HAZARDOUS AREA CLASSIFICATIONS

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HSE Manager
HAZARDOUS/ CLASSIFIED AREAS DEFINITIONS
DEFINISI DAERAH BERBAHAYA

An area shall be deemed to be a hazardous area, where:
Hazardous area is an area in which an explosive gas atmosphere is present, or likely to be present.
WHY DO WE NEED TO CLASSIFY AREAS?

Hazardous Area Classification is a method of analyzing and classifying the environment where explosive gas atmospheres may occur to allow the proper selection of electrical apparatus to be installed in that environment.
Background

• 1923 - Hazardous locations first appear in the NEC

• 1935 - Classes added to the concept

• 1947 - Divisions added

• RP 500 and NFPA 497 primary sources of guidance for Area Classification

• NEC provided guidance for equipment selection and installation methods

• API RP 505
Methods of Classifying Hazardous Area

• API 500 – American Petroleum Institute - using Divisions Method only for Petroleum Industries

• NEC, European Standards, API 505 - using Zoning Method for general industries including Petroleum: Class I is for Flammable/Explosive/gas Mixtures, Class II is for Combustible Dusts, Class III is for fibers

• Oil & Gas Industries usually API- RP500 to identify Hazardous Area Classification on all of its installations
AREA CLASSIFICATIONS

API RP 500 - Classification of location for electrical Installation at Petroleum Facilities

Class I: A location which flammable gasses or vapors are, or may be present in the air quantities sufficient to produce explosive or ignitable mixtures.

Class II liquids: liquids having Flash Point (FP) above 37.8° C or 100° F and below 60° C or 140° F

Class IIIA liquids: liquids having Flash Point (FP) at or above 60° C or 140° F and below 93° C or 200° F

Class IIIB liquids: liquids having Flash Point (FP) at or above 93° C or 200° F

API 505 – NEC (National Electrical Codes), article 505 - with a scope limited to the Petroleum Facilities, NFPA 497

Class I Flammable, gases, vapors or liquids
Class II Combustible dusts
Class III Ignitable fibers and flyings
CLASS I, DIVISION 1 - API 500

- Flammable gas or vapor concentration is likely to exist in the air under normal operating conditions
- Flammable atmospheric concentration is likely to occur frequently because of routine maintenance, or operations
- The area below the surrounding elevation or grade is such that flammable liquids or vapors may accumulate therein
Typical areas

- Inadequately ventilated pump rooms for flammable gas or for volatile, flammable liquids
- Venting
- Oily waste water sewer / basins
CLASS I, DIVISION 2 - API 500

- Flammable gas or vapor concentration is likely to exist in the air only under abnormal operating conditions.
- Vapours or gases will normally be confined within closed containers or closed systems from which they can escape only during abnormal conditions such as accidental release/leak.
- Locations adjacent to Division 1 areas.
- Ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation.
CLASS I, DIVISION 2 - API 500

Typical areas

- Areas where the piping system is without valves, fittings, flanges
- Areas where permanent ignition sources are present, for example flare pits, tips,
A Class I, Zone 0 location is a location where ignitable concentrations of flammable gases, vapors or liquids; are present continuously; or are present for long periods or time.
A Class I, Zone 1 location is a location where ignitable concentrations of flammable gases, vapors or liquids:
- are likely to exist under normal operating conditions;
- may exist frequently because of repair or maintenance operations;
- adjacent to a Zone 0 location.
A Class I, Zone 2 location is location where:

- Flammable gas or vapor concentration is likely to exist in the air only under abnormal operating conditions.
- Volatile flammable liquids or flammable gases or vapor exist, but are normally confined within closed containers and adequately ventilated.
- Ignitable concentrations of gases, vapors or liquids are normally prevented by positive mechanical ventilation.
- Adjacent to a Zone 1 location.
# CLASS I DIVISION/ ZONE AREA CLASSIFICATION COMPARISON

