HUBBELL®

KILLARK®

2011 National Electrical Code® Review & Application Guide

Articles 500-506, 510-511 & 513-516

KILLARK® Established in 1913, Killark has become a global provider of harsh and hazardous location equipment. The Killark range encompasses industrial and explosionproof products engineered to withstand the toughest extremes in climate from the dry and arid Middle East, tropical Asia to frozen Northern Canada.

Safety and reliability has been the cornerstone of our business for almost a century. Killark is dedicated to meeting customer needs, with engineering solutions, new product development and on-time delivery in every phase of the project.

This commitment underpins our proven ability to supply lower cost total system solutions and savings over the entire lifetime of a project.

Innovative Thinking has Made Killark an Industry Leader.

Killark is known for providing individual client solutions to complex environmental requirements. Reliable and proven technology, coupled with value added engineering enables lower total installation costs with a lifetime of savings.

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Guide to Using This Code Update

The entire text of the 2011 *National Electrical Code®*, Articles 500 through 506 and 510 through 516, are provided in blue text.

Changes to the *National Electrical Code®* are indicated where the blue text is highlighted as shown in the following example:

(4) Interlocked armor Type MC cable having an overall jacket of suitable polymeric material and installed with listed dusttight termination fittings.

Explainitory comments on *NEC* changes are in black type and prece ded with a black diamond ◆.

An arrow ➤ indicates where portions of the previous *NEC* have been removed.

Supplemental commentary to the Code is in black italic type and preceded with a white star bullet ✪.

Typical Killark Switchrack assembly for applications requiring overcurrent and short circuit protection of lighting, appliances and motor circuits.

INTRODUCTION

Purpose of Review

This Review is intended to help the reader understand the 2011 *National Electrical Code®*

It provides reasons for some of the requirements, includes material from documents referenced in the *NEC®*, plus additional references, and in general provides information on the various types of electrical equipment used in hazardous locations. The Review also offers guidance for selecting the correct equipment.

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Various sources have been used to compile the information presented in this publication.

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DEFINITIONS OF HAZARDOUS (CLASSIFIED) LOCATIONS

Nonhazardous Locations

Although flammable gases and vapors, and combustible dusts, exist almost everywhere, they are usually present only in minute quantities, much less than necessary for a fire or explosion hazard to exist. See the following information on flammable limits. Thus, the presence of a flammable gas or vapor, or combustible dust, does not in itself define a hazardous location. These materials must be present in sufficient quantities (concentrations) to present a potential explosion hazard.

Locations where there is an explosion hazard because of the presence of high explosives, such as blasting agents and munitions, are not classified by the *National Electrical Code*® as hazardous locations. There are standards covering the handling and use of such materials, and some of these require electrical equipment suitable for use in hazardous locations as defined in the *NEC*®. This is because such equipment provides a greater degree of safety than ordinary location or general purpose equipment, not because such equipment has been tested for use in the presence of high explosives.

Self Sufficient Power Supply — Provides a mix of 120/240V and 480VAC receptacles and includes panel boards and one main shut off. May be supplied with trailer as mobile unit or used at a permanent location.

Class I, Div. 2 Killark Series LED lighting fixture provides energy efficiency and long service life.

In a like manner, locations made hazardous because of the presence of pyrophoric materials, such as some phosphorous compounds, are not classified by the *National Electrical Code*® as hazardous locations. See the second sentence of Section 500.5(A). Pyrophoric is defined in the dictionary as "igniting spontaneously" or "emitting sparks when scratched or struck, especially with steel."

Where pyrophoric material or high explosives are present, precautions beyond those in the *National Electrical Code*® are necessary.

Hazardous Locations

Hazardous locations are those locations where fire or explosion hazards may exist due to flammable gases, flammable liquid-produced vapors, combustible liquid produced vapors, dust, or ignitible fibers/flyings. See *NEC*® Section 500.1. The *National Electrical Code*® uses the term "hazardous (classified) locations" because some standards refer to such locations as "classified locations." The *National Electrical Code* Committee, when asked to change from "hazardous locations" to "classified locations" voted not to do so because they believed there was a need for a stronger term. They did, however, add the parenthetical word "classified" to avoid confusion.

Because the hazards and methods of protecting electrical equipment against these hazards can differ for different materials, hazardous locations are divided into classes, groups, and divisions in the classification scheme in Article 500 of the *National Electrical Code*®. In Article 505 of the *National Electrical Code*®, first appearing in the 1996 *NEC*® edition, Class I hazardous locations only are divided into groups and zones, the groups corresponding roughly to the groups in Article 500 and the zones having the same meaning as the divisions in Article 500.

The Class I, Zone System of Article 505 of the *National Electrical Code*® was developed as an alternate classification system that is based on the classification system of the International Electrotechnical Commission (IEC). Article 505 is similar to the Class, Division System of Articles 500 and 501 except that in Article 505, the level of hazard probability is divided into Class I, Zones 0, 1, and 2 instead of the two levels of risk in Class I Division 1 and Division 2.

The Zone System of Article 506 of the *National Electrical Code*® was developed as an alternate classification system that is also based on the classification system of the International Electrotechnical Commission (IEC). Article 506 is similar to the Class II, and Class III Division System of Articles 502 and 503; however, there are significant differences between the systems. Zones 20, 21, and 22 represent hazardous locations containing combustible dusts, or ignitable fibers or flyings based on the likelihood of the material present and not on the type of material. Within the Zone 20, 21 and 22 system there are no group designations. The requirements of Article 506 do not apply to combustible metal dust similar to those of Class II, Group E.

INTERPRETATION OF THE NATIONAL ELECTRICAL CODE

DEFINITIONS OF HAZARDOUS LOCATIONS

CLASS I, II, AND III, GROUPS A, B, C, D, E, F, AND G, DIVISIONS 1 AND 2

CLASS I, II, AND III LOCATIONS

GENERAL

The classes are defined in 500.5 (A), 500.5(B), 500.5(C) and 500.5(D) of the *NEC*® .

CLASS I LOCATIONS

Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitible mixtures.

The Code uses the term "gases or vapors" because of common usage in the English language. The term "gases" is commonly used to refer to materials that are in a gaseous state under normal atmospheric conditions, such as hydrogen and methane. The term "vapors" refers to the gases over a material that is a liquid under normal atmospheric conditions (such as gasoline) but which emits gases within the flammable range under these same atmospheric conditions.

CLASS II LOCATIONS

Class II locations are those that are hazardous because of the presence of combustible dust.

Note that the dust must be present in sufficient quantities for a fire or explosion hazard to exist. The fact that there is some combustible dust present does not mean a Class II hazardous location exists

To be considered a "dust" the combustible material must exist as a finely divided solid of 420 microns (0.017 In.) or less. Such a dust will pass through a No. 40 U.S. Standard Sieve.

CLASS III LOCATIONS

Class III locations are those that are hazardous because of the presence of easily ignitable fibers or flyings, but in which the fibers or flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitible mixtures.

Easily ignitible fibers and flyings present a fire hazard but not an explosion hazard.

A typical example of this type of material is the cotton lint that accumulates in the lint trap of clothes dryers. Listed clothes dryers are designed so that even if the lint ignites, the fire will be contained within the dryer enclosure.

CLASS I, GROUPS A, B, C, AND D LOCATIONS

The groups are defined in *NEC*® Sections 500.6(A)(1), (2), (3), and (4). "See Appendix A Tables A1, A2, and A3 for the grouping of Class I materials."

Class I locations are divided into groups because different materials have different explosion and ignition characteristics. The grouping permits equipment to be tested based on the type of flammable material in which it is intended to be used. It also permits area classification to be based on the type of material anticipated in that location.

The grouping is based on two major factors: the explosion pressure generated during an explosion, and the maximum gap between ground flat mating metal surfaces that will prevent propagation of an explosion through the gap to a flammable atmosphere of the same flammable material and concentration.

The highest explosion pressures of the materials grouped in the *NEC*® are generated by acetylene, the only material in Group A. Thus, explosionproof equipment designed for Group A must be very strong to withstand the anticipated explosion pressure, and must have a very small gap between joint surfaces. Explosionproof equipment for Group A is the most difficult to design and there is less explosionproof equipment listed for this group than for any other group.

Group B materials produce explosion pressures somewhat less then acetylene, and the design of explosionproof enclosures for this group is somewhat less rigorous than for Group A enclosures. However, because of the very high explosion pressures in both Groups A and B, and, in particular, the very small gap between mating surfaces needed to prevent propagation of an explosion, there are no explosionproof motors listed for use in either Group A or B locations.

The chemical materials in Group C fall between Groups B and D in both the explosion pressures generated and the gap between mating surfaces of explosionproof equipment that will prevent an explosion.

Group D is the most common group encountered in the field, and there is more equipment available for this group than for any other group.

There is no consistent relationship between such properties as ignition temperature, flash point, and flammable limits, and the Class I hazardous location group into which the various materials fall. This will be evident from a review of Tables A1, A2, and A3 in Appendix A.

TABLE I

Relationship Between Class I Groups*

		Maximum Explosion Pressure, psi		
Maximum** Safe Gap, In	Group	Mixture Quiescent	Mixture Turbulent	Mixture Ignited at End of 1½ in. Conduit***
0.003	A	180	260	1140
0.003	B	136	188	845
0.012	C	110	178	200
0.029	D	95	156	160

* From Underwriters Laboratories Inc. Bulletin of Research No. 58. This bulletin was published in 1968. It has since been shown that the 0.012 In MESG for Group C was the result of the test equipment used, and should be greater.

** 3⁄4-in. wide, 4-in. long, flat machined metal-to-metal joint

*** Represents pressure piling conditions

CLASS II, GROUPS E, F, AND G.

These groups are defined in *NEC*® Sections 500.6(B)(1), (2), and (3). "See Appendix B Tables B1, B2, and B3 for materials in the various groups."

The division into three groups in Class II locations is for the same reasons Class I locations are divided into Groups A, B, C, and D: equipment design and area classification. However, the three Class II groups are based on different characteristics than the four Class I groups because the design of dust-ignitionproof equipment for Class II locations is based on different principles than the design of explosionproof equipment for Class I locations. In Class II locations the ignition temperature of the dust, the electrical conductivity of the dust, and the thermal blanketing effect the dust can have on heat-producing equipment, such as lighting fixtures and motors, are the deciding factors in determining the Class II group.

Group E dusts include the metal dusts, such as aluminum and magnesium. In addition to being highly abrasive, and thus likely to cause overheating of motor bearings if the dust gets into the bearing. Group E dusts are electrically conductive. If they are allowed to enter an enclosure, they can cause electrical failure of the equipment.

The Group F dusts are carbonaceous, the primary dust in this group being coal dust. These dusts have somewhat lower ignition temperatures than the Group E dusts and a layer of a Group F dust has a higher thermal insulating value than a layer of a Group E dust, thus requiring more careful control of the temperature on the surface of the equipment. Such dusts are semi-conductive but this is not usually a factor for equipment rated 600 volts and less.

The Group G dusts include plastic dusts, most chemical dusts, and food and grain dusts. They are not electrically conductive. These dusts, in general, have the highest thermal insulating characteristics and the lowest ignition temperatures. Thus, dust-ignitionproof equipment for use in Group G atmospheres must have the lowest surface temperatures to prevent ignition of a dust layer by the heat generated within the equipment.

Because of the different design characteristics, equipment suitable for Class I locations is not necessarily suitable for Class II locations, and equipment suitable for Class II locations is not necessarily suitable for Class I locations. The equipment must be approved for each class and group of location involved.

Much equipment suitable for Class I locations is also suitable for Class II locations, and is so marked, although when used in Class II locations there may be restrictions, such as lower maximum lamp wattage to maintain the lower surface temperature needed for equipment in dust atmospheres.

CLASS III GROUPS

There are no groups in Class III locations.

CLASS I, DIVISIONS 1 AND 2 LOCATIONS

GENERAL

The divisions are defined in *NEC*® Sections 500.5(B)(1) and (2). The subdivision of Class I into two divisions identifies the likelihood or risk that an ignitible concentration of gases or vapors will be in the location. Division 1 identifies locations where the risk is high or medium. Division 2 identifies locations where there is a small but still finite risk. If the risk is extremely low, the location is not considered a hazardous location. Such a location is typified by a single family home with natural gas or propane as the energy source for heating. The gas could, and on extremely rare occasions does, leak into the home and an explosion occurs. However the risk is so low (because of the safety systems built into the gas supply and heating equipment) that such locations are not classified as hazardous locations in accordance with the *NEC*®.

CLASS I, DIVISION 1 LOCATIONS

This is a location where the explosion hazard exists under normal operating conditions. The area may be hazardous all or most of the time, or it may only be hazardous some of the time.

Division 1 also includes locations where breakdown or faulty operation of electrical equipment or processes might release ignitible concentrations of flammable gases or vapors, and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition. An example of such a location might be an area where a flammable liquid is stored under cryogenic conditions, and a leak of the extremely low-temperature liquid directly onto electrical equipment could cause failure of the electrical equipment at the same time the vapors of the evaporating liquid are within the flammable range.

CLASS I, DIVISION 2 LOCATIONS

Class I, Division 2 locations are those where ignitible concentrations of flammable gases or vapors are not normally present, but could be present in the event of a fault, such as a leak at a valve in a pipeline carrying flammable liquids.

Division 2 locations also often exist around Division 1 locations where there is no barrier or partition to separate the Division 1 space from a nonhazardous location, or where ventilation failure (an abnormal condition) might extend the area where flammables exist under normal conditions.

Electrical equipment approved for Class I, Division 1 locations is also suitable for use in Division 2 locations.

CLASS II, DIVISIONS 1 AND 2 LOCATIONS

GENERAL

These divisions are described in *NEC*® Sections 500.5(C)(1) and 500.5(C)(2). Just as in Class I, Divisions 1 and 2, the subdivision of Class II into Divisions 1 and 2 identifies the likelihood that there will be an explosion hazard.

CLASS II, DIVISION 1 LOCATIONS

A Class II, Division 1 location is one where combustible dust is normally in suspension in the air in sufficient quantities to produce ignitible mixtures, or where mechanical failure or abnormal operation of equipment or machinery might cause an explosive or ignitible dust-air mixture to be produced, and might also provide a source of ignition through simultaneous failure of electrical equipment. A Class II, Division 1 locations also exists where combustible dusts of an electrically conductive nature may be present in hazardous quantities (Group E locations). The term "hazardous quantity" is intended to mean those locations where the dust may not be in suspension in the air in sufficient quantity to cause an explosion, but might have settled on electrical equipment so that the electrically conductive particles can penetrate the openings in the electrical equipment enclosure and cause an electrical failure, or where the dust can get into motor bearings and cause excessive temperatures because of bearing failure.

Class II, Div. 1 and 2 Group G Grain Elevator

CLASS II, DIVISION 2 LOCATIONS

This is a location where combustible dust is not normally in the air in quantities sufficient to produce explosive or ignitible mixtures, and dust accumulations are not normally sufficient to interfere with the normal operation of electrical equipment, such as clogging ventilating openings or causing bearing failure. It includes locations where combustible dust may be in suspension in the air only as a result of infrequent malfunctioning of handling or processing equipment, and those locations where dust accumulation may be on or in the vicinity of the electrical equipment and may be sufficient to interfere with the safe dissipation of heat from the equipment, or may be ignitable by abnormal operation or failure of the electrical equipment.

CLASS III, DIVISIONS 1 AND 2 LOCATIONS

CLASS III, DIVISION 1 LOCATIONS

This is a location where the equipment producing the ignitible fibers or flyings is located (near textile mill machinery, for example) or where the material is handled (for example, where the material is stuffed into bags).

CLASS III, DIVISION 2 LOCATIONS

This is a location where the easily ignitible fibers are stored or handled, except in manufacturing processes (which is Division 1).

THE ZONE SYSTEM

CLASS I, GROUPS IIA, IIB, AND IIC, ZONES 0, 1 AND 2 LOCATIONS

GENERAL

This method of area classification first appeared in the 1996 *National Electrical Code®*, and follows the international method of area classification as developed by the International Electrotechnical Commission (IEC). The requirements are in Article 505 of the *National Electrical Code®*.

Article 505 is only applicable to Class I (gases and vapors) locations. Like the subdivisions in Section 500.6(A)(1), (2), (3), and (4) into Groups A, B, C, and D, and 500.5(B)(1) and (2) into Divisions 1 and 2, and for the same reasons, (area classification and equipment testing) hazardous locations classified under Article 505 are divided into groups and divisions. In Article 505 the "divisions" are called "zones."

CLASS I, GROUPS IIC, IIB, AND IIA LOCATIONS

GENERAL

In the international system of classification, Group I is reserved for classification and equipment intended for use in underground mines, outside the scope of the *National Electrical Code®*. For information on electrical equipment in underground mines, see the Federal Register, regulations of the Mine Safety and Health Administration (MSHA).

GROUP IIC LOCATIONS

This group is defined in Section 505.6(A), and is the equivalent to a combination of Class I, Groups A and B as described in Sections 500.6(A)(1) and (A)(2). In the international system of classification, only the gap between machined flat mating surfaces, plus the igniting current (directly related to ignition energy), is considered in grouping materials. Explosion pressure is not one of the considerations.

CLASS I, GROUP IIB LOCATIONS

This group is defined in Section 505.6(B). It is equivalent to Class I, Group C as described in Section 500.6(B)(3).

CLASS I, GROUP IIA LOCATIONS

This group is defined in Section 505.6(C). It is equivalent to Class I, Group D as described in Section 500.6(A)(4).

CLASS I, ZONES 0, 1, AND 2 LOCATIONS

CLASS I, ZONE 0 LOCATIONS

This zone is defined in *NEC®* Section 505.B(1). These are locations in which ignitible concentrations of flammable gases or vapors are present continuously or for long periods of time. Zone 0 represents the most dangerous part of the Division 1 classification described in Section 500.5(B)(1).

CLASS I, ZONE 1 LOCATIONS

This zone is defined in *NEC®* Section 505.5(B)(2). These locations are the same as Class I, Division 1 locations as described in Section 500.5(B)(1), except they do not include those locations defined as Class I, Zone 0, where ignitible concentrations are present all or most of the time.

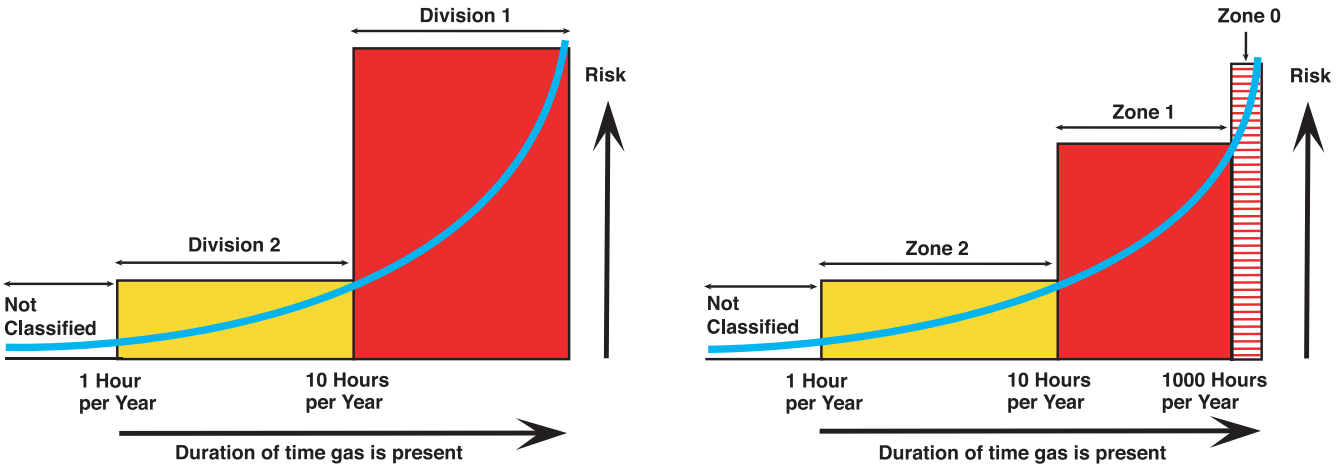
CLASS I, ZONE 2 LOCATIONS

This zone is defined in *NEC®* Section 505.(B)(2). These locations are the same as Class I, Division 2 locations as defined in Section 500.5(B)(2).

The Classes of material are further divided into "Divisions" or "Zones" based on the risk of fire or explosion of the material present. The Zone system has three levels of hazard whereas the Division system has two levels.

The table below provides a comparison between the "Class, Division" System and the "Zone" System.

HAZARDOUS MATERIAL	CLASS, DIVISION SYSTEM	ZONE SYSTEM
Gases or Vapors	Division 1	Zone 0 & Zone 1
	Division 2	Zone 2



The illustrations above compare the Division and Zone systems in terms of risk assessment.

The frequency of occurance determines the level of hazard for a location, the longer the material is present, the greater the risk.

FREQUENCY OF OCCURRENCE	CLASS, DIVISION SYSTEM	ZONE SYSTEM
Continuous	Class 1, Div. 1	Zone 0
Intermittent Periodically		Zone 1
Abnormal Conditions	Class 1, Div. 2	Zone 2

The abnormal conditions of occurrence, or lower risk areas, Division 2 and Zone 2 are basically identical in the Zone and Division system. However, in areas where a hazard is expected to occur during normal operation, Division 1 and Zone 1 and 0, the Zone system deals with highest areas of risk, Zone 0, separately and the risk associated with the remaining location Zone 1, is considered lower. The Division system tends to be less specific in its consideration of Division 1. The Division system treats all areas where a hazard is expected to occur in normal operation the same.

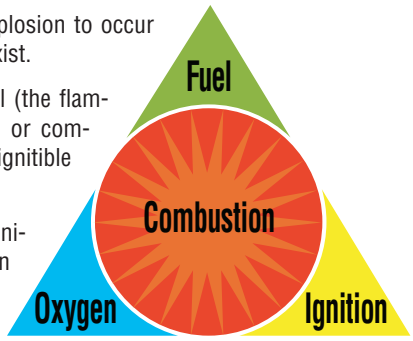
The following chart illustrates the differences between the various Zones.

GRADE OF RELEASE	ZONE	FLAMMABLE MIXTURE PRESENT
Continuous	0	1000 hours per year or more (10%)
Primary	1	Between 10 and 1000 hours per year or more (0.1% to 10%)
Secondary	2	Less than 10 hours per year (0.01% to 0.1)
Unclassified	–	Less than 1 hour per year (Less than 0.01%) (1)

This is a combination of Tables 2 and 3 from API RP505 (1) The 1-hour per year in API RP505 is considered to be high by some industry experts.

THE FIRE TRIANGLE

In order for a fire or explosion to occur three conditions must exist.



(1) There must be a fuel (the flammable gas or vapor, or combustible dust) in ignitible quantities,

(2) There must be an ignition source (energy in the form of heat or a spark) of sufficient energy to cause ignition, and

(3) There must be oxygen, usually the oxygen in the air.

These three conditions are called the fire triangle as shown on page above. Remove any one or more of these three and a fire or explosion cannot occur. This is the basis of the various protection systems for electrical equipment permitted in the *National Electrical Code*® for use in hazardous (Classified) locations.

ZONES 20, 21 AND 22

GENERAL

Article 506 is similar to the Class II, and Class III Division System of Articles 502 and 503. there are though important differences between the systems. Zones 20, 21, and 22 represent hazardous locations containing combustible dusts, or ignitable fibers/flyings. Zones 20, 21, and 22 are based on the likelihood of the material present and not on the type of material. Within the Zone 20, 21 and 22 system there are no group designations, and the requirements of Article 506 do not apply to combustible metal dust similar to those of Class II, Group E.

PROPERTIES OF CLASS I GASES AND VAPORS

Flammable Limits

For each flammable gas or vapor there is a minimum and maximum concentration beyond which an explosion cannot occur. These minimums and maximums are called the flammable or explosive limits. If the mixture has too little fuel (a lean mixture), it cannot be ignited so that an explosion cannot occur. If there is too much fuel (a rich mixture), again, the mixture cannot be ignited to cause an explosion.

Some materials have very broad flammable limits, and some have very narrow flammable limits. See the Appendix A Tables A1, A2, and A3 for these limits.

Mixtures of dust and air have measurable lower flammable limits, but there is no finite upper limit as the concentration of dust approaches the density of the solid material from which the dust originates. The lower explosive limit for dust-air mixtures is usually a dust cloud so dense visibility beyond 3 – 5 ft is impossible.

The flammable limits of gases and vapors are usually measured in percentage of the material in air by volume. The lower flammable limit of dust-air mixtures is usually measured in ounces per cubic foot.

Oxygen

Although an explosion usually occurs because of mixture of the fuel with the oxygen in the air, this is not always true. For example, a mixture of the (now seldom used) anesthetic gases, ethyl ether and nitrous oxide, can produce violent explosions because the oxygen is provided by the nitrous oxide.

If the oxygen concentration exceeds that normally found in air (21% by volume) flammable limits are normally expanded, and the ignition energy needed to cause ignition is decreased. In addition, the explosion is often considerably more violent than if the oxygen concentration had been the same as in air.

Heat (Ignition Source)

The energy needed to cause ignition may be a spark, an open flame, or a heated surface. If a spark, a certain finite amount of energy must be released into the flammable mixture. The amount of electrical energy needed is very low. It is measured in millijoules, or milliwatt-seconds. The ignition energy needed varies with each material and each concentration of the mixture. For the most easily ignitible hydrogen-air mixture, a spark release of only 0.017 millijoules is needed. For methane-air mixtures the ignition energy is 0.3 millijoules. The minimum ignition energies for dust-air mixtures run considerably higher, but are still very small when compared to the electrical energy available in most electrical equipment.

If the ignition source is a hot surface, it must heat the flammable mixture or combustible dust layer to its ignition temperature. For gases and vapors, because of turbulence at the heated surface, the temperature of the surface must be somewhat above the ignition temperature of the "gas or vapor- air mixture" for the mixture itself to actually reach its ignition temperature. This is not true for dust layers, which usually have an ignition temperature below the dust cloud ignition temperature. Control of surface temperatures is critical in Class II locations.

"See Appendix A Tables A1 through A3 and Appendix B Tables B1 through B3 for ignition temperature information."

Flash Point

All flammable liquids have what is called a flash point. See the Appendix A Tables A1, A2, and A3. The flash point is the minimum temperature at which the liquid gives off a vapor in sufficient concentrations to form an ignitible mixture with air near the surface of the liquid within the test vessel. Various ASTM test methods are used to measure the flash point.

The flash points of gases such as hydrogen and methane are well below zero, sometimes close to absolute zero. The flash points are therefore not usually listed for gases.

A flammable liquid as defined in various codes and standards is a liquid with a flash point below 100° F. Combustible liquids have flash points at or above 100° F. Diesel fuel, which by Federal Regulations has a flash point of at least 100° F, does not normally create a hazardous location as defined in the *National Electrical Code®* because at temperatures below 100° F there is insufficient vapor present to result in an ignitible mixture. However, if the ambient temperature exceeds 100° F, diesel fuel becomes a volatile flammable liquid as defined in Article 100 of the *National Electrical Code®* and can create a hazardous location.

Ignition Temperature

The ignition temperature is the minimum temperature required to initiate self-sustained combustion independently of the heating or heated element. Ignition temperatures vary substantially as the test conditions, and even the person conducting the test, change. The ignition temperatures of gases and liquids shown in NFPA 325 are the lowest recorded ignition temperatures from reliable testing laboratories, using one of the ASTM test methods. Since these methods have been changed several times over the years, the ignition temperatures in NFPA 325 have also been changing with each new edition, as new test data based on the newest test methods, becomes available. This is the reason the ignition temperatures in NFPA 325 and NFPA 497 do not always agree. The lowest published ignition temperature should be the one used to determine the acceptability of equipment. See Appendix A for ignition temperature data on gases and liquids.

The ignition temperature of combustible dusts is also influenced by the test conditions. Although the lowest temperature is usually for a dust layer rather than a dust cloud, this is not true for all materials. See Appendix B for ignition temperature data on dusts.

Vapor Density

Vapor density is the weight of a volume of a vapor or gas with no air present compared to the weight of an equal volume of air, both at the same normal atmospheric temperature and pressure. If a mixture has a vapor density of less than 1, it is lighter than air and under still-air conditions will rise. If the mixture has a vapor density greater than1 it will fall since the substance is heavier than air. However, if the vapor density is very close to that of air, it may either rise or fall, depending upon air movement in the location and the rate and direction of release. Vapor density increases as the temperature is reduced, so a vapor or gas with a vapor density less than air at the same temperature as the air can be heavier than air if at low temperatures. The vapor density and temperature are important in area classification decisions.

AREA CLASSIFICATION

Areas or locations are classified by:

(1) Class (Class I, II, or III) depending upon the type of material present,

(2) Group (Groups A, B, C, D, E, F, or G) in accordance with Article 500, or if Article 505 is used, (Groups IIA, IIB, or IIC), and

(3) Divisions (1 or 2) if Article 500 is used, or Zones (0, 1, or 2) if Article 505 is used, depending upon the likelihood of the flammable or combustible material being present in ignitible quantities. In some occupancies it is relatively easy to classify the areas because the rules are in the *National Electrical Code®* and/or other NFPA codes and standards. For example, gasoline filling stations are covered in Article 514 of the *NEC®* , and in NFPA 30A (Automotive and Marine Service Station Code) from which the area classification information in Article 514 is extracted.

(4) Article 505 is an alternate to the method of area classification for Class I locations as permitted in Article 500. The Zone Classification System is based on that of the International Electrotechnical Commission (IEC).

(5) Article 506 is an alternative Classification System to Class II, and Class III that is based on the International Electrotechnical Commission System (IEC). Zones 20, 21 and 22 apply to combustible dusts or ignitible fibers/flyings. Combustible metallic dusts are not covered by Article 506.

Following is a list of the standards and recommended practices containing area classification information, in addition to Articles 510-516 of the *National Electrical Code®*.

Hazardous Location sites encompacing a variety of Classified locations for Class I, Divisions 1 & 2.

NFPA Codes and Standards

NFPA #	Title
30	Flammable and Combustible Liquids Code
30A	Automotive and Marine Service Station Code
30B	Aerosol Products, Manufacture and Storage
32	Drycleaning Plants
33	Spray Application Using Flammable and Combustible Materials
34	Dipping and Coating Processes Using Flammable or Combustible Liquids
35	Manufacturer of Organic Coatings
36	Solvent Extraction Plants
40	Storage and Handling of Cellulose Nitrate Motion Picture Film
45	Fire Protection for Laboratories Using Chemicals
50A	Gaseous Hydrogen Systems at Consumer Sites
50B	Liquefied Hydrogen Systems at Consumer Sites
51	Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes
51A	Acetylene Cylinder Charging Plants
52	Compressed Natural Gas (CNG) Vehicular fuel systems
54	National Fuel Gas Code
55	Storage, Use and Handling of Compressed and Liquified Gases in Portable Cylinders
58	Storage and Handling of Liquefied Petroleum Gases
59	Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants
59A	Storage and Handling of Liquefied Natural Gas, (LNG) Production,
61	Prevention of Fires and Dust Explosions in Agricultural and Wood Products Facilities
88A	Parking Structures
88B	Repair Garages
99	Health Care Facilities
120	Coal Preparation Plants
303	Marinas and Boatyards
328	Control of Flammable and Combustible Liquids and Gases in Manholes, Sewers, and Similar Underground Structures
329	Handling Underground Releases of Flammable and Combustible Liquids
395	Storage of Flammable and Combustible Liquids at Farms and Isolated Sites
407	Aircraft Fuel Servicing
409	Aircraft Hangers
480	Storage, Handling and Processing of Magnesium Solids and Powders
481	Production, Processing, Handling and Storage of Titanium
495	Explosive Materials Code
496	Purged and Pressurized Enclosures for Electrical Equipment in Hazardous (Classified) Locations
497	Classification of Flammable Liquids, Gases or Vapors and of Class I Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas
499	Classification of Combustible Dusts and of Class II Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas
560	Storage, Handling and Use of Ethylene Oxide for Sterilization and Fumigation
651	Manufacture of Aluminum Powder
654	Prevention of Fire and Dust Explosions in the Chemical, Dye, Pharmaceutical and Plastics Industries
655	Prevention of Sulfur Fires, and Explosions
820	Fire Protection in Wastewater Treatment and Collection Facilities
8503	Pulverized Fuel Systems
8505	Stoker Operation

Documents by Other Than NFPA

Number	Organization	Title
500A	American Petroleum Institute	Classification of Locations for Electrical Installations in Petroleum Refineries
505	American Petroleum Institute	Recommended Practice for Classification of Locations for Electrical Installations in Petroleum Refineries classified as Class I, Zone 0, Zone 1 or Zone 2
500B	American Petroleum Institute	Recommended Practice for Design and Installation of Electrical Systems for Off-Shore Petroleum Platforms
ISA S12.24.01	International Society for Measurement and Control	Electrical Apparatus for Explosive Gas Atmospheres, Classification of Hazardous Areas
79-10	International Electrotechnical Commission	Electrical Apparatus for Explosive Gas Atmospheres, Classification of Hazardous Areas
IP15	Institute of Petroleum (London, U.K.)	Area Classification Code for Petroleum Installations

In addition, there are regulations by a variety of U.S. Government agencies, including the United States Coast Guard, Occupational Safety and Health Administration, Environmental Protection Agency, Department of Defense, and Department of Agriculture. Most of these are either the same as or are based on the requirements in the *National Electrical Code®*.

There will always be locations where electrical equipment must be installed and the location is obviously a hazardous one, yet none of the many published documents provide details as to where Division 1 starts and ends, where Division 2 starts and ends, and where the area or space is no longer considered a hazardous location. This is when the expertise of qualified people is needed. Sometimes the local fire marshal or one of the fire department's specialists has such expertise, and sometimes it will be necessary to employ the services of a consulting engineer or engineering firm experienced in area classification. Those not familiar with this specialty should not attempt to classify areas without expert help. Not only may the attempt result in a dangerous situation, but the area may be "over classified," resulting in higher costs for installation and maintenance.

Class I, Propane Dispensing

Class I, Gasoline and Diesel Fuel Dispensing

EQUIPMENT DESIGN AND CONSTRUCTION

There are a number of ways of protecting electrical equipment so that it cannot cause an explosion when used in a surrounding flammable atmosphere, or ignite a layer of dust or fibers on the equipment. The two most common ways are explosionproof equipment in Class I, Division 1 and some Division 2 locations and dust-ignitionproof equipment in Class II, Division 1 locations.

If Article 505 is used for area classification, flameproof and increased safety equipment is most common in Class I, Zone 1 locations. Intrinsically safe equipment is also a very popular in Division 1 and Zone 1 locations for low energy applications. Most Killark equipment for use in hazardous locations is designed to meet the requirements for both explosionproof and dust-ignitionproof equipment.

Killark North American nameplate example for explosionproof and dust-ignitionproof enclosure showing listing for Class 1, Div. 1, Class II, Div. 1, Class III and Class I Zone 1 locations.

Killark nameplate example for a Certified flameproof enclosure listed to ATEX and IEC Ex Standards for the International Zone System.

Nameplate for a Certified flameproof enclosure "System" listed to ATEX and IEC Ex Standards for the International Zone System.

Explosionproof Equipment

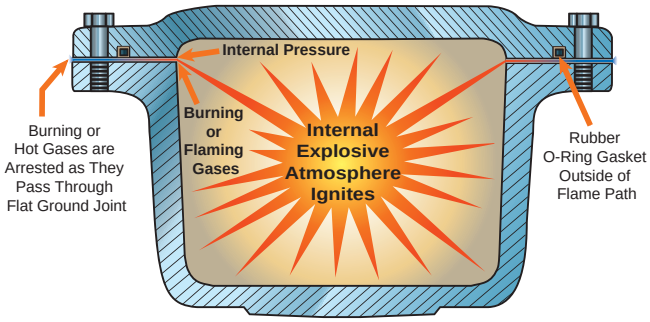
"Explosionproof" is a method of protection designed to remove the heat energy (ignition source) leg of the fire triangle (see page 7), thus making the equipment safe for use in Class I hazardous locations.

Article 100 of the *National Electrical Code*® defines "explosionproof equipment" as equipment enclosed in a case that:

(1) Is capable of withstanding an explosion of a gas or vapor that may occur within the case,

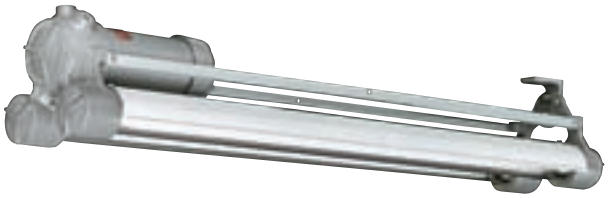
(2) Is capable of preventing the ignition of a gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within the enclosure, and

(3) Operates at such an external temperature that a surrounding flammable atmosphere will not be ignited by the outside of the enclosure.



Flat Ground Joint Surface Flamepath

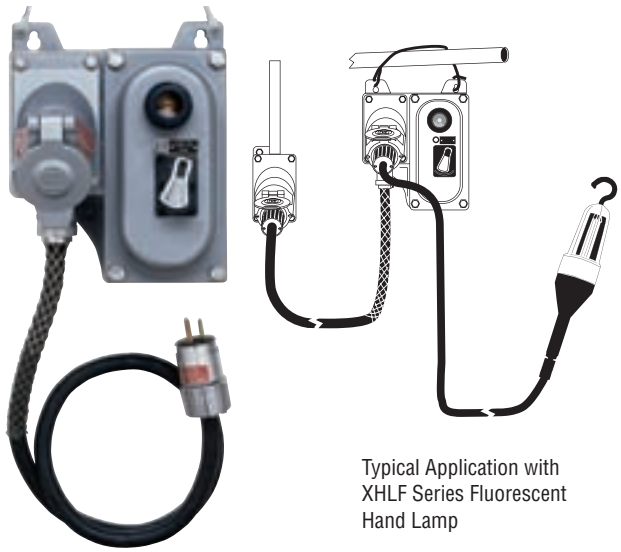
In designing explosionproof equipment, it is assumed that the flammable gas or vapor will enter the equipment enclosure and be ignited by a spark or arc within the enclosure. The threaded joints provided by rigid metal conduit and intermediate metal conduit are not gastight, so the gas can enter around these threads. In addition, all electrical equipment intended to be connected to a wiring system has a removable cover of some kind to permit wiring and facilitate repair of the electrical parts. Some equipment has external shafts to permit operation of internal switches or, as in motors, to transmit mechanical motion through the enclosure. The gases can enter through the interface between the removable cover and the remainder of the enclosure, or through the shaft and body interface. These interfaces are called "joint surfaces," or just "joints" and are commonly referred to as "flame paths". Entry of the gas or vapor into the enclosure or conduit wiring system through the various joint surfaces is accelerated as a result of normal heating and cooling of the internal electrical equipment, such as enclosed conductors and lighting equipment. The air inside the enclosure expands when heated, driving some of the air out through the joints. When the electrical supply to the equipment is turned off, the equipment cools, the atmosphere inside contracts creating a partial vacuum, drawing the external atmosphere, possibly flammable vapors or gases, into the enclosure through the joints. Once inside the enclosure, the flammable gases or vapors remain, mixed with the air in the enclosure, until another heating cycle starts. This heating cycle may reduce the concentration of flammables within the enclosure, but they will not be completely eliminated. The next cooling cycle draws more flammables into the enclosure.



HFX Series Explosionproof Fluorescent Fixture

EXB Series Quantum Junction Box with Touchscreen Display

Since flammable gases and vapors are likely inside an enclosure, the equipment design must be capable of withstanding an explosion inside the enclosure caused by a spark at the contacts of switching devices, high temperatures, or an electrical fault. The joints in the enclosure must be so designed that the hot gases transmitted through them to the surrounding atmosphere as a result of the explosion will not have sufficient energy to ignite a surrounding flammable atmosphere. In addition, the external surfaces of the enclosure must not be hot enough to ignite the surrounding atmosphere as a result of heat energy. This heat energy may be the result of normal operation of heat-producing equipment, or it may be the result of an electrical arc to the enclosure from an arcing ground fault.



Typical Application with XHLF Series Fluorescent Hand Lamp

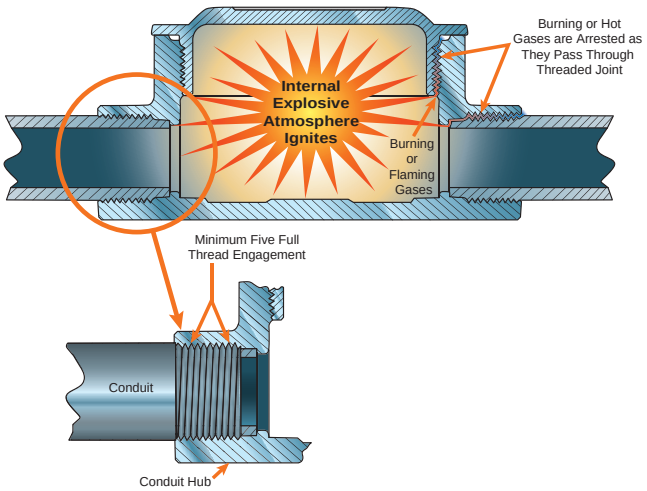
UGFI Series Ground Fault Protector

Y Series Capped Elbow *GR Series Junction Box*

B7C Series Compact Motor Starters

There are five basic types of joints in explosionproof enclosures which are: Threaded Joints, Machined Flat Joints, Cylindrical Joints, Rabbet Joints and Labyrinth Joints.

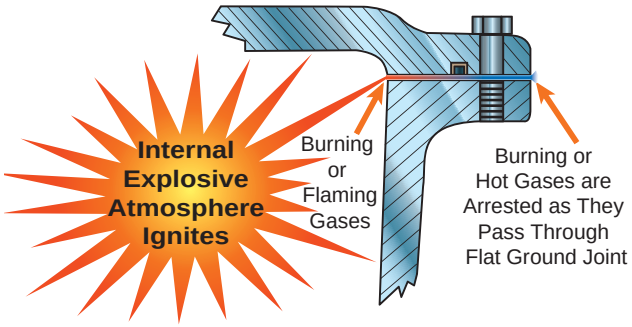
Threaded joints, such as for conduit threads, and threads for covers or operator shafts are also used for covers on junction boxes and other electrical equipment. Hot gases and flames within the enclosure are, in effect, cooled as they pass over and around the threads, and have insufficient energy when they reach the surrounding flammable atmosphere to ignite it.



Threaded Joint Surface Flamepath

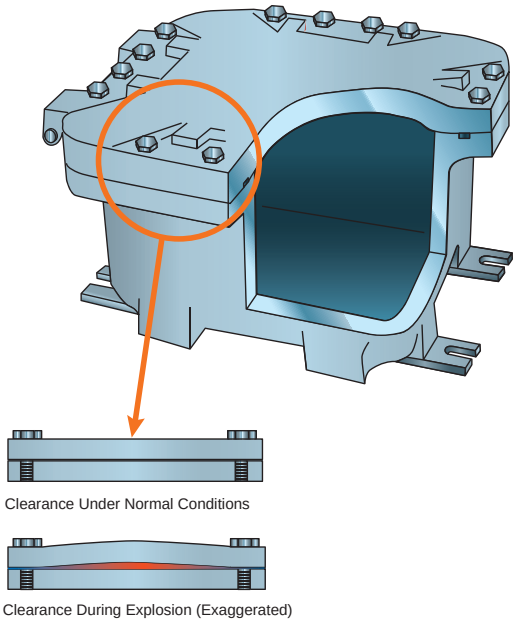
GEJ Series Conduit Outlet Body Threaded Joint

A machined and ground flat joint between two mating surfaces that are tightly bolted together is another type of joint commonly found in enclosures. This joint also operates by preventing the hot gases resulting from an internal explosion from reaching the surrounding atmosphere with sufficient energy to cause an explosion.



Flat Ground Joint Surface Flamepath

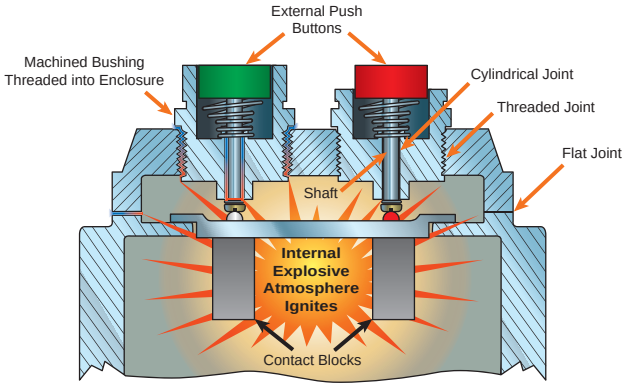
SWBC Series Enclosure Machined Flat Joint



Bolted Flange Joint Clearance Examples

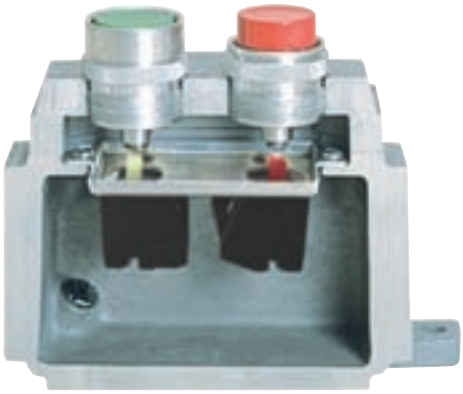
For explosionproof equipment the clearance between flat joint surfaces is usually maintained at not more than 0.0015 inches under quiescent conditions. However, when there is an explosion within the enclosure, the enclosure bends slightly as a result of the internal pressure, producing a larger gap between the mating surfaces.

The clearance between mating surfaces under the dynamic conditions of an explosion depends on the explosion pressure, rate of pressure rise, rigidity of the enclosure material, the tensile strength of the bolts, and the spacing between the bolts. This is why it is so important to actually test the enclosure under explosion conditions. It is also why leaving even one bolt out when assembling an enclosure, or leaving a bolt loose, can destroy the explosionproof properties of the enclosure. So, too, can scratches and corrosion on joint surfaces.

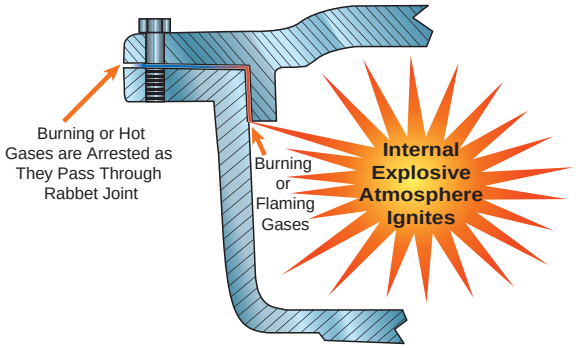


Cylindrical, Threaded, Flat Joint Surface Flamepath

A cylindrical joint such as used in push-buttons and toggle switches, and on electric motors, is essentially a flat joint bent into a circle, but with enough clearance to permit movement of the shaft.



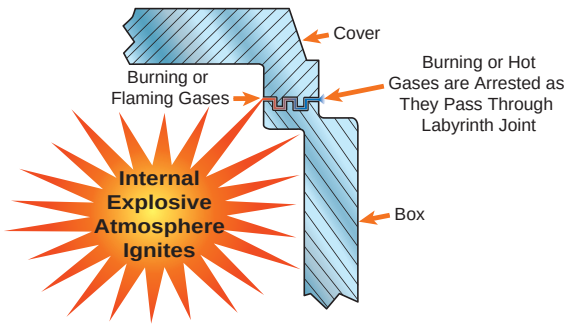
Control Station with "Touch Safe" Control Blocks Machined Flat, Threaded and Cylindrical Joints



Rabbet Joint Surface Flamepath

A rabbet joint is commonly used for large diameter cylindrical parts, such as between a motor end bell and the main frame. This is basically a variation of a cylindrical joint.

A labyrinth joint is used on both rectangular and cylindrical parts. It forces the expanding hot gases to make several right-angle turns before they can exit the enclosure.



Labyrinth Joint Surface Flamepath

DUST-IGNITIONPROOF EQUIPMENT

"Dust-ignitionproof" is a method of protection that removes the fuel leg of the fire triangle shown on page 7 from the inside of the enclosure, and the heat energy (ignition source) leg from the outside of the enclosure, thus making the equipment safe for use in Class II hazardous locations.

Dust-igniti onproof apparatus is defined in the second paragraph of Section 502-1 as:

(1) Being enclosed in a manner that will exclude dust, and

(2) Being constructed so that arcs, sparks, or heat generated inside of the enclosure will not ignite exterior accumulation or atmospheric suspension of a specified dust on or in the vicinity of the enclosure.

This protection method is designed to keep combustible dust outside of the enclosure, to prevent hot particles or sparks within the enclosure as a result of normal equipment operation or electrical fault, from passing from the inside to the outside of the enclosure through enclosure joints, and to prevent ignition of combustible dust suspended in the air or in layers on the equipment from being ignited by heat generated within the equipment. This heat can, as in explosionproof apparatus, result from normal or abnormal equipment operation, or arcing ground faults.

Since the enclosure is not expected to withstand an internal explosion, because the combustible materials are kept outside of the enclosure, the physical strength of the enclosure need only be sufficient to withstand abuse. It must also be thick enough to withstand internal arcing ground faults for enough time for the circuit overcurrent protection to open the circuit and stop the arcing. Unlike explosionproof equipment, dust-ignitionproof equipment is often made of sheet metal rather than cast metal. The same types of joints are used in the enclosure, but the requirements are not as rigid. These joints are needed only to prevent dust from entering the enclosure and hot particles from exiting under fault conditions.

Control of external surface temperatures, however, is more rigorous for dust-ignitionproof equipment than for explosionproof equipment, because the ignition temperature of dusts is usually lower than that for gases and vapors. Also, dust layers on the equipment can prevent dissipation of heat generated within the equipment, thus increasing the surface temperature even under normal operating conditions.

For additional information on equipment protection systems in hazardous locations as defined in Article 500, see the commentary In *NEC*® Section 500.7. For equipment protection systems in hazardous locations as defined in Article 505, see commentary In Section 505.8. For locations as defined in Article 506 see commentary in Section 506.8.

Class II, Divisions 1 and 2, DB Series Enclosure

Compact LED Luminaire for Class II, Divisions 1 and 2 Dust Locations

Non-Metallic/Non-Glass Fixture for Class II, Division 2 Locations

Fuel additive blending system utilizes Killark explosionproof enclosures, controls instrumentation housings and fittings.

ARTICLE 500
Hazardous (Classified) Locations, Classes I, II, and III, Divisions 1 and 2

Informational Note: Text that is followed by a reference in brackets has been extracted from NFPA 497-2008, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas, and NFPA 499-2008, Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installation in Chemical Process Areas.* Only editorial changes were made to the extracted text to make it consistent with this Code.

◆ The informational note has been revised to agree with the titles of standards that are reference.

500.1 Scope — Articles 500 Through 504.

Articles 500 through 504 cover the requirements for electrical and electronic equipment and wiring for all voltages in Class I, Divisions 1 and 2; Class II, Divisions 1 and 2; and Class III, Divisions 1 and 2 locations where fire or explosion hazards may exist due to flammable gases, flammable liquid–produced vapors, combustible liquid–produced vapors, combustible dusts, or ignitible fibers/flyings.

Informational Note No. 1: The unique hazards associated with explosives, pyrotechnics, and blasting agents are not addressed in this article.

Informational Note No. 2: For the requirements for electrical and electronic equipment and wiring for all voltages in Zone 0, Zone 1, and Zone 2 hazardous (classified) locations where fire or explosion hazards may exist due to flammable gases or vapors or flammable liquids, refer to Article 505.

Informational Note No. 3: For the requirements for electrical and electronic equipment and wiring for all voltages in Zone 20, Zone 21, and Zone 22 hazardous (classified) locations where fire or explosion hazards may exist due to combustible dusts or ignitible fibers/flyings, refer to Article 506.

✪ *500.1 SCOPE - This section indicates that Articles 500 through 504 cover both electrical and electronic equipment, and wiring for all voltages in Class I, Divisions 1 and 2; Class II, Divisions 1 and 2; and Class III, Divisions 1 and 2 locations including equipment rated 0-50 volts, 51-600 volts, and over 600 volts. However, the requirements in Articles 500 through 504 are limited to locations where a fire or explosion hazard may exist due to flammable gases, flammable liquid produced vapors, combustible dust, or ignitible fibers or flyings. If an explosion hazard does not exist due to the presence of one or more of these materials, Articles 500 through 504 are not applicable.*

500.2 Definitions.

For purposes of Articles 500 through 504 and Articles 510 through 516, the following definitions apply.

Associated Nonincendive Field Wiring Apparatus. Apparatus in which the circuits are not necessarily nonincendive themselves but that affect the energy in nonincendive field wiring circuits and are relied upon to maintain nonincendive energy levels. Associated nonincendive field wiring apparatus may be either of the following:

(1) Electrical apparatus that has an alternative type of protection for use in the appropriate hazardous (classified) location

(2) Electrical apparatus not so protected that shall not be used in a hazardous (classified) location

Informational Note: Associated nonincendive field wiring apparatus has designated associated nonincendive field wiring apparatus connections for nonincendive field wiring apparatus and may also have connections for other electrical apparatus.

Combustible Dust. Any finely divided solid material that is 420 microns (0.017 in.) or smaller in diameter (material passing a U.S. No. 40 Standard Sieve) and presents a fire or explosion hazard when dispersed and ignited in air. [**499,** 2008]

◆ Added a new definition for combustible dust that was taken from NFPA 499 for consistency between the requirements in NFPA 499 and the installation requirements of the NEC.

Combustible Gas Detection System. A protection technique utilizing stationary gas detectors in industrial establishments.

Control Drawing. A drawing or other document provided by the manufacturer of the intrinsically safe or associated apparatus, or of the nonincendive field wiring apparatus or associated nonincendive field wiring apparatus, that details the allowed interconnections between the intrinsically safe and associated apparatus or between the nonincendive field wiring apparatus or associated nonincendive field wiring apparatus.

Dust-Ignitionproof. Equipment enclosed in a manner that excludes dusts and does not permit arcs, sparks, or heat otherwise generated or liberated inside of the enclosure to cause ignition of exterior accumulations or atmospheric suspensions of a specified dust on or in the vicinity of the enclosure.

Informational Note: For further information on dust-ignitionproof enclosures, see Type 9 enclosure in ANSI/NEMA 250-1991, *Enclosures for Electrical Equipment,* and ANSI/UL 1203-1994, *Explosionproof and Dust-Ignitionproof Electrical Equipment for Hazardous (Classified) Locations.*

Dusttight. Enclosures constructed so that dust will not enter under specified test conditions.

Informational Note: See ANSI/ISA-12.12.01-2007, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Electrical and Electronic Equipment. Materials, fittings, devices, appliances, and the like that are part of, or in connection with, an electrical installation.

Informational Note: Portable or transportable equipment having self-contained power supplies, such as battery-operated equipment, could potentially become an ignition source in hazardous (classified) locations. See ISA-RP12.12.03-2002, *Recommended Practice for Portable Electronic Products Suitable for Use in Class I and II, Division 2, Zone 2 and Class III, Division 1 and 2 Hazardous (Classified) Locations.*

Explosionproof Equipment. Equipment enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor that may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and that operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby.

◆ Explosionproof Apparatus was changed to Explosionproof Equipment to be in agreement with the wording used in Articles 500, 501, 502 and 503.

Informational Note: For further information, see ANSI/UL 1203-1994, *Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.*

Hermetically Sealed. Equipment sealed against the entrance of an external atmosphere where the seal is made by fusion, for example, soldering, brazing, welding, or the fusion of glass to metal.

Informational Note: For further information, see ANSI/ISA- 12.12.01-2007, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Division 1 and 2 Hazardous (Classified) Locations.*

Nonincendive Circuit. A circuit, other than field wiring, in which any arc or thermal effect produced under intended operating conditions of the equipment is not capable, under specified test conditions, of igniting the flammable gas–air, vapor–air, or dust–air mixture.

Informational Note: Conditions are described in ANSI/ISA- 12.12.01-2007, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Nonincendive Component. A component having contacts for making or breaking an incendive circuit and the contacting mechanism is constructed so that the component is incapable of igniting the specified flammable gas–air or vapor–air mixture. The housing of a nonincendive component is not intended to exclude the flammable atmosphere or contain an explosion.

Informational Note: For further information, see ANSI/ISA- 12.12.01-2007, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Nonincendive Equipment. Equipment having electrical/electronic circuitry that is incapable, under normal operating conditions, of causing ignition of a specified flammable gas–air, vapor–air, or dust–air mixture due to arcing or thermal means.

Informational Note: For further information, see ANSI/ISA- 12.12.01-2007, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Nonincendive Field Wiring. Wiring that enters or leaves an equipment enclosure and, under normal operating conditions of the equipment, is not capable, due to arcing or thermal effects, of igniting the flammable gas–air, vapor– air, or dust–air mixture. Normal operation includes opening, shorting, or grounding the field wiring.

Nonincendive Field Wiring Apparatus. Apparatus intended to be connected to nonincendive field wiring.

Informational Note: For further information, see ANSI/ISA- 12.12.01-2007, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Oil Immersion. Electrical equipment immersed in a protective liquid in such a way that an explosive atmosphere that may be above the liquid or outside the enclosure cannot be ignited.

Informational Note: For further information, see ANSI/UL 698-1995, *Industrial Control Equipment for Use in Hazardous (Classified) Locations.*

Purged and Pressurized. The process of (1) purging, 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; and (2) pressurization, supplying an enclosure with a protective gas with or without continuous flow at sufficient pressure to prevent the entrance of a flammable gas or vapor, a combustible dust, or an ignitible fiber.

Informational Note: For further information, see ANSI/ NFPA 496-2008, *Purged and Pressurized Enclosures for Electrical Equipment.*

Unclassified Locations. Locations determined to be neither Class I, Division 1; Class I, Division 2; Class I, Zone 0; Class I, Zone 1; Class I, Zone 2; Class II, Division 1; Class II, Division 2; Class III, Division 1; Class III, Division 2; Zone 20; Zone 21; Zone 22; or any combination thereof.

500.3 Other Articles.

Except as modified in Articles 500 through 504, all other applicable rules contained in this Code shall apply to electrical equipment and wiring installed in hazardous (classified) locations.

✪ *500.3 OTHER ARTICLES - This section requires that all other applicable rules contained in the NEC® apply to electrical equipment and wiring installed in hazardous (classified) locations. Thus, if there is a requirement in other than Articles 500 through 504 that the equipment be listed, that requirement is applicable to equipment used under the requirements of Articles 500 through 504 unless modified in these articles. The intent is that all equipment used in hazardous locations meet all of the applicable Code requirements for equipment used in non-hazardous locations.*

500.4 General.

(A) Documentation. All areas designated as hazardous (classified) locations shall be properly documented. This documentation shall be available to those authorized to design, install, inspect, maintain, or operate electrical equipment at the location.

✪ *500.4 GENERAL - (A) Documentation. The documentation required may consist of area classification drawings such as are commonly used in petro-chemical plants and petroleum refineries, a written description, or reference to a specific NEC® article or NFPA or other published standard or recommended practice. If the reference is to another document, that document should also be available. Note that this information is required to be available not only to designers, installers and inspectors, but also to operators and maintenance personnel.*

(B) Reference Standards. Important information relating to topics covered in Chapter 5 may be found in other publications.

Informational Note No. 1: It is important that the authority having jurisdiction be familiar with recorded industrial experience as well as with the standards of the National Fire Protection Association (NFPA), the American Petroleum Institute (API), and the International Society of Automation (ISA), that may be of use in the classification of various locations, the determination of adequate ventilation, and the protection against static electricity and lightning hazards.

