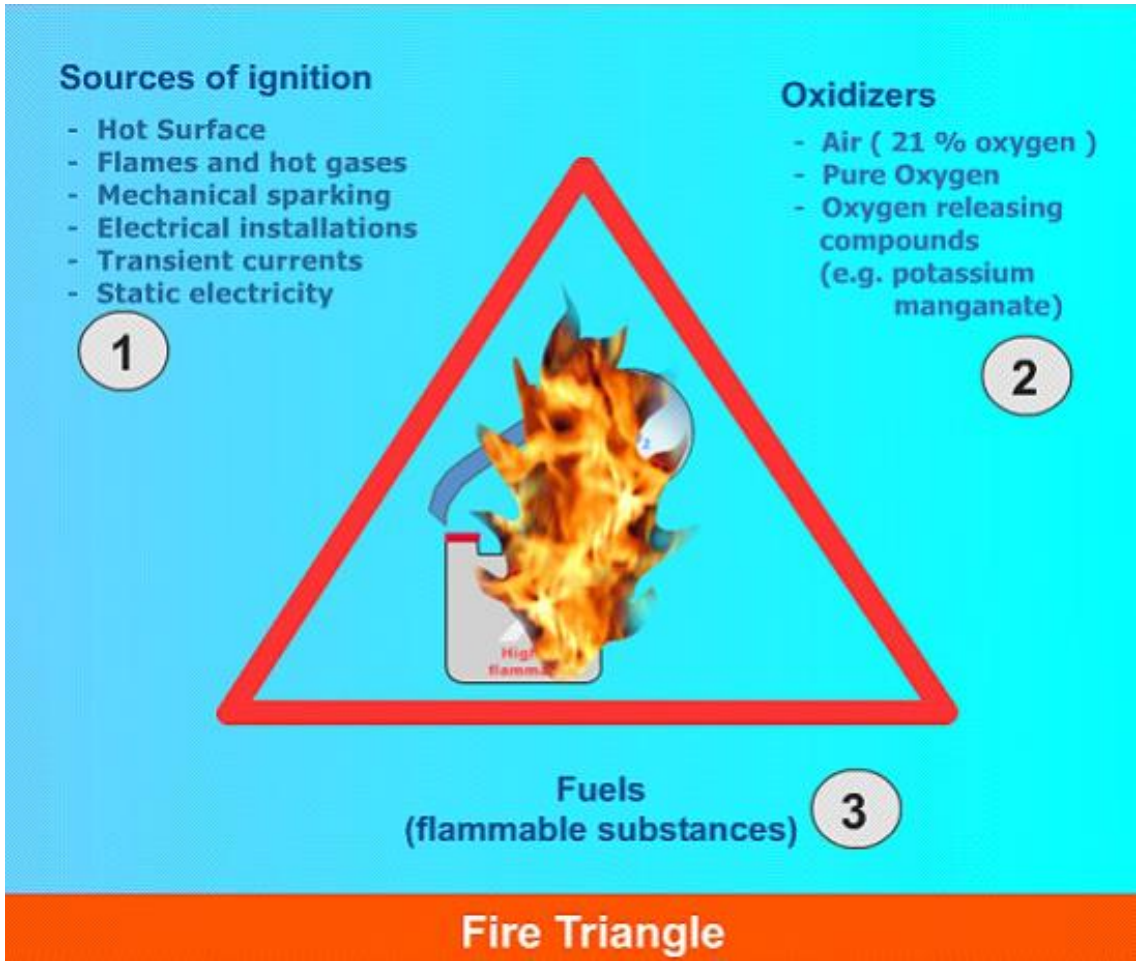
- This reaction can be initiated by **Spark** or **Hot Surfaces**

- **Flammable Materials can be:**
  - Flammable vapors generated by liquid
  - Flammable Mists
  - Flammable Gases
  - Combustible Dusts

Fire Triangle

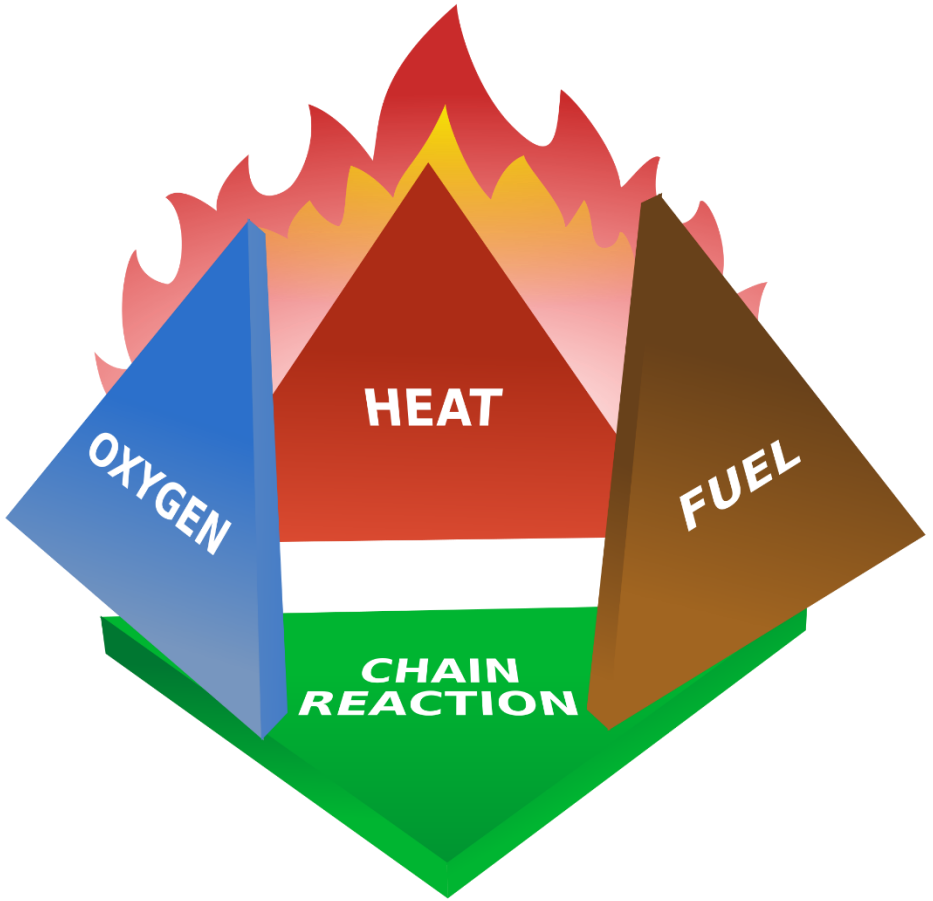
- **Fuel**
- **Heat**
- **Oxygen**

All three elements must be present to initiate a fire.



Fire Tetrahedron

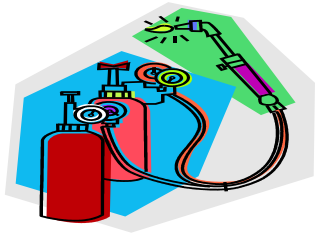
- Fuel
- Heat
- Oxygen
- Chemical reaction



Fire Tetrahedron

FUEL

May be the combustible material. Can be solid ,liquid or gas



OXIDIZING AGENT (O2)

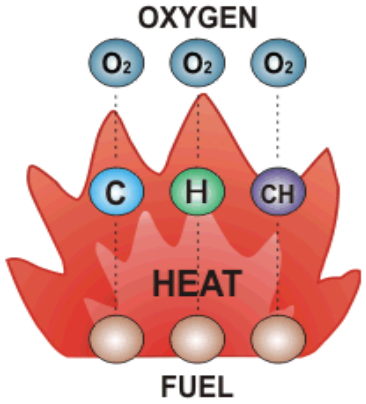
Those materials that yield oxygen or other Oxidizing gases during the course of a chemical reaction.

HEAT

Heat is the energy component needed to increase the fuel's temperature to the point where sufficient vapors are produced for ignition to occur.

CHEMICAL CHAIN REACTION

The chemical chain reaction known as fire occurs when fuel, oxygen and heat are present in the right conditions and amount.



What is an Explosion?

Explosion

is an uncontrolled release of energy accompanied by a sudden and violent expansion of gases and possibly rapid combustion of any flammable materials present.

Explosion


Factor
La zona donde ocurrió el siniestro se extrae y procesa
gas natural obtenido en la Cuenca de Burgos.

Properties of Hazardous Materials

Flammability Range

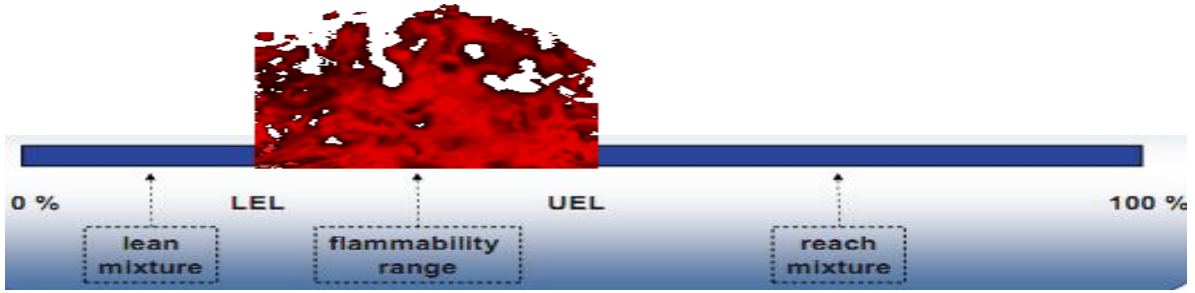
The minimum or maximum concentration of gas in air that will ignite.

Lower Flammability Limit

The lowest concentration at which a fuel/air mixture will burn. Below this there is too little fuel (the mixture is too lean)

Upper Flammability Limit

The highest concentration at which a fuel/air mixture will burn. Above this there is not enough oxygen (the mixture is too rich)



Fuel	LEL - LFL %	UEL - UFL %
Motor Gasoline	1.6	7
Kerosene	0.7	7.5
Propane Gas	2.2	9.5
Butane Gas	1.9	8.5
Hydrogen Gas	4	75
Acetylene	1.5	82
Methanol	6	36.5
Ethanol	3.3	19
Ammonia Gas	15	28
Carbon Monoxide	12.5	74

Properties of Hazardous Materials

Flash Point

The minimum temperature to which a liquid fuel gives off sufficient vapor that can be ignited momentarily by a flame.

Fire Point

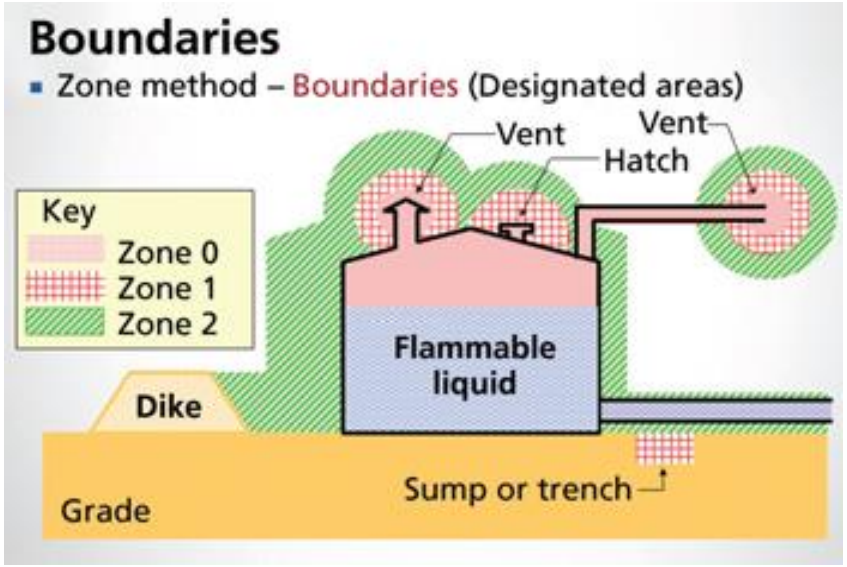
The minimum temperature to which a liquid fuel gives off sufficient vapor to support continuous combustion.

Auto Ignition Temperature

The minimum temperature at which a liquid fuel will ignite without the presence of a pilot flame or spark.

What is Hazardous Area?

The area in which an explosive gas atmosphere **present or likely to be present** in quantities such as to require specific precautions for construction, installation and use of electrical apparatus**.**



What is Hazardous Area?

HAC is Defined by three main criteria:

- Type of the hazard (gas , vapor, dust, fibers)
- Likelihood of the hazard being present in flammable concentrations
- The Auto Ignition Temperature of the hazardous temperature.

Why do we classify Hazardous Areas?

- If proper area classification and safety engineering practices are followed while working in those areas we can greatly reduce the **risk of fire and explosions hazards** in these places.

- All electrical equipment produce **energy in the form of sparks** which can ignite these hazardous materials and or cause explosions causing catastrophic damage .

- In hazardous area we use special purpose explosion protected electrical equipment and instruments.

Concept of Classification

- Hazardous Area Classification is to be done for the areas of the plant that would have instances of flammable mixtures of vapors ,gases or dusts in normal day to day operations.

- Under unusual conditions like a catastrophic accidental release of large quantity of inflammable which are not easily predictable.

- Under usual day to day operational conditions in the plant or facility there are some areas which would have the presence of flammable mixtures of vapors and gases e.g.. Vapor space in the storage tank, around a mechanical seal of a pump , the area around surrounding the breathing valve on the storage tank.

Basic concepts

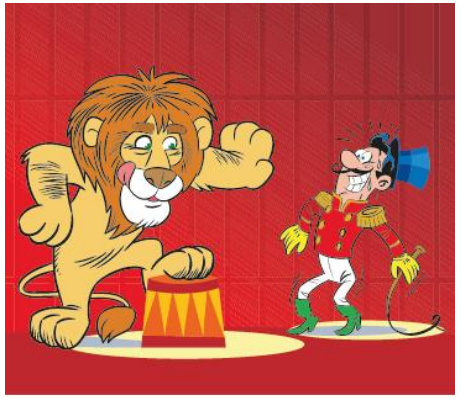
- What is Hazard?
- What is Risk?
- Can we avoid the risk altogether?
- Area classification – a measure of the risk
- Area classification benefits.
- How does Area Classification work?
- How can area classification reduce the costs?

HAZARD & RISK

Hazard

is the source of potential damage, harm or adverse health effects. A hazard can exist without incurring any harm.

HAZARD – Exists without doing harm



RISK – Only when exposed to hazard

NO EXPOSURE: NO RISK

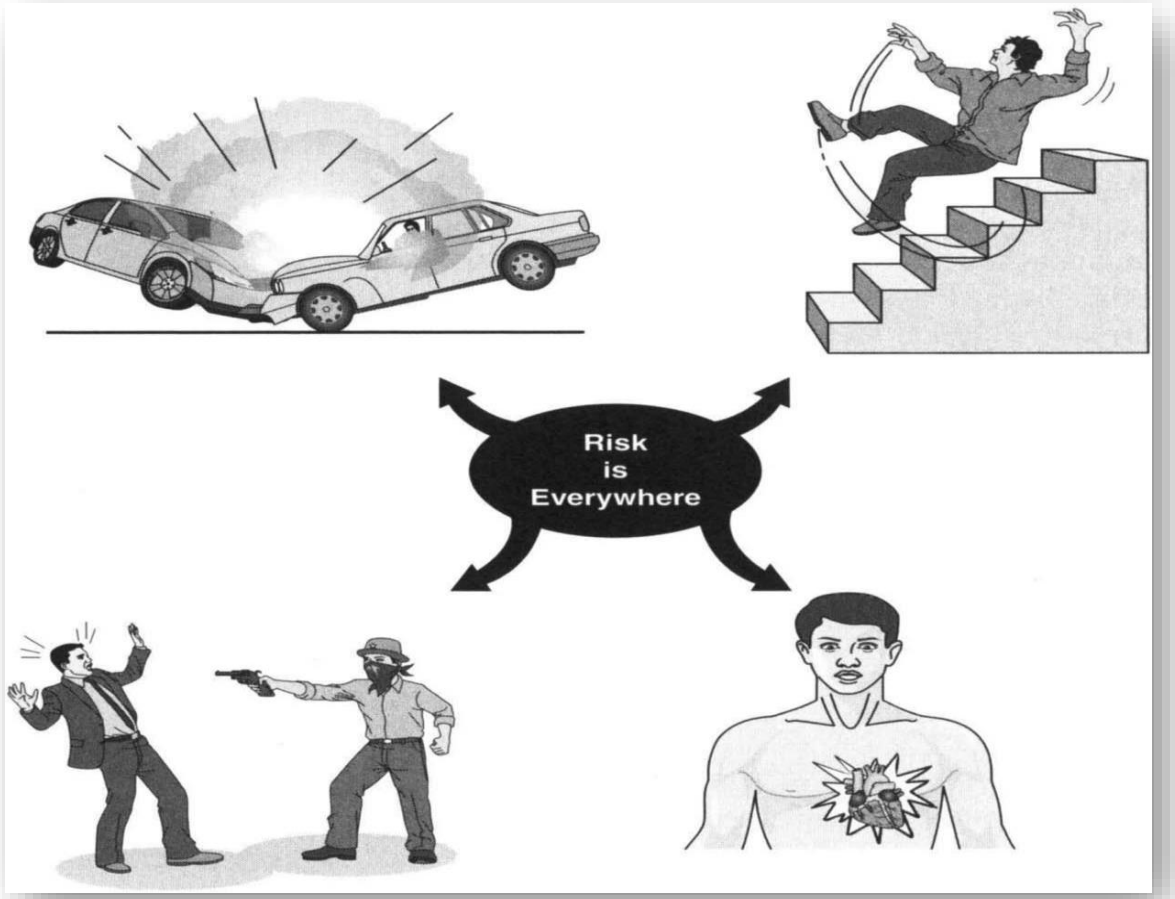
What is the risk?

- Is the measure of likelihood that the undesired event or accident will actually occur

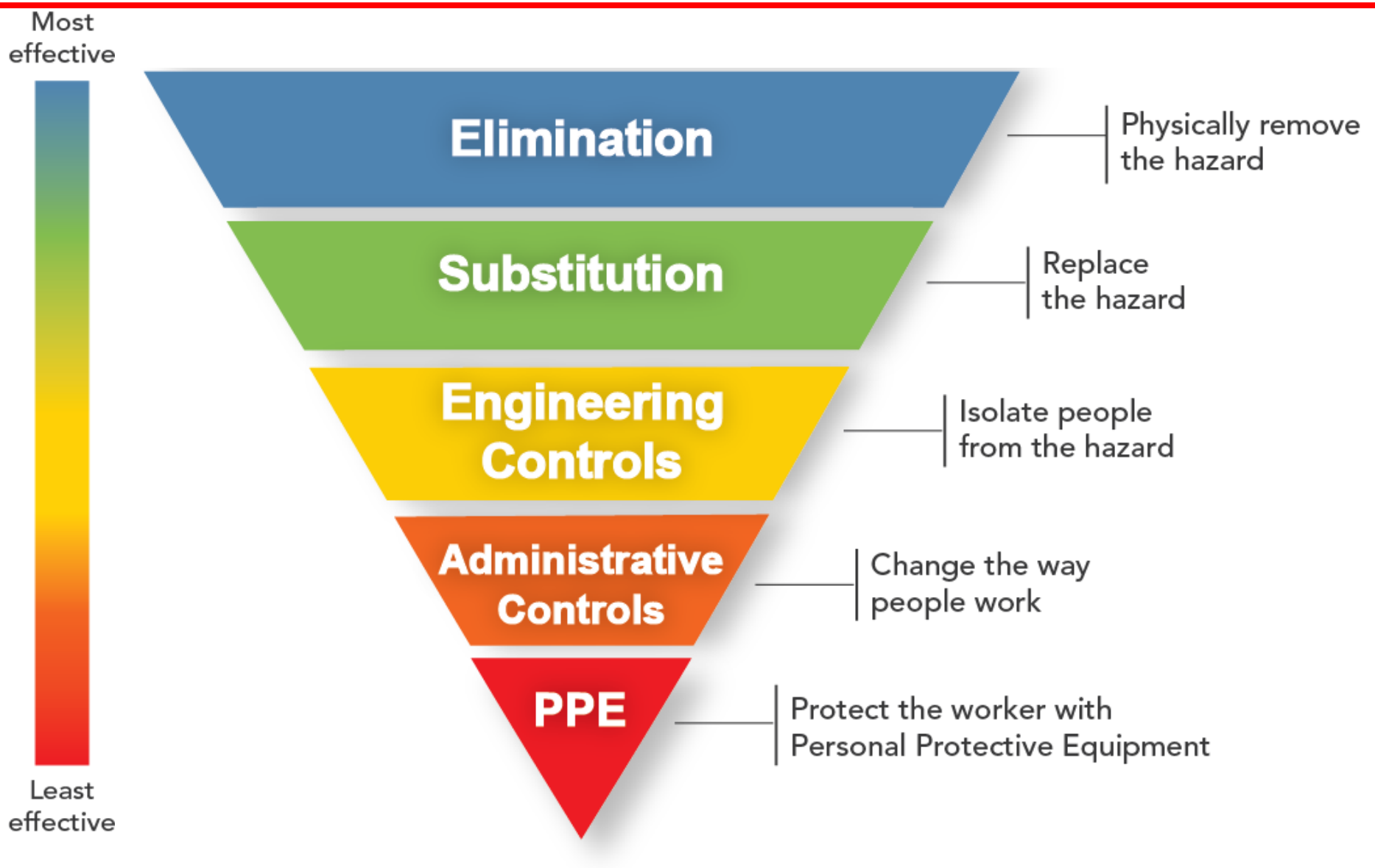
Thus **Risk= (Probability of Occurrence) X (Severity of Consequence).**

Can we avoid the risk altogether?

- **It is not possible in the world without some amount of risk**



Hierarchy of Control



Can we avoid the risk altogether?

- Since we **cannot avoid the risk** we can manage it in a logical way.
- Since we have no control over the **severity of the consequence** , we reduce the other factor in the risk equation which is the **probability of the occurrence**.
- In the same way we manage the risk of handling and storing large amounts of flammable and explosive materials by **area classification which reduce the probability of the materials catching fire or explosion.**

Area classification - A Measure of the Risk

- **Hazardous Area Classification** provides a profile of the risk of explosion in these areas.
- It Cannot predict definitively that an explosion will or will not take place in that area.
- It only segregates the plant areas into areas where the likelihood of an explosion is high and areas where the likelihood is low or improbable.
- The classification provides us a tool to mitigate the risk of explosion in such areas.

How Does Area Classification Works ?

- **Identify** which areas of the plant are more hazardous and need special attention or equipment.
- **Identify** areas of the plant carry more risks than others.
- **Area classification** allows the operations managers to mitigate these risks by taking appropriate safety measures in each identified areas and reduce the overall risk of the facility
- **Design** operations , material and staff movement to restrict access to these areas and have special work procedures for these areas.

Area Classification Benefits

- Give us a **risk profile** of the plant or facility to enable us to **operate it safer**
- Enables **top management** to really understand the **real risk** of the facility and then come up with **appropriate strategies to mitigate the risk**.
- Enable us to **design and install electrical instrumentation and control system** equipment that will not cause **fires or explosions at the optimum cost**
- **Reduce the costs of compliance** to regulations and standards without compromising on the safety
- Make the **overall operations safer and more profitable**

How Area Classification Reduce Costs?

- **It tells us what kind of equipment can be used in the area and what type cannot be used.**

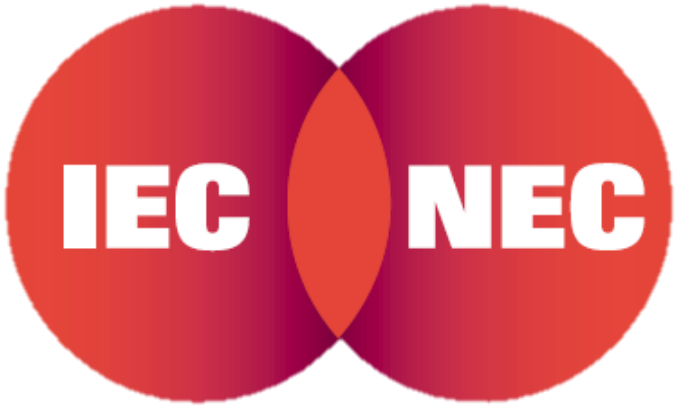
- **Put explosion** protected electrical equipment designed for use only in certain area.
- The equipment **carry marking which** tells weather it can be used or not.
- Based on this it will be safely use the equipment in that area **without any worry.**
- There would be some electrical equipment and instruments that are suitable for **use only in zone 2** whereas certain other types can be used safely **in zone 1**

Standards for Area Classification

- European System /**IEC** System (**Zones & Groups**)
- North American System (**NEC**) (**Classes & Divisions**)

IEC : **I**nternational **E**lectrotechnical **C**ommittee.

NEC : **N**ational **E**lectric **C**ode.



Standards for Area Classification

European System /IEC System

- The European System is based on **zones**

- Every **Hazardous Area** is broken up into different **zones** based on the likelihood of a hazardous gas/vapor mixture being present.

European System /IEC

WHAT IS A ZONE?