<table>
<thead>
<tr>
<th>Division 1:</th>
<th>Zone 0:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where ignitable concentrations of flammable gases, vapors or liquids can exist all of the time or some of the time under normal operating conditions.</td>
<td>Where ignitable concentrations of flammable gases, vapors or liquids can exist all of the time or for long periods of time under normal operating conditions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Division 2:</th>
<th>Zone 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where ignitable concentrations of flammable gases, vapors or liquids are not likely to exist under normal operating conditions.</td>
<td>Where ignitable concentrations of flammable gases, vapors or liquids are not likely to exist under normal operating conditions.</td>
</tr>
<tr>
<td>API 500</td>
<td>API 505</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>CLASS I, ZONE 0</td>
<td></td>
</tr>
<tr>
<td>CLASS I, DIVISION 1</td>
<td>CLASS I, ZONE 1</td>
</tr>
<tr>
<td>CLASS I, DIVISION 2</td>
<td>CLASS I, ZONE 2</td>
</tr>
</tbody>
</table>
CONDITION AFFECTING EXTENT OF HAZARDOUS AREAS

- Ventilations
- Enclosure
- Distance
EXTENT OF HAZARDOUS AREA CLASSIFICATIONS

Figure 2—Adequately Ventilated Nonenclosed Area Adjacent to a Classified Area (See Section 6.7.1)

Figure 3—Enclosed Area Adjacent to a Classified Area (See Section 6.7.2)
Figure 4—Enclosed Area Adjacent to a Classified Area (See Section 6.7.3)
Figure 8—Combustible Liquid Storage Tank in a Nonenclosed Adequately Ventilated Area
(Sec 8.2.1.3)

Note:
The interior of the vent piping is Zone 1. Cross hatching has been omitted for drawing clarity.
A. Vents not subject to discharging continuously or for long periods of time.

B. Vents discharging continuously or for long periods of time.

Legend:
- Zone 0
- Zone 1
- Zone 2
Figure 21—Adequately Ventilated Process Location With Heavier-Than-Air Gas or Vapor Source Located Above Grade
(See Section 8.2.1.1)

Note:
Distances given are for typical refinery installations; they must be used with judgement, with consideration given to all factors discussed in the text. In some instances, greater or lesser distances may be justified.
Figure 28—Drilling Rig, Adequate Ventilation in Substructure, and Derrick is Not Enclosed, But is Equipped With a Windbreak, Open Top, and Open V-Door
(See Section 10.4.1.1.)
Figure 31—Platform Drilling Rig, Adequately Ventilated in Substructure and Inside Derrick, Several Drilling Walls Beneath in an Adequately Ventilated Area (See Section 10.4.1.2.)
Notes:
1. This area classified due to proximity to cargo tanks.
2. Areas more than 3m (10 ft) above the weatherdeck are unclassified except as required by the acoustic for production equipment detailed herein.
3. Air vent must:
   a) continuously ventilated at 2.2 m³ / minute for each ton of cargo, and
   b) be designed so as to prevent entry of combustible gas.
4. Gas detectors must be installed in accordance with section 1.6.2.1.
5. If ventilated air changes per hour, Rec of ventilation is not met, or gas detectors are not installed, then the area is classified Zone 1.
6. All areas are subject to the hightest space requirements of section 12.4.
7. Cargo is defined as a flammable gas or liquid or flammable or combustible liquid with a flashpoint below 50°C (122°F).

Figure 06. Typical Floating Production Storage and Offloading Unit (FPSO) (See Section 12.2.1)
Vent: outlet for free flow of high velocity vapor mixtures. Vent outlet for passage of large amount of vapor, air or inert gas mixtures during cargo handling, and ballasting or during discharge. Also for vent outlet for cargo pressure/vacuum valve...

7m (21')

3m (10')

(Note 4)

Weather deck

(Note 1)

(Note 2)

(Cargo tanks
(Notes)

Adjacent spaces must meet the requirements of section 12.5 (Typical, see Note 5)

Cargo handling room (Note 3)

Endosed space immediately above, below, or next to a cargo tank.
SELECTION OF ELECTRICAL EQUIPMENT IN HAZARDOUS AREAS
EXPLOSION-PROTECTION EQUIPMENT
What is Explosion Protected Equipment?

