

9.0 HAZARDOUS (CLASSIFIED) LOCATIONS

9.1 INTRODUCTION

General purpose electrical equipment can cause explosions and fires in areas where flammable vapors, liquids, and gases and combustible dusts or fibers are present. These exposures require special electrical equipment that is designed for the specific hazard involved. This includes explosion-proof equipment for flammable vapor, liquid and gas hazards and dust-ignition-proof equipment for combustible dust. Other equipment used includes non-sparking equipment, intrinsically safe equipment, and purged and pressurized equipment.

This section will provide the Company's guidelines for bidding and performing work in hazardous (classified) locations and a general overview of the NEC Article 500 code requirements.

9.2 TRADITIONAL NEC METHOD FOR HAZARDOUS (CLASSIFIED) LOCATIONS

The following table summarizes NEC's traditional method of listing Class I, II, III hazardous (classified) locations.

<u>Classes</u>	<u>Groups</u>	<u>Divisions 1</u>	<u>Divisions 2</u>
I Gases, Vapors and Liquids (Art. 501)	A: acetylene B: hydrogen, etc. C: ethyl ether, etc. D: acetone, ammonia, ethylene oxide, etc.	Normally explosive	Not normally present in an explosive concentration (but may accidentally exist)
II Dusts (Art. 502)	E: combustible metal dusts, Al, Mg, etc. F: combustible carbonaceous dusts G: flour, wood, grain plastic or chemical dusts	Ignitable quantities of dust normally in or may be in suspension	Dust not normally suspended in an ignitable concentration (but may accidentally exist) Dust layers are present.
III Fibers and Flyings (Art. 503)	Textiles, woodworking, etc. (easily ignitable)	Handled or used in manufacturing	Stored or handled in storage (exclusive of manufacturing)

9.3 ADDITIONAL NEC & IEC METHOD FOR HAZARDOUS CLASS I LOCATIONS

In 1996, NEC introduced an additional hazardous location classification method that is more complex. This new method can be confusing, because it lists hazard ratings in reverse order for example "0" is normally thought as being not hazardous, but with this new method "0" is the most hazardous location.

Article 505 in Chapter 5 of the NEC covers the general requirements and how these rules apply to the electrical wiring and equipment installed in locations classified as Class I, Zone 0, Zone 1, or Zone 2. The concept of using Zones, per the IEC, instead of Divisions, per the NEC, has been used internationally for many years. In the past, the International Electrotechnical Commission (IEC) has regulated the requirements for such a system. The IEC system uses two groups to identify the hazards involved. Group I is used for mining, while Group II is used for surface industries and offshore installations. Group II consists of three subgroups which are A, B, and C respectively. Subgroups A, B, and C are designed to represent categories of flammable gases or vapors that are based upon the minimum ignition energy of the hazard. Subgroup A represents the most difficult flammable gas or vapor to ignite and Subgroup C is the easiest to ignite.

Whenever, the Customer has selected this method to classify hazardous locations for the facility design, the Site Superintendent should conduct a pre-job orientation sessions with Foremen to review the Class I, Zone 0, 1, & 2 code requirements and compliance with NEC 505 code standards.

9.4 CUSTOMER'S PRE-BID REVIEW MEETING

At the Customer's project pre-bid review meeting, the President and Site Superintendent should request additional information on the scope of work to be performed in hazardous (classified) locations in order to properly bid the job. The Customer's Project Manager should be able to inform bidders of the method that will be used for the hazardous (classified) locations either the traditional NEC classification method or the IEC classification method.

If possible, the President and Site Superintendent or responsible designee should go on a site tour to survey the various existing hazardous (classified) locations to determine the actual or potential hazardous exposures that Company employees will be exposed to while working in hazardous locations.

9.5 CUSTOMER'S PROJECT SPECIFICATIONS, PLANS, AND DRAWINGS

The President and the Site Superintendent should review the Customer's project specifications, plans, drawings, and vendor information to determine the types, amount, and locations of the electrical cables, equipment, components, and/or systems that will be installed in hazardous (classified) locations. These documents should clearly outline the hazardous area and the extent of the classified boundaries. The plans should also clearly illustrate the divisions and the extent of the areas included in the scope of work packages. The project specifications should have tables showing the properties of the flammable materials with a written description based on the classification, which explains the methods and procedures of each area being classified.