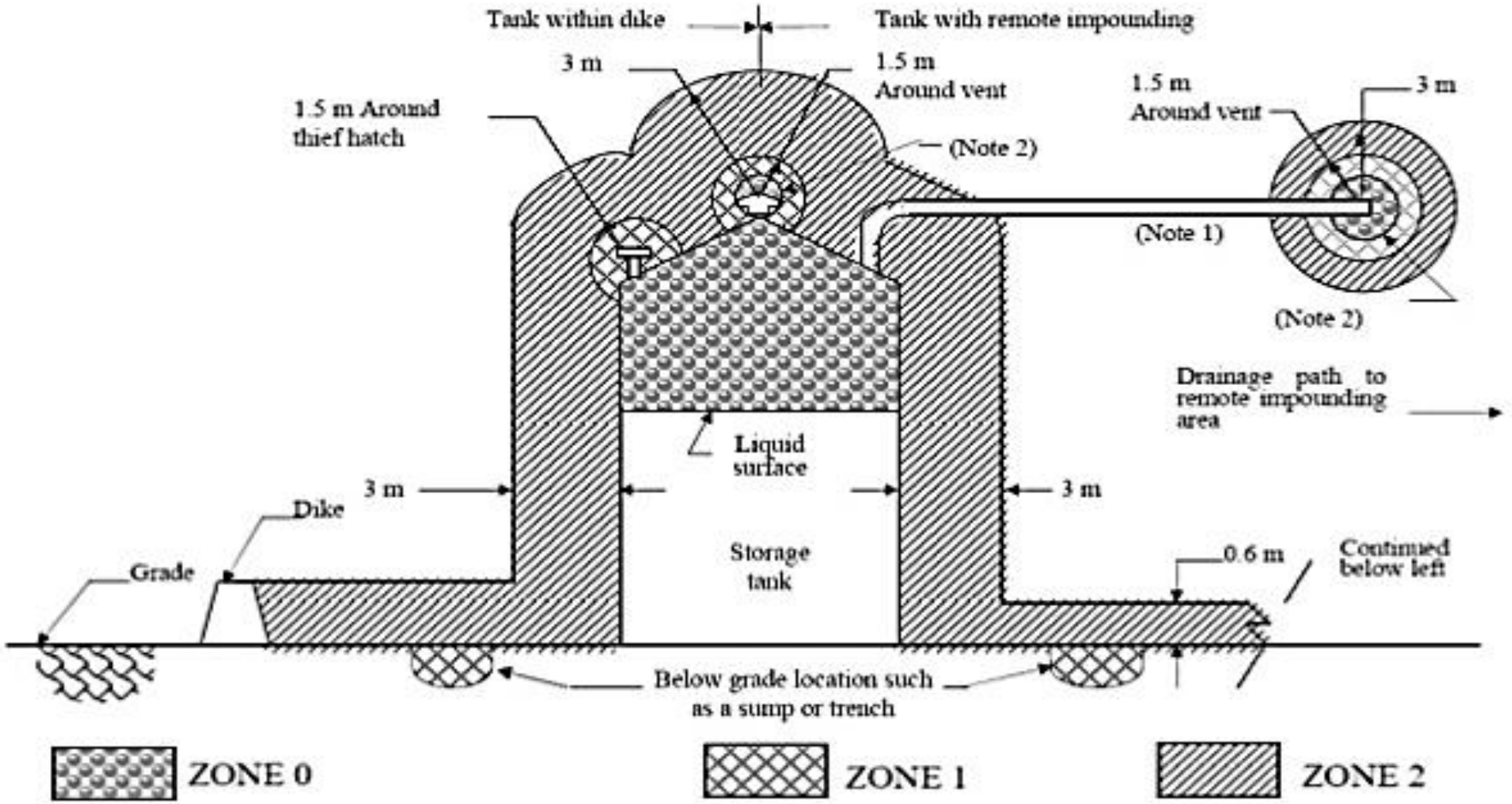
THE IEC HAS DEFINED 3 AREAS OF HAZARDOUS GAS OR VAPOR RELEASE AS FOLLOWS:

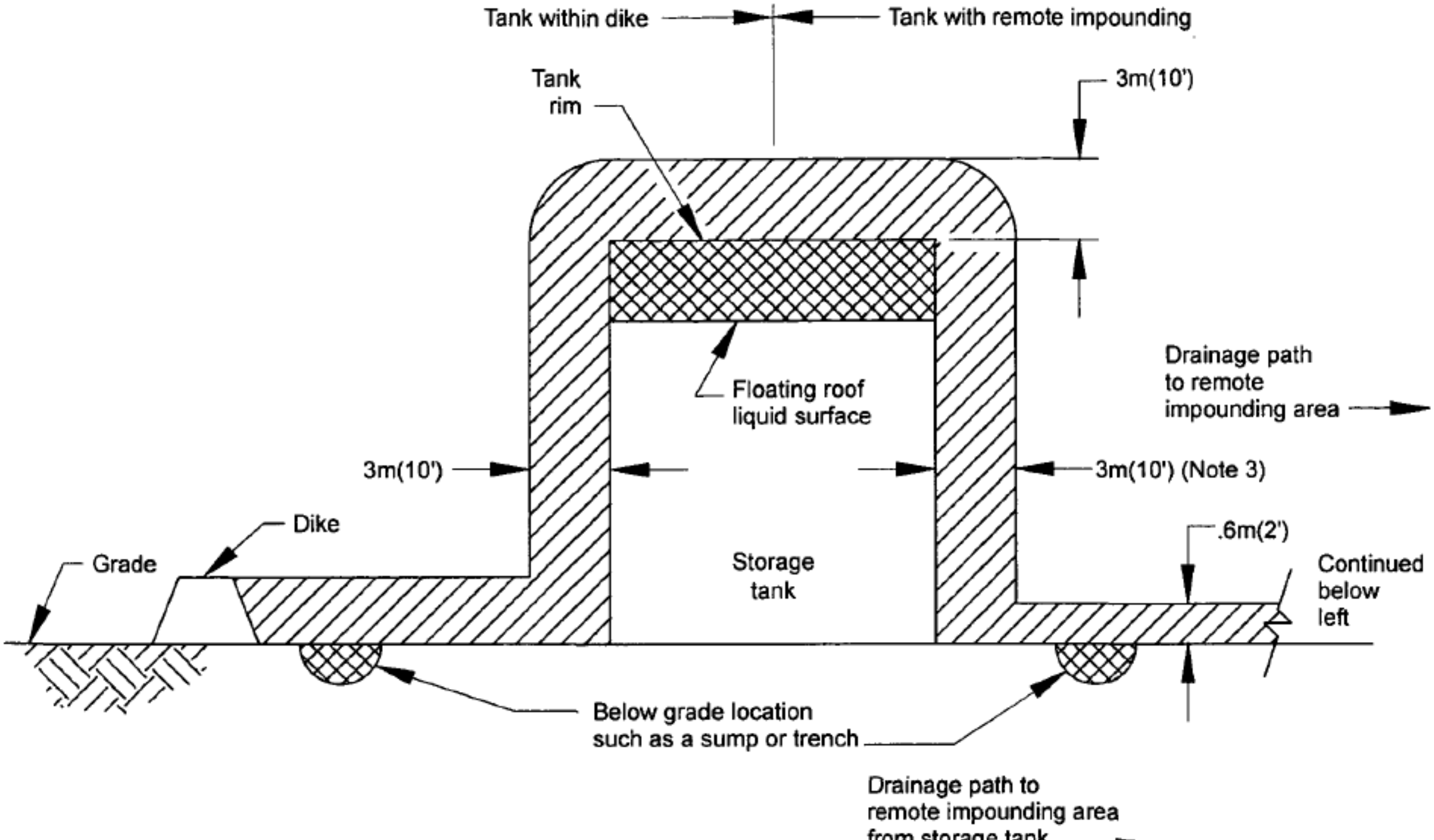
ZONE 0	ZONE 1	ZONE 2
Explosive Atmosphere Is Continuously Present	**Explosive Atmosphere Is Often Present**	**Explosive Atmosphere May Accidentally Be Present**
Zone in which an explosive mixture of gas, vapor or mist is continuously present.	Zone in which an explosive mixture of gas, vapor or mist is likely to occur during normal operation.	Zone in which an explosive mixture is not likely to occur in normal operation, and if it occurs will only exist for a short time (leaks or maintenance).

European System /IEC

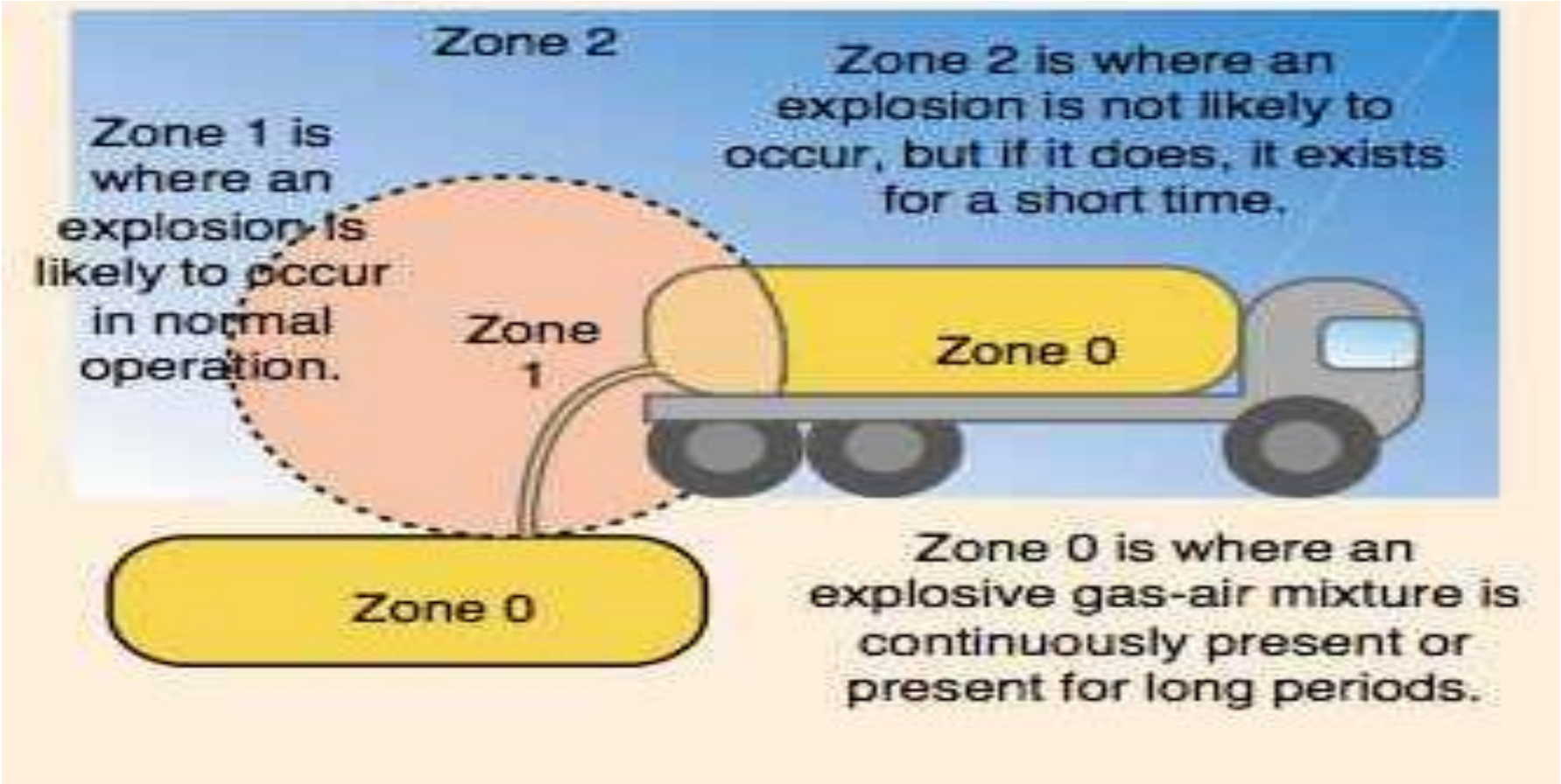
Condition	Time of exposure	IEC Zone	Degree of hazard
An area in which flammable mixtures of gases or vapors with air are present continuously, or for long periods of time	>1000 hours per year	Zone 0	High
An area in which flammable mixtures of gases or vapors are present intermittently	10 to 1000 hours per year	Zone 1	Medium
An area in which flammable mixtures of gases or vapors are present rarely and for short periods of time	<10 hours per year	Zone 2	Low

Examples




Tank within dike
Tank with remote impounding
Tank rim
3m(10')
Floating roof liquid surface
Drainage path to remote impounding area
3m(10')
3m(10') (Note 3)
Dike
Grade
.6m(2')
Storage tank
Continued below left
Below grade location such as a sump or trench
Drainage path to remote impounding area from storage tank

Examples

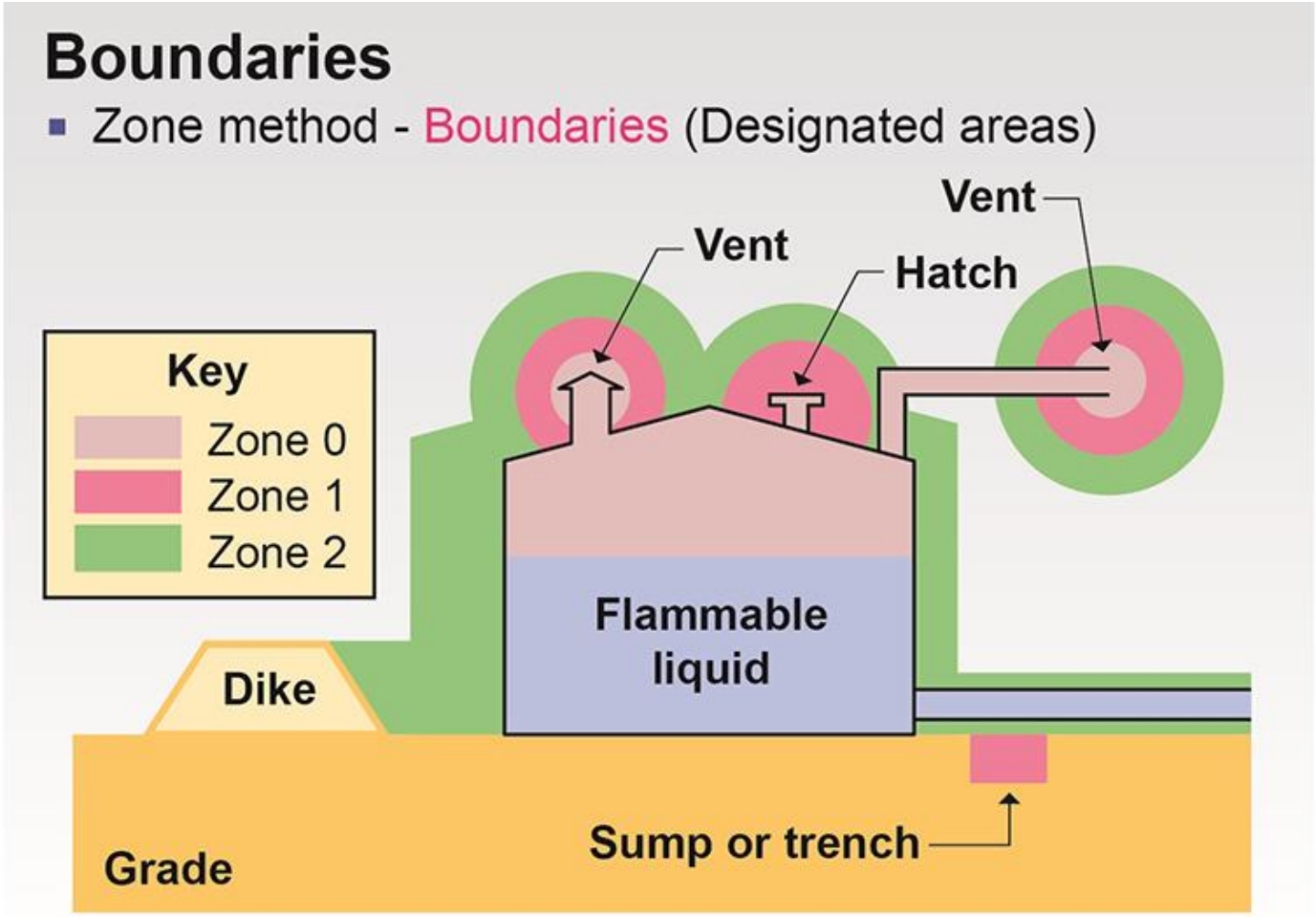

Zone 2
Zone 2 is where an explosion is not likely to occur, but if it does, it exists for a short time.
Zone 1 is where an explosion is likely to occur in normal operation.
Zone 1
Zone 0
Zone 0
Zone 0 is where an explosive gas-air mixture is continuously present or present for long periods.

European System (ZONES)

For gases and vapours and dusts and fibres there are three zones:

Gas	Dust	Hazardous Area Characteristics
Zone 0	Zone 20	A hazardous atmosphere is highly likely to be present and may be present for long periods of time (>1000 hours per year) or even continuously
Zone 1	Zone 21	A hazardous atmosphere is possible but unlikely to be present for long periods of time (>10 <1000 hours per year
Zone 2	Zone 22	A hazardous atmosphere is not likely to be present in normal operation or infrequently and for short periods of time (<10 hours per year)

ZONES(CONT.)


Boundaries
Zone method - Boundaries (Designated areas)
Vent
Vent
Hatch
Key
Zone 0
Zone 1
Zone 2
Flammable liquid
Dike
Sump or trench
Grade

ZONES(CONT.)

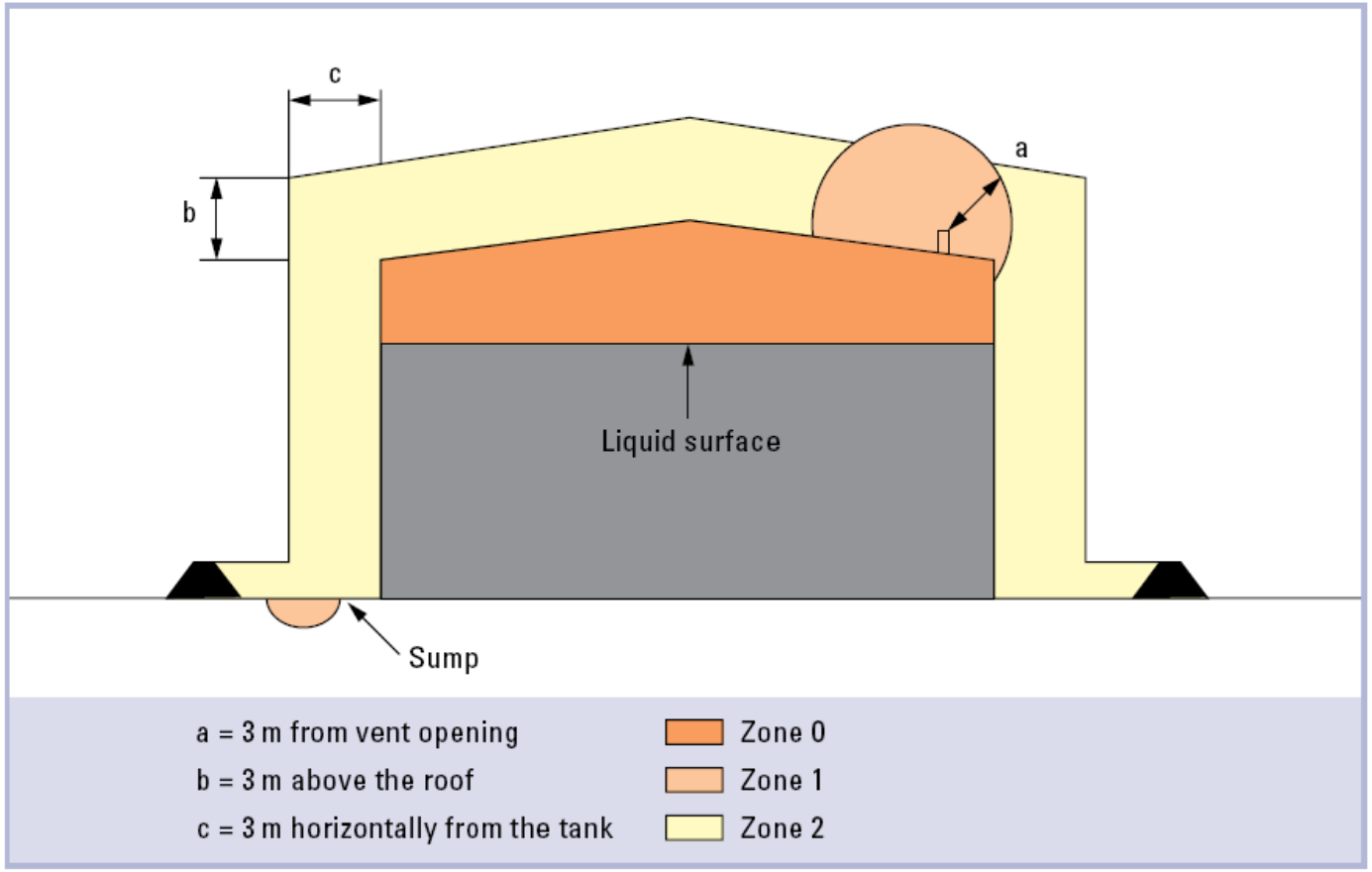


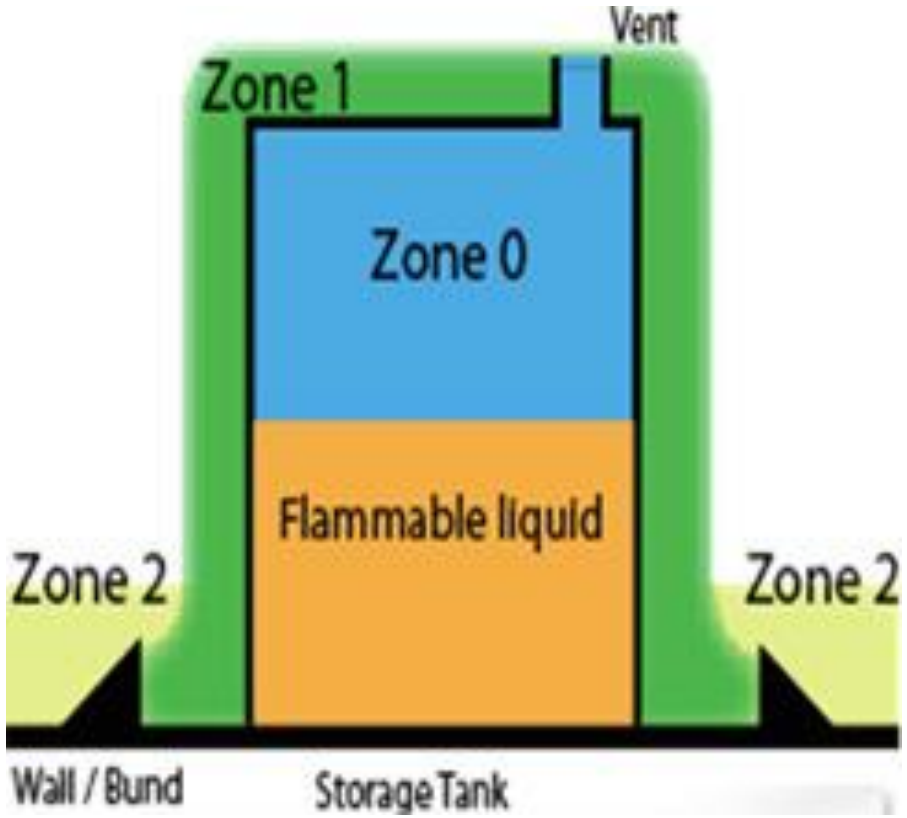
Figure 1: Example no. 8 of IEC 60069-10-1, flammable liquid storage tank, situated outdoor, with fixed roof

ZONES(CONT)

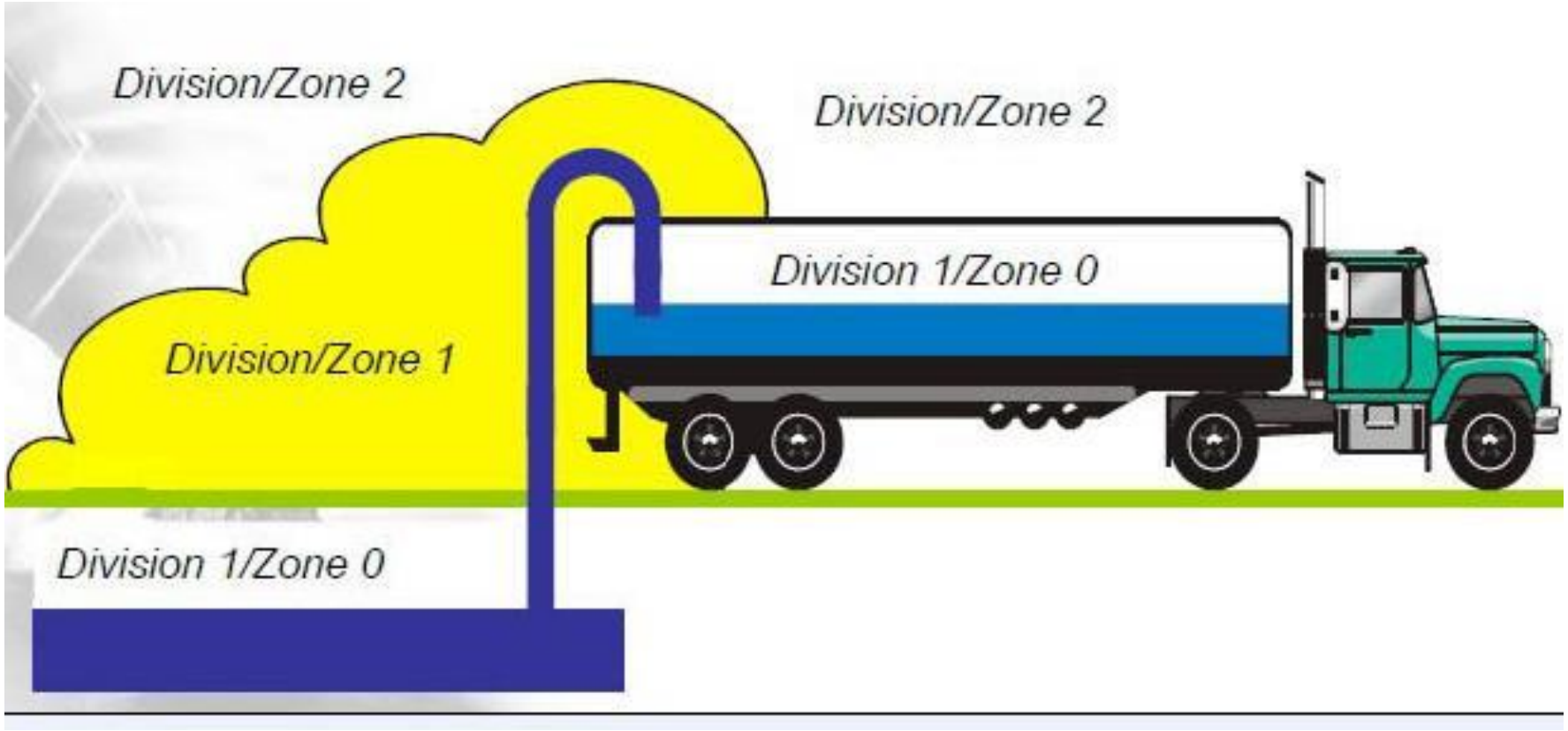
Typical Zone designation.