Equipment which is constructed in such way that one of the 3 elements of fire triangle is removed, such that the possibility of explosion is eliminated.
oxygen

Fuel

Ex ‘p’
Ex ‘o’
Ex ‘m’
Ex ‘v’

Ex ‘d’
Ex ‘q’

Ex ‘n’
Ex ‘e’
Ex ‘i’

Heat/ Sparks

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EXPLOSION-PROTECTION METHODS / EQUIPMENT

Popular types

- Flameproof (EX d)
- Increased Safety (Ex e)
- Non-Sparking (Ex n)
- Pressurization (Ex p)
- Intrinsically Safe (Ex i)
OTHER TYPES OF EXPLOSION PROTECTION

Un Popular types

- Powder filled \textit{Ex} ‘q’ type
- Oil immersed \textit{Ex} ‘o’ type
- Special \textit{Ex} ‘s’ type
- Encapsulated \textit{Ex} ‘m’ type
- Ventilated \textit{Ex} ‘v’ type
EXPLOSIONPROOF EQUIPMENT

Equipment that has an enclosure capable of:

• withstanding an explosion of specified gas or vapor that is expected to occur within the enclosure
• preventing the ignition of specified gas or vapor surrounding the enclosure due to sparks, flashes or explosion of the gas or vapor within the enclosure, and
• operating at an external temperatures that will not ignite a specified gas or vapor surrounding the enclosure
WITHSTANDING THE PRESSURE OF AN EXPLOSION

The ability of an enclosure to withstand an explosion without rupture or permanent distortion is dependent upon:

- the strength of the enclosure material
- securement means, such as bolts, nuts

The strength of the enclosure material and securement means is determined by the following requirements:

- type of metal or metal alloy (zinc & magnesium are not allowed)
- type of plastic (including resistance to chemical atmospheres)
- casting / molding design
- hydrostatic pressure testing
EX ‘d’ Type FLAMEPROOF EQUIPMENT

(US- Explosion-Proof, UK- Flame-Proof, GERMANY - Pressure-Proof)

A type of protection in which withstanding an internal explosion of a flammable mixture of a specified gas or vapor mixture, relieve the internal explosion/ pressure via enclosure flame paths such as lids and glands. Prevent transmission of hot gasses and flame through joints or apertures in the enclosure assembly such as would ignite the external explosive atmosphere.
EXPLOSION PROOF

When an explosion occurs, the surrounding hazardous environment is not exposed to hot gases or hot surfaces.

AN EXPLOSION PROOF ENCLOSURE

<table>
<thead>
<tr>
<th>EXPLOSION-PROOF PLUSES &amp; MINUSES</th>
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<tbody>
<tr>
<td><strong>Plus</strong></td>
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<tr>
<td>Good, robust box</td>
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<tr>
<td>Predominant in U.S.</td>
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<tr>
<td>Safe area equipment need not be certified</td>
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<tr>
<td>Frequently not temperature classified</td>
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<tr>
<td>Allow high powered devices</td>
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<tr>
<td>Installation and maintenance skills commonly available</td>
</tr>
<tr>
<td><strong>Minus</strong></td>
</tr>
<tr>
<td>Heavy box, material choice limited</td>
</tr>
<tr>
<td>No fire maintenance</td>
</tr>
<tr>
<td>Conduit seals, tapered thread</td>
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<tr>
<td>Entry make changes difficult</td>
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<tr>
<td>Not accepted in many areas of the world</td>
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</tbody>
</table>

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Hazardous Location Equipment Seals

Seals are placed in threaded conduit.

Area and sparks contained within an approved housing.

Seals limit the explosion to an area close to the source.

The equipment is designed so that only cool gases are allowed to vent to the surrounding hazardous area.
Flame Paths

Hot gases escape through openings designed into threaded joint.

Openings designed into threaded joint.

Explosion-proof enclosure

Accurately machined ground joint of flange, maximum gap 0.0015 in.

Minimum flame path length is 3/8 inch

Cool gases

Threaded boss

Openings designed into ground joint.
Hot gases are cooled as they pass through the threads.

Only cooled gases escape.

Threaded join 5 full threads minimum.
Hot gases are cooled as they pass across a machined flanged joint.
Effect of internal explosion on cover-to-body joint
INTRINSICALLY SAFE EQUIPMENT & CIRCUITS (Ex ‘i’)

A type of protection which any energy/heat released by the electrical equipment is incapable of causing ignition of a given explosive atmosphere.

Ex ‘ia’ incapable of causing ignition in normal operation, with either a single fault, or any combination of two faults applied.

Ex ‘ib’ incapable of causing ignition in normal operation, with single fault applied.
AN INTRINSIC SAFETY SYSTEM

TABLE 1: INTRINSIC SAFETY ADVANTAGES & DISADVANTAGES

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosure to suit</td>
<td>Low power limits</td>
</tr>
<tr>
<td>Suitable for Zone 0</td>
<td>Engineering knowledge</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Requirements</td>
</tr>
<tr>
<td>Internationally accepted</td>
<td>Installation &amp; maintenance</td>
</tr>
<tr>
<td>Live maintenance</td>
<td>Knowledge requirements</td>
</tr>
</tbody>
</table>
INCREASED SAFETY EQUIPMENT (Ex ‘e’)  

A type of protection which is designed and rated to prevent an explosion and reduce the risk of both explosive/flammable gas ingress and an ignition source.