Informational Note No. 2: For further information on the classification of locations, see NFPA 30-2008, *Flammable and Combustible Liquids Code; NFPA 32-2007, Standard for Drycleaning Plants;* NFPA 33-2011, *Standard for Spray Application Using Flammable or Combustible Materials;* NFPA 34-2011, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids;* NFPA 35-2005, *Standard for the Manufacture of Organic Coatings;* NFPA 36-2009, *Standard for Solvent Extraction Plants;* NFPA 45-2011, *Standard on Fire Protection for Laboratories Using Chemicals;* NFPA 55-2010, *Compressed Gases and Cryogenic Fluids Code;* NFPA 58-2011, *Liquefied Petroleum Gas Code;* NFPA 59-2008, Utility LPGas Plant Code; NFPA 497-2008, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas;* NFPA 499-2008, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas;* NFPA 820-2008, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities;* ANSI/API RP500- 1997, *Recommended Practice for Classification of Locations of Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2;* ISA-12.10- 1988, *Area Classification in Hazardous (Classified) Dust Locations.*

Informational Note No. 3: For further information on protection against static electricity and lightning hazards in hazardous (classified) locations, see NFPA 77-2007, *Recommended Practice on Static Electricity;* NFPA 780-2011, *Standard for the Installation of Lightning Protection Systems;* and API RP 2003-1998, *Protection Against Ignitions Arising Out of Static Lightning and Stray Currents.*

Informational Note No. 4: For further information on ventilation, see NFPA 30-2008, *Flammable and Combustible Liquids Code;* and API RP 500-1997, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2.*

Informational Note No. 5: For further information on electrical systems for hazardous (classified) locations on offshore oil- and gas-producing platforms, see ANSI/API RP 14F-1999, *Recommended Practice for Design and Installation of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Division 1 and Division 2 Locations.*

✪ *500.4 GENERAL - (B) Reference Standards. Most of this section consists of references to a variety of codes, standards, and recommended practices. Included are standards for protection against lightning and protection against static electricity. These ignition sources are outside the scope of the Nataional Electrical Code®. Although excellent protection can be provided, nothing will provide 100% protection against lightning as an ignition source. Protection against ignition by static electricity is essential if flammable liquids are being transferred from one container to another, or combustible dusts being moved. The key to protecting against static electricity is proper grounding and bonding.*

500.5 Classifications of Locations.

(A) Classifications of Locations. Locations shall be classified depending on the properties of the flammable gas, flammable liquid-produced vapor, combustible-liquid produced vapors, combustible dusts, or fibers/flyings that may be present, and the likelihood that a flammable or combustible concentration or quantity is present. Where pyrophoric materials are the only materials used or handled, these locations shall not be classified. Each room, section, or area shall be considered individually in determining its classification.

Informational Note: Through the exercise of ingenuity in the layout of electrical installations for hazardous (classified) locations, it is frequently possible to locate much of the equipment in a reduced level of classification or in an unclassified location and, thus, to reduce the amount of special equipment required.

Rooms and areas containing ammonia refrigeration systems that are equipped with adequate mechanical ventilation may be classified as “unclassified” locations.

Informational Note: For further information regarding classification and ventilation of areas involving ammonia, see ANSI/ASHRAE 15-1994, *Safety Code for Mechanical Refrigeration,* and ANSI/CGA G2.1-1989, *Safety Requirements for the Storage and Handling of Anhydrous Ammonia.*

(B) Class I Locations. Class I locations are those in which flammable gases, flammable liquid–produced vapors, or combustible liquid–produced vapors are or may be present in the air in quantities sufficient to produce explosive or ignitible mixtures. Class I locations shall include those specified in 500.5(B)(1) and (B)(2).

Hazardous Location sites encompacing a variety of Classified locations for Class I, Divisions 1 & 2.

(1) Class I, Division 1. A Class I, Division 1 location is a location

(1) In which ignitible concentrations of flammable gases, flammable liquid–produced vapors, or combustible liquid–produced vapors can exist under normal operating conditions, or

(2) In which ignitible concentrations of such flammable gases, flammable liquid–produced vapors, or combustible liquids above their flash points may exist frequently because of repair or maintenance operations or because of leakage, or

(3) In which breakdown or faulty operation of equipment or processes might release ignitible concentrations of flammable gases, flammable liquid–produced vapors, or combustible liquid–produced vapors and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition.

Informational Note No. 1: This classification usually includes the following locations:

(1) Where volatile flammable liquids or liquefied flammable gases are transferred from one container to another

(2) Interiors of spray booths and areas in the vicinity of spraying and painting operations where volatile flammable solvents are used

(3) Locations containing open tanks or vats of volatile flammable liquids

(4) Drying rooms or compartments for the evaporation of flammable solvents

(5) Locations containing fat- and oil-extraction equipment using volatile flammable solvents

(6) Portions of cleaning and dyeing plants where flammable liquids are used

(7) Gas generator rooms and other portions of gas manufacturing plants where flammable gas may escape

(8) Inadequately ventilated pump rooms for flammable gas or for volatile flammable liquids

(9) The interiors of refrigerators and freezers in which volatile flammable materials are stored in open, lightly stoppered, or easily ruptured containers

(10) All other locations where ignitible concentrations of flammable vapors or gases are likely to occur in the course of normal operations

Informational Note No. 2: In some Division 1 locations, ignitible concentrations of flammable gases or vapors may be present continuously or for long periods of time. Examples include the following:

(1) The inside of inadequately vented enclosures containing instruments normally venting flammable gases or vapors to the interior of the enclosure

(2) The inside of vented tanks containing volatile flammable liquids

(3) The area between the inner and outer roof sections of a floating roof tank containing volatile flammable fluids (4) Inadequately ventilated areas within spraying or coating operations using volatile flammable fluids

(5) The interior of an exhaust duct that is used to vent ignitible concentrations of gases or vapors

Experience has demonstrated the prudence of avoiding the installation of instrumentation or other electrical equipment in these particular areas altogether or where it cannot be avoided because it is essential to the process and other locations are not feasible [see 500.5(A), Informational Note] using electrical equipment or instrumentation approved for the specific application or consisting of intrinsically safe systems as described in Article 504.

(2) Class I, Division 2. A Class I, Division 2 location is a location

(1) In which volatile flammable gases, flammable liquid–produced vapors, or combustible liquid–produced vapors are handled, processed, or used, but in which the liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems or in case of abnormal operation of equipment, or

(2) In which ignitible concentrations of flammable gases, flammable liquid–produced vapors, or combustible liquid–produced vapors are normally prevented by positive mechanical ventilation and which might become hazardous through failure or abnormal operation of the ventilating equipment, or

(3) That is adjacent to a Class I, Division 1 location, and to which ignitible concentrations of flammable gases, flammable liquid–produced vapors, or combustible liquid–produced vapors above their flash points might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

Informational Note No. 1: This classification usually includes locations where volatile flammable liquids or flammable gases or vapors are used but that, in the judgment of the authority having jurisdiction, would

become hazardous only in case of an accident or of some unusual operating condition. The quantity of flammable material that might escape in case of accident, the adequacy of ventilating equipment, the total area involved, and the record of the industry or business with respect to explosions or fires are all factors that merit consideration in determining the classification and extent of each location.

Informational Note No. 2: Piping without valves, checks, meters, and similar devices would not ordinarily introduce a hazardous condition even though used for flammable liquids or gases. Depending on factors such as the quantity and size of the containers and ventilation, locations used for the storage of flammable liquids or liquefied or compressed gases in sealed containers may be considered either hazardous (classified) or unclassified locations. See NFPA 30- 2008, *Flammable and Combustible Liquids Code*, and NFPA 58-2011, *Liquefied Petroleum Gas Code*.

(C) Class II Locations. Class II locations are those that are hazardous because of the presence of combustible dust. Class II locations shall include those specified in 500.5(C)(1) and (C)(2).

Class II, Coal Handling Operation

(1) Class II, Division 1. A Class II, Division 1 location is a location

(1) In which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitible mixtures, or

(2) Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitible mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electrical equipment, through operation of protection devices, or from other causes, or

(3) In which Group E combustible dusts may be present in quantities sufficient to be hazardous.

Informational Note: Dusts containing magnesium or aluminum are particularly hazardous, and the use of extreme precaution is necessary to avoid ignition and explosion.

(2) Class II, Division 2. A Class II, Division 2 location is a location

(1) In which combustible dust due to abnormal operations may be present in the air in quantities sufficient to produce explosive or ignitible mixtures; or

(2) Where combustible dust accumulations are present but are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but could as a result of infrequent malfunctioning of handling or processing equipment become suspended in the air; or

(3) In which combustible dust accumulations on, in, or in the vicinity of the electrical equipment could be sufficient to interfere with the safe dissipation of heat from electrical equipment, or could be ignitible by abnormal operation or failure of electrical equipment.

Informational Note No. 1: The quantity of combustible dust that may be present and the adequacy of dust removal systems are factors that merit consideration in determining the classification and may result in an unclassified area.

Informational Note No. 2: Where products such as seed are handled in a manner that produces low quantities of dust, the amount of dust deposited may not warrant classification.

(D) Class III Locations. Class III locations are those that are hazardous because of the presence of easily ignitible fibers or where materials producing combustible flyings are handled, manufactured, or used, but in which such fibers/flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitible mixtures. Class III locations shall include those specified in 500.5(D)(1) and (D)(2).

Class III, Saw Mill

(1) Class III, Division 1. A Class III, Division 1 location is a location in which easily ignitible fibers/flyings are handled, manufactured, or used.

Informational Note No. 1: Such locations usually include some parts of rayon, cotton, and other textile mills; combustible fibers/flyings manufacturing and processing plants; cotton gins and cotton-seed mills; flax-processing plants; clothing manufacturing plants; woodworking plants; and establishments and industries involving similar hazardous processes or conditions.

Informational Note No. 2: Easily ignitible fibers/flyings include rayon, cotton (including cotton linters and cotton waste), sisal or henequen, istle, jute, hemp, tow, cocoa fiber, oakum, baled waste kapok, Spanish moss, excelsior, and other materials of similar nature.

(2) Class III, Division 2. A Class III, Division 2 location is a location in which easily ignitible fibers/flyings are stored or handled other than in the process of manufacture.

500.6 Material Groups.

For purposes of testing, approval, and area classification, various air mixtures (not oxygen-enriched) shall be grouped in accordance with 500.6(A) and (B).

Exception: Equipment identified for a specific gas, vapor, or dust.

Informational Note: This grouping is based on the characteristics of the materials. Facilities are available for testing and identifying equipment for use in the various atmospheric groups.

(A) Class I Group Classifications. Class I groups shall be according to 500.6(A)(1) through (A)(4).

Informational Note No. 1: Informational Note Nos. 2 and 3 apply to 500.6(A).

Informational Note No. 2: The explosion characteristics of air mixtures of gases or vapors vary with the specific material involved. For Class I locations, Groups A, B, C, and D, the classification involves determinations of maximum explosion pressure and maximum safe clearance between parts of a clamped joint in an enclosure. It is necessary, therefore, that equipment be identified not only for class but also for the specific group of the gas or vapor that will be present.

Informational Note No. 3: Certain chemical atmospheres may have characteristics that require safeguards beyond those required for any of the Class I groups. Carbon disulfide is one of these chemicals because of its low ignition temperature (90°C) and the small joint clearance permitted to arrest its flame.

◆ This new informational note was added to provide information covering testing of specific dust samples in accordance with established ASTM testing procedures.

(1) Group A. Acetylene. [**497**:3.3.5.1.1]

(2) Group B. Flammable gas, flammable liquid–produced vapor, or combustible liquid–produced vapor mixed with air that may burn or explode, having either a maximum experimental safe gap (MESG) value less than or equal to 0.45 mm or a minimum igniting current ratio (MIC ratio) less than or equal to 0.40. [**497**:3.3.5.1.2]

Informational Note: A typical Class I, Group B material is hydrogen.

Exception No. 1: Group D equipment shall be permitted to be used for atmospheres containing butadiene, provided all conduit runs into explosionproof equipment are provided with explosionproof seals installed within 450 mm (18 in.) of the enclosure.

Exception No. 2: Group C equipment shall be permitted to be used for atmospheres containing allyl glycidyl ether, n-butyl glycidyl ether, ethylene oxide, propylene oxide, and acrolein, provided all conduit runs into explosionproof equipment are provided with explosionproof seals installed within 450 mm (18 in.) of the enclosure.

(3) Group C. Flammable gas, flammable liquid–produced vapor, or combustible liquid–produced vapor mixed with air that may burn or explode, having either a maximum experimental safe gap (MESG) value greater than 0.45 mm and less than or equal to 0.75 mm, or a minimum igniting current ratio (MIC ratio) greater than 0.40 and less than or equal to 0.80. [**497**:3.3.5.1.3]

Informational Note: A typical Class I, Group C material is ethylene.

(4) Group D. Flammable gas, flammable liquid–produced vapor, or combustible liquid–produced vapor mixed with air that may burn or explode, having either a maximum experimental safe gap (MESG) value greater than 0.75 mm or a minimum igniting current ratio (MIC ratio) greater than 0.80. [**497**:3.3.5.1.4]

Informational Note No. 1: A typical Class I, Group D material is propane.

Informational Note No. 2: For classification of areas involving ammonia atmospheres, see ANSI/ASHRAE 15- 1994, *Safety Code for Mechanical Refrigeration,* and ANSI/CGA G2.1-1989, *Safety Requirements for the Storage and Handling of Anhydrous Ammonia.*

(B) Class II Group Classifications. *Class II groups shall be in accordance with 500.6(B)(1) through (B)(3).*

(1) Group E. *Atmospheres containing combustible metal dusts, including aluminum, magnesium, and their commercial alloys, or other combustible dusts whose particle size, abrasiveness, and conductivity present similar hazards in the use of electrical equipment. [**499**:3.3.4.1]*

Informational Note: Certain metal dusts may have characteristics that require safeguards beyond those required for atmospheres containing the dusts of aluminum, magnesium, and their commercial alloys. For example, zirconium, thorium, and uranium dusts have extremely low ignition temperatures [as low as 20°C (68°F)] and minimum ignition energies lower than any material classified in any of the Class I or Class II groups.

(2) Group F. Atmospheres containing combustible carbonaceous dusts that have more than 8 percent total entrapped volatiles (see ASTM D 3175-02, *Standard Test Method for Volatile Matter in the Analysis Sample for Coal and Coke,* for coal and coke dusts) or that have been sensitized by other materials so that they present an explosion hazard. Coal, carbon black, charcoal, and coke dusts are examples of carbonaceous dusts. [**499**:3.3.4.2]

Informational Note: Testing of specific dust samples, following established ASTM testing procedures, is a method used to identify the combustibility of a specific dust and the need to classify those locations containing that material as Group F.

(3) Group G. Atmospheres containing combustible dusts not included in Group E or F, including flour, grain, wood, plastic, and chemicals.

Informational Note No. 1: For additional information on group classification of Class II materials, see NFPA 499-2008, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.*

Informational Note No. 2: The explosion characteristics of air mixtures of dust vary with the materials involved. For Class II locations, Groups E, F, and G, the classification involves the tightness of the joints of assembly and shaft openings to prevent the entrance of dust in the dustignitionproof enclosure, the blanketing effect of layers of dust on the equipment that may cause overheating, and the ignition temperature of the dust. It is necessary, therefore, that equipment be identified not only for the class but also for the specific group of dust that will be present.

Informational Note No. 3: Certain dusts may require additional precautions due to chemical phenomena that can result in the generation of ignitible gases. See ANSI C2- 2007, *National Electrical Safety Code*, Section 127A, Coal Handling Areas.

500.7 Protection Techniques.

Section 500.7(A) through (L) shall be acceptable protection techniques for electrical and electronic equipment in hazardous (classified) locations.

✪ *500.7 PROTECTION TECHNIQUES - This section details all the protection techniques for electrical and electronic equipment in hazardous locations that are recognized by Article 500 of the National Electical Code®.*

(A) Explosionproof Equipment. This protection technique shall be permitted for equipment in Class I, Division 1 or 2 locations.

(B) Dust Ignitionproof. This protection technique shall be permitted for equipment in Class II, Division 1 or 2 locations.

(C) Dusttight. This protection technique shall be permitted for equipment in Class II, Division 2 or Class III, Division 1 or 2 locations.

(D) Purged and Pressurized. This protection technique shall be permitted for equipment in any hazardous (classified) location for which it is identified.

(E) Intrinsic Safety. This protection technique shall be permitted for equipment in Class I, Division 1 or 2; or Class II, Division 1 or 2; or Class III, Division 1 or 2 locations. The provisions of Articles 501 through 503 and Articles 510 through 516 shall not be considered applicable to such installations, except as required by Article 504, and installation of intrinsically safe apparatus and wiring shall be in accordance with the requirements of Article 504.

(F) Nonincendive Circuit. This protection technique shall be permitted for equipment in Class I, Division 2; Class II, Division 2; or Class III, Division 1 or 2 locations.

(G) Nonincendive Equipment. This protection technique shall be permitted for equipment in Class I, Division 2; Class II, Division 2; or Class III, Division 1 or 2 locations.

(H) Nonincendive Component. This protection technique shall be permitted for equipment in Class I, Division 2; Class II, Division 2; or Class III, Division 1 or 2 locations.

(I) Oil Immersion. This protection technique shall be permitted for current-interrupting contacts in Class I, Division 2 locations as described in 501.115(B)(1)(2).

(J) Hermetically Sealed. This protection technique shall be permitted for equipment in Class I, Division 2; Class II, Division 2; or Class III, Division 1 or 2 locations.

(K) Combustible Gas Detection System. A combustible gas detection system shall be permitted as a means of protection in industrial establishments with restricted public access and where the conditions of maintenance and supervision ensure that only qualified persons service the installation. Where such a system is installed, equipment specified in 500.7(K)(1), (K)(2), or (K)(3) shall be permitted.

The type of detection equipment, its listing, installation location(s), alarm and shutdown criteria, and calibration frequency shall be documented when combustible gas detectors are used as a protection technique.

Informational Note No. 1: For further information, see ANSI/ISA-60079-29-1, *Explosive Atmospheres - Part 29-1: Gas detectors - Performance requirements of detectors for flammable gases*, and ANSI/UL 2075, Gas and Vapor Detectors and Sensors.

Informational Note No. 2: For further information, see ANSI/API RP 500, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division I or Division 2.*

Informational Note No. 3: For further information, see ANSI/ISA-60079-29-2, *Explosive Atmospheres - Part 29-2: Gas detectors - Selection, installation, use and maintenance of detectors for flammable gases and oxygen.*

Informational Note No. 4: For further information, see ISA-TR12.13.03, *Guide for Combustible Gas Detection as a Method of Protection.*

(1) Inadequate Ventilation. In a Class I, Division 1 location that is so classified due to inadequate ventilation, electrical equipment suitable for Class I, Division 2 locations shall be permitted. Combustible gas detection equipment shall be listed for Class I, Division 1, for the appropriate material group, and for the detection of the specific gas or vapor to be encountered.

(2) Interior of a Building. In a building located in, or with an opening into, a Class I, Division 2 location where the interior does not contain a source of flammable gas or vapor, electrical equipment for unclassified locations shall be permitted. Combustible gas detection equipment shall be listed for Class I, Division 1 or Class I, Division 2, for the appropriate material group, and for the detection of the specific gas or vapor to be encountered.

(3) Interior of a Control Panel. In the interior of a control panel containing instrumentation utilizing or measuring flammable liquids, gases, or vapors, electrical equipment suitable for Class I, Division 2 locations shall be permitted. Combustible gas detection equipment shall be listed for Class I, Division 1, for the appropriate material group, and for the detection of the specific gas or vapor to be encountered.

(L) Other Protection Techniques. Other protection techniques used in equipment identified for use in hazardous (classified) locations.

500.8 Equipment.

Articles 500 through 504 require equipment construction and installation that ensure safe performance under conditions of proper use and maintenance.

Informational Note No. 1: It is important that inspection authorities and users exercise more than ordinary care with regard to installation and maintenance.

Informational Note No. 2: Since there is no consistent relationship between explosion properties and ignition temperature, the two are independent requirements.

Informational Note No. 3: Low ambient conditions require special consideration. Explosionproof or dust-ignitionproof equipment may not be suitable for use at temperatures lower than −25ºC (−13ºF) unless they are identified for low-temperature service. However, at low ambient temperatures, flammable concentrations of vapors may not exist in a location classified as Class I, Division 1 at normal ambient temperature.

(A) Suitability. Suitability of identified equipment shall be determined by one of the following:

(1) Equipment listing or labeling

(2) Evidence of equipment evaluation from a qualified testing laboratory or inspection agency concerned with product evaluation

(3) Evidence acceptable to the authority having jurisdiction such as a manufacturer's self-evaluation or an owner's engineering judgment.

Informational Note: Additional documentation for equipment may include certificates demonstrating compliance with applicable equipment standards, indicating special conditions of use, and other pertinent information. Guidelines for certificates may be found in ANSI/ISA 12.00.02, *Certificate Standard for AEx Equipment for Hazardous (Classified) Locations.*

(B) Approval for Class and Properties.

(1) Equipment shall be identified not only for the class of location but also for the explosive, combustible, or ignitible properties of the specific gas, vapor, dust, or fibers/flyings that will be present. In addition, Class I equipment shall not have any exposed surface that operates at a temperature in excess of the ignition temperature of the specific gas or vapor. Class II equipment shall not have an external temperature higher than that specified in 500.8(D)(2). Class III equipment shall not exceed the maximum surface temperatures specified in 503.5.

Informational Note: Luminaires and other heat-producing apparatus, switches, circuit breakers, and plugs and receptacles are potential sources of ignition and are investigated for suitability in classified locations. Such types of equipment, as well as cable terminations for entry into explosionproof enclosures, are available as listed for Class I, Division 2 locations. Fixed wiring, however, may utilize wiring methods that are not evaluated with respect to classified locations. Wiring products such as cable, raceways, boxes, and fittings, therefore, are not marked as being suitable for Class I, Division 2 locations. Also see 500.8(C)(6)(a).

(2) Equipment that has been identified for a Division 1 location shall be permitted in a Division 2 location of the same class, group, and temperature class and shall comply with (a) or (b) as applicable.

(a) Intrinsically safe apparatus having a control drawing requiring the installation of associated apparatus for a Division 1 installation shall be permitted to be installed in a Division 2 location if the same associated apparatus is used for the Division 2 installation.

(b) Equipment that is required to be explosionproof shall incorporate seals in accordance with 501.15(A) or (D) when the wiring methods of 501.10(B) are employed.

(3) Where specifically permitted in Articles 501 through 503, general-purpose equipment or equipment in general purpose enclosures shall be permitted to be installed in Division 2 locations if the equipment does not constitute a source of ignition under normal operating conditions.

(4) Equipment that depends on a single compression seal, diaphragm, or tube to prevent flammable or combustible fluids from entering the equipment shall be identified for a Class I, Division 2 location even if installed in an unclassified location. Equipment installed in a Class I, Division 1 location shall be identified for the Class I, Division 1 location.

Informational Note: Equipment used for flow measurement is an example of equipment having a single compression seal, diaphragm, or tube.

(5) Unless otherwise specified, normal operating conditions for motors shall be assumed to be rated full-load steady conditions.

(6) Where flammable gases, flammable liquid–produced vapors, combustible liquid–produced vapors, or combustible dusts are or may be present at the same time, the simultaneous presence of both shall be considered when determining the safe operating temperature of the electrical equipment.

Informational Note: The characteristics of various atmospheric mixtures of gases, vapors, and dusts depend on the specific material involved.

(C) Marking. Equipment shall be marked to show the environment for which it has been evaluated. Unless otherwise specified or allowed in (C)(6), the marking shall include the information specified in (C)(1) through (C)(5).

(1) Class. The marking shall specify the class(es) for which the equipment is suitable.

(2) Division. The marking shall specify the division if the equipment is suitable for Division 2 only. Equipment suitable for Division 1 shall be permitted to omit the division marking.

Informational Note: Equipment not marked to indicate a division, or marked "Division 1" or "Div. 1," is suitable for both Division 1 and 2 locations; see 500.8(B)(2). Equipment marked "Division 2" or "Div. 2" is suitable for Division 2 locations only.

(3) Material Classification Group. The marking shall specify the applicable material classification group(s) in accordance with 500.6.

Exception: Fixed luminaires marked for use only in Class I, Division 2 or Class II, Division 2 locations shall not be required to indicate the group.

(4) Equipment Temperature. The marking shall specify the temperature class or operating temperature at a 40°C ambient temperature, or at the higher ambient temperature if the equipment is rated and marked for an ambient temperature of greater than 40°C. The temperature class, if provided, shall be indicated using the temperature class (T Codes) shown in Table 500.8(C). Equipment for Class I and Class II shall be marked with the maximum safe operating temperature, as determined by simultaneous exposure to the combinations of Class I and Class II conditions.

Table 500.8(C) Classification of Maximum Surface Temperature

Maximum Temperature		Temperature Class
°C	°F	(T 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

Exception: Equipment of the non–heat-producing type, such as junction boxes, conduit, and fittings, and equipment of the heat-producing type having a maximum temperature not more than 100°C shall not be required to have a marked operating temperature or temperature class.

Informational Note: More than one marked temperature class or operating temperature, for gases and vapors, dusts, and different ambient temperatures, may appear.

(5) Ambient Temperature Range. Electrical equipment designed for use in the ambient temperature range between –25°C to +40°C shall require no ambient temperature marking. For equipment rated for a temperature range other than –25°C to +40°C, the marking shall specify the special range of ambient temperatures in degrees Celsius. The marking shall include either the symbol "Ta" or "Tamb."

Informational Note: As an example, such a marking might be "–30°C ≤ Ta ≤ +40°C."

(6) Special Allowances.

(a) *General-Purpose Equipment.* Fixed general-purpose equipment in Class I locations, other than fixed luminaires, that is acceptable for use in Class I, Division 2 locations shall not be required to be marked with the class, division, group, temperature class, or ambient temperature range.

(b) *Dusttight Equipment.* Fixed dusttight equipment, other than fixed luminaires, that is acceptable for use in Class II, Division 2 and Class III locations shall not be required to be marked with the class, division, group, temperature class, or ambient temperature range.

(c) *Associated Apparatus.* Associated intrinsically safe apparatus and associated nonincendive field wiring apparatus that are not protected by an alternative type of protection shall not be marked with the class, division, group, or temperature class. Associated intrinsically safe apparatus and associated nonincendive field wiring apparatus shall be marked with the class, division, and group of the apparatus to which it is to be connected.

(d) *Simple Apparatus.* "Simple apparatus" as defined in Article 504, shall not be required to be marked with class, division, group, temperature class, or ambient temperature range.

(D) Temperature.

(1) Class I Temperature. The temperature marking specified in 500.8(C) shall not exceed the ignition temperature of the specific gas or vapor to be encountered.

Informational Note: For information regarding ignition temperatures of gases and vapors, see NFPA 497-2008, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors, and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.*

(2) Class II Temperature. The temperature marking specified in 500.8(C) shall be less than the ignition temperature of the specific dust to be encountered. For organic dusts that may dehydrate or carbonize, the temperature marking shall not exceed the lower of either the ignition temperature or 165°C (329°F).

Informational Note: See NFPA 499-2008, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas,* for minimum ignition temperatures of specific dusts.

The ignition temperature for which equipment was approved prior to this requirement shall be assumed to be as shown in Table 500.8(D)(2).

(E) Threading. The supply connection entry thread form shall be NPT or metric. Conduit and fittings shall be made wrenchtight to prevent sparking when fault current flows through the conduit system, and to ensure the explosionproof integrity of the conduit system where applicable. Equipment provided with threaded entries for field wiring connections shall be installed in accordance with 500.8(E)(1) or (E)(2) and with (E)(3).

◆ This section was revised to require entry threads to be either NPT or Metric. The requirement for thread engagement and related exception was relocated to 500.8(E)(1).

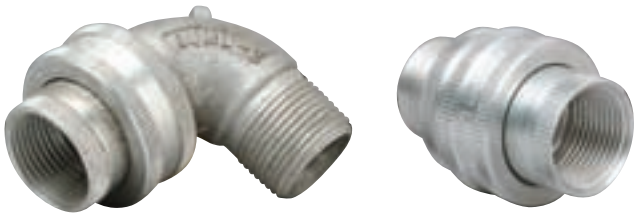
Table 500.8(D)(2) Class II Temperatures

Class II Group	Equipment Not Subject to Overloading °C	°F	Equipment (Such as Motors or Power Transformers) That May Be Overloaded — Normal Operation °C	°F	Abnormal Operation °C	°F
E	200	392	200	392	200	392
F	200	392	150	302	200	392
G	165	329	120	248	165	329

(1) Equipment Provided with Threaded Entries for NPT Threaded Conduit or Fittings. For equipment provided with threaded entries for NPT threaded conduit or fittings, listed conduit, conduit fittings, or cable fittings shall be used. All NPT threaded conduit and fittings shall be threaded with a National (American) Standard Pipe Taper (NPT) thread.

NPT threaded entries into explosionproof equipment shall be made up with at least five threads fully engaged.

Exception: For listed explosionproof equipment, joints with factory threaded NPT entries shall be made up with at least 4 1/2 threads fully engaged.



Male to female GUML angle union and GUF female to female union.

Informational Note No. 1: Thread specifications for male NPT threads are located in ANSI/ASME B1.20.1-1983, *Pipe Threads, General Purpose (Inch).*

Informational Note No. 2: Female NPT threaded entries use a modified National Standard Pipe Taper (NPT) thread with thread form per ANSI/ASME B1.20.1-1983, *Pipe Threads, General Purpose (Inch). See ANSI/UL 1203, Explosionproof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.*

◆ Informational note 2 was added covering industry standards for female threaded entries.

(2) Equipment Provided with Threaded Entries for Metric Threaded Conduit or Fittings. For equipment with metric threaded entries, listed conduit fittings or listed cable fittings shall be used. Such entries shall be identified as being metric, or listed adapters to permit connection to conduit or NPT threaded fittings shall be provided with the equipment and shall be used for connection to conduit or NPT threaded fittings.

Metric threaded entries into explosionproof equipment shall have a class of fit of at least 6g/6H and shall be made up with at least five threads fully engaged for Group C and Group D, and at least eight threads fully engaged for Group A and Group B.

◆ 500.8(E)(2) was revised to require listed conduit or cable fittings with equipment having metric threaded entries, and to provide requirements covering thread engagements for explosionproof with threaded metric entries.

Informational Note: Threading specifications for metric threaded entries are located in ISO 965-1-1998, *ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data*, and ISO 965-3-1998, *ISO general purpose metric screw threads — Tolerances — Part 3: Deviations for constructional screw threads.*

(3) Unused Openings. All unused openings shall be closed with listed metal close-up plugs. The plug engagement shall comply with 500.8(E)(1) or (E)(2).

Close-up plugs installed in enclosure

◆ This section added a requirement covering the use of close-up plugs and thread engagement.

(F) Optical Fiber Cables. Where an optical fiber cable contains conductors that are capable of carrying current (composite optical fiber cable), the optical fiber cable shall be installed in accordance with the requirements of Article 500, 501, 502, or 503, as applicable.

500.9 Specific Occupancies.

Articles 510 through 517 cover garages, aircraft hangars, motor fuel dispensing facilities, bulk storage plants, spray application, dipping and coating processes, and health care facilities.

ARTICLE 501
Class I Locations

I. General

501.1 Scope.

Article 501 covers the requirements for electrical and electronic equipment and wiring for all voltages in Class I, Division 1 and 2 locations where fire or explosion hazards may exist due to flammable gases or vapors or flammable liquids.

Informational Note: For the requirements for electrical and electronic equipment and wiring for all voltages in Zone 0, Zone 1, or Zone 2 hazardous (classified) locations where fire or explosion hazards may exist due to flammable gases or vapors or flammable liquids, refer to Article 505.

501.5 Zone Equipment.

Equipment listed and marked in accordance with 505.9(C)(2) for use in Zone 0, 1, or 2 locations shall be permitted in Class I, Division 2 locations for the same gas and with a suitable temperature class. Equipment listed and marked in accordance with 505.9(C)(2) for use in Zone 0 locations shall be permitted in Class I, Division 1 or Division 2 locations for the same gas and with a suitable temperature class.

II. Wiring

501.10 Wiring Methods.

Wiring methods shall comply with 501.10(A) or (B).

(A) Class I, Division 1.

(1) General. In Class I, Division 1 locations, the wiring methods in (a) through (d) shall be permitted.

(a) Threaded rigid metal conduit or threaded steel intermediate metal conduit.

Exception: Type PVC conduit and Type RTRC conduit shall be permitted where encased in a concrete envelope a minimum of 50 mm (2 in.) thick and provided with not less than 600 mm (24 in.) of cover measured from the top of the conduit to grade. The concrete encasement shall be permitted to be omitted where subject to the provisions of 514.8, Exception No. 2, and 515.8(A). Threaded rigid metal conduit or threaded steel intermediate metal conduit shall be used for the last 600 mm (24 in.) of the underground run to emergence or to the point of connection to the aboveground raceway. An equipment grounding conductor shall be included to provide for electrical continuity of the raceway system and for grounding of non–current-carrying metal parts.

(b) *Type MI cable terminated with fittings listed for the location.* Type MI cable shall be installed and supported in a manner to avoid tensile stress at the termination fittings.

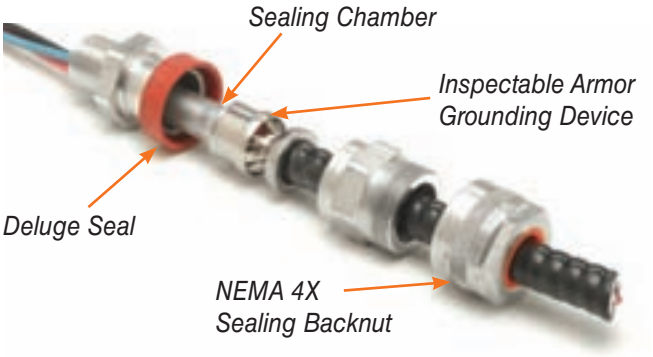
(c) *In industrial establishments with restricted public access,* where the conditions of maintenance and supervision ensure that only qualified persons service the installation, Type MC-HL cable listed for use in Class I, Zone 1 or Division 1 locations, with a gas/vaportight continuous corrugated metallic sheath, an overall jacket of suitable polymeric material, and a separate equipment grounding conductor(s) in accordance with 250.122, and terminated with fittings listed for the application.

Type MC-HL cable shall be installed in accordance with the provisions of Article 330, Part II.

◆ This new material requires that MC-HL cable must be installed in accordance with Article 330 Part II.

(d) *In industrial establishments with restricted public access,* where the conditions of maintenance and supervision ensure that only qualified persons service the installation, Type ITC-HL cable listed for use in Class I, Zone 1 or Division 1 locations, with a gas/vaportight continuous corrugated metallic sheath and an overall jacket of suitable polymeric material, and terminated with fittings listed for the application, and installed in accordance with the provisions of Article 727.

CLENCHER Metal Clad Cable Connector



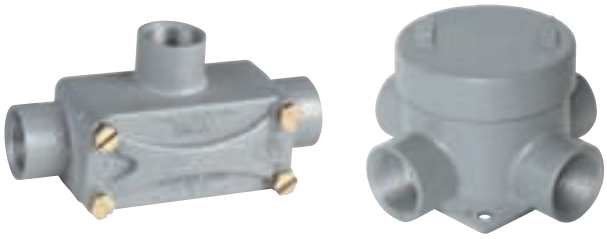
CLENCHER Construction Details

◆ This new wording requires that Type ITC-HL cable be installed in accordance with the requirements of Article 727.

(2) Flexible Connections. Where necessary to employ flexible connections, as at motor terminals, flexible fittings listed for the location, or flexible cord in accordance with the provisions of 501.140 terminated with cord connectors listed for the location, shall be permitted.

Flexible Couplings in Stainless Steel and Bronze

(3) Boxes and Fittings. All boxes and fittings shall be approved for Class I, Division 1.



Aluminum Conduit Body and Aluminum Outlet Body

Flame Arrestor and KDB Drain/Breather

(B) Class I, Division 2.

(1) General. In Class I, Division 2 locations, the following wiring methods shall be permitted:

(1) All wiring methods permitted in 501.10(A).

➤ Indicates portions of the previous NEC have been removed

(2) Enclosed gasketed busways and enclosed gasketed wireways.

Enclosed and Gasketed Wireway

(3) Type PLTC and Type PLTC-ER cable in accordance with the provisions of Article 725, including installation in cable tray systems. The cable shall be terminated with listed fittings.

◆ This change requires that types PLTC and Type PLTC-ER cables be terminated with listed fittings.

(4) Type ITC and Type ITC-ER cable as permitted in 727.4 and terminated with listed fittings.

◆ This change requires that type ITC-ER cable be terminated with listed fittings.

(5) Type MC, MV, or TC cable, including installation in cable tray systems. The cable shall be terminated with listed fittings.

◆ This change requires that types MC, MV or TC cables be terminated with listed fittings.

(6) In industrial establishments with restricted public access, where the conditions of maintenance and supervision ensure that only qualified persons service the installation and where metallic conduit does not provide sufficient corrosion resistance, listed reinforced thermosetting resin conduit (RTRC), factory elbows, and associated fittings, all marked with the suffix -XW, and Schedule 80 PVC conduit, factory elbows, and associated fittings shall be permitted.

Where seals are required for boundary conditions as defined in 501.15(A)(4), the Division 1 wiring method shall extend into the Division 2 area to the seal, which shall be located on the Division 2 side of the Division 1–Division 2 boundary.

(2) Flexible Connections. Where provision must be made for limited flexibility, one or more of the following shall be permitted:

(1) Listed flexible metal fittings.

◆ This section now requires the flexible metal fittings to be listed.

(2) Flexible metal conduit with listed fittings.

(3) Liquidtight flexible metal conduit with listed fittings.

(4) Liquidtight flexible nonmetallic conduit with listed fittings.

(5) Flexible cord listed for extra-hard usage and terminated with listed fittings. A conductor for use as an equipment grounding conductor shall be included in the flexible cord.

◆ This cord must now be terminated with listed fittings.

Informational Note: See 501.30(B) for grounding requirements where flexible conduit is used.

(3) Nonincendive Field Wiring. Nonincendive field wiring shall be permitted using any of the wiring methods permitted for unclassified locations. Nonincendive field wiring systems shall be installed in accordance with the control drawing(s). Simple apparatus, not shown on the control drawing, shall be permitted in a nonincendive field wiring circuit, provided the simple apparatus does not interconnect the nonincendive field wiring circuit to any other circuit.

Informational Note: Simple apparatus is defined in 504.2.

Separate nonincendive field wiring circuits shall be installed in accordance with one of the following:

(1) In separate cables

(2) In multiconductor cables where the conductors of each circuit are within a grounded metal shield

(3) In multiconductor cables or in raceways, where the conductors of each circuit have insulation with a minimum thickness of 0.25 mm (0.01 in.)

(4) Boxes and Fittings. Boxes and fittings shall not be required to be explosionproof except as required by 501.105(B)(1), 501.115(B)(1), and 501.150(B)(1).

501.15 Sealing and Drainage.

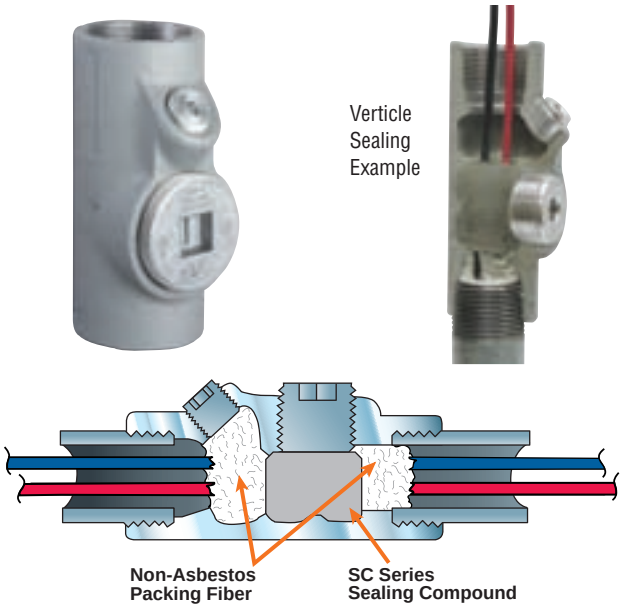
Seals in conduit and cable systems shall comply with 501.15(A) through (F). Sealing compound shall be used in Type MI cable termination fittings to exclude moisture and other fluids from the cable insulation.

Informational Note No. 1: Seals are provided in conduit and cable systems to minimize the passage of gases and vapors and prevent the passage of flames from one portion of the electrical installation to another through the conduit. Such communication through Type MI cable is inherently prevented by construction of the cable. Unless specifically designed and tested for the purpose, conduit and cable seals are not intended to prevent the passage of liquids, gases, or vapors at a continuous pressure differential across the seal. Even at differences in pressure across the seal equivalent to a few inches of water, there may be a slow passage of gas or vapor through a seal and through conductors passing through the seal. See 501.15(E)(2). Temperature extremes and highly corrosive liquids and vapors can affect the ability of seals to perform their intended function. See 501.15(C)(2).

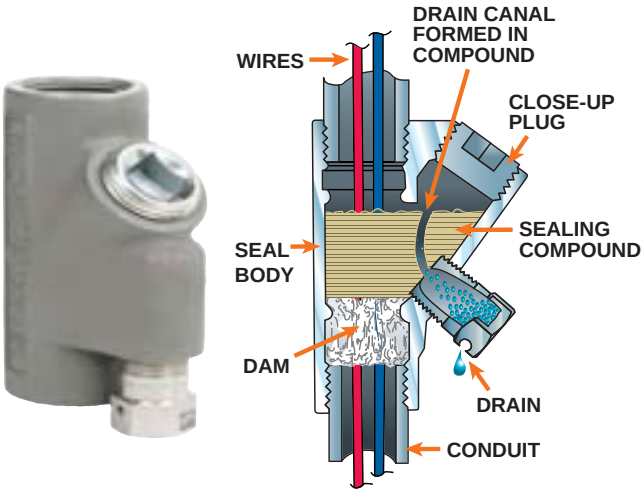
Informational Note No. 2: Gas or vapor leakage and propagation of flames may occur through the interstices between the strands of standard stranded conductors larger than 2 AWG. Special conductor constructions, for example, compacted strands or sealing of the individual strands, are means of reducing leakage and preventing the propagation of flames.

✪ *500.15 SEALING AND DRAINAGE - The sealing compound must be of a type approved for the conditions and use. Only the manufacturer's sealing compound listed for use with the fitting should be used. There are two reasons for this. First, sealing fittings are tested only with the compound submitted by the m a n u f a c t u rer of the sealing fitting, which is usually that manufacture r 's own sealing compound. Second, and perhaps more important, some (but not all) sealing compounds expand as they dry (none shrink), and can create considerable force on the inside of the sealing fitting. Unless the fitting has been tested using this particular compound, there is no way of knowing whether or not it will withstand the expansion forces.*

(A) Conduit Seals, Class I, Division 1. In Class I, Division 1 locations, conduit seals shall be located in accordance with 501.15(A)(1) through (A)(4).



ENY Series Sealing Fitting



EYD Series Sealing Fitting

(1) Entering Enclosures. In each conduit entry into an explosionproof enclosure where either of the following apply:

(1) The enclosure contains apparatus, such as switches, circuit breakers, fuses, relays, or resistors, that may produce arcs, sparks, or high temperatures that are considered to be an ignition source in normal operation.

(2) The entry is metric designator 53 (trade size 2) or larger and the enclosure contains terminals, splices, or taps.

For the purposes of this section, high temperatures shall be considered to be any temperatures exceeding 80 percent of the autoignition temperature in degrees Celsius of the gas or vapor involved.

Exception to 501.15(A)(1)(1): Seals shall not be required for conduit entering an enclosure where such switches, circuit

breakers, fuses, relays, or resistors comply with one of the following:

(1) Are enclosed within a chamber hermetically sealed against the entrance of gases or vapors

(2) Are immersed in oil in accordance with 501.115(B)(1)(2)

(3) Are enclosed within a factory-sealed explosionproof chamber located within the enclosure, identified for the location, and marked "factory sealed" or equivalent, unless the enclosure entry is metric designator 53 (trade size 2) or larger

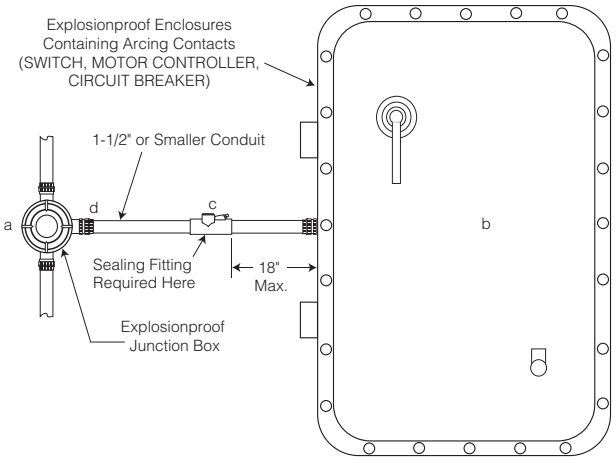
(4) Are in nonincendive circuits

Factory-sealed enclosures shall not be considered to serve as a seal for another adjacent explosionproof enclosure that is required to have a conduit seal.

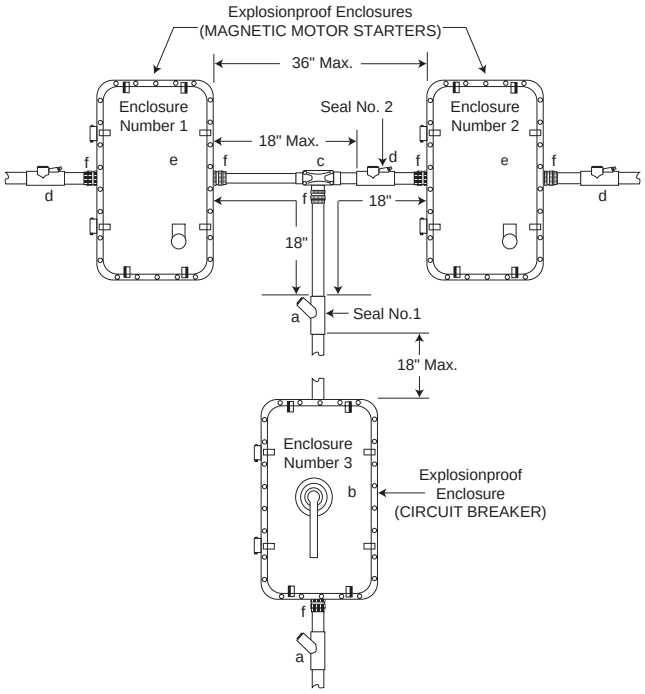
Factory Sealed Control Station

Factory Sealed Ground Fault Protector

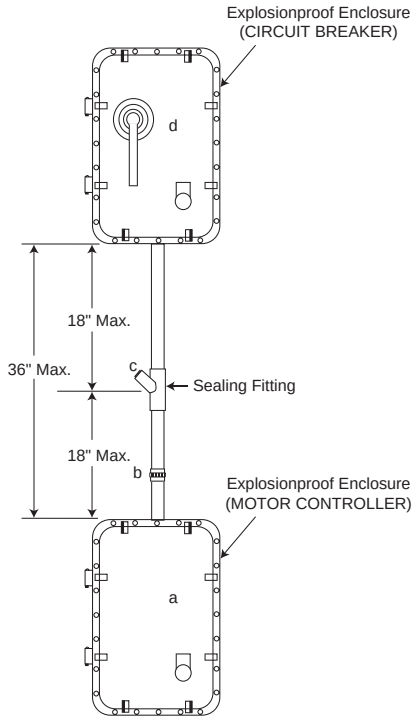
Conduit seals shall be installed within 450 mm (18 in.) from the enclosure. Only explosionproof unions, couplings, reducers, elbows, capped elbows, and conduit bodies similar to L, T, and Cross types that are not larger than the trade size of the conduit shall be permitted between the sealing fitting and the explosionproof enclosure.



(a) GE Series Explosionproof Fitting
(b) B702 Series Prism Explosionproof Combination Magnetic Motor Starter
(c) EYS or ENY Series Explosionproof Conduit Sealing Fitting
(d) GUF or GUM Series Explosionproof Unions



(a) ENY or EYS or EY Series Explosionproof Conduit Sealing Fitting
(b) B7C Series Prism Explosionproof Circuit Breaker
(c) XT Series Explosionproof Conduit Outlet Body
(d) ENY or EYS Series Explosionproof Conduit Sealing Fitting
(e) B701 Series Prism Explosionproof Magnetic Motor Starter
(f) GUF or GUM Series Explosionproof Unions



(a) B701 Series Prism Explosionproof Magnetic Motor Starter
(b) GUF Series Explosionproof Union
(c) ENY or EYS or EY Series Explosionproof Conduit Sealing Fitting
(d) B7C Series Prism Explosionproof Circuit Breaker

(2) Pressurized Enclosures. In each conduit entry into a pressurized enclosure where the conduit is not pressurized as part of the protection system. Conduit seals shall be installed within 450 mm (18 in.) from the pressurized enclosure.

Informational Note No. 1: Installing the seal as close as possible to the enclosure will reduce problems with purging the dead airspace in the pressurized conduit.

Informational Note No. 2: For further information, see NFPA 496-2008, Standard for Purged and Pressurized Enclosures for Electrical Equipment.

(3) Two or More Explosionproof Enclosures. Where two or more explosionproof enclosures for which conduit seals are required under 501.15(A)(1) are connected by nipples or by runs of conduit not more than 900 mm (36 in.) long, a single conduit seal in each such nipple connection or run of conduit shall be considered sufficient if located not more than 450 mm (18 in.) from either enclosure.

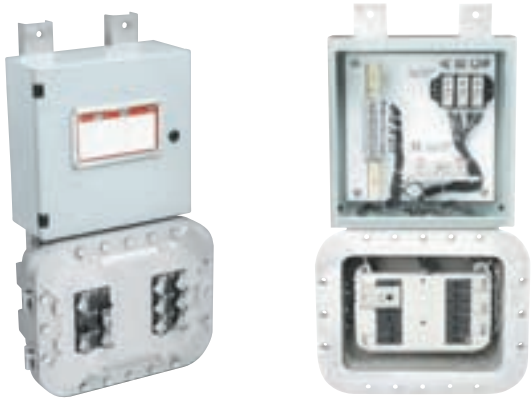
(4) Class I, Division 1 Boundary. In each conduit run leaving a Class I, Division 1 location. The sealing fitting shall be permitted on either side of the boundary of such location within 3.05 m (10 ft) of the boundary and shall be designed and installed so as to minimize the amount of gas or vapor within the Division 1 portion of the conduit from being communicated to the conduit beyond the seal. Except for listed explosionproof reducers at the conduit seal, there shall be no union, coupling, box, or fitting between the conduit seal and the point at which the conduit leaves the Division 1 location.

Exception No. 1: Metal conduit that contains no unions, couplings, boxes, or fittings, and passes completely through a Class I, Division 1 location with no fittings less than 300 mm (12 in.) beyond each boundary, shall not require a conduit seal if the termination points of the unbroken conduit are in unclassified locations.

Exception No. 2: For underground conduit installed in accordance with 300.5 where the boundary is below grade, the sealing fitting shall be permitted to be installed after the conduit emerges from below grade, but there shall be no union, coupling, box, or fitting, other than listed explosionproof reducers at the sealing fitting, in the conduit between the sealing fitting and the point at which the conduit emerges from below grade.

(B) Conduit Seals, Class I, Division 2. In Class I, Division 2 locations, conduit seals shall be located in accordance with 501.15(B)(1) and (B)(2).

(1) Entering Enclosures. For connections to enclosures that are required to be explosionproof, a conduit seal shall be provided in accordance with 501.15(A)(1)(1) and (A)(3). All portions of the conduit run or nipple between the seal and such enclosure shall comply with 501.10(A).



Factory Sealed Panelboard for Class I, Division 2 location. Enclosures are connected together with factory poured sealing chambers.

(2) Class I, Division 2 Boundary. In each conduit run passing from a Class I, Division 2 location into an unclassified location. The sealing fitting shall be permitted on either side of the boundary of such location within 3.05 m (10 ft) of the boundary. Rigid metal conduit or threaded steel intermediate metal conduit shall be used between the sealing fitting and the point at which the conduit leaves the Division 2 location, and a threaded connection shall be used at the sealing fitting. Except for listed reducers at the conduit seal, there shall be no union, coupling, box, or fitting between the conduit seal and the point at which the conduit leaves the Division 2 location. Conduits shall be sealed to minimize the amount of gas or vapor within the Division 2 portion of the conduit from being communicated to the conduit beyond the seal. Such seals shall not be required to be explosionproof but shall be identified for the purpose of minimizing passage of gases under normal operating conditions and shall be accessible.

Exception No. 1: Metal conduit that contains no unions, couplings, boxes, or fittings, and passes completely through a Class I, Division 2 location with no fittings less than 300 mm (12 in.) beyond each boundary, shall not be required to be sealed if the termination points of the unbroken conduit are in unclassified locations.

Exception No. 2: Conduit systems terminating at an unclassified location where a wiring method transition is made to cable tray, cablebus, ventilated busway, Type MI cable, or cable not installed in any cable tray or raceway system shall not be required to be sealed where passing from the Class I, Division 2 location into the unclassified location. The unclassified location shall be outdoors or, if the conduit system is all in one room, it shall be permitted to be indoors. The conduits shall not terminate at an enclosure containing an ignition source in normal operation.

Exception No. 3: Conduit systems passing from an enclosure or room that is unclassified as a result of pressurization into a Class I, Division 2 location shall not require a seal at the boundary.

Informational Note: For further information, refer to NFPA 496-2008, Standard for Purged and Pressurized Enclosures for Electrical Equipment.

Exception No. 4: Segments of aboveground conduit systems shall not be required to be sealed where passing from a Class I, Division 2 location into an unclassified location if all of the following conditions are met:

(1) No part of the conduit system segment passes through a Class I, Division 1 location where the conduit contains unions, couplings, boxes, or fittings within 300 mm (12 in.) of the Class I, Division 1 location.

(2) The conduit system segment is located entirely in outdoor locations.

(3) The conduit system segment is not directly connected to canned pumps, process or service connections for flow, pressure, or analysis measurement, and so forth, that depend on a single compression seal, diaphragm, or tube to prevent flammable or combustible fluids from entering the conduit system.

(4) The conduit system segment contains only threaded metal conduit, unions, couplings, conduit bodies, and fittings in the unclassified location.

(5) The conduit system segment is sealed at its entry to each enclosure or fitting housing terminals, splices, or taps in Class I, Division 2 locations.

(C) Class I, Divisions 1 and 2. Seals installed in Class I, Division 1 and Division 2 locations shall comply with 501.15(C)(1) through (C)(6).

Exception: Seals not required to be explosionproof by 501.15(B)(2) or 504.70.

(1) Fittings. Enclosures for connections or equipment shall be provided with an integral means for sealing, or sealing fittings listed for the location shall be used. Sealing fittings shall be listed for use with one or more specific compounds and shall be accessible.

(2) Compound. The compound shall provide a seal against passage of gas or vapors through the seal fitting, shall not be affected by the surrounding atmosphere or liquids, and shall not have a melting point of less than 93°C (200°F).

(3) Thickness of Compounds. Except for listed cable sealing fittings, the thickness of the sealing compound in a completed seal shall not be less than the metric designator (trade size) of the sealing fitting expressed in the units of measurement employed, and in no case less than 16 mm (5⁄8 in.).

(4) Splices and Taps. Splices and taps shall not be made in fittings intended only for sealing with compound, nor shall other fittings in which splices or taps are made be filled with compound.

(5) Assemblies. In an assembly where equipment that may produce arcs, sparks, or high temperatures is located in a compartment separate from the compartment containing splices or taps, and an integral seal is provided where conductors pass from one compartment to the other, the entire assembly shall be identified for the location. Seals in conduit connections to the compartment containing splices or taps shall be provided in Class I, Division 1 locations where required by 501.15(A)(1)(2).

(6) Conductor Fill. The cross-sectional area of the conductors permitted in a seal shall not exceed 25 percent of the cross-sectional area of a rigid metal conduit of the same trade size unless it is specifically identified for a higher percentage of fill.

(D) Cable Seals, Class I, Division 1. In Class I, Division 1 locations, cable seals shall be located according to 501.15(D)(1) through (D)(3).

(1) At Terminations. Cable shall be sealed at all terminations. The sealing fitting shall comply with 501.15(C). Multiconductor Type MC-HL cables with a gas/vaportight continuous corrugated metallic sheath and an overall jacket of suitable polymeric material shall be sealed with a listed fitting after removing the jacket and any other covering so that the sealing compound surrounds each individual insulated conductor in such a manner as to minimize the passage of gases and vapors.

Exception: Shielded cables and twisted pair cables shall not require the removal of the shielding material or separation of the twisted pairs, provided the termination is by an approved means to minimize the entrance of gases or vapors and prevent propagation of flame into the cable core.

(2) Cables Capable of Transmitting Gases or Vapors. Cables in conduit with a gas/vaportight continuous sheath capable of transmitting gases or vapors through the cable core shall be sealed in the Division 1 location after removing the jacket and any other coverings so that the sealing compound will surround each individual insulated conductor and the outer jacket.

Exception: Multiconductor cables with a gas/vaportight continuous sheath capable of transmitting gases or vapors through the cable core shall be permitted to be considered as a single conductor by sealing the cable in the conduit within 450 mm (18 in.) of the enclosure and the cable end within the enclosure by an approved means to minimize the entrance of gases or vapors and prevent the propagation of flame into the cable core, or by other approved methods. For shielded cables and twisted pair cables, it shall not be required to remove the shielding material or separate the twisted pair.

(3) Cables Incapable of Transmitting Gases or Vapors. Each multiconductor cable in conduit shall be considered as a single conductor if the cable is incapable of transmitting gases or vapors through the cable core. These cables shall be sealed in accordance with 501.15(A).

(E) Cable Seals, Class I, Division 2. In Class I, Division 2 locations, cable seals shall be located in accordance with 501.15(E)(1) through (E)(4).

(1) Terminations. Cables entering enclosures that are required to be explosionproof shall be sealed at the point of entrance. The sealing fitting shall comply with 501.15(B)(1). Multiconductor cables with a gas/vaportight continuous sheath capable of transmitting gases or vapors through the cable core shall be sealed in a listed fitting in the Division 2 location after removing the jacket and any other coverings so that the sealing compound surrounds each individual insulated conductor in such a manner as to minimize the passage of gases and vapors. Multiconductor cables in conduit shall be sealed as described in 501.15(D).

Exception No. 1: Cables passing from an enclosure or room that is unclassified as a result of Type Z pressurization into a Class I, Division 2 location shall not require a seal at the boundary.

Exception No. 2: Shielded cables and twisted pair cables shall not require the removal of the shielding material or separation of the twisted pairs, provided the termination is by an approved means to minimize the entrance of gases or vapors and prevent propagation of flame into the cable core.

(2) Cables That Do Not Transmit Gases or Vapors. Cables that have a gas/vaportight continuous sheath and do not transmit gases or vapors through the cable core in excess of the quantity permitted for seal fittings shall not be required to be sealed except as required in 501.15(E)(1). The minimum length of such cable run shall not be less than that length that limits gas or vapor flow through the cable core to the rate permitted for seal fittings [200 cm^3/hr (0.007 ft^3/hr) of air at a pressure of 1500 pascals (6 in. of water)].