Zone 0 is inside the vented tank and near the vent.
Zone 1 is a perimeter around the vent.
Zone 2 is the area outside the tank.

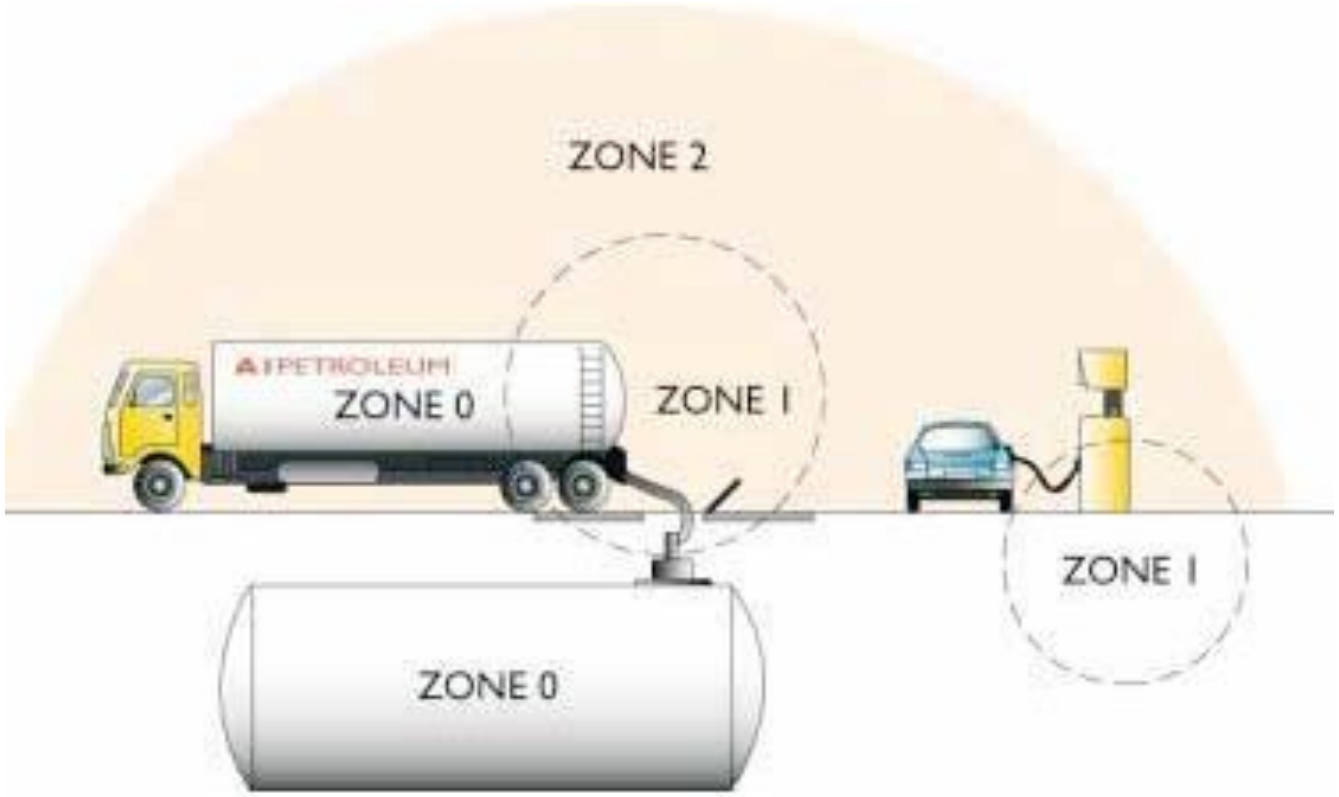
ZONES(CONT.)


Vent
Zone 1
Zone 0
Flammable liquid
Zone 2
Zone 2
Wall / Bund
Storage Tank

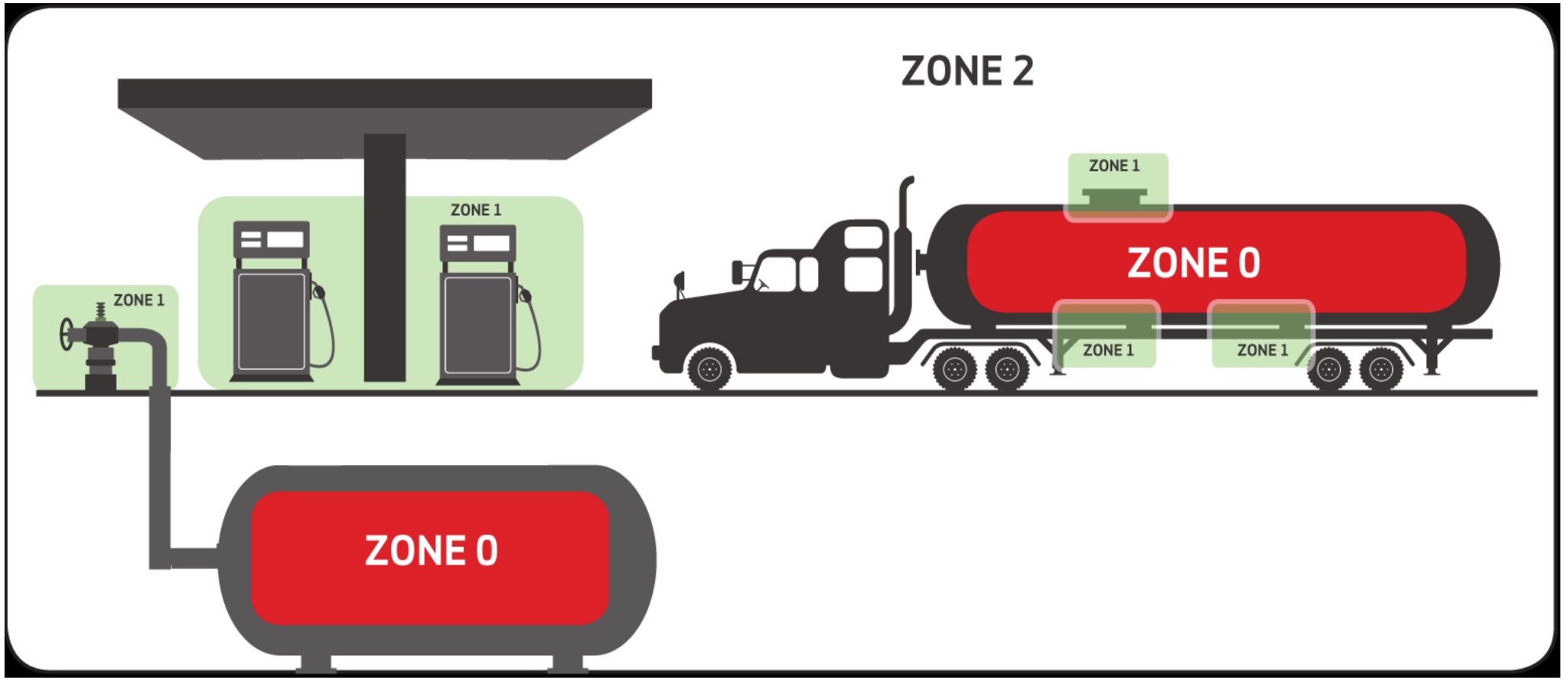
ZONES(CONT.)


Division/Zone 2
Division/Zone 2
Division 1/Zone 0
Division/Zone 1
Division 1/Zone 0

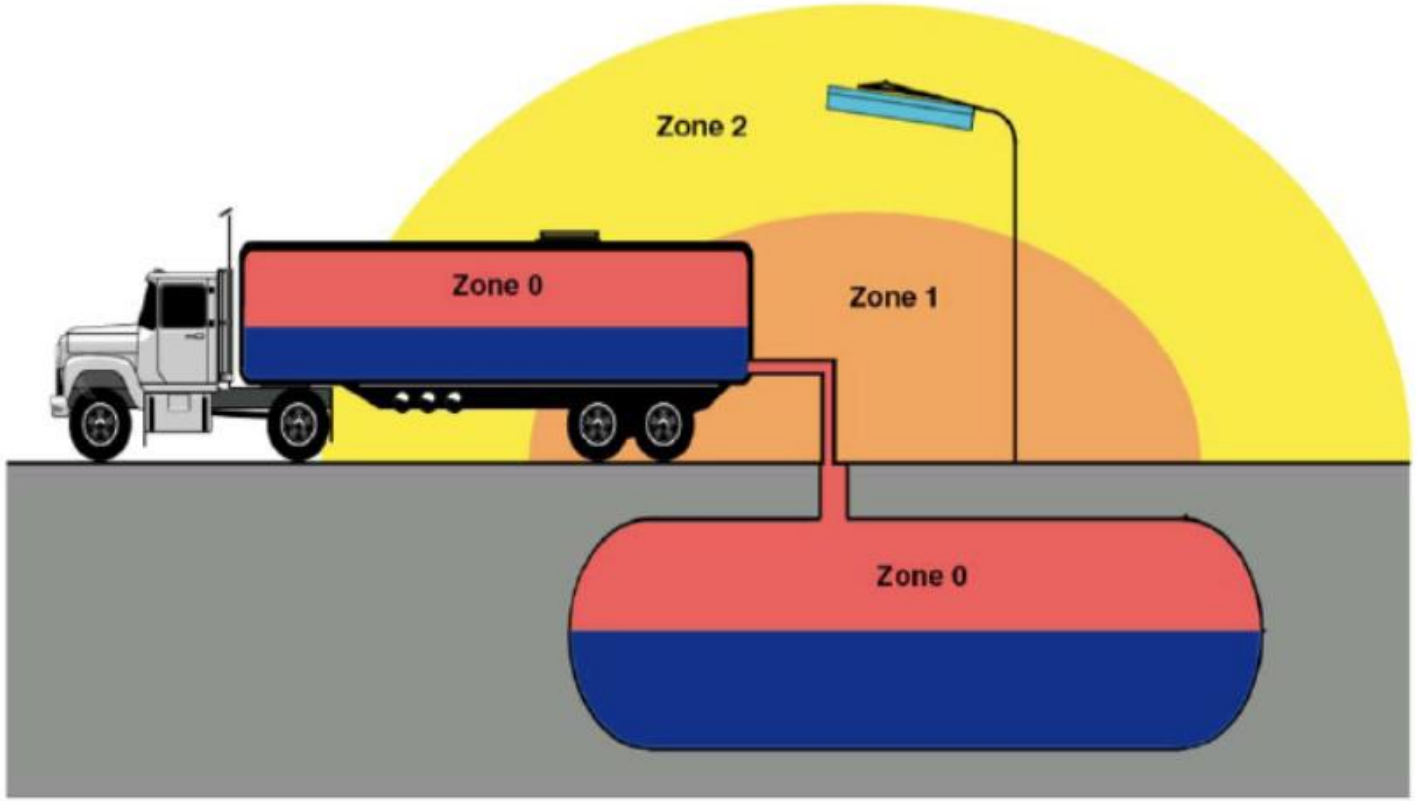
ZONES(CONT.)



ZONES(CONT.)

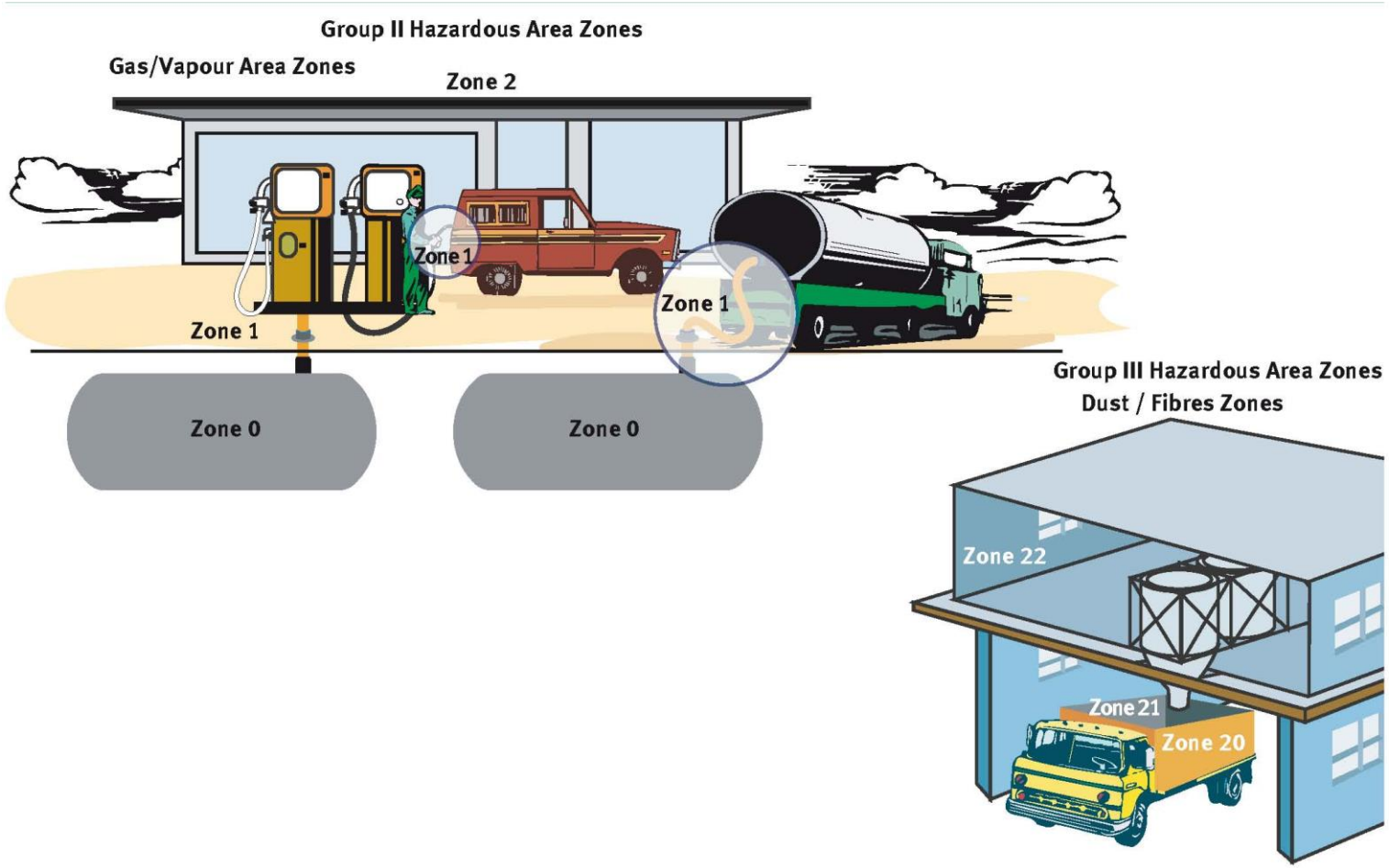


ZONES(CONT.)

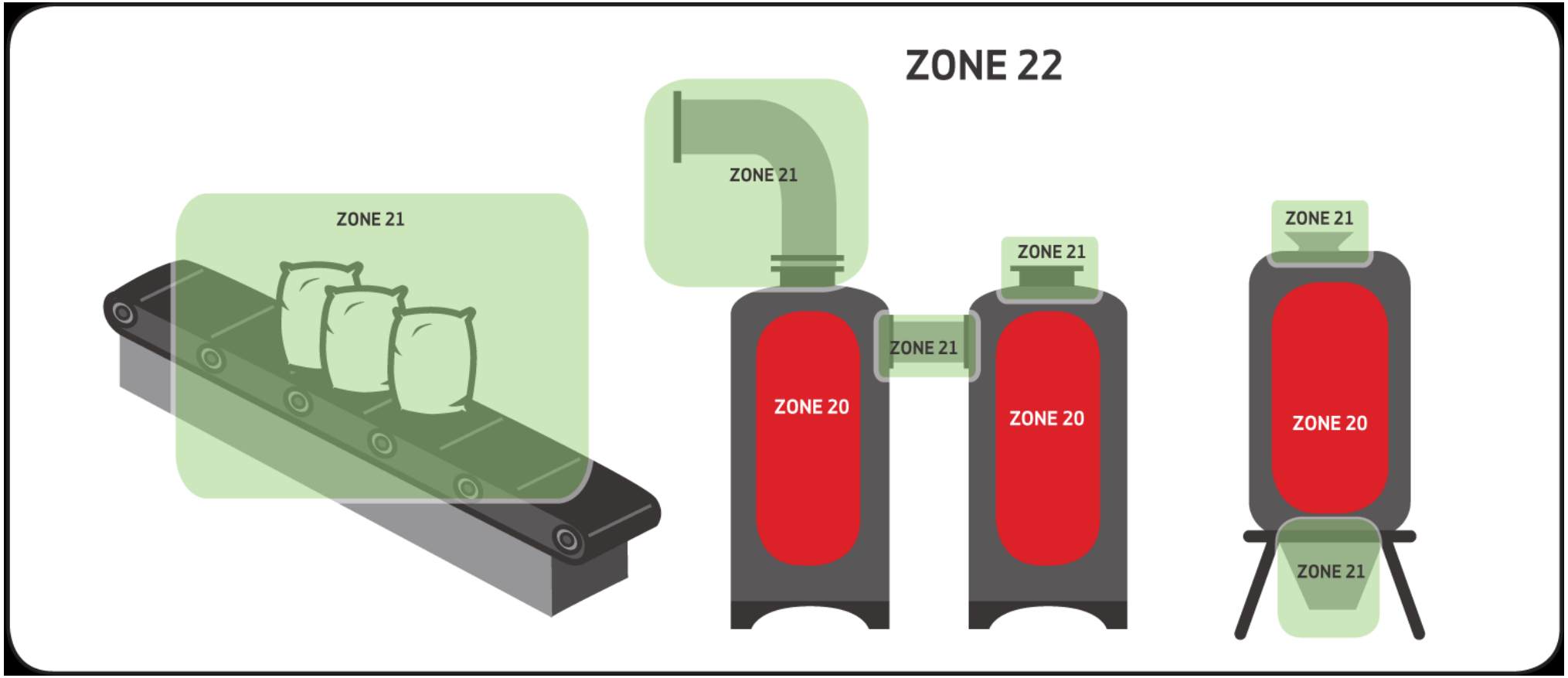


ZONES(CONT.)

ZONES(CONT.)


Group II Hazardous Area Zones
Gas/Vapour Area Zones
Zone 2
Zone 1
Zone 1
Zone 1
Zone 0
Zone 0
Group III Hazardous Area Zones
Dust / Fibres Zones
Zone 22
Zone 21
Zone 20

ZONES(CONT.)


ZONE 22
ZONE 21
ZONE 21
ZONE 21
ZONE 21
ZONE 20
ZONE 20
ZONE 21
ZONE 20
ZONE 21

ZONES(CONT.)

Zone 0

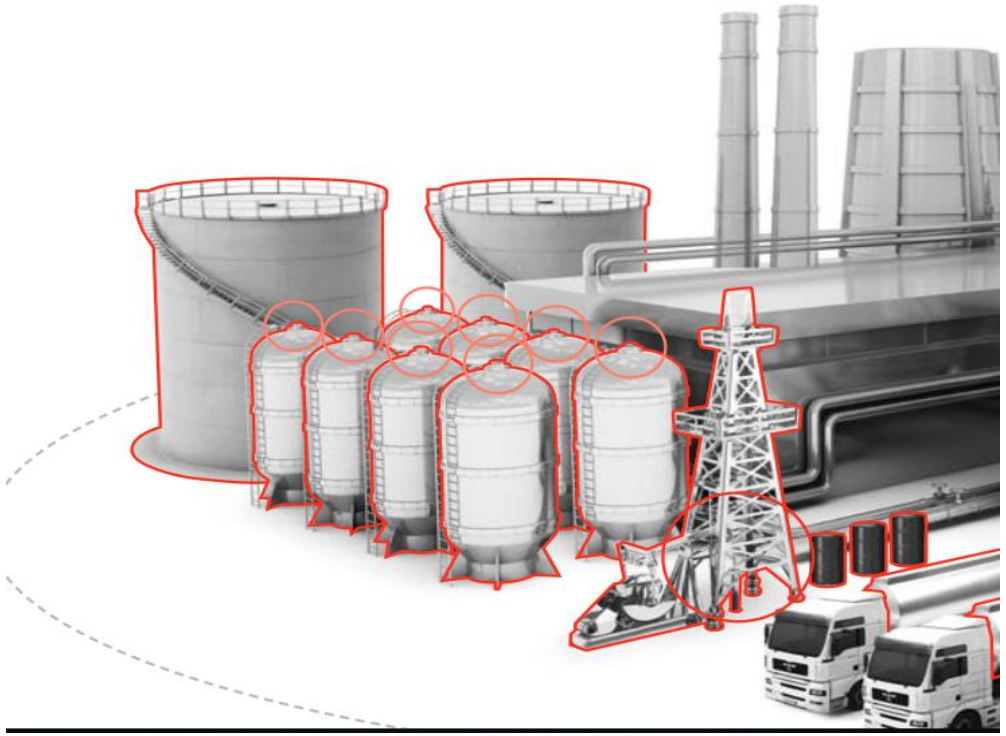
Permanent / Frequent

Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods, or frequently.

Zone 1

Ocassional

Site where an atmosphere consisting of a mixture of air and inflammable substances in the form of gas, vapour or mist is likely to arise occasionally during normal operation.



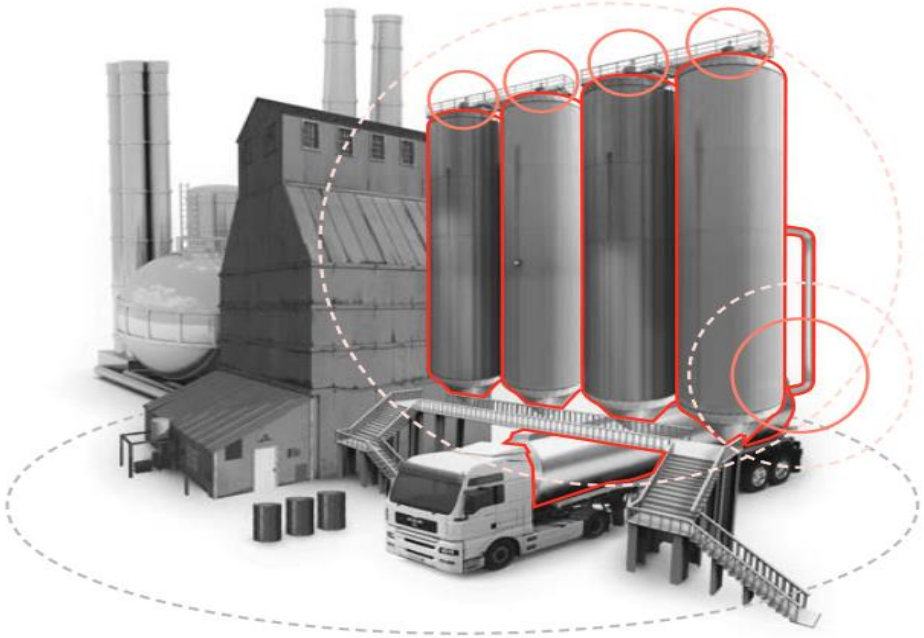
ZONES(CONT.)