9.6 GOVERNING AUTHORITIES, CODES, AND STANDARDS

The President and Site Superintendent should also review the requirements of the authority having jurisdiction (AHJ), their relevant codes and standards, permits and other licensing requirements needed to perform the work.

The AHJ is the organization, office, or individual responsible for approving equipment, and installation, etc. The AHJ can be federal, state, or local, a fire chief or marshal, fire preventive bureau, labor department, a rating bureau, etc. The following are some of the relevant codes, standards, and testing laboratories:

- Manufacturer's data.
- Local Building Codes.
- National Electrical Code (NEC).
- National Fire Protection Association (NFPA 70 E).
- Occupational Safety and Health Administration (OSHA).
- Underwriters Laboratories (UL).
- Factory Mutual Research Corporation (FM).
- Electrical Testing Laboratories (ETL).
- American Gas Association (AGA).
- National Electrical Manufacturers Association (NEMA).
- American Petroleum Institute (API).
- Mine Safety and Health Administration (MSHA).
- United States Coast Guard (USCG).
- Instrument Society of America (ISA).
- Institute of Electrical and Electronic Engineers (IEEE).
- International Electrotechnical Commission (IEC).

9.7 PURCHASING GUIDELINES AND NEC CODE REQUIREMENTS

The President and Site Superintendent will review the project's bid proposal scope of work packages to determine if the Company will be responsible for directly purchasing the electrical cables, equipment, components, and systems that will be installed in hazardous (classified) locations. It should be the Company's policy that the Company's home office Purchasing Agent and the Site Superintendents will only purchase electrical cables, equipment, components, and systems that meet or exceed the current NEC code requirements for installation in hazardous (classified) locations. The requirements in the NEC, which has in the past specifically address the electric cables, wiring methods, equipment, components, and systems installed in hazardous (classified) locations are the following:

Alarm systems	501.14	502.14	503.12
Attachment plugs	501.12	502.13	503.11
Capacitors	501.2	502.2	503.2
Circuit breakers	501.6 (B)	502.6	503.4
Conductor insulation	501.13		
Electric cranes	501.8		503.13
Electric hoists and similar equipment			503.13
Flexible cords	501.11	502.12	503.10
Fuses	501.6 (B)	502.6	503.4
Generators	501.8	502.8	503.6
Grounding	501.16	502.16	503.16
Instruments	501.3	502.14	
Luminaires (Lighting fixtures)	501.9	502.11	503.9
Live parts	501.15	502.15	503.15
Local loudspeaker and communication	501.14		503.12
Meters	501.3	502.14	
Motor controllers	501.6	502.6	503.4
Motors	501.8	502.8	503.6
Multiwire branch circuits	501.18	502.18	
Receptacles	501.12	502.13	503.11
Relays	501.3	502.14	503.12
Remote control systems	501.14	502.14	503.12
Resistors	501.3 (B)(2)	502.7 (B)(3)	503.5
Sealing and drainage	501.5	502.5	
Signaling systems	501.14	502.14	503.12
Storage battery charging equipment			503.14
Surge protection	501.17	502.17	
Switches	501.6(B)	502.6	503.4
Transformers	501.2	502.2	503.2
Utilization equipment	501.10	502.10	503.8
Ventilating piping	501.8 (A)	502.9	503.7
Wiring connections	501.3 (B)(6)	502.4 (B)(2)	503.3 (A)(2)
Wiring methods	501.4	502.4	503.3

When the Customer or others purchase the electrical cables, equipment, components, and systems to be installed by the Company, the Site Superintendent should only install the Customer furnished electrical materials and products that comply with current NEC code requirements, unless instructed by the Customer's Project Manager, in writing, to install the materials and products.