Informational Note: The cable core does not include the interstices of the conductor strands.

(3) Cables Capable of Transmitting Gases or Vapors. Cables with a gas/vaportight continuous sheath capable of transmitting gases or vapors through the cable core shall not be required to be sealed except as required in 501.15(E)(1), unless the cable is attached to process equipment or devices that may cause a pressure in excess of 1500 pascals (6 in. of water) to be exerted at a cable end, in which case a seal, barrier, or other means shall be provided to prevent migration of flammables into an unclassified location.

Exception: Cables with an unbroken gas/vaportight continuous sheath shall be permitted to pass through a Class I, Division 2 location without seals.

(4) Cables Without Gas/Vaportight Sheath. Cables that do not have gas/vaportight continuous sheath shall be sealed at the boundary of the Division 2 and unclassified location in such a manner as to minimize the passage of gases or vapors into an unclassified location.

(F) Drainage.

(1) Control Equipment. Where there is a probability that liquid or other condensed vapor may be trapped within enclosures for control equipment or at any point in the raceway system, approved means shall be provided to prevent accumulation or to permit periodic draining of such liquid or condensed vapor.

✪ *(F) DRAINAGE.(1) CONTROL EQUIPMENT. - The intent is to prevent either flammable liquids or water from accumulating in a conduit system. Listed explosionproof drain fittings are available for this purpose. Accumulation of water is most likely where there are heating and cooling cycles and where the conduit system or equipment connected to it is outdoors or in damp or wet locations. If drains are located in a sealing fitting, a drain channel may be necessary through the sealing compound to the drain fitting.* *See page 27.*

(2) Motors and Generators. Where the authority having jurisdiction judges that there is a probability that liquid or condensed vapor may accumulate within motors or generators, joints and conduit systems shall be arranged to minimize the entrance of liquid. If means to prevent accumulation or to permit periodic draining are judged necessary, such means shall be provided at the time of manufacture and shall be considered an integral part of the machine.

501.17 Process Sealing.

This section shall apply to process connected equipment, which includes, but is not limited to, canned pumps, submersible pumps, flow, pressure, temperature, or analysis measurement instruments. A process seal is a device to prevent the migration of process fluids from the designed containment into the external electrical system. Process connected electrical equipment that incorporates a single process seal, such as a single compression seal, diaphragm, or tube to prevent flammable or combustible fluids from entering a conduit or cable system capable of transmitting fluids, shall be provided with an additional means to mitigate a single process seal failure, The additional means may include, but is not limited to the following:

(1) A suitable barrier meeting the process temperature and pressure conditions that the barrier will be subjected to upon failure of the single process seal. There shall be a vent or drain between the single process seal and the suitable barrier. Indication of the single process seal failure shall be provided by visible leakage, an audible whistle, or other means of monitoring.

(2) A listed Type MI cable assembly, rated at not less than 125 percent of the process pressure and not less than 125 percent of the maximum process temperature (in degrees Celsius), installed between the cable or conduit and the single process seal.

(3) A drain or vent located between the single process seal and a conduit or cable seal. The drain or vent shall be suf-

ficiently sized to prevent overpressuring the conduit or cable seal above 6 in. water column (1493 Pa). Indication of the single process seal failure shall be provided by visible leakage, an audible whistle, or other means of monitoring.

Process-connected electrical equipment that does not rely on a single process seal or is listed and marked "single seal" or "dual seal" shall not be required to be provided with an additional means of sealing.

Informational Note: For construction and testing requirements for process sealing for listed and marked "single seal" or "dual seal" requirements, refer to ANSI/ISA- 12.27.01-2003, *Requirements for Process Sealing Between Electrical Systems and Potentially Flammable or Combustible Process Fluids.*

◆ This Section is new to the 2011 NEC® even though much of the material was relocated from the material that was In 501.15(F)(3). Requirements were added covering listed type MI cable assemblies.

501.20 Conductor Insulation, Class I, Divisions 1 and 2.

Where condensed vapors or liquids may collect on, or come in contact with, the insulation on conductors, such insulation shall be of a type identified for use under such conditions; or the insulation shall be protected by a sheath of lead or by other approved means.

✪ *501.20 CONDUCTOR INSULATION, CLASS I, DIVISIONS 1 & 2 - Since many flammable liquids and vapors can rapidly deteriorate conductor insulation, including the jackets of flexible cords, careful attention must be paid to the compatibility of the insulating materials involved and the flammable gases and vapors. For example, in gasoline filling stations gasoline-resistant insulation should be used. The manufacturers of the cables, conductors, and flexible cords can provide information on the suitability of their products for environments not specifically mentioned in the manufacturer's technical specification literature.*

501.25 Uninsulated Exposed Parts, Class I, Divisions 1 and 2.

There shall be no uninsulated exposed parts, such as electrical conductors, buses, terminals, or components, that operate at more than 30 volts (15 volts in wet locations). These parts shall additionally be protected by a protection technique according to 500.7(E), (F), or (G) that is suitable for the location.

501.30 Grounding and Bonding, Class I, Divisions 1 and 2.

Wiring and equipment in Class I, Division 1 and 2 locations shall be grounded as specified in Article 250 and in accordance with the requirements of 501.30(A) and (B).

(A) Bonding. The locknut-bushing and double-locknut types of contacts shall not be depended on for bonding purposes, but bonding jumpers with proper fittings or other approved means of bonding shall be used. Such means of bonding shall apply to all intervening raceways, fittings, boxes, enclosures, and so forth between Class I locations and the point of grounding for service equipment or point of grounding of a separately derived system.

Exception: The specific bonding means shall be required only to the nearest point where the grounded circuit conductor and the grounding electrode are connected together on the line side of the building or structure disconnecting means as specified in 250.32(B), provided the branch-circuit overcurrent protection is located on the load side of the disconnecting means.

Informational Note: See 250.100 for additional bonding requirements in hazardous (classified) locations.

(B) Types of Equipment Grounding Conductors. Flexible metal conduit and liquidtight flexible metal conduit shall include an equipment bonding jumper of the wire type in compliance with 250.102.

◆ This change now requires a wire –type equipment bonding jumper.

Exception: In Class I, Division 2 locations, the bonding jumper shall be permitted to be deleted where all of the following conditions are met:

(1) Listed liquidtight flexible metal conduit 1.8 m (6 ft) or less in length, with fittings listed for grounding, is used.

(2) Overcurrent protection in the circuit is limited to 10 amperes or less.

(3) The load is not a power utilization load.

✪ *501.30 GROUNDING AND BONDING, CLASS I, DIVISIONS 1 & 2 - Proper grounding and bonding is essential for safety in hazardous locations. If a low-impedance path of adequate current-carrying capacity is not provided back to the service disconnecting means or other point where the system is grounded, several dangerous conditions, as follows, can exist.*

501.35 Surge Protection.

(A) Class I, Division 1. Surge arresters, surge-protective devices, and capacitors shall be installed in enclosures identified for Class I, Division 1 locations. Surge-protective capacitors shall be of a type designed for specific duty.

(B) Class I, Division 2. Surge arresters and surge-protective devices shall be nonarcing, such as metal-oxide varistor (MOV) sealed type, and surge-protective capacitors shall be of a type designed for specific duty. Enclosures shall be permitted to be of the general-purpose type. Surge protection of types other than described in this paragraph shall be installed in enclosures identified for Class I, Division 1 locations.

501.40 Multiwire Branch Circuits.

In a Class I, Division 1 location, a multiwire branch circuit shall not be permitted.

Exception: Where the disconnect device(s) for the circuit opens all ungrounded conductors of the multiwire circuit simultaneously.

III. Equipment

501.100 Transformers and Capacitors.

(A) Class I, Division 1. In Class I, Division 1 locations, transformers and capacitors shall comply with 501.100(A)(1) and (A)(2).

(1) Containing Liquid That Will Burn. Transformers and capacitors containing a liquid that will burn shall be installed only in vaults that comply with 450.41 through 450.48 and with (1) through (4) as follows:

(1) There shall be no door or other communicating opening between the vault and the Division 1 location.

(2) Ample ventilation shall be provided for the continuous removal of flammable gases or vapors.

(3) Vent openings or ducts shall lead to a safe location outside of buildings.

(4) Vent ducts and openings shall be of sufficient area to relieve explosion pressures within the vault, and all portions of vent ducts within the buildings shall be of reinforced concrete construction.

(2) Not Containing Liquid That Will Burn. Transformers and capacitors that do not contain a liquid that will burn shall be installed in vaults complying with 501.100(A)(1) or be identified for Class I locations.

(B) Class I, Division 2. In Class I, Division 2 locations, transformers shall comply with 450.21 through 450.27, and capacitors shall comply with 460.2 through 460.28.

◆ This section now includes reverences to compliances for transformers and capacitors.

501.105 Meters, Instruments, and Relays.

(A) Class I, Division 1. In Class I, Division 1 locations, meters, instruments, and relays, including kilowatt-hour meters, instrument transformers, resistors, rectifiers, and thermionic tubes, shall be provided with enclosures identified for Class I, Division 1 locations. Enclosures for Class I, Division 1 locations include explosionproof enclosures and purged and pressurized enclosures.

Informational Note: See NFPA 496-2008, Standard for Purged and Pressurized Enclosures for Electrical Equipment.

(B) Class I, Division 2. In Class I, Division 2 locations, meters, instruments, and relays shall comply with 501.105(B)(1) through (B)(6).

(1) Contacts. Switches, circuit breakers, and make-and-break contacts of pushbuttons, relays, alarm bells, and horns shall have enclosures identified for Class I, Division 1 locations in accordance with 501.105(A).

Exception: General-purpose enclosures shall be permitted if current-interrupting contacts comply with one of the following:

(1) Are immersed in oil

(2) Are enclosed within a chamber that is hermetically sealed against the entrance of gases or vapors

(3) Are in nonincendive circuits

(4) Are listed for Division 2

(2) Resistors and Similar Equipment. Resistors, resistance devices, thermionic tubes, rectifiers, and similar equipment that are used in or in connection with meters, instruments, and relays shall comply with 501.105(A).

Exception: General-purpose-type enclosures shall be permitted if such equipment is without make-and-break or sliding contacts [other than as provided in 501.105(B)(1)] and if the maximum operating temperature of any exposed surface will not exceed 80 percent of the ignition temperature in degrees Celsius of the gas or vapor involved or has been tested and found incapable of igniting the gas or vapor. This exception shall not apply to thermionic tubes.

(3) Without Make-or-Break Contacts. Transformer windings, impedance coils, solenoids, and other windings that do not incorporate sliding or make-or-break contacts shall be provided with enclosures. General-purpose-type enclosures shall be permitted.

(4) General-Purpose Assemblies. Where an assembly is made up of components for which general-purpose enclosures are acceptable as provided in 501.105(B)(1), (B)(2), and (B)(3), a single general-purpose enclosure shall be acceptable for the assembly. Where such an assembly includes any of the equipment described in 501.105(B)(2), the maximum obtainable surface temperature of any component of the assembly shall be clearly and permanently indicated on the outside of the enclosure. Alternatively, equipment shall be permitted to be marked to indicate the temperature class for which it is suitable, using the temperature class (T Code) of Table 500.8(C).

(5) Fuses. Where general-purpose enclosures are permitted in 501.105(B)(1) through (B)(4), fuses for overcurrent protection of instrument circuits not subject to overloading in normal use shall be permitted to be mounted in general purpose enclosures if each such fuse is preceded by a switch complying with 501.105(B)(1).

(6) Connections. To facilitate replacements, process control instruments shall be permitted to be connected through flexible cord, attachment plug, and receptacle, provided all of the following conditions apply:

(1) A switch complying with 501.105(B)(1) is provided so that the attachment plug is not depended on to interrupt current.

(2) The current does not exceed 3 amperes at 120 volts, nominal.

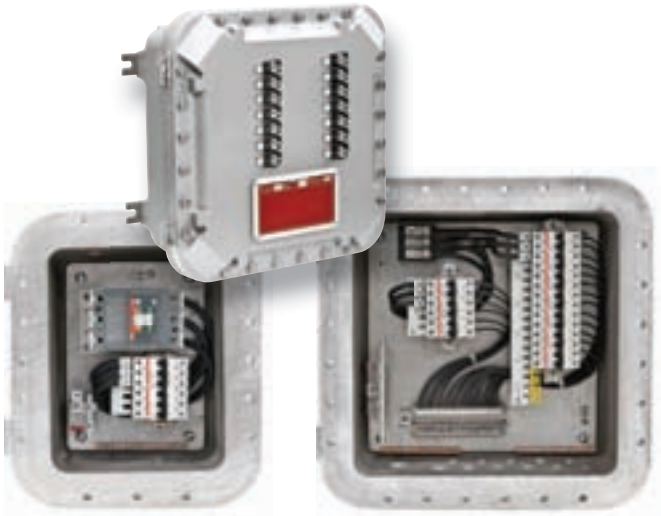
(3) The power-supply cord does not exceed 900 mm (3 ft), is of a type listed for extra-hard usage or for hard usage if protected by location, and is supplied through an attachment plug and receptacle of the locking and grounding type.

(4) Only necessary receptacles are provided.

(5) The receptacle carries a label warning against unplugging under load.

501.115 Switches, Circuit Breakers, Motor Controllers, and Fuses.

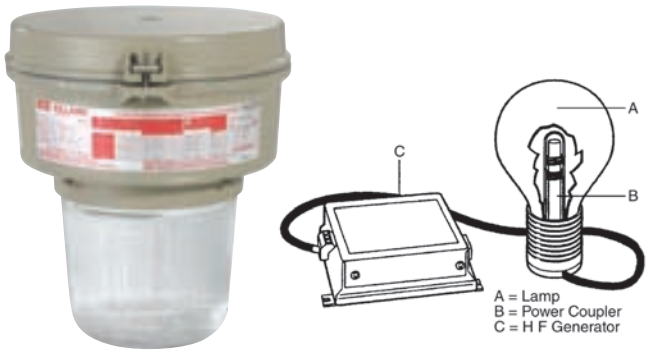
(A) Class I, Division 1. In Class I, Division 1 locations, switches, circuit breakers, motor controllers, and fuses, including pushbuttons, relays, and similar devices, shall be provided with enclosures, and the enclosure in each case, together with the enclosed apparatus, shall be identified as a complete assembly for use in Class I locations.



With Main Breaker Without Main Breaker

Circuit Breaker Panelboard with IEC Breakers and Busbar System

Class I, Division 2 Control Station with Factory Sealed Contact Block



QL Induction Fixture for Class I, Division 2

(B) Class I, Division 2. Switches, circuit breakers, motor controllers, and fuses in Class I, Division 2 locations shall comply with 501.115(B)(1) through (B)(4).

(1) Type Required. Circuit breakers, motor controllers, and switches intended to interrupt current in the normal performance of the function for which they are installed shall be provided with enclosures identified for Class I,

Division 1 locations in accordance with 501.105(A), unless general-purpose enclosures are provided and any of the following apply:

(1) The interruption of current occurs within a chamber hermetically sealed against the entrance of gases and vapors.

(2) The current make-and-break contacts are oil-immersed and of the general-purpose type having a 50-mm (2-in.) minimum immersion for power contacts and a 25-mm (1-in.) minimum immersion for control contacts.

(3) The interruption of current occurs within a factory sealed explosionproof chamber.

(4) The device is a solid state, switching control without contacts, where the surface temperature does not exceed 80 percent of the ignition temperature in degrees Celsius of the gas or vapor involved.

(2) Isolating Switches. Fused or unfused disconnect and isolating switches for transformers or capacitor banks that are not intended to interrupt current in the normal performance of the function for which they are installed shall be permitted to be installed in general-purpose enclosures.

(3) Fuses. For the protection of motors, appliances, and lamps, other than as provided in 501.115(B)(4), standard plug or cartridge fuses shall be permitted, provided they are placed within enclosures identified for the location; or fuses shall be permitted if they are within general-purpose enclosures, and if they are of a type in which the operating element is immersed in oil or other approved liquid, or the operating element is enclosed within a chamber hermetically sealed against the entrance of gases and vapors, or the fuse is a nonindicating, filled, current-limiting type.

(4) Fuses Internal to Luminaires. Listed cartridge fuses shall be permitted as supplementary protection within luminaires.

✪ *501.115 SWITCHES, CIRCUIT BREAKERS, MOTOR CONTROLLERS, AND FUSES - The equipment described in this section employs contacts or circuit-interrupting means that are designed to open circuits under normal or near-normal conditions. They may also be required to open circuits under fault conditions, such as short circuits and ground faults. Ignition-capable sparks at contacts and within fuse cartridges, some of very high energy, are therefore anticipated.*

501.120 Control Transformers and Resistors.

Transformers, impedance coils, and resistors used as, or in conjunction with, control equipment for motors, generators, and appliances shall comply with 501.120(A) and (B).

(A) Class I, Division 1. In Class I, Division 1 locations, transformers, impedance coils, and resistors, together with any switching mechanism associated with them, shall be provided with enclosures identified for Class I, Division 1 locations in accordance with 501.105(A).

(B) Class I, Division 2. In Class I, Division 2 locations, control transformers and resistors shall comply with 501.120(B)(1) through (B)(3).

(1) Switching Mechanisms. Switching mechanisms used in conjunction with transformers, impedance coils, and resistors shall comply with 501.115(B).

(2) Coils and Windings. Enclosures for windings of transformers, solenoids, or impedance coils shall be permitted to be of the general-purpose type.

(3) Resistors. Resistors shall be provided with enclosures; and the assembly shall be identified for Class I locations, unless resistance is nonvariable and maximum operating temperature, in degrees Celsius, will not exceed 80 percent of the ignition temperature of the gas or vapor involved or has been tested and found incapable of igniting the gas or vapor.

501.125 Motors and Generators.

(A) Class I, Division 1. In Class I, Division 1 locations, motors, generators, and other rotating electrical machinery shall be one of the following:

(1) Identified for Class I, Division 1 locations

(2) Of the totally enclosed type supplied with positive pressure ventilation from a source of clean air with discharge to a safe area, so arranged to prevent energizing of the machine until ventilation has been established and the enclosure has been purged with at least 10 volumes of air, and also arranged to automatically de-energize the equipment when the air supply fails

(3) Of the totally enclosed inert gas-filled type supplied with a suitable reliable source of inert gas for pressurizing the enclosure, with devices provided to ensure a positive pressure in the enclosure and arranged to automatically de-energize the equipment when the gas supply fails

(4) Of a type designed to be submerged in a liquid that is flammable only when vaporized and mixed with air, or in a gas or vapor at a pressure greater than atmospheric and that is flammable only when mixed with air; and the machine is so arranged to prevent energizing it until it has been purged with the liquid or gas to exclude air, and also arranged to automatically de-energize the equipment when the supply of liquid or gas or vapor fails or the pressure is reduced to atmospheric

Totally enclosed motors of the types specified in 501.125(A)(2) or (A)(3) shall have no external surface with an operating temperature in degrees Celsius in excess of 80 percent of the ignition temperature of the gas or vapor involved. Appropriate devices shall be provided to detect and automatically de-energize the motor or provide an adequate alarm if there is any increase in temperature of the motor beyond designed limits. Auxiliary equipment shall be of a type identified for the location in which it is installed.

Informational Note: See D2155-69, ASTM Test Procedure.

(B) Class I, Division 2. In Class I, Division 2 locations, motors, generators, and other rotating electrical machinery in which are employed sliding contacts, centrifugal or other types of switching mechanism (including motor overcurrent, overloading, and overtemperature devices), or integral resistance devices, either while starting or while running, shall be identified for Class I, Division 1 locations, unless such sliding contacts, switching mechanisms, and resistance devices are provided with enclosures identified for Class I, Division 2 locations in accordance with 501.105(B). The exposed surface of space heaters used to prevent condensation of moisture during shutdown periods shall not exceed 80 percent of the ignition temperature in degrees Celsius of the gas or vapor involved when operated at rated voltage, and the maximum space heater surface temperature [based on a 40°C or higher marked ambient] shall be permanently marked on a visible nameplate mounted on the motor. Otherwise, space heaters shall be identified for Class I, Division 2 locations. In Class I, Division 2 locations, the installation of open or nonexplosionproof enclosed motors, such as squirrel-cage induction motors without brushes, switching mechanisms, or similar arc-producing devices that are not identified for use in a Class I, Division 2 location, shall be permitted.

Informational Note No. 1: It is important to consider the temperature of internal and external surfaces that may be exposed to the flammable atmosphere.

Informational Note No. 2: It is important to consider the risk of ignition due to currents arcing across discontinuities and overheating of parts in multisection enclosures of large motors and generators.

Such motors and generators may need equipotential bonding jumpers across joints in the enclosure and from enclosure to ground. Where the presence of ignitible gases or vapors is suspected, clean-air purging may be needed immediately prior to and during start-up periods.

Informational Note No. 3: For further information on the application of electric motors in Class I, Division 2 hazardous (classified) locations, see IEEE Std. 1349-2001, *IEEE Guide for the Application of Electric Motors in Class I, Division 2 Hazardous (Classified) Locations.*

501.130 Luminaires.

Luminaires shall comply with 501.130(A) or (B).

Explosionproof LED Luminaire

Explosionproof Fluorescent Fixture and Explosionproof Floodlight

(A) Class I, Division 1. In Class I, Division 1 locations, luminaires shall comply with 501.130(A)(1) through (A)(4).

(1) Luminaires. Each luminaire shall be identified as a complete assembly for the Class I, Division 1 location and shall be clearly marked to indicate the maximum wattage of lamps for which it is identified. Luminaires intended for portable use shall be specifically listed as a complete assembly for that use.

(2) Physical Damage. Each luminaire shall be protected against physical damage by a suitable guard or by location.

(3) Pendant Luminaires. Pendant luminaires shall be suspended by and supplied through threaded rigid metal conduit stems or threaded steel intermediate conduit stems, and threaded joints shall be provided with set-screws or other effective means to prevent loosening. For stems longer than 300 mm (12 in.), permanent and effective bracing against lateral displacement shall be provided at a level not more than 300 mm (12 in.) above the lower end of the stem, or flexibility in the form of a fitting or flexible connector identified for the Class I, Division 1 location shall be provided not more than 300 mm (12 in.) from the point of attachment to the supporting box or fitting.

(4) Supports. Boxes, box assemblies, or fittings used for the support of luminaires shall be identified for Class I locations.

(B) Class I, Division 2. In Class I, Division 2 locations, luminaires shall comply with 501.130(B)(1) through (B)(6).

Range of Ballast Tank Sizes and Optics

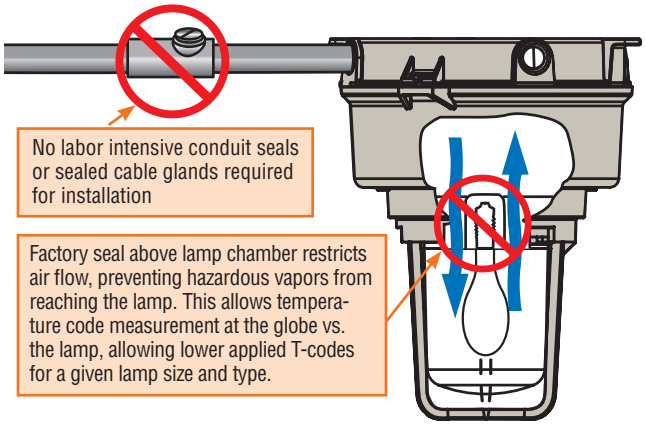
Swing-Barrel Nut Tank Mounting System

(1) Luminaires. Where lamps are of a size or type that may, under normal operating conditions, reach surface temperatures exceeding 80 percent of the ignition temperature in degrees Celsius of the gas or vapor involved, luminaires shall comply with 501.130(A)(1) or shall be of a type that has been tested in order to determine the marked operating temperature or temperature class (T Code).

Signal Luminaires

Industrial Floodlight

Battery Backed Emergency Luminaires



Luminaire with Optional Restricted Breathing

(2) Physical Damage. Luminaires shall be protected from physical damage by suitable guards or by location. Where there is danger that falling sparks or hot metal from lamps or luminaires might ignite localized concentrations of flammable vapors or gases, suitable enclosures or other effective protective means shall be provided.

(3) Pendant Luminaires. Pendant luminaires shall be suspended by threaded rigid metal conduit stems, threaded steel intermediate metal conduit stems, or other approved means. For rigid stems longer than 300 mm (12 in.), permanent and effective bracing against lateral displacement shall be provided at a level not more than 300 mm (12 in.) above the lower end of the stem, or flexibility in the form of an identified fitting or flexible connector shall be provided not more than 300 mm (12 in.) from the point of attachment to the supporting box or fitting.

(4) Portable Lighting Equipment. Portable lighting equipment shall comply with 501.130(A)(1).

Exception: Where portable lighting equipment is mounted on movable stands and is connected by flexible cords, as covered in 501.140, it shall be permitted, where mounted in any position, if it conforms to 501.130(B)(2).

(5) Switches. Switches that are a part of an assembled fixture or of an individual lampholder shall comply with 501.115(B)(1).

(6) Starting Equipment. Starting and control equipment for electric-discharge lamps shall comply with 501.120(B).

Exception: A thermal protector potted into a thermally protected fluorescent lamp ballast if the luminaire is identified for the location.

501.135 Utilization Equipment.

(A) Class I, Division 1. In Class I, Division 1 locations, all utilization equipment shall be identified for Class I, Division 1 locations.

(B) Class I, Division 2. In Class I, Division 2 locations, all utilization equipment shall comply with 501.135(B)(1) through (B)(3).

(1) Heaters. Electrically heated utilization equipment shall conform with either item (1) or item (2):

(1) The heater shall not exceed 80 percent of the ignition temperature in degrees Celsius of the gas or vapor involved on any surface that is exposed to the gas or vapor when continuously energized at the maximum rated ambient temperature. If a temperature controller is not provided, these conditions shall apply when the heater is operated at 120 percent of rated voltage.

Exception No. 1: For motor-mounted anticondensation space heaters, see 501.125.

Exception No. 2: Where a current-limiting device is applied to the circuit serving the heater to limit the current in the heater to a value less than that required to raise the heater surface temperature to 80 percent of the ignition temperature.

(2) The heater shall be identified for Class I, Division 1 locations.

Exception to (2): Electrical resistance heat tracing identified for Class I, Division 2 locations.

(2) Motors. Motors of motor-driven utilization equipment shall comply with 501.125(B).

(3) Switches, Circuit Breakers, and Fuses. Switches, circuit breakers, and fuses shall comply with 501.115(B).

501.140 Flexible Cords, Class I, Divisions 1 and 2.

(A) Permitted Uses. Flexible cord shall be permitted:

(1) For connection between portable lighting equipment or other portable utilization equipment and the fixed portion of their supply circuit.

(2) For that portion of the circuit where the fixed wiring methods of 501.10(A) cannot provide the necessary degree of movement for fixed and mobile electrical utilization equipment, and the flexible cord is protected by location or by a suitable guard from damage and only in an industrial establishment where conditions of maintenance and engineering supervision ensure that only qualified persons install and service the installation.

(3) For electric submersible pumps with means for removal without entering the wet-pit. The extension of the flexible cord within a suitable raceway between the wet-pit and the power source shall be permitted.

(4) For electric mixers intended for travel into and out of open-type mixing tanks or vats.

(5) For temporary portable assemblies consisting of receptacles, switches, and other devices that are not considered portable utilization equipment but are individually listed for the location.

◆ This new requirement covers the use of portable assemblies that are now considered portable utilization equipment that are individually listed for the location. An example would be a power cart that provides power during service or maintenance.

(B) Installation. Where flexible cords are used, the cords shall comply with all of the following:

(1) Be of a type listed for extra-hard usage

(2) Contain, in addition to the conductors of the circuit, an equipment grounding conductor complying with 400.23

➤ Indicates portions of the previous NEC have been removed

(3) Be supported by clamps or by other suitable means in such a manner that there is no tension on the terminal connections

(4) In Division 1 locations or in Division 2 locations where the boxes, fittings, or enclosures are required to be explosionproof, the cord shall be terminated with a cord connector or attachment plug listed for the location or a cord connector installed with a seal listed for the location. In Division 2 locations where explosionproof equipment is not required, the cord shall be terminated with a listed cord connector or listed attachment plug.

◆ This section was revised so that listed cord connectors or the use of a seal is required where cords terminate in explosionproof enclosures.

(5) Be of continuous length. Where 501.140(A)(5) is applied, cords shall be of continuous length from the power source to the temporary portable assembly and from the temporary portable assembly to the utilization equipment.

Informational Note: See 501.20 for flexible cords exposed to liquids having a deleterious effect on the conductor insulation.

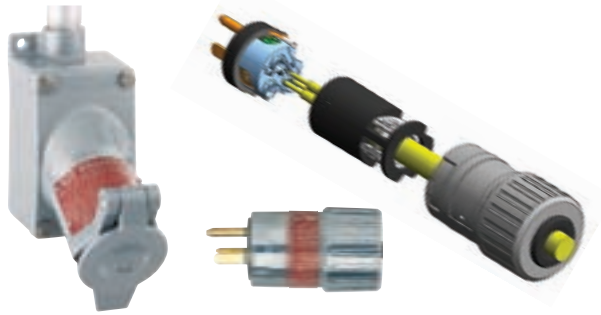
◆ This Section revised the requirement to cover cords used to supply temporary power assemblies and for equipment supplied from the temporary power assembly.

501.145 Receptacles and Attachment Plugs, Class I, Divisions 1 and 2.

Receptacles and attachment plugs shall be of the type providing for connection to the equipment grounding conductor of a flexible cord and shall be identified for the location.

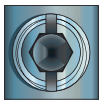
Exception: As provided in 501.105(B)(6).

✪ *501.145 RECEPTACLES AND ATTACHMENT PLUGS, CLASS I, DIVISIONS 1 & 2 - In both Divisions 1 and 2, receptacles and attachment plugs are required to be approved for the location except as provided in Section 501.105(B)(6) for rack-mounted instrumentation. In general, there are two types of receptacle-plug combinations. In one, the receptacle is de-energized by a switching device in an explosionproof chamber separated by a seal from the chamber containing the receptacle contacts. The receptacle contacts cannot be energized until the attachment plug has been fully inserted and the switch closed by a rotation of the attachment plug or some other arrangement that locks the plug into position. In order to remove the attachment plug, the switch must first be operated to de-energize all contacts except the grounding contact. This operation also releases the plug mechanically so that it can be removed. The second type of receptacle-plug combination is one in which the attachment plug contacts mate with the receptacle contacts deep within a housing surrounding each individual mating contact so that, in effect, contact is made and broken within an explosionproof enclosure. In all cases, the arrangement is such that the continuity of the grounding system is completed within the receptacle-plug combination before the attachment plug contacts are energized, and the attachment plug contacts are de-energized before the grounding circuit is opened. Also, in all cases, the attachment plug is designed so that highly reliable strain relief is provided for the cord to prevent strain at the connections.*



NEMA Bladed Receptacle and Quick Wiring Plug

Pin and Sleeve Plug and Receptacle



Allen/Slot Terminals Allow Higher Torque Values Typical in the Oil Instustry

Wet Location

Panel Mount NEMA Bladed Type Receptacle and Connector

Interlocked Pin and Sleeve Plug and Receptacle

Panel Power

Breaker Protected Interlocked Pin and Sleeve Receptacle

GFI Protected NEMA Bladed Receptacle

Harsh Location

501.150 Signaling, Alarm, Remote-Control, and Communications Systems.

(A) Class I, Division 1. In Class I, Division 1 locations, all apparatus and equipment of signaling, alarm, remote-control, and communications systems, regardless of voltage, shall be identified for Class I, Division 1 locations, and all wiring shall comply with 501.10(A), 501.15(A), and 501.15(C).

(B) Class I, Division 2. In Class I, Division 2 locations, signaling, alarm, remote-control, and communications systems shall comply with 501.150(B)(1) through (B)(4).

(1) Contacts. Switches, circuit breakers, and make-and-break contacts of pushbuttons, relays, alarm bells, and horns shall have enclosures identified for Class I, Division 1 locations in accordance with 501.105(A).

Exception: General-purpose enclosures shall be permitted if current-interrupting contacts are one of the following:

(1) Immersed in oil

(2) Enclosed within a chamber hermetically sealed against the entrance of gases or vapors

(3) In nonincendive circuits

(4) Part of a listed nonincendive component

(2) Resistors and Similar Equipment. Resistors, resistance devices, thermionic tubes, rectifiers, and similar equipment shall comply with 501.105(B)(2).

(3) Protectors. Enclosures shall be provided for lightning protective devices and for fuses. Such enclosures shall be permitted to be of the general-purpose type.

(4) Wiring and Sealing. All wiring shall comply with 501.10(B), 501.15(B), and 501.15(C).

Signal Light, Class I, Divisions 1 and 2

LED Signal Light Class I, Division 2

XENON Signal Light Class I, Division 2

ARTICLE 502
Class II Locations

I. General

502.1 Scope.

Article 502 covers the requirements for electrical and electronic equipment and wiring for all voltages in Class II, Division 1 and 2 locations where fire or explosion hazards may exist due to combustible dust.

Grain Processing

Food Particles

502.5 Explosionproof Equipment.

Explosionproof equipment and wiring shall not be required and shall not be acceptable in Class II locations unless also identified for such locations.

✪ *502.5 EXPLOSIONPROOF EQUIPMENT - This section clarifies that explosionproof equipment acceptable under the requirements of Article 501 for Class I locations is not required under the requirements of Article 502 for Class II locations and is not acceptable unless it is also approved for Class II locations. Most Killark equipment is suitable for both Class I and Class II locations, and is so marked.*

502.6 Zone Equipment.

Equipment listed and marked in accordance with 506.9(C)(2) for Zone 20 locations shall be permitted in Class II, Division 1 locations for the same dust atmosphere; and with a suitable temperature class.

Equipment listed and marked in accordance with 506.9(C)(2) for Zone 20, 21, or 22 locations shall be permitted in Class II, Division 2 locations for the same dust atmosphere and with a suitable temperature class.

◆ This change added a new permission to use Zone 0 equipment in a Class II, Division 1 or 2 location.

II. Wiring

502.10 Wiring Methods.

Wiring methods shall comply with 502.10(A) or (B).

(A) Class II, Division 1.

(1) General. In Class II, Division 1 locations, the wiring methods in (1) through (4) shall be permitted:

(1) Threaded rigid metal conduit, or threaded steel intermediate metal conduit.

(2) Type MI cable with termination fittings listed for the location. Type MI cable shall be installed and supported in a manner to avoid tensile stress at the termination fittings.

(3) In industrial establishments with limited public access, where the conditions of maintenance and supervision ensure that only qualified persons service the installation, Type MC-HL cable, listed for use in Class II, Division 1 locations, with a gas/vaportight continuous corrugated metallic sheath, an overall jacket of suitable polymeric material, a separate equipment grounding conductor(s) in accordance with 250.122, and provided with termination fittings listed for the application, shall be permitted.

(4) Fittings and boxes shall be provided with threaded bosses for connection to conduit or cable terminations and shall be dusttight. Fittings and boxes in which taps, joints, or terminal connections are made, or that are used in Group E locations, shall be identified for Class II locations.

(2) Flexible Connections. Where necessary to employ flexible connections, one or more of the following shall also be permitted:

(1) Dusttight flexible connectors

(2) Liquidtight flexible metal conduit with listed fittings

(3) Liquidtight flexible nonmetallic conduit with listed fittings

(4) Interlocked armor Type MC cable having an overall jacket of suitable polymeric material and provided with termination fittings listed for Class II, Division 1 locations.

(5) Flexible cord listed for extra-hard usage and terminated with listed dusttight fittings. Where flexible cords are used, they shall comply with 502.140.

Informational Note: See 502.30(B) for grounding requirements where flexible conduit is used.

(B) Class II, Division 2.

(1) General. In Class II, Division 2 locations, the following wiring methods shall be permitted:

(1) All wiring methods permitted in 502.10(A).

(2) Rigid metal conduit, intermediate metal conduit, electrical metallic tubing, dusttight wireways.

(3) Type MC or MI cable with listed termination fittings.

(4) Type PLTC and Type PLTC-ER cable in accordance with the provisions of Article 725, including installation in cable tray systems. The cable shall be terminated with listed fittings.

◆ This was revised by adding Type PLTC-ER cable and to require the cables to be terminated with listed fittings

(5) Type ITC and Type ITC-ER cable as permitted in 727.4 and terminated with listed fittings.

◆ This was revised by adding Type ITC-ER cable and to require the cables to be terminated with listed fittings.

(6) Type MC, MI, or TC cable installed in ladder, ventilated trough, or ventilated channel cable trays in a single layer, with a space not less than the larger cable diameter between the two adjacent cables, shall be the wiring method employed.

(7) In industrial establishments with restricted public access where the conditions of maintenance and supervision ensure that only qualified persons service the installation and where metallic conduit does not provide sufficient corrosion resistance, reinforced thermosetting resin conduit (RTRC) factory elbows, and associated fittings, all marked with suffix -XW, and Schedule 80 PVC conduit, factory elbows and associated fittings shall be permitted.

◆ This new change added new requirements that permit Reinforced thermal resin conduit (RTRC-XW) and Polyvinyl Chloride Conduit (PVC) in industrial installations under specified conditions.

Exception to (6): Type MC cable listed for use in Class II, Division 1 locations shall be permitted to be installed without the spacings required by (6).

(2) Flexible Connections. Where provision must be made for flexibility, 502.10(A)(2) shall apply.

(3) Nonincendive Field Wiring. Nonincendive field wiring shall be permitted using any of the wiring methods permitted for unclassified locations. Nonincendive field wiring systems shall be installed in accordance with the control drawing(s). Simple apparatus, not shown on the control drawing, shall be permitted in a nonincendive field wiring circuit, provided the simple apparatus does not interconnect the nonincendive field wiring circuit to any other circuit.

Informational Note: Simple apparatus is defined in 504.2.

Separate nonincendive field wiring circuits shall be installed in accordance with one of the following:

(1) In separate cables

(2) In multiconductor cables where the conductors of each circuit are within a grounded metal shield

(3) In multiconductor cables or in raceways where the conductors of each circuit have insulation with a minimum thickness of 0.25 mm (0.01 in.)

◆ This Article was revised to permit installation of nonincendive field wiring in raceways where the conductors of each circuit have insulation with a thickness of not less than 0.25 mm (0.01 in.)

(4) Boxes and Fittings. All boxes and fittings shall be dusttight.

502.15 Sealing, Class II, Divisions 1 and 2.

Where a raceway provides communication between an enclosure that is required to be dust-ignitionproof and one that is not, suitable means shall be provided to prevent the entrance of dust into the dust-ignitionproof enclosure through the raceway. One of the following means shall be permitted:

(1) A permanent and effective seal

(2) A horizontal raceway not less than 3.05 m (10 ft) long

(3) A vertical raceway not less than 1.5 m (5 ft) long and extending downward from the dust-ignitionproof enclosure

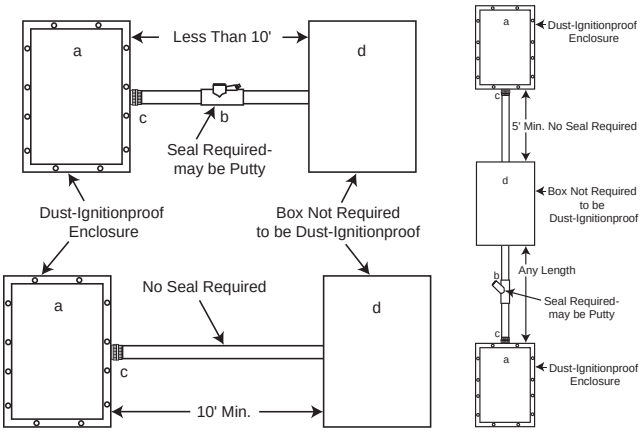
(4) A raceway installed in a manner equivalent to (2) or (3) that extends only horizontally and downward from the dust-ignition proof enclosures

Where a raceway provides communication between an enclosure that is required to be dust-ignitionproof and an enclosure in an unclassified location, seals shall not be required.

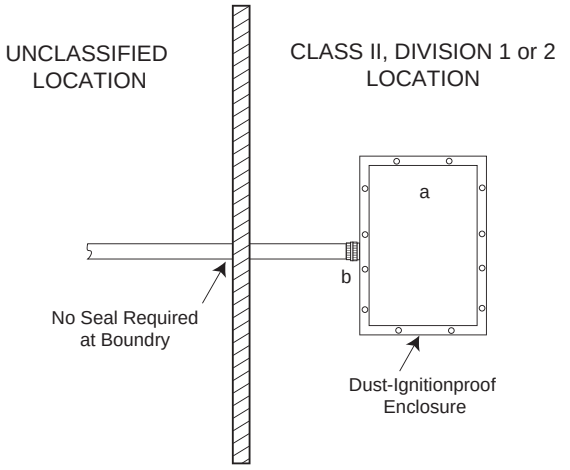
Sealing fittings shall be accessible.

Seals shall not be required to be explosionproof.

Informational Note: Electrical sealing putty is a method of sealing.



Sealing, Class II, Divisions 1 and 2.



No seal is required at the boundary of a Class II location and a location that is unclassified, or between a Division 1 and 2 location.

✪ *502.15, SEALING, CLASS II, DIVISIONS 1 AND 2. - Unlike seals in Class I locations, seals in Class II locations serve only one purpose. The seals are needed to prevent dust from entering dust-ignitionproof enclosures. It is expected that any dust that enters a horizontal raceway will settle to the bottom of the raceway as there is little or no air circulation within the raceway. Only a relatively short length of conduit is needed to accomplish this. If the raceway is horizontal from the point where dust can enter the raceway to the dust-ignitionproof enclosure, only a ten-foot length of conduit is necessary to eliminate a seal in the system. If the dust-ignitionproof enclosure is above the point where dust can enter the conduit system, only a 5-foot length of conduit is needed as the dust is unlikely to rise much above the point of entry. If the necessary minimum length of raceway is not provided, or the dust-ignitionproof enclosure is below the point where dust can enter the raceway, a seal is re q u i red. The seal is not required to be explosionproof. No seal is required at the boundary of a Class II location and a location that is unclassified, or between a Division 1 and 2 location.*

502.25 Uninsulated Exposed Parts, Class II, Divisions 1 and 2.

There shall be no uninsulated exposed parts, such as electrical conductors, buses, terminals, or components, that operate at more than 30 volts (15 volts in wet locations). These parts shall additionally be protected by a protection technique according to 500.7(E), (F), or (G) that is suitable for the location.

502.30 Grounding and Bonding, Class II, Divisions 1 and 2.

Wiring and equipment in Class II, Division 1 and 2 locations shall be grounded as specified in Article 250 and in accordance with the requirements of 502.30(A) and (B).

(A) Bonding. The locknut-bushing and double-locknut types of contact shall not be depended on for bonding purposes, but bonding jumpers with proper fittings or other approved means of bonding shall be used. Such means of bonding shall apply to all intervening raceways, fittings, boxes, enclosures, and so forth, between Class II locations and the point of grounding for service equipment or point of grounding of a separately derived system.

Exception: The specific bonding means shall only be required to the nearest point where the grounded circuit conductor and the grounding electrode conductor are connected together on the line side of the building or structure disconnecting means as specified in 250.32(B) if the branch-circuit overcurrent protection is located on the load side of the disconnecting means.

Informational Note: See 250.100 for additional bonding requirements in hazardous (classified) locations.

(B) Types of Equipment Grounding Conductors. Liquidtight flexible metal conduit shall include an equipment bonding jumper of the wire type in compliance with 250.102.

◆ This section has been revised to require installation of a wire-type equipment bonding jumper in compliance with 250.102.

Exception: In Class II, Division 2 locations, the bonding jumper shall be permitted to be deleted where all of the following conditions are met:

(1) Listed liquidtight flexible metal conduit 1.8 m (6 ft) or less in length, with fittings listed for grounding, is used.

(2) Overcurrent protection in the circuit is limited to 10 amperes or less.

(3) The load is not a power utilization load.

502.35 Surge Protection — Class II, Divisions 1 and 2.

Surge arresters and surge-protective devices installed in a Class II, Division 1 location shall be in suitable enclosures. Surge-protective capacitors shall be of a type designed for specific duty.

502.40 Multiwire Branch Circuits.

In a Class II, Division 1 location, a multiwire branch circuit shall not be permitted.

Exception: Where the disconnect device(s) for the circuit opens all ungrounded conductors of the multiwire circuit simultaneously.

III. Equipment

502.100 Transformers and Capacitors.

(A) Class II, Division 1. In Class II, Division 1 locations, transformers and capacitors shall comply with 502.100(A)(1) through (A)(3).

(1) Containing Liquid That Will Burn. Transformers and capacitors containing a liquid that will burn shall be installed only in vaults complying with 450.41 through 450.48, and, in addition, (1), (2), and (3) shall apply.

(1) Doors or other openings communicating with the Division 1 location shall have self-closing fire doors on both sides of the wall, and the doors shall be carefully fitted and provided with suitable seals (such as weather stripping) to minimize the entrance of dust into the vault.

(2) Vent openings and ducts shall communicate only with the outside air.

(3) Suitable pressure-relief openings communicating with the outside air shall be provided.

(2) Not Containing Liquid That Will Burn. Transformers and capacitors that do not contain a liquid that will burn shall be installed in vaults complying with 450.41 through 450.48 or be identified as a complete assembly, including terminal connections.

(3) Group E. No transformer or capacitor shall be installed in a Class II, Division 1, Group E location.

◆ This section has been revised to prohibit the installation of transformers and capacitors in Group E locations.

(B) Class II, Division 2. In Class II, Division 2 locations, transformers and capacitors shall comply with 502.100(B)(1) through (B)(3).

(1) Containing Liquid That Will Burn. Transformers and capacitors containing a liquid that will burn shall be installed in vaults that comply with 450.41 through 450.48.

(2) Containing Askarel. Transformers containing askarel and rated in excess of 25 kVA shall be as follows:

(1) Provided with pressure-relief vents

(2) Provided with a means for absorbing any gases generated by arcing inside the case, or the pressure-relief vents shall be connected to a chimney or flue that will carry such gases outside the building

(3) Have an airspace of not less than 150 mm (6 in.) between the transformer cases and any adjacent combustible material

(3) Dry-Type Transformers. Dry-type transformers shall be installed in vaults or shall have their windings and terminal connections enclosed in tight metal housings without ventilating or other openings and shall operate at not over 600 volts, nominal.

502.115 Switches, Circuit Breakers, Motor Controllers, and Fuses.

(A) Class II, Division 1. In Class II, Division 1 locations, switches, circuit breakers, motor controllers, fuses, push buttons, relays, and similar devices shall be provided with enclosures identified for the location.

Compact Manual NEMA Starter

◆ This section has been revised by adding fuses, push buttons, relays and similar devices to the existing devices that require enclosures identified for the location for all Class II, Division 1 locations.

➤ Indicates portions of the previous NEC have been removed

(B) Class II, Division 2. In Class II, Division 2 locations, enclosures for fuses, switches, circuit breakers, and motor controllers, including push buttons, relays, and similar devices, shall be dusttight or otherwise identified for the location.

Circuit Breaker Panel Board

◆ Revised to require dusttight enclosures or enclosures identified for Class II, Division 2 locations if they contain arcing devices.

502.120 Control Transformers and Resistors.

(A) Class II, Division 1. In Class II, Division 1 locations, control transformers, solenoids, impedance coils, resistors, and any overcurrent devices or switching mechanisms associated with them shall be provided with enclosures identified for the location.

(B) Class II, Division 2. In Class II, Division 2 locations, transformers and resistors shall comply with 502.120(B)(1) through (B)(3).

(1) Switching Mechanisms. Switching mechanisms (including overcurrent devices) associated with control transformers, solenoids, impedance coils, and resistors shall be provided with enclosures that are dusttight or otherwise identified for the location.

(2) Coils and Windings. Where not located in the same enclosure with switching mechanisms, control transformers, solenoids, and impedance coils shall be provided with enclosures that are dusttight or otherwise identified for the location.

(3) Resistors. Resistors and resistance devices shall have dust-ignitionproof enclosures that are dusttight or otherwise identified for the location.

➤ Indicates portions of the previous NEC have been removed

502.125 Motors and Generators.

(A) Class II, Division 1. In Class II, Division 1 locations, motors, generators, and other rotating electrical machinery shall be in conformance with either of the following:

(1) Identified for the location

(2) Totally enclosed pipe-ventilated, meeting temperature limitations in 502.5

(B) Class II, Division 2. In Class II, Division 2 locations, motors, generators, and other rotating electrical equipment shall be totally enclosed nonventilated, totally enclosed pipe-ventilated, totally enclosed water-air-cooled, totally enclosed fan-cooled or dust-ignitionproof for which maximum full-load external temperature shall be in accordance with 500.8(D)(2) for normal operation when operating in free air (not dust blanketed) and shall have no external openings.

Exception: If the authority having jurisdiction believes accumulations of nonconductive, nonabrasive dust will be moderate and if machines can be easily reached for routine cleaning and maintenance, the following shall be permitted to be installed:

(1) Standard open-type machines without sliding contacts, centrifugal or other types of switching mechanism (including motor overcurrent, overloading, and overtemperature devices), or integral resistance devices

(2) Standard open-type machines with such contacts, switching mechanisms, or resistance devices enclosed within dusttight housings without ventilating or other openings

(3) Self-cleaning textile motors of the squirrel-cage type

502.128 Ventilating Piping.

Ventilating pipes for motors, generators, or other rotating electrical machinery, or for enclosures for electrical equipment, shall be of metal not less than 0.53 mm (0.021 in.) in thickness or of equally substantial noncombustible material and shall comply with all of the following:

(1) Lead directly to a source of clean air outside of buildings

(2) Be screened at the outer ends to prevent the entrance of small animals or birds

(3) Be protected against physical damage and against rusting or other corrosive influences

Ventilating pipes shall also comply with 502.128(A) and (B).

(A) Class II, Division 1. In Class II, Division 1 locations, ventilating pipes, including their connections to motors or to the dust-ignitionproof enclosures for other equipment, shall be dusttight throughout their length. For metal pipes, seams and joints shall comply with one of the following:

(1) Be riveted and soldered

(2) Be bolted and soldered

(3) Be welded

(4) Be rendered dusttight by some other equally effective means

(B) Class II, Division 2. In Class II, Division 2 locations, ventilating pipes and their connections shall be sufficiently tight to prevent the entrance of appreciable quantities of dust into the ventilated equipment or enclosure and to prevent the escape of sparks, flame, or burning material that might ignite dust accumulations or combustible material in the vicinity. For metal pipes, lock seams and riveted or welded joints shall be permitted; and tight-fitting slip joints shall be permitted where some flexibility is necessary, as at connections to motors.

502.130 Luminaires.

(A) Class II, Division 1. In Class II, Division 1 locations, luminaires for fixed and portable lighting shall comply with 502.130(A)(1) through (A)(4).

Reduced Profile LED Luminaire

(1) Luminaires. Each luminaire shall be identified for the location and shall be clearly marked to indicate the maximum wattage of the lamp for which it is designed.

(2) Physical Damage. Each luminaire shall be protected against physical damage by a suitable guard or by location.

(3) Pendant Luminaires. Pendant luminaires shall be suspended by threaded rigid metal conduit stems, by threaded steel intermediate metal conduit stems, by chains with approved fittings, or by other approved means. For rigid stems longer than 300 mm (12 in.), permanent and effective bracing against lateral displacement shall be provided at a level not more than 300 mm (12 in.) above the lower end of the stem, or flexibility in the form of a fitting or a flexible connector listed for the location shall be provided not more than 300 mm (12 in.) from the point of attachment to the supporting box or fitting. Threaded joints shall be provided with set screws or other effective means to prevent loosening. Where wiring between an outlet box or fitting and a pendant luminaire is not enclosed in conduit, flexible cord listed for hard usage shall be permitted to be used in accordance with 502.10(A)(2)(5). Flexible cord shall not serve as the supporting means for a luminaire.

◆ Flexible cord listed for extra-hard usage, terminated with a listed fitting is permitted to be used between a fitting or outlet box and a luminaire. The flexible cord cannot be used to support the luminaire.

(4) Supports. Boxes, box assemblies, or fittings used for the support of luminaires shall be identified for Class II locations.

(B) Class II, Division 2. In Class II, Division 2 locations, luminaires shall comply with 502.130(B)(1) through (B)(5).

Utility LED Fixtures

(1) Portable Lighting Equipment. Portable lighting equipment shall be identified for the location. They shall be clearly marked to indicate the maximum wattage of lamps for which they are designed.

(2) Fixed Lighting. Luminaires for fixed lighting shall be provided with enclosures that are dusttight or otherwise identified for the location. Each luminaire shall be clearly marked to indicate the maximum wattage of the lamp that shall be permitted without exceeding an exposed surface temperature in accordance with 500.8(D)(2) under normal conditions of use.

◆ This section was changed to require luminaires be provided with dusttight enclosures or enclosures identified for Class II, Division 2 applications.

(3) Physical Damage. Luminaires for fixed lighting shall be protected from physical damage by suitable guards or by location.

(4) Pendant Luminaires. Pendant luminaires shall be suspended by threaded rigid metal conduit stems, by threaded steel intermediate metal conduit stems, by chains with approved fittings, or by other approved means. For rigid stems longer than 300 mm (12 in.), permanent and effective bracing against lateral displacement shall be provided at a level not more than 300 mm (12 in.) above the lower end of the stem, or flexibility in the form of an identified fitting or a flexible connector shall be provided not more than 300 mm (12 in.) from the point of attachment to the supporting box or fitting. Where wiring between an outlet box or fitting and a pendant luminaire is not enclosed in conduit, flexible cord listed for hard usage shall be permitted if terminated with a listed cord connector that maintains the protection technique. Flexible cord shall not serve as the supporting means for a luminaire.

(5) Electric-Discharge Lamps. Starting and control equipment for electric-discharge lamps shall comply with the requirements of 502.120(B).

502.135 Utilization Equipment.

(A) Class II, Division 1. In Class II, Division 1 locations, all utilization equipment shall be identified for the location.

(B) Class II, Division 2. In Class II, Division 2 locations, all utilization equipment shall comply with 502.135(B)(1) through (B)(4).

(1) Heaters. Electrically heated utilization equipment shall be identified for the location.

Exception: Metal-enclosed radiant heating panel equipment shall be permitted to be dusttight and marked in accordance with 500.8(C).

(2) Motors. Motors of motor-driven utilization equipment shall comply with 502.125(B).

(3) Switches, Circuit Breakers, and Fuses. Enclosures for switches, circuit breakers, and fuses shall comply with 502.115(B).

(4) Transformers, Solenoids, Impedance Coils, and Resistors. Transformers, solenoids, impedance coils, and resistors shall comply with 502.120(B).

502.140 Flexible Cords — Class II, Divisions 1 and 2.

Flexible cords used in Class II locations shall comply with all of the following:

(1) Be of a type listed for extra-hard usage

Exception: Flexible cord listed for hard usage as permitted by 502.130(A)(3) and (B)(4).

(2) Contain, in addition to the conductors of the circuit, an equipment grounding conductor complying with 400.23

➤ Indicates portions of the previous NEC have been removed

(3) Be supported by clamps or by other suitable means in such a manner that there will be no tension on the terminal connections

(4) In Division 1 locations, the cord shall be terminated with a cord connector listed for the location or a listed cord connector installed with a seal listed for the location. In Division 2 locations, the cord shall be terminated with a listed dusttight cord connector.

◆ This section specifies the requirements covering the use of cord connectors in Class II, Divisions 1 & 2 locations.

502.145 Receptacles and Attachment Plugs.

(A) Class II, Division 1. In Class II, Division 1 locations, receptacles and attachment plugs shall be of the type providing for connection to the equipment grounding conductor of the flexible cord and shall be identified for Class II locations.

Ground Fault Protector

XHLF Fluorescent Hand Lamp

(B) Class II, Division 2. In Class II, Division 2 locations, receptacles and attachment plugs shall be of the type that provides for connection to the equipment grounding conductor of the flexible cord and shall be designed so that connection to the supply circuit cannot be made or broken while live parts are exposed.

✪ *502.145 RECEPTACLES AND ATTACHMENT PLUGS.- (A) CLASS II, DIVISION 1. Receptacles and attachment plugs in Division 1 locations are required to be identified for Class II locations. They shall be of the type that provides for connection to the equipment-grounding conductor of the flexible cord.*

(B) CLASS II, DIVISION 2. In Division 2 locations they are required to be designed so that connection to the supply circuit cannot be made or broken while live parts are exposed, but they are not required to be specifically approved for Class II locations. Because of the potential problem of contamination of insulating material and arc tracking, Certification Agencies have not listed any attachment plugs or receptacles for use in Class II, Group E locations.

502.150 Signaling, Alarm, Remote-Control, and Communications Systems; and Meters, Instruments, and Relays.

Informational Note: See Article 800 for rules governing the installation of communications circuits.

(A) Class II, Division 1. In Class II, Division 1 locations, signaling, alarm, remote-control, and communications systems; and meters, instruments, and relays shall comply with 502.150(A)(1) through (A)(3).

(1) Contacts. Switches, circuit breakers, relays, contactors, fuses and current-breaking contacts for bells, horns, howlers, sirens, and other devices in which sparks or arcs may be produced shall be provided with enclosures identified for the location.

Exception: Where current-breaking contacts are immersed in oil or where the interruption of current occurs within a chamber sealed against the entrance of dust, enclosures shall be permitted to be of the general-purpose type.

(2) Resistors and Similar Equipment. Resistors, transformers, choke coils, rectifiers, thermionic tubes, and other heat-generating equipment shall be provided with enclosures identified for the location.

Exception: Where resistors or similar equipment are immersed in oil or enclosed in a chamber sealed against the entrance of dust, enclosures shall be permitted to be of the general-purpose type.

(3) Rotating Machinery. Motors, generators, and other rotating electrical machinery shall comply with 502.125(A).

➤ Indicates portions of the previous NEC have been removed

(B) Class II, Division 2. In Class II, Division 2 locations, signaling, alarm, remote-control, and communications systems; and meters, instruments, and relays shall comply with 502.150(B)(1) through (B)(4).

(1) Contacts. Contacts shall comply with 502.150(A)(1) or shall be installed in enclosures that are dusttight or otherwise identified for the location.

◆ This section was revised to require enclosures that contain contacts to be inside enclosures that are dusttight or identified for the location.

Exception: In nonincendive circuits, enclosures shall be permitted to be of the general-purpose type.

(2) Transformers and Similar Equipment. The windings and terminal connections of transformers, choke coils, and similar equipment shall comply with 502.120(B)(2).

(3) Resistors and Similar Equipment. Resistors, resistance devices, thermionic tubes, rectifiers, and similar equipment shall comply with 502.120(B)(3).

(4) Rotating Machinery. Motors, generators, and other rotating electrical machinery shall comply with 502.125(B).

ARTICLE 503
Class III Locations

I. General

✪ *503 - CLASS III LOCATIONS - In general, the requirements for Class III, Division 1 locations are the same as the requirements for Class II, Division 2 locations. In Class III, Division 2 locations the requirements are essentially the same as for Class III, Division 1 locations, with exceptions for certain types of wiring and machinery that has been shown to be acceptable in Class III locations. Since electric cranes, hoists, and similar equipment are common in Class III locations, special rules are applicable as noted in Section 503.155. There are also special rules for storage-battery charging equipment in 503.160.*

503.1 Scope.

Article 503 covers the requirements for electrical and electronic equipment and wiring for all voltages in Class III, Division 1 and 2 locations where fire or explosion hazards may exist due to ignitible fibers/flyings.

