APPENDIX 20

ELECTRICAL INSTALLATION REQUIREMENTS

Hazardous Area Classifications

When electrical equipment is used in, around, or near an atmosphere that has flammable gases, vapors, or flammable liquids, there is always a possibility or risk that a fire or explosion might occur. Those areas where the possibility or risk of fire or explosion might occur due to an explosive atmosphere and/or mixture is often called a hazardous (or classified) location/area.

Currently there are two systems used to classify these hazardous areas; the Class/Division system and the Zone system. The Class/Division system is used predominately in the United States, whereas the rest of the world generally uses the Zone system.

Class/Division System

Hazardous locations per the Class/Division system are classified according to the Class, Division, and Group.

1. Class—The Class defines the general nature (or properties) of the hazardous material in the surrounding atmosphere which may or may not be in sufficient quantities.

- **Class I—** Locations in which flammable gases or vapors may or may not be in sufficient quantities to produce explosive or ignitable mixtures.
- **Class II—**Locations in which combustible dusts (either in suspension, intermittently, or periodically) may or may not be in sufficient quantities to produce explosive or ignitable mixtures.
- **Class III—**Locations in which ignitable fibers may or may not be in sufficient quantities to produce explosive or ignitable mixtures.

Note: Class II and III do not apply to offshore and are shown for information purposes only.

2. Division— The Division defines the probability of the hazardous material being able to produce an explosive or ignitable mixture based upon its presence.

- **Division 1** indicates that the hazardous material has a high probability of producing an explosive or ignitable mixture due to it being present continuously, intermittently, or periodically or from the equipment itself under normal operating conditions.

- **Division 2** indicates that the hazardous material has a low probability of producing an explosive or ignitable mixture and is present only during abnormal conditions for a short period of time.

3. Group—The Group defines the type of hazardous material in the surrounding atmosphere. Groups A, B, C, and Dare for gases (Class I only) while groups E, F, and G are for dusts and flyings (Class II or III).

- **Group A—**Atmospheres containing acetylene.
- **Group B—**Atmospheres containing a flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor. Typical gases include hydrogen, butadiene, ethylene oxide, propylene oxide, and acrolein.
- **Group C—**Atmospheres containing a flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor. Typical gases include hydrogen sulfide, ethyl either, ethylene, and acetaldehyde.
- **Group D**—Atmospheres containing a flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor. Typical gases include acetone, ammonia, benzene, butane, ethanol, gasoline, methane, natural gas, naphtha, and propane.

Zone System

Hazardous locations per the Zone system are classified according to its Zone. For gas atmospheres electrical equipment is further divided into Groups and Subgroups.

The Zone defines the probability of the hazardous material (gas), being present in sufficient quantities to produce explosive or ignitable mixtures.

- **Gas**
  - **Zone 0—**Ignitable concentrations of flammable gases or vapors which are present continuously or for long periods of time.
  - **Zone 1—**Ignitable concentrations of flammable gases or vapors which are likely to occur under normal operating conditions.
  - **Zone 2—**Ignitable concentrations of flammable gases or vapors which are not likely to occur under normal operating conditions and do so only for a short period of time.

- **Group—** Electrical equipment used in gas atmospheres is divided into two groups.

  - **Group I—**Equipment used in mines with atmospheres containing methane or gases and vapors of equivalent hazard. (**Note:** **Group I** does not apply to offshore and is shown for information purposes only).
  - **Group II—**All other equipment; which is further subdivided into three subgroups.

- **Group IIA—**Atmospheres containing propane, or gases and vapors of equivalent hazard.
- **Group IIB—**Atmospheres containing ethylene, or gases and vapors of equivalent hazard.
- **Group IIC—**Atmospheres containing acetylene or hydrogen, or gases and vapors of equivalent hazard.

Protection Techniques and Methods

Various protection techniques and methods have been developed and employed, thus reducing or minimizing the potential risks of explosion or fire from electrical equipment located in hazardous locations.

Note: The protection techniques listed in API RP 14F and 14FZ are listed below for Divisions and Zones.