In the 2000 Edition of NFPA 70E- on page 70E-41 in subsection 5-4.6.1 It states, the "Classification of areas and selection of equipment and wiring methods should be under the supervision of a Qualified Registered Engineer". Therefore, when this IEC system is being used for the project, the Site Superintendent should

review all specifications, plans, drawings, equipment, and wiring to determine if the work to be performed and the electrical cables, wiring methods, equipment, components, and systems installed by the Company have been approved by the design firm's Qualified Registered Engineer.

The Site Superintendent should ensure that Foremen and Qualified Employees assigned to work in hazardous (classified) locations are knowledgeable of the current NEC, NFPA 70E, and other applicable code requirements addressing hazardous (classified) locations.

9.8 PRE-JOB PLANNING

Each Foreman must ensure that his or her crew members will be able to safely perform the work in hazardous (classified) locations. Foremen should:

a. Determine the Scope of Work

Prior to performing a job hazard survey, the Foreman should review the project job specifications, latest drawings, equipment list, vendor manuals, and the Customer's documentation to determine the full extent of the work requirements. The Foreman should obtain and review the applicable governing codes and standards for electrical cables, wiring methods, equipment, components, and systems installed in hazardous (classified) locations.

b. Obtain Material Safety Data Sheets

The Foreman should obtain from the Safety Coordinator and/or Customer's personnel a copy of the material safety data sheets for each hazardous material that his or her crew members will be exposed to while performing work in the hazardous (classified) locations. Each crew member should be issued his or her own copy of these MSDS's during the Foreman's job briefing meeting at which time job task safety planning issues will be reviewed with crew members.

c. NEC Code Compliance Guidelines

The following guidelines should assist the Foreman in determining that electrical equipment to be installed by crew members has been properly marked, classified, grouped, identified by division, and located within the boundaries for which it is designed to be used.

1. Flammable Liquids

Flammable liquids are defined as being any liquid having a closed cup flash point below 100 °F and a vapor pressure not exceeding 40 lbs./sq. in. absolute at 100 °F. flammable and combustible liquids are subdivided into Classes I, II, and III. Classes I, II, and III are used to identify flammable and combustible liquids and should not be confused with class as defined in the National Electrical Code (NEC).

Flammable liquids (Class I) are those having flash points below 73 °F and having boiling points below 100 °F. Class I(B) liquids are those having flash points below 73 °F and having boiling points at or above 100 °F. Class I(C) liquids are those having flash points at or above 73 °F and below 100 °F.

Combustible liquids (Class II and III) are those having flash points at or above 100 °F and below 140 °F. Class III(A) liquids are those having flash points at or above 140 °F and below 200 °F. Class III(B) liquids are those having flash points at or above 200 °F.

2. Determining Group

Equipment must be selected, tested, and approved for the type of flammable material involved. Maximum explosive pressures, MESG, safe operating temperatures (ignition temperature), and ignition energy must be considered in the design and testing of safe electrical equipment for installation in classified areas. The NEC has a partial list of the most commonly encountered materials which have been tested. They are grouped on the basis of their flammability characteristics:

- Group A - Acetylene.
- Group B - Hydrogen.
- Group C - Carbon monoxide, ethylene.
- Group D - Gasoline, benzene, propane, ethyl alcohol, methane.
- Group E-G - Dusts.

3. Determining Class

The National Electrical Code (NEC) refers to three classes:

- Class I Flammable gases and vapors.
- Class II Combustible dusts.
- Class III Easily ignitable fibers or flyings.

4. Determining Division

The National Electrical Code (NEC) recognizes two divisions and these are as follows:

- Division 1: A location that is likely to have flammable gases or vapors present under normal conditions.
- Division 2: A location that is likely to have flammable gases or vapors present only under abnormal conditions.

5. Determining Extent (Boundaries) of Classified Areas

It is important to exercise sound engineering experience and judgment in determining the extent (boundaries) of a classified area. Having established the presence of flammable substances and determined the perimeter of the classified area, the class, the group, and the division is selected. The next step is to select the equipment and installation techniques. The following steps will aid in determining the extent of the boundaries of the classified area:

- The flammable materials involved.
- The type of installation.
- The Class (I, II, or III).
- The Group.
- The Division (1 or 2).
- Flash point of material.
- Ignition of sources.
- Volume and pressure release.
- Ventilation.
- Fire walls and barriers.
- Purging and pressurization.