503.5 General.

Equipment installed in Class III locations shall be able to function at full rating without developing surface temperatures high enough to cause excessive dehydration or gradual carbonization of accumulated fibers/flyings. Organic material that is carbonized or excessively dry is highly susceptible to spontaneous ignition. The maximum surface temperatures under operating conditions shall not exceed 165°C (329°F) for equipment that is not subject to overloading, and 120°C (248°F) for equipment (such as motors or power transformers) that may be overloaded.

Informational Note: For electric trucks, see NFPA 505- 2011, Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation.

503.6 Zone Equipment.

Equipment listed and marked in accordance with 506.9(C)(2) for Zone 20 locations and with a temperature class of not greater than T120°C (for equipment that may be overloaded) or not greater than T165°C (for equipment not subject to overloading) shall be permitted in Class III, Division 1 locations.

Equipment listed and marked in accordance with 506.9(C)(2) for Zone 20, 21, or 22 locations and with a temperature class of not greater than T120°C (for equipment that may be overloaded) or not greater than T165°C (for equipment not subject to overloading) shall be permitted in Class III, Division 2 locations.

◆ Added new permission to use Zone 20 equipment in Class III, Division 1 or 2 locations if it meets the requirements specified. It also permits equipment listed and marked in accordance with 506.9(C)(2) for Zone 20, 21, or 22 to be installed in Class III, Division 2 Locations.

II. Wiring

503.10 Wiring Methods.

Wiring methods shall comply with 503.10(A) or (B).

(A) Class III, Division 1.

(1) General. In Class III, Division 1 locations, the wiring method shall be in accordance with (1) through (4):

(1) Rigid metal conduit, Type PVC conduit, Type RTRC conduit, intermediate metal conduit, electrical metallic tubing, dusttight wireways, or Type MC or MI cable with listed termination fittings.

(2) Type PLTC and Type PLTC-ER cable in accordance with the provisions of Article 725 including installation in cable tray systems. The cable shall be terminated with listed fittings.

(3) Type ITC and Type ITC-ER cable as permitted in 727.4 and terminated with listed fittings.

(4) Type MC, MI, or TC cable installed in ladder, ventilated trough, or ventilated channel cable trays in a single layer, with a space not less than the larger cable diameter between the two adjacent cables, shall be the wiring method employed.

Exception to (4): Type MC cable listed for use in Class II, Division 1 locations shall be permitted to be installed without the spacings required by 503.10(A)(1)(4).

◆ This section was revised to permit additional wiring methods in a Class III, Division 1 location, and for consistency with the same requirement in Articles 501 and 502.

(2) Boxes and Fittings. All boxes and fittings shall be dusttight.

Duraloy 7 Series Iron and Aluminum Conduit Outlet Bodies

(3) Flexible Connections. Where necessary to employ flexible connections, one or more of the following shall be permitted:

(1) Dusttight flexible connectors

(2) Liquidtight flexible metal conduit with listed fittings,

(3) Liquidtight flexible nonmetallic conduit with listed fittings,

(4) Interlocked armor Type MC cable having an overall jacket of suitable polymeric material and installed with listed dusttight termination fittings

◆ This Section was added to permit the use of interlocked armor type MC Cable with an overall jacket of polymeric material installed with listed dusttight termination fittings.

(5) Flexible cord in compliance with 503.140

Informational Note: See 503.30(B) for grounding requirements where flexible conduit is used.

(4) Nonincendive Field Wiring. Nonincendive field wiring shall be permitted using any of the wiring methods permitted for unclassified locations. Nonincendive field wiring systems shall be installed in accordance with the control drawing(s). Simple apparatus, not shown on the control drawing, shall be permitted in a nonincendive field wiring circuit, provided the simple apparatus does not interconnect the nonincendive field wiring circuit to any other circuit.

Informational Note: Simple apparatus is defined in 504.2.

Separate nonincendive field wiring circuits shall be installed in accordance with one of the following:

(1) In separate cables

(2) In multiconductor cables where the conductors of each circuit are within a grounded metal shield

(3) In multiconductor cables where the conductors of each circuit have insulation with a minimum thickness of 0.25 mm (0.01 in.)

(B) Class III, Division 2. In Class III, Division 2 locations, the wiring method shall comply with 503.10(A).

Exception: In sections, compartments, or areas used solely for storage and containing no machinery, open wiring on insulators shall be permitted where installed in accordance with Article 398, but only on condition that protection as required by 398.15(C) be provided where conductors are not run in roof spaces and are well out of reach of sources of physical damage.

503.25 Uninsulated Exposed Parts, Class I II, Divisions 1 and 2.

There shall be no uninsulated exposed parts, such as electrical conductors, buses, terminals, or components, that operate at more than 30 volts (15 volts in wet locations). These parts shall additionally be protected by a protection technique according to 500.7(E), (F), or (G) that is suitable for the location.

Exception: As provided in 503.155.

503.30 Grounding and Bonding — Class III, Divisions 1 and 2.

Wiring and equipment in Class III, Division 1 and 2 locations shall be grounded as specified in Article 250 and with the following additional requirements in 503.30(A) and (B).

(A) Bonding. The locknut-bushing and double-locknut types of contacts shall not be depended on for bonding purposes, but bonding jumpers with proper fittings or other approved means of bonding shall be used. Such means of bonding shall apply to all intervening raceways, fittings, boxes, enclosures, and so forth, between Class III locations and the point of grounding for service equipment or point of grounding of a separately derived system.

Exception: The specific bonding means shall only be required to the nearest point where the grounded circuit conductor and the grounding electrode conductor are connected together on the line side of the building or structure disconnecting means as specified in 250.32(B) if the branch-circuit overcurrent protection is located on the load side of the disconnecting means.

Informational Note: See 250.100 for additional bonding requirements in hazardous (classified) locations.

(B) Types of Equipment Grounding Conductors. Liquidtight flexible metal conduit shall include an equipment bonding jumper of the wire type in compliance with 250.102.

◆ This section was revised to require the inclusion of an equipment bonding jumper of the wire type.

Exception: In Class III, Division 1 and 2 locations, the bonding jumper shall be permitted to be deleted where all of the following conditions are met:

(1) Listed liquidtight flexible metal 1.8 m (6 ft) or less in length, with fittings listed for grounding, is used.

(2) Overcurrent protection in the circuit is limited to 10 amperes or less.

(3) The load is not a power utilization load.

III. Equipment

503.100 Transformers and Capacitors — Class III, Divisions 1 and 2.

Transformers and capacitors shall comply with 502.100(B).

503.115 Switches, Circuit Breakers, Motor Controllers, and Fuses — Class III, Divisions 1 and 2.

Switches, circuit breakers, motor controllers, and fuses, including pushbuttons, relays, and similar devices, shall be provided with dusttight enclosures.

503.120 Control Transformers and Resistors — Class III, Divisions 1 and 2.

Transformers, impedance coils, and resistors used as, or in conjunction with, control equipment for motors, generators, and appliances shall be provided with dusttight enclosures complying with the temperature limitations in 503.5.

503.125 Motors and Generators — Class III, Divisions 1 and 2.

In Class III, Divisions 1 and 2 locations, motors, generators, and other rotating machinery shall be totally enclosed non-ventilated, totally enclosed pipe ventilated, or totally enclosed fan cooled.

Exception: In locations where, in the judgment of the authority having jurisdiction, only moderate accumulations of lint or flyings are likely to collect on, in, or in the vicinity of a rotating electrical machine and where such machine is readily accessible for routine cleaning and maintenance, one of the following shall be permitted:

(1) Self-cleaning textile motors of the squirrel-cage type

(2) Standard open-type machines without sliding contacts, centrifugal or other types of switching mechanisms, including motor overload devices

(3) Standard open-type machines having such contacts, switching mechanisms, or resistance devices enclosed within tight housings without ventilating or other openings

503.128 Ventilating Piping — Class III, Divisions 1 and 2.

Ventilating pipes for motors, generators, or other rotating electrical machinery, or for enclosures for electric equipment, shall be of metal not less than 0.53 mm (0.021 in.) in thickness, or of equally substantial noncombustible material, and shall comply with the following:

(1) Lead directly to a source of clean air outside of buildings

(2) Be screened at the outer ends to prevent the entrance of small animals or birds

(3) Be protected against physical damage and against rusting or other corrosive influences

Ventilating pipes shall be sufficiently tight, including their connections, to prevent the entrance of appreciable quantities of fibers/flyings into the ventilated equipment or enclosure and to prevent the escape of sparks, flame, or burning material that might ignite accumulations of fibers/flyin gs or combustible material in the vicinity. For metal pipes, lock seams and riveted or welded joints shall be permitted; and tight-fitting slip joints shall be permitted where some flexibility is necessary, as at connections to motors.

503.130 Luminaires — Class III, Divisions 1 and 2.

MBL Series Compact LED Luminaire

LINEARLITE Series DBF Fluorescent Luminaire

NVS Series Signal Luminaires

(A) Fixed Lighting. Luminaires for fixed lighting shall provide enclosures for lamps and lampholders that are designed to minimize entrance of fibers/flyings and to prevent the escape of sparks, burning material, or hot metal. Each luminaire shall be clearly marked to show the maximum wattage of the lamps that shall be permitted without exceeding an exposed surface temperature of 165°C (329°F) under normal conditions of use.

(B) Physical Damage. A luminaire that may be exposed to physical damage shall be protected by a suitable guard.

(C) Pendant Luminaires. Pendant luminaires shall be suspended by stems of threaded rigid metal conduit, threaded intermediate metal conduit, threaded metal tubing of

equivalent thickness, or by chains with approved fittings. For stems longer than 300 mm (12 in.), permanent and effective bracing against lateral displacement shall be provided at a level not more than 300 mm (12 in.) above the lower end of the stem, or flexibility in the form of an identified fitting or a flexible connector shall be provided not more than 300 mm (12 in.) from the point of attachment to the supporting box or fitting.

(D) Portable Lighting Equipment. Portable lighting equipment shall be equipped with handles and protected with substantial guards. Lampholders shall be of the unswitched type with no provision for receiving attachment plugs. There shall be no exposed current-carrying metal parts, and all exposed non–current-carrying metal parts shall be grounded. In all other respects, portable lighting equipment shall comply with 503.130(A).

503.135 Utilization Equipment — Class III, Divisions 1 and 2.

(A) Heaters. Electrically heated utilization equipment shall be identified for Class III locations.

(B) Motors. Motors of motor-driven utilization equipment shall comply with 503.125.

(C) Switches, Circuit Breakers, Motor Controllers, and Fuses. Switches, circuit breakers, motor controllers, and fuses shall comply with 503.115.

503.140 Flexible Cords — Class III, Divisions 1 and 2

Flexible cords shall comply with the following:

(1) Be of a type listed for extra-hard usage

(2) Contain, in addition to the conductors of the circuit, an equipment grounding conductor complying with 400.23

➤ Indicates portions of the previous NEC have been removed

(3) Be supported by clamps or other suitable means in such a manner that there will be no tension on the terminal connections

(4) Be terminated with a listed dusttight cord connector.

◆ Flexible cords for Class II, Divisions 1 and 2 must now be terminated with a listed dusttight cord connector.

503.145 Receptacles and Attachment Plugs — Class III, Divisions 1 and 2.

Receptacles and attachment plugs shall be of the grounding type, shall be designed so as to minimize the accumulation or the entry of fibers/flyings, and shall prevent the escape of sparks or molten particles.

Exception: In locations where, in the judgment of the authority having jurisdiction, only moderate accumulations of lint or flyings are likely to collect in the vicinity of a receptacle, and where such receptacle is readily accessible for routine cleaning, general-purpose grounding-type receptacles mounted so as to minimize the entry of fibers/flyings shall be permitted.

503.150 Signaling, Alarm, Remote-Control, and Local Loudspeaker Intercommunications Systems — Class III, Divisions 1 and 2.

Signaling, alarm, remote-control, and local loudspeaker intercommunications systems shall comply with the requirements of Article 503 regarding wiring methods, switches, transformers, resistors, motors, luminaires, and related components.

503.155 Electric Cranes, Hoists, and Similar Equipment — Class III, Divisions 1 and 2.

Where installed for operation over combustible fibers or accumulations of flyings, traveling cranes and hoists for material handling, traveling cleaners for textile machinery, and similar equipment shall comply with 503.155(A) through (D).

(A) Power Supply. The power supply to contact conductors shall be electrically isolated from all other systems, ungrounded, and shall be equipped with an acceptable ground detector that gives an alarm and automatically de-energizes the contact conductors in case of a fault to ground or gives a visual and audible alarm as long as power is supplied to the contact conductors and the ground fault remains.

(B) Contact Conductors. Contact conductors shall be located or guarded so as to be inaccessible to other than authorized persons and shall be protected against accidental contact with foreign objects.

(C) Current Collectors. Current collectors shall be arranged or guarded so as to confine normal sparking and prevent escape of sparks or hot particles. To reduce sparking, two or more separate surfaces of contact shall be provided for each contact conductor. Reliable means shall be provided to keep contact conductors and current collectors free of accumulations of lint or flyings.

(D) Control Equipment. Control equipment shall comply with 503.115 and 503.120.

503.160 Storage Battery Charging Equipment — Class III, Divisions 1 and 2.

Storage battery charging equipment shall be located in separate rooms built or lined with substantial noncombustible materials. The rooms shall be constructed to prevent the entrance of ignitible amounts of flyings or lint and shall be well ventilated.

ARTICLE 504
Intrinsically Safe Systems

504.1 Scope.

This article covers the installation of intrinsically safe (I.S.) apparatus, wiring, and systems for Class I, II, and III locations.

Informational Note: For further information, see ANSI/ISA-RP 12.06.01-2003, *Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation — Part 1: Intrinsic Safety.*

✪ *504-1, SCOPE - As indicated in Section 500.7(e), intrinsically safe apparatus and wiring are not required to meet the provisions of Articles 501 through 503, and Articles 510 through 516 shall not be considered applicable to such installations, except as required by Article 504, and installation of intrinsically safe apparatus shall be in accordance with the requirements of Article 504.*

504.2 Definitions.

Associated Apparatus. Apparatus in which the circuits are not necessarily intrinsically safe themselves but that affect the energy in the intrinsically safe circuits and are relied on to maintain intrinsic safety. Associated apparatus may be either of the following:

(1) Electrical apparatus that has an alternative-type protection for use in the appropriate hazardous (classified) location

(2) Electrical apparatus not so protected that shall not be used within a hazardous (classified) location

Informational Note No. 1: Associated apparatus has identified intrinsically safe connections for intrinsically safe apparatus and also may have connections for nonintrinsically safe apparatus.

Informational Note No. 2: An example of associated apparatus is an intrinsic safety barrier, which is a network designed to limit the energy (voltage and current) available to the protected circuit in the hazardous (classified) location, under specified fault conditions.

Control Drawing. See the definition in 500.2.

Different Intrinsically Safe Circuits. Intrinsically safe circuits in which the possible interconnections have not been evaluated and identified as intrinsically safe.

Intrinsically Safe Apparatus. Apparatus in which all the circuits are intrinsically safe.

Intrinsically Safe Circuit. A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions.

Informational Note: Test conditions are described in ANSI/UL 913-1997, Standard for *Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.*

Intrinsically Safe System. An assembly of interconnected intrinsically safe apparatus, associated apparatus, and interconnecting cables, in that those parts of the system that may be used in hazardous (classified) locations are intrinsically safe circuits.

Informational Note: An intrinsically safe system may include more than one intrinsically safe circuit.

Simple Apparatus. An electrical component or combination of components of simple construction with well-defined electrical parameters that does not generate more than 1.5 volts, 100 milliamps, and 25 milliwatts, or a passive component that does not dissipate more than 1.3 watts and is compatible with the intrinsic safety of the circuit in which it is used.

Informational Note: The following apparatus are examples of simple apparatus:

(a) Passive components, for example, switches, junction boxes, resistance temperature devices, and simple semiconductor devices such as LEDs

(b) Sources of stored energy consisting of single components in simple circuits with well-defined parameters, for example, capacitors or inductors, whose values are considered when determining the overall safety of the system

(c) Sources of generated energy, for example, thermocouples and photocells, which do not generate more than 1.5 V, 100 mA, and 25 mW

504.3 Application of Othe r Articles.

Except as modified by this article, all applicable articles of this *Code* shall apply.

504.4 Equipment.

All intrinsically safe apparatus and associated apparatus shall be listed.

Exception: Simple apparatus, as described on the control drawing, shall not be required to be listed.

504.10 Equipment Installation.

(A) Control Drawing. Intrinsically safe apparatus, associated apparatus, and other equipment shall be installed in accordance with the control drawing(s).

Exception: A simple apparatus that does not interconnect intrinsically safe circuits.

Informational Note No. 1: The control drawing identification is marked on the apparatus.

Informational Note No. 2: Associated apparatus with a marked Um of less than 250 V may require additional overvoltage protection at the inputs to limit any possible fault voltages to less than the Um marked on the product.

(B) Location. Intrinsically safe apparatus shall be permitted to be installed in any hazardous (classified) location for which it has been identified. General-purpose enclosures shall be permitted for intrinsically safe apparatus.

Associated apparatus shall be permitted to be installed in any hazardous (classified) location for which it has been identified or, if protected by other means, permitted by Articles 501 through 503 and Article 505.

Simple apparatus shall be permitted to be installed in any hazardous (classified) location in which the maximum surface temperature of the simple apparatus does not exceed the ignition temperature of the flammable gases or vapors, flammable liquids, combustible dusts, or ignitible fibers/flyings present.

For simple apparatus, the maximum surface temperature can be determined from the values of the output power from the associated apparatus or apparatus to which it is connected to obtain the temperature class. The temperature class can be determined by:

(1) Reference to Table 504.10(B)

(2) Calculation using the following equation:

$$T = P_o R_{th} + T_{amb}$$

where:

T = surface temperature

P_o = output power marked on the associated apparatus or intrinsically safe apparatus

R_{th} = thermal resistance of the simple apparatus

T_{amb} = ambient temperature (normally 40°C) and reference Table 500.8(C)

In addition, components with a surface area smaller than 10 cm^2 (excluding lead wires) may be classified as T5 if their surface temperature does not exceed 150°C.

Table 504.10(B) Assessment for T4 Classification According to Component Size and Temperature

Total Surface Area Excluding Lead Wires	Requirement for T4 Classification
<20 mm^2	Surface temperature ≤275°C
≥20 mm^2 ≤10 cm^2	Surface temperature ≤200°C
≥20 mm^2	Power not exceeding 1.3 W*

*Based on 40°C ambient temperature. Reduce to 1.2 W with an ambient of 60°C or 1.0 W with 80°C ambient temperature.

◆ Revised to relocate 40°C ambient temperature information to an existing table note.

Informational Note: The following apparatus are examples of simple apparatus:

(1) Passive components, for example, switches, junction boxes, resistance temperature devices, and simple semiconductor devices such as LEDs

(2) Sources of generated energy, for example, thermocouples and photocells, which do not generate more than 1.5 V, 100 mA, and 25 mW

504.20 Wiring Methods.

Any of the wiring methods suitable for unclassified locations, including those covered by Chapter 7 and Chapter 8, shall be permitted for installing intrinsically safe apparatus. Sealing shall be as provided in 504.70, and separation shall be as provided in 504.30.

504.30 Separation of Intrinsically Safe Conductors.

(A) From Nonintrinsically Safe Circuit Conductors.

(1) In Raceways, Cable Trays, and Cables. Conductors of intrinsically safe circuits shall not be placed in any raceway, cable tray, or cable with conductors of any nonintrinsically safe circuit.

Exception No. 1: Where conductors of intrinsically safe circuits are separated from conductors of nonintrinsically safe circuits by a distance of at least 50 mm (2 in.) and secured, or by a grounded metal partition or an approved insulating partition.

Informational Note: No. 20 gauge sheet metal partitions 0.91 mm (0.0359 in.) or thicker are generally considered acceptable.

Exception No. 2: Where either (1) all of the intrinsically safe circuit conductors or (2) all of the nonintrinsically safe circuit conductors are in grounded metal-sheathed or metal-clad cables where the sheathing or cladding is capable of carrying fault current to ground.

Informational Note: Cables meeting the requirements of Articles 330 and 332 are typical of those considered acceptable.

Exception No. 3: Intrinsically safe circuits in a Division 2 or Zone 2 location shall be permitted to be installed in a raceway, cable tray, or cable along with nonincendive field wiring circuits when installed in accordance with 504.30(B).

Exception No. 4: Intrinsically safe circuits passing through a Division 2 or Zone 2 location to supply apparatus that is located in a Division 1, Zone 0 or Zone 1 location shall be permitted to be installed in a raceway, cable tray, or cable along with nonincendive field wiring circuits when installed in accordance with 504.30(B).

Informational Note: Nonincendive field wiring circuits are described in 501.10(B)(3), 502.10(B)(3), 503.10(B)(3), 505.15(C)(1)(g), and 506.15(C)(7).

(2) Within Enclosures. Conductors of intrinsically safe circuits shall be secured so that any conductor that might come loose from a terminal is unlikely to come into contact with another terminal. The conductors shall be separated from conductors of nonintrinsically safe circuits by one of the methods in (1) through (4).

(1) Separation by at least 50 mm (2 in.) from conductors of any nonintrinsically safe circuits.

(2) Separation from conductors of nonintrinsically safe circuits by use of a grounded metal partition 0.91 mm (0.0359 in.) or thicker.

(3) Separation from conductors of nonintrinsically safe circuits by use of an approved insulating partition.

(4) Where either (1) all of the intrinsically safe circuit conductors or (2) all of the nonintrinsically safe circuit conductors are in grounded metal-sheathed or metal-clad cables where the sheathing or cladding is capable of carrying fault current to ground.

Informational Note No. 1: Cables meeting the requirements of Articles 330 and 332 are typical of those considered acceptable.

➤ Indicates portions of the previous NEC have been removed

Informational Note No. 2: The use of separate wiring compartments for the intrinsically safe and nonintrinsically safe terminals is a typical method of complying with this requirement.

Informational Note No. 3: Physical barriers such as grounded metal partitions or approved insulating partitions or approved restricted access wiring ducts separated from other such ducts by at least 19 mm (3⁄4 in.) can be used to help ensure the required separation of the wiring.

(3) Other (Not in Raceway or Cable Tray Systems). Conductors and cables of intrinsically safe circuits run in other than raceway or cable tray systems shall be separated by at least 50 mm (2 in.) and secured from conductors and cables of any nonintrinsically safe circuits.

Exception: Where either (1) all of the intrinsically safe circuit conductors are in Type MI or MC cables or (2) all of the nonintrinsically safe circuit conductors are in raceways or Type MI or MC cables where the sheathing or cladding is capable of carrying fault current to ground.

(B) From Different Intrinsically Safe Circuit Conductors. The clearance between two terminals for connection of field wiring of different intrinsically safe circuits shall be at least 6 mm (0.25 in.), unless this clearance is permitted to be reduced by the control drawing. Different intrinsically safe circuits shall be separated from each other by one of the following means:

(1) The conductors of each circuit are within a grounded metal shield.

(2) The conductors of each circuit have insulation with a minimum thickness of 0.25 mm (0.01 in.).

◆ Revised to include the provision for clearance between field wiring terminals of different intrinsically safe circuits as part of the general requirement that references the methods of separation in (1) & (2).

Exception: Unless otherwise identified.

➤ Indicates portions of the previous NEC have been removed

504.50 Grounding.

(A) Intrinsically Safe Apparatus, Enclosures, and Raceways. Intrinsically safe apparatus, enclosures, and raceways, if of metal, shall be connected to the equipment grounding conductor.

Informational Note: In addition to an equipment grounding conductor connection, a connection to a grounding electrode may be needed for some associated apparatus, for example, zener diode barriers, if specified in the control drawing. See ANSI/ISA-RP 12.06.01-2003, *Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation — Part 1: Intrinsic Safety.*

✪ *504.50 GROUNDING - Low-impedance grounding is essential. This is particularly true for intrinsically safe systems derived from zener diode barriers. The control drawings for such barriers usually specify an impedance to ground of not more than one ohm.*

(B) Associated Apparatus and Cable Shields. Associated apparatus and cable shields shall be grounded in accordance with the required control drawing. See 504.10(A).

Informational Note: Supplementary connection(s) to the grounding electrode may be needed for some associated apparatus, for example, zener diode barriers, if specified in the control drawing. See ANSI/ISA RP 12.06.01-2003, *Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation — Part 1: Intrinsic Safety.*

(C) Connection to Grounding Electrodes. Where connection to a grounding electrode is required, the grounding electrode shall be as specified in 250.52(A)(1), (A)(2), (A)(3), and (A)(4) and shall comply with 250.30(A)(4). Sections 250.52(A)(5), (A)(7), and (A)(8) shall not be used if any of the electrodes specified in 250.52(A)(1), (A)(2), (A)(3), or (A)(4) are present.

504.60 Bonding.

(A) Hazardous Locations. In hazardous (classified) locations, intrinsically safe apparatus shall be bonded in the hazardous (classified) location in accordance with 250.100.

(B) Unclassified. In unclassified locations, where metal raceways are used for intrinsically safe system wiring in hazardous (classified) locations, associated apparatus shall be bonded in accordance with 501.30(A), 502.30(A), 503.30(A), 505.25, or 506.25 as applicable.

✪ *504.60 BONDING - The requirements for bonding are the same for intrinsically safe systems as they are for non-intrinsically safe systems in hazardous locations.*

504.70 Sealing.

Conduits and cables that are required to be sealed by 501.15, 502.15, 505.16, and 506.16 shall be sealed to minimize the passage of gases, vapors, or dusts. Such seals shall not be required to be explosionproof or flameproof but shall be identified for the purpose of minimizing passage of gases, vapors, or dusts under normal operating conditions and shall be accessible.

Exception: Seals shall not be required for enclosures that contain only intrinsically safe apparatus, except as required by 501.15(F)(3).

✪ *504.70, SEALING - Seals are required only to minimize the passage of gases, vapors, or dusts through raceways or cables. The seal is not required to be explosionproof since it is not required to contain an explosion in this application.*

504.80 Identification.

Labels required by this section shall be suitable for the environment where they are installed with consideration given to exposure to chemicals and sunlight.

(A) Terminals. Intrinsically safe circuits shall be identified at terminal and junction locations in a manner that is intended to prevent unintentional interference with the circuits during testing and servicing.

✪ *504.80 IDENTIFICATION - Terminals are required to be identified if they are for intrinsically safe circuits. Only persons familiar with intrinsically safe systems should be permitted to test such systems. Ringing a circuit through with a 500 volt megger, common in power system maintenance, can destroy all of the zener diode barriers in the system.*

(B) Wiring. Raceways, cable trays, and other wiring methods for intrinsically safe system wiring shall be identified with permanently affixed labels with the wording "Intrinsic Safety Wiring" or equivalent. The labels shall be located so as to be visible after installation and placed so that they may be readily traced through the entire length of the installation. Intrinsic safety circuit labels shall appear in every section of the wiring system that is separated by enclosures, walls, partitions, or floors. Spacing between labels shall not be more than 7.5 m (25 ft).

Exception: Circuits run underground shall be permitted to be identified where they become accessible after emergence from the ground.

Informational Note No. 1: Wiring methods permitted in unclassified locations may be used for intrinsically safe systems in hazardous (classified) locations. Without labels to identify the application of the wiring, enforcement authorities cannot determine that an installation is in compliance with this Code.

Informational Note No. 2: In unclassified locations, identification is necessary to ensure that nonintrinsically safe wire will not be inadvertently added to existing raceways at a later date.

(C) Color Coding. Color coding shall be permitted to identify intrinsically safe conductors where they are colored light blue and where no other conductors colored light blue are used. Likewise, color coding shall be permitted to identify raceways, cable trays, and junction boxes where they are colored light blue and contain only intrinsically safe wiring.

ARTICLE 505
Zone 0, 1, and 2 Locations

Informational Note: Text that is followed by a reference in brackets has been extracted from NFPA 497-2008, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*. Only editorial changes were made to the extracted text to make it consistent with this Code.

505.1 Scope.

This article covers the requirements for the zone classification system as an alternative to the division classification system covered in Article 500 for electrical and electronic equipment and wiring for all voltages in Class I, Zone 0, Zone 1, and Zone 2 hazardous (classified) locations where fire or explosion hazards may exist due to flammable gases, vapors, or liquids.

Informational Note: For the requirements for electrical and electronic equipment and wiring for all voltages in Class I, Division 1 or Division 2; Class II, Division 1 or Division 2; and Class III, Division 1 or Division 2 hazardous (classified) locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, or combustible dusts or fibers, refer to Articles 500 through 504.

✪ *505.1 SCOPE - Article 505 is an alternate to the method of area classification for Class I locations as permitted in Article 500. The Zone Classification System is based on that of the International Electrotechnical Commission (IEC).*

505.2 Definitions.

For purposes of this article, the following definitions apply.

Combustible Gas Detection System. A protection technique utilizing stationary gas detectors in industrial establishments.

Electrical and Electronic Equipment. Materials, fittings, devices, appliances, and the like that are part of, or in connection with, an electrical installation.

Informational Note: Portable or transportable equipment having self-contained power supplies, such as battery-operated equipment, could potentially become an ignition source in hazardous (classified) locations.

Encapsulation "m." Type of protection where electrical parts that could ignite an explosive atmosphere by either sparking or heating are enclosed in a compound in such a way that this explosive atmosphere cannot be ignited.

Informational Note No. 1: See ANSI/ISA-60079-18 (12.23.01)-2009, *Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations, Type of Protection — Encapsulation "m"*; IEC 60079–18-1992, *Electrical apparatus for explosive gas atmospheres — Part 18: Encapsulation "m";* and ANSI/UL 60079-18, *Electrical Apparatus for Explosive Gas Atmospheres — Part 18: Encapsulation "m"*.

Informational Note No. 2: Encapsulation is designated type of protection "ma" for use in Zone 0 locations. Encapsulation is designated type of protection "m" or "mb" for use in Zone 1 locations.

Flameproof "d." Type of protection where the enclosure will withstand an internal explosion of a flammable mixture that has penetrated into the interior, without suffering damage and without causing ignition, through any joints or structural openings in the enclosure, of an external explosive gas atmosphere consisting of one or more of the gases or vapors for which it is designed.

Informational Note: See ANSI/ISA-60079-1 (12.22.01)- 2008, *Explosive Atmospheres, Part 1: Equipment protection by flameproof enclosures "d"*; and ANSI/UL 60079–1, *Electrical Apparatus for Explosive Gas Atmospheres — Part 1: Flameproof Enclosures "d."*

Increased Safety "e." Type of protection applied to electrical equipment that does not produce arcs or sparks in normal service and under specified abnormal conditions, in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of the occurrence of arcs and sparks.

Informational Note: See ANSI/ISA-60079-7 (12.16.01)- 2008, *Explosive Atmospheres, Part 7: Equipment protection by increased safety "e";* and ANSI/UL 60079-7, *Electrical Apparatus for Explosive Gas Atmospheres — Part 7: Increased Safety "e."*

Intrinsic Safety "i." Type of protection where any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions.

Informational Note No. 1: See ANSI/UL 913-1997, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Hazardous Locations;* ANSI/ISA- 60079-11 (12.02.01)-2009, *Explosive Atmospheres, Part 11: Equipment protection by intrinsic safety "i";* and ANSI/UL 60079-11, *Explosive Atmospheres, Part 11: Equipment protection by intrinsic safety "i."*

Informational Note No. 2: Intrinsic safety is designated type of protection "ia" for use in Zone 0 locations. Intrinsic safety is designated type of protection "ib" for use in Zone 1 locations. Intrinsic safety is designated type of protection "ic" for use in Zone 2 locations.

Informational Note No. 3: Intrinsically safe associated apparatus, designated by [ia], [ib], or [ic], is connected to intrinsically safe apparatus ("ia," "ib," or "ic," respectively) but is located outside the hazardous (classified) location unless also protected by another type of protection (such as flameproof).

Oil Immersion "o." Type of protection where electrical equipment is immersed in a protective liquid in such a way that an explosive atmosphere that may be above the liquid or outside the enclosure cannot be ignited.

Informational Note: See ANSI/ISA-60079-6 (12.00.05)- 2009, *Explosive Atmospheres, Part 6: Equipment protection by oil immersion "o"*; and ANSI/UL 60079-6, *Electrical Apparatus for Explosive Gas Atmospheres — Part 6: Oil-Immersion "o."*

Powder Filling "q." Type of protection where electrical parts capable of igniting an explosive atmosphere are fixed in position and completely surrounded by filling material (glass or quartz powder) to prevent the ignition of an external explosive atmosphere.

Informational Note: See ANSI/ISA-60079-5 (12.00.04)- 2009, *Explosive Atmospheres, Part 5: Equipment protection by powder filling "q"*; and ANSI/UL 60079-5, *Electrical Apparatus for Explosive Gas Atmospheres — Part 5: Powder Filling "q."*

Pressurization "p." Type of protection for electrical equipment that uses the technique of guarding against the ingress of the external atmosphere, which may be explosive, into an enclosure by maintaining a protective gas therein at a pressure above that of the external atmosphere.

Informational Note: See ANSI/ISA-60079-2 (12.04.01)- 2004, *Explosive Atmospheres, Part 2: Equipment protection by pressurized enclosures "p"*; and IEC 60079-13, *Electrical apparatus for explosive gas atmospheres — Part 13: Construction and use of rooms or buildings protected by pressurization.*

Type of Protection "n." Type of protection where electrical equipment, in normal operation, is not capable of igniting a surrounding explosive gas atmosphere and a fault capable of causing ignition is not likely to occur.

Informational Note: See ANSI/UL 60079-15, *Electrical Apparatus for Explosive Gas Atmospheres — Part 15: Type of Protection "n"*; and ANSI/ISA-60079-15 (12.12.02)-2008, *Electrical Apparatus for Use in Class I, Zone 2 Hazardous (Classified) Locations: Type of Protection "n."*

Unclassified Locations. Locations determined to be neither Class I, Division 1; Class I, Division 2; Class I, Zone 0; Zone 1; Zone 2; Class II, Division 1; Class II, Division 2; Class III, Division 1; Class III, Division 2; or any combination thereof.

505.3 Other Articles.

All other applicable rules contained in this *Code* shall apply to electrical equipment and wiring installed in hazardous (classified) locations.

Exception: As modified by Article 504 and this article.

505.4 General.

(A) Documentation for Industrial Occupancies. All areas in industrial occupancies designated as hazardous (classified) locations shall be properly documented. This documentation shall be available to those authorized to design, install, inspect, maintain, or operate electrical equipment at the location.

Informational Note: For examples of area classification drawings, see ANSI/API RP 505-1997, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, or Zone 2;* ANSI/ISA-TR(12.24.01)-1998 (IEC 60079-10 Mod), *Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2;* IEC 60079-10-1995, *Electrical Apparatus for Explosive Gas Atmospheres, Classification of Hazardous Areas; and Model Code of Safe Practice in the Petroleum Industry, Part 15: Area Classification Code for Petroleum Installations*, IP 15, The Institute of Petroleum, London.

(B) Reference Standards. Important information relating to topics covered in Chapter 5 may be found in other publications.

Informational Note No. 1: It is important that the authority having jurisdiction be familiar with recorded industrial experience as well as with standards of the National Fire Protection Association (NFPA), the American Petroleum Institute (API), the International Society of Automation (ISA), and the International Electrotechnical Commission (IEC) that may be of use in the classification of various locations, the determination of adequate ventilation, and the protection against static electricity and lightning hazards.

Informational Note No. 2: For further information on the classification of locations, see *NFPA497-2008, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*; ANSI/API RP 505-1997, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, or Zone 2;* ANSI/ISA-TR(12.24.01)-1998 (IEC 60079-10-Mod), *Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2;* IEC 60079-10-1995, *Electrical Apparatus for Explosive Gas Atmospheres, Classification of Hazardous Areas; and Model Code of Safe Practice in the Petroleum Industry, Part 15: Area Classification Code for Petroleum Installations*, IP 15, The Institute of Petroleum, London.

Informational Note No. 3: For further information on protection against static electricity and lightning hazards in hazardous (classified) locations, see NFPA 77-2007, *Recommended Practice on Static Electricity;* NFPA 780-2011, *Standard for the Installation of Lightning Protection Systems;* and API RP 2003-1998, *Protection Against Ignitions Arising Out of Static Lightning and Stray Currents.*

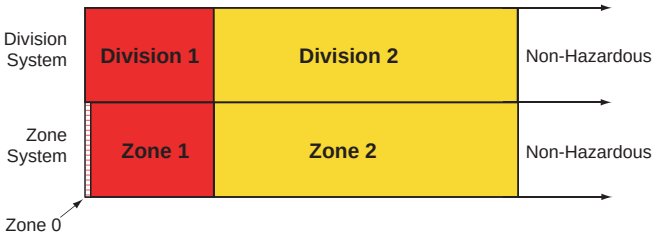
Informational Note No. 4: For further information on ventilation, see NFPA 30-2008, *Flammable and Combustible Liquids Code*, and ANSI/API RP 505-1997, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, or Zone 2.*

Informational Note No. 5: For further information on electrical systems for hazardous (classified) locations on offshore oil and gas producing platforms, see ANSI/API RP 14FZ-2000, *Recommended Practice for Design and Installation of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Zone 0, Zone 1, and Zone 2 Locations.*

Informational Note No. 6: For further information on the installation of electrical equipment in hazardous (classified) locations in general, see IEC 60079-14-1996, *Electrical apparatus for explosive gas atmospheres — Part 14: Electrical installations in explosive gas atmospheres (other than mines)*, and IEC 60079-16-1990, *Electrical apparatus for explosive gas atmospheres — Part 16: Artificial ventilation for the protection of analyzer(s) houses.*

Informational Note No. 7: For further information on application of electrical equipment in hazardous (classified) locations in general, see ANSI/ISA-60079-0 (12.00.01)- 2005, *Electrical Apparatus for Use in Class I, Zones 0, and 1, Hazardous (Classified) Locations: General Requirements;* ANSI/ISA-12.01.01-1999, *Definitions and Information Pertaining to Electrical Apparatus in Hazardous (Classified) Locations;* and ANSI/UL 60079-0, *Electrical Apparatus for Explosive Gas Atmospheres — Part 0: General Requirements.*

505.5 Classifications of Locations.



Differences Between Divisions and Zones.

(A) Classification of Locations. Locations shall be classified depending on the properties of the flammable vapors, liquids, or gases that may be present and the likelihood that a flammable or combustible concentration or quantity is present. Where pyrophoric materials are the only materials used or handled, these locations shall not be classified. Each room, section, or area shall be considered individually in determining its classification.

Informational Note No. 1: See 505.7 for restrictions on area classification.

Informational Note No. 2: Through the exercise of ingenuity in the layout of electrical installations for hazardous (classified) locations, it is frequently possible to locate much of the equipment in reduced level of classification or in an unclassified location and, thus, to reduce the amount of special equipment required.

Rooms and areas containing ammonia refrigeration systems that are equipped with adequate mechanical ventilation may be classified as "unclassified" locations.

Informational Note: For further information regarding classification and ventilation of areas involving ammonia, see ANSI/ASHRAE 15-1994, *Safety Code for Mechanical Refrigeration;* and ANSI/CGA G2.1-1989 (14-39), *Safety Requirements for the Storage and Handling of Anhydrous Ammonia.*

(B) Class I, Zone 0, 1, and 2 Locations. Class I, Zone 0, 1, and 2 locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitible mixtures. Class I, Zone 0, 1, and 2 locations shall include those specified in 505(B)(1), (B)(2), and (B)(3).

(1) Class I, Zone 0. A Class I, Zone 0 location is a location in which

(1) Ignitible concentrations of flammable gases or vapors are present continuously, or

(2) Ignitible concentrations of flammable gases or vapors are present for long periods of time.

Informational Note No. 1: As a guide in determining when flammable gases or vapors are present continuously or for long periods of time, refer to ANSI/API RP 505-1997, *Recommended Practice for Classification of Locations for Electrical Installations of Petroleum Facilities Classified as Class I, Zone 0, Zone 1 or Zone 2;* ANSI/ISA-TR12.24.01- 1998 (IEC 60079-10 Mod), *Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2;* IEC 60079- 10-1995, *Electrical apparatus for explosive gas atmospheres, classifications of hazardous areas;* and *Area Classification Code for Petroleum Installations, Model Code, Part 15*, Institute of Petroleum.

Informational Note No. 2: This classification includes locations inside vented tanks or vessels that contain volatile flammable liquids; inside inadequately vented spraying or coating enclosures, where volatile flammable solvents are used; between the inner and outer roof sections of a floating roof tank containing volatile flammable liquids; inside open vessels, tanks and pits containing volatile flammable liquids; the interior of an exhaust duct that is used to vent ignitible concentrations of gases or vapors; and inside inadequately ventilated enclosures that contain normally venting instruments utilizing or analyzing flammable fluids and venting to the inside of the enclosures.

Informational Note No. 3: It is not good practice to install electrical equipment in Zone 0 locations except when the equipment is essential to the process or when other locations are not feasible. [See 505.5(A) Informational Note No. 2.] If it is necessary to install electrical systems in a Zone 0 location, it is good practice to install intrinsically safe systems as described by Article 504.

(2) Class I, Zone 1. A Class I, Zone 1 location is a location

(1) In which ignitible concentrations of flammable gases or vapors are likely to exist under normal operating conditions; or

(2) In which ignitible concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or

(3) In which equipment is operated or processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitible concentrations of flammable gases or vapors and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition; or

(4) That is adjacent to a Class I, Zone 0 location from which ignitible concentrations of vapors could be communicated, unless communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

Informational Note No. 1: Normal operation is considered the situation when plant equipment is operating within its design parameters. Minor releases of flammable material may be part of normal operations. Minor releases include the releases from mechanical packings on pumps. Failures that involve repair or shutdown (such as the breakdown of pump seals and flange gaskets, and spillage caused by accidents) are not considered normal operation.

Informational Note No. 2: This classification usually includes locations where volatile flammable liquids or liquefied flammable gases are transferred from one container to another. In areas in the vicinity of spraying and painting operations where flammable solvents are used; adequately ventilated drying rooms or compartments for evaporation of flammable solvents; adequately ventilated locations containing fat and oil extraction equipment using volatile flammable solvents; portions of cleaning and dyeing plants where volatile flammable liquids are used; adequately ventilated gas generator rooms and other portions of gas manufacturing plants where flammable gas may escape; inadequately ventilated pump rooms for flammable gas or for volatile

flammable liquids; the interiors of refrigerators and freezers in which volatile flammable materials are stored in the open, lightly stoppered, or in easily ruptured containers; and other locations where ignitible concentrations of flammable vapors or gases are likely to occur in the course of normal operation but not classified Zone 0.

(3) Class I, Zone 2. A Class I, Zone 2 location is a location

(1) In which ignitible concentrations of flammable gases or vapors are not likely to occur in normal operation and, if they do occur, will exist only for a short period; or

(2) In which volatile flammable liquids, flammable gases, or flammable vapors are handled, processed, or used but in which the liquids, gases, or vapors normally are confined within closed containers of closed systems from which they can escape, only as a result of accidental rupture or breakdown of the containers or system, or as a result of the abnormal operation of the equipment with which the liquids or gases are handled, processed, or used; or

(3) In which ignitible concentrations of flammable gases or vapors normally are prevented by positive mechanical ventilation but which may become hazardous as a result of failure or abnormal operation of the ventilation equipment; or

(4) That is adjacent to a Class I, Zone 1 location, from which ignitible concentrations of flammable gases or vapors could be communicated, unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

Informational Note: The Zone 2 classification usually includes locations where volatile flammable liquids or flammable gases or vapors are used but which would become hazardous only in case of an accident or of some unusual operating condition.

505.6 Material Groups.

For purposes of testing, approval, and area classification, various air mixtures (not oxygen enriched) shall be grouped as required in 505.6(A), (B), and (C).

Informational Note: Group I is intended for use in describing atmospheres that contain firedamp (a mixture of gases, composed mostly of methane, found underground, usually in mines). This *Code* does not apply to installations underground in mines. See 90.2(B).

Group II shall be subdivided into IIC, IIB, and IIA, as noted in 505.6(A), (B), and (C), according to the nature of the gas or vapor, for protection techniques "d," "ia," "ib," "[ia]," and "[ib]," and, where applicable, "n" and "o."

Informational Note No. 1: The gas and vapor subdivision as described above is based on the maximum experimental safe gap (MESG), minimum igniting current (MIC), or both. Test equipment for determining the MESG is described in IEC 60079-1A-1975, Amendment No. 1 (1993), *Construction and verification tests of flameproof enclosures of electrical apparatus;* and *UL Technical Report No. 58* (1993). The test equipment for determining MIC is described in IEC 60079-11-1999, *Electrical apparatus for explosive gas atmospheres — Part 11: Intrinsic safety "i."* The classification of gases or vapors according to their maximum experimental safe gaps and minimum igniting currents is described in IEC 60079-12-1978, *Classification of mixtures of gases or vapours with air according to their maximum experimental safe gaps and minimum igniting currents.*

Informational Note No. 2: Verification of electrical equipment utilizing protection techniques "e," "m," "p," and "q," due to design technique, does not require tests involving MESG or MIC. Therefore, Group II is not required to be subdivided for these protection techniques.

Informational Note No. 3: It is necessary that the meanings of the different equipment markings and Group II classifications be carefully observed to avoid confusion with Class I, Divisions 1 and 2, Groups A, B, C, and D.

Class I, Zone 0, 1, and 2, groups shall be as follows:

(A) Group IIC. Atmospheres containing acetylene, hydrogen, or flammable gas, flammable liquid–produced vapor, or combustible liquid–produced vapor mixed with air that may burn or explode, having either a maximum experimental safe gap (MESG) value less than or equal to 0.50 mm or minimum igniting current ratio (MIC ratio) less than or equal to 0.45. [**497:**3.3.5.2.1]

Informational Note: Group IIC is equivalent to a combination of Class I, Group A, and Class I, Group B, as described in 500.6(A)(1) and (A)(2).

(B) Group IIB. Atmospheres containing acetaldehyde, ethylene, or flammable gas, flammable liquid–produced vapor, or combustible liquid–produced vapor mixed with air that may burn or explode, having either maximum experimental safe gap (MESG) values greater than 0.50 mm and less than or equal to 0.90 mm or minimum igniting current ratio (MIC ratio) greater than 0.45 and less than or equal to 0.80. [**497:**3.3.5.2.2]

Informational Note: Group IIB is equivalent to Class I, Group C, as described in 500.6(A)(3).

(C) Group IIA. Atmospheres containing acetone, ammonia, ethyl alcohol, gasoline, methane, propane, or flammable gas, flammable liquid–produced vapor, or combustible liquid–produced vapor mixed with air that may burn or explode, having either a maximum experimental safe gap (MESG) value greater than 0.90 mm or minimum igniting current ratio (MIC ratio) greater than 0.80. [**497:**3.3.5.2.3]

Informational Note: Group IIA is equivalent to Class I, Group D as described in 500.6(A)(4).

505.7 Special Precaution.

Article 505 requires equipment construction and installation that ensures safe performance under conditions of proper use and maintenance.

Informational Note No. 1: It is important that inspection authorities and users exercise more than ordinary care with regard to the installation and maintenance of electrical equipment in hazardous (classified) locations.

Informational Note No. 2: Low ambient conditions require special consideration. Electrical equipment depending on the protection

techniques described by 505.8(A) may not be suitable for use at temperatures lower than −20°C (−4°F) unless they are identified for use at lower temperatures. However, at low ambient temperatures, flammable concentrations of vapors may not exist in a location classified Class I, Zones 0, 1, or 2 at normal ambient temperature.

(A) Implementation of Zone Classification System. Classification of areas, engineering and design, selection of equipment and wiring methods, installation, and inspection shall be performed by qualified persons.

(B) Dual Classification. In instances of areas within the same facility classified separately, Class I, Zone 2 locations shall be permitted to abut, but not overlap, Class I, Division 2 locations. Class I, Zone 0 or Zone 1 locations shall not abut Class I, Division 1 or Division 2 locations.

(C) Reclassification Permitted. A Class I, Division 1 or Division 2 location shall be permitted to be reclassified as a Class I, Zone 0, Zone 1, or Zone 2 location, provided all of the space that is classified because of a single flammable gas or vapor source is reclassified under the requirements of this article.

(D) Solid Obstacles. Flameproof equipment with flanged joints shall not be installed such that the flange openings are closer than the distances shown in Table 505.7(D) to any solid obstacle that is not a part of the equipment (such as steelworks, walls, weather guards, mounting brackets, pipes, or other electrical equipment) unless the equipment is listed for a smaller distance of separation.

Table 505.7(D) Minimum Distance of Obstructions from Flameproof "d" Flange Openings

	Minimum Distance	
Gas Group	**mm**	**in.**
IIC	40	1.5781
IIB	30	.8125
IIA	10	.3906

(E) Simultaneous Presence of Flammable Gases and Combustible Dusts or Fibers/Flyings. Where flammable gases, combustible dusts, or fibers/flyings are or may be present at the same time, the simultaneous presence shall be considered during the selection and installation of the electrical equipment and the wiring methods, including the determination of the safe operating temperature of the electrical equipment.

◆ This new requirement covering simultaneous presence of flammable gases and combustible dusts or fibers/flyings in Class I, Zone 0, 1, and 2 locations was added to this section.

505.8 Protection Techniques.

Acceptable protection techniques for electrical and electronic equipment in hazardous (classified) locations shall be as described in 505.8(A) through (I).

Informational Note: For additional information, see ANSI/ISA-60079-0 (12.00.01)-2009, *Electrical Apparatus for Use in Class I, Zones 0, 1, and 2 Hazardous (Classified) Locations, General Requirements;* ANSI/ISA-12.01.01- 1999, *Definitions and Information Pertaining to Electrical Apparatus in Hazardous (Classified) Locations; and ANSI/UL 60079–0, Electrical Apparatus for Explosive Gas Atmospheres — Part 0: General Requirements.*

(A) Flameproof "d". This protection technique shall be permitted for equipment in Class I, Zone 1 or Zone 2 locations.

Class I, Zone 2 Control Station with Factory Sealed Contact Block

(B) Purged and Pressurized. This protection technique shall be permitted for equipment in those Class I, Zone 1 or Zone 2 locations for which it is identified.

(C) Intrinsic Safety. This protection technique shall be permitted for apparatus and associated apparatus in Class I, Zone 0, Zone 1, or Zone 2 locations for which it is listed.

(D) Type of Protection "n". This protection technique shall be permitted for equipment in Class I, Zone 2 locations. Type of protection "n" is further subdivided into nA, nC, and nR.

Informational Note: See Table 505.9(C)(2)(4) for the descriptions of subdivisions for type of protection "n".

(E) Oil Immersion "o". This protection technique shall be permitted for equipment in Class I, Zone 1 or Zone 2 locations.

(F) Increased Safety "e". This protection technique shall be permitted for equipment in Class I, Zone 1 or Zone 2 locations.

FRP and Stainless Steel Terminal Enclosures

(G) Encapsulation "m". This protection technique shall be permitted for equipment in Class I, Zone 0, Zone 1, or Zone 2 locations for which it is identified.

◆ This section was revised to permit encapsulation "m" as a protection technique in Zone 0 locations.

Informational Note: See Table 505.9(C)(2)(4) for the descriptions of subdivisions for encapsulation.

(H) Powder Filling "q". This protection technique shall be permitted for equipment in Class I, Zone 1 or Zone 2 locations.

(I) Combustible Gas Detection System. A combustible gas detection system shall be permitted as a means of protection in industrial establishments with restricted public access and where the conditions of maintenance and supervision ensure that only qualified persons service the installation. Where such a system is installed, equipment specified in 505.8(I)(1), (I)(2), or (I)(3) shall be permitted. The type of detection equipment, its listing, installation location(s), alarm and shutdown criteria, and calibration frequency shall be documented when combustible gas detectors are used as a protection technique.

Informational Note No. 1: For further information, see ANSI/API RP 505-1997, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2.*

Informational Note No. 2: For further information, see ANSI/ISA-60079-29-2, *Explosive Atmospheres - Part 29-2: Gas detectors - Selection, installation, use and maintenance of detectors for flammable gases and oxygen.*

Informational Note No. 3: For further information, see ISA-TR12.13.03, *Guide for Combustible Gas Detection as a Method of Protection.*

(1) Inadequate Ventilation. In a Class I, Zone 1 location that is so classified due to inadequate ventilation, electrical equipment suitable for Class I, Zone 2 locations shall be permitted. Combustible gas detection equipment shall be listed for Class I, Zone 1, for the appropriate material group, and for the detection of the specific gas or vapor to be encountered.

(2) Interior of a Building. In a building located in, or with an opening into, a Class I, Zone 2 location where the interior does not contain a source of flammable gas or vapor, electrical equipment for unclassified locations shall be permitted. Combustible gas detection equipment shall be listed for Class I, Zone 1 or Class I, Zone 2, for the appropriate material group, and for the detection of the specific gas or vapor to be encountered.

(3) Interior of a Control Panel. In the interior of a control panel containing instrumentation utilizing or measuring flammable liquids, gases, or vapors, electrical equipment suitable for Class I, Zone 2 locations shall be permitted. Combustible gas detection equipment shall be listed for Class I, Zone 1, for the appropriate material group, and for the detection of the specific gas or vapor to be encountered.

505.9 Equipment.

(A) Suitability. Suitability of identified equipment shall be determined by one of the following:

(1) Equipment listing or labeling

(2) Evidence of equipment evaluation from a qualified testing laboratory or inspection agency concerned with product evaluation

(3) Evidence acceptable to the authority having jurisdiction such as a manufacturer's self-evaluation or an owner's engineering judgment

Informational Note: Additional documentation for equipment may include certificates demonstrating compliance with applicable equipment standards, indicating special conditions of use, and other pertinent information.

(B) Listing.

(1) Equipment that is listed for a Zone 0 location shall be permitted in a Zone 1 or Zone 2 location of the same gas or vapor, provided that it is installed in accordance with the requirements for the marked type of protection. Equipment that is listed for a Zone 1 location shall be permitted in a Zone 2 location of the same gas or vapor, provided that it is installed in accordance with the requirements for the marked type of protection.

(2) Equipment shall be permitted to be listed for a specific gas or vapor, specific mixtures of gases or vapors, or any specific combination of gases or vapors.

Informational Note: One common example is equipment marked for "IIB. + H2."

(C) Marking. Equipment shall be marked in accordance with 505.9(C)(1) or (C)(2).

(1) Division Equipment. Equipment identified for Class I, Division 1 or Class I, Division 2 shall, in addition to being marked in accordance with 500.8(C), be permitted to be marked with all of the following:

(1) Class I, Zone 1 or Class I, Zone 2 (as applicable)

(2) Applicable gas classification group(s) in accordance with Table 505.9(C)(1)(2)

(3) Temperature classification in accordance with 505.9(D)(1)

Table 505.9(C)(1)(2) Gas Classification Groups

Gas Group	Comment
IIC	See 505.6(A)
IIB	See 505.6(B)
IIA	See 505.6(C)

(2) Zone Equipment. Equipment meeting one or more of the protection techniques described in 505.8 shall be marked with all of the following in the order shown:

(1) Class

(2) Zone

(3) Symbol "AEx"

(4) Protection technique(s) in accordance with Table 505.9(C)(2)(4)

(5) Applicable gas classification group(s) in accordance with Table 505.9(C)(1)(2)

(6) Temperature classification in accordance with 505.9(D)(1)

Exception No. 1: Associated apparatus NOT suitable for installation in a hazardous (classified) location shall be required to be marked only with (3), (4), and (5), but BOTH the symbol AEx (3) and the symbol for the type of protection (4) shall be enclosed within the same square brackets, for example, [AEx ia] IIC.

Exception No. 2: Simple apparatus as defined in 504.2 shall not be required to have a marked operating temperature or temperature class.

Electrical equipment of types of protection "e," "m," "ma," "mb," "px," "py," "pz," or "q" shall be marked Group II. Electrical equipment of types of protection "d," "ia," "ib," "ic," [ia]," "[ib]," or "[ic]" shall be marked Group IIA, IIB, or IIC, or for a specific gas or vapor. Electrical equipment of types of protection "n" shall be marked Group II unless it contains enclosed-break devices, nonincendive components, or energy-limited equipment or circuits, in which case it shall be marked Group IIA, IIB, or IIC, or a specific gas or vapor. Electrical equipment of other types of protection shall be marked Group II unless the type of protection utilized by the equipment requires that it be marked Group IIA, IIB, or IIC, or a specific gas or vapor.

◆ Revised to include equipment of protection types "ib," "ic," "[ia]," "[ib]," or "[ic]" that must be marked Group IIA, IIB, and IIC or for a specific gas or vapor.

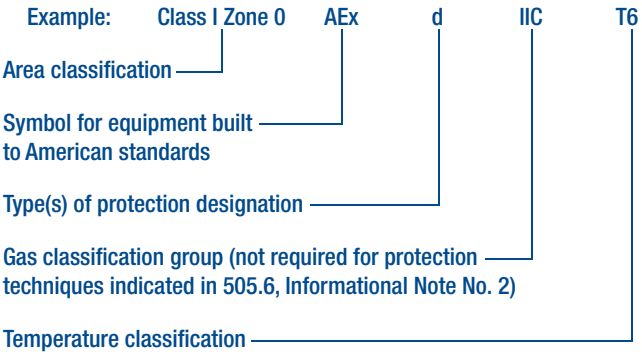
Informational Note No. 1: An example of the required marking for intrinsically safe apparatus for installation in Class I, Zone 0 is "Class I, Zone 0, AEx ia IIC T6." An explanation of the marking that is required is shown in Informational Note Figure 505.9(C)(2).

Informational Note No. 2: An example of the required marking for intrinsically safe associated apparatus mounted in a flameproof enclosure for installation in Class I, Zone 1 is "Class I, Zone 1 AEx d[ia] IIC T4."

Informational Note No. 3: An example of the required marking for intrinsically safe associated apparatus NOT for installation in a hazardous (classified) location is "[AEx ia] IIC."

Informational Note No. 4: The EPL (or equipment protection level) may appear in the product marking. EPLs are designated as G for gas, D for dust, or M for mining and are then followed by a letter (a, b, or c) to give the user a better understanding as to whether the equipment provides either (a) a "very high," (b) a "high," or (c) an "enhanced" level of protection against ignition of an explosive atmosphere. For example, an AEx d IIC T4 motor (which is suitable by protection concept for application in Zone 1) may additionally be marked with an EPL of "Gb" to indicate that it was provided with a high level of protection, such as AEx d IIC T4 Gb.

Informational Note No. 5: Equipment installed outside a Zone 0 location, electrically connected to equipment located inside a Zone 0 location, may be marked Class I, Zone 0/1. The "/" indicates that equipment contains a separation element and can be installed at the boundary between a Zone 0 and a Zone 1 location. See ANSI/ISA-60079-26, *Electrical Apparatus for Use in Class I, Zone 0 Hazardous (Classified) Locations.*



Informational Note Figure 505.9(C)(2) Zone Equipment Marking.

(D) Class I Temperature. The temperature marking specified below shall not exceed the ignition temperature of the specific gas or vapor to be encountered.