Class/Division system

Intrinsically Safe Systems
These are low-energy systems designed to assure safety by eliminating the ignition source leg of the fire triangle. The energy in the system is maintained below that needed to ignite the flammable atmosphere, even under fault conditions. Opening, grounding, or short-circuiting of field-installed wiring is considered a condition of normal operation in this protection technique, rather than a fault condition. The common protective device used in intrinsically safe circuits is a Zener Diode Barrier.

While this type of device controls the energy going to a circuit, it does not prevent incorrectly installed products such as capacitors, which may store energy, from increasing the maximum current permitted in the system. It is important to understand that intrinsic safety is a “system approach” and that no single device provides total protection.

Explosion-proof enclosure - An enclosure which is capable of withstanding an explosion of a gas or vapor within it and of preventing the ignition of an explosive gas or vapor which may surround it, and which operates at such an external temperature that a surrounding gas or vapor will not be ignited.

Hermetically Sealed
This protection technique is limited to Zone 2 or Division 2 locations only and works by eliminating the ignition source leg of the fire triangle. It defines “hermetically sealed” as a fusion process such as soldering, brazing, welding, or the fusion of glass to metal. So-called “hermetically sealed” relays that are sealed by use of gaskets are not included in this definition. Typical hermetically sealed devices are mercury-tube switches and reed switches.

Non-Incendive Equipment Type “nC” Protection:
This is a method of protection of sparking contacts in Class I, Zone 2 or Division 2 locations. A non-incendive component is one having contacts for making or breaking an incendive circuit where the contact mechanism is constructed so that the component is incapable of igniting the specified flammable gas or vapor-air mixture. The housing of a non-incendive component is not intended to exclude the flammable atmosphere or contain an explosion.

Purged and Pressurized
This is a type of protection which prevents the entry of the surrounding atmosphere into the enclosure of the electrical apparatus by maintaining a positive pressure within the enclosure of a protective gas (air, inert, or other suitable gas) at a higher pressure than the surrounding atmosphere.

Purging is the process of supplying an enclosure with a protective gas at a sufficient flow and positive pressure to reduce the concentration of any flammable gas or vapor initially present to an acceptable level. This technique can be used to change a Class I, Division 1 location into a nonhazardous location or into a Division 2 location, or to change a Class I, Division 2 location into a nonhazardous location. It requires a noncombustible enclosure (which may be a control room or a machine room) that is first purged of any combustibles or flammables that may be present, and is then maintained at a positive pressure sufficient to assure that combustibles or flammables cannot enter the enclosure and be ignited by electrical equipment within the enclosure. The purging may be a continuous purge or a single purge with a positive pressure maintained to make up for leaks. The pressurizing medium may be either air, commonly used in a control room where people will be working, or a nonflammable gas.

TYPE	EXPLANAT ION	Area
X	Changes the area within the unit from Division 1 to nonhazardous	Division 1
Y	Changes the area within the unit from Division 1 to Division 2	Division 1
Z	Changes the area within the unit from Division 2 to nonhazardous	Division 2

Zone System

1. **Flameproof (Type "d”) Equipment**
   Flameproof (Type "d”) is a type of protection that is similar to explosionproof equipment protection that has been one of the most common protection techniques used in the United States. In this protection technique, the equipment is in an enclosure that has been tested to withstand an internal explosion of a gas- or vapor-to-air mixture that can penetrate into the interior of the enclosure. The enclosure must contain the flame and the explosion pressure without damaging the enclosure and without permitting the flame to leave the enclosure through any joints or other openings in the enclosure and without igniting the surrounding gases.

2. Purged and Pressurized (Type "p”) Equipment
Purged and pressurized (Type "p”) is a type of protection that uses inert gas or instrument quality air as a protective gas to purge the inside of the enclosure of any hazardous quantity of flammable gases or vapors. The enclosure is then kept pressurized at a pressure high enough above the outer atmosphere surrounding the enclosure to prevent the flammable gas or vapor from re-entering the enclosure. This guards against an ignitable concentration of gas accumulating within the enclosure and then being ignited by an arcing or sparking part or hot electrical equipment. This protection technique also permits a general type enclosure to be used rather than an explosionproof or flameproof enclosure, as would normally be the case.