Generally there are 3 aspects that are covered by the additional safety measures:

• Parts that may cause sparks in normal use
• Creepage and clearance distance to prevent tracking
• Prevention of any part of the equipment, including internal components, from exceeding the temperature rating equipment
PRESSURIZATION TYPE (Ex ‘p’) 

A type of protection by which the entry of surrounding atmosphere into the enclosure of the electrical apparatus is prevented by continuous pressure from a supply of uncontaminated air or other non flammable gas, maintaining the internal pressure above the external atmospheric pressure.
NON-SPARKING TYPE EQUIPMENT (Ex ‘n’ )

A type of protection applied to electrical apparatus where the material used in this type of equipment will not produce any sparks such that it is not capable of igniting a surrounding atmosphere and a fault capable of causing ignition is not likely to occur.
POWDER FILLED TYPE EQUIPMENT (Ex ‘q’)

A type of protection applied to electrical apparatus where Equipment enclosure is filled with quartz /sand so that if any arc occurring within the enclosure of electrical equipment it will not ignite the surrounding atmosphere.
OIL IMMERSED TYPE EQUIPMENT (Ex ‘o’)

A type of protection applied to electrical apparatus where Equipment enclosure is filled or immersed in oil in such a way that an explosive atmosphere which, may be above the oil or outside the enclosure cannot be ignited.
Encapsulation Ex ‘m’

A type of protection applied to electrical apparatus where a device is encased in molded resin, such a way that an explosive atmosphere should not occur.
Hermetic Sealing Ex ‘h’

A type of protection applied to electrical apparatus where this devices is constructed such that external atmosphere can not gain access to the interior/ enclosure, in which a seal is made by fusion eg. Soldering, brazing.
SPECIAL TYPE EQUIPMENT (Ex ‘s’)

This is a concept that has been adopted to permit the certification of those types of equipment which by their nature, do not comply with the constructional or other requirements specified for equipment with established types of protection but which, nevertheless, can be shown, wherever necessary, by test to be suitable for use in hazardous areas in prescribed zones.
SELECTION OF ELECTRICAL EQUIPMENT IN HAZARDOUS AREAS

How to select equipment for various areas/locations?

Selection Criteria
- Gas Grouping (based on ignition energy)
- Temperature Classification
- Classified Zones/Division
Definition: MESG

MESG (Maximum Experimental Safe GAP)

The maximum clearance between two parallel metal surfaces that has been found, under specified test conditions, to prevent an explosion in a test chamber from being propagated to a secondary chamber containing the same gas or vapor at the same concentration.
MESG (Maximum Experimental Safe GAP) diagram
Definition : MIC Ratio

**MIC (Minimum Igniting Current) Ratio**
The ratio of the minimum current required to ignite the ignitable mixture of a gas or vapor, divided by the minimum current required to ignite methane gas.

The MIC ratio is based upon the use of methane gas as a base for comparison to the other gases in question.
CLASS I, DIVISION 1 & 2
GROUPS

- **GROUP A**
  - Acetylene

- **GROUP B**
  - Gases or vapors having
    - MESG $\leq 0.45$ mm or
    - MIC Ratio $\leq 0.40$

Examples are:
hydrogen, fuel and combustible process gases containing more than 30 percent hydrogen by volume, butadiene, ethylene oxide, propylene oxide, and acrolein
CLASS I, DIVISION 1 & 2 GROUPS (cont.)

GROUP C
Gases or vapors having:
- $0.45\text{ mm} < \text{MESG} \leq 0.75\text{ mm}$ or
- $0.40 < \text{MIC Ratio} \leq 0.80$
Examples are:
ethyl ether and ethylene.

GROUP D
Gases or vapors having:
- $0.75\text{ mm} < \text{MESG}$
- $0.80 < \text{MIC Ratio}$
Examples are:
acetone, ammonia, benzene, butane, cyclopropane, ethanol, gasoline, hexane, methanol, methane, naphtha, and propane
CLASS I, ZONE 0, 1 AND 2 GROUPS

GROUP II C
Atmospheres containing acetylene, hydrogen, or gases or vapors having:

- MESG ≤ 0.50 mm
- MIC Ratio ≤ 0.45
CLASS I, ZONE 0, 1 AND 2 GROUPS (cont.)