Informational Note: For information regarding ignition temperatures of gases and vapors, see NFPA 497-2008, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas;* and IEC 60079-20-1996, *Electrical Apparatus for Explosive Gas Atmospheres, Data for Flammable Gases and Vapours, Relating to the Use of Electrical Apparatus.*

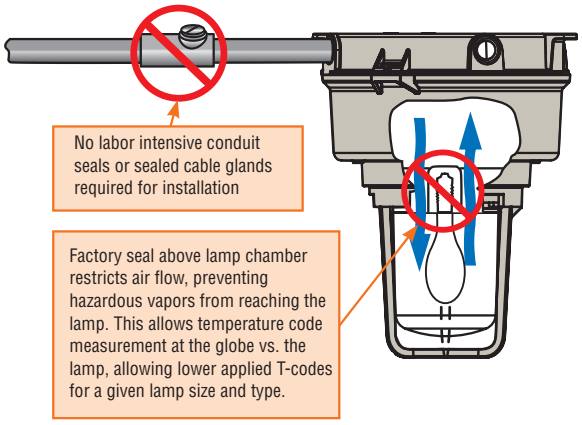
(1) Temperature Classifications. Equipment shall be marked to show the operating temperature or temperature class referenced to a 40°C ambient, or at the higher ambient temperature if the equipment is rated and marked for an ambient temperature of greater than 40°C. The temperature class, if provided, shall be indicated using the temperature class (T Code) shown in Table 505.9(D)(1).

Table 505.9(C)(2)(4) Types of Protection Designation

Designation	Technique	Zone*
d	Flameproof enclosure	1
db	Flameproof enclosure	1
e	Increased safety	1
eb	Increased safety	1
ia	Intrinsic safety	0
ib	Intrinsic safety	1
ic	Intrinsic safety	2
[ia]	Associated apparatus	Unclassified**
[ib]	Associated apparatus	Unclassified**
[ic]	Associated apparatus	Unclassified**
m	Encapsulation	1
ma	Encapsulation	0
mb	Encapsulation	1
nA	Nonsparking equipment	2
nAc	Nonsparking equipment	2
nC	Sparking equipment in which the contacts are suitably protected other than by restricted breathing enclosure	2
nCc	Sparking equipment in which the contacts are suitably protected other than by restricted breathing enclosure	2
nR	Restricted breathing enclosure	2
nRc	Restricted breathing enclosure	2
o	Oil immersion	1
ob	Oil immersion	1
px	Pressurization	1
pxb	Pressurization	1
py	Pressurization	1
pyb	Pressurization	1
pz	Pressurization	2
pzc	Pressurization	2
q	Powder filled	1
qb	Powder filled	1

*Does not address use where a combination of techniques is used.

**Associated apparatus is permitted to be installed in a hazardous (classified) location if suitably protected using another type of protection.



Luminaire with Optimal Restricted Breathing

Electrical equipment designed for use in the ambient temperature range between −20°C and +40°C shall require no ambient temperature marking.

Electrical equipment that is designed for use in a range of ambient temperatures other than −20°C to +40°C is considered to be special; and the ambient temperature range shall then be marked on the equipment, including either the symbol "Ta" or "Tamb" together with the special range of ambient temperatures, in degrees Celsius.

◆ Table 505.9(C)(2)(4) Types of Protection Designation was revised to include current protection techniques for Class I, Zones 0, 1, & 2 locations.

Table 505.9(D)(1) Classification of Maximum Surface Temperature for Group II Electrical Equipment

Temperature Class (T Code)	Maximum Surface Temperature (°C)
T1	≤450
T2	≤300
T3	≤200
T4	≤135
T5	≤100
T6	≤85

➤ Indicates portions of the previous NEC have been removed

Informational Note: As an example, such a marking might be "−30°C to +40°C."

Exception No. 1: Equipment of the non–heat-producing type, such as conduit fittings, and equipment of the heatproducing type having a maximum temperature of not more than 100°C (212°F) shall not be required to have a marked operating temperature or temperature class.

Exception No. 2: Equipment identified for Class I, Division 1 or Division 2 locations as permitted by 505.20(B) and (D) shall be permitted to be marked in accordance with 500.8(C) and Table 500.8(C).

(E) Threading. The supply connection entry thread form shall be NPT or metric. Conduit and fittings shall be made wrenchtight to prevent sparking when fault current flows through the conduit system, and to ensure the explosionproof or flameproof integrity of the conduit system where applicable. Equipment provided with threaded entries for field wiring connections shall be installed in accordance with 505.9(E)(1) or (E)(2) and with (E)(3).

◆ This section was revised to require entry threads to be either NPT or metric.

(1) Equipment Provided with Threaded Entries for NPT Threaded Conduit or Fittings. For equipment provided with threaded entries for NPT threaded conduit or fittings, listed conduit, conduit fittings, or cable fittings shall be used.

All NPT threaded conduit and fittings referred to herein shall be threaded with a National (American) Standard Pipe Taper (NPT) thread.

NPT threaded entries into explosionproof or flameproof equipment shall be made up with at least five threads fully engaged.

Exception: For listed explosionproof or flameproof equipment, factory threaded NPT entries shall be made up with at least 41/2 threads fully engaged.

◆ The requirements for NPT thread type, and engagement for explosionproof or flameproof entries and the related exception have been relocated to this section.

Informational Note No. 1: Thread specifications for male NPT threads are located in ANSI/ASME B1.20.1-1983, *Pipe Threads, General Purpose (Inch).*

Informational Note No. 2: Female NPT threaded entries use a modified National Standard Pipe Taper (NPT) thread with thread form per ANSI/ASME B1.20.1-1983, *Pipe Threads, General Purpose (Inch).* See ANSI UL/ISA 60079-1, *Electrical Apparatus for Explosive Gas Atmospheres – Part 1: Flameproof Enclosures "d".*

(2) Equipment Provided with Threaded Entries for Metric Threaded Conduit or Fittings. For equipment with metric threaded entries, listed conduit fittings or listed cable fittings shall be used. Such entries shall be identified as being metric, or listed adapters to permit connection to conduit or NPT threaded fittings shall be provided with the equipment and shall be used for connection to conduit or NPT threaded fittings.

◆ Equipment with Metric threaded entries must use listed conduit fittings or listed cable fittings.

Metric threaded entries into explosionproof or flameproof equipment shall have a class of fit of at least 6g/6H and be made up with at least five threads fully engaged for Groups C, D, IIB, or IIA and not less than eight threads fully engaged for Groups A, B, IIC, or IIB + H_2.

◆ For Metric threaded entries the class of fit is specified and the engagement is specified for the various groups.

Informational Note: Threading specifications for metric threaded entries are located in ISO 965/1-1980, *ISO general pupose metric screw threads — Tolerances — Part 1: Principles and basic data,* and ISO 965-3-1998, *ISO general purpose metric screw threads — Tolerances — Part 3: Deviations for constructional screw threads;* and ISO 965/3-1980, *Metric Screw Threads.*

(3) Unused Openings. All unused openings shall be closed with close-up plugs listed for the location and shall maintain the type of protection. The plug engagement shall comply with 505.9(E)(1) or 505.9(E)(2).

◆ All unused openings must now be closed with listed close-up plugs that meet engagement requirements and maintain the type of protection.

(F) Optical Fiber Cables. Where an optical fiber cable contains conductors that are capable of carrying current (composite optical fiber cable), the optical fiber cable shall be installed in accordance with the requirements of Articles 505.15 and 505.16.

505.15 Wiring Methods.

Wiring methods shall maintain the integrity of protection techniques and shall comply with 505.15(A) through (C).

(A) Class I, Zone 0. In Class I, Zone 0 locations, only intrinsically safe wiring methods in accordance with Article 504 shall be permitted.

Informational Note: Article 504 only includes protection technique "ia."

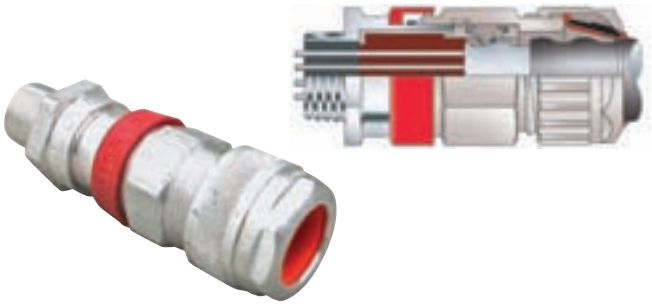
(B) Class I, Zone 1.

(1) General. In Class I, Zone 1 locations, the wiring methods in (B)(1)(a) through (B)(1)(f) shall be permitted.

(a) All wiring methods permitted by 505.15(A).

(b) In industrial establishments with restricted public access, where the conditions of maintenance and supervision ensure that only qualified persons service the installation, and where the cable is not subject to physical damage, Type MC-HL cable listed for use in Class I, Zone 1 or Division 1 locations, with a gas/vaportight continuous corrugated metallic sheath, an overall jacket of suitable polymeric material, and a separate equipment grounding conductor(s) in accordance with 250.122, and terminated with fittings listed for the application.

Type MC-HL cable shall be installed in accordance with the provisions of Article 330, Part II.



CLENCHER Metal Clad Cable Connetor

provisions of Article 330, Part II and must be terminated with fittings listed for the application.

(c) In industrial establishments with restricted public access, where the conditions of maintenance and supervision ensure that only qualified persons service the installation, and where the cable is not subject to physical damage, Type ITC-HL cable listed for use in Class I, Zone 1 or Division 1 locations, with a gas/vaportight continuous corrugated metallic sheath and an overall jacket of suitable polymeric material, and terminated with fittings listed for the application. Type ITC-HL cable shall be installed in accordance with the provisions of Article 727.

◆ Type ITC-HL cable must now be installed according to the provisions of Article 727, and must be terminated with fittings listed for the application.

Informational Note: See 727.4 and 727.5 for restrictions on use of Type ITC cable.

(d) Type MI cable terminated with fittings listed for Class I, Zone 1 or Division 1 locations. Type MI cable shall be installed and supported in a manner to avoid tensile stress at the termination fittings.

(e) Threaded rigid metal conduit, or threaded steel intermediate metal conduit.

(f) Type PVC conduit and Type RTRC conduit shall be permitted where encased in a concrete envelope a minimum of 50 mm (2 in.) thick and provided with not less than 600 mm (24 in.) of cover measured from the top of the conduit to grade. Threaded rigid metal conduit or threaded steel intermediate metal conduit shall be used for the last 600 mm (24 in.) of the underground run to emergence or to the point of connection to the aboveground raceway. An equipment grounding conductor shall be included to provide for electrical continuity of the raceway system and for grounding of non–current-carrying metal parts.

(2) Flexible Connections. Where necessary to employ flexible connections, flexible fittings listed for Class I, Zone 1 or Division 1 locations, or flexible cord in accordance with the provisions of 505.17 terminated with a listed cord connector that maintains the type of protection of the terminal compartment, shall be permitted.

◆ This section was revised to require listed cord connectors that maintain type of protection required for terminal compartment.

Increased Safety Connector – Certain Restrictions Apply

(C) Class I, Zone 2.

(1) General. In Class I, Zone 2 locations, the following wiring methods shall be permitted.

(a) All wiring methods permitted by 505.15(B).

(b) Types MC, MV, or TC cable, including installation in cable tray systems. The cable shall be terminated with listed fittings. Single conductor Type MV cables shall be shielded or metallic-armored.

◆ Type MC Cable has been added and the cables shall be terminated with listed fittings.

(c) Type ITC and Type ITC-ER cable as permitted in 727.4 and terminated with listed fittings.

◆ Type ITC-ER Cable has been added and the cables shall be terminated with listed fittings.

(d) Type PLTC and Type PLTC-ER cable in accordance with the provisions of Article 725, including installation in cable tray systems. The cable shall be terminated with listed fittings.

◆ Type PLTC-ER Cable has been added and the cables shall be terminated with listed fittings.

(e) Enclosed gasketed busways, enclosed gasketed wireways.

➤ Indicates portions of the previous NEC have been removed

(f) In industrial establishments with restricted public access, where the conditions of maintenance and supervision ensure that only qualified perso ns service the installation, and where metallic conduit does not provide sufficient corrosion resistance, listed reinforced thermosetting resin conduit (RTRC), factory elbows, and associated fittings, all marked with the suffix -XW, and Schedule 80 PVC conduit, factory elbows, and associated fittings shall be permitted. Where seals are required for boundary conditions as defined in 505.16(C)(1)(b), the Zone 1 wiring method shall extend into the Zone 2 area to the seal, which shall be located on the Zone 2 side of the Zone 1–Zone 2 boundary.

(g) Intrinsic safety type of protection "ic" shall be permitted using any of the wiring methods permitted for unclassified locations. Intrinsic safety type of protection "ic" systems shall be installed in accordance with the control drawing(s). Simple apparatus, not shown on the control drawing, shall be permitted in an intrinsic safety type of protection "ic" circuit, provided the simple apparatus does not interconnect the intrinsic safety type of protection "ic" systems to any other circuit.

Informational Note: Simple apparatus is defined in 504.2.

Separate intrinsic safety type of protection "ic" systems shall be installed in accordance with one of the following:

(1) In separate cables

(2) In multiconductor cables where the conductors of each circuit are within a grounded metal shield

(3) In multiconductor cables where the conductors of each circuit have insulation with a minimum thickness of 0.25 mm (0.01 in.)

◆ This section was revised from "nonincendive" to protection technique "ic" (intrinsic safety).

(2) Flexible Connections. Where provision must be made for limited flexibility, flexible metal fittings, flexible metal conduit with listed fittings, liquidtight flexible metal conduit with listed fittings, liquidtight flexible nonmetallic conduit with listed fittings, or flexible cord in accordance with the provisions of 505.17 terminated with a listed cord connector that maintains the type of protection of the terminal compartment shall be permitted.

◆ This section was revised to require listed cord connectors that maintain the type of protection of the terminal compartment.

Informational Note: See 505.25(B) for grounding requirements where flexible conduit is used.

505.16 Sealing and Drainage.

Seals in conduit and cable systems shall comply with 505.16(A) through (E). Sealing compound shall be used in Type MI cable termination fittings to exclude moisture and other fluids from the cable insulation.

Informational Note No. 1: Seals are provided in conduit and cable systems to minimize the passage of gases and vapors and prevent the passage of flames from one portion of the electrical installation to another through the conduit. Such communication through Type MI cable is inherently prevented by construction of the cable. Unless specifically designed and tested for the purpose, conduit and cable seals are not intended to prevent the passage of liquids, gases, or vapors at a continuous pressure differential across the seal. Even at differences in pressure across the seal equivalent to a few inches of water, there may be a slow passage of gas or vapor through a seal and through conductors passing through the seal. See 505.16(C)(2)(b). Temperature extremes and highly corrosive liquids and vapors can affect the ability of seals to perform their intended function. See 505.16(D)(2).

Informational Note No. 2: Gas or vapor leakage and propagation of flames may occur through the interstices between the strands of standard stranded conductors larger than 2 AWG. Special conductor constructions, for example, compacted strands or sealing of the individual strands, are means of reducing leakage and preventing the propagation of flames.

(A) Zone 0. In Class I, Zone 0 locations, seals shall be located according to 505.16(A)(1), (A)(2), and (A)(3). (1) Conduit Seals. Seals shall be provided within 3.05 m (10 ft) of where a conduit leaves a Zone 0 location. There shall be no unions, couplings, boxes, or fittings, except listed reducers at the seal, in the conduit run between the seal and the point at which the conduit leaves the location.

Exception: A rigid unbroken conduit that passes completely through the Zone 0 location with no fittings less than 300 mm (12 in.) beyond each boundary shall not be required to be sealed if the termination points of the unbroken conduit are in unclassified locations.

(2) Cable Seals. Seals shall be provided on cables at the first point of termination after entry into the Zone 0 location.

(3) Not Required to Be Explosionproof or Flameproof. Seals shall not be required to be explosionproof or flameproof.

(B) Zone 1. In Class I, Zone 1 locations, seals shall be located in accordance with 505.16(B)(1) through (B)(8).

(1) Type of Protection "d" or "e" Enclosures. Conduit seals shall be provided within 50 mm (2 in.) for each conduit entering enclosures having type of protection "d" or "e."

Exception No. 1: Where the enclosure having type of protection "d" is marked to indicate that a seal is not required.

Exception No. 2: For type of protection "e," conduit and fittings employing only NPT to NPT raceway joints or fittings listed for type of protection "e" shall be permitted between the enclosure and the seal, and the seal shall not be required to be within 50 mm (2 in.) of the entry.

Informational Note: Examples of fittings employing other than NPT threads include conduit couplings, capped elbows, unions, and breather drains.

Exception No. 3: For conduit installed between type of protection "e" enclosures employing only NPT to NPT raceway joints or conduit fittings listed for type of protection "e," a seal shall not be required.

(2) Explosionproof Equipment. Conduit seals shall be provided for each conduit entering explosionproof equipment according to (B)(2)(a), (B)(2)(b), and (B)(2)(c).

(a) In each conduit entry into an explosionproof enclosure where either (1) the enclosure contains apparatus, such as switches, circuit breakers, fuses, relays, or resistors, that may produce arcs, sparks, or high temperatures that are considered to be an ignition source in normal operation, or (2) the entry is metric designator 53 (trade size 2) or larger and the enclosure contains terminals, splices, or taps. For the purposes of this section, high temperatures shall be considered to be any temperatures exceeding 80 percent of the autoignition temperature in degrees Celsius of the gas or vapor involved.

Exception: Conduit entering an enclosure where such switches, circuit breakers, fuses, relays, or resistors comply with one of the following:

(1) Are enclosed within a chamber hermetically sealed against the entrance of gases or vapors.

(2) Are immersed in oil.

(3) Are enclosed within a factory-sealed explosionproof chamber located within the enclosure, identified for the location, and marked "factory sealed" or equivalent, unless the entry is metric designator 53 (trade size 2) or larger. Factory-sealed enclosures shall not be considered to serve as a seal for another adjacent explosionproof enclosure that is required to have a conduit seal.

(b) Conduit seals shall be installed within 450 mm (18 in.) from the enclosure. Only explosionproof unions, couplings, reducers, elbows, capped elbows, and conduit bodies similar to L, T, and cross types that are not larger than the trade size of the conduit shall be permitted between the sealing fitting and the explosionproof enclosure.

(c) Where two or more explosionproof enclosures for which conduit seals are required under 505.16(B)(2) are connected by nipples or by runs of conduit not more than 900 mm (36 in.) long, a single conduit seal in each such nipple connection or run of conduit shall be considered sufficient if located not more than 450 mm (18 in.) from either enclosure.

(3) Pressurized Enclosures. Conduit seals shall be provided in each conduit entry into a pressurized enclosure where the conduit is not pressurized as part of the protection system. Conduit seals shall be installed within 450 mm (18 in.) from the pressurized enclosure.

Informational Note No. 1: Installing the seal as close as possible to the enclosure reduces problems with purging the dead airspace in the pressurized conduit.

Informational Note No. 2: For further information, see NFPA 496-2008, *Standard for Purged and Pressurized Enclosures for Electrical Equipment.*

(4) Class I, Zone 1 Boundary. Conduit seals shall be provided in each conduit run leaving a Class I, Zone 1 location. The sealing fitting shall be permitted on either side of the boundary of such location within 3.05 m (10 ft) of the boundary and shall be designed and installed so as to minimize the amount of gas or vapor within the Zone 1 portion of the conduit from being communicated to the conduit beyond the seal. Except for listed explosionproof reducers at the conduit seal, there shall be no union, coupling, box, or fitting between the conduit seal and the point at which the conduit leaves the Zone 1 location.

Exception: Metal conduit containing no unions, couplings, boxes, or fittings and passing completely through a Class I, Zone 1 location with no fittings less than 300 mm (12 in.) beyond each boundary shall not require a conduit seal if the termination points of the unbroken conduit are in unclassified locations.

(5) Cables Capable of Transmitting Gases or Vapors. Conduits containing cables with a gas/vaportight continuous sheath capable of transmitting gases or vapors through the cable core shall be sealed in the Zone 1 location after removing the jacket and any other coverings so that the sealing compound surrounds each individual insulated conductor and the outer jacket.

Exception: Multiconductor cables with a gas/vaportight continuous sheath capable of transmitting gases or vapors through the cable core shall be permitted to be considered as a single conductor by sealing the cable in the conduit within 450 mm (18 in.) of the enclosure and the cable end within the enclosure by an approved means to minimize the entrance of gases or vapors and prevent the propagation of flame into the cable core, or by other approved methods. For shielded cables and twisted pair cables, it shall not be required to remove the shielding material or separate the twisted pair.

(6) Cables Incapable of Transmitting Gases or Vapors. Each multiconductor cable in conduit shall be considered as a single conductor if the cable is incapable of transmitting gases or vapors through the cable core. These cables shall be sealed in accordance with 505.16(D).

(7) Cables Entering Enclosures. Cable seals shall be provided for each cable entering flameproof or explosionproof enclosures. The seal shall comply with 505.16(D).

(8) Class I, Zone 1 Boundary. Cables shall be sealed at the point at which they leave the Zone 1 location.

Exception: Where cable is sealed at the termination point.

(C) Zone 2. In Class I, Zone 2 locations, seals shall be located in accordance with 505.16(C)(1) and (C)(2).

(1) Conduit Seals. Conduit seals shall be located in accordance with (C)(1)(a) and (C)(1)(b).

(a) For connections to enclosures that are required to be flameproof or explosionproof, a conduit seal shall be provided in accordance with 505.16(B)(1) and (B)(2). All portions of the conduit run or nipple between the seal and such enclosure shall comply with 505.16(B).

(b) In each conduit run passing from a Class I, Zone 2 location into an unclassified location. The sealing fitting shall be permitted on either side of the boundary of such location within 3.05 m (10 ft) of the boundary and shall be designed and installed so as to minimize the amount of gas or vapor within the Zone 2 portion of the conduit from being communicated to the conduit beyond the seal. Rigid metal conduit or threaded steel intermediate metal conduit shall be used between the sealing fitting and the point at which the conduit leaves the Zone 2 location, and a threaded connection shall be used at the sealing fitting. Except for listed explosionproof reducers at the conduit seal, there shall be no union, coupling, box, or fitting between the conduit seal and the point at which the conduit leaves the Zone 2 location. Conduits shall be sealed to minimize the amount of gas or vapor within the Class I, Zone 2 portion of the conduit from being communicated to the conduit beyond the seal. Such seals shall not be required to be flameproof or explosionproof but shall be identified for the purpose of minimizing passage of gases under normal operating conditions and shall be accessible.

◆ The requirements for boundary seals passing from Class I, Zone 2 location into an unclassified location have been revised.

Exception No. 1: Metal conduit containing no unions, couplings, boxes, or fittings and passing completely through a Class I, Zone 2 location with no fittings less than 300 mm (12 in.) beyond each boundary shall not be required to be sealed if the termination points of the unbroken conduit are in unclassified locations.

Exception No. 2: Conduit systems terminating at an unclassified location where a wiring method transition is made to cable tray, cablebus, ventilated busway, Type MI cable, or cable that is not installed in a raceway or cable tray system shall not be required to be sealed where passing from the Class I, Zone 2 location into the unclassified location. The unclassified location shall be outdoors or, if the conduit system is all in one room, it shall be permitted to be indoors. The conduits shall not terminate at an enclosure containing an ignition source in normal operation.

Exception No. 3: Conduit systems passing from an enclosure or room that is unclassified as a result of pressurization into a Class I, Zone 2 location shall not require a seal at the boundary.

Informational Note: For further information, refer to NFPA 496-2008, *Standard for Purged and Pressurized Enclosures for Electrical Equipment.*

Exception No. 4: Segments of aboveground conduit systems shall not be required to be sealed where passing from a Class I, Zone 2 location into an unclassified location if all the following conditions are met:

(1) No part of the conduit system segment passes through a Zone 0 or Zone 1 location where the conduit contains unions, couplings, boxes, or fittings within 300 mm (12 in.) of the Zone 0 or Zone 1 location.

(2) The conduit system segment is located entirely in outdoor locations.

(3) The conduit system segment is not directly connected to canned pumps, process or service connections for flow, pressure, or analysis measurement, and so forth, that depend on a single compression seal, diaphragm, or tube to prevent flammable or combustible fluids from entering the conduit system.

(4) The conduit system segment contains only threaded metal conduit, unions, couplings, conduit bodies, and fittings in the unclassified location.

(5) The conduit system segment is sealed at its entry to each enclosure or fitting housing terminals, splices, or taps in Zone 2 locations.

(2) Cable Seals. Cable seals shall be located in accordance with (C)(2)(a), (C)(2)(b), and (C)(2)(c).

(a) Explosionproof and Flameproof Enclosures. Cables entering enclosures required to be flameproof or explosionproof shall be sealed at the point of entrance. The seal shall comply with 505.16(D). Multiconductor cables with a gas/vaportight continuous sheath capable of transmitting gases or vapors through the cable core shall be sealed in the Zone 2 location after removing the jacket and any other coverings so that the sealing compound surrounds each individual insulated conductor in such a manner as to minimize the passage of gases and vapors. Multiconductor cables in conduit shall be sealed as described in 505.16(B)(4).

Exception No. 1: Cables passing from an enclosure or room that is unclassified as a result of Type Z pressurization into a Zone 2 location shall not require a seal at the boundary.

Exception No. 2: Shielded cables and twisted pair cables shall not require the removal of the shielding material or separation of the twisted pairs, provided the termination is by an approved means to minimize the entrance of gases or vapors and prevent propagation of flame into the cable core.

(b) *Cables That Will Not Transmit Gases or Vapors.* Cables with a gas/vaportight continuous sheath and that will not transmit gases or vapors through the cable core in excess of the quantity permitted for seal fittings shall not be required to be sealed except as required in 505.16(C)(2)(a). The minimum length of such cable run shall not be less than the length that limits gas or vapor flow through the cable core to the rate permitted for seal fittings [200 cm^3/hr (0.007 ft^3/hr) of air at a pressure of 1500 pascals (6 in. of water)].

Informational Note No. 1: For further information on construction, testing, and marking requirements for conduit sealing fittings, see ANSI/UL 1203, *Explosionproof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.*

Informational Note No. 2: The cable core does not include the interstices of the conductor strands.

(c) *Cables Capable of Transmitting Gases or Vapors.* Cables with a gas/vaportight continuous sheath capable of transmitting gases or vapors through the cable core shall not be required to be sealed except as required in 505.16(C)(2)(a), unless the cable is attached to process equipment or devices that may cause a pressure in excess of 1500 pascals (6 in. of water) to be exerted at a cable end, in which case a seal, barrier, or other means shall be provided to prevent migration of flammables into an unclassified area.

Exception: Cables with an unbroken gas/vaportight continuous sheath shall be permitted to pass through a Class I, Zone 2 location without seals.

(d) *Cables Without Gas/Vaportight Continuous Sheath.* Cables that do not have gas/vaportight continuous sheath shall be sealed at the boundary of the Zone 2 and unclassified location in such a manner as to minimize the passage of gases or vapors into an unclassified location.

Informational Note: The cable sheath may be either metal or a nonmetallic material.

(D) Class I, Zones 0, 1, and 2. Where required, seals in Class I, Zones 0, 1, and 2 locations shall comply with 505.16(D)(1) through (D)(5).

(1) Fittings. Enclosures for connections or equipment shall be provided with an integral means for sealing, or sealing fittings listed for the location shall be used. Sealing fittings shall be listed for use with one or more specific compounds and shall be accessible.

(2) Compound. The compound shall provide a seal against passage of gas or vapors through the seal fitting, shall not be affected by the surrounding atmosphere or liquids, and shall not have a melting point less than 93°C (200°F).

(3) Thickness of Compounds. In a completed seal, the minimum thickness of the sealing compound shall not be less than the trade size of the sealing fitting and, in no case, less than 16 mm (5⁄8 in.).

Exception: Listed cable sealing fittings shall not be required to have a minimum thickness equal to the trade size of the fitting.

(4) Splices and Taps. Splices and taps shall not be made in fittings intended only for sealing with compound, nor shall other fittings in which splices or taps are made be filled with compound.

(5) Conductor Fill. The cross-sectional area of the conductors permitted in a seal shall not exceed 25 percent of the cross-sectional area of a rigid metal conduit of the same trade size unless it is specifically listed for a higher percentage of fill.

(E) Drainage.

(1) Control Equipment. Where there is a probability that liquid or other condensed vapor may be trapped within enclosures for control equipment or at any point in the raceway system, approved means shall be provided to prevent accumulation or to permit periodic draining of such liquid or condensed vapor.

(2) Motors and Generators. Where the authority having jurisdiction judges that there is a probability that liquid or condensed vapor may accumulate within motors or generators, joints and conduit systems shall be arranged to minimize entrance of liquid. If means to prevent accumulation or to permit periodic draining are judged necessary, such means shall be provided at the time of manufacture and shall be considered an integral part of the machine.

➤ Indicates portions of the previous NEC have been removed

505.17 Flexible Cords, Class I, Zones 1 and 2.

A flexible cord shall be permitted for connection between portable lighting equipment or other portable utilization equipment and the fixed portion of their supply circuit. Flexible cord shall also be permitted for that portion of the circuit where the fixed wiring methods of 505.15(B) cannot provide the necessary degree of movement for fixed and mobile electrical utilization equipment, in an industrial establishment where conditions of maintenance and engineering supervision ensure that only qualified persons install and service the installation, and the flexible cord is protected by location or by a suitable guard from damage. The length of the flexible cord shall be continuous. Where flexible cords are used, the cords shall comply with the following:

(1) Be of a type listed for extra-hard usage

(2) Contain, in addition to the conductors of the circuit, an equipment grounding conductor complying with 400.23

(3) Be connected to terminals or to supply conductors in an approved manner

(4) Be supported by clamps or by other suitable means in such a manner that there will be no tension on the terminal connections

(5) Be terminated with a listed cord connector that maintains the type of protection where the flexible cord enters boxes, fittings, or enclosures that are required to be explosionproof or flameproof

◆ This section was revised to require listed cord connectors that maintain the type of protection of the enclosure.

(6) Cord entering an increased safety "e" enclosure shall be terminated with a listed increased safety "e" cord connector.

Informational Note: See 400.7 for permitted uses of flexible cords.

Electric submersible pumps with means for removal without entering the wet-pit shall be considered portable utilization equipment. The extension of the flexible cord within a suitable raceway between the wet-pit and the power source shall be permitted.

Electric mixers intended for travel into and out of opentype mixing tanks or vats shall be considered portable utilization equipment.

Informational Note: See 505.18 for flexible cords exposed to liquids having a deleterious effect on the conductor insulation.

505.18 Conductors and Conductor Insulation.

(A) Conductors. For type of protection "e," field wiring conductors shall be copper. Every conductor (including spares) that enters Type "e" equipment shall be terminated at a Type "e" terminal.

(B) Conductor Insulation. Where condensed vapors or liquids may collect on, or come in contact with, the insulation on conductors, such insulation shall be of a type identified for use under such conditions, or the insulation shall be protected by a sheath of lead or by other approved means.

505.19 Uninsulated Exposed Parts.

There shall be no uninsulated exposed parts, such as electrical conductors, buses, terminals, or components that operate at more than 30 volts (15 volts in wet locations). These parts shall additionally be protected by type of protection ia, ib, or nA that is suitable for the location.

505.20 Equipment Requirements.

(A) Zone 0. In Class I, Zone 0 locations, only equipment specifically listed and marked as suitable for the location shall be permitted.

Exception: Intrinsically safe apparatus listed for use in Class I, Division 1 locations for the same gas, or as permitted by 505.9(B)(2), and with a suitable temperature class shall be permitted.

(B) Zone 1. In Class I, Zone 1 locations, only equipment specifically listed and marked as suitable for the location shall be permitted.

Exception No. 1: Equipment identified for use in Class I, Division 1 or listed for use in Zone 0 locations for the same gas, or as permitted by 505.9(B)(2), and with a suitable temperature class shall be permitted.

Exception No. 2: Equipment identified for Class I, Zone 1 or Zone 2 type of protection "p" shall be permitted.

(C) Zone 2. In Class I, Zone 2 locations, only equipment specifically listed and marked as suitable for the location shall be permitted.

Exception No. 1: Equipment listed for use in Zone 0 or Zone 1 locations for the same gas, or as permitted by 505.9(B)(2), and with a suitable temperature class, shall be permitted.

Exception No. 2: Equipment identified for Class I, Zone 1 or Zone 2 type of protection "p" shall be permitted.

Exception No. 3: Equipment identified for use in Class I, Division 1 or Division 2 locations for the same gas, or as permitted by 505.9(B)(2), and with a suitable temperature class shall be permitted.

Exception No. 4: In Class I, Zone 2 locations, the installation of open or nonexplosionproof or nonflameproof enclosed motors, such as squirrel-cage induction motors without brushes, switching mechanisms, or similar arc-producing devices that are not identified for use in a Class I, Zone 2 location shall be permitted.

Informational Note No. 1: It is important to consider the temperature of internal and external surfaces that may be exposed to the flammable atmosphere.

Informational Note No. 2: It is important to consider the risk of ignition due to currents arcing across discontinuities and overheating of parts in multisection enclosures of large motors and generators. Such motors and generators may need equipotential bonding jumpers across joints in the enclosure and from enclosure to ground. Where the presence of ignitible gases or vapors is suspected, clean air purging may be needed immediately prior to and during start-up periods.

(D) Manufacturer's Instructions. Electrical equipment installed in hazardous (classified) locations shall be installed in accordance with the instructions (if any) provided by the manufacturer.

505.21 Multiwire Branch Circuits.

In a Class I, Zone 1 location, a multiwire branch circuit shall not be permitted.

Exception: Where the disconnect device(s) for the circuit opens all ungrounded conductors of the multiwire circuit simultaneously.

505.22 Increased Safety "e" Motors and Generators.

In Class I, Zone 1 locations, Increased Safety "e" motors and generators of all voltage ratings shall be listed for Zone 1 locations, and shall comply with all of the following:

(1) Motors shall be marked with the current ratio, I_A/I_N, and time, t_E.

(2) Motors shall have controllers marked with the model or identification number, output rating (horsepower or kilowatt), full-load amperes, starting current ratio (I_A/I_N), and time (t_E) of the motors that they are intended to protect; the controller marking shall also include the specific overload protection type (and setting, if applicable) that is listed with the motor or generator.

(3) Connections shall be made with the specific terminals listed with the motor or generator.

(4) Terminal housings shall be permitted to be of substantial, nonmetallic, nonburning material, provided an internal grounding means between the motor frame and the equipment grounding connection is incorporated within the housing.

(5) The provisions of Part III of Article 430 shall apply regardless of the voltage rating of the motor.

(6) The motors shall be protected against overload by a separate overload device that is responsive to motor current. This device shall be selected to trip or shall be rated in accordance with the listing of the motor and its overload protection.

(7) Sections 430.32(C) and 430.44 shall not apply to such motors.

(8) The motor overload protection shall not be shunted or cut out during the starting period.

505.25 Grounding and Bonding.

Grounding and bonding shall comply with Article 250 and the requirements in 505.25(A) and (B).

(A) Bonding. The locknut-bushing and double-locknut types of contacts shall not be depended on for bonding purposes, but bonding jumpers with proper fittings or other approved means of bonding shall be used. Such means of bonding shall apply to all intervening raceways, fittings, boxes, enclosures, and so forth, between Class I locations and the point of grounding for service equipment or point of grounding of a separately derived system.

Exception: The specific bonding means shall be required only to the nearest point where the grounded circuit conductor and the grounding electrode are connected together on the line side of the building or structure disconnecting means as specified in 250.32(B), provided the branchcircuit overcurrent protection is located on the load side of the disconnecting means.

Informational Note: See 250.100 for additional bonding requirements in hazardous (classified) locations.

(B) Types of Equipment Grounding Conductors. Flexible metal conduit and liquidtight flexible metal conduit shall include an equipment bonding jumper of the wire type in compliance with 250.102.

Exception: In Class I, Zone 2 locations, the bonding jumper shall be permitted to be deleted where all of the following conditions are met:

(a) Listed liquidtight flexible metal conduit 1.8 m (6 ft) or less in length, with fittings listed for grounding, is used.

(b) Overcurrent protection in the circuit is limited to 10 amperes or less.

(c) The load is not a power utilization load.

◆ A requirement was added for flexible metal conduit and liquidtight flexible metal conduit to include an equipment bonding jumper of the wire type.

505.26 Process Sealing.

This section shall apply to processconnected equipment, which includes, but is not limited to, canned pumps, submersible pumps, flow, pressure, temperature, or analysis measurement instruments. A process seal is a device to prevent the migration of process fluids from the designed containment into the external electrical system. Process connected electrical equipment that incorporates a single process seal, such as a single compression seal, diaphragm, or tube to prevent flammable or combustible fluids from entering a conduit or cable system capable of transmitting fluids, shall be provided with an additional means to mitigate a single process seal failure. The additional means may include, but is not limited to the following:

(1) A suitable barrier meeting the process temperature and pressure conditions that the barrier is subjected to upon failure of the single process seal. There shall be a vent or drain between the single process seal and the suitable barrier. Indication of the single process seal failure shall be provided by visible leakage, an audible whistle, or other means of monitoring.

(2) A listed Type MI cable assembly, rated at not less than 125 percent of the process pressure and not less than 125 percent of the maximum process temperature (in degrees Celsius), installed between the cable or conduit and the single process seal.

(3) A drain or vent located between the single process seal and a conduit or cable seal. The drain or vent shall be sufficiently sized to prevent overpressuring the conduit or cable seal above 6 in. water column (1493 Pa). Indication of the single process seal failure shall be provided by visible leakage, an audible whistle, or other means of monitoring.

Process-connected electrical equipment that does not rely on a single process seal or is listed and marked "single seal" or "dual seal" shall not be required to be provided with an additional means of sealing.

Informational Note: For construction and testing requirements for process sealing for listed and marked "single seal" or "dual seal" requirements, refer to ANSI/ISA- 12.27.01-2003, Requirements for Process Sealing Between Electrical Systems and Potentially Flammable or Combustible Process Fluids.

ARTICLE 506
Zone 20, 21, and 22 Locations for Combustible Dusts or Ignitible Fibers/Flyings

Informational Note: Text that is followed by a reference in brackets has been extracted from NFPA 499-2008, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installation in Chemical Process Areas.* Only editorial changes were made to the extracted text to make it consistent with this *Code.*

506.1 Scope.

This article covers the requirements for the zone classification system as an alternative to the division classification system covered in Article 500, Article 502, and Article 503 for electrical and electronic equipment and wiring for all voltages in Zone 20, Zone 21, and Zone 22 hazardous (classified) locations where fire and explosion hazards may exist due to combustible dusts or ignitible fibers/flyings. Combustible metallic dusts are not covered by the requirements of this article.

Informational Note No. 1: For the requirements for electrical and electronic equipment and wiring for all voltages in Class I, Division 1 or Division 2; Class II, Division 1 or Division 2; Class III, Division 1 or Division 2; and Class I, Zone 0 or Zone 1 or Zone 2 hazardous (classified) locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, or combustible dusts or fibers, refer to Articles 500 through 505.

Informational Note No. 2: Zone 20, Zone 21, and Zone 22 area classifications are based on the modified IEC area classification system as defined in ANSI/ISA-61241-10 (12.10.05)- 2004, *Electrical Apparatus for Use in Zone 20, Zone 21, and Zone 22 Hazardous (Classified) Locations — Classification of Zone 20, Zone 21, and Zone 22 Hazardous (Classified) Locations.*

Informational Note No. 3: The unique hazards associated with explosives, pyrotechnics, and blasting agents are not addressed in this article.

✪ *506.1 SCOPE - Article 506 is an alternative Classification System to Class II, and Class III that is based on the International Electrotechnical Commission System (IEC). Zones 20, 21 and 22 apply to combustible dusts or ignitable fibers/flyings. Combustible metallic dusts are not covered by Article 506.*

506.2 Definitions.

For purposes of this article, the following definitions apply.

Associated Nonincendive Field Wiring Apparatus. Apparatus in which the circuits are not necessarily nonincendive themselves but that affect the energy in nonincendive field wiring circuits and are relied upon to maintain nonincendive energy levels. Associated nonincendive field wiring apparatus may be either of the following:

(1) Electrical apparatus that has an alternative type of protection for use in the appropriate hazardous (classified) location

(2) Electrical apparatus not so protected that shall not be used in a hazardous (classified) location

Informational Note: Associated nonincendive field wiring apparatus has designated associated nonincendive field wiring apparatus connections for nonincendive field wiring apparatus and may also have connections for other electrical apparatus.

Combustible Dust. Any finely divided solid material that is 420 microns (0.017 in.) or smaller in diameter (material passing a U.S. No. 40 Standard Sieve) and presents a fire or explosion hazard when dispersed and ignited in air. [**499**:3.3.3]

◆ A new definition for Combustible Dust that was extracted from NFPA 499 was made to provide consistency between area classification provisions in NFPA 499 and installation requirements in the NEC.

Dust-Ignitionproof. Equipment enclosed in a manner that excludes dusts and does not permit arcs, sparks, or heat otherwise generated or liberated inside of the enclosure to cause ignition of exterior accumulations or atmospheric suspensions of a specified dust on or in the vicinity of the enclosure.

Informational Note: For further information on dustignitionproof enclosures, see Type 9 enclosure in ANSI/NEMA 250-1991, Enclosures for Electrical Equipment, and ANSI/UL 1203-1994, Explosionproof and Dust-Ignitionproof Electrical Equipment for Hazardous (Classified) Locations.

Dusttight. Enclosures constructed so that dust will not enter under specified test conditions.

Nonincendive Circuit. A circuit, other than field wiring, in which any arc or thermal effect produced under intended operating conditions of the equipment is not capable, under specified test conditions, of igniting the flammable gas–air, vapor–air, or dust–air mixture.

Informational Note: Conditions are described in ANSI/ISA- 12.12.01-2007, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Nonincendive Equipment. Equipment having electrical/electronic circuitry that is incapable, under normal operating conditions, of causing ignition of a specified flammable gas–air, vapor–air, or dust–air mixture due to arcing or thermal means.

Informational Note: Conditions are described in ANSI/ISA- 12.12.01-2007, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Nonincendive Field Wiring. Wiring that enters or leaves an equipment enclosure and, under normal operating conditions of the equipment, is not capable, due to arcing or thermal effects, of igniting the flammable gas–air, vapor– air, or dust–air mixture. Normal operation includes opening, shorting, or grounding the field wiring.

Nonincendive Field Wiring Apparatus. Apparatus intended to be connected to nonincendive field wiring.

Informational Note: Conditions are described in ANSI/ISA- 12.12.01-2007, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Pressurized. The process of supplying an enclosure with a protective gas with or without continuous flow at sufficient pressure to prevent the entrance of combustible dust or ignitible fibers/flyings.

Informational Note: For further information, see ANSI/NFPA 496-2008, *Standard for Purged and Pressurized Enclosures for Electrical Equipment.*

Protection by Encapsulation "mD." Type of protection where electrical parts that could cause ignition of a mixture of combustible dust or fibers/flyings in air are protected by enclosing them in a compound in such a way that the explosive atmosphere cannot be ignited.

Informational Note No. 1: For additional information, see ANSI/ISA-61241-18 (12.10.07)-2006, *Electrical Apparatus for Use in Zone 20, Zone 21 and Zone 22 Hazardous (Classified) Locations — Protection by Encapsulation "mD".*

Informational Note No. 2: Encapsulation is designated level of protection "maD" for use in Zone 20 locations. Encapsulation is designated level of protection "mbD" for use in Zone 21 locations.

Protection by Enclosure "tD." Type of protection for explosive dust atmospheres where electrical apparatus is provided with an enclosure providing dust ingress protection and a means to limit surface temperatures.

Informational Note: For additional information, see ANSI/ISA-61241-0 (12.10.02)-2006, *Electrical Apparatus for Use in Zone 20, Zone 21 and Zone 22 Hazardous (Classified) Locations — General Requirement,* and ANSI/ISA-61241-1 (12.10.03)-2006, *Electrical Apparatus for Use in Zone 21 and Zone 22 Hazardous (Classified) Locations — Protection by Enclosure "tD".*

Protection by Intrinsic Safety "iD." Type of protection where any spark or thermal effect is incapable of causing ignition of a mixture of combustible dust, fibers, or flyings in air under prescribed test conditions.

Informational Note: For additional information, see ANSI/ISA-61241-11 (12.10.04), *Electrical Apparatus for Use in Zone 20, Zone 21 and Zone 22 Hazardous (Classified) Locations — Protection by Intrinsic Safety "iD."*

Protection by Pressurization "pD." Type of protection that guards against the ingress of a mixture of combustible dust or fibers/flyings in air into an enclosure containing electrical equipment by providing and maintaining a protective gas atmosphere inside the enclosure at a pressure above that of the external atmosphere.

Informational Note: For additional information, see ANSI/ISA-61241-2 (12.10.06), *Electrical Apparatus for Use in Zone 21 and Zone 22 Hazardous (Classified) Locations — Protection by Pressurization "pD."*

Zone 20 Hazardous (Classified) Location. An area where combustible dust or ignitible fibers/flyings are present continuously or for long periods of time in quantities sufficient to be hazardous, as classified by 506.5(B)(1).

Zone 21 Hazardous (Classified) Location. An area where combustible dust or ignitible fibers/flyings are likely to exist occasionally under normal operation in quantities sufficient to be hazardous, as classified by 506.5(B)(2).

Zone 22 Hazardous (Classified) Location. An area where combustible dust or ignitible fibers/flyings are not likely to occur under normal operation in quantities sufficient to be hazardous, as classified by 506.5(B)(3).

506.4 General.

(A) Documentation for Industrial Occupancies. Areas designated as hazardous (classified) locations shall be properly documented. This documentation shall be available to those authorized to design, install, inspect, maintain, or operate electrical equipment.

(B) Reference Standards. Important information relating to topics covered in Chapter 5 are found in other publications.

Informational Note: It is important that the authority having jurisdiction be familiar with the recorded industrial experience as well as with standards of the National Fire Protection Association (NFPA), the International Society of Automation (ISA), and the International Electrotechnical Commission (IEC) that may be of use in the classification of various locations, the determination of adequate ventilation, and the protection against static electricity and lightning hazards.

506.5 Classification of Locations.

(A) Classifications of Locations. Locations shall be classified on the basis of the properties of the combustible dust or ignitible fibers/flyings that may be present, and the likelihood that a combustible or combustible concentration or quantity is present. Each room, section, or area shall be considered individually in determining its classification. Where pyrophoric materials are the only materials used or handled, these locations are outside of the scope of this article.

(B) Zone 20, Zone 21, and Zone 22 Locations. Zone 20, Zone 21, and Zone 22 locations are those in which combustible dust or ignitible fibers/flyings are or may be present in the air or in layers, in quantities sufficient to produce explosive or ignitible mixtures. Zone 20, Zone 21, and Zone 22 locations shall include those specified in 506.5(B)(1), (B)(2), and (B)(3).

Informational Note: Through the exercise of ingenuity in the layout of electrical installations for hazardous (classified) locations, it is frequently possible to locate much of the equipment in a reduced level of classification and, thus, to reduce the amount of special equipment required.

(1) Zone 20. A Zone 20 location is a location in which

(a) Ignitible concentrations of combustible dust or ignitible fibers/flyings are present continuously.

(b) Ignitible concentrations of combustible dust or ignitible fibers/flyings are present for long periods of time.

Informational Note No. 1: As a guide to classification of Zone 20 locations, refer to ANSI/ISA-61241-10 (12.10.05)- 2004, *Electrical Apparatus for Use in Zone 20, Zone 21, and Zone 22 Hazardous (Classified) Locations — Classification of Zone 20, Zone 21, and Zone 22 Hazardous (Classified) Locations*.

Informational Note No. 2: Zone 20 classification includes locations inside dust containment systems; hoppers, silos, etc., cyclones and filters, dust transport systems, except some parts of belt and chain conveyors, etc.; blenders, mills, dryers, bagging equipment, etc.

(2) Zone 21. A Zone 21 location is a location

(a) In which ignitible concentrations of combustible dust or ignitible fibers/flyings are likely to exist occasionally under normal operating conditions; or

(b) In which ignitible concentrations of combustible dust or ignitible fibers/flyings may exist frequently because of repair or maintenance operations or because of leakage; or

(c) In which equipment is operated or processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitible concentrations of combustible dust or ignitible fibers/flyings and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition; or

(d) That is adjacent to a Zone 20 location from which ignitible concentrations of dust or ignitible fibers/flyings could be communicated, unless communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

Informational Note No. 1: As a guide to classification of Zone 21 locations, refer to ANSI/ISA-61241-10 (12.10.05)- 2004, *Electrical Apparatus for Use in Zone 20, Zone 21, and Zone 22 Hazardous (Classified) Locations — Classification of Zone 20, Zone 21, and Zone 22 Hazardous (Classified) Locations*.

Informational Note No. 2: This classification usually includes locations outside dust containment and in the immediate vicinity of access doors subject to frequent removal or opening for operation purposes when internal combustible mixtures are present; locations outside dust containment in the proximity of filling and emptying points, feed belts, sampling points, truck dump stations, belt dump over points, etc. where no measures are employed to prevent the formation of combustible mixtures; locations outside dust containment where dust accumulates and where due to process operations the dust layer is likely to be disturbed and form combustible mixtures; locations inside dust containment where explosive dust clouds are likely to occur (but neither continuously, nor for long periods, nor frequently) as, for example, silos (if filled and/or emptied only occasionally) and the dirty side of filters if large self-cleaning intervals are occurring.

(3) Zone 22. A Zone 22 location is a location

(a) In which ignitible concentrations of combustible dust or ignitible fibers/flyings are not likely to occur in normal operation and, if they do occur, will only persist for a short period; or

(b) In which combustible dust or fibers/flyings are handled, processed, or used but in which the dust or fibers/flyings are normally confined within closed containers of closed systems from which they can escape only as a result of the abnormal operation of the equipment with which the dust or fibers/flyings are handled, processed, or used; or

(c) That is adjacent to a Zone 21 location, from which ignitible concentrations of dust or fibers/flyings could be communicated, unless such communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

Informational Note No. 1: As a guide to classification of Zone 22 locations, refer to ANSI/ISA-61241-10 (12.10.05)- 2004, *Electrical Apparatus for Use in Zone 20, Zone 21, and Zone 22 Hazardous (Classified) Locations — Classification of Zone 20, Zone 21, and Zone 22 Hazardous (Classified) Locations*.

Informational Note No. 2: Zone 22 locations usually include outlets from bag filter vents, because in the event of a malfunction there can be emission of combustible mixtures; locations near equipment that has to be opened at infrequent intervals or equipment that from experience can easily form leaks where, due to pressure above atmospheric, dust will blow out; pneumatic equipment, flexible connections that can become damaged, etc.; storage locations for bags containing dusty product, since failure of bags can occur during handling, causing dust leakage; and locations where controllable dust layers are formed that are likely to be raised into explosive dust–air mixtures. Only if the layer is removed by cleaning before hazardous dust–air mixtures can be formed is the area designated unclassified.

Informational Note No. 3: Locations that normally are classified as Zone 21 can fall into Zone 22 when measures are employed to prevent the formation of explosive dust–air mixtures. Such measures include exhaust ventilation. The measures should be used in the vicinity of (bag) filling and emptying points, feed belts, sampling points, truck dump stations, belt dump over points, etc.

506.6 Special Precaution.

Article 506 requires equipment construction and installation that ensures safe performance under conditions of proper use and maintenance.

Informational Note: It is important that inspection authorities and users exercise more than ordinary care with regard to the installation and maintenance of electrical equipment in hazardous (classified) locations.

(A) Implementation of Zone Classification System. Classification of areas, engineering and design, selection of equipment and wiring methods, installation, and inspection shall be performed by qualified persons.

(B) Dual Classification. In instances of areas within the same facility classified separately, Zone 22 locations shall be permitted to abut, but not overlap, Class II or Class III, Division 2 locations. Zone 20 or Zone 21 locations shall not abut Class II or Class III, Division 1 or Division 2 locations.

(C) Reclassification Permitted. A Class II or Class III, Division 1 or Division 2 location shall be permitted to be reclassified as a Zone 20, Zone 21, or Zone 22 location, provided that all of the space that is classified because of a single combustible dust or ignitible fiber/flying source is reclassified under the requirements of this article.

(D) Simultaneous Presence of Flammable Gases and Combustible Dusts or Fibers/Flyings. Where flammable gases, combustible dusts, or fibers/flyings are or may be present at the same time, the simultaneous presence shall be considered during the selection and installation of the electrical equipment and the wiring methods, including the determination of the safe operating temperature of the electrical equipment.

506.8 Protection Techniques.

Acceptable protection techniques for electrical and electronic equipment in hazardous (classified) locations shall be as described in 506.8(A) through (J).

(A) Dust Ignitionproof. This protection technique shall be permitted for equipment in Zone 20, Zone 21, and Zone 22 locations for which it is identified.

(B) Pressurized. This protection technique shall be permitted for equipment in Zone 21 and Zone 22 locations for which it is identified.

(C) Intrinsic Safety. This protection technique shall be permitted for equipment in Zone 20, Zone 21, and Zone 22 locations for which it is identified. Installation of intrinsically safe apparatus and wiring shall be in accordance with the requirements of Article 504.

(D) Dusttight. This protection technique shall be permitted for equipment in Zone 22 locations for which it is identified.

(E) Protection by Encapsulation "mD". This protection technique shall be permitted for equipment in Zone 20, Zone 21, and Zone 22 locations for which it is identified.

◆ Protection by Encapsulation "mD" is now permitted for Zone 20, Zone 21, and Zone 22 locations for which it is identified.

Informational Note: See Table 506.9(C)(2)(3) for the descriptions of subdivisions for encapsulation.

◆ This informational note was added to provide information for the description of the subdivisions for encapsulation.

(F) Nonincendive Circuit. This protection technique shall be permitted for equipment in Zone 22 locations for which it is identified.

(G) Nonincendive Equipment. This protection technique shall be permitted for equipment in Zone 22 locations for which it is identified.

(H) Protection by Enclosure "tD". This protection technique shall be permitted for equipment in Zone 21 and Zone 22 locations for which it is identified.

(I) Protection by Pressurization "pD". This protection technique shall be permitted for equipment in Zone 21 and Zone 22 locations for which it is identified.

(J) Protection by Intrinsic Safety "iD". This protection technique shall be permitted for equipment in Zone 20, Zone 21, and Zone 22 locations for which it is listed.

506.9 Equipment Requirements.

(A) Suitability. Suitability of identified equipment shall be determined by one of the following:

(1) Equipment listing or labeling

(2) Evidence of equipment evaluation from a qualified testing laboratory or inspection agency concerned with product evaluation

(3) Evidence acceptable to the authority having jurisdiction such as a manufacturer's self-evaluation or an owner's engineering judgment

Informational Note: Additional documentation for equipment may include certificates demonstrating compliance with applicable equipment standards, indicating special conditions of use, and other pertinent information.

(B) Listing.

(1) Equipment that is listed for Zone 20 shall be permitted in a Zone 21 or Zone 22 location of the same dust or ignitible fiber/flying. Equipment that is listed for Zone 21 may be used in a Zone 22 location of the same dust fiber/flying.

(2) Equipment shall be permitted to be listed for a specific dust or ignitible fiber/flying or any specific combination of dusts fibers/flyings.

(C) Marking.

(1) Division Equipment. Equipment identified for Class II, Division 1 or Class II, Division 2 shall, in addition to being marked in accordance with 500.8(C), be permitted to be marked with both of the following:
(1) Zone 20, 21, or 22 (as applicable)
(2) Temperature classification in accordance with 506.9(D)

(2) Zone Equipment. Equipment meeting one or more of the protection techniques described in 506.8 shall be marked with the following in the order shown:
(1) Zone
(2) Symbol "AEx"
(3) Protection technique(s) in accordance with Table 506.9(C)(2)(3)
(4) Temperature classification, marked as a temperature value, in degrees C, preceded by T
(5) Ambient temperature marking in accordance with 506.9(D)

Informational Note: The EPL (or equipment protection level) may appear in the product marking. EPLs are designated as G for gas, D for dust, or M for mining, and are then followed by a letter (a, b, or c) to give the user a better understanding as to whether the equipment provides either (a) a "very high," (b) "high," or (c) an "enhanced" level of protection against

ignition of an explosive atmosphere. For example, an AEx pb IIIB T165°C motor (which is suitable by protection concept for application in Zone 21) may additionally be marked with an EPL of "Db", AEx p IIIB T165°C Db.

◆ This informational note was added to provide information on Equipment Protection Levels.

Table 506.9(C)(2)(3) Types of Protection Designation

Designation	Technique	Zone*
iaD	Protection by intrinsic safety	20
ia	Protection by intrinsic safety	20
ibD	Protection by intrinsic safety	21
ib	Protection by intrinsic safety	21
[iaD]	Associated apparatus	Unclassified**
[ia]	Associated apparatus	Unclassified**
[ibD]	Associated apparatus	Unclassified**
[ib]	Associated apparatus	Unclassified**
ma	D Protection by encapsulation	20
ma	Protection by encapsulation	20
mbD	Protection by encapsulation	21
mb	Protection by encapsulation	21
pD	Protection by pressurization	21
p	Protection by pressurization	21
pb	Protection by pressurization	21
tD	Protection by enclosures	21
ta	Protection by enclosures	21
tb	Protection by enclosures	21
tc	Protection by enclosures	22

*Does not address use where a combination of techniques is used.

**Associated apparatus is permitted to be installed in a hazardous (classified) location if suitably protected using another type of protection.

◆ This table was revised to include the present designations for the protection techniques for Class I, Zones 0, 1, & 2 locations.

Informational Note: The "D" suffix on the type of protection designation was employed prior to the introduction of Group IIIA, IIIB, and IIIC; which is now used to distinguish between the type of protection employed for Group II (Gases) or Group III (Dusts).

(D) Temperature Classifications. Equipment shall be marked to show the operating temperature referenced to a 40°C (104°F) ambient. Electrical equipment designed for use in the ambient temperature range between −20°C and +40°C shall require no additional ambient temperature marking. Electrical equipment that is designed for use in a range of ambient temperatures other than −20°C and +40°C is considered to be special; and the ambient temperature range shall then be marked on the equipment, including either the symbol "Ta" or "Tamb" together with the special range of ambient temperatures. As an example, such a marking might be "–30°C ≥ Ta ≤ +40°C." Electrical equipment suitable for ambient temperatures exceeding 40°C (104°F) shall be marked with both the maximum ambient temperature and the operating temperature at that ambient temperature.

Exception No. 1: Equipment of the non–heat-producing type, such as conduit fittings, shall not be required to have a marked operating temperature.

Exception No. 2: Equipment identified for Class II, Division 1 or Class II, Division 2 locations as permitted by 506.20(B) and (C) shall be permitted to be marked in accordance with 500.8(C) and Table 500.8(C).

(E) Threading. The supply connection entry thread form shall be NPT or metric. Conduit and fittings shall be made wrenchtight to prevent sparking when the fault current flows through the conduit system and to ensure the integrity of the conduit system. Equipment provided with threaded entries for field wiring connections shall be installed in accordance with 506.9(E)(1) or (E)(2) and with (E)(3).

◆ This section was revised to require entry threads to be either NPT or metric.

(1) Equipment Provided with Threaded Entries for NPT Threaded Conduit or Fittings. For equipment provided with threaded entries for NPT threaded conduit or fittings, listed conduit fittings, or cable fittings shall be used. All NPT threaded conduit and fittings referred to herein shall be threaded with a National (American) Standard Pipe Taper (NPT) thread.

Informational Note: Thread specifications for NPT threads are located in ANSI/ASME B1.20.1-1983, *Pipe Threads, General Purpose (Inch).*

(2) Equipment Provided with Threaded Entries for Metric Threaded Conduit or Fittings. For equipment with metric threaded entries, listed conduit fittings or listed cable fittings shall be used. Such entries shall be identified as being metric, or listed adapters to permit connection to conduit or NPT threaded fittings shall be provided with the equipment and shall be used for connection to conduit or NPT threaded fittings. Metric threaded entries shall be made up with at least five threads fully engaged.