9.9 EQUIPMENT REQUIREMENTS BY TYPE OF CLASS

a. Class I, Division 1 Hazardous Locations Equipment Requirements

1. Arcing devices, such as switches, circuit breakers, motor controllers, and fuses, must be approved for Class I locations - see NEC 501.6(A).
2. Conduit and cable systems are required to be sealed to prevent the passage of gases, vapors, and flame from one part of the electrical installation to another through the conduit. Type MI cable inherently prevents this from happening by its construction; however, it must be sealed to keep moisture and other fluids from entering the cable at terminations - see NEC 501.5.
 - Seals are required, where conduit passes from Division 1 to Division 2 or non-hazardous locations.
 - Seals are required within 18 inches from enclosures containing arcing devices.
 - Seals are required if conduit is 2 inches in diameter or larger entering an enclosure containing terminations, splices, or taps.
3. Flexible cords must be designed for extra-hard usage, contain an equipment-grounding conductor supported so that there will be no tension on the terminal connections, and provided with suitable seals, where these enter boxes, fittings, or explosion-proof enclosures - see NEC 501.11.
4. Grounding of equipment is required of all non-current-carrying metal parts of the electrical system. In addition, locknuts and bushings must not be relied upon for electrical connection between raceways and equipment. If locknuts and bushings are used, bonding jumpers are required - see NEC 501.16.
5. Luminaires (Lighting Fixtures, both fixed and portable), must be explosion-proof and guarded against physical damage - see NEC 501.9(A)(1) thru (A)(4).
6. Meters, relays, and instruments, such as, voltage or current meters and pressure or temperature sensors, must be in enclosures approved for Class I, Division 1 locations. Such enclosures include explosion-proof and purged and pressurized enclosures - see NEC 501.3(A).
7. Motors should be:
 - Approved for use in Class I, Division 1 locations.
 - Totally enclosed with positive-pressure ventilation.
 - Totally enclosed inert-gas-filled with a positive pressure within the enclosure.
 - Submerged in a flammable liquid or gas.

The last kind of installation is permissible, however, only when there is pressure on the enclosure greater than atmospheric pressure and the liquid or gas is only flammable in air. This type of motor is not permitted to be energized, until it has been purged of all air. The latter three types of motors must be arranged to be de-energized should the pressure fall or the supply of liquid or gas fall-as with the submerged type. Types (2) and (3) may not operate at a surface temperature above 80 percent of the ignition temperature of the gas or vapor involved - see NEC 501.8(A).

8. Raceways or enclosures, where liquid or condensed vapor may be trapped will require drainage. An approved system of preventing accumulations or to permit periodic drainage are two methods to control condensation of vapors and liquid accumulation - see NEC 501.5(F).
9. Receptacles and attachment plugs for use with portable equipment must be approved explosion-proof and provided with an equipment-grounding connection - see NEC 501.12.

10. Signaling, alarm, remote control and communications systems are required to be approved for Class I, Division 1 locations regardless of voltage - see NEC 501.14(A).
11. Wiring methods acceptable for use in Class I, Division 1 locations include threaded rigid metal or steel intermediate metal conduit and type MI cable. Flexible fittings, such as, motor terminations, must be approved for Class I locations. All boxes and enclosures must be explosion-proof and threaded for conduit or cable terminations. All joints must be wrench-tight with a minimum of five threads engaged - see NEC 501.4(A).