Zone definitions – Dust

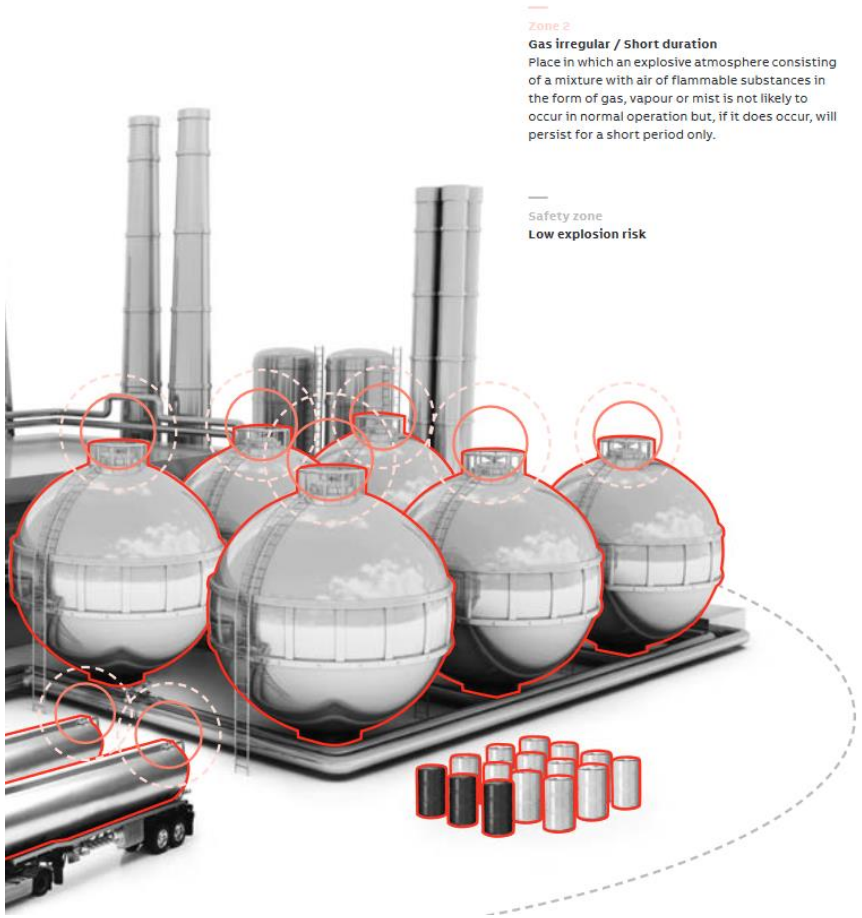
Zone 1
Ocassional
Site where an atmosphere consisting of a mixture of air and inflammable substances in the form of gas, vapour or mist is likely to arise occasionally during normal operation.

Zone 2
Gas irregular / Short duration
Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

Safety zone
Low explosion risk



ZONES(CONT.)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Gas irregular / Short duration
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Safety zone
Low explosion risk

Zone 0

Permanent / Frequent

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Zone 1

Ocassional

Site where an atmosphere consisting of a mixture of air and inflammable substances in the form of gas, vapour or mist is likely to arise occasionally during normal operation.

Safety zone

Low explosion risk

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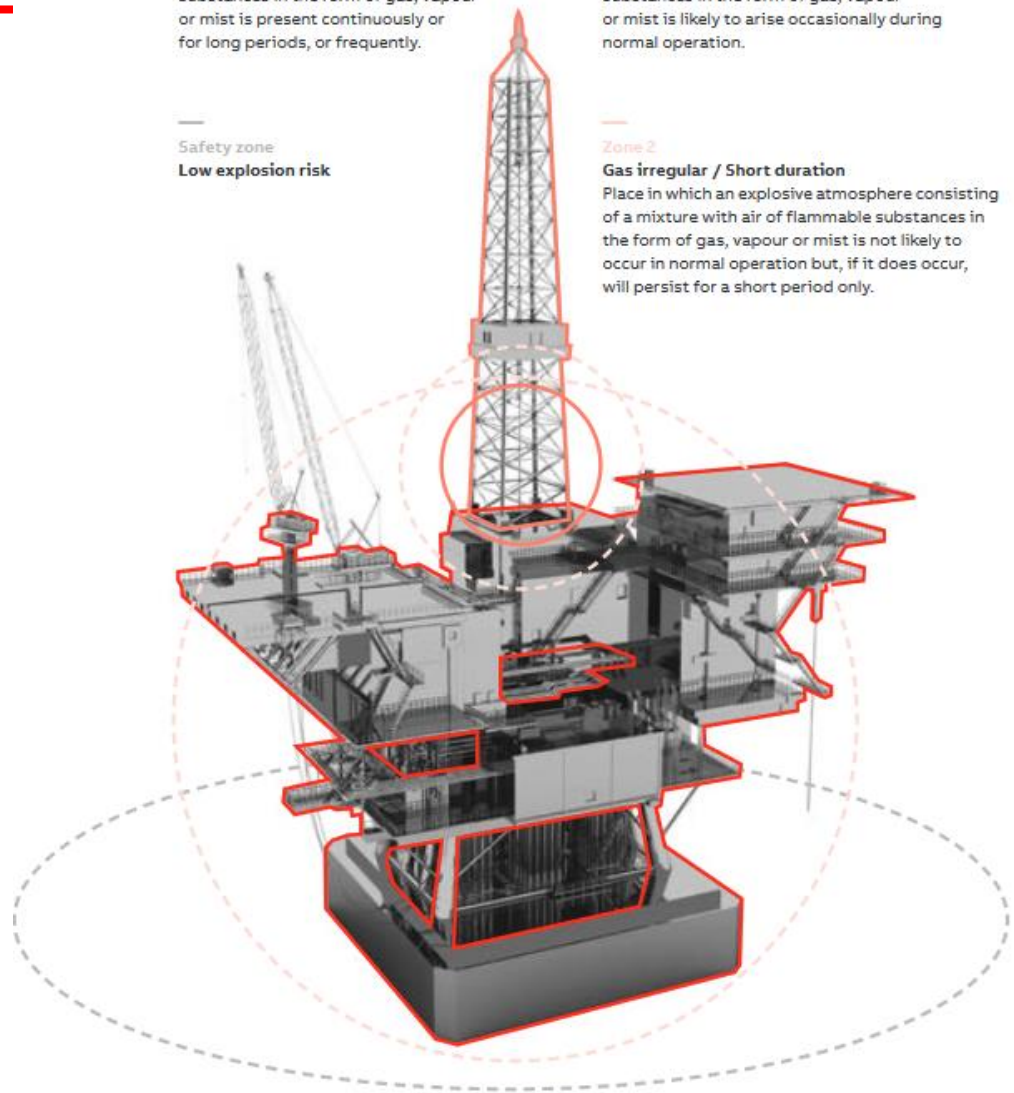
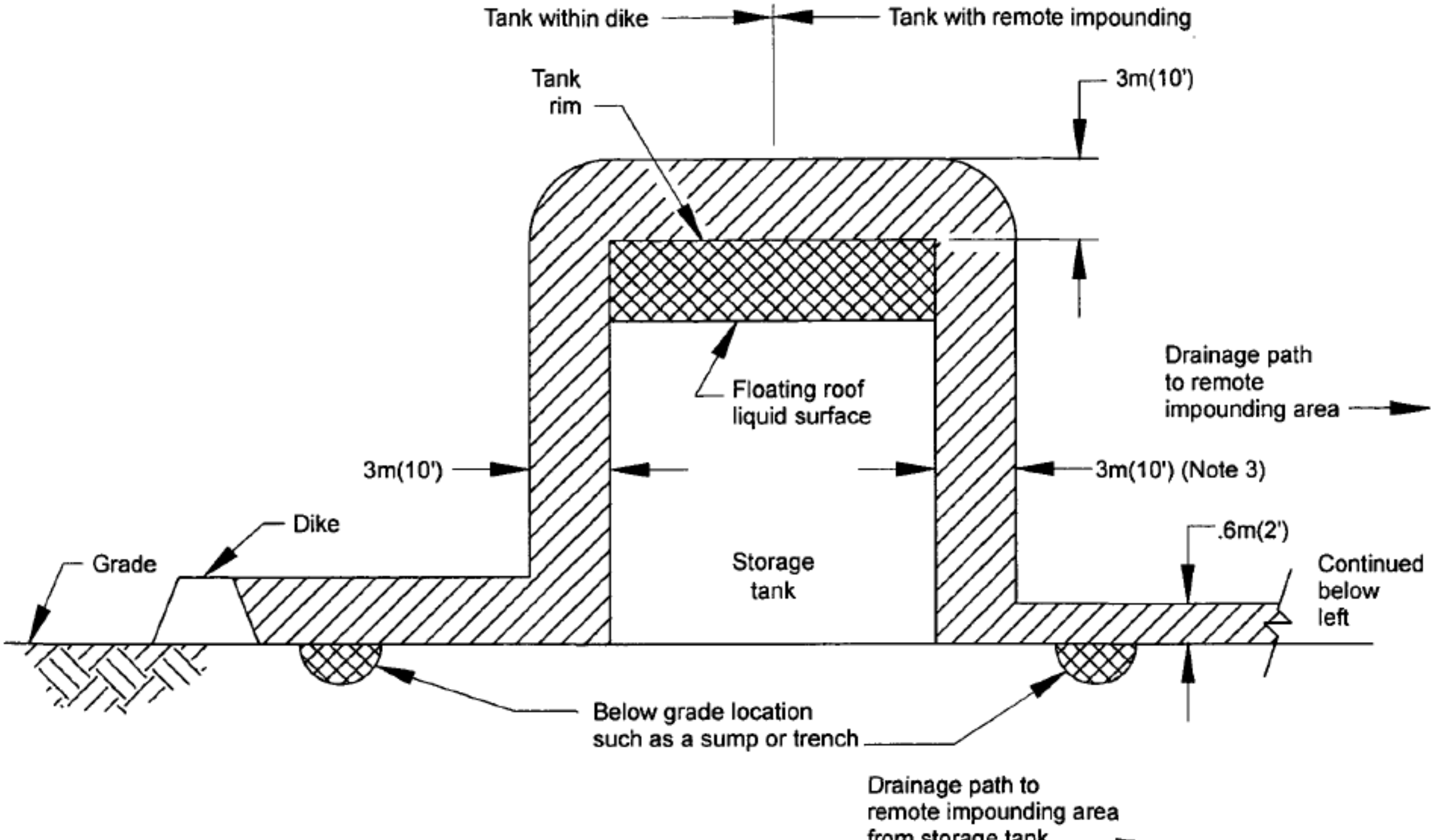
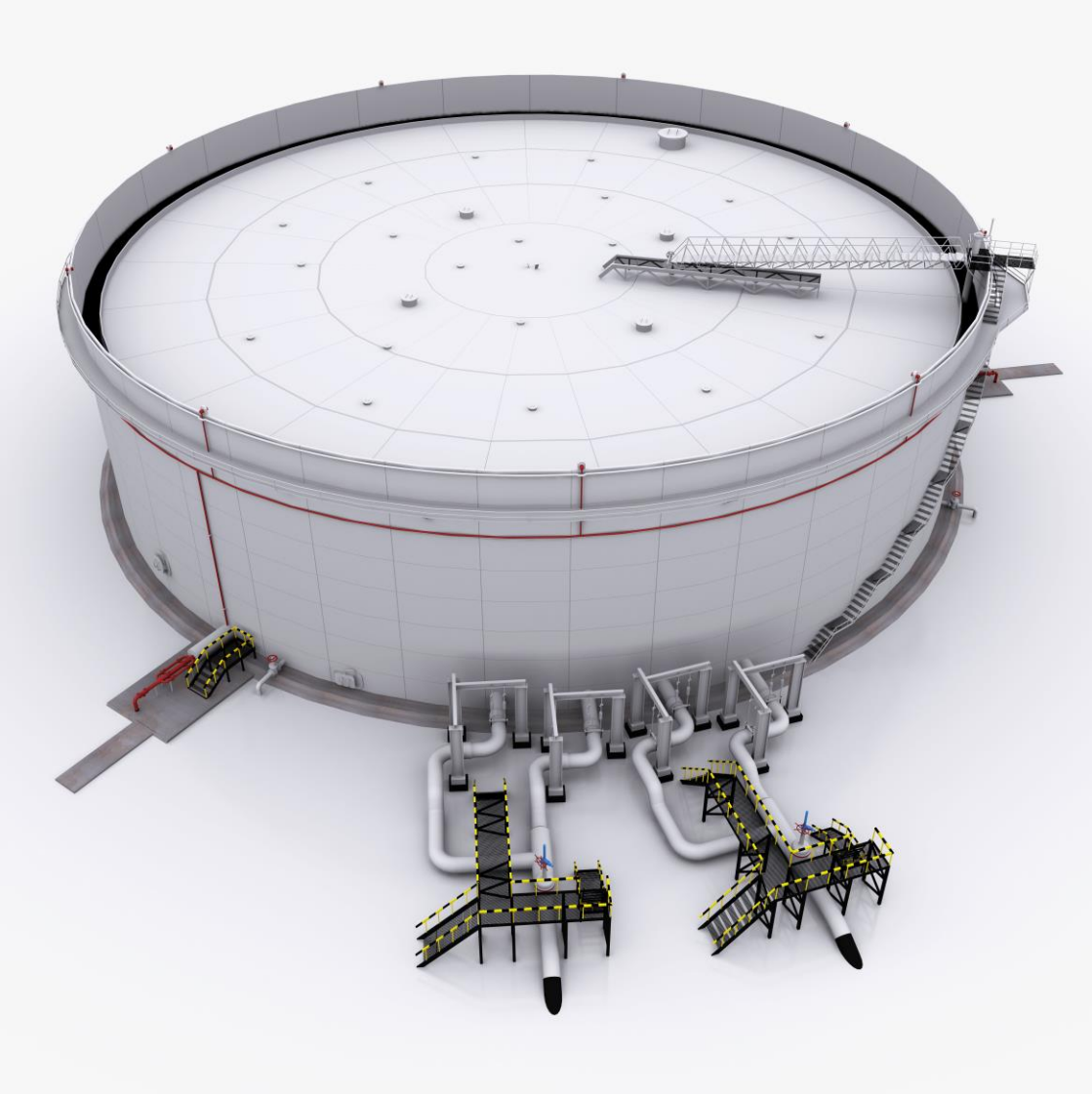
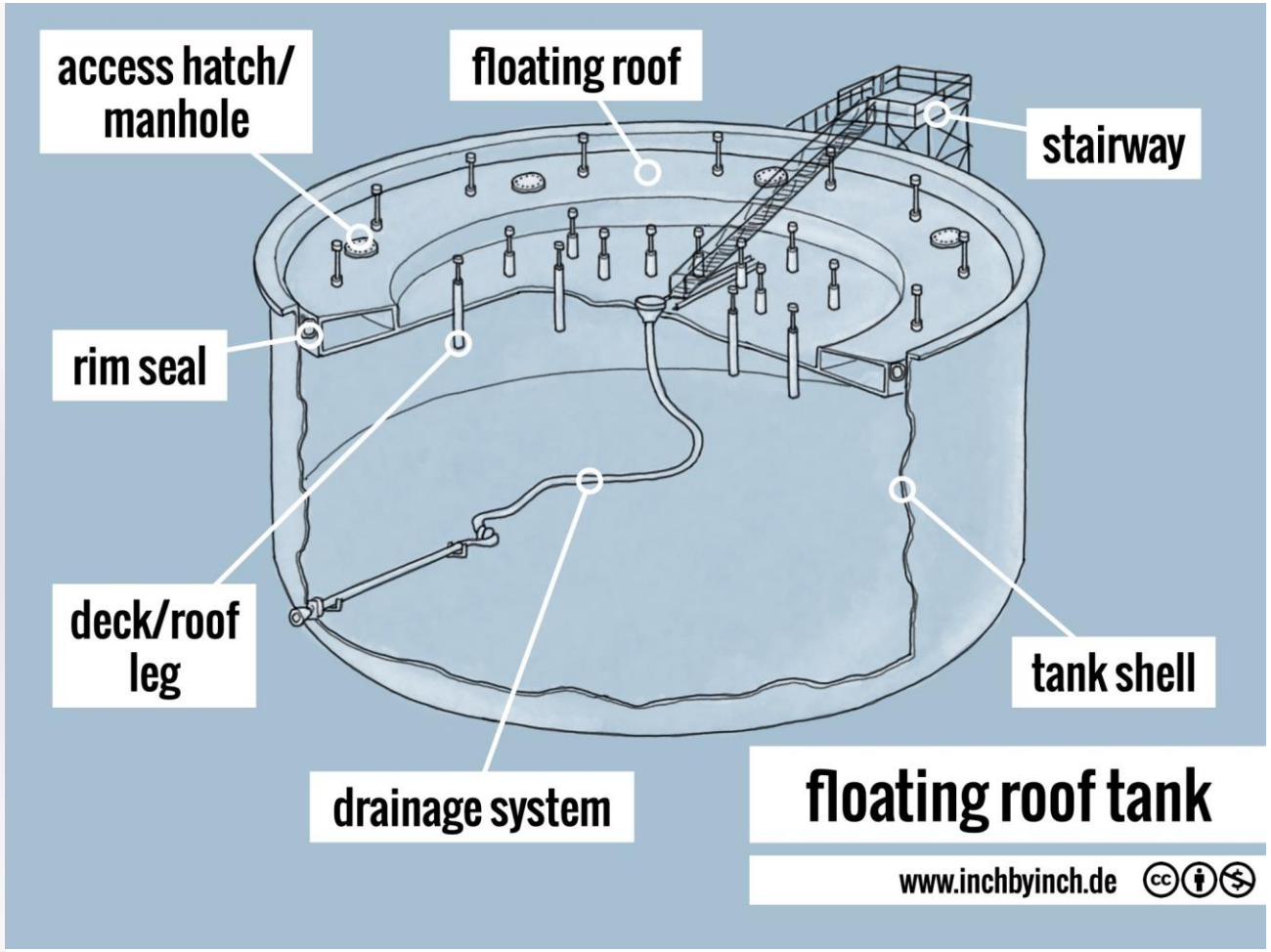



Tank within dike
Tank with remote impounding
Tank rim
3m(10')
Floating roof liquid surface
Drainage path to remote impounding area
3m(10')
3m(10') (Note 3)
Dike
Grade
.6m(2')
Storage tank
Continued below left
Below grade location such as a sump or trench
Drainage path to remote impounding area from storage tank

Floating roof tank





DETERMINING A "ZONE" REQUIRES ANSWERING 4 ESSENTIAL QUESTIONS

1

What is emission level of gas/vapor?
(a) continuous, (b) first level emission, (released during normal operation)
(c) second level emission (released during abnormal operation)

2

What type of openings currently exist?
(a) continuously open, (b) normally closed,
(c) weatherproof, (d) emergency open only

3

What is ventilation?
(a) very good, (b) good, (c) poor

4

What is level of ventilation?
(a) high, (b) average, (c) weak

Openings classification

- Openings are classified as A, B, C, D with the following characteristics:
  - Type A – Openings not conforming to the characteristics specified for types B, C or D
  - Examples:
  - open passages for access or utilities, for example, ducts, pipes through walls, ceilings and floors;
  - fixed ventilation outlets in rooms, buildings and similar openings of types B, C and D which are opened frequently or for long periods.

Openings classification(cont.)

- Openings are classified as A, B, C, D with the following characteristics:
  - Type B – Openings which are normally closed (for example, automatic closing) and infrequently opened, and which are close-fitting.

Openings classification(cont.)

- Type C – Openings normally closed and infrequently opened, conforming to type B, which are also fitted with sealing devices (for example, a gasket) along the whole perimeter; or two type B openings in series, having independent automatic closing devices.

Openings classification(cont.)

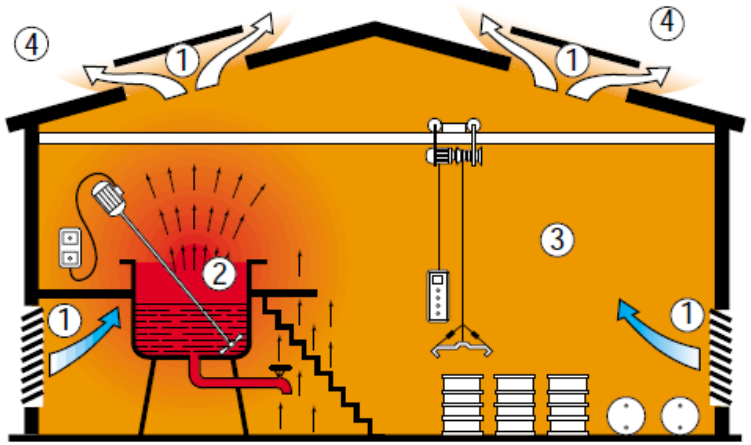
- Openings are classified as A, B, C, D with the following characteristics:
- Type D – Openings normally closed conforming to type C which can only be opened by special means or in an emergency.

Grade of release	Ventilation						
	Degree						
	High			Medium			Low
	Availability						
	Good	Fair	Poor	Good	Fair	Poor	Good, fair or poor
Continuous	(Zone 0 NE) Non-hazardous[a]	(Zone 0 NE) Zone 2[a]	(Zone 0 NE) Zone 1[a]	Zone 0	Zone 0 + Zone 2	Zone 0 + Zone 1	Zone 0
Primary	(Zone 1 NE) Non-hazardous[a]	(Zone 1 NE) Zone 2[a]	(Zone 1 NE) Zone 2[a]	Zone 1	Zone 1 + Zone 2	Zone 1 + Zone 2	Zone 1 or zone 0[c]
Secondary[b]	(Zone 2 NE) Non-hazardous[a]	(Zone 2 NE) Non-hazardous[a]	Zone 2	Zone 2	Zone 2	Zone 2	Zone 1 and even zone 0[c]

Table B.1 – Influence of Independent Ventilation on Type of Zone

ZONE 0 | ZONE 1 | ZONE 2 | NON HAZARDOUS ZONE

EXAMPLE 1



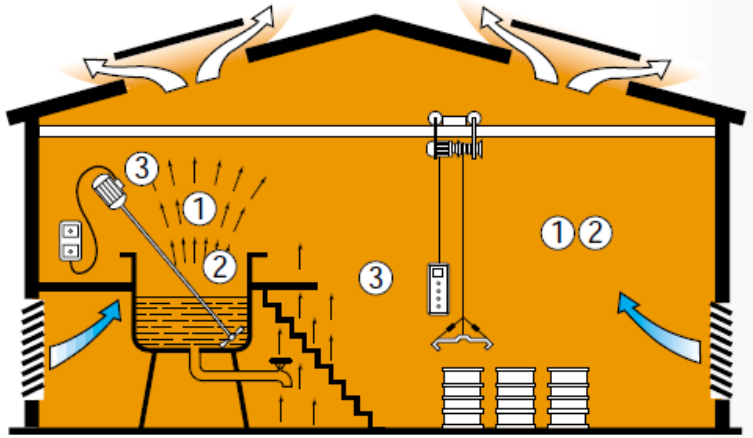
CONDITIONS:

① All manual ventilation
② Zone 0 area
③ Zone 1 area
④ Non hazardous area

- Open air mixing tank
- No mechanical ventilation
- Products stored in work area

CLASS I, DIVISION 1 | CLASS I, DIVISION 2 | NON CLASSIFIED

EXAMPLE 1



CONDITIONS:

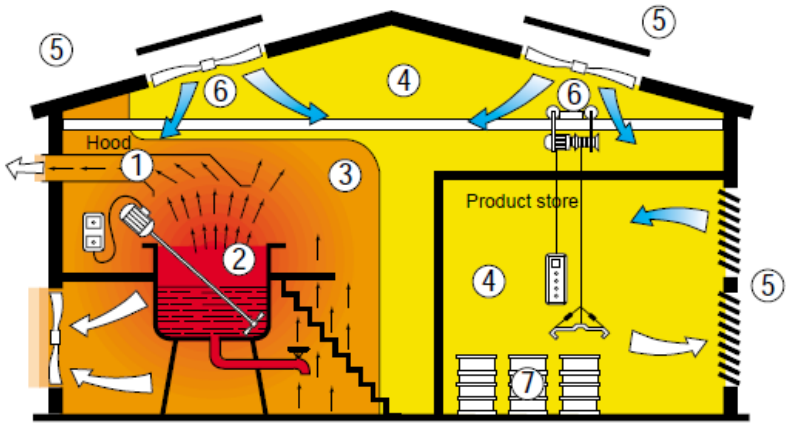
① Class I, Division 1 hazard exists during normal operation conditions

- Open air mixing tank
- Products stored in work area

② Area classified based on properties of vapors present
③ Electrical equipment must use approved Div. 1 NEC® protection techniques and wiring methods

EXAMPLE 2

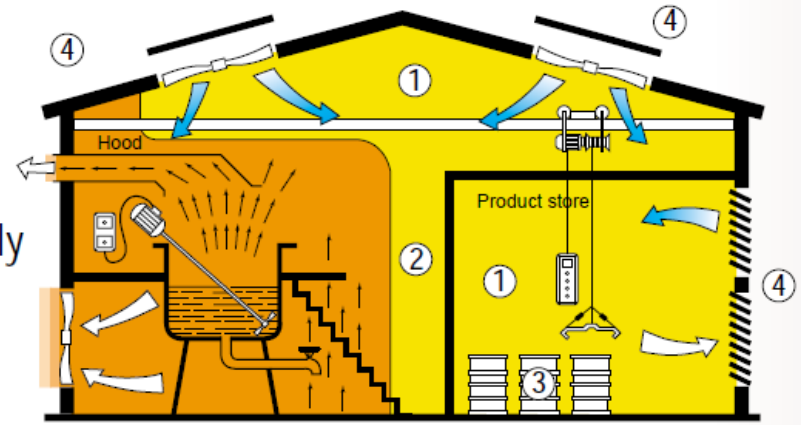
CONDITIONS:



① Hood over tank
② Zone 0 area
③ Zone 1 area
④ Zone 2 area
⑤ Non hazardous area
⑥ Mechanical ventilation
⑦ Stored products separated from work area

EXAMPLE 2

CONDITIONS:

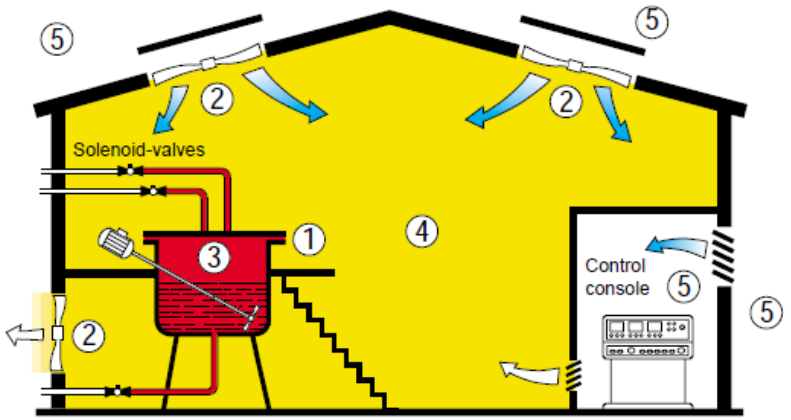


① Division 2 area can exist where vapors are normally in closed system or containers
② Division 1 and 2 areas separated by barrier or space (transition zone)
- Hazardous areas properly documented
- Div. 2 must use approved NEC® wiring methods and products