◆ Equipment threaded with entries for metric threads shall use listed conduit fittings or listed cable fittings. Metric

threads shall be made up with at least five threads that are fully engaged.

(3) Unused Openings. All unused openings shall be closed with listed metal close-up plugs. The plug engagement shall comply with 506.9(E)(1) or (E)(2).

◆ All unused openings must be closed with listed metal close-up plugs with engagement that complies with the requirements specivied.

(F) Optical Fiber Cables. Where an optical fiber cable contains conductors that are capable of carrying current (composite optical fiber cable), the optical fiber cable shall be installed in accordance with the requirements of Articles 506.15 and 506.16.

506.15 Wiring Methods.

Wiring methods shall maintain the integrity of the protection techniques and shall comply with 506.15(A), (B), or (C).

(A) Zone 20. In Zone 20 locations, the following wiring methods shall be permitted.

(1) Threaded rigid metal conduit or threaded steel intermediate metal conduit.

(2) Type MI cable terminated with fittings listed for the location. Type MI cable shall be installed and supported in a manner to avoid tensile stress at the termination fittings.

Exception: MI cable and fittings listed for Class II, Division 1 locations shall be permitted to be used.

(3) In industrial establishments with limited public access, where the conditions of maintenance and supervision ensure that only qualified persons service the installation, Type MC-HL cable listed for use in Zone 20 locations, with a continuous corrugated metallic sheath, an overall jacket of suitable polymeric material, and a separate equipment grounding conductor(s) in accordance with 250.122, and terminated with fittings listed for the application, shall be permitted. Type MC-HL cable shall be installed in accordance with the provisions of Article 330, Part II.

◆ This section was revised to reference installation requirements contained in Article 330 and to require use of listed termination fittings for MC-HL cable.

Exception: Type MC-HL cable and fittings listed for Class II, Division 1 locations shall be permitted to be used.

(4) In industrial establishments with restricted public access, where the conditions of maintenance and supervision ensure that only qualified persons service the installation, and where the cable is not subject to physical damage, Type ITC-HL cable listed for use in Zone 1 or Class I, Division 1 locations, with a gas/vaportight continuous corrugated metallic sheath and an overall jacket of suitable polymeric material, and terminated with fittings listed for the application. Type ITC-HL cable shall be installed in accordance with the provisions of Article 727.

◆ Added a new requirement covering the use and installation of ITC-HL cable.

(5) Fittings and boxes shall be identified for use in Zone 20 locations.

Exception: Boxes and fittings listed for Class II, Division 1 locations shall be permitted to be used.

(6) Where necessary to employ flexible connections, liquidtight flexible metal conduit with listed fittings, liquidtight flexible nonmetallic conduit with listed fittings, or flexible cord listed for extra-hard usage and provided with listed fittings shall be used. Where flexible cords are used, they shall also comply with 506.17 and shall be terminated with a listed cord connector that maintains the type of protection of the terminal compartment. Where flexible connections are subject to oil or other corrosive conditions, the insulation of the conductors shall be of a type listed for the condition or shall be protected by means of a suitable sheath.

◆ Revised this section to require listed cord connectors that maintain the type of protection required for the terminal compartment for liquidtight flexible metal conduit an liquidtight flexible nonmetallic conduit.

Exception: Flexible conduit and flexible conduit and cord fittings listed for Class II, Division 1 locations shall be permitted to be used.

Informational Note: See 506.25 for grounding requirements where flexible conduit is used.

(B) Zone 21. In Zone 21 locations, the wiring methods in (B)(1) and (B)(2) shall be permitted.

(1) All wiring methods permitted in 506.15(A).

(2) Fittings and boxes that are dusttight, provided with threaded bosses for connection to conduit, in which taps, joints, or terminal connections are not made, and are not used in locations where metal dust is present, may be used.

(C) Zone 22. In Zone 22 locations, the following wiring methods shall be permitted.

(1) All wiring methods permitted in 506.15(B).

(2) Rigid metal conduit, intermediate metal conduit, electrical metallic tubing, dusttight wireways.

(3) Type MC or MI cable with listed termination fittings.

(4) Type PLTC and Type PLTC-ER cable in accordance with the provisions of Article 725, including installation in cable tray systems. The cable shall be terminated with listed fittings.

◆ This section was revised to require installation of PLTC-ER cable according to the provisions of Article 725 and require the cables be terminated with listed fittings.

(5) Type ITC and Type ITC-ER cable as permitted in 727.4 and terminated with listed fittings.

◆ This section was revised to require installation of ITC-ER cable according to the provisions of Article 727.4 and require the cables be terminated with listed fittings.

(6) Type MC, MI, MV, or TC cable installed in ladder, ventilated trough, or ventilated channel cable trays in a single layer, with a space not less than the larger cable diameter between two adjacent cables, shall be the wiring method employed. Single-conductor Type MV cables shall be shielded or metallic armored.

(7) Nonincendive field wiring shall be permitted using any of the wiring methods permitted for unclassified locations. Nonincendive field wiring systems shall be installed in accordance with the control drawing(s)

Simple apparatus, not shown on the control drawing, shall be permitted in a nonincendive field wiring circuit, provided the simple apparatus does not interconnect the nonincendive field wiring circuit to any other circuit.

Informational Note: *Simple apparatus* is defined in 504.2.

Separation of nonincendive field wiring circuits shall be in accordance with one of the following:

a. Be in separate cables

b. Be in multiconductor cables where the conductors of each circuit are within a grounded metal shield

c. Be in multiconductor cables where the conductors have insulation with a minimum thickness of 0.25 mm (0.01 in.)

(8) Boxes and fittings shall be dusttight.

506.16 Sealing.

Where necessary to protect the ingress of combustible dust or ignitible fibers/flyings, or to maintain the type of protection, seals shall be provided. The seal shall be identified as capable of preventing the ingress of combustible dust or ignitible fibers/flyings and maintaining the type of protection but need not be explosionproof or flameproof.

506.17 Flexible Cords.

Flexible cords used in Zone 20, Zone 21, and Zone 22 locations shall comply with all of the following:

(1) Be of a type listed for extra-hard usage

(2) Contain, in addition to the conductors of the circuit, an equipment grounding conductor complying with 400.23

(3) Be connected to terminals or to supply conductors in an approved manner

(4) Be supported by clamps or by other suitable means in such a manner to minimize tension on the terminal connections

(5) Be terminated with a listed cord connector that maintains the protection technique of the terminal compartment

506.20 Equipment Installation.

◆ This section was revised to require listed cord connectors that must maintain the same type of protection as the terminal compartment.

(A) Zone 20. In Zone 20 locations, only equipment listed and marked as suitable for the location shall be permitted.

Exception: Equipment listed for use in Class II, Division 1 locations with a suitable temperature class shall be permitted.

(B) Zone 21. In Zone 21 locations, only equipment listed and marked as suitable for the location shall be permitted.

Exception No. 1: Apparatus listed for use in Class II, Division 1 locations with a suitable temperature class shall be permitted.

Exception No. 2: Pressurized equipment identified for Class II, Division 1 shall be permitted.

(C) Zone 22. In Zone 22 locations, only equipment listed and marked as suitable for the location shall be permitted.

Exception No. 1: Apparatus listed for use in Class II, Division 1 or Class II, Division 2 locations with a suitable temperature class shall be permitted.

Exception No. 2: Pressurized equipment identified for Class II, Division 1 or Division 2 shall be permitted.

(D) Manufacturer's Instructions. Electrical equipment installed in hazardous (classified) locations shall be installed in accordance with the instructions (if any) provided by the manufacturer.

(E) Temperature. The temperature marking specified in 506.9(C)(2)(5) shall comply with (E)(1) or (E)(2):

(1) For combustible dusts, less than the lower of either the layer or cloud ignition temperature of the specific combustible dust. For organic dusts that may dehydrate or carbonize, the temperature marking shall not exceed the lower of either the ignition temperature or 165°C (329°F).

(2) For ignitible fibers/flyings, less than 165°C (329°F) for equipment that is not subject to overloading, or 120°C (248°F) for equipment (such as motors or power transformers) that may be overloaded.

Informational Note: See NFPA 499-2008, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Processing Areas*, for minimum ignition temperatures of specific dusts.

506.21 Multiwire Branch Circuits.

In Zone 20 and Zone 21 locations, a multiwire branch circuit shall not be permitted.

Exception: Where the disconnect device(s) for the circuit opens all ungrounded conductors of the multiwire circuit simultaneously.

506.25 Grounding and Bonding.

Grounding and bonding shall comply with Article 250 and the requirements in 506.25(A) and (B).

(A) Bonding. The locknut-bushing and double-locknut types of contacts shall not be depended on for bonding purposes, but bonding jumpers with proper fittings or other approved means of bonding shall be used. Such means of bonding shall apply to all intervening raceways, fittings, boxes, enclosures, and so forth, between Zone 20, Zone 21, and Zone 22 locations and the point of grounding for service equipment or point of grounding of a separately derived system.

Exception: The specific bonding means shall be required only to the nearest point where the grounded circuit conductor and the grounding electrode conductor are connected together on the line side of the building or structure disconnecting means as specified in 250.32(B) if the branch side overcurrent protection is located on the load side of the disconnecting means.

Informational Note: See 250.100 for additional bonding requirements in hazardous (classified) locations.

(B) Types of Equipment Grounding Conductors. Liquidtight flexible metal conduit shall include an equipment bonding jumper of the wire type in compliance with 250.102.

◆ Liquidtight flexible metal conduit must include a wire-type equipment bonding jumper.

Exception: In Zone 22 locations, the bonding jumper shall be permitted to be deleted where all of the following conditions are met:

(1) Listed liquidtight flexible metal conduit 1.8 m (6 ft) or less in length, with fittings listed for grounding, is used.

(2) Overcurrent protection in the circuit is limited to 10 amperes or less.

(3) The load is not a power utilization load.

ARTICLE 510
Hazardous (Classified) Locations — Specific

510.1 Scope.

Articles 511 through 517 cover occupancies or parts of occupancies that are or may be hazardous because of atmospheric concentrations of flammable liquids, gases, or vapors, or because of deposits or accumulations of materials that may be readily ignitible.

510.2 General.

The general rules of this Code and the provisions of Articles 500 through 504 shall apply to electrical wiring and equipment in occupancies within the scope of Articles 511 through 517, except as such rules are modified in Articles 511 through 517. Where unusual conditions exist in a specific occupancy, the authority having jurisdiction shall judge with respect to the application of specific rules.

✪ *510.2 GENERAL - The second sentence of Section 510-2 provides the authority having jurisdiction with authorization to apply additional rules or exemptsome installations from specific rules in the Code where unusual conditions exist. This specific rule was invoked when overhead gasoline dispensing systems were first introduced, and again when vapor recovery systems were introduced, both before there were any rules covering such installations in either NFPA 30A or Article 514 of the National Electrical Code®. The major oil companies helped the authorities having jurisdiction for enforcement of the Code in developing the additional requirements needed for these new installations.*

ARTICLE 511
Commercial Garages, Repair and Storage

Informational Note: Text that is followed by a reference in brackets has been extracted from NFPA 30A-2008, *Code for Motor Fuel Dispensing Facilities and Repair Garages.* Only editorial changes were made to the extracted text to make it consistent with this *Code.*

511.1 Scope.

These occupancies shall include locations used for service and repair operations in connection with self-propelled vehicles (including, but not limited to, passenger automobiles, buses, trucks, and tractors) in which volatile flammable liquids or flammable gases are used for fuel or power.

✪ *511.1 SCOPE - Garages are defined in Article 100 as buildings or portions of buildings in which one or more self-propelled vehicles carrying volatile flammable liquid for fuel or power are kept for use, sale, storage, rental, repair, exhibition, or demonstration purposes. The definition does not include those buildings or parts of buildings in which motorboats, outboard motors, and small gasoline motors used to power lawn mowers, etc. are repaired. Marinas are covered in a separate NFPA standard. Other locations where small motors are repaired should be judged under the requirements of Article 500 and 501, as the requirements of Article 511 are not based on repair facilities for such equipment. This does not mean that Article 511 should not be used as a guide, however.*

511.2 Definitions.

Major Repair Garage. A building or portions of a building where major repairs, such as engine overhauls, painting, body and fender work, and repairs that require draining of the motor vehicle fuel tank are performed on motor vehicles, including associated floor space used for offices, parking, or showrooms. [**30A**:3.3.12.1]

Minor Repair Garage. A building or portions of a building used for lubrication, inspection, and minor automotive maintenance work, such as engine tune-ups, replacement of parts, fluid changes (e.g., oil, antifreeze, transmission fluid, brake fluid, air-conditioning refrigerants), brake system repairs, tire rotation, and similar routine maintenance work, including associated floor space used for offices, parking, or showrooms. [**30A**:3.3.12.2]

511.3 Area Classification, General.

Where Class I liquids or gaseous fuels are stored, handled, or transferred, electrical wiring and electrical utilization equipment shall be designed in accordance with the requirements for Class I, Division 1 or 2 hazardous (classified) locations as classified in accordance with 500.5 and 500.6, and this article. A Class I location shall not extend beyond an unpierced wall, roof, or other solid partition that has no openings. [**30A**:8.3.5, 8.3.2]

(A) Parking Garages. Parking garages used for parking or storage shall be permitted to be unclassified.

Informational Note: For further information, see NFPA 88A- 2011, *Standard for Parking Structures,* and NFPA 30A-2008, *Code for Motor Fuel Dispensing Facilities and Repair Garages.*

(B) Repair Garages, With Dispensing. Major and minor repair garages that dispense motor fuels into the fuel tanks of vehicles, including flammable liquids having a flash point below 38°C (100°F) such as gasoline, or gaseous fuels such as natural gas, hydrogen, or LPG, shall have the dispensing functions and components classified in accordance with Table 514.3(B)(1) in addition to any classification required by this section. Where Class I liquids, other than fuels, are dispensed, the area within 900 mm (3 ft) of any fill or dispensing point, extending in all directions, shall be a Class I, Division 2 location.

(C) Major Repair Garages. Where flammable liquids having a flash point below 38°C (100°F) such as gasoline, or gaseous fuels such as natural gas, hydrogen, or LPG, will not be dispensed, but repair activities that involve the transfer of such fluids or gases are performed, the classification rules in (1), (2), and (3) shall apply.

(1) Floor Areas.

(a) *Ventilation Provided.* The floor area shall be unclassified where there is mechanical ventilation providing a minimum of four air changes per hour or 0.3 m^3/min/m^2 (1 cfm/ft^2) of exchanged air for each square meter (foot) of floor area. Ventilation shall provide for air exchange across the entire floor area, and exhaust air shall be taken at a point within 0.3 m (12 in.) of the floor.

(b) *Ventilation Not Provided.* The entire floor area up to a level of 450 mm (18 in.) above the floor shall be classified as Class I, Division 2 if the ventilation does not comply with 511.3(C)(1)(a).

(2) Ceiling Areas. Where lighter-than-air gaseous fueled vehicles, such as vehicles fueled by natural gas or hydrogen, are repaired or stored, the area within 450 mm (18 in.) of the ceiling shall be considered for classification in accordance with (a) and (b).

(a) *Ventilation Provided.* The ceiling area shall be unclassified where ventilation is provided, from a point not more than 450 mm (18 in.) from the highest point in the ceiling, to exhaust the ceiling area at a rate of not less than 0.3 m^3/min/m^2 (1 cfm/ft^2) of ceiling area at all times that the building is occupied or when vehicles using lighterthan- air gaseous fuels are parked below this area.

◆ The requirement was changed from “not less than 18 in.” to “not more than 18.”

(b) *Ventilation Not Provided.* Ceiling areas that are not ventilated in accordance with 511.3(C)(2)(a) shall be classified as Class I, Division 2.

(3) Pit Areas in Lubrication or Service Room. Any pit, belowgrade work area, or subfloor work area shall be classified as provided in (a) or (b).

(a) *Ventilation Provided.* The pit area shall be a Class I, Division 2 location where there is mechanical ventilation providing a minimum of six air changes per hour.

(b) *Ventilation Not Provided.* Where ventilation is not provided in accordance with 511.3(C)(3)(a), any pit or depression below floor level shall be a Class I, Division 1 location that extends up to the floor level.

(D) Minor Repair Garages. Where flammable liquids having a flash point below 38°C (100°F) such as gasoline, or gaseous fuels such as natural gas or hydrogen, will not be dispensed or transferred, the classification rules in (D)(1), (D)(2), and (D)(3) shall apply to the lubrication and service rooms.

(1) Floor Areas. Floor areas in minor repair garages without pits, belowgrade work areas, or subfloor work areas shall be unclassified. Where floor areas include pits, belowgrade work areas, or subfloor work areas in lubrication or service rooms, the classification rules in (a) or (b) shall apply.

(a) *Ventilation Provided.* The entire floor area shall be unclassified where there is mechanical ventilation providing a minimum of four air changes per hour or 0.3 $m^3/min/m^2$ (1 cfm/ft^2) of exchanged air for each square meter (foot) of floor area. Ventilation shall provide for air exchange across the entire floor area, and exhaust air shall be taken at a point within 0.3 m (12 in.) of the floor.

(b) *Ventilation Not Provided.* The floor area up to a level of 450 mm (18 in.) above any unventilated pit, belowgrade work area, or subfloor work area and extending a distance of 900 mm (3 ft) horizontally from the edge of any such pit, belowgrade work area, or subfloor work area, shall be classified as Class I, Division 2.

(2) Ceiling Areas. Where lighter-than-air gaseous fuels (such as natural gas or hydrogen) will not be transferred, such locations shall be unclassified.

(3) Pit Areas in Lubrication or Service Room. Any pit, belowgrade work area, or subfloor work area shall be classified as provided in (a) or (b).

(a) *Ventilation Provided.* Where ventilation is provided to exhaust the pit area at a rate of not less than 0.3 $m^3/min/m^2$ (1 cfm/ft^2) of floor area at all times that the building is occupied, or when vehicles are parked in or over this area and where exhaust air is taken from a point within 300 mm (12 in.) of the floor of the pit, belowgrade work area, or subfloor work area, the pit shall be unclassified. [**30A**:7.4.5.4. Table 8.3.1]

(b) *Ventilation Not Provided.* Where ventilation is not provided in accordance with 511.3(D)(3)(a), any pit or depression below floor level shall be a Class I, Division 2 location that extends up to the floor level.

(E) Modifications to Classification.

(1) Specific Areas Adjacent to Classified Locations. Areas adjacent to classified locations in which flammable vapors are not likely to be released, such as stock rooms, switchboard rooms, and other similar locations, shall be unclassified where mechanically ventilated at a rate of four or more air changes per hour, or designed with positive air pressure, or where effectively cut off by walls or partitions.

(2) Alcohol-Based Windshield Washer Fluid. The area used for storage, handling, or dispensing into motor vehicles of alcohol-based windshield washer fluid in repair garages shall be unclassified unless otherwise classified by a provision of 511.3. [**30A**:8.3.5, Exception]

511.4 Wiring and Equipment in Class I Locations.

(A) Wiring Located in Class I Locations. Within Class I locations as classified in 511.3, wiring shall conform to applicable provisions of Article 501.

(B) Equipment Located in Class I Locations. Within Class I locations as defined in 511.3, equipment shall conform to applicable provisions of Article 501.

(1) Fuel-Dispensing Units. Where fuel-dispensing units (other than liquid petroleum gas, which is prohibited) are located within buildings, the requirements of Article 514 shall govern.

Where mechanical ventilation is provided in the dispensing area, the control shall be interlocked so that the dispenser cannot operate without ventilation, as prescribed in 500.5(B)(2).

(2) Portable Lighting Equipment. Portable lighting equipment shall be equipped with handle, lampholder, hook, and substantial guard attached to the lampholder or handle. All exterior surfaces that might come in contact with battery terminals, wiring terminals, or other objects shall be of nonconducting material or shall be effectively protected with insulation. Lampholders shall be of an unswitched type and shall not provide means for plug-in of attachment plugs. The outer shell shall be of molded composition or other suitable material. Unless the lamp and its cord are supported or arranged in such a manner that they cannot be used in the locations classified in 511.3, they shall be of a type identified for Class I, Division 1 locations.

511.7 Wiring and Equipment Installed Above Class I Locations.

(A) Wiring in Spaces Above Class I Locations.

(1) Fixed Wiring Above Class I Locations. All fixed wiring above Class I locations shall be in metal raceways, rigid nonmetallic conduit, electrical nonmetallic tubing, flexible metal conduit, liquidtight flexible metal conduit, or liquidtight flexible nonmetallic conduit, or shall be Type MC, AC, MI,

manufactured wiring systems, or PLTC cable in accordance with Article 725, or Type TC cable or Type ITC cable in accordance with Article 727. Cellular metal floor raceways or cellular concrete floor raceways shall be permitted to be used only for supplying ceiling outlets or extensions to the area below the floor, but such raceways shall have no connections leading into or through any Class I location above the floor.

(2) Pendant. For pendants, flexible cord suitable for the type of service and listed for hard usage shall be used.

(B) Electrical Equipment Installed Above Class I Locations.

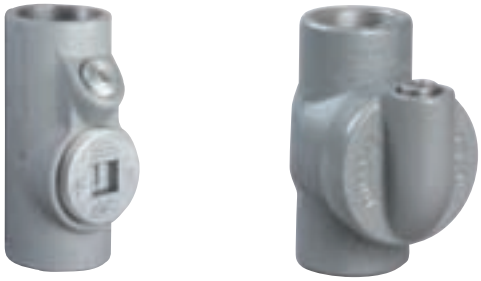
(1) Fixed Electrical Equipment. Electrical equipment in a fixed position shall be located above the level of any defined Class I location or shall be identified for the location.

(a) *Arcing Equipment.* Equipment that is less than 3.7 m (12 ft) above the floor level and that may produce arcs, sparks, or particles of hot metal, such as cutouts, switches, charging panels, generators, motors, or other equipment (excluding receptacles, lamps, and lampholders) having make-and-break or sliding contacts, shall be of the totally enclosed type or constructed so as to prevent the escape of sparks or hot metal particles.

(b) *Fixed Lighting.* Lamps and lampholders for fixed lighting that is located over lanes through which vehicles are commonly driven or that may otherwise be exposed to physical damage shall be located not less than 3.7 m (12 ft) above floor level, unless of the totally enclosed type or constructed so as to prevent escape of sparks or hot metal particles.

511.9 Sealing.

Seals complying with the requirements of 501.15 and 501.15(B)(2) shall be provided and shall apply to horizontal as well as vertical boundaries of the defined Class I locations.



Sealing Fittings for Verticle or Horizontal Conduit

Sealing Fittings for Verticle Conduit Only, Shown With and W/O Drain

511.10 Special Equipment.

(A) Battery Charging Equipment. Battery chargers and their control equipment, and batteries being charged, shall not be located within locations classified in 511.3.

(B) Electric Vehicle Charging Equipment.

(1) General. All electrical equipment and wiring shall be installed in accordance with Article 625, except as noted in 511.10(B)(2) and (B)(3). Flexible cords shall be of a type identified for extra-hard usage.

(2) Connector Location. No connector shall be located within a Class I location as defined in 511.3.

(3) Plug Connections to Vehicles. Where the cord is suspended from overhead, it shall be arranged so that the lowest point of sag is at least 150 mm (6 in.) above the floor. Where an automatic arrangement is provided to pull both cord and plug beyond the range of physical damage, no additional connector shall be required in the cable or at the outlet.

511.12 Ground-Fault Circuit-Interrupter Protection for Personnel.

All 125-volt, single-phase, 15- and 20-ampere receptacles installed in areas where electrical diagnostic equipment, electrical hand tools, or portable lighting equipment are to be used shall have ground-fault circuit-interrupter protection for personnel.

511.16 Grounding and Bonding Requirements.

(A) General Grounding Requirements. All metal raceways, the metal armor or metallic sheath on cables, and all non–current-carrying metal parts of fixed or portable electrical equipment, regardless of voltage, shall be grounded.

(B) Supplying Circuits with Grounded and Grounding Conductors in Class I Locations. Grounding in Class I locations shall comply with 501.30.

(1) Circuits Supplying Portable Equipment or Pendants. Where a circuit supplies portables or pendants and includes a grounded conductor as provided in Article 200, receptacles, attachment plugs, connectors, and similar devices shall be of the grounding type, and the grounded conductor of the flexible cord shall be connected to the screw shell of any lampholder or to the grounded terminal of any utilization equipment supplied.

(2) Approved Means. Approved means shall be provided for maintaining continuity of the equipment grounding conductor between the fixed wiring system and the non– current-carrying metal portions of pendant luminaires, portable luminaires, and portable utilization equipment.

ARTICLE 513
Aircraft Hangars

513.1 Scope.

This article shall apply to buildings or structures in any part of which aircraft containing Class I (flammable) liquids or Class II (combustible) liquids whose temperatures are above their flash points are housed or stored and in which aircraft might undergo service, repairs, or alterations. It shall not apply to locations used exclusively for aircraft that have never contained fuel or unfueled aircraft.

Informational Note No. 1: For definitions of aircraft hangar and unfueled aircraft, see NFPA 409-2011, *Standard on Aircraft Hangars.*

Informational Note No. 2: For further information on fuel classification see NFPA 30-2008, *Flammable and Combustible Liquids Code.*

✪ *513.1 SCOPE - If a building is used only for aircraft that have never been fueled, it is not considered a hanger and is not within the scope of Article 513. Such a location would include some parts of aircraft manufacturing plants. Also, if the fuel tanks have been drained and purged, so that there is no flammable gas or liquid present, the building is not considered a hanger as far as the rules in Article 513 are concerned.*

513.2 Definitions.

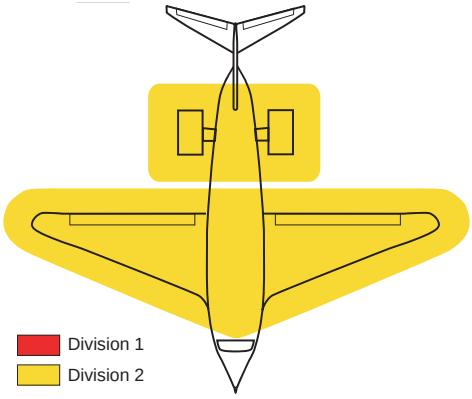
For the purpose of this article, the following definitions shall apply.

Aircraft Painting Hangar. An aircraft hangar constructed for the express purpose of spray/coating/dipping applications and provided with dedicated ventilation supply and exhaust.

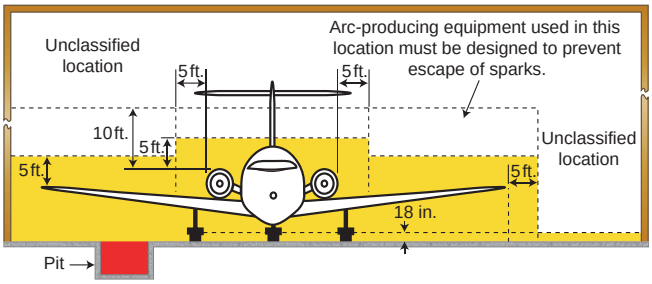
Mobile Equipment. Equipment with electrical components suitable to be moved only with mechanical aids or is provided with wheels for movement by person(s) or powered devices.

Portable Equipment. Equipment with electrical components suitable to be moved by a single person without mechanical aids.

513.3 Classification of Locations.



Division 1 and 2 Space in Vicinity of Aircraft in Hanger



Division 1 and 2 Space in Vicinity of Aircraft in Hanger

(A) Below Floor Level. Any pit or depression below the level of the hangar floor shall be classified as a Class I, Division 1 or Zone 1 location that shall extend up to said floor level.

(B) Areas Not Cut Off or Ventilated. The entire area of the hangar, including any adjacent and communicating areas not suitably cut off from the hangar, shall be classified as a Class I, Division 2 or Zone 2 location up to a level 450 mm (18 in.) above the floor.

(C) Vicinity of Aircraft.

(1) Aircraft Maintenance and Storage Hangars. The area within 1.5 m (5 ft) horizontally from aircraft power plants or aircraft fuel tanks shall be classified as a Class I, Division 2 or Zone 2 location that shall extend upward from the floor to a level 1.5 m (5 ft) above the upper surface of wings and of engine enclosures.

(2) Aircraft Painting Hangars. The area within 3 m (10 ft) horizontally from aircraft surfaces from the floor to 3 m (10 ft) above the aircraft shall be classified as Class I, Division 1 or Class I, Zone 1. The area horizontally from aircraft surfaces between 3.0 m (10 ft) and 9.0 m (30 ft) from the floor to 9.0 m (30 ft) above the aircraft surface shall be classified as Class I, Division 2 or Class I, Zone 2.

Informational Note: See NFPA 33-2011, *Standard for Spray Application Using Flammable or Combustible Materials*, for information on ventilation and grounding for static protection in spray painting areas.

(D) Areas Suitably Cut Off and Ventilated. Adjacent areas in which flammable liquids or vapors are not likely to be released, such as stock rooms, electrical control rooms, and other similar locations, shall be unclassified where adequately ventilated and where effectively cut off from the hangar itself by walls or partitions.

513.4 Wiring and Equipment in Class I Locations.

(A) General. All wiring and equipment that is or may be installed or operated within any of the Class I locations defined in 513.3 shall comply with the applicable provisions of Article 501 or Article 505 for the division or zone in which they are used.

Attachment plugs and receptacles in Class I locations shall be identified for Class I locations or shall be designed such that they cannot be energized while the connections are being made or broken.

(B) Stanchions, Rostrums, and Docks. Electrical wiring, outlets, and equipment (including lamps) on or attached to stanchions, rostrums, or docks that are located or likely to be located in a Class I location, as defined in 513.3(C), shall comply with the applicable provisions of Article 501 or Article 505 for the division or zone in which they are used.

513.7 Wiring and Equipment Not Installed in Class I Locations.

(A) Fixed Wiring. All fixed wiring in a hangar but not installed in a Class I location as classified in 513.3 shall be installed in metal raceways or shall be Type MI, TC, or MC cable.

Exception: Wiring in unclassified locations, as described in 513.3(D), shall be permitted to be any suitable type wiring method recognized in Chapter 3.

(B) Pendants. For pendants, flexible cord suitable for the type of service and identified for hard usage or extra-hard usage shall be used. Each such cord shall include a separate equipment grounding conductor.

(C) Arcing Equipment. In locations above those described in 513.3, equipment that is less than 3.0 m (10 ft) above wings and engine enclosures of aircraft and that may produce arcs, sparks, or particles of hot metal, such as lamps and lampholders for fixed lighting, cutouts, switches, receptacles, charging panels, generators, motors, or other equipment having make-and- break or sliding contacts, shall be of the totally enclosed type or constructed so as to prevent the escape of sparks or hot metal particles.

Exception: Equipment in areas described in 513.3(D) shall be permitted to be of the general-purpose type.

(D) Lampholders. Lampholders of metal-shell, fiber-lined types shall not be used for fixed incandescent lighting.

(E) Stanchions, Rostrums, or Docks. Where stanchions, rostrums, or docks are not located or likely to be located in a Class I location, as defined in 513.3(C), wiring and equipment shall comply with 513.7, except that such wiring and equipment not more than 457 mm (18 in.) above the floor in any position shall comply with 513.4(B). Receptacles and attachment plugs shall be of a locking type that will not readily disconnect.

(F) Mobile Stanchions. Mobile stanchions with electrical equipment complying with 513.7(E) shall carry at least one permanently affixed warning sign with the following words or equivalent:

WARNING
KEEP 5 FT CLEAR OF AIRCRAFT
ENGINES AND FUEL TANK AREAS

or

WARNING
KEEP 1.5 METERS CLEAR OF AIRCRAFT
ENGINES AND FUEL TANK AREAS

513.8 Underground Wiring.

(A) Wiring and Equipment Embedded, Under Slab, or Underground. All wiring installed in or under the hangar floor shall comply with the requirements for Class I, Division 1 locations. Where such wiring is located in vaults, pits, or ducts, adequate drainage shall be provided.

(B) Uninterrupted Raceways, Embedded, Under Slab, or Underground. Uninterrupted raceways that are embedded in a hangar floor or buried beneath the hangar floor shall be considered to be within the Class I location above the floor, regardless of the point at which the raceway descends below or rises above the floor.

513.9 Sealing.

Seals shall be provided in accordance with 501.15 or 505.16, as applicable. Sealing requirements specified shall apply to horizontal as well as to vertical boundaries of the defined Class I locations.

513.10 Special Equipment.

(A) Aircraft Electrical Systems.

(1) De-energizing Aircraft Electrical Systems. Aircraft electrical systems shall be de-energized when the aircraft is stored in a hangar and, whenever possible, while the aircraft is undergoing maintenance.

(2) Aircraft Batteries. Aircraft batteries shall not be charged where installed in an aircraft located inside or partially inside a hangar.

(B) Aircraft Battery Charging and Equipment. Battery chargers and their control equipment shall not be located or operated within any of the Class I locations defined in 513.3 and shall preferably be located in a separate building or in an area such as defined in 513.3(D). Mobile chargers shall carry at least one permanently affixed warning sign with the following words or equivalent:

WARNING
KEEP 5 FT CLEAR OF AIRCRAFT ENGINES
AND FUEL TANK AREAS

or

WARNING
KEEP 1.5 METERS CLEAR OF AIRCRAFT
ENGINES AND FUEL TANK AREAS

Tables, racks, trays, and wiring shall not be located within a Class I location and, in addition, shall comply with Article 480.

(C) External Power Sources for Energizing Aircraft.

(1) Not Less Than 450 mm (18 in.) Above Floor. Aircraft energizers shall be designed and mounted such that all electrical equipment and fixed wiring will be at least 450 mm (18 in.) above floor level and shall not be operated in a Class I location as defined in 513.3(C).

(2) Marking for Mobile Units. Mobile energizers shall carry at least one permanently affixed warning sign with the following words or equivalent:

WARNING
KEEP 5 FT CLEAR OF AIRCRAFT ENGINES
AND FUEL TANK AREAS
or
WARNING
KEEP 1.5 METERS CLEAR OF AIRCRAFT
ENGINES AND FUEL TANK AREAS

(3) Cords. Flexible cords for aircraft energizers and ground support equipment shall be identified for the type of service and extra-hard usage and shall include an equipment grounding conductor.

(D) Mobile Servicing Equipment with Electrical Components.

(1) General. Mobile servicing equipment (such as vacuum cleaners, air compressors, air movers) having electrical wiring and equipment not suitable for Class I, Division 2 or Zone 2 locations shall be so designed and mounted that all such fixed wiring and equipment will be at least 450 mm (18 in.) above the floor. Such mobile equipment shall not be operated within the Class I location defined in 513.3(C) and shall carry at least one permanently affixed warning sign with the following words or equivalent:

WARNING
KEEP 5 FT CLEAR OF AIRCRAFT ENGINES
AND FUEL TANK AREAS
or
WARNING
KEEP 1.5 METERS CLEAR OF AIRCRAFT
ENGINES AND FUEL TANK AREAS

(2) Cords and Connectors. Flexible cords for mobile equipment shall be suitable for the type of service and identified for extra-hard usage and shall include an equipment grounding conductor. Attachment plugs and receptacles shall be identified for the location in which they are installed and shall provide for connection of the equipment grounding conductor.

(3) Restricted Use. Equipment that is not identified as suitable for Class I, Division 2 locations shall not be operated in locations where maintenance operations likely to release flammable liquids or vapors are in progress.

(E) Portable Equipment.

(1) Portable Lighting Equipment. Portable lighting equipment that is used within a hangar shall be identified for the location in which they are used. For portable luminaires, flexible cord suitable for the type of service and identified for extra-hard usage shall be used. Each such cord shall include a separate equipment grounding conductor.

(2) Portable Utilization Equipment. Portable utilization equipment that is or may be used within a hangar shall be of a type suitable for use in Class I, Division 2 or Zone 2 locations. For portable utilization equipment, flexible cord suitable for the type of service and approved for extra-hard usage shall be used. Each such cord shall include a separate equipment grounding conductor.

513.12 Ground-Fault Circuit-Interrupter Protection for Personnel.

All 125-volt, 50/60-Hz, single-phase, 15– and 20- ampere receptacles installed in areas where electrical diagnostic equipment, electrical hand tools, or portable lighting equipment are to be used shall have ground-fault circuit-interrupter protection for personnel.

513.16 Grounding and Bonding Requirements.

(A) General Grounding Requirements. All metal raceways, the metal armor or metallic sheath on cables, and all non–current-carrying metal parts of fixed or portable electrical equipment, regardless of voltage, shall be grounded. Grounding in Class I locations shall comply with 501.30 for Class I, Division 1 and 2 locations and 505.25 for Class I, Zone 0, 1, and 2 locations.

(B) Supplying Circuits with Grounded and Grounding Conductors in Class I Locations.

(1) Circuits Supplying Portable Equipment or Pendants. Where a circuit supplies portables or pendants and includes a grounded conductor as provided in Article 200, receptacles, attachment plugs, connectors, and similar devices shall be of the grounding type, and the grounded conductor of the flexible cord shall be connected to the screw shell of any lampholder or to the grounded terminal of any utilization equipment supplied.

(2) Approved Means. Approved means shall be provided for maintaining continuity of the grounding conductor between the fixed wiring system and the non–current-carrying metal portions of pendant luminaires, portable luminaires, and portable utilization equipment.

ARTICLE 514
Motor Fuel Dispensing Facilities

Informational Note: Text that is followed by a reference in brackets has been extracted from NFPA 30A-2008, *Code for Motor Fuel Dispensing Facilities and Repair Garages.* Only editorial changes were made to the extracted text to make it consistent with this *Code.*

514.1 Scope.

This article shall apply to motor fuel dispensing facilities, marine/motor fuel dispensing facilities, motor fuel dispensing facilities located inside buildings, and fleet vehicle motor fuel dispensing facilities.

Class I, Gasoline and Diesel Fuel Dispensing

Class I, Propane Dispensing

Informational Note: For further information regarding safeguards for motor fuel dispensing facilities, see NFPA 30A-2008, *Code for Motor Fuel Dispensing Facilities and Repair Garages.*

514.2 Definition.

Motor Fuel Dispensing Facility. That portion of a property where motor fuels are stored and dispensed from fixed equipment into the fuel tanks of motor vehicles or marine craft or into approved containers, including all equipment used in connection therewith. [**30A**:3.3.11]

Informational Note: Refer to Articles 510 and 511 with respect to electrical wiring and equipment for other areas used as lubritoriums, service rooms, repair rooms, offices, salesrooms, compressor rooms, and similar locations.

514.3 Classification of Locations.

(A) Unclassified Locations. Where the authority having jurisdiction can satisfactorily determine that flammable liquids having a flash point below 38°C (100°F), such as gasoline, will not be handled, such location shall not be required to be classified.

(B) Classified Locations.

(1) Class I Locations. Table 514.3(B)(1) shall be applied where Class I liquids are stored, handled, or dispensed and shall be used to delineate and classify motor fuel dispensing facilities and commercial garages as defined in Article 511. Table 515.3 shall be used for the purpose of delineating and classifying aboveground tanks. A Class I location shall not extend beyond an unpierced wall, roof, or other solid partition. [**30A**:8.1, 8.3]

(2) Compressed Natural Gas, Liquefied Natural Gas, and Liquefied Petroleum Gas Areas. Table 514.3(B)(2) shall be used to delineate and classify areas where compressed natural gas (CNG), liquefied natural gas (LNG), or liquefied petroleum gas (LPG) is stored, handled, or dispensed. Where CNG or LNG dispensers are installed beneath a canopy or enclosure, either the canopy or the enclosure shall be designed to prevent accumulation or entrapment of ignitible vapors, or all electrical equipment installed beneath the canopy or enclosure shall be suitable for Class I, Division 2 hazardous (classified) locations. Dispensing devices for liquefied petroleum gas shall be located not less than 1.5 m (5 ft) from any dispensing device for Class I liquids. [**30A**:12.1, 12.4, 12.5]

Informational Note No. 1: For information on area classification where liquefied petroleum gases are dispensed, see NFPA 58-2011, *Liquefied Petroleum Gas Code.*

Informational Note No. 2: For information on classified areas pertaining to LP-Gas systems other than residential or commercial, see NFPA 58-2011, *Liquefied Petroleum Gas Code*, and NFPA 59-2008, *Utility LP-Gas Plant Code.*

Informational Note No. 3: See 555.21 for motor fuel dispensing stations in marinas and boatyards.

Table 514.3(B)(1) Class I Locations — Motor Fuel Dispensing Facilities

Location	Division (Group D)	Zone (Group IIA)	Extent of Classified Location[1]
Dispensing Device (except Overhead Type) [2,3]			
Under dispenser containment	1	1	Entire space within and under dispenser pit or containment
Dispenser	2	2	Within 450 mm (18 in.) of dispenser enclosure or that portion of dispenser enclosure containing liquid handling components, extending horizontally in all directions and down to grade level
Outdoor	2	2	Up to 450 mm (18 in.) above grade level, extending 6 m (20 ft) horizontally in all directions from dispenser enclosure
Indoor			
- with mechanical ventilation	2	2	Up to 450 mm (18 in.) above floor level, extending 6 m (20 ft) horizontally in all directions from dispenser enclosure
- with gravity ventilation	2	2	Up to 450 mm (18 in.) above floor level, extending 7.5 m (25 ft) horizontally in all directions from dispenser enclosure
Dispensing Device — Overhead Type[4]	1	1	Space within dispenser enclosure and all electrical equipment integral with dispensing hose or nozzle
	2	2	Within 450 mm (18 in.) of dispenser enclosure, extending horizontally in all directions and down to grade level
	2	2	Up to 450 mm (18 in.) above grade level, extending 6 m (20 ft) horizontally in all directions from a point vertically below edge of dispenser enclosure
Remote Pump —			
Outdoor	1	1	Entire space within any pit or box below grade level, any part of which is within 3 m (10 ft) horizontally from any edge of pump
	2	2	Within 900 mm (3 ft) of any edge of pump, extending horizontally in all directions
	2	2	Up to 450 mm (18 in.) above grade level, extending 3 m (10 ft) horizontally in all directions from any edge of pump
Indoor	1	1	Entire space within any pit 2 2 Within 1.5 m (5 ft) of any edge of pump, extending in all directions
	2	2	Up to 900 mm (3 ft) above floor level, extending 7.5 m (25 ft) horizontally in all directions from any edge of pump
Sales, Storage, Rest Rooms including structures (such as the attendant's kiosk) on or adjacent to dispensers	unclassified	unclassified	Except as noted below
	1	1	Entire volume, if there is any opening to room within the extent of a Division 1 or Zone 1 location
	2	2	Entire volume, if there is any opening to room within the extent of a Division 2 or Zone 2 location
Tank, Aboveground			
Inside tank	1	0	Entire inside volume
Shell, ends, roof, dike area	1	1	Entire space within dike, where dike height exceeds distance from tank shell to inside of dike wall for more than 50 percent of tank circumference
	2	2	Entire space within dike, where dike height does not exceed distance from tank shell to inside of dike wall for more than 50 percent of tank circumference

(Continues)

Table 514.3(B)(1) ***Continued***

Location	Division (Group D)	Zone (Group IIA)	Extent of Classified Location[1]
Vent	2	2	Within 3 m (10 ft) of shell, ends, or roof of tank
	1	1	Within 1.5 m (5 ft) of open end of vent, extending in all directions
	2	2	Between 1.5 m and 3 m (5 ft and 10 ft) from open end of vent, extending in all directions
Tank, Underground			
Inside tank	1	0	Entire inside volume
Fill Opening	1	1	Entire space within any pit or box below grade level, any part of which is within a Division 1 or Division 2 classified location or within a Zone 1 or Zone 2 classified location
	2	2	Up to 450 mm (18 in.) above grade level, extending 1.5 m (5 ft) horizontally in all directions from any tight-fill connection and extending 3 m (10 ft) horizontally in all directions from any loose-fill connection
Vent	1	1	Within 1.5 m (5 ft) of open end of vent, extending in all directions
	2	2	Between 1.5 m and 3 m (5 ft and 10 ft) from open end of vent, extending in all directions
Vapor Processing System			
Pits	1	1	Entire space within any pit or box below grade level, any part of which: (1) is within a Division 1 or Division 2 classified location; (2) is within a Zone 1 or Zone 2 classified location; (3) houses any equipment used to transfer or process vapors
Equipment in protective enclosures	2	2	Entire space within enclosure
Equipment *not* within protective enclosure	2	2	Within 450 mm (18 in.) of equipment containing flammable vapors or liquid, extending horizontally in all directions and down to grade level
	2	2	Up to 450 mm (18 in.) above grade level within 3 m (10 ft) horizontally of the vapor processing equipment
- Equipment enclosure	1	1	Entire space within enclosure, if flammable vapor or liquid is present under normal operating conditions
	2	2	Entire space within enclosure, if flammable vapor or liquid is not present under normal operating conditions
- Vacuum assist blower	2	2	Within 450 mm (18 in.) of blower, extending horizontally in all directions and down to grade level
	2	2	Up to 450 mm (18 in.) above grade level, extending 3 m (10 ft) horizontally in all directions
Vault	1	1	Entire interior space, if Class I liquids are stored within

[1]For marine application, *grade level* means the surface of a pier, extending down to water level.
[2]Refer to Figure 514.3 for an illustration of classified location around dispensing devices.
[3]Area classification inside the dispenser enclosure is covered in UL 87, *Standard for Power-Operated Dispensing Devices for Petroleum Products.*
[4]Ceiling-mounted hose reel. [**30A**: Table 8.3.1]

◆ Table 514.3(B)(1) was changed based on 2008 edition of NFPA 30A.

Table 514.3(B)(2) Electrical Equipment Classified Areas for Dispensing Devices

Dispensing Device	Extent of Classified Area	
	Class I, Division 1	Class I, Division 2
Compressed natural gas	Entire space within the dispenser enclosure	1.5 m (5 ft) in all directions from dispenser enclosure
Liquefied natural gas	Entire space within the dispenser enclosure and 1.5 m (5 ft) in all directions from the dispenser enclosure	From 1.5 m to 3.0 m (5 ft to 10 ft) in all directions from the dispenser enclosure
Liquefied petroleum gas	Entire space within the dispenser enclosure; 450 mm (18 in.) from the exterior surface of the dispenser enclosure to an elevation of 1.2 m (4 ft) above the base of the dispenser; the entire pit or open space beneath the dispenser and within 6.0 m (20 ft) horizontally from any edge of the dispenser when the pit or trench is not mechanically ventilated.	Up to 450 mm (18 in.) aboveground and within 6.0 m (20 ft) horizontally from any edge of the dispenser enclosure, including pits or trenches within this area when provided with adequate mechanical ventilation

[30A: Table 12.6.2**]**

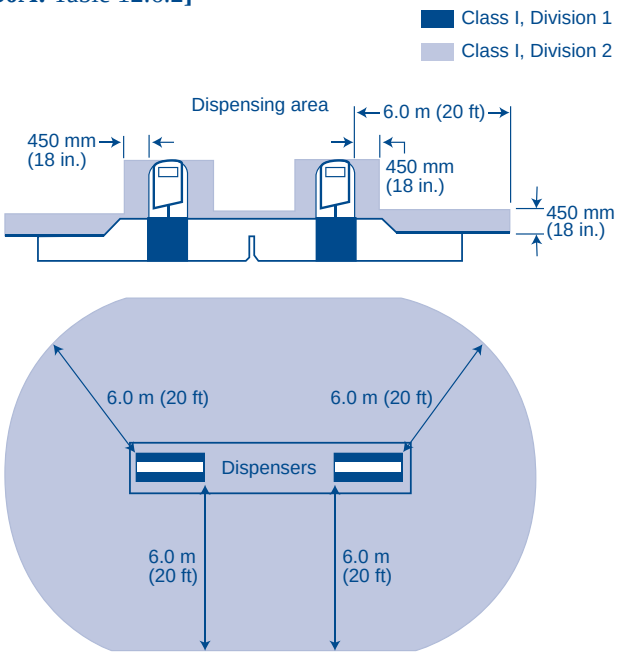


Figure 514.3 Classified Areas Adjacent to Dispensers as Detailed in Table 514.3(B)(1). [30A:Figure 8.3.1]

514.4 Wiring and Equipment Installed in Class I Locations.

All electrical equipment and wiring installed in Class I locations as classified in 514.3 shall comply with the applicable provisions of Article 501.

Exception: As permitted in 514.8.

Informational Note: For special requirements for conductor insulation, see 501.20.

514.7 Wiring and Equipment Above Class I Locations.

Wiring and equipment above the Class I locations as classified in 514.3 shall comply with 511.7.

514.8 Underground Wiring.

Underground wiring shall be installed in threaded rigid metal conduit or threaded steel intermediate metal conduit. Any portion of electrical wiring that is below the surface of a Class I, Division 1, or a Class I, Division 2, location [as classified in Table 514.3(B)(1) and Table 514.3(B)(2)] shall be sealed within 3.05 m (10 ft) of the point of emergence above grade. Except for listed explosionproof reducers at the conduit seal, there shall be no union, coupling, box, or fitting between the conduit seal and the point of emergence above grade. Refer to Table 300.5.

Exception No. 1: Type MI cable shall be permitted where it is installed in accordance with Article 332.

Exception No. 2: Type PVC conduit and Type RTRC conduit shall be permitted where buried under not less than 600 mm (2 ft) of cover. Where Type PVC conduit or Type RTRC conduit is used, threaded rigid metal conduit or threaded steel intermediate metal conduit shall be used for the last 600 mm (2 ft) of the underground run to emergence or to the point of connection to the aboveground raceway, and an equipment grounding conductor shall be included to provide electrical continuity of the raceway system and for grounding of non–current-carrying metal parts.

◆ This exception was revised to permit Types PVC and RTRC conduits when the installation complies with the other requirements.

514.9 Sealing.

(A) At Dispenser. A listed seal shall be provided in each conduit run entering or leaving a dispenser or any cavities or enclosures in direct communication therewith. The sealing fitting shall be the first fitting after the conduit emerges from the earth or concrete.

(B) At Boundary. Additional seals shall be provided in accordance with 501.15. Sections 501.15(A)(4) and (B)(2) shall apply to horizontal as well as to vertical boundaries of the defined Class I locations.

✪ *514.9 SEALING - At the dispenser, an approved seal complying with Section 501.5 is required in each conduit run entering or leaving the dispenser or any cavities or enclosures in direct communication with the dispenser.This sealing fitting is required to be the first fitting after the conduit emerges from the earth or concrete. Not even a conduit union is permitted between the sealing fitting and the point of emergence. An additional seal or seals are required to be provided at the boundary of any hazardous location in accordance with Section 501.15(A)(4) and (B)(2); that is, at the boundaries of Division 1 and Division 2 locations.*

514.11 Circuit Disconnects.

(A) General. Each circuit leading to or through dispensing equipment, including all associated power, communications, data, and video circuits, and equipment for remote pumping systems, shall be provided with a clearly identified and readily accessible switch or other approved means, located remote from the dispensing devices, to disconnect simultaneously from the source of supply, all conductors of the circuits, including the grounded conductor, if any. Single-pole breakers utilizing handle ties shall not be permitted.

◆ This section was changed to identify all of the types of circuits that are required to be disconnected and change from “acceptable” to “approved” in regard to other types of disconnecting means.

(B) Attended Self-Service Motor Fuel Dispensing Facilities. Emergency controls as specified in 514.11(A) shall be installed at a location acceptable to the authority having jurisdiction, but controls shall not be more than 30 m (100 ft) from dispensers. [**30A**:6.7.1]

Enclosed Spool Static Discharge Reel

(C) Unattended Self-Service Motor Fuel Dispensing Facilities. Emergency controls as specified in 514.11(A) shall be installed at a location acceptable to the authority having jurisdiction, but the control shall be more than 6 m (20 ft) but less than 30 m (100 ft) from the dispensers. Additional emergency controls shall be installed on each group of dispensers or the outdoor equipment used to control the dispensers. Emergency controls shall shut off all power to all dispensing equipment at the station. Controls shall be manually reset only in a manner approved by the authority having jurisdiction. [**30A**:6.7.2]

Informational Note: For additional information, see 6.7.1 and 6.7.2 of NFPA 30A-2008, *Code for Motor Fuel Dispensing Facilities and Repair Garages.*

514.13 Provisions for Maintenance and Service of Dispensing Equipment.

Each dispensing device shall be provided with a means to remove all external voltage sources, including power, communications, data, and video circuits and including feedback, during periods of maintenance and service of the dispensing equipment. The location of this means shall be permitted to be other than inside or adjacent to the dispensing device. The means shall be capable of being locked in the open position.

◆ This section was changed to identify all of the types of circuits that are required to be disconnected.

514.16 Grounding and Bonding.

All metal raceways, the metal armor or metallic sheath on cables, and all non– current-carrying metal parts of fixed and portable electrical equipment, regardless of voltage, shall be grounded and bonded. Grounding and bonding in Class I locations shall comply with 501.30.

Open Spool Static Discharge Reel

ARTICLE 515
Bulk Storage Plants

Informational Note: Text that is followed by a reference in brackets has been extracted from NFPA 30-2008, *Flammable and Combustible Liquids Code.* Only editorial changes were made to the extracted text to make it consistent with this *Code.*

515.1 Scope.

This article covers a property or portion of a property where flammable liquids are received by tank vessel, pipelines, tank car, or tank vehicle and are stored or blended in bulk for the purpose of distributing such liquids by tank vessel, pipeline, tank car, tank vehicle, portable tank, or container.

515.2 Definition.

Bulk Plant or Terminal. That portion of a property where liquids are received by tank vessel, pipelines, tank car, or tank vehicle and are stored or blended in bulk for the purpose of distributing such liquids by tank vessel, pipeline, tank car, tank vehicle, portable tank, or container. [**30**:3.3.32.1]

Informational Note: For further information, see NFPA 30-2008, *Flammable and Combustible Liquids Code.*

515.3 Class I Locations.

Table 515.3 shall be applied where Class I liquids are stored, handled, or dispensed and shall be used to delineate and classify bulk storage plants. The class location shall not extend beyond a floor, wall, roof, or other solid partition that has no communicating openings. [**30**:8.1, 8.2.2]

Informational Note No. 1: The area classifications listed in Table 515.3 are based on the premise that the installation meets the applicable requirements of NFPA 30-2008, *Flammable and Combustible Liquids Code*, Chapter 5, in all respects. Should this not be the case, the authority having jurisdiction has the authority to classify the extent of the classified space.

Informational Note No. 2: See 555.21 for gasoline dispensing stations in marinas and boatyards.

Table 515.3(B)(1) Electrical Area Classifications

Location	NEC Class I Division	Zone	Extent of Classified Area
Indoor equipment installed in accordance with Section 5.3 of NFPA 30 where flammable vapor–air mixtures can exist under normal operation	1	0	The entire area associated with such equipment where flammable gases or vapors are present continuously or for long periods of time
	1	1	Area within 1.5 m (5 ft) of any edge of such equipment, extending in all directions
	2	2	Area between 1.5 m and 2.5 m (5 ft and 8 ft) of any edge of such equipment, extending in all directions; also, space up to 900 mm (3 ft) above floor or grade level within 1.5 m to 7.5 m (5 ft to 25 ft) horizontally from any edge of such equipment[1]
Outdoor equipment of the type covered in Section 5.3 of NFPA 30 where flammable vapor–air mixtures may exist under normal operation	1	0	The entire area associated with such equipment where flammable gases or vapors are present continuously or for long periods of time
	1	1	Area within 900 mm (3 ft) of any edge of such equipment, extending in all directions
	2	2	Area between 900 mm (3 ft) and 2.5 m (8 ft) of any edge of such equipment, extending in all directions; also, space up to 900 mm (3 ft) above floor or grade level within 900 mm to 3.0 m (3 ft to 10 ft) horizontally from any edge of such equipment
Tank storage installations inside buildings	1	1	All equipment located below grade level
	2	2	Any equipment located at or above grade level

(Continues)

Table 515.3 *Continued*

Location	NEC Class I Division	Zone	Extent of Classified Area
Tank – aboveground	1	0	Inside fixed roof tank
	1	1	Area inside dike where dike height is greater than the distance from the tank to the dike for more than 50 percent of the tank circumference
Shell, ends, or roof and dike area	2	2	Within 3.0 m (10 ft) from shell, ends, or roof of tank; also, area inside dike to level of top of dike wall
Vent	1	0	Area inside of vent piping or opening
	1	1	Within 1.5 m (5 ft) of open end of vent, extending in all directions
	2	2	Area between 1.5 m and 3.0 m (5 ft and 10 ft) from open end of vent, extending in all directions
Floating roof with fixed outer roof	1	0	Area between the floating and fixed roof sections and within the shell
Floating roof with no fixed outer roof	1	1	Area above the floating roof and within the shell
Underground tank fill opening	1	1	Any pit, or space below grade level, if any part is within a Division 1 or 2, or Zone 1 or 2, classified location
	2	2	Up to 450 mm (18 in.) above grade level within a horizontal radius of 3.0 m (10 ft) from a loose fill connection, and within a horizontal radius of 1.5 m (5 ft) from a tight fill connection
Vent – discharging upward	1	0	Area inside of vent piping or opening
	1	1	Within 900 mm (3 ft) of open end of vent, extending in all directions
	2	2	Area between 900 mm and 1.5 m (3 ft and 5 ft) of open end of vent, extending in all directions
Drum and container filling – outdoors or indoors	1	0	Area inside the drum or container
	1	1	Within 900 mm (3 ft) of vent and fill openings, extending in all directions
	2	2	Area between 900 mm and 1.5 m (3 ft and 5 ft) from vent or fill opening, extending in all directions; also, up to 450 mm (18 in.) above floor or grade level within a horizontal radius of 3.0 m (10 ft) from vent or fill opening
Pumps, bleeders, withdrawal fittings			
Indoors	2	2	Within 1.5 m (5 ft) of any edge of such devices, extending in all directions; also, up to 900 mm (3 ft) above floor or grade level within 7.5 m (25 ft) horizontally from any edge of such devices
Outdoors	2	2	Within 900 mm (3 ft) of any edge of such devices, extending in all directions. Also, up to 450 mm (18 in.) above grade level within 3.0 m (10 ft) horizontally from any edge of such devices

(Continues)

Table 515.3 *Continued*

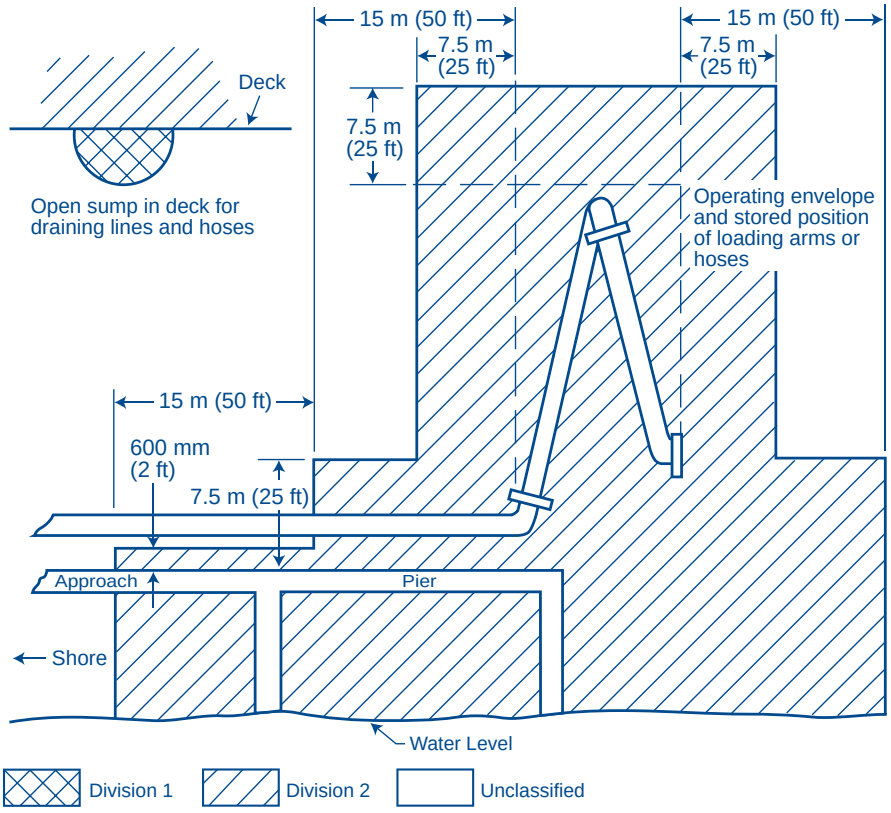
Location	NEC Class I Division	Zone	Extent of Classified Area
Pits and sumps			
Without mechanical ventilation	1	1	Entire area within a pit or sump if any part is within a Division 1 or 2, or Zone 1 or 2, classified location
With adequate mechanical ventilation	2	2	Entire area within a pit or sump if any part is within a Division 1 or 2, or Zone 1 or 2, classified location
Containing valves, fittings, or piping, and not within a Division 1 or 2, or Zone 1 or 2, classified location	2	2	Entire pit or sump
Drainage ditches, separators, impounding basins			
Outdoors	2	2	Area up to 450 mm (18 in.) above ditch, separator, or basin; also, area up to 450 mm (18 in.) above grade within 4.5 m (15 ft) horizontally from any edge
Indoors			Same classified area as pits
Tank vehicle and tank car[2] loading through open dome	1	0	Area inside of the tank
	1	1	Within 900 mm (3 ft) of edge of dome, extending in all directions
	2	2	Area between 900 mm and 4.5 m (3 ft and 15 ft) from edge of dome, extending in all directions
Loading through bottom connections with atmospheric venting	1	0	Area inside of the tank
	1	1	Within 900 mm (3 ft) of point of venting to atmosphere, extending in all directions
	2	2	Area between 900 mm and 4.5 m (3 ft and 15 ft) from point of venting to atmosphere, extending in all directions; also, up to 450 mm (18 in.) above grade within a horizontal radius of 3.0 m (10 ft) from point of loading connection
Office and rest rooms	Unclassified		If there is any opening to these rooms within the extent of an indoor classified location, the room shall be classified the same as if the wall, curb, or partition did not exist.
Loading through closed dome with atmospheric venting	1	1	Within 900 mm (3 ft) of open end of vent, extending in all directions
	2	2	Area between 900 mm and 4.5 m (3 ft and 15 ft) from open end of vent, extending in all directions; also, within 900 mm (3 ft) of edge of dome, extending in all directions
Loading through closed dome with vapor control	2	2	Within 900 mm (3 ft) of point of connection of both fill and vapor lines extending in all directions
Bottom loading with vapor control or any bottom unloading	2	2	Within 900 mm (3 ft) of point of connections, extending in all directions; also up to 450 mm (18 in.) above grade within a horizontal radius of 3.0 m (10 ft) from point of connections

(Continues)

Table 515.3 *Continued*

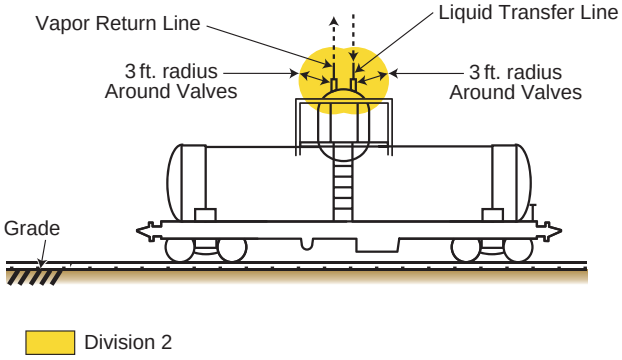
Location	NEC Class I Division	Zone	Extent of Classified Area
Storage and repair garage for tank vehicles	1	1	All pits or spaces below floor level
	2	2	Area up to 450 mm (18 in.) above floor or grade level for entire storage or repair garage
Garages for other than tank vehicles	Unclassified		If there is any opening to these rooms within the extent of an outdoor classified location, the entire room shall be classified the same as the area classification at the point of the opening.
Outdoor drum storage	Unclassified		
Inside rooms or storage lockers used for the storage of Class I liquids	2	2	Entire room
Indoor warehousing where there is no flammable liquid transfer	Unclassified		If there is any opening to these rooms within the extent of an indoor classified location, the room shall be classified the same as if the wall, curb, or partition did not exist.
Piers and wharves			See Figure 515.3.