b. Class I, Division 2 Hazardous Locations Equipment Requirements

1. Arcing devices are required to be in explosion-proof enclosures. These include switches, circuit breakers, motor controllers and fuses. However, general-purpose enclosures may be used for Class I, Division 2 locations if the arcing and sparking parts are contained in a hermetically-sealed chamber or are oil immersed, or if solid-state devices without switching contacts are used - see NEC 501.6(B).
2. Conduit systems connected to explosion-proof enclosures must be sealed. Seals are also required where conduit passes from hazardous to non-hazardous areas - see NEC 501.5(B)(1) thru (B)(4).
3. Flexible cords in Divisions 1 and 2 are required to be: suitable for extra-hard usage, contained an equipment-grounding conductor, connected to terminals in an approved manner, properly supported, and provided with suitable seals, where necessary.
4. Grounding of equipment is required of all non-current-carrying metal parts of the electrical system. In addition, lock nuts and bushings must not be relied upon for electrical connection between raceways and equipment. If locknuts and bushings are used, bonding jumpers are required. A conduit threaded into a box or enclosure must be engaged wrench-tight to ensure electrical continuity and be acceptable as a grounding connection.
5. Lighting fixtures in Class I, Division 2 locations must be totally enclosed and protected from physical damage. If normal operating surface temperatures exceed 80 percent of the ignition temperature of the gas, liquid or vapor involved, then explosion-proof fixtures must be installed.
6. Meters, instruments and relays in Class I, Division 2 locations must be in approved explosion-proof enclosures. However, general-purpose equipment may be used if circuit-interrupting contacts are immersed in oil or enclosed in a hermetically sealed chamber or in circuits that do not release enough energy to ignite the hazardous atmosphere - see NEC 501.3(B).
7. Motors, generators and other rotating electrical machinery suitable for use in Class I, Division 1 locations are also acceptable in Class I, Division 2 locations. Other motors must have their contacts, switching devices, and resistance devices in enclosures suitable for Class I, Division 2 locations. Motors without brushes, switching mechanisms, or similar arc-producing devices are also acceptable - see NEC 501.8(B).
8. Raceways or enclosures, where liquid or condensed vapor may be trapped will require drainage - see NEC 501.5(F).
9. Receptacles and attachment plugs must be approved for Class I locations.
10. Signaling systems and other similar systems - see NEC 501.14.
11. Wiring methods: generally, threaded rigid or intermediate conduit or types PLTC, MI, MC, MV, TC, or ITC cable systems must be used. Boxes and fittings are not required to be explosion-proof unless they enclose arcing or sparking devices. Numerous restrictions apply to cable use - see NEC 501.4(B).

c. Class II Hazardous Locations Equipment Requirements

1. Flexible cords in Divisions 1 and 2 are required to be: suitable for extra-hard usage, contain an equipment-grounding conductor, connected to terminals in an approved manner, properly supported, and be provided with suitable seals, where necessary.
2. Grounding of equipment is required of all non-current-carrying metal parts of the electrical system. Lock-nuts and bushings must not be relied upon for electrical connection between raceways and equipment enclosures. If locknuts or bushings are used, bonding jumpers are required. A conduit threaded into a box or enclosure and engaged wrench-tight is acceptable as a grounding connection.
3. Luminaires (Lighting Fixtures) in Class II, Division 1 locations, must be dust-ignition-proof. Lighting fixtures in Class II Division 2 locations must be designed to minimize accumulation of dust and must be enclosed to prevent the release of sparks or hot metal. In both divisions, each fixture must be clearly marked for the maximum wattage of the lamp, so that the maximum permissible surface temperature for the fixture is not exceeded. Additionally, fixtures must be protected from damage - see NEC 502.11.
4. Motors, generators, and other rotating electrical machinery in Class II, Division 1 locations, must be dust-ignition-proof or totally enclosed and pipe-ventilated. Rotating equipment in Class II, Division 2 areas, must be one of the following types: dust-ignition-proof, totally enclosed & pipe-ventilated, totally enclosed & non-ventilated, totally enclosed & fan-cooled, or totally enclosed & water/air-cooled. Under certain conditions, standard open-type machines and self-cleaning squirrel-cage motors may be used - see NEC 502.8(A).
5. Raceways provides a path to the dust-ignition-proof enclosure from another enclosure that could allow the entrance of dust must be provided with suitable means of preventing the entrance of dust into a dust-ignition-proof enclosure - see NEC 502.5.
6. Receptacles and attachment plugs used in Class II, Division 1 areas are required to be approved for Class II locations and provided with a connection for an equipment-grounding conductor. In Division 2 areas, the receptacle must be designed, so the connection to the supply circuit cannot be made or broken, while the parts are exposed. This is commonly done with an interlocking arrangement between a circuit breaker and the receptacle. The plug cannot be removed, until the circuit breaker is in the off position, and the breaker cannot be switched to the on position, unless the plug is inserted in the receptacle - see NEC 502.13(A).
7. Signaling systems and other similar systems - see NEC 502.14.
8. Switches, circuit breakers, motor controllers, and fuses installed in Class II, Division 1 locations must be dust-ignition proof. In Class II, Division 2 areas, enclosures for fuses, switches, circuit breakers, and motor controllers must be dust-tight - see NEC 502.6.
9. Wiring methods for Class II, Division 1 locations: boxes and fittings containing arcing and sparking parts are required to be in dust-ignition-proof enclosures. Threaded metal conduit or type MI cable with approved terminations is required for Class II, Division 1 locations; some use of Type MC cable is permitted - see NEC 502.4(A). In Class II Division 2 locations, boxes and fittings are not required to be dust-ignition-proof, but must be designed to minimize the entrance of dust and prevent the escape of sparks or burning material. In addition to the wiring systems suitable for Division 1 locations, the following systems are suitable for Division 2 locations: electrical metallic tubing, dust-tight wireways and the following types of cables with many restrictions: MC, MT, PLTC, ITC, TC. - see NEC 502.4(B).