3. Intrinsic Safety (Types "ia” or "ib”) Equipment
Intrinsic Safety (Types "ia” or "ib”) is a type of protection technique that uses an apparatus that limits the maximum level of current and voltage measured as energy (usually in millijoules) under normal or fault conditions that can be delivered into the hazardous location. The intrinsically safe associated apparatus providing this energy limitation has a further identification marking on the equipment that indicates the type of intrinsic safety. The marking will be "ia” or "ib” and should be located on the nameplate of the apparatus. This equipment should provide a level of safety that, even in a double fault condition ("ia”) or a single fault condition ("ib”), there will not be enough ignition energy to ignite the gas or vapor in that area.

4. Protection (Type "n”) Equipment
Protection (Type "n”) equipment is a protection technique applied to electrical equipment which does not have enough ignition energy to ignite the gas or vapor during normal operation and is not likely to have a fault that could cause ignition. This type of protection is similar to the nonincendive circuits and equipment used in Class I, Division 2 locations. If there is a possibility of a fault occurring within the system, then some other method of protection should be chosen or extra protection against faults should be incorporated.

5. Oil Immersion (Type "o”) Equipment
Oil immersion (Type "o”) equipment is a type of protection in which the electrical equipment is immersed in a protective fluid of nonconductive silicone or mineral oil. The fluid level should be such that the electrical parts and any arcing or sparking parts of the oil-encased equipment are immersed and the liquid always covers the electrical parts. This ensures that the gas or vapor located above the arcing or sparking parts or the gas or vapor located exterior to the enclosure cannot be ignited by the electrical arcing parts within the oil.

6. Increased Safety (Type "e”) Equipment
Increased safety (Type "e”) equipment is a type of protection applied to electrical equipment that does not produce arcs or sparks during normal operation and under certain abnormal conditions. This equipment has additional security against the possibility of excessive temperature and the equipment is assembled very carefully to ensure that arcing or sparking from part to part or connection to connection will not occur. The increased safety concept is often combined with flameproof and other protection techniques at the termination point outside of the enclosure to permit a connection point.

7. Encapsulation (Type "m”) Equipment
Encapsulation (Type "m”) equipment is a type in which any parts that could cause ignition of an explosive atmosphere by either excessive temperature or by arcing or sparking has been encapsulated in a compound of some sort. This encapsulation will prevent the flammable or combustible material from migrating into the enclosure in a large enough volume to form an ignitable atmosphere at the point of excessive temperature or electrical arc within the equipment.

8. Powder Filling (Type "q”) Equipment
Similar to encapsulation equipment, powder filling (Type "q”) equipment protection incorporates a quartz or glass powder as a filling material. This method surrounds the hot or arcing electrical parts and doesn’t permit the ignition of the gas or vapor at a point either inside or outside the equipment enclosure.

9. Non-Sparking Type “nA” Protection
This is protection suitable for use in Class I, Zone 2 or Division 2 locations only. It is subdivided into three categories, “**nA**”, “**nC**” and “**nR**”.
A - Non-sparking equipment.
C - Sparking equipment in which the contacts are suitably protected other than by restricted breathing.
R - Restricted breathing enclosure. This is similar to hermetically sealed however it also includes other enclosures where the rate of leaking of a flammable into the enclosure is restricted. Special leak tests are conducted on the enclosure.

10. Energy Limited (nL)
Limit energy of sparks; limit the temperature of a device.

Types of Protection Techniques Table

Divisions

Area	Protection Technique
Division 1	Explosionproof , “XP” Intrinsic Safety, “IS” (2 fault) Pressurization, “p” • Type X • Type Y Any Class I Zone 0 method
Division 2	Pressurization, “p” - Type Z (from div 2 to unclassified) Hermetically Sealed, “NC” Non-incendive , “NI” Oil Immersion “o” Any Zone 0 or 1 technique Any Class I, Div 1 or 2 technique

<u>NOTE:</u> When you look at the techniques allowed under the Zone Method below, there are twice as many protection methods.