③ Stored products outside Div. 1 work area
④ Non hazardous area

EXAMPLE 3

CONDITIONS:

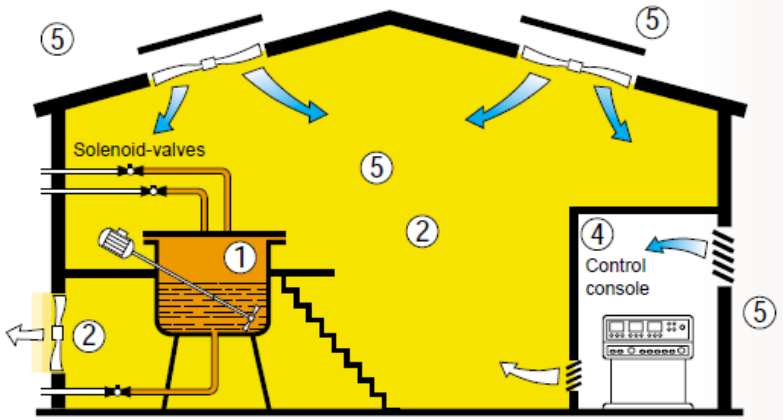


① Tank closed
② Mechanical ventilation
③ Zone 0
④ Zone 2
⑤ Non hazardous area

- Operations control outside zones

EXAMPLE 3

CONDITIONS:



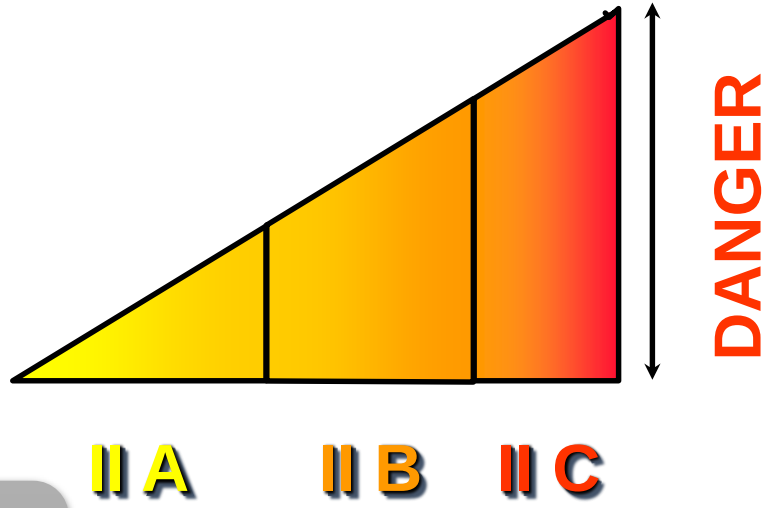
① Closed tank and piping confines Div. 1
② Yellow area qualifies as Div. 2
③ Stored products not present
④ Purged/pressurized control room qualifies as "non hazardous" is sealed off from Div. 2 area
⑤ Electrical equipment in Div. 2 must use approved Div. 2 protection techniques and products

IEC Gas Grouping

Under IEC system **Materials** are classified under various **Groups** as follows :

Group I : Mining applications (underground mines containing firedamp the mine gas that compromised mainly of Methane)

Group II :: (surface industry) Flammable Gases like hydrogen propane ..etc. flammable vapors like acetone ,benzene etc. Group II is subdivided into A,B,C



IEC Gas Grouping

Representative Gas/Vapor	Group	Degree of hazard
Hydrogen	II C	High
Ethylene	II B	Medium
Propane	II A	Low

North American System/ NEC

- This system consists of **Classes** , **Divisions & Groups**:

Class I :locations in which flammable gases, flammable liquids-produced vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures ,

Class II :locations that are hazardous because of present of combustible dust.

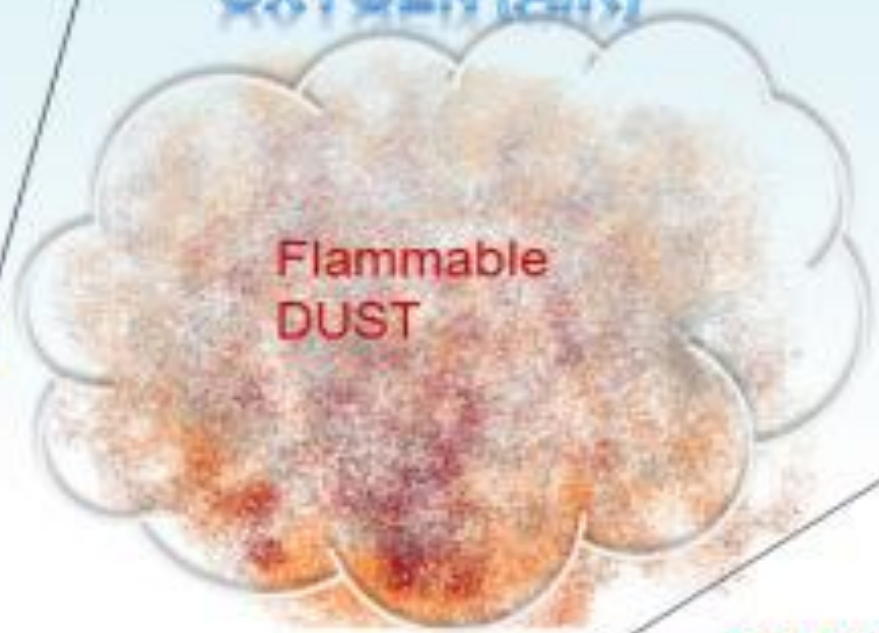
Class III :locations that are hazardous because of the presence of easily ignitable fibers.

CLASS I

OXYGEN (AIR)

CLASS II

OXYGEN (AIR)



CLASS III

OXYGEN (AIR)

The Term "CLASS", indicates the PHYSICAL FORM of the flammable material, which in the presence of air (OXYGEN) form a Hazardous Location

North American System/NEC

- The NEC System is based on **Divisions**

Division 1

- In which ignitable concentrations of hazard exists under normal operation conditions and/or where hazard is caused by frequent maintenance or repair work or frequent equipment failure.

Division 2

- In which ignitable concentrations of hazard are handled, processed or used, but which are normally in closed containers or closed systems from which they can only escape through accidental rupture or breakdown of such containers or systems.

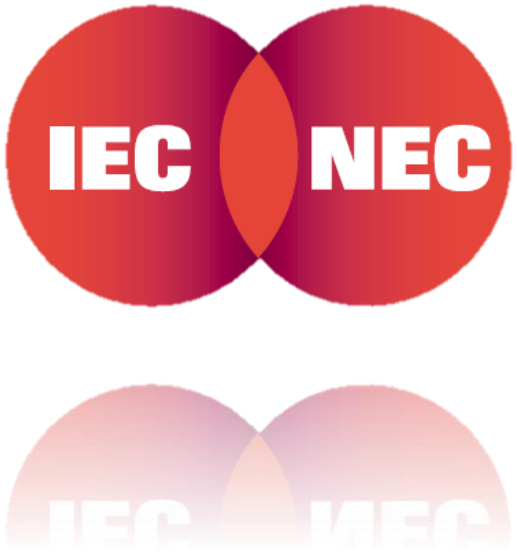
North American System

- In the **North American System** each **Class** has several **Groups** under it.

Class	Group	Example Material
Class I	A	Acetylene
Class I	B	Hydrogen
Class I	C	Ethylene
Class I	D	Propane

Class	Group	Example Material
Class II	E	Aluminium, Magnesium dusts
Class II	F	Atmosphere containing combustible carbonaceous dusts like coal and coke
Class II	G	Dusts that are not included in E or F like flour and grain dust

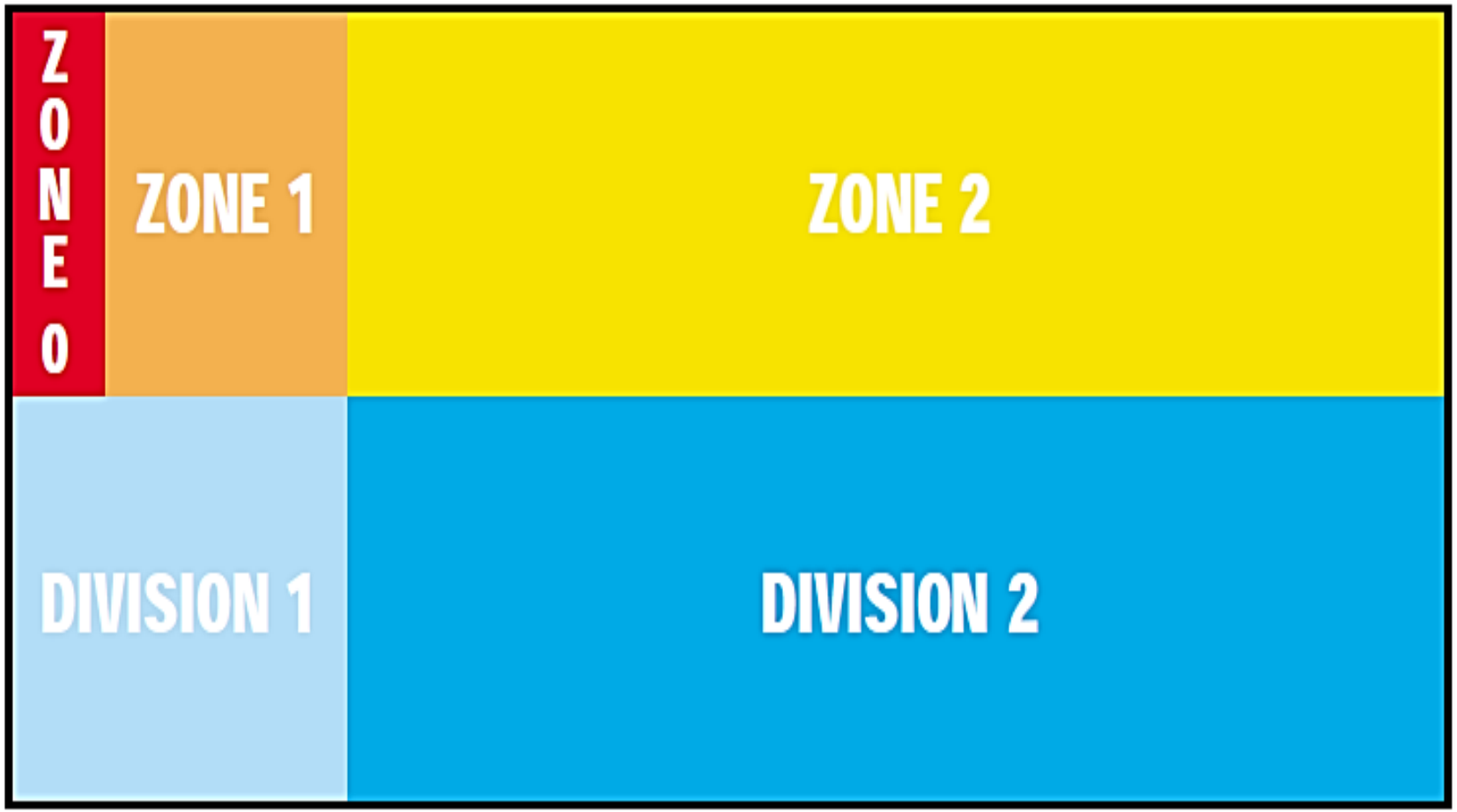
Material Classification under the two systems



Typical Gas/Material	European/IEC Gas Group	North American Gas Group
Acetylene	IIC	A
Hydrogen	IIC	B
Ethylene	IIB	C
Propane	IIA	D
Metal	-	E
Coal Dust	-	F
Grain Dust	-	G

COMPARING IEC ZONES AND NEC® DIVISIONS

IEC NEC



Temperature Classification

Why This Is Necessary ?

As a hot surface can provide sufficient energy to ignite flammable mixtures of vapors , gases or dusts in the hazardous area.

IEC

Temperature Class	Max Surface Temperature
	^{0}C
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

North America /NEC

Maximum Temperature ^{0}C	Maximum Temperature ^{0}F	Code
450	842	T1
300	572	T2
280	536	T2A
260	500	T2B
230	446	T2C
215	419	T2D
200	392	T3
180	356	T3A
165	329	T3B
160	320	T3C
135	275	T4
120	248	T4A
100	212	T5
85	185	T6

Example of Temperature Classification

An area is handling Carbon Disulfide (an extremely flammable material falling under IEC Group IIC). It is expected that Carbon Disulfide may be present for long periods of time, but lesser than 1000 hours in a year. Then the area could be classified as Zone 1, Group IIC, T6. The last symbol T6 denotes the temperature classification. This area is classified as T6 because Carbon Disulfide has an ignition temperature of 90 degrees C. Hence, the maximum surface temperature that an apparatus located in such an area has to be less than this value, else it will be a potential source of ignition (if it comes into contact with such a hot surface).

Protection Techniques

Popular Types

Exd: Flame/Explosion Proof
Exi: Intrinsically safe
Exe: Increased safety
Exn: No-sparking
Exp: Pressurization

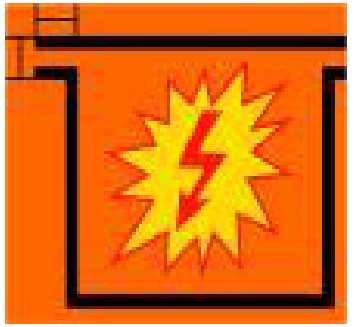
Not - Popular Types

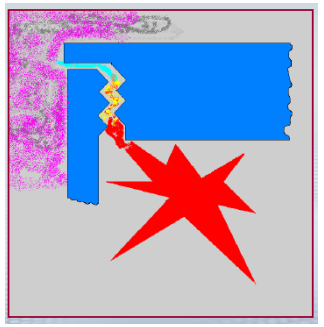
Exq: Powder Filled
Exo: Oil Immersed

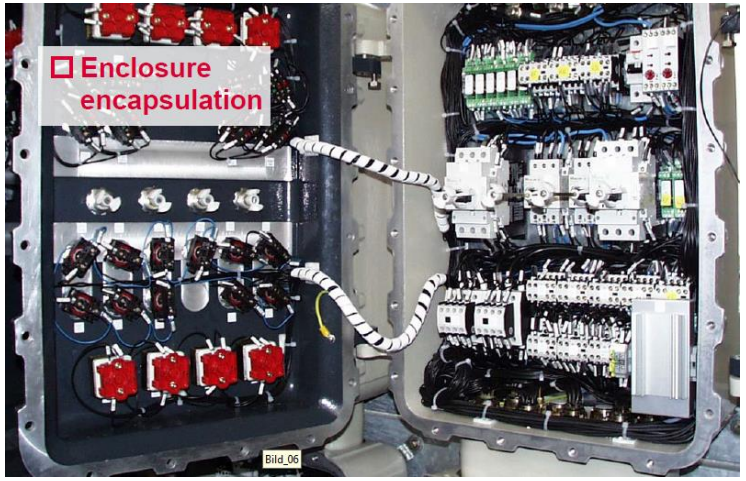
Protection Techniques

Flameproof enclosure “ d ”

- is totally enclosed construction.
- When gas or vapor get into the enclosure and an explosion take place,
- the enclosure withstands the pressure of explosion and,
- preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and which operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby.







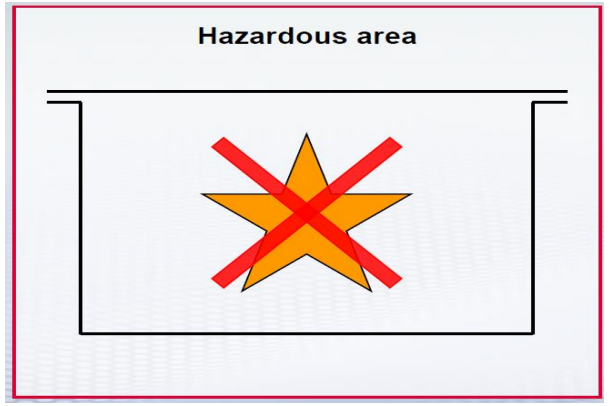
Application:

switchgear, motors, Machine Control Systems

Protection Techniques

Increased Safety “ e ”

- IN case of INCREASED SAFETY CONCEPT additional measures are applied to increase the level of safety,
- thus preventing the possibility of high temperatures and the occurrence of sparks or electric arcs within the enclosure or on exposed parts of electrical equipment
- “Increased safety” increases the insulation performance



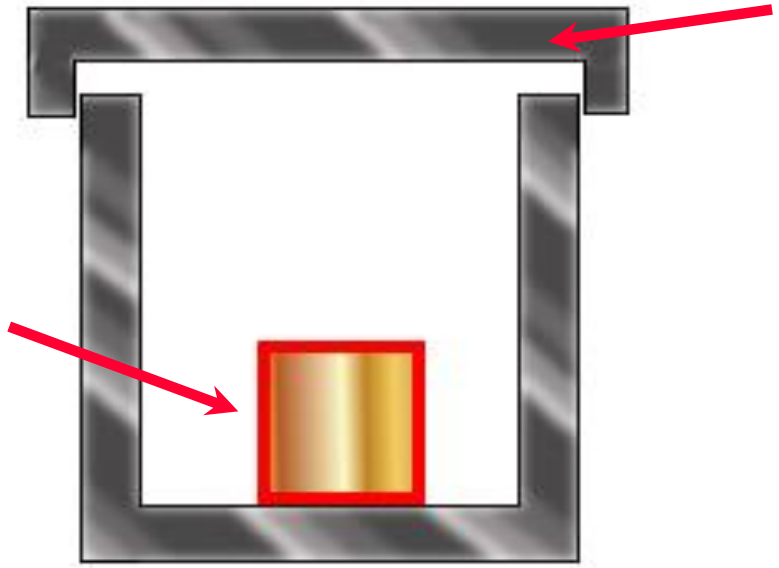
Application :

Junction boxes/terminal boxes - Lighting - Measuring instruments - Transformers - Squirrel cage motors

Protection Techniques

The “e” Principal

Ex certified electrical components (with electrical connections that cannot loosen by themselves)



insulated enclosure, minimum IP 54

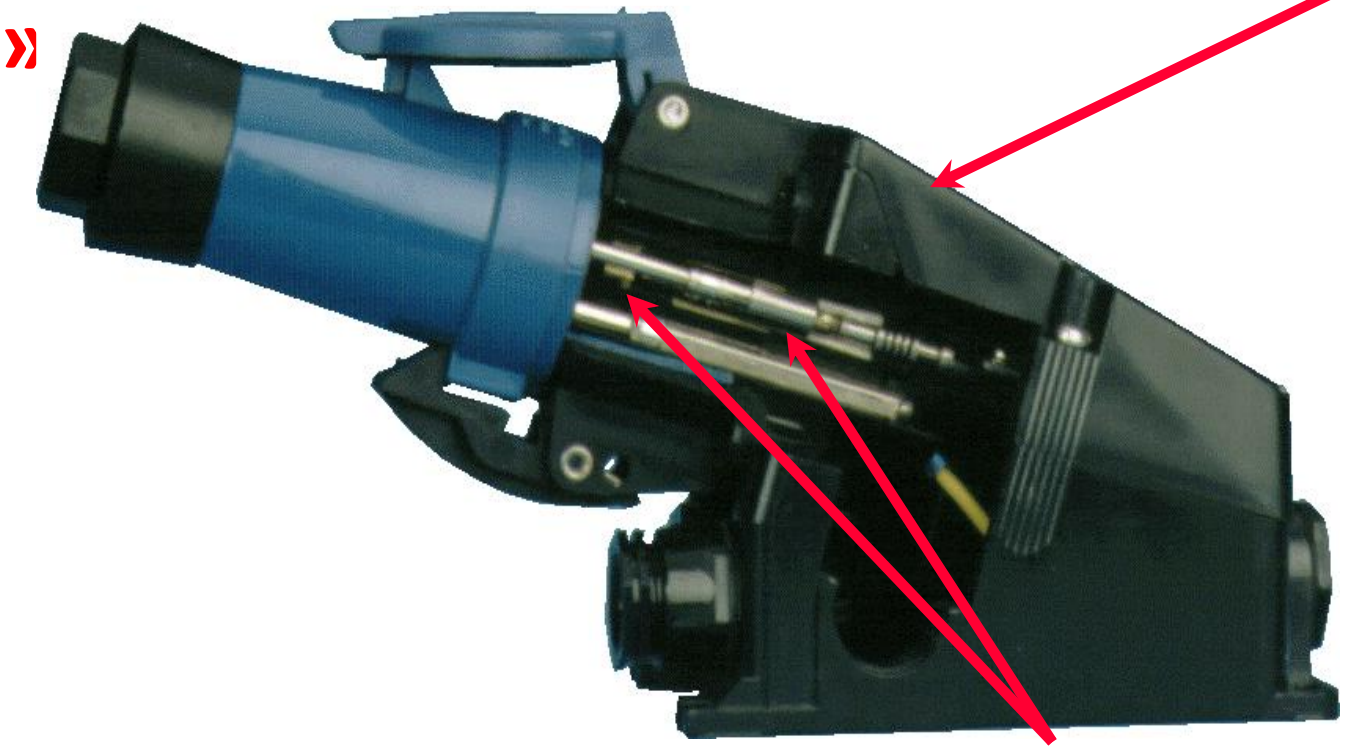
Protection Techniques

“de” protection

- Mainly junction boxes have 100% increased safety “e”
- Sparking equipment often incorporates “d ” components
- Most products commonly referred to as “e” combine the 2 types of protection “e+d”

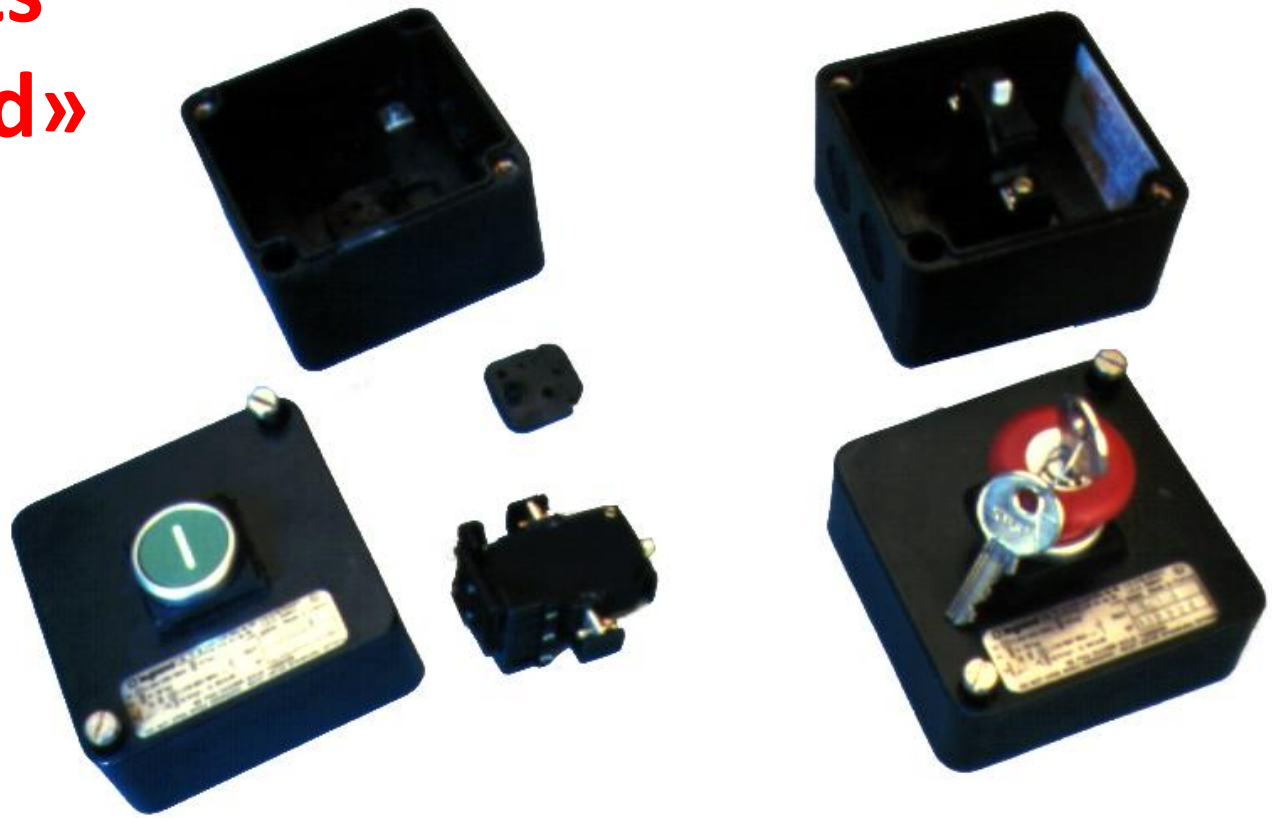
Protection Techniques

“de” products
also called «ed»



Protection Techniques

“de” products
also called «ed»



Control stations

Protection Techniques

“de” products

also called «ed»

fluorescent luminaire

Protection Techniques

“de” products
also called «ed»

stainless steel - “e” (junction box)
cabinet - “de” (control station)

Protection Techniques

Intrinsically safe “ i ”

- Electrical system /apparatus and its wiring is not capable of realizing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific flammable or combustible mixture in its most ignitable concentrations.