- **GROUP II B**
  Atmospheres containing ethylene or acetaldehyde, or gases or vapors having:
  - $0.50 \text{ mm} < \text{MESG} \leq 0.90 \text{ mm}$
  - $0.45 \text{ MIC Ratio} \leq 0.80$

- **GROUP II A**
  Atmospheres containing acetone, ammonia, ethyl, alcohol, gasoline, methane, propane or gases or vapors having:
  - $0.90 \text{ mm} < \text{MESG}$
  - $0.80 < \text{MIC Ratio}$
## CLASS I DIVISION / ZONE
### GAS GROUP COMPARISON

<table>
<thead>
<tr>
<th>API RP 500 Division 1 and 2</th>
<th>API RP 505/ NEC/ European Std. Zone 0, 1 and 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (acetylene)</td>
<td>II C (acetylene &amp; hydrogen, Butadiene, Ethylene Oxide, Propylene Oxide, and acrolein)</td>
</tr>
<tr>
<td>B (Hydrogen, Butadiene, Ethylene Oxide, Propylene Oxide, and acrolein)</td>
<td>II B (Ethyl Ether and Ethylene)</td>
</tr>
<tr>
<td>C (Ethyl Ether and Ethylene)</td>
<td>II A (Acetone, Ammonia, Benzene, Butane, Cyclopropane, Ethanol)</td>
</tr>
<tr>
<td>D (Acetone, Ammonia, Benzene, Butane, Cyclopropane, Ethanol, Gasoline, Hexane, Methanol, Methane, Naphta and Propane)</td>
<td></td>
</tr>
</tbody>
</table>
# TEMPERATURE CLASS COMPARISON

<table>
<thead>
<tr>
<th>DIVISION 1 and 2</th>
<th>ZONE 0, 1 and 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 ($\leq 450^0$ C)</td>
<td>T1 ($\leq 450^0$ C)</td>
</tr>
<tr>
<td>T2 ($\leq 300^0$ C)</td>
<td>T2 ($\leq 300^0$ C)</td>
</tr>
<tr>
<td>T2A,B,C,D ($\leq 280^0$ C, $\leq 260^0$, $\leq 230^0$, $\leq 215^0$)</td>
<td>-</td>
</tr>
<tr>
<td>T3 ($\leq 200^0$ C)</td>
<td>T3 ($\leq 200^0$ C)</td>
</tr>
<tr>
<td>T3A,B,C ($\leq 180^0$ C, $\leq 65^0$, $\leq 160^0$)</td>
<td>-</td>
</tr>
<tr>
<td>T4 ($\leq 135^0$ C)</td>
<td>T4 ($\leq 135^0$ C)</td>
</tr>
<tr>
<td>T4A ($\leq 120^0$ C)</td>
<td>-</td>
</tr>
<tr>
<td>T5 ($\leq 100^0$ C)</td>
<td>T5 ($\leq 100^0$ C)</td>
</tr>
<tr>
<td>T6 ($\leq 85^0$ C)</td>
<td>T6 ($\leq 85^0$ C)</td>
</tr>
</tbody>
</table>
CLASS I DIVISION I GROUP CD T3

CLASS I ZONE I GROUP IIA T3
# Equipment Certification Mark

## Testing Authorities - EEC and North America

<table>
<thead>
<tr>
<th>Authority</th>
<th>Country</th>
<th>Marks Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASFFFA</td>
<td>United Kingdom</td>
<td>Ex, FLP</td>
</tr>
<tr>
<td>PTB BVS</td>
<td>Germany</td>
<td>Ex, Sch</td>
</tr>
<tr>
<td>INERIS LCIE</td>
<td>France</td>
<td>MS, AE</td>
</tr>
<tr>
<td>CESI</td>
<td>Italy</td>
<td>AD-PE</td>
</tr>
<tr>
<td>ALL</td>
<td></td>
<td>Ex</td>
</tr>
<tr>
<td>Underwriters Laboratory</td>
<td>USA</td>
<td>UL</td>
</tr>
<tr>
<td>Factory Mutual</td>
<td>USA</td>
<td>Factory Mutual System Approved</td>
</tr>
<tr>
<td>CSA</td>
<td>Canada</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 2.3.2a*
RECOMMENDED PROTECTION METHODS FOR CLASS I, DIVISION 1