Zones

Area	Protection Technique
ZONE 0	Intrinsic safety, “ia” (2 fault) Encapsulation, “ma” Class I, Div 1 intrinsic safety
ZONE 1	Flameproof, “d” Pressurization, “px” or “py” Powder filling, “q” Oil immersion, “o” Increased safety, “e” Intrinsic safety, “ib” (1 fault) Encapsulation, “mb” Any Zone 0 method Any Class I, Div 1 technique
ZONE 2	Pressurization, “pz” Encapsulated, “nC” Enclosed-break, “nC” Hermetically-sealed, “nC” Non-incendive, “nC” Non-sparking, “nA” Restricted breathing, “nR” Energy-limited, “nL” Any Zone 0 or 1 technique Any Class I, Div 1 or 2 technique

Division Equipment Marking

(Per API RP 500 & 14F)

TEMPERATURE CLASSIFICATION

T class Max Surface Temp

T1 ≤ 450°C
T2 ≤ 300°C
T3 ≤ 200°C
T4 ≤ 135°C
T5 ≤ 100°C
T6 ≤ 85°C

AREA CLASSIFICATION

Class I Division 1 Group D T5

Division 1 Hazard Under normal Conditions
Division 2 Hazard Under Abnormal Conditions

GAS GROUPING

Group A- Acetylene
Group B : Hydrogen
Group C : Hydrogen Sulfide (H_2S)
Group D: Methane

Zone Equipment Markings

(API RP 505 & 14FZ)

TEMPERATURE CLASSIFICATION
T class Max Surface Temp
T1 ≤ 450°C
T2 ≤ 300°C
T3 ≤ 200°C
T4 ≤ 135°C
T5 ≤ 100°C
T6 ≤ 85°C

AREA CLASSIFICATION

AEx - Compliance to API RP 505 & 14FZ
EEx - Compliance to CENELEC 60079 Standards
Ex - Compliance to IEC & CSA Standards

Class I, Zone 1, A Ex ed IIC T5

Zone 0 Continuous Hazard
Zone 1 Intermittent Hazard
Zone 2 Hazard Under Abnormal Conditions

For use in Explosive Atmosphere

GAS GROUPING
II All Gases
IIA Methane
IIB Hydrogen Sulfide
IIC Acetylene/Hydrogen
IIB+H2 Ethylene & Hydrogen

PROTECTION METHOD
m Encapsulation (Zone 1)
d Flameproof (Zone 1)
e Increased Safety (Zone 1)
i* Intrinsically Safe (Zone 0/1)
o Oil Immersion (Zone 1)
p Pressurized (Zone 1)
q Powder Filling (Zone 1)
n* Non-Sparking (Zone 2)
*denotes additional sub-categories
NOTE: Main protection concept appears first

Zone 0 Continuous Hazard
Zone 1 Intermittent Hazard
Zone 2 Hazard Under Abnormal Conditions

Electrical Safety Checklist

1. Are electrical one-line drawings available? Are they current? Do they properly reflect changes made to the facility? Are all major electrical items included on the drawings? (30 CFR 250.802(e)4)

2. Are area classification drawings available? Are they current? Do they cover all parts and levels of the facility? (30 CFR 250.802(e)4)

3. Are provisions made for sufficient ventilation of hydrogen to prevent the accumulation of explosive mixtures from rechargeable batteries? (14FZ 10.3.4.2)
   All rechargeable battery systems should be installed such that hydrogen cannot collect in sufficient quantity to create a hazard (flammable mixture). This may require that batteries inside buildings be installed in enclosures vented to the outside.

4. Are all conductive (metal) enclosures containing live parts properly grounded? (14FZ 6.10.3.1)
   All metal equipment, such as buildings, skids, and vessels should be grounded to the steel structure or grounding network. Equipment that is welded to the structure or deck is considered to be adequately grounded. The physical contact obtained when equipment is bolted to a steel structure is not necessarily an adequate ground.