d. Class III Hazardous Locations Equipment Requirements

1. Luminaires (Lighting Fixtures) must have enclosures designed to minimize the entry of fibers, to prevent the escape of sparks or hot metal, and to have a maximum exposed surface temperature of less than 165 °C - see NEC 503.9.
2. Motors, generators, and other rotating electric machinery must be totally enclosed non-ventilated, totally enclosed pipe-ventilated, or totally enclosed fan-cooled. The windings of totally enclosed non-ventilated motors are completely enclosed in a tight casing and are cooled by radiation and conduction through the frame. Enclosed pipe-ventilated motors have openings for a ventilating pipe that conveys air to the motor and then discharges it to a safe area. In totally enclosed fan-cooled motors, the windings are cooled by an internal fan that circulates air inside the enclosure. Under certain conditions, self-cleaning textile motors and standard open-type machines may be used - see NEC 503.6.
3. Switches, circuit breakers, motor controllers, and similar devices used in Class III hazardous locations must be within tight metal enclosures that are designed to minimize the entry of fibers and flyings and must not have any openings through which sparks or burning materials might escape - see NEC 503.4.
4. Wiring in Division 1 and most Division 2 locations, must be in conduit, electrical metallic tubing, dust-tight wireways, or Type MC or MI cable, all with boxes, fittings and connections that will provide a dust-tight wiring system - see NEC 503.3.

9.10 FOREMAN'S PRE-JOB SAFETY PLANNING MEETINGS

The Foreman should conduct a daily pre-job safety planning meeting with employees assigned to work in a hazardous location and should make frequent work area inspections.

10.0 PERSONAL PROTECTION EQUIPMENT & OTHER ELECTRICAL PROTECTIVE EQUIPMENT

10.1 GENERAL REQUIREMENTS

Company employees should be safeguarded from injury, while working on job tasks, where potential electrical hazards exist by suitable protective equipment. Protective equipment is not only personal protective equipment, but also any equipment that places an obstacle or insulation between the employee and the electrical hazard. The protective equipment addressed in this section is for exposures to electrical hazards of shock, arc flash, and arc blast. However, when the job task assignments require that employees be protected from other types of work hazards, such as, confined space entry, fall exposures, high noise, airborne contaminants, and other construction job site conditions, the Company's site-specific safety procedures covering these work conditions should be complied with by Foremen and employees.

10.2 RESPONSIBILITIES

a. Site Superintendent

Each Site Superintendent should:

- Review local collective bargaining agreements for requirements and precedents on provision of PPE.
- Determine if the Customer has established requirements for site contractor employees wearing PPE.
- Review scope of work and determine those project job tasks that will require employees to work on:
 - Energized equipment at 600V and below and work is done within the flash protection boundary.
 - Energized equipment above 600V and work is done within the flash protection boundary.
 - Power systems having greater short circuit current capacity or longer fault clearing times that require a flash hazard analysis be completed prior to starting the work.