Motors - Ex d, Ex p
Transformers & Capacitors - Ex d
Control & Instrument Transformers - Ex i
Lighting Fitting - Ex d
Switch Gear & Control Gear - Ex d
Communication/ Telephone equipment/Meters - Ex i
Portable Hand Lamps - Ex i
RECOMMENDED PROTECTION METHODS FOR CLASS I, DIVISION 2

Motors- **Ex d, Ex p, Ex n, Ex e**
Transformers & Capacitors - **Ex d, Ex p** (auxiliary devices to be located in pressurized room/hermetically sealed / intrinsically safe)
Control & Instrument Transformers - **Ex i**
Lighting Fitting - **Ex d, Ex e, Ex n**
Switch Gear & Control Gear - **Ex d, Ex o, Ex**
Communication/ Telephone equipment/Meters - **Ex i**
Portable Hand Lamps- **Ex i**
RECOMMENDED PROTECTION METHODS
FOR ZONE 0

No electrical equipment should be allowed. When this is not practicable, Ex ‘ia’ apparatus or circuits to be used
<table>
<thead>
<tr>
<th>Area</th>
<th>Protection Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 0</td>
<td>Intrinsically Safe (2 fault), ‘ia’</td>
</tr>
<tr>
<td></td>
<td>Class I, Division 1 Intrinsically Safe (2 fault)</td>
</tr>
<tr>
<td>Zone 1</td>
<td>Encapsulated, ‘m’</td>
</tr>
<tr>
<td></td>
<td>Flameproof, ‘d’</td>
</tr>
<tr>
<td></td>
<td>Increased Safety, ‘e’</td>
</tr>
<tr>
<td></td>
<td>Intrinsically Safe (1 fault), ‘1b’</td>
</tr>
<tr>
<td></td>
<td>Oil Immersed, ‘o’</td>
</tr>
<tr>
<td></td>
<td>Powder Filled, ‘q’</td>
</tr>
<tr>
<td></td>
<td>Purged / pressurized, ‘p’</td>
</tr>
<tr>
<td></td>
<td>Any Class I, Zone 0 technique</td>
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<tr>
<td></td>
<td>Any Class I, Division 1 technique</td>
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</table>
# CLASS I, ZONE 2 PROTECTION TECHNIQUES

<table>
<thead>
<tr>
<th>Area</th>
<th>Protection Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 2</td>
<td>Energy Limited ‘nC’ (‘nL’ in EN50021)</td>
</tr>
<tr>
<td></td>
<td>Hermetically Sealed, ‘nC’</td>
</tr>
<tr>
<td></td>
<td>Nonincendive, ‘nC’</td>
</tr>
<tr>
<td></td>
<td>Non – Sparking, ‘nA’</td>
</tr>
<tr>
<td></td>
<td>Pressurization ‘nZ’ (‘nP’ in EN50021)</td>
</tr>
<tr>
<td></td>
<td>Restricted Breathing, ‘nR’</td>
</tr>
<tr>
<td></td>
<td>Sealed Device, ‘nC’</td>
</tr>
<tr>
<td></td>
<td>Any Class I, Zone 0 or 1 technique</td>
</tr>
<tr>
<td></td>
<td>Any Class I, Division1 or 2 technique</td>
</tr>
<tr>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------</td>
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<tr>
<td>Ex i</td>
<td>Intrinsic safety</td>
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<td></td>
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</tr>
<tr>
<td>Ex d</td>
<td>Flame proof (explosion proof in NFPA-70)</td>
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<tr>
<td>Ex e</td>
<td>Increased safety</td>
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<tr>
<td>Ex n</td>
<td>Non-sparking</td>
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<tr>
<td>Ex v1</td>
<td>Ventilation</td>
</tr>
<tr>
<td>Ex v2</td>
<td>Cooling</td>
</tr>
<tr>
<td>Ex p</td>
<td>Pressurised enclosure</td>
</tr>
<tr>
<td></td>
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<td>Ex p1</td>
<td>Purged enclosure</td>
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<td>Ex a</td>
<td>Usage specific protection</td>
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<td>Ex m</td>
<td>Encapsulated enclosure</td>
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<td>Ex e</td>
<td>Oil filled enclosure</td>
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<tr>
<td>Ex q</td>
<td>Sand (or glass) filled enclosure</td>
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<tr>
<td>Ex h</td>
<td>Hermatically sealed enclosure</td>
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| DIP | Dust excluding ignition proof | Exclusion of the hazard | All electrical equipment | AS 2238 | AS 2361.1 | AS 2361.10 | Class 2 |
Explosionproof Pushbutton Switch