[1]The release of Class I liquids may generate vapors to the extent that the entire building, and possibly an area surrounding it, should be considered a Class I, Division 2 or Zone 2 location.
[2]When classifying extent of area, consideration shall be given to fact that tank cars or tank vehicles may be spotted at varying points. Therefore, the extremities of the loading or unloading positions shall be used. [**30**: Table 8.2.2]



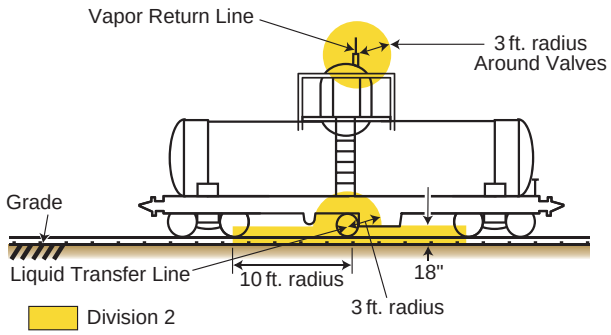
Notes:
(1) The "source of vapor" shall be the operating envelope and stored position of the outboard flange connection of the loading arm (or hose).
(2) The berth area adjacent to tanker and barge cargo tanks is to be Division 2 to the following extent:
  a. 7.6 m (25 ft) horizontally in all directions on the pier side from that portion of the hull containing cargo tanks
  b. From the water level to 7.6 m (25 ft) above the cargo tanks at their highest position
(3) Additional locations may have to be classified as required by the presence of other sources of flammable liquids on the berth, by Coast Guard, or other regulations.

Figure 515.3 Marine Terminal Handling Flammable Liquids. [30:Figure 7.7.16]



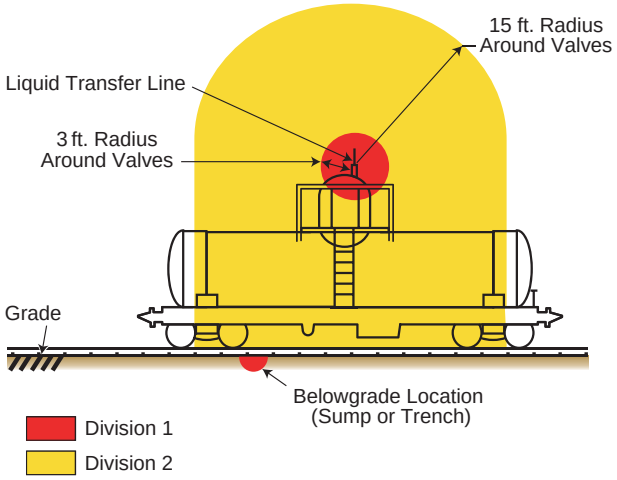
Material: Flammable Liquid

Tank car/tank truck loading and unloading via closed system.Transfer through dome only.



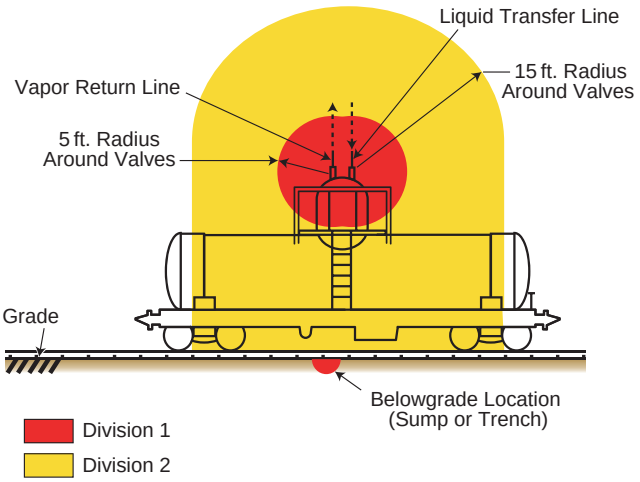
Material: Flammable Liquid

Tank car/tank truck loading and unloading via closed system.Bottom product transfer only.



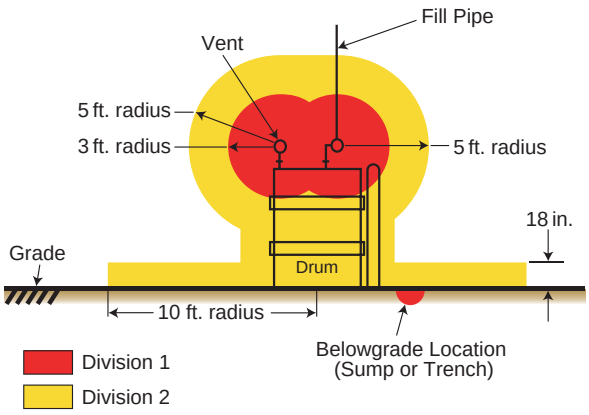
Material: Flammable Liquid

Tank car/tank truck loading and unloading via open system.Top or bottom product transfer.



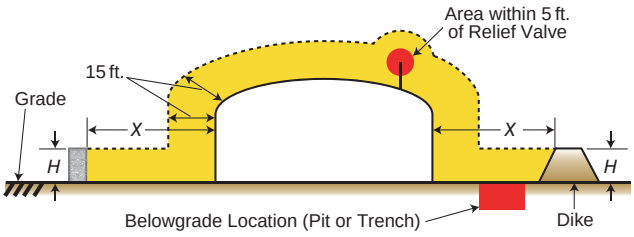
Material: Flammable Liquid

Tank car/tank truck loading and unloading via closed system.Transfer through dome only.

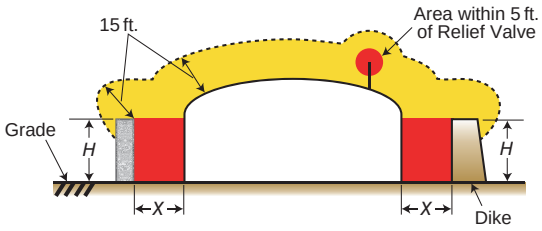


Material: Flammable Liquid

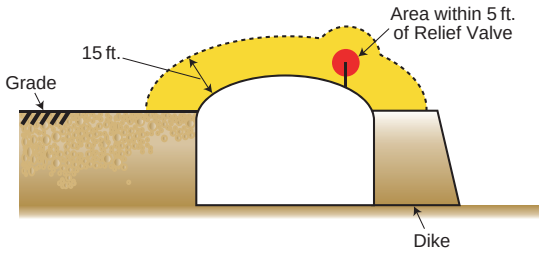
Drum filling station, outdoors or indoors, with adequate ventilation.



Dike Height Less Than Distance from Container to Dike (*H* Less Than *X*)



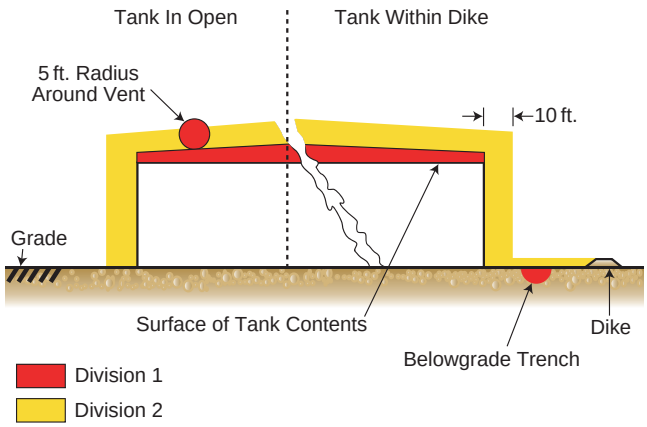
Dike Height Greater Than Distance from Container to Dike (*H* Greater Than *X*)



Dike Height Same as Grade Level

Division 1
Division 2

Storage tanks for cryogenic liquids..



Fixed roof storage tank, outdoors at grade.

515.4 Wiring and Equipment Located in Class I Locations.

All electrical wiring and equipment within the Class I locations defined in 515.3 shall comply with the applicable provisions of Article 501 or Article 505 for the division or zone in which they are used.

Exception: As permitted in 515.8.

515.7 Wiring and Equipment Above Class I Locations.

(A) FixedWiring. All fixed wiring above Class I locations shall be in metal raceways, Schedule 80 PVC conduit, Type RTRC marked with the suffix -XW, or Type MI, Type TC, or Type MC cable, or Type PLTC and Type PLTC-ER cable in accordance with the provisions of Article 725, including installation in cable tray systems or Type ITC and Type ITC-ER cable as permitted in 727.4. The cable shall be terminated with listed fittings.

◆ This section was changed to include type PLTC, and type PLTC-ER when installed in accordance with Article 725, and, ITC cable and ITC-ER cable when installed in accordance with Article 727.4. These cables are required to be terminated with listed fittings.

(B) Fixed Equipment. Fixed equipment that may produce arcs, sparks, or particles of hot metal, such as lamps and lampholders for fixed lighting, cutouts, switches, receptacles, motors, or other equipment having make-and-break or sliding contacts, shall be of the totally enclosed type or be constructed so as to prevent the escape of sparks or hot metal particles.

(C) Portable Luminaires or Other Utilization Equipment. Portable luminaires or other utilization equipment and their flexible cords shall comply with the provisions of Article 501 or Article 505 for the class of location above which they are connected or used.

515.8 Underground Wiring.

(A) Wiring Method. Underground wiring shall be installed in threaded rigid metal conduit or threaded steel intermediate metal conduit or, where buried under not less than 600 mm (2 ft) of cover, shall be permitted in Type PVC conduit, Type RTRC conduit, or a listed cable. Where Type PVC conduit or Type RTRC conduit is used, threaded rigid metal conduit or threaded steel intermediate metal conduit shall be used for not less than the last 600 mm (2 ft) of the conduit run to the conduit point of emergence from the underground location or to the point of connection to an aboveground raceway. Where cable is used, it shall be enclosed in threaded rigid metal conduit or threaded steel intermediate metal conduit from the point of lowest buried cable level to the point of connection to the aboveground raceway.

◆ This section was changed to permit Types PVC and RTRC rigid nonmetallic conduits.

(B) Insulation. Conductor insulation shall comply with 501.20.

◆ This section was changed to speciy Types PVC and RTRC rigid nonmetallic conduits

(C) Nonmetallic Wiring. Where Type PVC conduit, Type RTRC conduit, or cable with a nonmetallic sheath is used, an equipment grounding conductor shall be included to provide for electrical continuity of the raceway system and for grounding of non–current-carrying metal parts.

515.9 Sealing.

Sealing requirements shall apply to horizontal as well as to vertical boundaries of the defined Class I locations. Buried raceways and cables under defined Class I locations shall be considered to be within a Class I, Division 1 or Zone 1 location.

✪ *515.9 SEALING - Suitable seals in accordance with Section 501.15(A)(4) and (B)(2) are required. These referenced sections are the ones that require seals at the boundaries of Division 1 and Division 2 locations. Buried raceways are considered to be within a Class I, Division 1 location if below either a Division 1 location or Division 2 location.*

515.10 Special Equipment — Gasoline Dispensers.

Where gasoline or other volatile flammable liquids or liquefied flammable gases are dispensed at bulk stations, the applicable provisions of Article 514 shall apply.

515.16 Grounding and Bonding.

All metal raceways, the metal armor or metallic sheath on cables, and all non–current-carrying metal parts of fixed or portable electrical equipment, regardless of voltage, shall be grounded and bonded as provided in Article 250.

Grounding and bonding in Class I locations shall comply with 501.30 for Class I, Division 1 and 2 locations and 505.25 for Class I, Zone 0, 1, and 2 locations.

Informational Note: For information on grounding for static protection, see 4.5.3.4 and 4.5.3.5 of NFPA 30-2008, *Flammable and Combustible Liquids Code.*

ARTICLE 516
Spray Application, Dipping, and Coating Processes

Informational Note: Text that is followed by a reference in brackets has been extracted from NFPA 33-2011, *Standard for Spray Application Using Flammable and Combustible Materials*, or NFPA 34-2011, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids.* Only editorial changes were made to the extracted text to make it consistent with this Code.

516.1 Scope.

This article covers the regular or frequent application of flammable liquids, combustible liquids, and combustible powders by spray operations and the application of flammable liquids, or combustible liquids at temperatures above their flashpoint, by dipping, coating, or other means.

Informational Note: For further information regarding safeguards for these processes, such as fire protection, posting of warning signs, and maintenance, see NFPA 33-2011, *Standard for Spray Application Using Flammable and Combustible Materials*, and NFPA 34-2011, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids.* For additional information regarding ventilation, see NFPA 91-2010, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.*

516.2 Definitions.

For the purpose of this article, the following definitions shall apply.

Spray Area. Normally, locations outside of buildings or localized operations within a larger room or space. Such are normally provided with some local vapor extraction/ventilation system. In automated operations, the area limits shall be the maximum area in the direct path of spray operations. In manual operations, the area limits shall be the maximum area of spray when aimed at 180 degrees to the application surface.

Spray Booth. An enclosure or insert within a larger room used for spray/coating/dipping applications. A spray booth may be fully enclosed or have open front or face and may include separate conveyor entrance and exit. The spray booth is provided with a dedicated ventilation exhaust but may draw supply air from the larger room or have a dedicated air supply.

Spray Room. A purposefully enclosed room built for spray/coating/dipping applications provided with dedicated ventilation supply and exhaust. Normally the room is configured to house the item to be painted, providing reasonable access around the item/process. Depending on the size of the item being painted, such rooms may actually be the entire building or the major portion thereof.

516.3 Classification of Locations.

Classification is based on dangerous quantities of flammable vapors, combustible mists, residues, dusts, or deposits.

(A) Class I, Division 1 or Class I, Zone 0 Locations. The following spaces shall be considered Class I, Division 1, or Class I, Zone 0, as applicable:

(1) The interior of any open or closed container of a flammable liquid

(2) The interior of any dip tank or coating tank

Informational Note: For additional guidance and explanatory diagrams, see 4.3.5 of NFPA 33-2011, *Standard for Spray Application Using Flammable or Combustible Materials*, and Sections 4.2, 4.3, and 4.4 of NFPA 34-2011, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids.*

(B) Class I or Class II, Division 1 Locations. The following spaces shall be considered Class I, Division 1, or Class I, Zone 1, or Class II, Division 1 locations, as applicable:

(1) The interior of spray booths and rooms except as specifically provided in 516.3(D).

(2) The interior of exhaust ducts.

(3) Any area in the direct path of spray operations.

(4) For open dipping and coating operations, all space within a 1.5-m (5-ft) radial distance from the vapor sources extending from these surfaces to the floor. The vapor source shall be the liquid exposed in the process and the drainboard, and any dipped or coated object from which it is possible to measure vapor concentrations exceeding 25 percent of the lower flammable limit at a distance of 300 mm (1 ft), in any direction, from the object.

(5) Sumps, pits, or belowgrade channels within 7.5 m (25 ft) horizontally of a vapor source. If the sump, pit, or channel extends beyond 7.5 m (25 ft) from the vapor source, it shall be provided with a vapor stop or it shall be classified as Class I, Division 1 for its entire length.

(6) All space in all directions outside of but within 900 mm (3 ft) of open containers, supply containers, spray gun cleaners, and solvent distillation units containing flammable liquids.

(C) Class I or Class II, Division 2 Locations. The following spaces shall be considered Class I, Division 2, or Class I, Zone 2, or Class II, Division 2 as applicable.

(1) Open Spraying. For open spraying, all space outside of but within 6 m (20 ft) horizontally and 3 m (10 ft) vertically of the Class I, Division 1 or Class I, Zone 1 location as defined in 516.3(A), and not separated from it by partitions. See Figure 516.3(C)(1). [**33**:6.5.1]

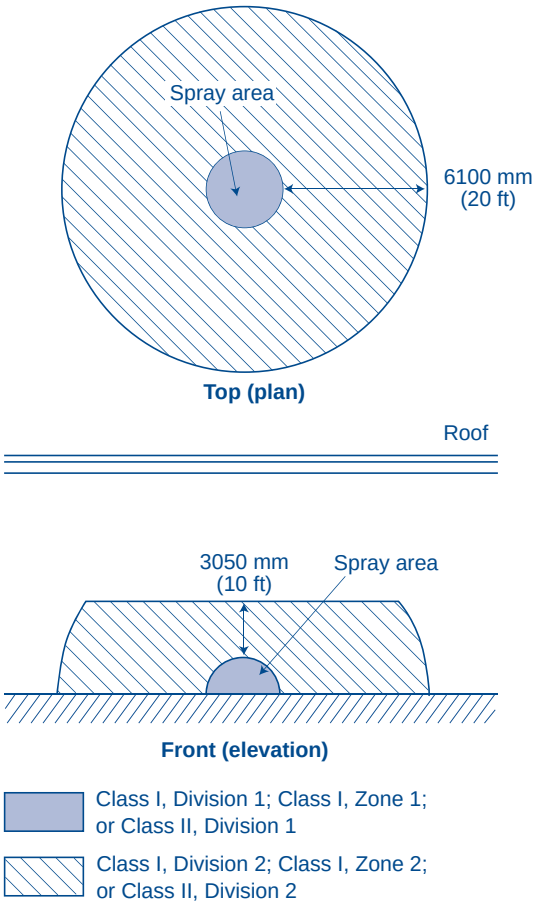


Figure 516.3(C)(1) Electrical Area Classification for Open Spray Areas. [33:Figure 6.5.1]

(2) Closed-Top, Open-Face, and Open-Front Spraying. If spray application operations are conducted within a closed-top, open-face, or open-front booth or room, any electrical wiring or utilization equipment located outside of the booth or room but within the boundaries designated as Division 2 or Zone 2 in Figure 516.3(C)(2) shall be suitable for Class I, Division 2, Class I, Zone 2, or Class II, Division 2 locations, whichever is applicable. The Class I, Division 2, Class I, Zone 2, or Class II, Division 2 locations shown in Figure 516.3(C)(2) shall extend from the edges of the open face or open front of the booth or room in accordance with the following:

(a) If the exhaust ventilation system is interlocked with the spray application equipment, the Division 2 or Zone 2 location shall extend 1.5 m (5 ft) horizontally and 900 mm (3 ft) vertically from the open face or open front of the booth or room, as shown in Figure 516.3(C)(2), top.

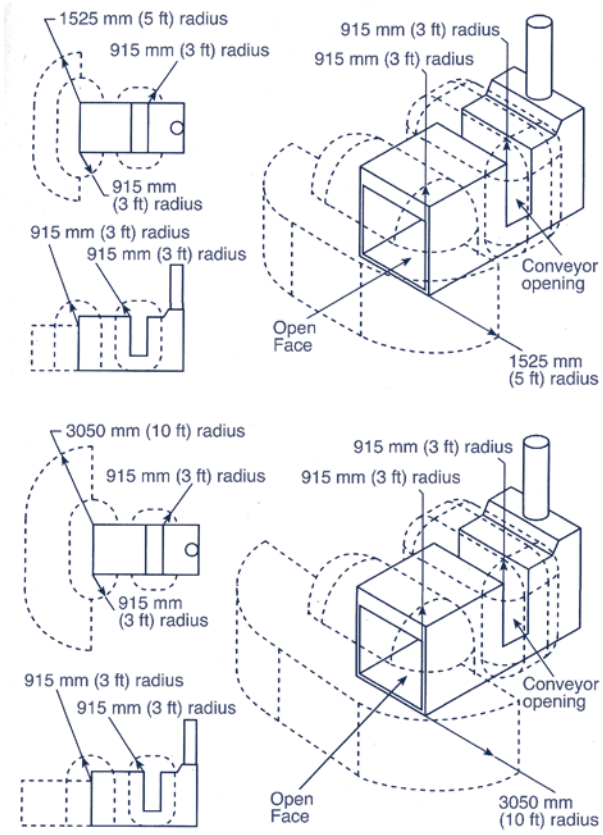


Figure 516.3(C)(2) Class I, Division 2, Class I, Zone 2, or Class II, Division 2 Locations Adjacent to a Closed Top, Open Face, or Open Front Spray Booth or Room. [33:Figures 6.5.2(a) and 6.5.2(b)]

(b) If the exhaust ventilation system is not interlocked with the spray application equipment, the Division 2 or Zone 2 location shall extend 3 m (10 ft) horizontally and 900 mm (3 ft) vertically from the open face or open front of the booth or room, as shown in Figure 516.3(C)(2), bottom.

For the purposes of this subsection, interlocked shall mean that the spray application equipment cannot be operated unless the exhaust ventilation system is operating and functioning properly and spray application is automatically stopped if the exhaust ventilation system fails. [**33**:6.5.2.2]

(3) Open-Top Spraying. For spraying operations conducted within an open top spray booth, the space 900 mm (3 ft) vertically above the booth and within 900 mm (3 ft) of other booth openings shall be considered Class I, Division 2; Class I, Zone 2; or Class II, Division 2. [**33**:6.5.3]

(4) Enclosed Booths and Rooms. For spraying operations confined to an enclosed spray booth or room, the space within 900 mm (3 ft) in all directions from any openings shall be considered Class I, Division 2; or Class I, Zone 2; or Class II, Division 2 as shown in Figure 516.3(C)(4). [**33**:6.5.4]

An Enclosed Paint Spray Room

(5) Dip Tanks and Drain Boards — Surrounding Space. For dip tanks and drain boards, the 914-mm (3-ft) space surrounding the Class I, Division 1 or Class I, Zone 1 location as defined in 516.3(A)(4) and as shown in Figure 516.3(C)(5). [**34**:6.4.4]

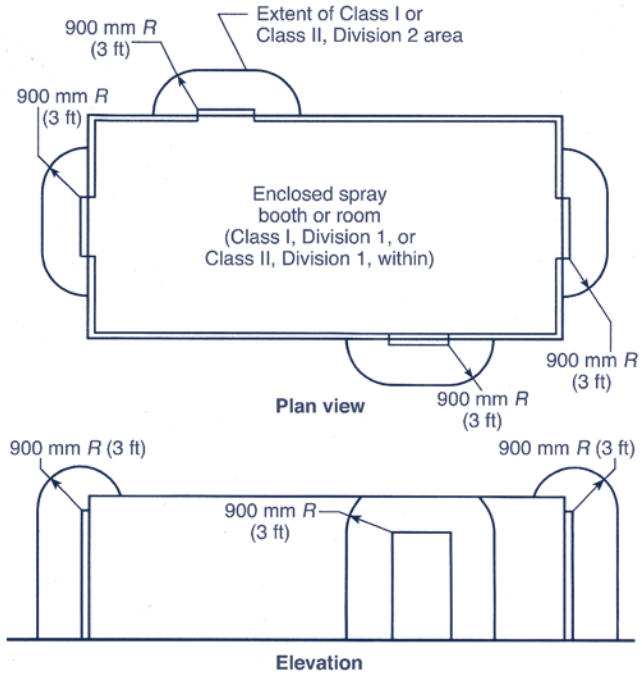


Figure 516.3(C)(4) Class I, Division 2, Class I, Zone 2, or Class II, Division 2 Locations Adjacent to an Enclosed Spray Booth or Spray Room. [33:Figure 6.5.4]

(6) Dip Tanks and Drain Boards — Space Above Floor. For dip tanks and drain boards, the space 900 mm (3 ft) above the floor and extending 6 m (20 ft) horizontally in all directions from the Class I, Division 1 or Class I, Zone 1 location.

*Exception: This space shall not be required to be considered a hazardous (classified) location where the vapor source area is 0.46 m^2 (5 ft^2) or less and where the contents of the open tank trough or container do not exceed 19 L (5 gal). In addition, the vapor concentration during operation and shutdown periods shall not exceed 25 percent of the lower flammable limit outside the Class I location specified in 516.3(B)(4). [**34**:6.4.4 Exception]*

(7) Open Containers. All space in all directions within 600 mm (2 ft) of the Division 1 or Zone 1 area surrounding open containers, supply containers, spray gun cleaners, and solvent distillation units containing flammable liquids, as well as the area extending 1.5 m (5 ft) beyond the Division 1 or Zone 1 area up to a height of 460 mm (18 in.) above the floor or grade level. [**33**:6.6.2]

(D) Enclosed Coating and Dipping Operations. The space adjacent to an enclosed dipping or coating process or apparatus shall be considered unclassified. [**34**:6.5.3]

*Exception: The space within 900 mm (3 ft) in all directions from any opening in the enclosures shall be classified as Class I, Division 2 or Class I, Zone 2, as applicable. [**34**:6.5.2]*

(E) Adjacent Locations. Adjacent locations that are cut off from the defined Class I or Class II locations by tight partitions without communicating openings, and within which flammable vapors or combustible powders are not likely to be released, shall be unclassified.

(F) Unclassified Locations. Locations using drying, curing, or fusion apparatus and provided with positive mechanical ventilation adequate to prevent accumulation of flammable concentrations of vapors, and provided with effective interlocks to de-energize all electrical equipment (other than equipment identified for Class I locations) in case the ventilating equipment is inoperative, shall be permitted to be unclassified where the authority having jurisdiction so judges.

Informational Note: For further information regarding safeguards, see NFPA 86-2011, *Standard for Ovens and Furnaces.*

516.4 Wiring and Equipment in Class I Locations.

(A) Wiring and Equipment —Vapors. All electrical wiring and equipment within the Class I location (containing vapor only — not residues) defined in 516.3 shall comply with the applicable provisions of Article 501 or Article 505, as applicable.

(B) Wiring and Equipment — Vapors and Residues. Unless specifically listed for locations containing deposits of dangerous quantities of flammable or combustible vapors, mists, residues, dusts, or deposits (as applicable), there shall be no electrical equipment in any spray area as herein defined whereon deposits of combustible residue may readily accumulate, except wiring in rigid metal conduit, intermediate metal conduit, Type MI cable, or in metal boxes or fittings containing no taps, splices, or terminal connections. [**33**:6.4.2]

(C) Illumination. Illumination of readily ignitible areas through panels of glass or other transparent or translucent material shall be permitted only if it complies with the following:

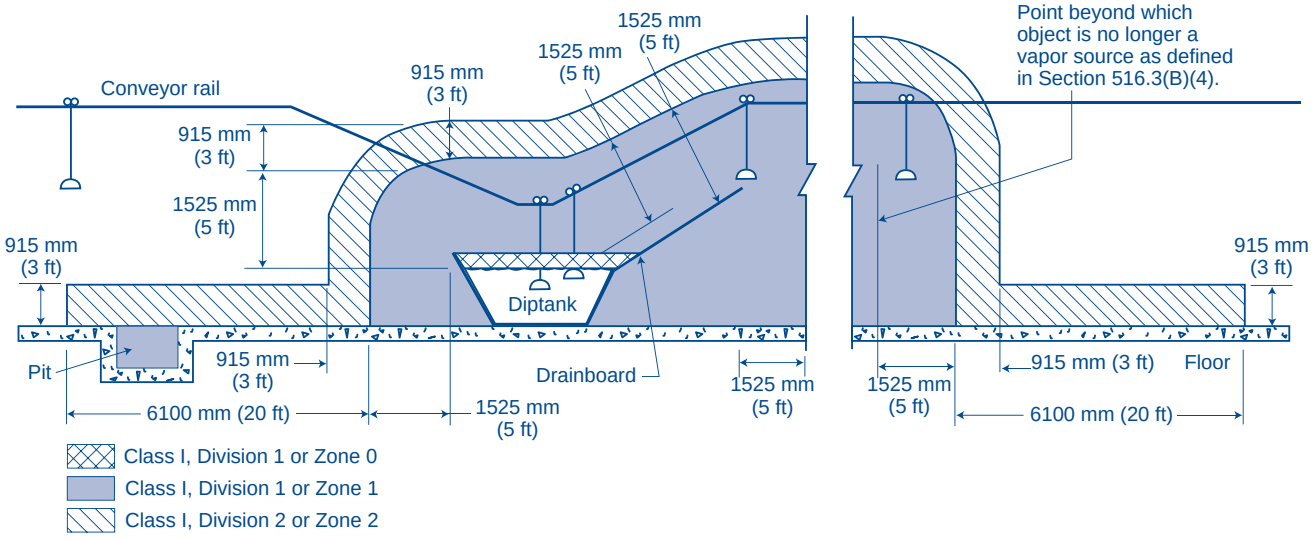


Figure 516.3(C)(5) Electrical Area Classification for Open Processes Without Vapor Containment or Ventilation. [34:Figure 6.4(a)]

(1) Fixed lighting units are used as the source of illumination.

(2) The panel effectively isolates the Class I location from the area in which the lighting unit is located.

(3) The lighting unit is identified for its specific location.

(4) The panel is of a material or is protected so that breakage is unlikely.

(5) The arrangement is such that normal accumulations of hazardous residue on the surface of the panel will not be raised to a dangerous temperature by radiation or conduction from the source of illumination.

(D) Portable Equipment. Portable electric luminaires or other utilization equipment shall not be used in a spray area during spray operations.

*Exception No. 1: Where portable electric luminaires are required for operations in spaces not readily illuminated by fixed lighting within the spraying area, they shall be of the type identified for Class I, Division 1 or Class 1, Zone 1 locations where readily ignitible residues may be present. [**33**:6.9 Exception]*

Exception No. 2: Where portable electric drying apparatus is used in spray booths and the following requirements are met:

(a) The apparatus and its electrical connections are not located within the spray enclosure during spray operations.

(b) Electrical equipment within 450 mm (18 in.) of the floor is identified for Class I, Division 2 or Class I, Zone 2 locations.

(c) All metallic parts of the drying apparatus are electrically bonded and grounded.

(d) Interlocks are provided to prevent the operation of spray equipment while drying apparatus is within the spray enclosure, to allow for a 3-minute purge of the enclosure before energizing the drying apparatus and to shut off drying apparatus on failure of ventilation system.

◆ Exc. 2 was revised to apply to spray booths in addition to those used for "automobile refinishing."

(E) Electrostatic Equipment. Electrostatic spraying or detearing equipment shall be installed and used only as provided in 516.10.

Informational Note: For further information, see NFPA 33-2011, *Standard for Spray Application Using Flammable or Combustible Materials.*

516.7 Wiring and Equipment Not Within Class I and II Locations.

(A) Wiring. All fixed wiring above the Class I and II locations shall be in metal raceways, Type PVC conduit, Type RTRC conduit, or electrical nonmetallic tubing; where cables are used, they shall be Type MI, Type TC, or Type MC cable. Cellular metal floor raceways shall only be permitted to supply ceiling outlets or as extensions to the area below the floor of a Class I or II location. Where cellular metal raceways, are used, they shall not have connections leading into or passing through the Class I or II location unless suitable seals are provided.

◆ This section was revised to permit Types PVC and RTRC rigid nonmetallic conduits.

(B) Equipment. Equipment that may produce arcs, sparks, or particles of hot metal, such as lamps and lampholders for fixed lighting, cutouts, switches, receptacles, motors, or other equipment having make-and-break or sliding contacts, where installed above a Class I or II location or above a loca-

tion where freshly finished goods are handled, shall be of the totally enclosed type or be constructed so as to prevent the escape of sparks or hot metal particles.

516.10 Special Equipment.

(A) Fixed Electrostatic Equipment. This section shall apply to any equipment using electrostatically charged elements for the atomization, charging, and/or precipitation of hazardous materials for coatings on articles or for other similar purposes in which the charging or atomizing device is attached to a mechanical support or manipulator. This shall include robotic devices. This section shall not apply to devices that are held or manipulated by hand. Where robot or programming procedures involve manual manipulation of the robot arm while spraying with the high voltage on, the provisions of 516.10(B) shall apply. The installation of electrostatic spraying equipment shall comply with 516.10(A)(1) through (A)(10). Spray equipment shall be listed. All automatic electrostatic equipment systems shall comply with 516.4(A)(1) through (A)(9).

(1) Power and Control Equipment. Transformers, high-voltage supplies, control apparatus, and all other electrical portions of the equipment shall be installed outside of the Class I location as defined in 516.3 or be of a type identified for the location.

Exception: High-voltage grids, electrodes, electrostatic atomizing heads, and their connections shall be permitted within the Class I location.

(2) Electrostatic Equipment. Electrodes and electrostatic atomizing heads shall be adequately supported in permanent locations and shall be effectively insulated from ground. Electrodes and electrostatic atomizing heads that are permanently attached to their bases, supports, reciprocators, or robots shall be deemed to comply with this section.

(3) High-Voltage Leads. High-voltage leads shall be properly insulated and protected from mechanical damage or exposure to destructive chemicals. Any exposed element at high voltage shall be effectively and permanently supported on suitable insulators and shall be effectively guarded against accidental contact or grounding.

(4) Support of Goods. Goods being coated using this process shall be supported on conveyors or hangers. The conveyors or hangers shall be arranged (1) to ensure that the parts being coated are electrically connected to ground with a resistance of 1 megohm or less and (2) to prevent parts from swinging.

(5) Automatic Controls. Electrostatic apparatus shall be equipped with automatic means that will rapidly deenergize the high-voltage elements under any of the following conditions:

(1) Stoppage of ventilating fans or failure of ventilating equipment from any cause

(2) Stoppage of the conveyor carrying goods through the high-voltage field unless stoppage is required by the spray process

(3) Occurrence of excessive current leakage at any point in the high-voltage system

(4) De-energizing the primary voltage input to the power supply

(6) Grounding. All electrically conductive objects in the spray area, except those objects required by the process to be at high voltage, shall be adequately grounded. This requirement shall apply to paint containers, wash cans, guards, hose connectors, brackets, and any other electrically conductive objects or devices in the area.

Informational Note: For more information on grounding and bonding for static electricity purposes, see NFPA 33- 2011, *Standard for Spray Application Using Flammable or Combustible Materials;* NFPA 34-2011, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids;* and NFPA 77-2007, *Recommended Practice on Static Electricity.*

(7) Isolation. Safeguards such as adequate booths, fencing, railings, interlocks, or other means shall be placed about the equipment or incorporated therein so that they, either by their location, character, or both, ensure that a safe separation of the process is maintained.

(8) Signs. Signs shall be conspicuously posted to convey the following:

(1) Designate the process zone as dangerous with regard to fire and accident

(2) Identify the grounding requirements for all electrically conductive objects in the spray area

(3) Restrict access to qualified personnel only

(9) Insulators. All insulators shall be kept clean and dry.

(10) Other Than Nonincendive Equipment. Spray equipment that cannot be classified as nonincendive shall comply with (A)(10)(a) and (A)(10)(b).

(a) Conveyors or hangers shall be arranged so as to maintain a safe distance of at least twice the sparking distance between goods being painted and electrodes, electrostatic atomizing heads, or charged conductors. Warnings defining this safe distance shall be posted. [**33**:11.4.1]

(b) The equipment shall provide an automatic means of rapidly de-energizing the high-voltage elements in the event the distance between the goods being painted and the electrodes or electrostatic atomizing heads falls below that specified in (a). [**33**:11.3.8]

(B) Electrostatic Hand-Spraying Equipment. This section shall apply to any equipment using electrostatically charged elements for the atomization, charging, and/or precipitation of materials for coatings on articles, or for other simi-

lar purposes in which the atomizing device is handheld or manipulated during the spraying operation. Electrostatic hand-spraying equipment and devices used in connection with paint-spraying operations shall be of listed types and shall comply with 516.10(B)(1) through (B)(5).

(1) General. The high-voltage circuits shall be designed so as not to produce a spark of sufficient intensity to ignite the most readily ignitible of those vapor–air mixtures likely to be encountered, or result in appreciable shock hazard upon coming in contact with a grounded object under all normal operating conditions. The electrostatically charged exposed elements of the handgun shall be capable of being energized only by an actuator that also controls the coating material supply.

(2) Power Equipment. Transformers, power packs, control apparatus, and all other electrical portions of the equipment shall be located outside of the Class I location or be identified for the location.

Exception: The handgun itself and its connections to the power supply shall be permitted within the Class I location.

(3) Handle. The handle of the spraying gun shall be electrically connected to ground by a metallic connection and be constructed so that the operator in normal operating position is in intimate electrical contact with the grounded handle to prevent buildup of a static charge on the operator's body. Signs indicating the necessity for grounding other persons entering the spray area shall be conspicuously posted.

(4) Electrostatic Equipment. All electrically conductive objects in the spraying area shall be adequately grounded. This requirement shall apply to paint containers, wash cans, and any other electrical conductive objects or devices in the area. The equipment shall carry a prominent, permanently installed warning regarding the necessity for this grounding feature.

Informational Note: For more information on grounding and bonding for static electricity purposes, see NFPA 33- 2011, *Standard for Spray Application Using Flammable or Combustible Materials;* NFPA 34-2011, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids;* and NFPA 77-2007, *Recommended Practice on Static Electricity.*

(5) Support of Objects. Objects being painted shall be maintained in metallic contact with the conveyor or other grounded support. Hooks shall be regularly cleaned to ensure adequate grounding of 1 megohm or less. Areas of contact shall be sharp points or knife edges where possible. Points of support of the object shall be concealed from random spray where feasible; and, where the objects being sprayed are supported from a conveyor, the point of attachment to the conveyor shall be located so as to not collect spray material during normal operation. [**33**: Chapter 12]

(C) Powder Coating. This section shall apply to processes in which combustible dry powders are applied. The hazards associated with combustible dusts are present in such a process to a degree, depending on the chemical composition of the material, particle size, shape, and distribution.

(1) Electrical Equipment and Sources of Ignition. Electrical equipment and other sources of ignition shall comply with the requirements of Article 502. Portable electric luminaires and other utilization equipment shall not be used within a Class II location during operation of the finishing processes. Where such luminaires or utilization equipment are used during cleaning or repairing operations, they shall be of a type identified for Class II, Division 1 locations, and all exposed metal parts shall be connected to an equipment grounding conductor.

Exception: Where portable electric luminaires are required for operations in spaces not readily illuminated by fixed lighting within the spraying area, they shall be of the type listed for Class II, Division 1 locations where readily ignitible residues may be present.

(2) Fixed Electrostatic Spraying Equipment. The provisions of 516.10(A) and 516.10(C)(1) shall apply to fixed electrostatic spraying equipment.

(3) Electrostatic Hand-Spraying Equipment. The provisions of 516.10(B) and 516.10(C)(1) shall apply to electrostatic hand-spraying equipment.

(4) Electrostatic Fluidized Beds. Electrostatic fluidized beds and associated equipment shall be of identified types. The high-voltage circuits shall be designed such that any discharge produced when the charging electrodes of the bed are approached or contacted by a grounded object shall not be of sufficient intensity to ignite any powder–air mixture likely to be encountered or to result in an appreciable shock hazard.

(a) Transformers, power packs, control apparatus, and all other electrical portions of the equipment shall be located outside the powder-coating area or shall otherwise comply with the requirements of 516.10(C)(1).

Exception: The charging electrodes and their connections to the power supply shall be permitted within the powder-coating area.

(b) All electrically conductive objects within the powder-coating area shall be adequately grounded. The powder-coating equipment shall carry a prominent, permanently installed warning regarding the necessity for grounding these objects.

Informational Note: For more information on grounding and bonding for static electricity purposes, see NFPA 33- 2011, *Standard for Spray Application Using Flammable or Combustible Materials;* NFPA 34-2011, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids;* and NFPA 77-2007, *Recommended Practice on Static Electricity.*

(c) Objects being coated shall be maintained in electrical contact (less than 1 megohm) with the conveyor or other support in order to ensure proper grounding. Hangers shall

be regularly cleaned to ensure effective electrical contact. Areas of electrical contact shall be sharp points or knife edges where possible.

(d) The electrical equipment and compressed air supplies shall be interlocked with a ventilation system so that the equipment cannot be operated unless the ventilating fans are in operation. **[33**: Chapter 15]

516.16 Grounding.

All metal raceways, the metal armors or metallic sheath on cables, and all non–current-carrying metal parts of fixed or portable electrical equipment, regardless of voltage, shall be grounded and bonded. Grounding and bonding shall comply with 501.30, 502.30, or 505.25, as applicable.

Alphabetical Listing of Selected Combustible Liquids, Gases or Vapor Materials

Chemical	CAS No.	Class I Division Group	Type[a]	Flash Point (°C)	AIT (°C)	%LFL	%UFL	Vapor Density (Air = 1)	Vapor Pressure[b] (mm Hg)	Class I Zone Group[c]	MIE (mJ)	MIC Ratio	MESG (mm)
Acetaldehyde	75-07-0	C[d]	I	-38	175	4.0	60.0	1.5	874.9	IIA	0.37	0.98	0.92
Acetic Acid	64-19-7	D[d]	II	39	426		19.9	2.1	15.6	IIA		2.67	1.76
Acetic Acid-tert-Butyl Ester	540-88-5	D	II			1.7	9.8	4.0	40.6				
Acetic Anhydride	108-24-7	D	II	49	316	2.7	10.3	3.5	4.9	IIA			1.23
Acetone	67-64-1	D[d]	I	-20	465	2.5	12.8	2.0	230.7	IIA	1.15	1.00	1.02
Acetone Cyanohydrin	75-86-5	D	IIIA	74	688	2.2	12.0	2.9	0.3				
Acetonitrile	75-05-8	D	I	6	524	3.0	16.0	1.4	91.1	IIA			1.50
Acetylene	74-86-2	A[d]	GAS		305	2.5	100	0.9	36600	IIC	0.017	0.28	0.25
Acrolein (Inhibited)	107-02-8	B(C)[d]	I		235	2.8	31.0	1.9	274.1	IIB	0.13		
Acrylic Acid	79-10-7	D	II	54	438	2.4	8.0	2.5	4.3	IIB			0.86
Acrylonitrile	107-13-1	D[d]	I	0	481	3	17	1.8	108.5	IIB	0.16	0.78	0.87
Adiponitrile	111-69-3	D	IIIA	93	550			1.0	0.002				
Allyl Alcohol	107-18-6	C[d]	I	22	378	2.5	18.0	2.0	25.4	IIB			0.84
Allyl Chloride	107-05-1	D	I	-32	485	2.9	11.1	2.6	366	IIA		1.33	1.17
Allyl Glycidyl Ether	106-92-3	B(C)[e]	II		57			3.9					
Alpha-Methyl Styrene	98-83-9	D	II		574	0.8	11.0	4.1	2.7				
n-Amyl Acetate	628-63-7	D	I	25	360	1.1	7.5	4.5	4.2	IIA			1.02
sec-Amyl Acetate	626-38-0	D	I	23		1.1	7.5	4.5		IIA			
Ammonia	7664-41-7	D[d,f]	GAS		651	15	28	0.6	7498.0	IIA	680	6.85	3.17
Aniline	62-53-3	D	IIIA	70	615	1.2	8.3	3.2	0.7	IIA			
Benzene	71-43-2	D[d]	I	-11	498	1.2	7.8	2.8	94.8	IIA	0.20	1.00	0.99
Benzyl Chloride	98-87-3	D	IIIA		585	1.1		4.4	0.5				
Bromopropyne	106-96-7	D	I	10	324	3.0							
n-Butane	3583-47-9	D[d,g]	GAS		288	1.9	8.5	2.0		IIA	0.25	0.94	1.07
1,3 Butadiene	106-99-0	B(D)[d,e]	GAS		420	2.0	11.5	1.9		IIB	0.13	0.76	0.79
1-Butanol	71-36-3	D[d]	I	36	343	1.4	11.2	2.6	7.0	IIA			0.91
Butyl alcohol (s) (butanol-2)	78-92-2	D[d]	I	23.8	405	1.7	9.8	2.6		IIA			
Butylamine	109-73-9	D	GAS	-12	312	1.7	9.8	2.5	92.9	IIA		1.13	
Butylene	25167-67-3	D	I		385	1.6	10.0	1.9	2214.6	IIA			0.94
n-Butyraldehyde	123-72-8	C[d]	I	-12	218	1.9	12.5	2.5	112.2	IIA			0.92
n-Butyl Acetate	123-86-4	D[d]	I	22	421	1.7	7.6	4.0	11.5	IIA		1.08	1.04
sec-Butyl Acetate	105-46-4	D	II	-8		1.7	9.8	4.0	22.2				
tert-Butyl Acetate	540-88-5	D	II			1.7	9.8	4.0	40.6				
n-Butyl Acrylate (Inhibited)	141-32-2	D	II	49	293	1.7	9.9	4.4	5.5	IIB			0.88
n-Butyl Glycidyl Ether	2426-08-6	B(C)[e]	II										
n-Butyl Formal	110-62-3	C	IIIA						34.3				
Butyl Mercaptan	109-79-5	C	I	2				3.1	46.4				
Butyl-2-Propenoate	141-32-2	D	II	49		1.7	9.9	4.4	5.5				
para tert-Butyl Toluene	98-51-1	D	IIIA										
n-Butyric Acid	107-92-6	D[d]	IIIA	72	443	2.0	10.0	3.0	0.8				
Carbon Disulfide	75-15-0	[d,h]	I	-30	90	1.3	50.0	2.6	358.8	IIC	0.009	0.39	0.20
Carbon Monoxide	630-08-0	C[d]	GAS		609	12.5	74	0.97		IIB			0.54
Chloroacetaldehyde	107-20-0	C	IIIA	88					63.1				
Chlorobenzene	108-90-7	D	I	29	593	1.3	9.6	3.9	11.9				
l-Chloro-1-Nitropropane	2425-66-3	C	IIIA										
Chloroprene	126-99-8	D	GAS	-20		4.0	20.0	3.0					
Cresol	1319-77-3	D	IIIA	81	559	1.1		3.7					
Crotonaldehyde	4170-30-3	C[d]	I	13	232	2.1	15.5	2.4	33.1	IIB			0.81
Cumene	98-82-8	D	I	36	424	0.9	6.5	4.1	4.6	IIA			1.05
Cyclohexane	110-82-7	D	I	-17	245	1.3	8.0	2.9	98.8	IIA	0.22	1.0	0.94

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Alphabetical Listing of Selected Combustible Liquids, Gases or Vapor Materials *Continued*

Chemical	CAS No.	Class I Division Group	Type[a]	Flash Point (˚C)	AIT (˚C)	%LFL	%UFL	Vapor Density (Air = 1)	Vapor Pressure[b] (mm Hg)	Class I Zone Group[c]	MIE (mJ)	MIC Ratio	MESG (mm)
Cyclohexanol	108-93-0	D	IIIA	68	300			3.5	0.7	IIA			
Cyclohexanone	108-94-1	D	II	44	420	1.1	9.4	3.4	4.3	IIA			0.98
Cyclohexene	110-83-8	D	I	-6	244	1.2		2.8	89.4	IIA		0.97	
Cyclopropane	75-19-4	D[d]	I		503	2.4	10.4	1.5	5430	IIA	0.17	0.84	0.91
p-Cymene	99-87-6	D	II	47	436	0.7	5.6	4.6	1.5	IIA			
Decene	872-05-9	D	II		235			4.8	1.7				
n-Decaldehyde	112-31-2	C	IIIA						0.09				
n-Decanol	112-30-1	D	IIIA	82	288			5.3	0.008				
Decyl Alcohol	112-30-1	D	IIIA	82	288			5.3	0.008				
Diacetone Alcohol	123-42-2	D	IIIA	64	603	1.8	6.9	4.0	1.4				
Di-Isobutylene	25167-70-8	D[d]	I	2	391	0.8	4.8	3.8			0.96		
Di-Isobutyl Ketone	108-83-8	D	II	60	396	0.8	7.1	4.9	1.7				
o-Dichlorobenzene	955-50-1	D	IIIA	66	647	2.2	9.2	5.1		IIA			
1,4-Dichloro-2,3 Epoxybutane	3583-47-9	D[d]	I			1.9	8.5	2.0		IIA	0.25	0.98	1.07
1,1-Dichloroethane	1300-21-6	D	I		438	6.2	16	3.4	227	IIA			1.82
1,2-Dichloroethylene	156-59-2	D	I	97	460	5.6	12.8	3.4	204	IIA			3.91
1,1-Dichloro-1-Nitroethane	594-72-9	C	IIIA	76				5.0					
1,3-Dichloropropene	10061-02-6	D	I	35		5.3	14.5	3.8					
Dicyclopentadiene	77-73-6	C	I	32	503				2.8	IIA			0.91
Diethylamine	109-87-9	C[d]	I	-28	312	1.8	10.1	2.5		IIA			1.15
Diethylaminoethanol	100-37-8	C	IIIA	60	320			4.0	1.6	IIA			
Diethyl Benzene	25340-17-4	D	II	57	395			4.6					
Diethyl Ether (Ethyl Ether)	60-29-7	C[d]	I	-45	160	1.9	36	2.6	538	IIB	0.19	0.88	0.83
Diethylene Glycol Monobutyl Ether	112-34-5	C	IIIA	78	228	0.9	24.6	5.6	0.02				
Diethylene Glycol Monomethyl Ether	111-77-3	C	IIIA	93	241				0.2				
n-n-Dimethyl Aniline	121-69-7	C	IIIA	63	371	1.0		4.2	0.7				
Dimethyl Formamide	68-12-2	D	II	58	455	2.2	15.2	2.5	4.1	IIA			1.08
Dimethyl Sulfate	77-78-1	D	IIIA	83	188			4.4	0 .7				
Dimethylamine	124-40-3	C	GAS		400	2.8	14.4	1.6		IIA			
2,2-Dimethylbutane	75-83-2	D[g]	I	-48	405				319.3				
2,3-Dimethylbutane	78-29-8	D[g]	I		396								
3,3-Dimethylheptane	1071-26-7	D[g]	I		325				10.8				
2,3-Dimethylhexane	31394-54-4	D[g]	I		438								
2,3-Dimethylpentane	107-83-5	D[g]	I		335				211.7				
Di-N-Propylamine	142-84-7	C	I	17	299				27.1	IIA			0.95
1,4-Dioxane	123-91-1	C[d]	I	12	180	2.0	22.0	3.0	38.2	IIB	0.19		0.70
Dipentene	138-86-3	D	II	45	237	0.7	6.1	4.7		IIA			1.18
Dipropylene Glycol Methyl Ether	34590-94-8	C	IIIA	85		1.1	3.0	5.1	0.5				
Diisopropylamine	108-18-9	C	GAS	-6	316	1.1	7.1	3.5		IIA			1.02
Dodecene	6842-15-5	D	IIIA	100	255								
Epichlorohydrin	3132-64-7	C[d]	I	33	411	3.8	21.0	3.2	13.0				
Ethane	74-84-0	D[d]	GAS	-29	472	3.0	12.5	1.0		IIA	0.24	0.82	0.91
Ethanol	64-17-5	D[d]	I	13	363	3.3	19.0	1.6	59.5	IIA		0.88	0.89
Ethylamine	75-04-7	D[d]	I	-18	385	3.5	14.0	1.6	1048		2.4		
Ethylene	74-85-1	C[d]	GAS		490	2.7	36.0	1.0		IIB	0.07	0.53	0.65
Ethylenediamine	107-15-3	D[d]	I	33	385	2.5	12.0	2.1	12.5				
Ethylenimine	151-56-4	C[d]	I	-11	320	3.3	54.8	1.5	211		0.48		
Ethylene Chlorohydrin	107-07-3	D	IIIA	59	425	4.9	15.9	2.8	7.2				

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Alphabetical Listing of Selected Combustible Liquids, Gases or Vapor Materials *Continued*

Chemical	CAS No.	Class I Division Group	Type[a]	Flash Point (˚C)	AIT (˚C)	%LFL	%UFL	Vapor Density (Air = 1)	Vapor Pressure[b] (mm Hg)	Class I Zone Group[c]	MIE (mJ)	MIC Ratio	MESG (mm)
Ethylene Dichloride	107-06-2	D[d]	I	13	413	6.2	16.0	3.4	79.7				
Ethylene Glycol Monoethyl Ether Acetate	111-15-9	C	II	47	379	1.7		4.7	2.3	IIA		0.53	0.97
Ethylene Glycol Monobutyl Ether Acetate	112-07-2	C	IIIA		340	0.9	8.5		0.9				
Ethylene Glycol Monobutyl Ether	111-76-2	C	IIIA		238	l.l	12.7	4.1	1.0				
Ethylene Glycol Monoethyl Ether	110-80-5	C	II		235	1.7	15.6	3.0	5.4				0.84
Ethylene Glycol Monomethyl Ether	109-86-4	D	II		285	1.8	14.0	2.6	9.2				0.85
Ethylene Oxide	75-21-8	B(C)[d,e]	I	-20	429	3	100	1.5	1314	IIB	0.065	0.47	0.59
2-Ethylhexaldehyde	123-05-7	C	II	52	191	0.8	7.2	4.4	1.9				
2-Ethylhexanol	104-76-7	D	IIIA	81		0.9	9.7	4.5	0.2				
2-Ethylhexyl Acrylate	103-09-3	D	IIIA	88	252				0.3				
Ethyl Acetate	141-78-6	D[d]	I	-4	427	2.0	11.5	3.0	93.2	IIA	0.46		0.99
Ethyl Acrylate (Inhibited)	140-88-5	D[d]	I	9	372	1.4	14.0	3.5	37.5	IIA			0.86
Ethyl Alcohol	64-17-5	D[d]	I	13	363	3.3	19.0	1.6	59.5	IIA		0.88	0.89
Ethyl Sec-Amyl Ketone	541-85-5	D	II	59									
Ethyl Benzene	100-41-4	D	I	15	432	0.8	6.7	3.7	9.6				
Ethyl Butanol	97-95-0	D	II	57		1.2	7.7	3.5	1.5				
Ethyl Butyl Ketone	106-35-4	D	II	46				4.0	3.6				
Ethyl Chloride	75-00-3	D	GAS	-50	519	3.8	15.4	2.2					
Ethyl Formate	109-94-4	D	GAS	-20	455	2.8	16.0	2.6		IIA			0.94
Ethyl Mercaptan	75-08-1	C[d]	I	-18	300	2.8	18.0	2.1	527.4	IIB		0.90	0.90
n-Ethyl Morpholine	100-74-3	C	I	32				4.0					
2-Ethyl-3-Propyl Acrolein	645-62-5	C	IIIA	68				4.4					
Ethyl Silicate	78-10-4	D	II					7.2					
Formaldehyde (Gas)	50-00-0	B	GAS		430	7	73	1.0		IIB			0.57
Formic Acid	64-18-6	D	II	50	434	18.0	57.0	1.6	42.7	IIA			1.86
Fuel Oil I	8008-20-6	D	II or IIIA[k]	38-72[k]	210	0.7	5.0						
Fuel Oil 2			II or IIIA[k]	52-96[k]	257								
Fuel Oil 6			IIIA or IIIB[k]	66-132[k]									
Furfural	98-01-1	C	IIIA	60	316	2.1	19.3	3.3	2.3				0.94
Furfuryl Alcohol	98-00-0	C	IIIA	75	490	1.8	16.3	3.4	0.6				
Gasoline	8006-61-9	D[d]	I	-46	280	1.4	7.6	3.0					
n-Heptane	142-82-5	D[d]	I	-4	204	1.0	6.7	3.5	45.5	IIA	0.24	0.88	0.91
n-Heptene	81624-04-6	D[g]	I	-1	204			3.4					0.97
n-Hexane	110-54-3	D[d,g]	I	-23	225	l.l	7.5	3.0	152	IIA	0.24	0.88	0.93
Hexanol	111-27-3	D	IIIA	63				3.5	0.8	IIA			0.98
2-Hexanone	591-78-6	D	I	35	424	1.2	8.0	3.5	10.6				
Hexene	592-41-6	D	I	-26	245	1.2	6.9		186				
sec-Hexyl Acetate	108-84-9	D	II	45				5.0					
Hydrazine	302-01-2	C	II	38	23		98.0	l.l	14.4				
Hydrogen	1333-74-0	B[d]	GAS		500	4	75	0.1		IIC	0.019	0.25	0.28
Hydrogen Cyanide	74-90-8	C[d]	GAS	-18	538	5.6	40.0	0.9		IIB			0.80
Hydrogen Selenide	7783-07-5	C	I						7793				
Hydrogen Sulfide	7783-06-4	C[d]	GAS		260	4.0	44.0	1.2		IIB	0.068		0.90
Isoamyl Acetate	123-92-2	D	I	25	360	1.0	7.5	4.5	6.1				
Isoamyl Alcohol	123-51-3	D	II	43	350	1.2	9.0	3.0	3.2	IIA			1.02
Isobutane	75-28-5	D[g]	GAS		460	1.8	8.4	2.0		IIA			0.95
Isobutyl Acetate	110-19-0	D[d]	I	18	421	2.4	10.5	4.0	17.8				
Isobutyl Acrylate	106-63-8	D	I		427			4.4	7.1				
Isobutyl Alcohol	78-83-1	D[d]	I	-40	416	1.2	10.9	2.5	10.5	IIA		0.92	0.98