Intrinsically safe “ i ”

Ex ia

Equipment that incapable of causing ignition in normal operation with two faults

Ex ib

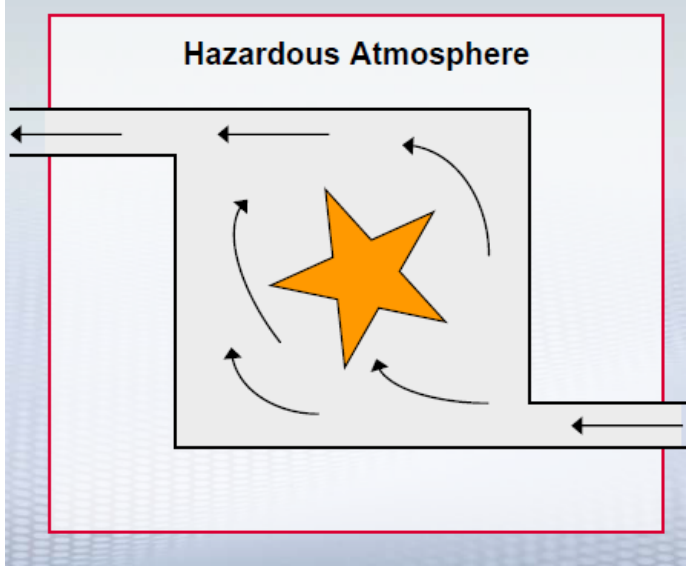
Equipment incapable of causing ignition in normal operation with a single fault

e.g. switch amplifier

Protection Techniques

Pressurization type “ p ”

- is a type of protection by which the entry of a surrounding atmosphere into the enclosure of the electrical apparatus is prevented by maintaining,
- inside the said enclosure, a protective gas at a higher pressure than that of the surrounding atmosphere.
- The over pressure is maintained with or without continuous flow of the protective gas.
- The protective gas can be either air, inert gas or an other suitable gas.



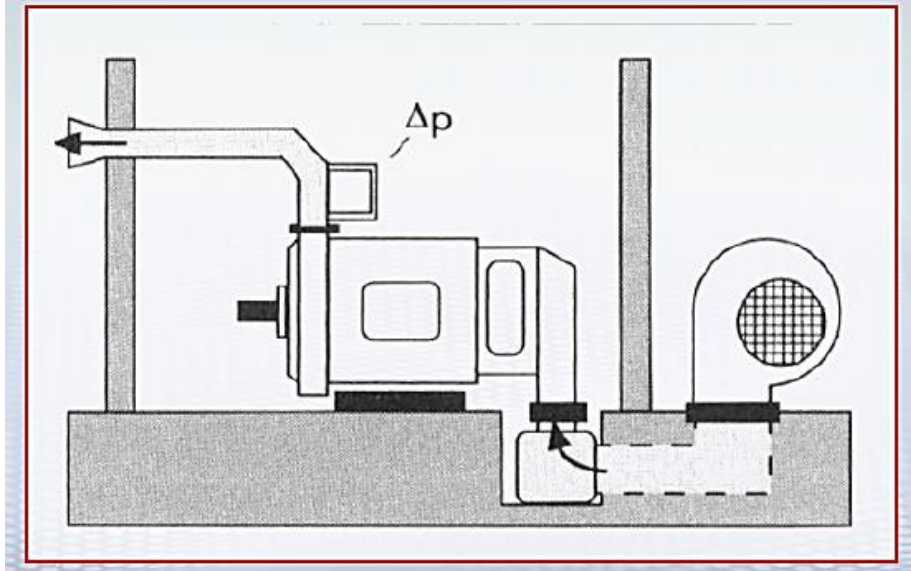
Protection Techniques

Pressurization type “ p ”

Application:

- Large machines
- Switching and M&C panels
- Switch rooms & control centers
- Analysis & monitoring apparatus
- Special application solutions

☐ Example: Motor in type of protection Ex-p



Right:
Ventilator and air input duct

Middle:
Ex area with motor, pressure monitor and exhaust duct support

Left:
Exhaust outlet

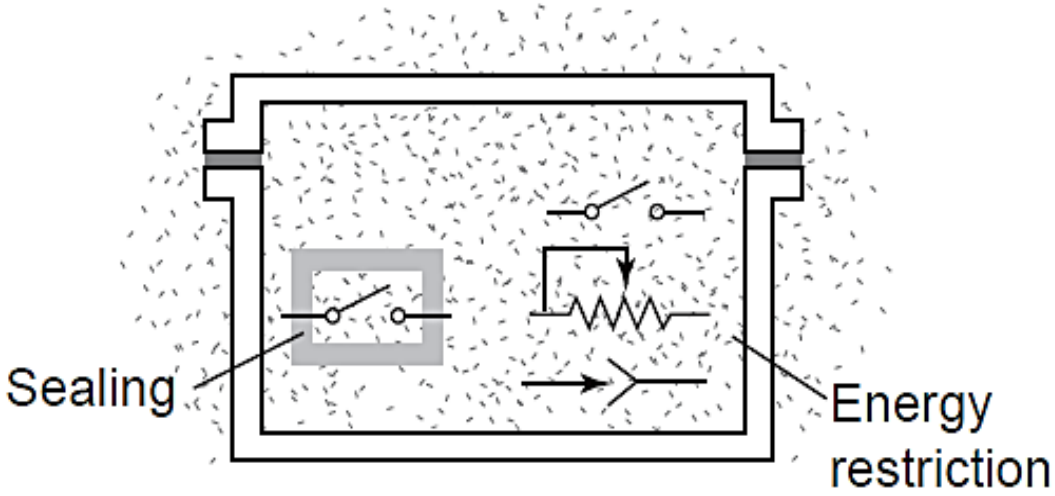
Source:
Fa. Dannfoss Bauer

Protection Techniques

No – sparking “n”

It is applicable to electric equipment which is not capable of igniting potentially explosive atmospheres under normal operation.

is the special explosion protection construction for **Zone 2** or **Division 2.**

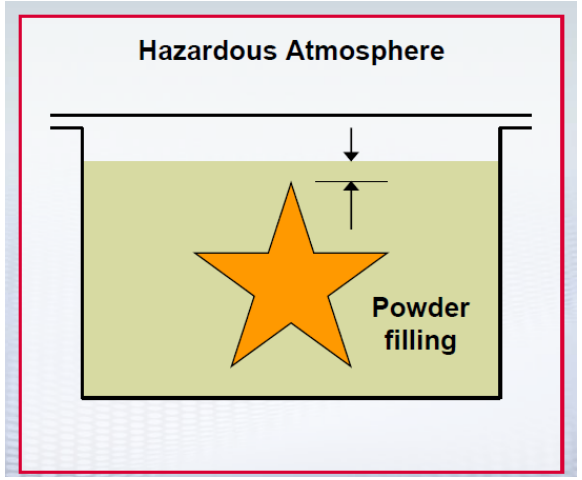


Protection Techniques

Powder Filled “q”

is a type of protection in which the enclosure of the electrical apparatus is **filled with a material in a finely granulated** state so that, in the intended conditions of service, any arc occurring **within the enclosure** of the electrical apparatus will not ignite the surrounding atmosphere.

No ignition shall be caused either by flame or by excessive temperature of the surfaces of the enclosure.



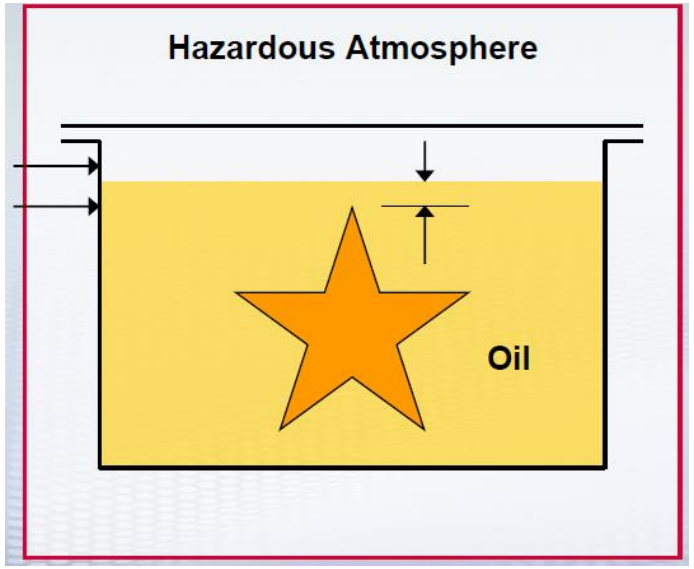
Application :

- Fuses
- Capacitors
- Electronic circuit boards - EVG

Protection Techniques

Oil immersion “o”

- is a type of protection in which the electrical apparatus or parts of the electrical apparatus are **immersed in oil**
- in such a way that an explosive atmosphere which may be **above the oil** or **outside the enclosure** cannot be ignited.



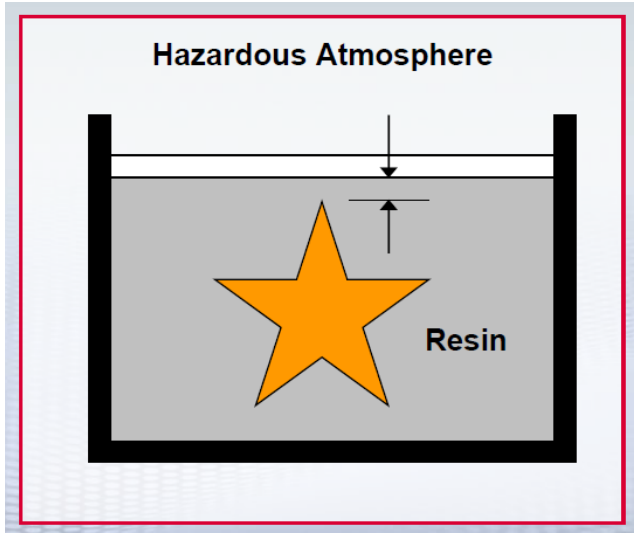
Application :

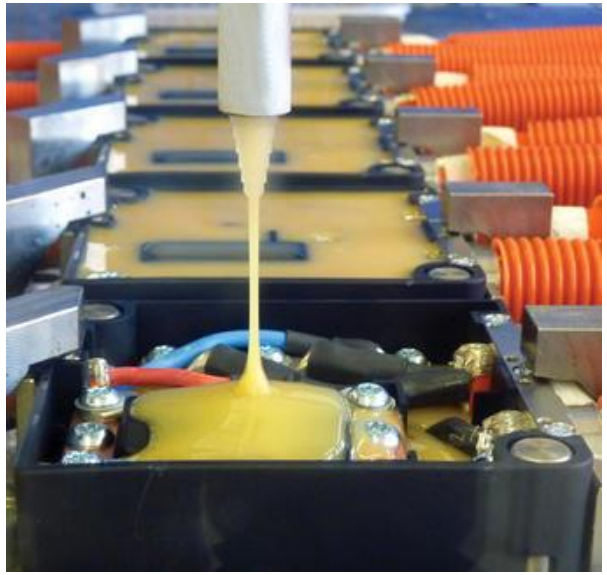
- Switching units
- Circuit breakers
- Transformers

Protection Techniques

Encapsulation “m”

- is a type of protection, in which the parts that could ignite an explosive atmosphere,
- **are enclosed** in a **resin** sufficiently resistant to environmental influences,
- in such a way that this explosive atmosphere cannot be ignited either by **sparking or heating which may occur within the encapsulation.**





Application :

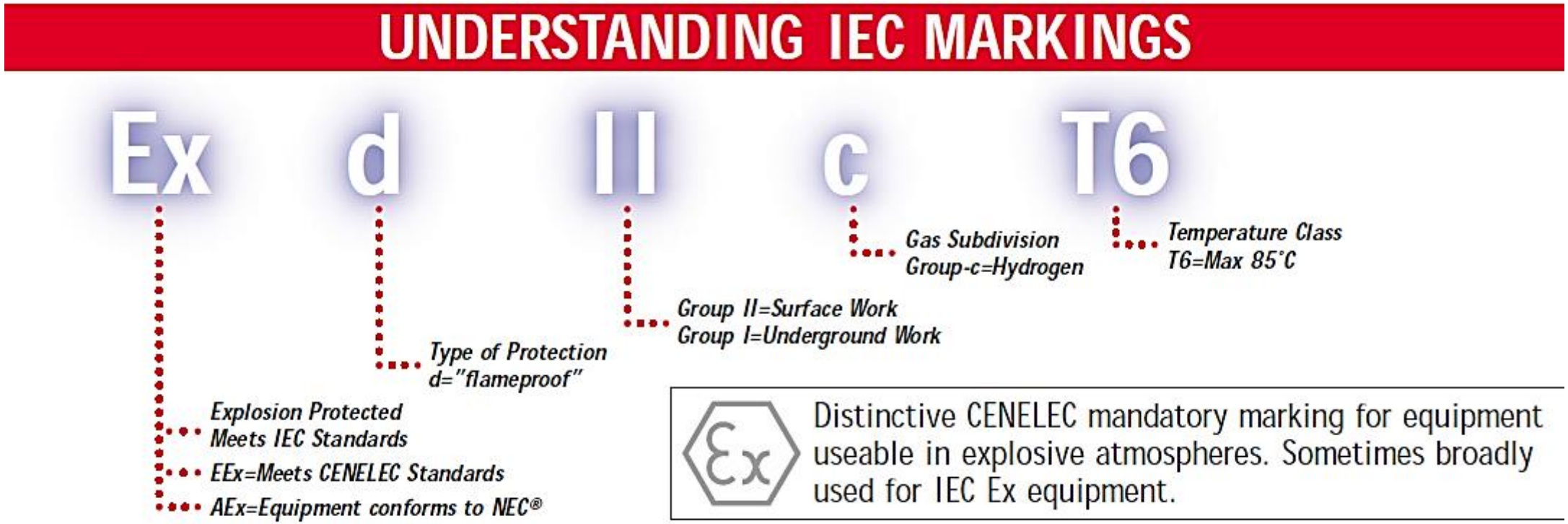
- Valves
- Electronic circuit boards
- Miniature motors

Protection method	Identification letters	Permitted in zone	Principle
Flameproof	d	1 or 2	Containment
Intrinsic safety (zone 0)	ia	0, 1, 2	Energy limited
Intrinsic safety (zone 1)	ib	1 or 2	Energy limited
Pressurization	p	1 or 2	Expels vapors
Increased safety	e	1 or 2	No arcs
Immersed in oil	o	1 or 2	Arc immersion
Filled with powder/sand	q	1 or 2	Arc immersion
Encapsulated	m	1 or 2	Hermetic seal
Apparatus with "n"* protection	n	2	No sparking

Methods of classifying Hazardous area

- API 500 (American Petroleum Institute) using Division method only for petroleum industries.
- European Standards IEC using ZONING method for general industries .
- API 505 For Petroleum industry using zoning method.
- North America using classes and divisions, Class I for Gas, Class 2 for Dust and Class 3 for Fiberd.

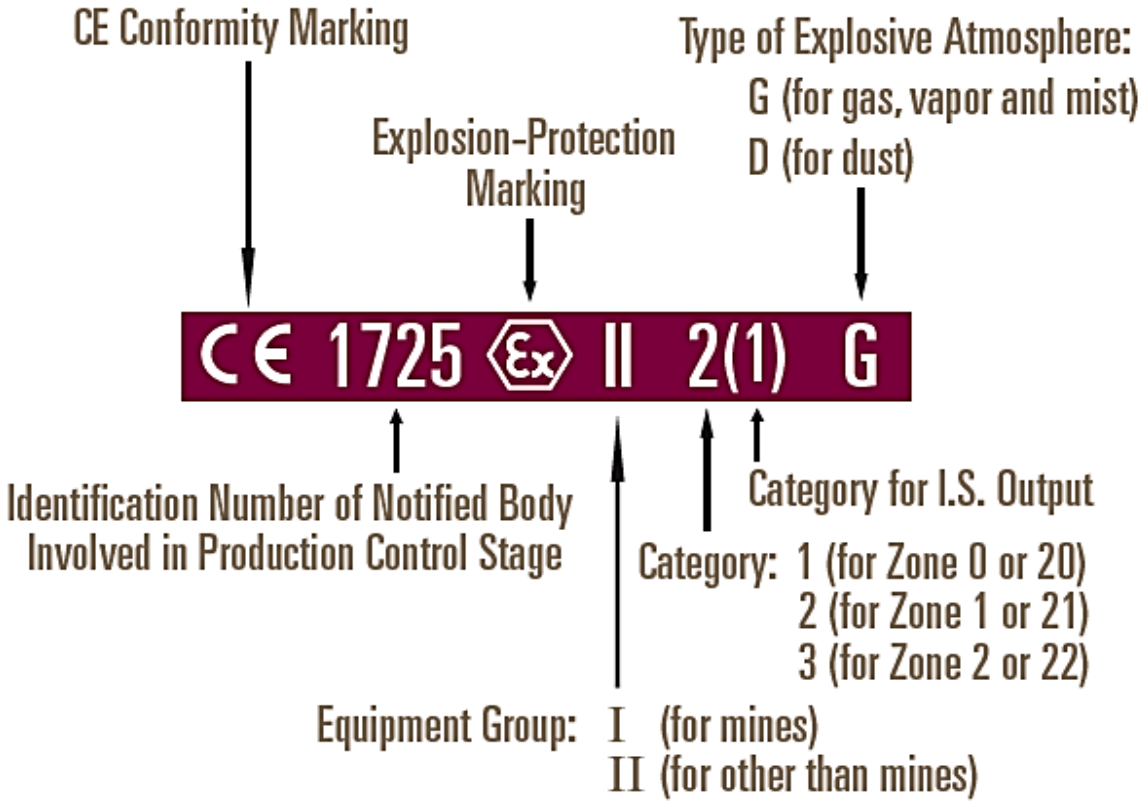
Ex Marking

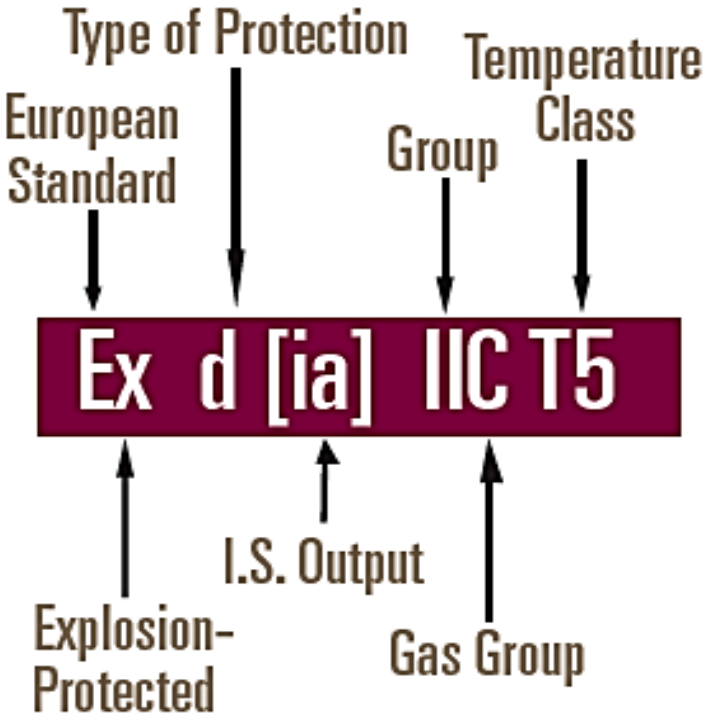


CENELEC: European committee for electrotechnical standardization

Ex Marking

ATEX MARKING SYSTEM

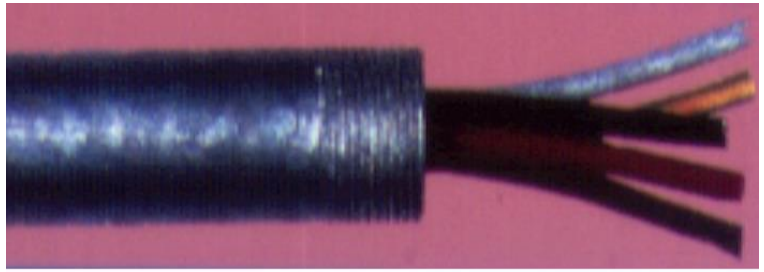




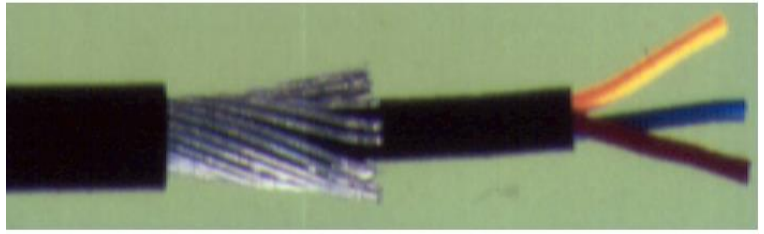
ATEX: Explosive Atmosphere

Methods of installation throughout the world

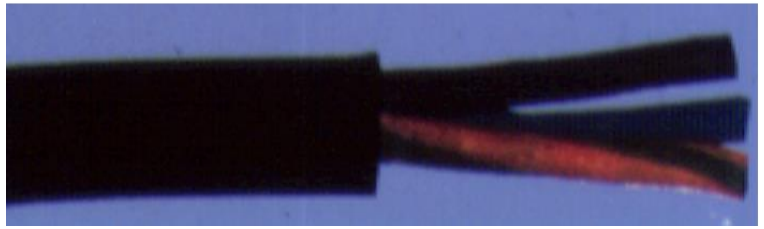
- conductors placed inside a rigid threaded conduit
- connection using a seal



- wire, braid or steel-tape armoured cable.
- connection using an earth continuity cable gland



- unarmoured cable
- connection using a cable gland



Methods of installation throughout the world

Multicore cables

Protection against mechanical shocks

- armoured cables

Or

- cable ducting + installation clamps

Protection against chemical attack

- most industrial cables are suitable

Protection against fire

- minimum : cable which does not propagate flames
- ideal : cable capable of withstanding fire

Methods of installation throughout the world

Selecting cable inlets

The cable gland must:

- be adapted to the type of **thread** of the product on which it is mounted
- be **Exe** or **Exd** certified
- have at least the same index of protection as the product on which it is mounted
- be adapted to the cable diameter and type
- sometimes clamp the cable

Methods of installation throughout the world

Selecting cable glands

The cable gland must be certified:

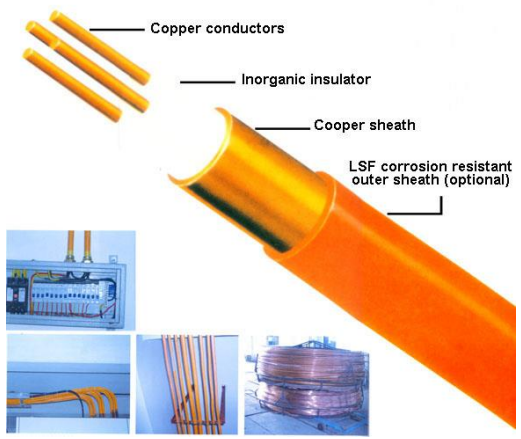
- Exe if the enclosure is Exe or Exed
- Exd if the enclosure is Exd

IP of the cable gland ≥ IP of the product (later will be explained)

Methods of installation throughout the world

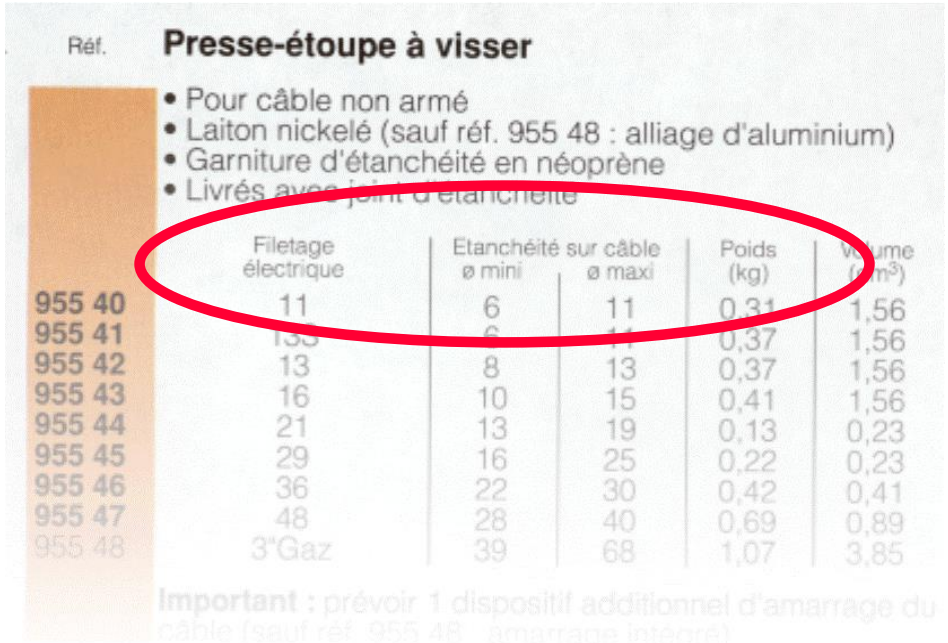
Selecting cable glands

The cable gland must be matched to the cable type



- Cable diameter
- Cable .armoured
  or .unarmoured
  or .MICC

Mineral-insulated copper-clad cable



Réf. **Presse-étoupe à visser**

- Pour câble non armé
- Laiton nickelé (sauf réf. 955 48 : alliage d'aluminium)
- Garniture d'étanchéité en néoprène
- Livrés avec joint d'étanchéité