Cylindrical Joint -->

Flat Joint -->

Threaded Conduit Entries

<-- Threaded Joint
Electrical Equipment Maintenance

- **Purpose:**
  Reduce hazard to life and property that can result from failure or malfunction of industrial-type electrical system and equipment
Fundamentals of Electrical Equipment Maintenance

- Design to accommodate maintenance
- Scheduling maintenance
- Personnel and equipment safety
- The protective scheme
- Acceptance testing
General attention

- **Enclosure**:
  Make sure the continuation of function where it shall prevent exposure of live parts and operating mechanism and protect the equipment from exposure to moisture and air contaminants outside the enclosure.

- **Security**:
  Inspect all doors and access panels to ensure that all hardware is in place and in good condition.

- **Leakage**:
  Identify any evidence of leakage and caulk any leaking seems.
- **Moisture:**
  Accumulation may occur even though panel are watertight. The source of moisture is condensation due to surface temp drop below the air dew point.

- **Heating:**
  If space heaters are provided, make sure that they are in good condition and operating properly.

- **Insulation:**
  Insulation deterioration will be accumulated during the operating which detract from its voltage withstanding capability.
- **Electrical distress:**
- Areas in which electrical distress is more likely to occur:
  - Boundaries between two adjoining insulators
  - Boundaries between an insulating member and the grounded metal structure
  - Taped or compounded splices or junctions
  - Phase to phase or phase to ground bridging path across insulating surface.
  - Hidden surface such as bus-bar support
Thermal damage:
Even slightly over design levels for prolonged periods, can significantly shorten the electrical life.

Basis for detecting heat damage:
- Discoloration
- Crazing, cracking, flaking of varnish coating
- Embrittlerment of tape and cable insulation
- Delamination
- Generalized carbonization
- Melting, oozing or exuding of substances from within an insulating assembly
Suggestion for Inclusion in a Walk-Through Inspection

- **Flexible Cords:**
  Check condition for badly worn, improper type, current carrying capacity too small.

- **Plugs and Connectors:**
  Check for stray strands and loose terminal.

- **Receptacle Outlets:**
  Check for continuity of grounding connection.

- **Portable Equipment:**
  Check for equipment name plate according to the Area classification.
- **Lighting Fixtures:**
  Check for no fixtures should be located close to highly combustible material.

- **Equipment Grounding:**
  Check for broken or loose connection at conduit bonding or equipment grounding.

- **Switchgear rooms and MCC rooms:**
  Check to see that they are clean and used for no other purpose, free of storage of any kind (combustible material), ventilation should be in working condition and unobstructed.

- **Enclosures of Electrical parts:**
  Check to see that covers secured in place.
- **Hazardous (classified) Location Equipment:**
  All bolts should be in place and tight. Permanent marking should not be obstructed by paint. No modification is permitted w/o re-certification.

- **Emergency Equipment:**
  - Exit lights should all be functioning properly.
  - Emergency lights should all be in working condition. Periodic test is recommended.
  - Emergency power supply should have periodic check and running test.
  - Alarm system, such as for fire, intrusion, smoke detection sprinkler and fire pump also receive periodic tests.
Hot gases are cooled as they pass through the threads.
Hot gases are cooled as they pass across a machined flanged joint
Effect of internal explosion on cover-to-body joint
Sealing fitting
Conclusion

- **Maintenance**:
  
  Proper maintenance will result in electrical apparatus function as expected.