5. Does the facility have a documented lockout/tagout procedure? (14FZ 12.9)
   A proper lockout/tagout procedure should be developed to guard against electrical shock, injury from movement, or injury from power-driven equipment

6. Does the facility have a documented hot work permit procedure? (30 CFR 250.52)

7. Do the MCCs and other electrical equipment spaces have adequate means of egress? (14FZ 6.12.3)

8. Are adequate workspace clearances provided around electrical equipment? (14FZ 6.12)

9. Are all live parts adequately enclosed or insulated against accidental contact? (14FZ 6.11)
    a) *Electrical conductors, buses, terminals, or components that prevent a shock hazard are not permitted to be uninsulated if exposed.*
    b) *Enclosures should be constructed of corrosion-resistant materials, such as copper-free aluminum, stainless steel (316 preferably), suitable plastic, fiberglass, or hot-dipped galvanized steel.*
    c) *Space heaters, breathers, drains, or a combination of such, should be considered for all enclosures as a means of preventing internal moisture buildup and consequent, equipment-corrosion damage.*

10. Is all electrical equipment operating at over 600 Volts adequately identified? (14FZ 12.8)
    Equipment operating at or containing live parts at voltage levels exceeding 600 volts, nominal, should be provided with suitable signs alerting personnel of the higher voltage to reduce the possibility of electrical shock. Such signs should be located at the point of access to live parts.

11. If the facility lost its primary source of power, would there be power (from batteries, back up generation or other means) to operate electrical firewater pumps? Provide emergency lighting? (30 CFR 250.123(b)8, 14FZ 9.4)

12. Are buildings (e.g., MCC buildings and communications buildings) located within classified locations provided with gas detector systems in accordance with API RP 500 or 505, or otherwise properly handled, to assure that enclosed electrical equipment not suitable for hazardous (classified) locations will not be a source of ignition? (API RP 500 Sections 4.8)

13. Are all hand held radios, portable gas detectors, or other Personal Electronic Devices (PED) designated for use in classified locations and labeled by a third party testing laboratory such as FM or UL as suitable for the location? (14FZ 12.4)

14. Are electrical tools provided with adequate warning signs? (14FZ 12.3.4)
    It is recommended that any portable electric tools kept offshore that do not have labels certifying their use in Class 1, Group D locations should be distinctly identified and permanently labeled "WARNING---SOURCE OF IGNITION WHEN IN USE."

15. Are all explosion proof enclosures provided with conduit or cable seals, properly installed? (14FZ 6.8)

16. Are all openings in explosion proof enclosures provided with plugs? Are all enclosures provided with covers and are all bolts in place and securely tightened? (14FZ 4.3)

17. Is nameplate data on transformers, generators and motors legible? (14FZ 8.2.3.1.2)
    Permanently attached nameplates should be of corrosion resistant material and provide the connection diagram, the name of the manufacturer, rated kilovolt-amperes, frequency, primary and secondary voltages, percent impedance, class of insulation, and the temperature rise for the insulation system.

18. Are explosion proof lighting fixtures properly protected from physical damage by guards or by location? (14FZ 9.3)

19. Are fixtures, cables, raceways and other electrical equipment properly physically supported? (14FZ 12.1.2)

20. Are all splices in cables and extension cords proper? (14FZ 6.7.9)
    Inline splices in electrical cables should be minimized to maintain circuit reliability; however, any such splices should maintain the electrical and mechanical integrity of the unspliced cable.

21. Are abandoned cables and raceways properly handled? (14FZ 12.10)
    Any abandoned conduit and other raceway (containing or not containing conductors) must be properly sealed to prevent the passage of flames and to minimize the passage of flammable gases and vapors from Zone O to Zone 1, Zone 1 to Zone 2, or Zone 2 to unclassified locations.

22. Are grounding pins on extension cord plugs intact? (14FZ 12.6)

23. Are extension cords used for temporary wiring only (i.e., not used in lieu of permanent wiring)? (14FZ 12.6)

24. Is the area surrounding liquid-filled transformers adequately bermed or diked for spill confinement? (14FZ 8.3.2.1)

25. Is the platform equipped with an operable Cathodic Protection System? (14FZ 11.17)
    a) *Sacrificial Anode Type System: Sacrificial galvanic anodes (typically aluminum, zinc, or magnesium) are attached via electrical conductors to the metal being protected (structures, pipelines). No external source of electrical power is required, the system depending on the galvanic voltage produced by the dissimilar metals as the driving force.*
    b) *Impressed Current Type System: Utilizes rectifiers powered by AC power to produce the DC necessary to make the structure negative with respect to the earth. The negative side of the rectifier is connected to the structure and the positive side of the rectifier is connected to anodes suspended in the water in a pattern as required for good current distribution.*