Réf.	Filetage électrique	Etanchéité sur câble ø mini	Etanchéité sur câble ø maxi	Poids (kg)	Volume (cm³)
955 40	11	6	11	0,31	1,56
955 41	[illegible]	[illegible]	[illegible]	0,37	1,56
955 42	13	8	13	0,37	1,56
955 43	16	10	15	0,41	1,56
955 44	21	13	19	0,13	0,23
955 45	29	16	25	0,22	0,23
955 46	36	22	30	0,42	0,41
955 47	48	28	40	0,69	0,89
955 48	3"Gaz	39	68	1,07	3,85

Important : prévoir 1 dispositif additionnel d'amarrage du câble (sauf réf. 955 48 : amarrage intégré)

Methods of installation throughout the world

Selecting cable glands

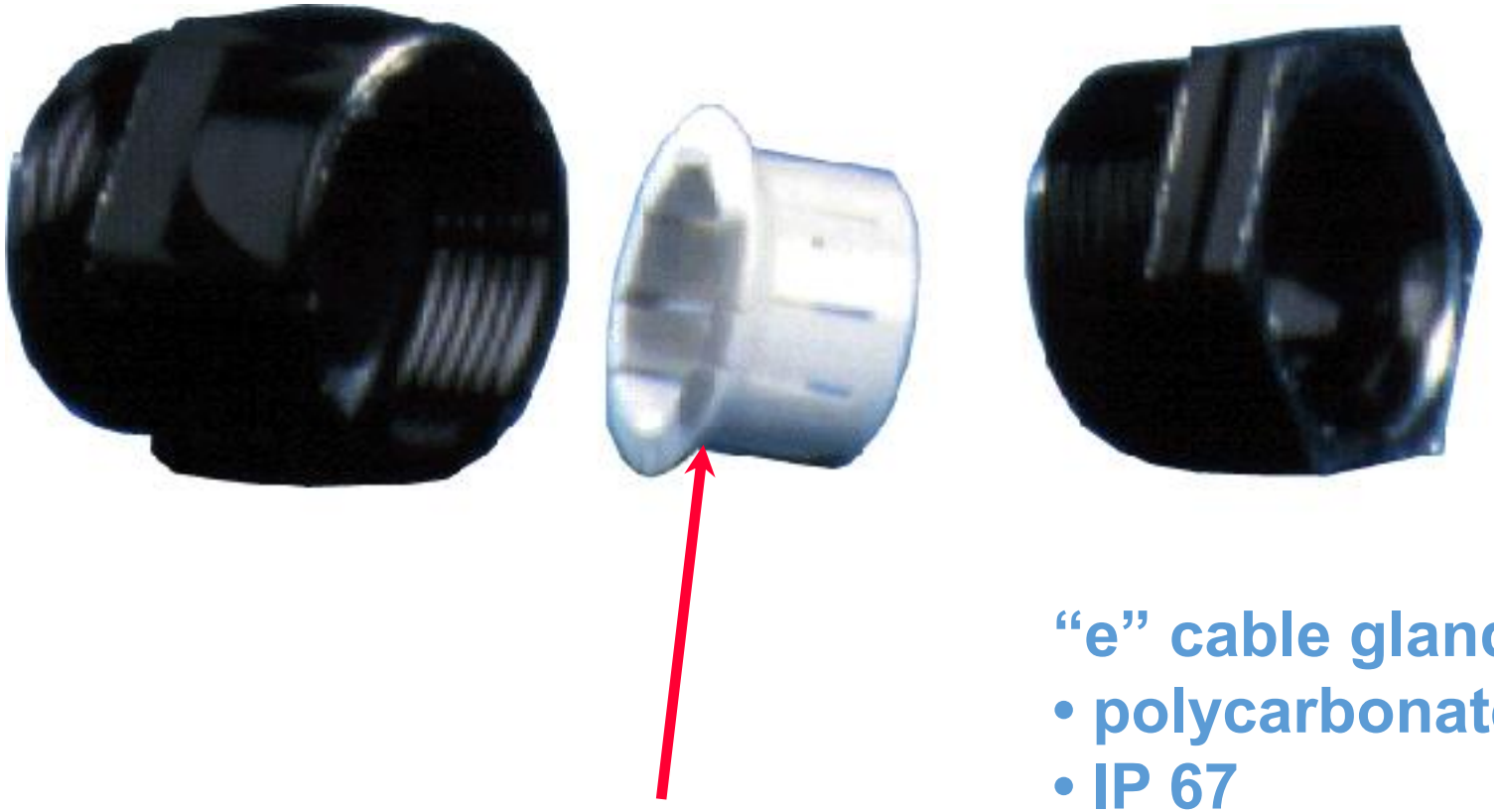
The cable must be correctly clamped by means of the cable gland

- Internal clamping system
- External clamping system

or by means of an installation clamp

Methods of installation throughout the world

Selecting cable glands

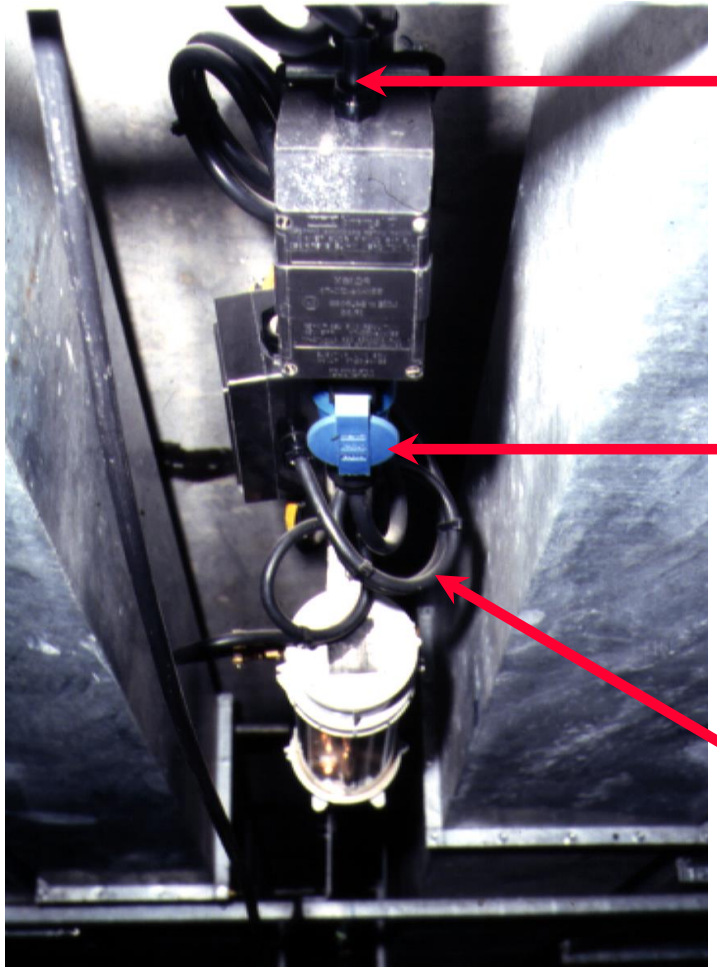


cable clamp

"e" cable gland
- polycarbonate
- IP 67
- for unarmoured cable

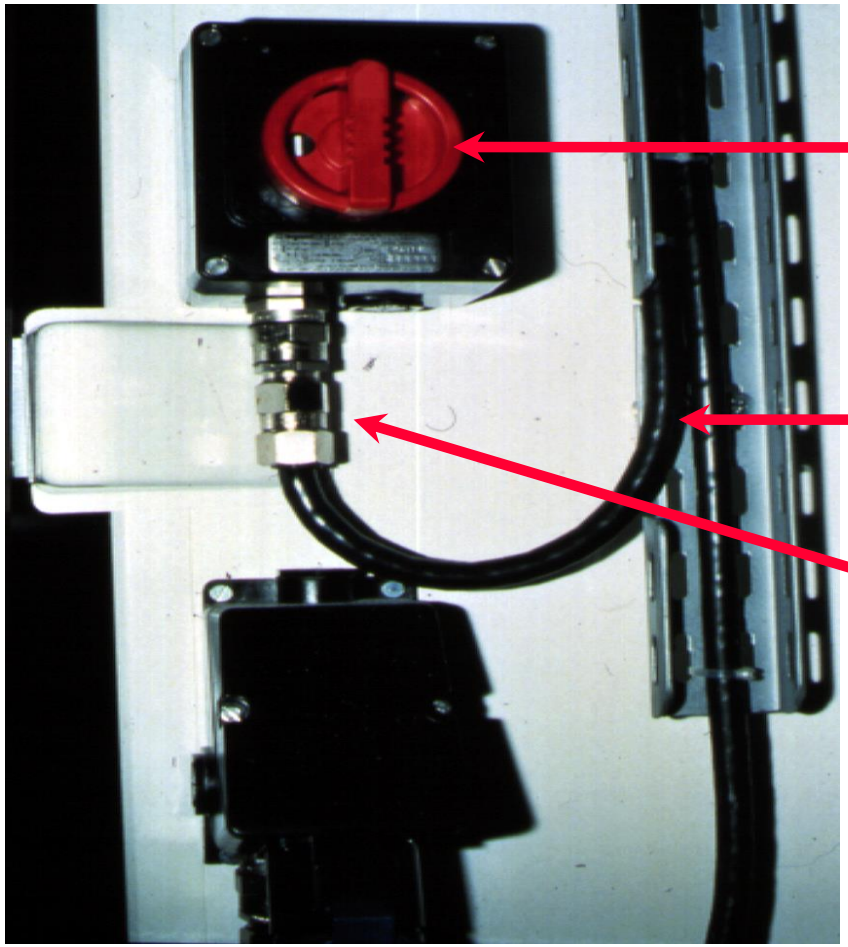
Methods of installation throughout the world

Selecting cable glands



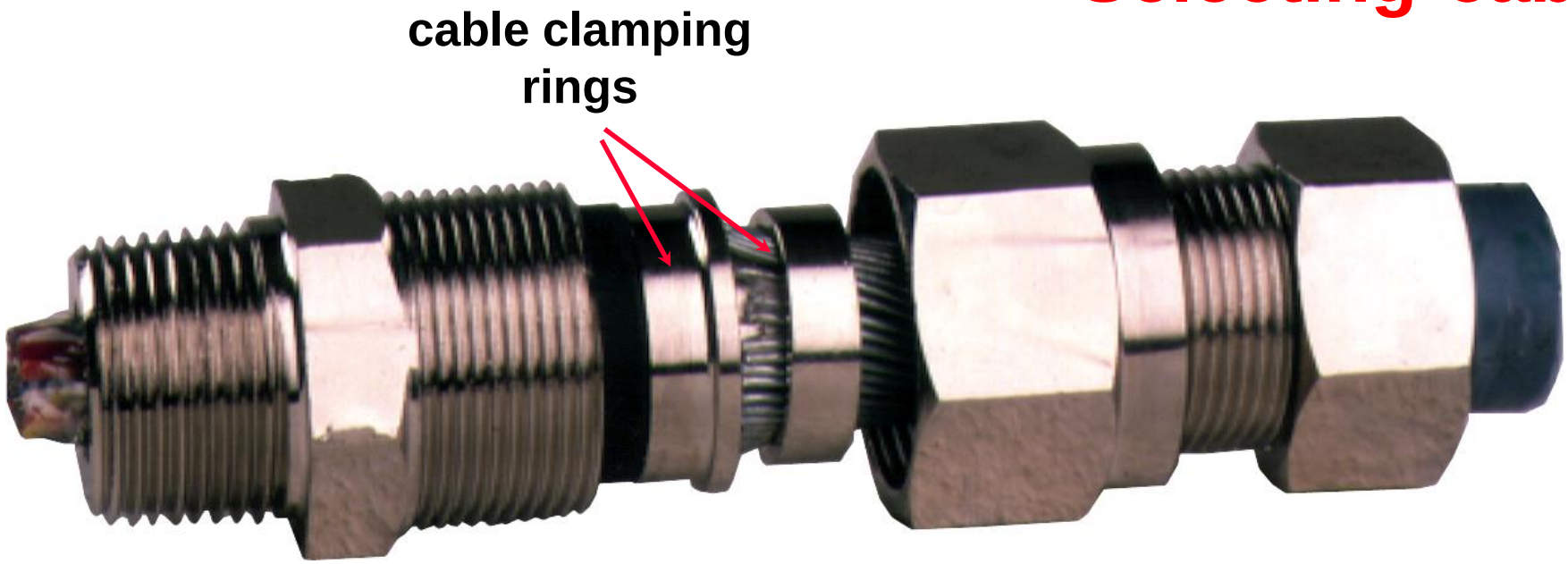
Methods of installation throughout the world

Selecting cable glands



Methods of installation throughout the world

Selecting cable glands



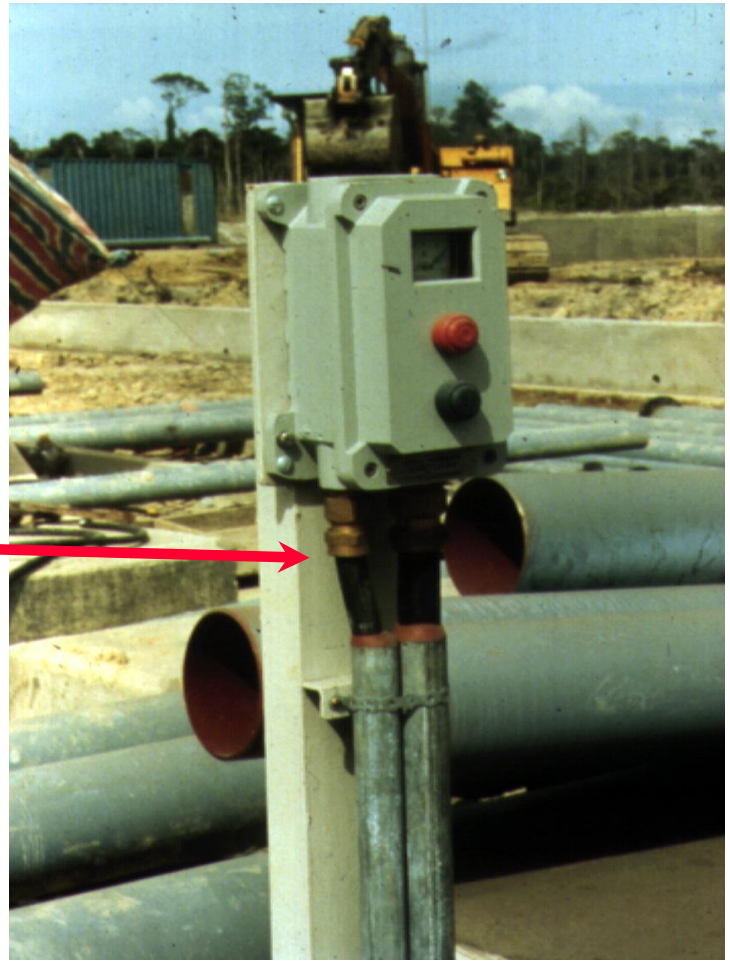
“e” cable gland for an armoured cable and earth continuity

NB: this type of gland ensures the earth continuity of the armoured cable

Methods of installation throughout the world

Selecting cable glands

“d” cable gland



Methods of installation throughout the world

Selecting cable glands

Compound

seal

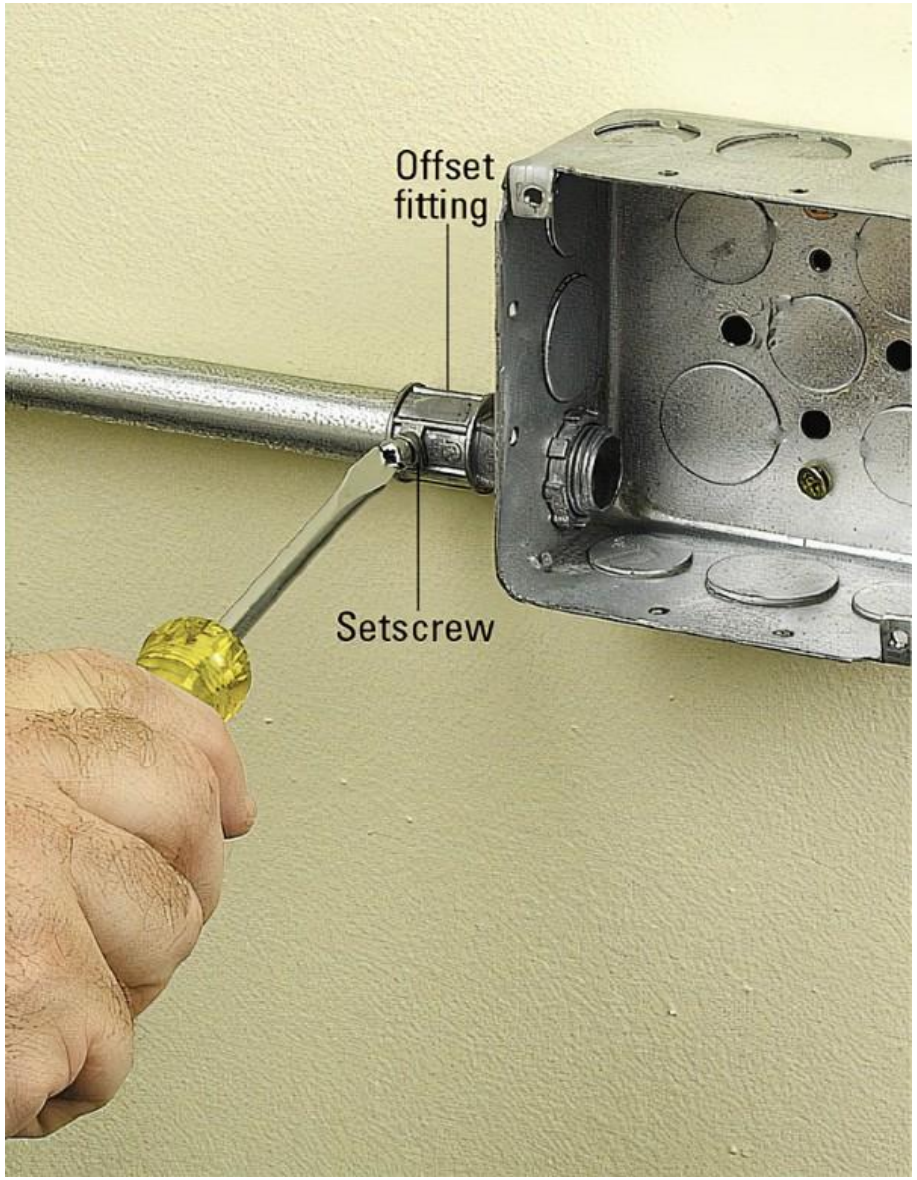
- The connection between the conduit and the electrical device is achieved using a seal
- The connector is filled with a sealing compound ➡ (to prevent an explosion from spreading through the conduits)

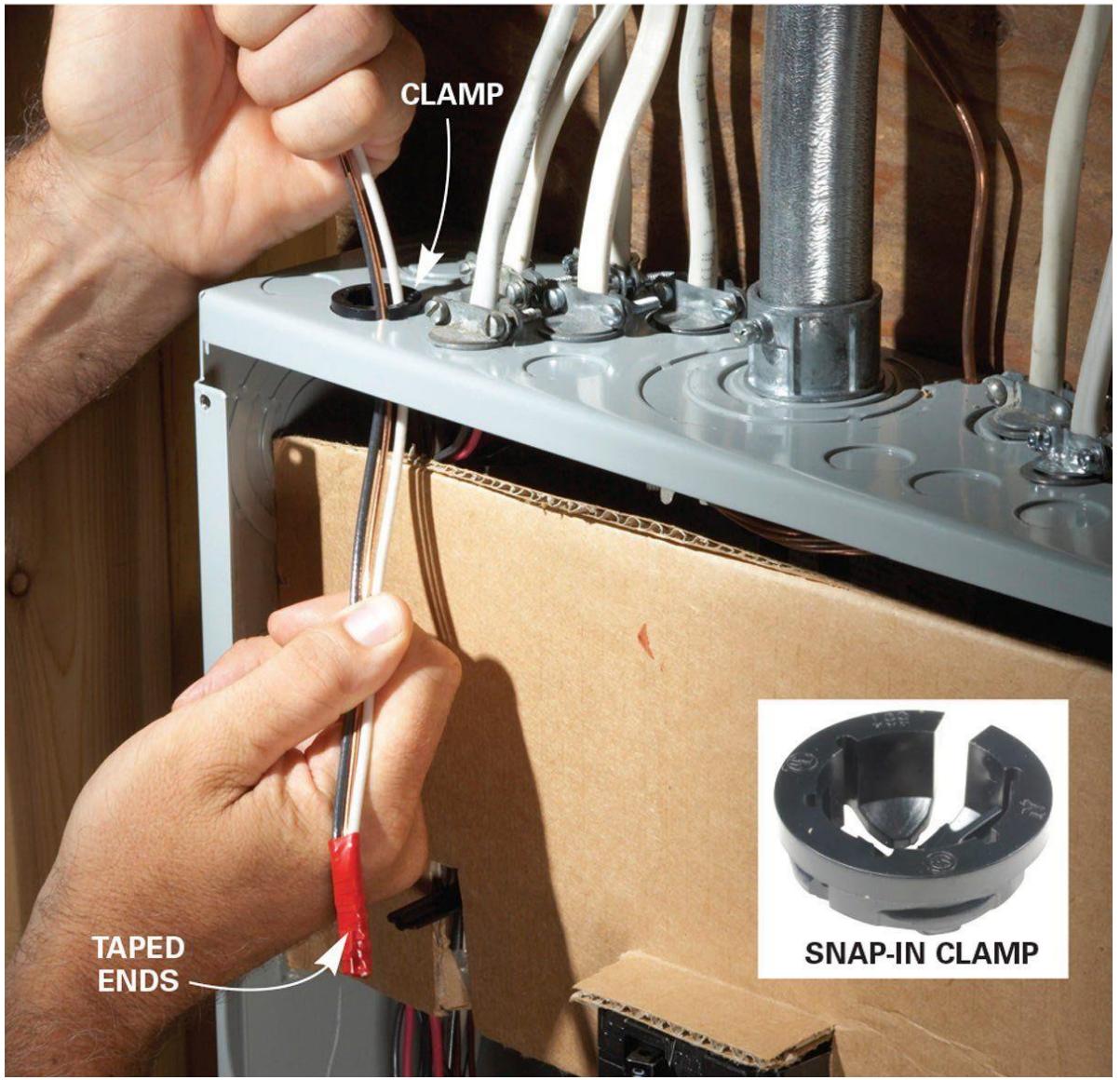
Methods of installation throughout the world

Advantages of an installation with cable glands compared to a conduit installation

- More competitive prices
- No need to thread the conduits on site
- No generalized seals
- Easier maintenance, inspection and extensions
- Far fewer problems with corrosion

Conduit installation





Installation with cable gland

What do you think?

EX !!!

What do you think?

EX !!!

Ingress Protection

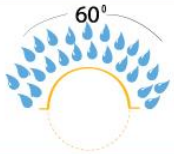
- **IP classification system** designates the degree of protection provided by an enclosure against **impact** and **water or dust penetration (ingress).**

- **It has two numbers;**
  - **First:** Protection against **solid objects**,
  - **second:** Protection against **water.**

Protection Against Solid Bodies Data Table

0	Tests	No Protection
1		Protected against solid bodies larger than 50 mm (eg. accidental contact with the hand)
2		Protected against solid bodies larger than 12.5 mm (eg. finger of the hand)
3		Protected against solid bodies larger than 2.5 mm (eg. tools, wires)
4		Protected against solid bodies larger than 1 mm (eg. fine tools, small wires)
5		Protected against dust (no harmful deposit)
6		Completely protected against dust

Protection Against Liquids Data Table

0	Tests	No Protection
1		Protected against vertically-falling drops of water (condensation)
2		Protected against drops of water falling at up to 15° from the vertical
3		Protected against drops of water falling at up to 60° from the vertical
4		Protected against projections of water from all directions
5		Protected against jets of water from all directions
6		Completely protected against jets of water of similar force to heavy seas
7		Protected against the effects of immersion
8		Protected against effects of prolonged immersion under specific conditions

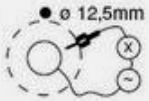
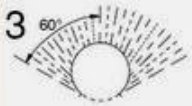
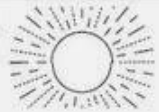
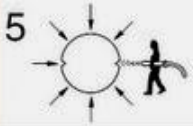
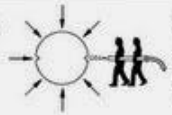
EXAMPLE: IP 54

IP Rating

IP Number	First Digit - SOLIDS	Second Digit - LIQUIDS
IP60	Protected from total dust ingress.	Not protected from liquids.
IP61	Protected from total dust ingress.	Protected from condensation.
IP62	Protected from total dust ingress.	Protected from water spray less than 15 degrees from vertical.
IP63	Protected from total dust ingress.	Protected from water spray less than 60 degrees from vertical.
IP64	Protected from total dust ingress.	Protected from water spray from any direction.
IP65	Protected from total dust ingress.	Protected from low pressure water jets from any direction.
IP66	Protected from total dust ingress.	Protected from high pressure water jets from any direction.
IP67	Protected from total dust ingress.	Protected from immersion between 15 centimeters and 1 meter in depth.
IP68	Protected from total dust ingress.	Protected from long term immersion up to a specified pressure.
IP69K	Protected from total dust ingress.	Protected from steam-jet cleaning.
1. IEC 60529, “degrees of Protection Provided by Enclosures (IP Codes),” Ed. 2.1 (Geneva: International Electrotechnical Commision, 2011)		
2. IEC 60529 (Ed. 2.1), clause 4.1.		