- **Modification of Certified apparatus**:
  
  Modification should not be done to certified “Hazardous classified” apparatus unless it is approved by authorized re-certification body.
MAINTENANCE RECOMMENDATIONS IN HAZARDOUS AREAS

DOS AND DON'TS OF HAZARDOUS AREA EQUIPMENT

Dos

• Disconnect electrical supply before opening or working on a non-intrinsically safe enclosure. As matter of safer general practice, all circuits, including IS, be isolated before any work can proceed in the field unless under hot work permit. Electrical isolation procedures must be employed.
• Check that threaded covers, flat joints, rotating shafts, bearings and operating shafts are well lubricated and without corrosion. At detailed inspection periods all joints should be cleaned of old grease, mating surfaces inspected and the appropriate fresh grease applied. It is recommended practice to use graphite or silicone based lubricants and avoid the use of metallic based greases such as copper or molybdenum based compounds.
MAINTENANCE RECOMMENDATIONS IN HAZARDOUS AREAS

DOS AND DON'TS OF HAZARDOUS AREA EQUIPMENT (Cont.)

Dos

- Check that all flame paths are clean and free from grit or foreign matter when being closed.
- Ensure that all enclosures are properly reassembled and all bolts are in place and tightened to the correct torque before connecting the supply. Use only certified replacement parts designed for that equipment. Do not replace seals (gasket or o-rings) with other than maker's approved parts.
- Check that all unused terminal screws are tightened.
- Check earthing in accordance with installation requirements.
- Check all door, gland plate or cover fixing screws are intact and spare cable entries are plugged with the correct type of plug.
- Check that manufacturer's label is securely fixed to the equipment and data is legible.
MAINTENANCE RECOMMENDATIONS IN HAZARDOUS AREAS

DOS AND DON'TS OF HAZARDOUS AREA EQUIPMENT (Cont.)

Dos
• Check that cable glands threads are tightly fixed to the equipment and cable armouring is effectively retained by the cable gland armour clamping cones.
• Fit weatherproof seals on cable glands when they enter explosion proof (Ex) Equipment
• Check that unused conductors of explosion proof (Ex) Equipment enclosures are terminated in certified terminals. Ensure spare conductors in an Ex'i' enclosure are linked to earth.
• Replace faulty I.S. barriers with only the correct type.
• Check that the screw thread on the gland correctly matches that on the enclosure, as incorrect matching of threads can invalidate the flameproofing.
• Flange faces to be smooth & original (to be careful while opening stuck covers)
MAINTENANCE RECOMMENDATIONS IN HAZARDOUS AREAS

DOS AND DON'TS OF HAZARDOUS AREA EQUIPMENT (Cont.)

Don't's

- Do not short circuit the hazardous area circuit
- Do not make additional openings, add terminals or carry out other alterations which may affect certification.
- **Do not cover flame path or name plate with paint when painting.**
- **Do not use sharp objects such as screwdrivers to open an enclosure since it may damage the flame path and render enclosure unsafe.**
- Do not use uncertified test equipment in hazardous areas such as multimeters and meggers to test equipment eg motors, even if disconnected from the supply, without a hot work clearance.
MAINTENANCE RECOMMENDATIONS IN HAZARDOUS AREAS

DOS AND DON'TS OF HAZARDOUS AREA EQUIPMENT (Cont.)

Don't's

• Do not try to repair faulty I.S Barriers. They only replaceable components on some isolated types is the safe area side fuse. If replacing the fuse, the correct type and rating must be used.
• Do not install more than one conductor in a terminal clamp of an Ex'e' or 'n' rated enclosure. Use certified cross connection inserts to link terminals.
• Any equipment which is originally flameproof may loose its integrity if not maintained properly
• No site modification / alteration
“ELECTRICAL EQUIPMENT USED IN HAZARDOUS AREAS ARE SPECIAL AND THEY NEEDS TO BE TREATED SPECIAL”,

Any equipment which is originally Explosion proof (EX) may lose its integrity if not maintained properly or modified
USEFUL REFERENCE BOOKS ON HAC

- NFPA 69, 1992, Explosion Prevention Systems
- ICI/RoSPA, 1972, ICI Electrical Installations Code
- NFPA 325M, Properties of Flammable Liquids, gases and solids
- Electrical Safety in Hazardous Locations, William Calder & Ernest C. Magison
HAC-RELEVANT INTERNATIONAL STANDARDS

- API RP 500/550
  Area Classification of Petroleum Installations
- IEC 79-10:1995 - Electrical Apparatus for Explosive Gas Atmospheres, part 10 Classification of hazardous areas
- IP Part 15, 1990 - Area Classification Code for Petroleum Installations
- BS EN 60079-10:1996 - Electrical Apparatus for Explosive Gas Atmospheres, part 10 Classification of hazardous areas
- BS 5345, 1983 - Selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive manufacturing), part 2, Recommendations for particular industrial situations