IP Rating

IP Yalıtım Standartları

Birinci karakteristik rakam		İkinci karakteristik rakam	
1 	50mm'den büyük katı cisimlere karşı korumalı	1 	Dik olarak damlayan suya karşı koruma
2 	12.5 mm'den büyük katı cisimlere karşı koruma	2 	15 dereceye kadar dikey olarak damlayan suya karşı korumalı
3 	2.5 mm'den büyük katı cisimlere karşı koruma	3 	60 dereceye kadar dikey olarak su püskürtmesine karşı korumalı
4 	1 mm'den büyük katı cisimlere karşı korumalı	4 	Her yönden sıçrayan suya karşı korumalı
5 	Toza karşı korumalı	5 	Her yönden püskürtülen su jetine karşı korumalı
6 	Toz geçirmez	6 	Her yönden püskürtülen şiddetli su jetine karşı korumalı
		7 	Geçici suya daldırmanın etkilerine karşı korumalı
		8 	Su altında bırakılmanın etkilerine karşı korumalı

IP ratings

Examples of IP Ratings and Uses			
Low IP ratings are appropriate for		High IP ratings are appropriate for	
1	Indoor use	1	Unsealed outdoor locations
2	Protected use inside sealed products	2	Places that have a lot of debris
3	Inside sealed signage	3	Areas with heavy foot traffic
4	When using aluminum extrusions	4	High splash areas
		5	High contact areas (people touching them)
		6	Wet locations

What if hazardous area is wrongly classified ?

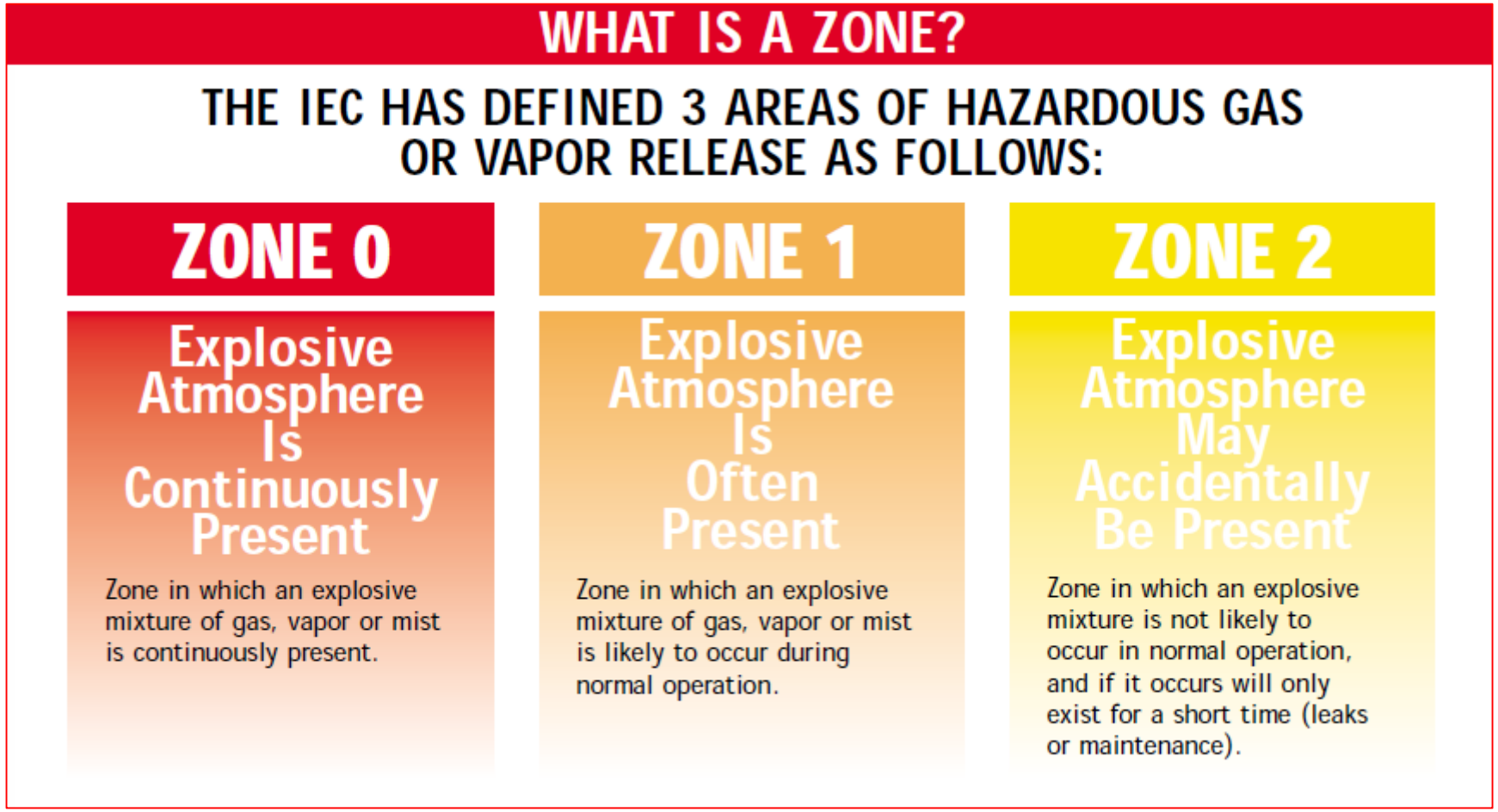
- Unnecessarily pay more money
- More Maintenance Costs
- Facility will incur more costs over its lifecycle.
- Cost could be high as they may result in unwanted explosion leading to loss of life and property

Methods of classifying Hazardous area

- API 500 (American Petroleum Institute) using Division method only for petroleum industries.
- European Standards IEC using ZONING method for general industries .
- API 505 For Petroleum industry using zoning method.
- North America using classes and divisions, Class I for Gas, Class 2 for Dust and Class 3 for Fiberd.

SUMMEERY

European System /IEC



North American System/ NEC

- This system consists of **Classes** , **Divisions & Groups**:

Class I :locations in which flammable gases, flammable liquids-produced vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures ,

Class II :locations that are hazardous because of present of combustible dust.

Class III :locations that are hazardous because of the presence of easily ignitable fibers.

North American System

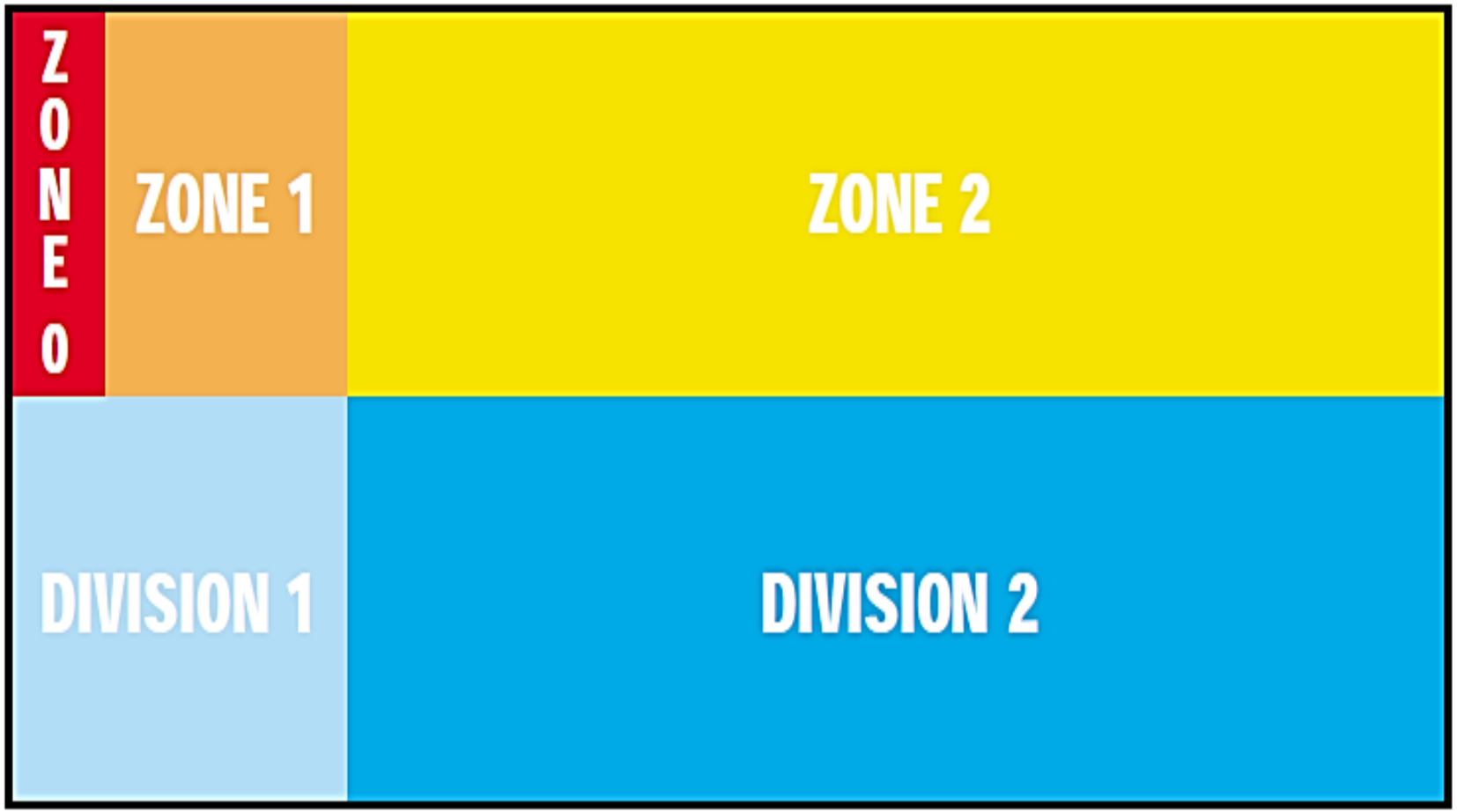
- In the **North American System** each **Class** has several **Groups** under it.

Class	Group	Example Material
Class I	A	Acetylene
Class I	B	Hydrogen
Class I	C	Ethylene
Class I	D	Propane

Class	Group	Example Material
Class II	E	Aluminium, Magnesium dusts
Class II	F	Atmosphere containing combustible carbonaceous dusts like coal and coke
Class II	G	Dusts that are not included in E or F like flour and grain dust

COMPARING IEC ZONES AND NEC® DIVISIONS

IEC NEC



Temperature Classification

Why This Is Necessary ?

As a hot surface can provide sufficient energy to ignite flammable mixtures of vapors , gases or dusts in the hazardous area.

IEC

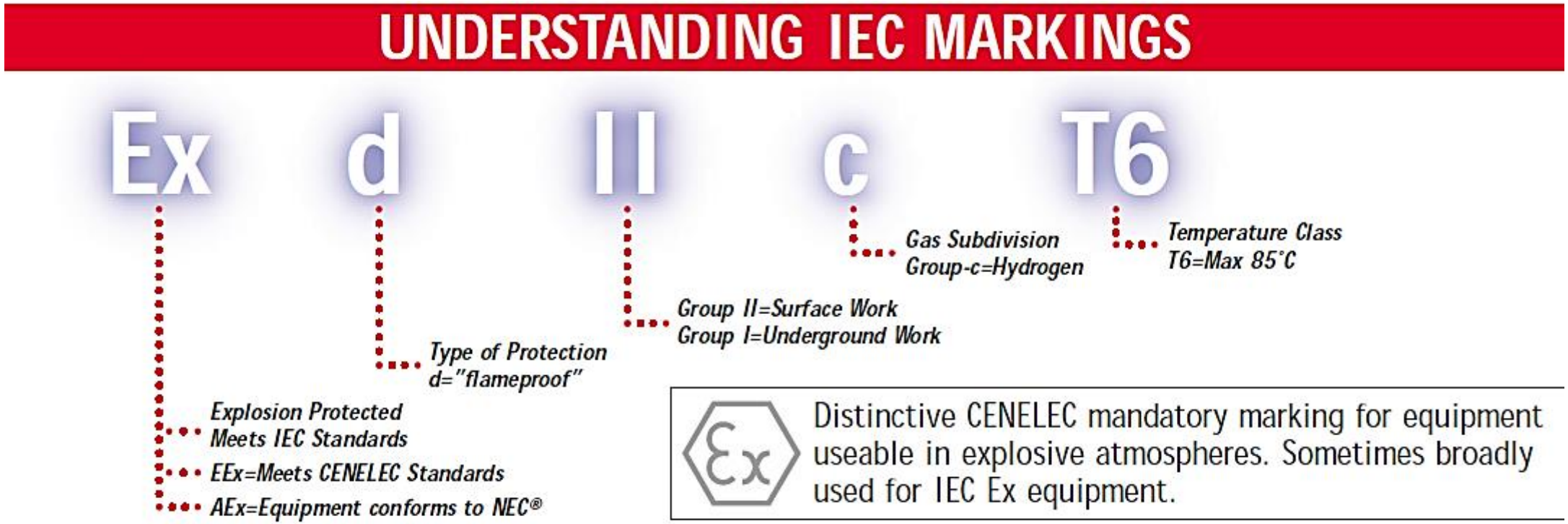
Temperature Class	Max Surface Temperature
	^{0}C
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

North America /NEC

Maximum Temperature ^{0}C	Maximum Temperature ^{0}F	Code
450	842	T1
300	572	T2
280	536	T2A
260	500	T2B
230	446	T2C
215	419	T2D
200	392	T3
180	356	T3A
165	329	T3B
160	320	T3C
135	275	T4
120	248	T4A
100	212	T5
85	185	T6

Protection method	Identification letters	Permitted in zone	Principle
Flameproof	d	1 or 2	Containment
Intrinsic safety (zone 0)	ia	0, 1, 2	Energy limited
Intrinsic safety (zone 1)	ib	1 or 2	Energy limited
Pressurization	p	1 or 2	Expels vapors
Increased safety	e	1 or 2	No arcs
Immersed in oil	o	1 or 2	Arc immersion
Filled with powder/sand	q	1 or 2	Arc immersion
Encapsulated	m	1 or 2	Hermetic seal
Apparatus with "n"* protection	n	2	No sparking

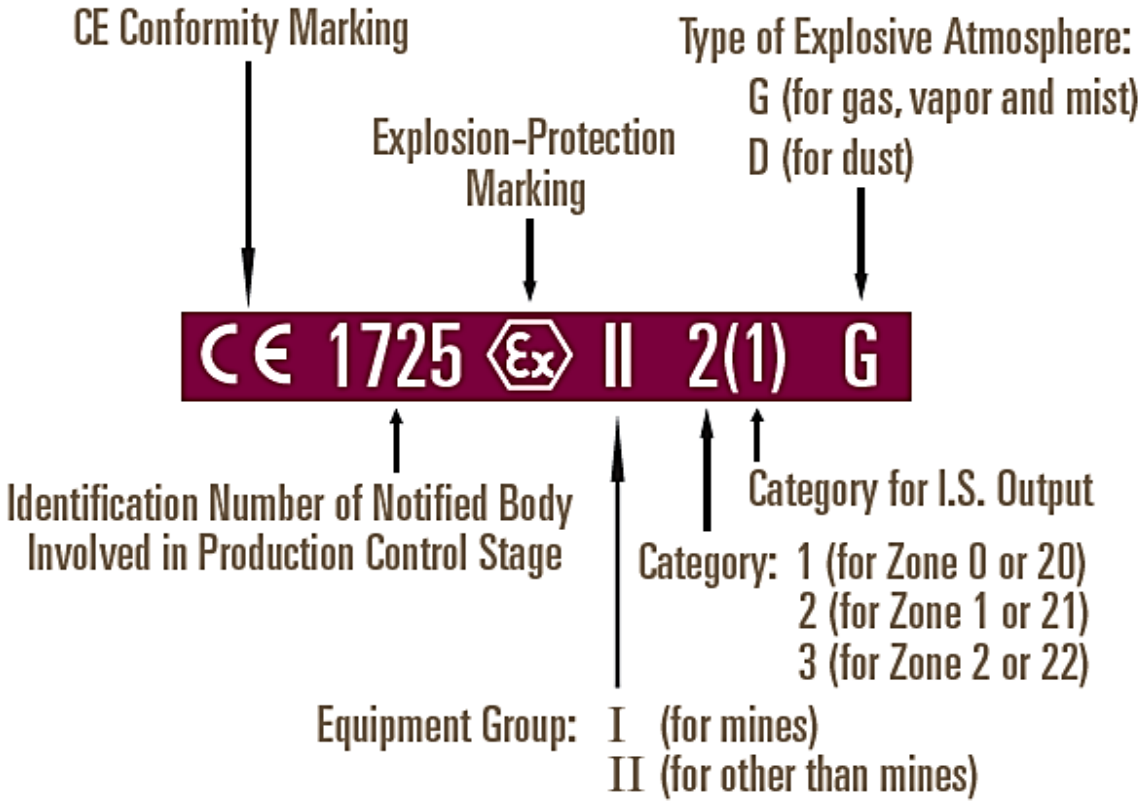
Ex Marking

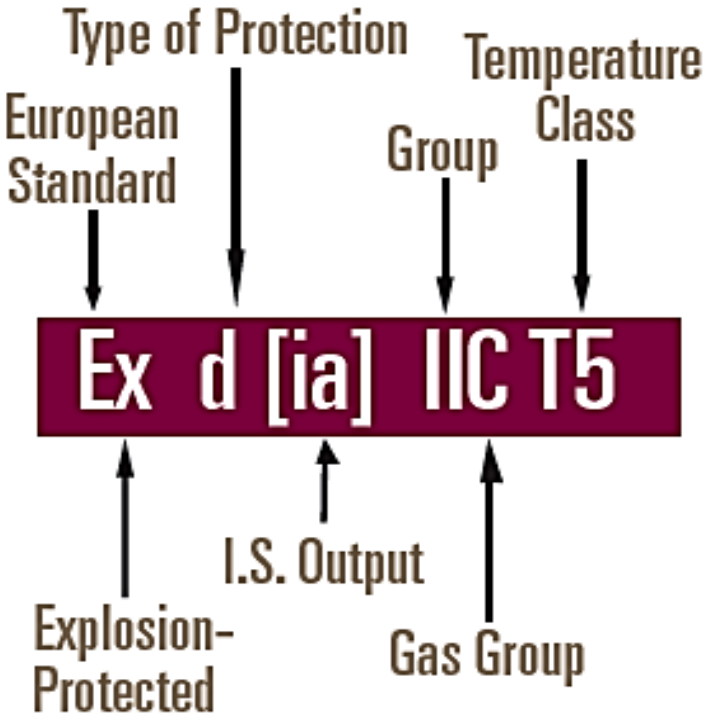


CENELEC: European committee for electrotechnical standardization

Ex Marking

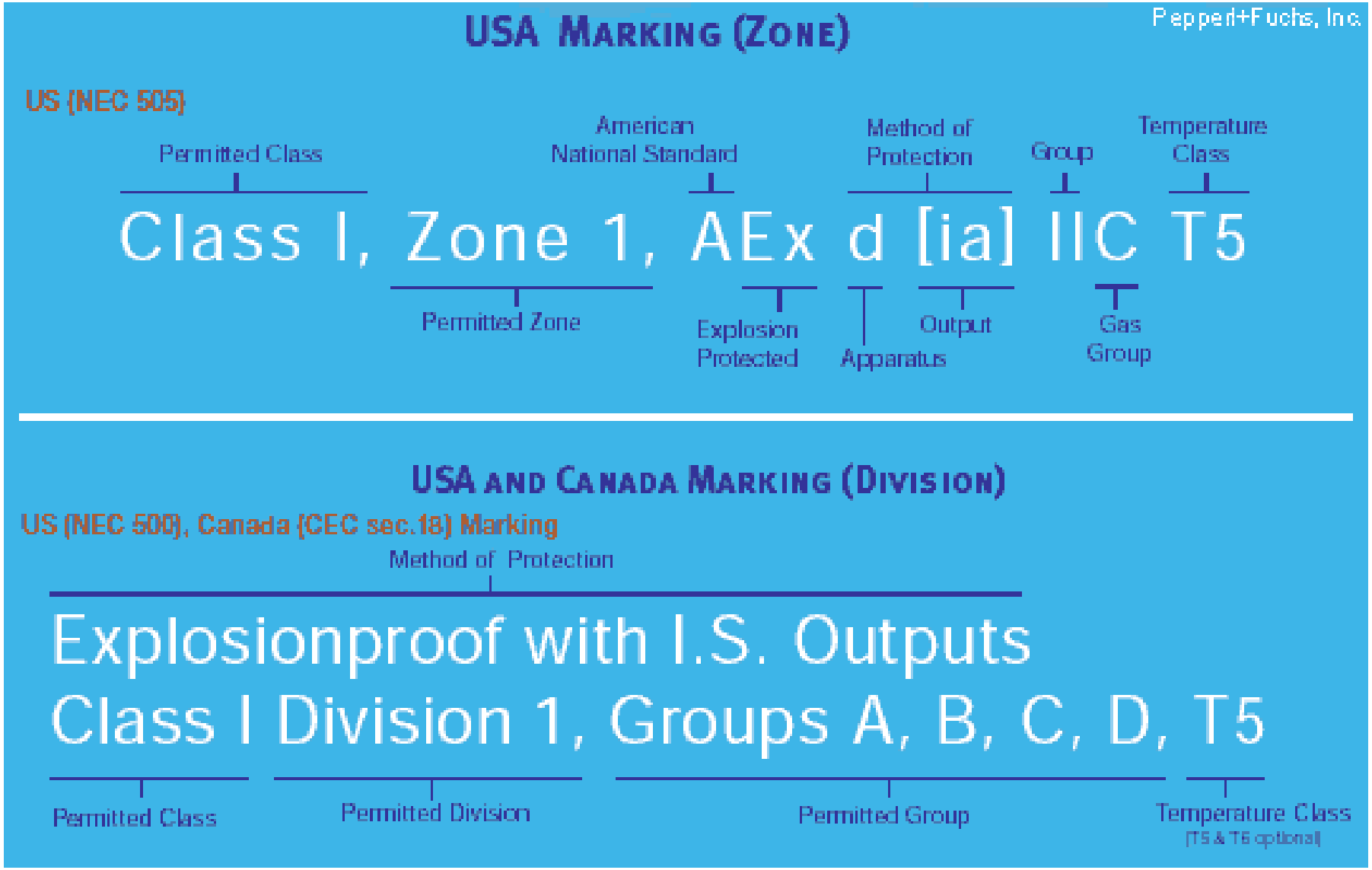
ATEX MARKING SYSTEM





ATEX: Explosive Atmosphere

NEC Marking


USA Marking (Zone)
Pepperl+Fuchs, Inc.
US (NEC 505)
Permitted Class
American National Standard
Method of Protection
Group
Temperature Class
Class I, Zone 1, AEx d [ia] IIC T5
Permitted Zone
Explosion Protected
Apparatus
Output
Gas Group
USA and Canada Marking (Division)
US (NEC 500), Canada (CEC sec.18) Marking
Method of Protection
Explosionproof with I.S. Outputs
Class I Division 1, Groups A, B, C, D, T5
Permitted Class
Permitted Division
Permitted Group
Temperature Class
(T5 & T6 optional)

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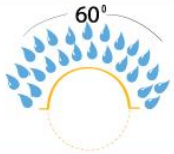
3		Protected against drops of water falling at up to 60° from the vertical
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EXAMPLE: IP 54

How to carry out area classification?

Step by step

STEP 1 :

Decide on the standard that would be followed (IEC- NEC)

STEP 2 :

Check out the lay out of the facility or the plant, the quantities that are handled in the process plant

STEP 3 :

what is the material temperature classification of these materials ?flash points, auto ignition temperature, density of vapor/ gas (lighter or heavier than air)

How to carry out Area Classification?

Step by step

STEP 4 :

- Divide the plant into different units
- Start to evaluate the sources of release of unit
- Classify them as continuous grade, primary grade or secondary grade
- Tabulate them findings in a worksheet and mark these on the general arrangement drawing of the unit

STEP 5 :

Evaluate ventilation in the area (closed or open) how does the wind go? Does the wind direction remain the same or changed if the vapor cloud formed , how far it will travel along with the wind ? Are there are any places where escaped vapors may accumulate

Sources of release

Continuous Grade

This is a source from where a vapor or gas gets continuously discharged (or for long continuous periods) to the surrounding air, during **normal** operations, which may result in the mixture of the vapor and air forming an explosive mixture.

Primary Grade

This is a source from where the vapor or gas gets discharged to the surrounding atmosphere, only intermittently during **normal** operations. This discharged vapor can form explosive mixtures with air and be the cause of an explosion.

Secondary Grade

This refers to release sources that are capable of releasing such vapors only sometimes, that too under some **abnormal** conditions. Hence such vapors may form explosive mixtures with the

How to carry out Area Classification?

Step by step

STEP 6 :

based on the findings on step 4&5 and the standard you are following mark the hazardous area on the drawings these extents will be surrounding the release points that have been marked in step4

STEP 7 :

Divide the hazardous area into divisions or zones (depending on the standard you are using)

Consequence of Poor area classification

- Over Classification – White Elephant
- Under Classification – Playing with Fire
- Proper Area Classification is the virtuous in between

Over classification- A White Elephant

- Increase **capital expenditure** on **new projects** due to more expensive equipment being specified
- **Increase operations and maintenance expenditure** of an existing facility as **replacement parts** will become more expensive maintenance work permits will be stringent and time consuming leading **to higher costs**
- **Unnecessary label** your facility dangerous in the **local community**
- Increase your **insurance premiums**

Under classification – Playing With Fire

- **Increase The Risks of your plant** or facility without anybody knowing it, especially the top management.
- In case of an **unfortunate accident expose** you and your company to **lawsuits.**
- Give lot **of bad press to your** company and even threaten its existence