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Alphabetical Listing of Selected Combustible Liquids, Gases or Vapor Materials *Continued*

Chemical	CAS No.	Class I Division Group	Type[a]	Flash Point (˚C)	AIT (˚C)	%LFL	%UFL	Vapor Density (Air = 1)	Vapor Pressure[b] (mm Hg)	Class I Zone Group[c]	MIE (mJ)	MIC Ratio	MESG (mm)
Isobutyraldehyde	78-84-2	C	GAS	-40	196	1.6	10.6	2.5		IIA			0.92
Isodecaldehyde	112-31-2	C	IIIA					5.4	0.09				
Isohexane	107-83-5	D[g]			264				211.7	IIA		1.00	
Isopentane	78-78-4	D[g]			420				688.6				
Isooctyl Aldehyde	123-05-7	C	II		197				1.9				
Isophorone	78-59-1	D		84	460	0.8	3.8	4.8	0.4				
Isoprene	78-79-5	D[d]	I	-54	220	1.5	8.9	2.4	550.6				
Isopropyl Acetate	108-21-4	D	I		460	1.8	8.0	3.5	60.4				
Isopropyl Ether	108-20-3	D[d]	I	-28	443	1.4	7.9	3.5	148.7	IIA	1.14		0.94
Isopropyl Glycidyl Ether	4016-14-2	C	I										
Isopropylamine	75-31-0	D	GAS	-26	402	2.3	10.4	2.0			2.0		
Kerosene	8008-20-6	D	II	72	210	0.7	5.0			IIA			
Liquefied Petroleum Gas	68476-85-7	D	I		405								
Mesityl Oxide	141-97-9	D[d]	I	31	344	1.4	7.2	3.4	47.6				
Methane	74-82-8	D[d]	GAS		600	5	15	0.6		IIA	0.28	1.00	1.12
Methanol	67-56-1	D[d]	I	12	385	6.0	36.0	1.1	126.3	IIA	0.14	0.82	0.92
Methyl Acetate	79-20-90	D	GAS	-10	454	3.1	16.0	2.6		IIA		1.08	0.99
Methyl Acrylate	96-33-3	D	GAS	-3	468	2.8	25.0	3.0		IIB		0.98	0.85
Methyl Alcohol	67-56-1	D[d]	I		385	6.0	36	1.1	126.3	IIA			0.91
Methyl Amyl Alcohol	108-11-2	D	II	41		1.0	5.5	3.5	5.3	IIA			1.01
Methyl Chloride	74-87-3	D	GAS	-46	632	8.1	17.4	1.7		IIA			1.00
Methyl Ether	115-10-6	C[d]	GAS	-41	350	3.4	27.0	1.6		IIB		0.85	0.84
Methyl Ethyl Ketone	78-93-3	D[d]	I	-6	404	1.4	11.4	2.5	92.4	IIB	0.53	0.92	0.84
Methyl Formal	534-15-6	C[d]	I	I	238			3.1					
Methyl Formate	107-31-3	D	GAS	-19	449	4.5	23.0	2.1		IIA			0.94
2-Methylhexane	31394-54-4	D[g]	I		280								
Methyl Isobutyl Ketone	141-79-7	D[d]	I	31	440	1.2	8.0	3.5	11				
Methyl Isocyanate	624-83-9	D	GAS	-15	534	5.3	26.0	2.0		IIA			1.21
Methyl Mercaptan	74-93-1	C	GAS	-18		3.9	21.8	1.7					
Methyl Methacrylate	80-62-6	D	I	10	422	1.7	8.2	3.6	37.2	lIA			0.95
Methyl N-Amyl Ketone	110-43-0	D	II	49	393	1.1	7.9	3.9	3.8				
Methyl Tertiary Butyl Ether	1634-04-4	D	I	-80	435	1.6	8.4	0.2	250.1				
2-Methyloctane	3221-61-2				220				6.3				
2-Methylpropane	75-28-5	D[g]	I		460				2639				
Methyl-1-Propanol	78-83-1	D[d]	I	-40	416	1.2	10.9	2.5	10.1	IIA			0.98
Methyl-2-Propanol	75-65-0	D[d]	I	10	360	2.4	8.0	2.6	42.2				
2-Methyl-5-Ethyl Pyridine	104-90-5	D		74		1.1	6.6	4.2					
Methylacetylene	74-99-7	C[d]	I			1.7		1.4	4306		0.11		
Methylacetylene-Propadiene	27846-30-6	C	I							lIB			0.74
Methylal	109-87-5	C	I	-18	237	1.6	17.6	2.6	398				
Methylamine	74-89-5	D	GAS		430	4.9	20.7	1.0		IIA			1.10
2-Methylbutane	78-78-4	D[g]		-56	420	1.4	8.3	2.6	688.6				
Methylcyclohexane	208-87-2	D	I	-4	250	1.2	6.7	3.4			0.27		
Methylcyclohexanol	25630-42-3	D		68	296			3.9					
2-Methycyclohexanone	583-60-8	D	II					3.9					
2-Methylheptane		D[g]			420								
3-Methylhexane	589-34-4	D[g]			280				61.5				
3-Methylpentane	94-14-0	D[g]			278								
2-Methylpropane	75-28-5	D[g]	I		460				2639				
2-Methyl-I-Propanol	78-83-1	D[d]	I	-40	223	1.2	10.9	2.5	10.5				

(continues)

Alphabetical Listing of Selected Combustible Liquids, Gases or Vapor Materials *Continued*

Chemical	CAS No.	Class I Division Group	Type[a]	Flash Point (˚C)	AIT (˚C)	%LFL	%UFL	Vapor Density (Air = 1)	Vapor Pressure[b] (mm Hg)	Class I Zone Group[c]	MIE (mJ)	MIC Ratio	MESG (mm)
2-Methyl-2-Propanol	75-65-0	D[d]	I	478	2.4	8	2.6	42.2					
2-Methyloctane	2216-32-2	D[g]		220									
3-Methyloctane	2216-33-3	D[g]		220				6.3					
4-Methyloctane	2216-34-4	D[g]		225				6.8					
Monoethanolamine	141-43-5	D		85	410			2.1	0.4	IIA			
Monoisopropanolamine	78-96-6	D	77	374			2.6	1.1					
Monomethyl Aniline	100-61-8	C		482				0.5					
Monomethyl Hydrazine	60-34-4	C	I	23	194	2.5	92.0	1.6					
Morpholine	110-91-8	C[d]	II	35	310	1.4	11.2	3.0	10.1	IIA			0.95
Naphtha (CoalTar)	8030-30-6	D	II	42	277					IIA			
Naphtha (Petroleum)	8030-30-6	D[d,i]	I	42	288	1.1	5.9	2.5		IIA			
Neopentane	463-82-1	D[g]		-65	450	1.4	8.3	2.6	1286				
Nitrobenzene	98-95-3	D		88	482	1.8		4.3	0.3	IIA			0.94
Nitroethane	79-24-3	C	I	28	414	3.4		2.6	20.7	IIB			0.87
Nitromethane	75-52-5	C	I	35	418	7.3		2.1	36.1	IIA		0.92	1.17
1-Nitropropane	108-03-2	C	I	34	421	2.2		3.1	10.1	IIB			0.84
2-Nitropropane	79-46-9	C[d]	I	28	428	2.6	11.0	3.1	17.1				
n-Nonane	111-84-2	D[g]	I	31	205	0.8	2.9	4.4	4.4	IIA			
Nonene	27214-95-8	D	I			0.8		4.4					
Nonyl Alcohol	143-08-8	D				0.8	6.1	5.0	0.02	IIA			
n-Octane	111-65-9	D[d,g]	I	13	206	1.0	6.5	3.9	14.0	IIA			0.94
Octene	25377-83-7	D	I	8	230	0.9		3.9					
n-Octyl Alcohol	111-87-5	D						4.5	0.08	IIA			1.05
n-Pentane	109-66-0	D[d,g]	I	-40	243	1.5	7.8	2.5	513	IIA	0.28	0.97	0.93
1-Pentanol	71-41-0	D[d]	I	33	300	1.2	10.0	3.0	2.5	IIA			1.30
2-Pentanone	107-87-9	D	I	7	452	1.5	8.2	3.0	35.6	IIA			0.99
1-Pentene	109-67-1	D	I	-18	275	1.5	8.7	2.4	639.7				
2-Pentene	109-68-2	D	I	-18				2.4					
2-Pentyl Acetate	626-38-0	D	I	23		1.1	7.5	4.5					
Phenylhydrazine	100-63-0	D		89				3.7	0.03				
Process Gas > 30% H_2	1333-74-0	B[j]	GAS		520	4	75.0	0.1			0.019	0.45	
Propane	74-98-6	D[d]	GAS		450	2.1	9.5	1.6		IIA	0.25	0.82	0.97
1-Propanol	71 -23-8	D[d]	I	15	413	2.2	13.7	2.1	20.7	IIA			0.89
2-Propanol	67-63-0	D[d]	I	12	399	2.0	12.7	2.1	45.4	IIA	0.65		1.00
Propiolactone	57-57-8	D				2.9		2.5	2.2				
Propionaldehyde	123-38-6	C	I	-9	207	2.6	17.0	2.0	318.5	IIB			0.86
Propionic Acid	79-09-4	D	II	54	466	2.9	12.1	2.5	3.7	IIA			1.10
Propionic Anhydride	123-62-6	D		74	285	1.3	9.5	4.5	1.4				
n-Propyl Acetate	109-60-4	D	I	14	450	1.7	8.0	3.5	33.4	IIA			1.05
n-Propyl Ether	111-43-3	C[d]	I	21	215	1.3	7.0	3.5	62.3				
Propyl Nitrate	627-13-4	B[d]	I	20	175	2.0	100.0						
Propylene	115-07-1	D[d]	GAS		460	2.4	10.3	1.5		IIA	0.28		0.91
Propylene Dichloride	78-87-5	D	I	16	557	3.4	14.5	3.9	51.7	lIA			1.32
Propylene Oxide	75-56-9	B(C)[d,e]	I	-37	449	2.3	36.0	2.0	534.4	IIB	0.13		0.70
Pyridine	110-86-1	D[d]	I	20	482	1.8	12.4	2.7	20.8	IIA			
Styrene	100-42-5	D[d]	I	31	490	0.9	6.8	3.6	6.1	IIA		1.21	
Tetrahydrofuran	109-99-9	C[d]	I	-14	321	2.0	11.8	2.5	161.6	IIB	0.54		0.87
Tetrahydronaphthalene	119-64-2	D	IIIA		385	0.8	5.0	4.6	0.4				
Tetramethyl Lead	75-74-1	C	II	38				9.2					
Toluene	108-88-3	D[d]	I	4	480	1.1	7.1	3.1	28.53	IIA	0.24		
n-Tridecene	2437-56-1	D	IIIA			0.6		6.4	593.4				
Triethylamine	121-44-8	C[d]	I	-9	249	1.2	8.0	3.5	68.5	IIA	0.75	1.05	
Triethylbenzene	25340-18-5	D		83			56.0	5.6					
2,2,3-Trimethylbutane		D[g]			442								
2,2,4-Trimethylbutane		D[g]			407								
2,2,3-Trimethylpentane		D[g]			396								
2,2,4-Trimethylpentane		D[g]			415					IIA			1.04
2,3,3-Trimethylpentane		D[g]			425								
Tripropylamine	102-69-2	D	II	41				4.9	1.5	IIA			1.13
Turpentine	8006-64-2	D	I	35	253	0.8			4.8				

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Alphabetical Listing of Selected Combustible Liquids, Gases or Vapor Materials *Continued*

Chemical	CAS No.	Class I Division Group	Type[a]	Flash Point (˚C)	AIT (˚C)	%LFL	%UFL	Vapor Density (Air = 1)	Vapor Pressure[b] (mm Hg)	Class I Zone Group[c]	MIE (mJ)	MIC Ratio	MESG (mm)
n-Undecene	28761-27-5	D	IIIA			0.7		5.5					
Unsymmetrical Dimethyl Hydrazine	57-14-7	C[d]	I	-15	249	2.0	95.0	1.9		IIB			0.85
Valeraldehyde	110-62-3	C	I	280	222			3.0	34.3				
Vinyl Acetate	108-05-4	D[d]	I	-6	402	2.6	13.4	3.0	113.4	IIA	0.70		0.94
Vinyl Chloride	75-01-4	D[d]	GAS	-78	472	3.6	33.0	2.2		IIA			0.96
Vinyl Toluene	25013-15-4	D		52	494	0.8	11.0	4.1					
Vinylidene Chloride	75-35-4	D	I		570	6.5	15.5	3.4	599.4	IIA			3.91
Xylene	1330-20-7	D[d]	I	25	464	0.9	7.0	3.7		IIA	0.2		1.09
Xylidine	121-69-7	C	IIIA	63	371	1.0		4.2	0.7				

[a] Type is used to designate if the material is a gas, flammable liquid, or combustible liquid. *(See 4.2.6 and 4.2.7.)*

[b] Vapor pressure reflected in units of mm Hg at 25°C (77°F) unless stated otherwise.

[c] Class I, Zone Groups are based on 1996 IEC TR3 60079-20, *Electrical apparatus for explosive gas atmospheres — Part 20: Data for flammable gases and vapours, relating to the use of electrical apparatus,* which contains additional data on MESG and group classifications.

[d] Material has been classified by test.

[e] Where all conduit runs into explosionproof equipment are provided with explosionproof seals installed within 450 mm (18 in.) of the enclosure, equipment for the group classification shown in parentheses is permitted.

[f] For classification of areas involving ammonia, see ASHRAE 15, *Safety Code for Mechanical Refrigeration,* and ANSI/CGAw G2.1, *Safety Requirements for the Storage and Handling of Anhydrous Ammonia.*

[g] Commercial grades of aliphatic hydrocarbon solvents are mixtures of several isomers of the same chemical formula (or molecular weight). The autoignition temperatures of the individual isomers are significantly different. The electrical equipment should be suitable for the AIT of the solvent mixture. *(See A. 4.4.2.)*

[h] Certain chemicals have characteristics that require safeguards beyond those required for any of the above groups. Carbon disulfide is one of these chemicals because of its low autoignition temperature and the small joint clearance necessary to arrest its flame propagation.

[i] Petroleum naphtha is a saturated hydrocarbon mixture whose boiling range is 20°C to 135°C (68°F to 275°F). It is also known as benzine, ligroin, petroleum ether, and naphtha.

[j] Fuel and process gas mixtures found by test not to present hazards similar to those of hydrogen may be grouped based on the test results.

[k] Liquid type and flash point vary due to regional blending differences.

Alphabetical Listing of Selected Combustible Dust Materials

Chemical Name	CAS No.	NEC Group	Code	Layer or Cloud Ignition Temp. (°C)
Acetal, Linear		G	NL	440
Acetoacet-p-phenetidide Acetoacetanilide	122-82-7	G	NL	560
Acetoacetanilide	102-01-2	G	M	440
Acetylamino-t-nitrothiazole		G		450
Acrylamide Polymer Acrylonitrile Polymer		G		460
Acrylonitrile-Vinyl Chloride-Vinylidenechloride copolmer (70-20-10)		G		210
Acrylonitrile-Vinyl Pyridine Copolymer		G		240
Adipic Acid	124-04-9	G	M	550
Alfalfa Meal		G		200
Alkyl Ketone Dimer Sizing Compound Allyl Alcohol Derivative		G	NL	160
Allyl Alcohol Derivative (CR-39)		G		500
Almond Shell		G		200
Aluminum, A422 Flake	7429-90-5	E		320
Aluminum, Atomized Collector Fines		E	CL	550
Aluminum - cobalt alloy (60-40)		E		570
Aluminum - copper alloy (50-50)		E		830
Aluminum-lithium alloy (15% Li)		E		400
Aluminum-magnesium alloy (Dowmetal)		E	CL	430
Aluminum-nickel alloy (58-42)		E		540
Aluminum-silicon alloy (12% Si)		E	NL	670
Amino-5-nitrothiazole	121-66-4	G		460
Anthranilic Acid	118-92-3	G	M	580
Apricot Pit		G	NL	230
Aryl-nitrosomethylamide		G		490
Asphalt	8052-42-4	F		510
Aspirin [acetol (2)]	50-78-2	G	M	660
Azelaic Acid	09-31-9	G	M	610
Azo-bis-butyronitrile	78-67-1	G		350
Benzethonium Chloride		G	CL	380
Benzoic Acid	65-85-0	G	M	440
Benzotriazole	95-14-7	G	M	440
Beta-naphthalene-axo-dimethylaniline		G		175
Bis(2-hydroxy-5-chlorophenyl) Methane	97-23-4	G	NL	570
Bisphenol-A	80-05-7	G	M	570
Boron, Commercial Amorphous (85% B)	7440-42-8	E		400
Calcium Silicide		E		540
Carbon Black (More Than 8% Total Entrapped Volatiles)		F		
Carboxymethyl Cellulose	9000-11-7	G		290
Carboxypolymethylene		G	NL	520
Cashew Oil, Phenolic, Hard		G		180
Cellulose		G		260
Cellulose Acetate		G		340
Cellulose Acetate Butyrate		G	NL	370
Cellulose Triacetate		G	NL	430
Charcoal (Activated)	64365-11-3	F		180
Charcoal (More Than 8% Total Entrapped Volatiles)		F		
Cherry Pit		G		220
Chlorinated Phenol		G	NL	570
Chlorinated Polyether Alcohol		G		460
Chloroacetoacetanilide	101-92-8	G	M	640
Chromium (97%) Electrolytic, Milled	7440-47-3	E		400
Cinnamon		G		230
Citrus Peel		G		270
Coal, Kentucky Bituminous		F		180
Coal, Pittsburgh Experimental		F		170
Coal, Wyoming		F		180
Cocoa Bean Shell		G		370
Cocoa, Natural, 19% Fat		G		240

(continues)

Alphabetical Listing of Selected Combustible Dust Materials *Continued*

Chemical Name	CAS No.	NEC Group	Code	Layer or Cloud Ignition Temp. (°C)
Coconut Shell		G		220
Coke (More Than 8% Total Entrapped Volatiles)		F		
Cork		G		210
Com		G		250
Com Dextrine		G		370
Corncob Grit		G		240
Cornstarch, Commercial		G		330
Cornstarch, Modified		G		200
Cottonseed Meal		G		200
Coumarone-Indene, Hard		G	NL	520
Crag No. 974	533-74-4	G	CL	310
Cube Root, South America	83-79-4	G		230
Di-alphacumyl Peroxide, on CA	80-43-3	G		180
Diallyl Phthalate	131-17-9	G	M	480
Dicyclopentadiene Dioxide		G	NL	420
Dieldrin (20%)	60-57-1	G	NL	550
Dihydroacetic Acid		G	NL	430
Dimethyl Isophthalate	1459-93-4	G	M	580
Dimethyl Terephthalate		G	M	570
Dinitro-o-toluamide	148-01-6	G	NL	500
Dinitrobenzoic Acid		G	NL	460
Diphenyl	92-52-4	G	M	630
Ditertiary-butyl-paracresol	128-37-0	G	NL	420
Dithane m-45	8018-01-7	G		180
Epoxy		G	NL	540
Epoxy-bisphenol A		G	NL	510
Ethyl Cellulose		G	CL	320
Ethyl Hydroxyethyl Cellulose		G	NL	390
Ethylene Oxide Polymer		G	NL	350
Ethylene-maleic Anhydride Copolymer		G	NL	540
Ferbam™	14484-64-1	G		150
Ferromanganese, Medium Carbon	12604-53-4	E		290
Ferrosilicon (88% Si, 9% Fe)	8049-17-0	E		800
Ferrotitanium (19% Ti, 74.1% Fe, 0.06% C)		E	CL	380
Flax Shive		G		230
Fumaric Acid	110-17-8	G	M	520
Garlic, Dehydrated		G	NL	360
Gilsonite	12002-43-6	F		500
Green Base Harmon Dye		G		175
GuarSeed		G	NL	500
Gulasonic Acid, Diacetone		G	NL	420
Gum, Arabic		G		260
Gum, Karaya		G		240
Gum, Manila		G	CL	360
Gum, Tragacanth	9000-65-1	G		260
Hemp Hurd		G		220
Hexamethylene Tetramine	100-97-0	G	S	410
Hydroxyethyl Cellulose		G	NL	410
Iron, 98% H_2 Reduced		E		290
Iron, 99% Carbonyl		E		310
Isotoic Anhydride		G	NL	700
L-sorbose		G	M	370
Lignin, Hydrolized, Wood-type, Fine		G	NL	450
Lignite, California		F		180
Lycopodium		G		190
Malt Barley		G		250
Manganese	7439-96-5	E		240
Magnesium, Grade B, Milled		E		430
Manganese Vancide		G		120
Mannitol	69-65-8	G	M	460

(continues)

Alphabetical Listing of Selected Combustible Dust Materials *Continued*

Chemical Name	CAS No.	NEC Group	Code	Layer or Cloud Ignition Temp. (°C)
Methacrylic Acid Polymer		G		290
Methionine (I-methionine)	63-68-3	G		360
Methyl Cellulose		G		340
Methyl Methacrylate Polymer	9011-14-7	G	NL	440
Methyl Acrylate		G	NL	440
Methyl		G	NL	480
Milk, Skimmed		G		200
N,N-Dimethylthio-formamide		G		230
Nitropyridone	100703-82-0	G	M	430
Nitrosamine		G	NL	270
Nylon Polymer	63428-84-2	G		430
Para-oxy-benzaldehyde	123-08-0	G	CL	380
Paraphenylene Diamine	106-50-3	G	M	620
Paratertiary Butyl Benzoic Acid	98-73-7	G	M	560
Pea Flour		G		260
Peach Pit Shell		G		210
Peanut Hull		G		210
Peat, Sphagnum	94114-14-4	G		240
Pecan Nut Shell	8002-03-7	G		210
Pectin	5328-37-0	G		200
Pentaerythritol	115-77-5	G	M	400
Petrin Acrylate Monomer	7659-34-9	G	NL	220
Petroleum Coke (More Than 8% Total Entrapped Volatiles)		F		
Petroleum Resin	64742-16-1	G		500
Phenol Formaldehyde	9003-35-4	G	NL	580
Phenol Formaldehyde, Polyalkylene-p	9003-35-4	G		290
Phenol Furfural	26338-61-4	G		310
Phenylbetanaphthylamine	135-88-6	G	NL	680
Phthalic Anydride	85-44-9	G	M	650
Phthalimide	85-41-6	G	M	630
Pitch, Coal Tar	65996-93-2	F	NL	710
Pitch, Petroleum	68187-58-6	F	NL	630
Polycarbonate		G	NL	710
Polyethylene, High Pressure Process	9002-88-4	G		380
Polyethylene, Low Pressure Process	9002-88-4	G	NL	420
Polyethylene Terephthalate	25038-59-9	G	NL	500
Polyethylene Wax	68441-04-8	G	NL	400
Polypropylene (no antioxidant)		G	NL	420
Polystyrene Latex	9003-53-6	G		500
Polystyrene Molding Compound	9003-53-6	G	NL	560
Polyurethane Foam, Fire Retardant	9009-54-5	G		390
Polyurethane Foam, No Fire Retardant	9009-54-5	G		440
Polyvinyl Acetate	9003-20-7	G	NL	550
Polyvinyl Acetate/ Alcohol	9002-89-5	G		440
Polyvinyl Butyral	63148-65-2	G		390
Polyvinyl Chloride-dioctyl Phthalate		G	NL	320
Potato Starch, Dextrinated	9005-25-8	G	NL	440
Pyrethrum	8003-34-7	G		210
Rayon (Viscose) Flock	61788-77-0	G		250
Red Dye Intermediate		G		175
Rice		G		220
Rice Bran		G	NL	490
Rice Hull		G		220
Rosin, DK	8050-09-7	G	NL	390
Rubber, Crude, Hard		G	NL	350
Rubber, Synthetic, Hard (33% S)	64706-29-2	G	NL	320
Safflower Meal		G		210
Salicylanilide	87-17-2	G	M	610
Sevin	63-25-2	G		140

(continues)

Alphabetical Listing of Selected Combustible Dust Materials *Continued*

Chemical Name	CAS No.	NEC Group	Code	Layer or Cloud Ignition Temp. (°C)
Shale, Oil	68308-34-9	F		
Shellac	9000-59-3	G	NL	400
Sodium Resinate	61790-51-0	G		220
Sorbic Acid (Copper Sorbate or Potash)	110-44-1	G		460
Soy Flour	68513-95-1	G		190
Soy Protein	9010-10-0	G		260
Stearic Acid, Aluminum Salt	637-12-7	G		300
Stearic Acid, Zinc Salt	557-05-1	G	M	510
Styrene Modified Polyester-Glass Fiber	100-42-5	G		360
Styrene-acrylonitrile (70-30)	9003-54-7	G	NL	500
Styrene-butadiene Latex (>75% styrene)	903-55-8	G	NL	440
Styrene-maleic Anhydride Copolymer	9011-13-6	G	CL	470
Sucrose	57-50-1	G	CL	350
Sugar, Powdered	57-50-1	G	CL	370
Sulfur	7704-34-9	G		220
Tantalum	7440-25-7	E		300
Terephthalic Acid	100-21-0	G	NL	680
Thorium (contains 1.2% 0)	7440-29-1	E	CL CL	270
Tin, 96%, Atomized (2% Pb)	7440-31-5	E		430
Titanium, 99% Ti	7440-32-6	E		330
Titanium Hydride (95% Ti, 3.8% H)	7704-98-5	E	CL	480
Trithiobisdimethylthio-formamide		G		230
Tung, Kernels, Oil-free	8001-20-5	G		240
Urea Formaldehyde Molding Compound	9011-05-6	G	NL	460
Urea Formaldehyde-phenol Formaldehyde	25104-55-6	G		240
Vanadium, 86.4%	7440-62-2	E		490
Vinyl Chloride-acrylonitrile Copolymer	9003-00-3	G		470
Vinyl Toluene-acrylonitrile Butadiene	76404-69-8	G	NL	530
Violet 200 Dye		G		175
Vitamin B1, Mononitrate	59-43-8	G	NL	360
Vitamin C	50-81-7	G		280
Walnut Shell, Black		G		220
Wheat		G		220
Wheat Flour	130498-22-5	G		360
Wheat Gluten, Gum	100684-25-1	G	NL	520
Wheat Starch		G	NL	380
Wheat Straw		G		220
Wood Flour		G		260
Woodbark, Ground		G		250
Yeast, Torula	68602-94-8	G		260
Zirconium Hydride	7704-99-6	E		270
Zirconium (contains 0.3% 0)	7440-67-7	E	CL	330

Notes:

1. Normally, the minimum ignition temperature of a layer of a specific dust is lower than the minimum ignition temperature of a cloud of that dust. Since this is not universally true, the lower of the two minimum ignition temperatures is listed. If no symbol appears in the "Code" column, then the layer ignition temperature is shown. "CL" means the cloud ignition temperature is shown. "NL" means that no layer ignition temperature is available, and the cloud ignition temperature is shown. "M" signifies that the dust layer melts before it ignites; the cloud ignition temperature is shown. "S" signifies that the dust layer sublimes before it ignites; the cloud ignition temperature is shown.
2. Certain metal dusts may have characteristics that require safeguards beyond those required for atmospheres containing the dusts of aluminum, magnesium, and their commercial alloys. For example, zirconium and thorium dusts may ignite spontaneously in air, especially at elevated temperatures.
3. Due to the impurities found in coal, its ignition temperatures vary regionally and ignition temperatures are not available for all regions in which coal is mined.

Domestic and International Standards Testing and Certifying Organizations

American National Standards Institute (ANSI)
Address: 1899 L Street, NW
11th Floor
Washington, DC 20036
Tel: 1.202.293.8020
Fax: 1.202.293.9287

– The Mission of the American National Standards Institute is to enhance both the global competitiveness of U.S. business and the U.S. quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems, and safeguarding their integrity.

The Institute oversees the creation, promulgation and use of thousands of norms and guidelines that directly impact businesses in nearly every sector: from acoustical devices to construction equipment, from dairy and livestock production to energy distribution, and many more. ANSI is also actively engaged in accrediting programs that assess conformance to standards – including globally-recognized cross-sector programs such as the ISO 9000 (quality) and ISO 14000 (environmental) management systems.

American Petroleum Institute (API)
Address: 1220 L Street, NW
Washington, DC 20005-4070
US

- The Mission of the API is to influence public policy in support of a strong, viable U.S. oil and natural gas industry. The American Petroleum Institute (API) is the only national trade association that represents all aspects of America's oil and natural gas industry. With more than 400 corporate members, from the largest major oil company to the smallest of independents, come from all segments of the industry. They are producers, refiners, suppliers, pipeline operators and marine transporters, as well as service and supply companies that support all segments of the industry.

Although our focus is primarily domestic, in recent years our work has expanded to include a growing international dimension, and today API is recognized around the world for its broad range of programs

Factory Mutual Research Corporation (FM)
Address: 1151 Boston-Providence Turnpike
Norwood MA 02062-9102
Telephone No.: 781-762-4300

FM Approvals mission is to certify products and services with a unique focus on:

- Objectively testing property loss prevention products and services and certifying those that meet rigorous loss prevention standards.
- Encouraging the development and use of FM Approved products and services that improve and advance property loss prevention practices.

FM Approvals strives to be the certification organization of choice, offering Global services with unsurpassed technical integrity and exceptional customer satisfaction. FM is an Occupational Safety & Health Administration (OSHA) recognized organization as a Nationally Recognized Testing Laboratory (NRTL).

The International Society of Automation
67 T.W. Alexander Drive
PO Box 12277
Research Triangle Park, NC 27709
Telephone: (919) 549-8411

The ISA develops standards; certifies industry professionals; provides education and training; publishes books and technical articles; and hosts conferences and exhibitions for automation professionals. ISA is the founding sponsor of the Automation Federation).

The Scope of the ISA12, Electrical Equipment for Hazardous Locations is to formulate standards, recommended practices, and technical reports for safe and practical use of equipment in hazardous (classified) locations, and for equipment used for the detection of combustible gases. The purpose of the committee is to organize, manage, and coordinate all ISA Standards and Practices Department activities related to electrical equipment for installation in hazardous (classified) locations, and for electrical equipment used to detect, alarm, or otherwise process signals relating to the detection of materials within their combustible ranges.

The ISA12 Standards Committee has adopted, with some modifications, many of the IEC 60079 series standards and is closely tied to the work of the TC31 US Technical Advisory Group -- working together toward harmonization with the ISA and IEC standards. The "Harmonized Standards" are published as ANSI/ISA Standards.

IEC Ex
Address: INTERNATIONAL ELECTROTECHNICAL COMMISSION
3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland
Phone No.: + 41 22 919 02 11

IECEx Certified Equipment Scheme Provides assurance that products listed on the IECEx Certificate conform to the International Standards also listed on the same IECEx Certificate.

This system provides an:

- IECEx Test Report (ExTR)
- IECEx Quality Assessment Report (QAR)
- IECEx Certifi cate of Conformity (CoC)

To obtain this certificate, the manufacturer prepares his application and submits it to the relevant

IECEx Certification Body (ExCB). Samples of the equipment will be tested by the laboratory of the ExCB

and a factory inspection will be organized. On-going periodic audits (factory inspections) ensure that the

stringent standards are being maintained by the manufacturer, over time.

Mine Safety and Health Administration (MSHA)
Address: 1100 Wilson Boulevard, 21st Floor
Arlington, VA 22209-3939

OSHA' Mission: The purpose of the Mine Safety and Health Administration is to prevent death, disease, and injury from mining and to promote safe and healthful workplaces for the Nation's miners

National Fire Protection Association (NFPA)
Address: 1 Batterymarch Park
Quincy, Massachusetts
USA 02169-7471
Telephone No: 617-770-3000

The mission of the international nonprofit NFPA, established in 1896, is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education. The world's leading advocate of fire prevention and an authoritative source on public safety, NFPA develops, publishes, and disseminates more than 300 consensus codes and standards intended to minimize the possibility and effects of fire and other risks.

Occupational Safety and Health Administration (OSHA)
Address: U.S. Department of Labor
Occupational Safety & Health Administration
200 Constitution Avenue
Washington, D.C. 20210

With the Occupational Safety and Health Act of 1970, Congress created the Occupational Safety and Health Administration (OSHA) to assure safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education and assistance.

OSHA is part of the United States Department of Labor. The administrator for OSHA is the Assistant Secretary of Labor for Occupational Safety and Health. OSHA's administrator answers to the Secretary of Labor, who is a member of the cabinet of the President of the United States.

Underwriters Laboratories Inc. (UL)
Address: 333 Pfingsten Road
Northbrook IL 60062-2096
Phone No. 847-272-8800

UL is an independent product safety certification organization. Established in 1894 the company has its headquarters in Northbrook, Illinois. UL develops standards and test procedures for products, materials, components, assemblies, tools and equipment, chiefly dealing with product safety. UL also evaluates and certifies the efficiency of a company's business processes through its management system registration programs. Additionally, UL analyzes drinking and other clean water samples through its drinking water laboratory in South Bend, Indiana and evaluates products for environmental sustainability through its subsidiary, UL Environment. UL is one of several companies approved for such testing by the U.S. federal agency Occupational Safety and Health Administration (OSHA). OSHA maintains a list of approved testing laboratories, known as Nationally Recognized Testing Laboratories.

Intertek
3933 US Route 11
Cortland, NY 13045
Phone No.: 1 607 753 6711

Intertek is an OSHA (Occupational Safety & Health Administration) recognized NRTL (Nationally Recognized Testing Laboratory) and is accredited as a TewwwCertification Body by the Standards Council of Canada.

United States Coast Guard
Address: US COAST GUARD
HEADQUARTERS
2100 2ND ST SW STOP 7000
WASHINGTON DC 20593-7000
Phone No. 202-372-4411

The Coast Guard regulates all US Shipping. It also has safety jurisdiction over foreign registry vessels entering US Ports, some port facilities, and offshore drilling operations in US waters. It has its own regulations, published in the Code of Federal Regulations.

CANADA
Canadian Standards Association
Mississauga Office
5060 Spectrum Way, Suite 100
Mississauga, Ontario
Canada, L4W 5N6
Phone No: (416) 747-4000

The Canadian Standards Association is a not-for-profit membership-based association serving business, industry, government and consumers in Canada and the global marketplace. CSA is an Occupational Safety & Health Administration (OSHA) recognized organization as a Nationally Recognized Testing Laboratory (NRTL). Accreditation of a standards development organization (SDO) is the formal recognition of their competence to develop standards, and comply with specific accreditation criteria as determined by the accreditor.

The Standards Council of Canada (SCC) has responsibility for coordination of the National Standards System (NSS) in Canada and has accredited CSA as one of four nationally accredited SDOs.

To achieve and maintain accreditation, several criteria must be met including:

1. Development of consensus standards which adhere to the principles used in Canada governing the consensus process.
2. Complying with criteria established for approval of National Standards of Canada.

INTERNATIONAL
ATEX
European Commission
Enterprise and Industry DG
B - 1049 Brussels (Belgium)

Since July 2003, Ex products that are placed on the European market must be certified to the ATEX directive (ATEX 94/9/EC). This involves the testing and assessment of such products to the latest ATEX standards.

The objective of ATEX is to ensure the free movement of goods throughout the European Union, by offering one harmonized compliance procedure accepted by all EU countries, eradicating the need for differing national standards.

This so called 'New Approach' directive removes barriers to trade by defining Essential Health and Safety Requirements (EHSRs) for Ex equipment. The EHSRs form the basis of an EU-accepted product conformity approval process that examines the potential ignition sources of equipment intended for use in potentially explosive

The Equipment and Protective systems intended for use in Potentially Explosive Atmospheres (ATEX) Directive 94/9/EC provides the technical requirements to be applied and the relevant conformity assessment procedures before placing this equipment on the European market. These requirements are given technical expression by "Harmonized Standards", developed by the European Standardization Organizations: CEN (for non-electrical equipment) and CENELEC (for electrical equipment) - develop standards which references are presented to and published by the European Commission in the Official Journal of the European Union (OJEU).

CENELEC
CEN-CENELEC Management Centre
CENELEC
17, Avenue Marnix
B-1000 Brussels
Phone: +32 2 519 68 71

CENELEC is the European Committee for Electrotechnical Standardization and is responsible for standardization in the electrotechnical engineering field. CENELEC prepares voluntary standards, which help facilitate trade between countries, create new markets, cut compliance costs and support the development of a Single European Market

CENELEC creates market access at European level but also at international level, adopting international standards wherever possible, through its close collaboration with the International Electrotechnical Commission (IEC), under the Dresden Agreement

DEMKO

DEMKO was founded in 1928 by the Danish government with the brief to test the safety of electrical products before they were marketed and sold in Denmark. As Underwriters Laboratories Inc.'s (UL's) major subsidiary, DEMKO is part of the world's largest independent, product safety-testing authority. UL is a not-for-profit organization recognized by manufacturers, retailers, insurance companies, other related authorities and, not least, by the consumers. UL has more than 5.200 employees staffing offices, engineering facilities and testing laboratories in more than 70 countries. In Denmark today, DEMKO is still the National Body for testing of electrical products to the appropriate European or International safety standards. When a product has been affixed with the well-known D-Mark, or has received a DEMKO certificate, the consumer is assured - and the manufacturer has a proof - that the product has been tested to the appropriate safety standards by an authoritative, independent third party. Although, since 1978, electrical products need no longer be affixed with the D-Mark in order to be sold in Denmark, many Danish manufacturers and importers continue to choose to have DEMKO test and affix D-Marks to their products for reasons of consumer safety and European Product Liability legislation.

The International Electrotechnical Commission
3, rue de Varembé
P.O. Box 131
CH - 1211 Geneva 20 - Switzerland
Phone No. : +41 22 919 02 11

Founded in 1906, the IEC (International Electrotechnical Commission) is the world's leading organization for the preparation and publication of International Standards for all electrical, electronic and related technologies. These are known collectively as "electrotechnology".

IEC provides a platform to companies, industries and governments for meeting, discussing and developing the International Standards they require.

All IEC International Standards are fully consensus-based and represent the needs of key stakeholders of every nation participating in IEC work. Every member country, no matter how large or small, has one vote and a say in what goes into an IEC International Standard.

The International Electrotechnical Commission (IEC) is the world's leading organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

Over 10 000 experts from industry, commerce, government, test and research labs, academia and consumer groups participate in IEC Standardization work.

The IEC is one of three global sister organizations (IEC, ISO, ITU) that develop International Standards for the world.

When appropriate, IEC cooperates with ISO (International Organization for Standardization) or ITU (International Telecommunication Union) to ensure that International Standards fit together seamlessly and complement each other. Joint committees ensure that International Standards combine all relevant knowledge of experts working in related areas.

Physikalisch-Technische Bundesanstalt (PTB)
Bundesallee 100,
38116 Braunschweig,

Phone No.: +49 (531) 592-0 PTB is the national metrology institute providing scientific and technical services. PTB measures with the highest accuracy and reliability – metrology as the core competence. PTB's certification body performs conformity assessments within the scope of different certification schemes. On 01-10-2008, the certification body was established by a fusion of the previous 3 certification bodies (a certification body for explosion protection, a certification body for non-automatic weighing instruments and a certification body for measuring instruments) as a horizontal unit which covers all departments of PTB in which product tests, on which the conformity assessments are based, are performed.

SIRA Test & Certification Ltd.
Rake Lane Eccleston
Chester, CH4 9JN, England

Phone No.: +44(0) 1244 670990 Sira has been at the forefront of Hazardous Area issues for over 25 years, and is now a world-leading force in the conformity assessment field. Sira is the UK's leading Notified Body (appointed by the UK Government) specializing in testing and certification of equipment intended for use in potentially explosive atmospheres. In July 2009, Sira was acquired by CSA International, the testing and certification division of the CSA Group. As part of CSA International, Sira forms part of an international conformity assessment company with over 1400 employees and a network of offices and laboratories in 60 countries. Sira has access to expertise and testing/certification facilities specializing in environmental, hazardous location and safe area products.

Comparison of Domestic and International Standards

IEC Standards & ATEX

The early IEC standards were largely based on the national standards of European countries. The first EU Directive [1976] for product standardization prompted the rapid development of Euro-norms [EN] which were numbered in the EN 50014 etc. series. Gradually the IEC 79 series, later re-numbered 60079- series were updated using the EN's as a basis but with growing international input. These were mostly the gas hazard standards. In the late 1990's it was agreed in CENELEC that all work that could be carried out at the IEC level, would be, and the standards voted in parallel as IEC standards and EN's. These standards carry the EN 60079- XX Numbering. The second ATEX directive [1994], introduced further factors. The directive covers gas and dust hazards and both electrical and mechanical equipment. It introduced basic requirements for safety, the "Essential Health and Safety Requirements [ESHR's]". Three levels of safety Categories 1, 2 and 3 were defined effectively as:

Category 1 - "very safe and considering two possible equipment faults"

Category 2 - "safe with one fault"

Category 3 - "safe in normal operation"

Although the performance criteria of the Categories aligned with the expected area of application, the Zones, the designation of equipment protection by zone was removed. The selection of a particular type of explosion protection for a particular zone was by risk assessment.

Rationalization

In order to eliminate this potentially long term anomaly at international level and to introduce the concept of a declared level of safety, IEC agreed to introduce "Equipment Protection Levels" [EPL's]. These EPL's are Ga, Gb and Gc for gas and Da, Db and Dc for dust. Ma and Mb also exist for mining. These are an alternative and additional specification for equipment made in accordance with the standards. The key point is that the definitions of product performance are in effect identical to the ATEX Category Definitions. In future, rationalization may see the EPL's incorporated into ATEX. The basic technical requirements for ATEX and IEC via the IEC Ex scheme (see the section on the IEC Ex scheme) will therefore be identical as EPL's are introduced right across the standards series. The ATEX marking is different from IEC and must be shown in addition to the IEC marking.

Sub-Division

A further effect of the introduction of EPL's is to give a definition to the emergence of sub-divisions in some of the protection concepts. The principle of sub-division is clear when one considers that Intrinsic Safety was divided into ia and ib and is now complimented by ic. Now encapsulation has sub-divisions of ma, mb and mc and Pressurization has px, py and pz. Sub-division of other concepts may be developed in due course and some existing requirements in the Ex n standard may be relocated.

Standards for Combustible Dusts

A further change is the addition to the General Requirements IEC 60079-0 of general requirements common to protection against the ignition of combustible dusts. This enables the dust protection concept standards to be incorporated in the 60079 series. As many equipment enclosures have certification for both gas and dust, this will be of benefit to both manufacturers and users. The current IEC dust standards are the IEC 61241 series. These cover test methods, construction and use. There are also various equipment standard concepts:

- tD, protection by enclosure
- pD pressurization
- mD encapsulation.

As stated, where possible these IEC 61241 standards are being incorporated into the IEC 60079 series. In Europe these standards are becoming Euro Norms (EN's) and supersede the EN 50281 series.

Euro Norms

Because of the movement towards IEC, references to EN's are not used in this introduction except where there is no current Euro-norm in the IEC series, in which case the EN numbering in the EN 50014 etc. series will be given in brackets.

Methods of Protection for Electrical Equipment in Explosive Gas Atmospheres

Explosive atmospheres can be ignited by sparks or hot surfaces arising from the use of electrical power. The hot surfaces can be those of enclosures, components and light sources. Under fault conditions electrical connections may become over-heated and cause arcs or sparks. In addition, sparks may be the result of the inadvertent discharge of stored energy or from switching contacts. Other possible sources of ignition are electrostatic discharges and frictional sparking. A number of methods of protecting against ignition have been established and these have been codified in construction standards. These codes enable manufacturers to design equipment of a uniform type and have it tested by certification authorities for compliance with the standards.

The basic methods of protection are summarized in Table 1.

Method	Type Of Protection
Designed to prevent any means of ignition arising	Ex e Increased Safety Ex nA Non Sparking tD (for dust hazards)
Designed to limit the ignition energy of the circuit	Ex i intrinsic Safety Ex op Optical Radiation Ex nL Energy Limitation
Designed to prevent the explosive mixture reaching a means of ignition	Ex m Encapsulation Ex p Pressurisation Ex o Oil immersion Ex nR Restricted Breathing
Designed to prevent any ignition from spreading outside of the apparatus	Ex d Flameproof Enclosure Ex q Powder Filling Ex nC Non Incendive

Table 1: Methods of Explosion Protection

General Requirements IEC 60079-0

This standard contains general requirements common to the series of standards for the protection sub-groups. Equipment will comply with the general requirements except where they are excluded or varied by the individual protection standard detailed below.

Ex d "Flameproof Enclosure" Protection - IEC 60079-1

The potentially incendive parts are contained within an enclosure into which the explosive atmosphere can enter but which will contain any resultant explosion and prevent its transmission outside of the enclosure.

Ex p "Pressurized Equipment" Protection - IEC 60079-2

One type of pressurization maintains a positive static pressure inside the equipment to prevent entry of gas and maintains a continuous flow of air or inert gas to neutralize or carry away any explosive mixture entering or being formed within the enclosure. In the case of Ex p, the source of release can be internal.

Essential to these methods are continuous monitoring systems to ensure their reliability and purging schedules on installation and following opening for maintenance.

Ex q "Powder Filling" Protection - IEC 60079-5

This technique involves the mounting of potentially incendive components in an enclosure filled with quartz or solid glass particles. The powder filling prevents explosive ignition. It was originally developed to protect heavy duty traction batteries. The method is now primarily of use where the incendive action is related to the abnormal release of electrical energy by the rupture of fuses or failure of components used in electronic equipment. The likelihood of possible incendive failure of the components is assessed and precautions taken to minimize it. Usually Ex q is used for discrete sub-assemblies and components inside Ex e equipment

Ex o "Oil immersion" Protection - IEC 60079-6

This is a technique primarily used for oil filled equipment. The oil acts as an insulating medium.

Ex e "Increased Safety" Protection - IEC 60079-7

Normally sparking components are excluded from this method of protection. Other components are designed to substantially reduce the likelihood of the occurrence of fault conditions which could cause ignition. This is done by reducing and controlling working temperatures, ensuring the electrical connections are reliable, increasing insulation effectiveness and reducing the probability of contamination by dirt and moisture ingress.

Ex i "Intrinsic Safety" Protection - IEC 60079-11

The circuit parameters are reliably controlled to reduce potential spark energy to below that which will ignite the specific gas mixture. This includes the occurrence of one (coded ib) or two (coded ia) component faults and consequent failures in the circuit. Ex ic has no countable faults. It should be noted that this method does not entirely protect against the local over-heating of damaged connections or conductors. These should be kept sound and suitably enclosed against damage.

Ex n "Non Sparking" Protection - IEC 60079-15

For this method, precautions are taken with connections and wiring to increase reliability, though not to as high a degree as for Ex e. Where internal surfaces are hotter than the desired T rating, they can be tightly enclosed to prevent the ready ingress of an explosive atmosphere. This is the "restricted breathing enclosure" technique. The 'Non Sparking' concept also requires that high ingress protection ratings of IP65 and above are built into the design. The coding Ex nR denotes that the protection method employs a restricted breathing enclosure. The restricted enclosure may be confined to the part of the equipment containing the hot components such as lamps. Where the normal non-sparking construction is used the coding is nA. There are other sub codes, nL - energy limitation and nC - non incendive, which refer to simplified forms of other protection methods listed above. The codes are used individually. The Ex n methods have been developed specifically for the design of equipment used in the remotely hazardous area, Zone 2. Ex n meets the basic requirements for ATEX category 3.

Ex m "Encapsulation" Protection - IEC 60079-18

Potentially incendive components are encapsulated, usually by organic resins, which exclude the explosive atmosphere and control the surface temperature under normal and fault conditions. The likelihood of overheating and disruptive failure of the components is assessed and precautions taken to minimize any effect on the protection.

Ex op "Optical radiation" - IEC 60079-28

This is primarily concerned with the control of pulsed and continuous wave optical radiation through fiber optic cable with restrictions on the ratio of emitted optical power to the irradiated area. The protection concepts include Inherently Safe which is analogous to Ex i and provides over-power/energy fault protection. Other methods include mechanical protection of the fiber and optical interlocks.

Ex t "Dust Protection by Enclosure" - IEC 60079-31

This method is applicable to electrical equipment protected by enclosure and surface temperature limitation for use in explosive and dust atmospheres. This standard will supersede IEC 61241-1. IEC 60079-31 combines practices A and B into a single practice

Protection Against the Ignition of Atmospheres Containing Dusts

Most of the gas protection techniques will in practice protect against dust ignition. The enclosure method, where dust is effectively excluded and the external surface temperature defined, is generally used for lighting. In the product data this is referred to as "dust protected enclosure". This is currently standardized as tD with sub-division into Practice A and Practice B as defined in 60079-14. With the advent of EPL the coding tD will be superseded by ta, tb and tc, and Practice A and B will be combined. Sub divisions of Ex m; maD and mbD, Ex i; iaD and ibD also Ex p; pD have been introduced for dusts.

Classification of Hazardous Areas and the Use of Protected Equipment

Codes of practice have been established for the classification of the potential hazards, the selection of suitable equipment to protect against the hazard and its installation and maintenance. The codes of practice list the methods of protection which, if used individually or in combination, may be employed to achieve an acceptable margin of safety. The hazardous areas are classified in Table 2 according to IEC 60079-10-1 and IEC 61241-10-2.

Zone	Description
Zone 0 and Zone 20	An area in which an explosive atmosphere is continuously present or for long periods or frequently
Zone 1 and Zone 21	An area in which an explosive atmosphere is likely to occur occasionally in normal operation
Zone 2 and Zone 22	An area in which an explosive atmosphere is not likely to occur in normal operation but, if it does occur, will persist for a short period only
Note: the definitions are for areas containing gas mist or vapour mixtures with air. The dust Zones have been added for ease of understanding and the definitions are effectively the same.	

Table 2: Hazardous Areas Classification

The deployment of protected apparatus in hazardous areas classified to IEC 60079-10-1 and EN 60079-10-2 is summarized according to IEC 60079-14 in table 3.

Zone	Type of Protection Assigned to Equipment	EPL
Zone 0	Ex ia Ex ma and types of protection suitable for Zone 0 as constructed to IEC 60079-26	Ga
Zone 1	Any type of protection suitable for Zone 0 and Ex d, Ex ib, Ex py, Ex e, Ex q and Ex mb (Also see notes on Ex s protection)	Gb
Zone 2	Any type of protection suitable for Zone 0 or 1 and Ex n, Ex mc, Ex ic, Ex pz and Ex o (Also see notes on Ex s protection)	Gc
Zone 20	tD A20, tD B20, iaD and maD	Da
Zone 21	Any type of protection suitable for Zone 20 and tD A21, tD B21, ibD, mbD and pD	Db
Zone 22	Any type of protection suitable for Zone 20 or 21 and tD A22 IP 6X	Dc
The suffix A and B for the dust protection methods refer to the two Practices A and B for the assessment of temperature with and without dust layers.		

Table 3: Selection of Protected Equipment in Hazardous Areas generally according to IEC 60079-14

The EU ATEX Directives

The relevant directives of the EU are:

- 94/9/EC Equipment and protective systems intended for use in potentially explosive
- 99/92/EC Minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres.

The directives are adopted into national law by the individual member states. Some candidate entrant states have also aligned their national regulations with ATEX.

ATEX covers hazards arising from the use of both electrical and mechanical equipment in explosive atmospheres. The ATEX equipment directive and the accompanying health and safety directive, specifying the protection of workers, apply to the European Union. The safety directive requires hazardous areas to be subjected to a risk analysis, classified into Zones and suitably equipped.

The manufacturer must make a declaration of compliance with the equipment directive and apply the CE mark before the product can be placed on the market in the EU.

The individual governments of the member states appoint "Notified Bodies" to carry out testing and certification. Equipment is divided into Equipment Groups (Group I for mining and Group II non-mining), the ignitable component of the explosive atmosphere, Gas (G) and Dust (D) and Categories 1, 2 and 3. The Categories provide respectively, very high, high and normal levels of protection against ignition.

The Categories should be considered as achieving the level of protection obtained by applying the existing protection techniques (Ex d, Ex e, Ex i, etc) no numerical basis has yet been devised for the expected safety level of categories or of equipment. Alternatively, the existing techniques can be replaced or supplemented by new concepts and engineering judgments made by the manufacturer in the design and construction of the equipment. Where required, this would be validated by notified bodies performing an EC type examination of the product.

In practice, the Categories are equated to suitability for Zones. The actual category of equipment specified by the user for a Zone will depend on the overall risk assessment. Zoning considers only the probability of the occurrence of an explosive atmosphere, its extent and duration. It does not consider possible consequential effects of an ignition having taken place, or of the environmental conditions at a particular site. Equipment will be marked with the Grouping and Category in addition to the marking required by the individual protection standards.

The ATEX directive lists "The Essential Health and Safety Requirements" (EHSR's) required to comply with the directive, in addition the product must be "safe". The term "safe" covers any property which is not covered by the directive, but is known to or could have been reasonably foreseen by the manufacturer. Compliance with the Euronorm gives a presumption of conformity with those aspects of the directive covered by the standard. Lists of these standards are published in the official journal (OJ) of the EU. The European Commission web site (www.europa.eu) contains a large quantity of material concerning the directives along with the actual directive itself and the guidelines for its application.

Examination Certificates

An EC type examination by a notified body is mandatory for Category 1 and 2 electrical equipment but not for Category 3.

The designation EC can not be used for certification of Category 3 equipment. In the data the term "type examination" rather than "EC type examination" is used for Category 3 equipment.

IEC and ATEX

The relationship between IEC Equipment Protection Levels, ATEX Categories and applications is shown below in table 4.

IEC EPL	ATEX Category	Degree of Safety	Design Requirement	Expected Zone of Use
Ga	Category 1	Very high level of protection	Two independent means of protection or safe with two independent faults	Zone 0
Da	Category 1	Very high level of protection	Two independent means of protection or safe with two independent faults	Zone 20
Gb	Category 2	High level of protection	Safe with frequently occurring disturbances or with a normal operating fault	Zone 1
Db	Category 2	High level of protection	Safe with frequently occurring disturbances or with a normal operating fault	Zone 21
Gc	Category 3	Enhanced level of protection	Safe in normal operation	Zone 2
Dc	Category 3	Enhanced level of protection	Safe in normal operation	Zone 22

Table 4: EPL, Atex Category, Design Requirements and Expected Application

Equipment Protection Levels (EPLs) are used as part of a risk assessment approach to the selection of Ex equipment. It is beneficial to identify and mark equipment according to their inherent ignition risk thus making selection easier and provide the basis of a better risk assessment approach, where appropriate.

Marking of an ATEX Product and the CE Mark

A product that carries the ATEX marking will include the CE mark, , the Group, the Category and the Category sub-group G or D. The product also carries the normal coding, Ex d etc. and the surface temperature and ambient temperature (Tamb) ratings. The Group also forms part of the marking in the product standards and pre-dates ATEX.

The Category is additional to the marking in accordance with the standard. This means that all of the familiar marking is still present. All products carry the general product safety and electromagnetic compatibility CE mark on the product, installation manual or packaging, as appropriate.

The marking attests that the product meets the requirements of the Low Voltage and Electro-Magnetic Compatibility (EMC) directives of the EU as transposed into UK law. If the product carries the CE mark for ATEX it is not repeated. The scope of compliance is given in the IOM. Products exported directly outside of the European Community are not required to carry any CE marking but local marking regulations may apply.

Surface Temperature Rating and Gas Grouping

Any explosive mixture can be classified for explosion protection under two main characteristics, temperature of ignition by a hot surface and the spark energy to ignite it.

The spark energy of ignition is also related to the intensity of the explosion. This latter property is crucial to the design of the joints in flameproof enclosures (Ex d) and the energy level limit of intrinsically safe (Ex i) and energy limited circuits.

Other important subsidiary characteristics are the specific gravity and flash point, which are used in the determination of the area classification

Surface Temperature for Ignition

The surface temperature rating is measured in the most onerous design attitude at the most severe supply voltage condition within the design tolerance. Usually this is +10% of rated voltage for lighting and with any fault or overload condition which could normally occur in service.

A normal overload condition for motors may be the starting or stalled condition and, for luminaires, the end of life of a lamp. In the case of Ex d, Ex m, Ex q, Ex nR and dust proof enclosure methods, the maximum temperature is measured on the external surface. In other methods of protection the maximum internal temperature of the equipment is measured.

The explosive mixtures are allocated into broad bands giving the Temperature Classes shown in Table 5.

Temperature Class	Maximum Surface Temperature °C
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

Table 5: Classification of Maximum Surface Temperatures for Electrical Temperatures for Electrical Equipment IEC 60079-0

For dust protection using the enclosure methods, the surface temperature is limited to a given value in °C, the T grouping prefix is not used.

Gas Grouping

The gases, vapors and dusts are classified as shown in Table 6. The possible number of chemical compounds is extensive and the list shown is only representative.

The changes introduced in IEC 60079-0 Edition 5 affect the marking of Groupings as all Group II and III equipment must be marked with the subdivision A, B, or C

Group	Representative Gases and Dusts
I	All underground coal mining. Firedamp (methane)
IIA	Industrial methane, propane, petrol and themajority of industrial gasses
IIB	Ethylene, coke oven gas and other industrial gasses
IIC	Hydrogen, acetylene, carbon disulphide
IIIA	Combustible flyings
IIIB	Non-conductive dust
IIIC	Conductive dust

Table 6: Gas and Dust Grouping for Electrical Equipment for IEC 60079-0

Protection of Explosive Atmospheres formed from Combustible Dusts

Explosives dusts i.e. those not requiring the presence of air to ignite are outside the scope of ignitable dust protection. With respect to the formation of an explosive atmosphere, the nature of dust is very different to that of gas or vapor. Dust, unlike gas does not disperse, it remains until cleared away by manual means or ventilation and can form layers. Layers of dust can ignite at much lower temperatures than clouds. This is because layers can insulate and increase the temperature and also because layers of some dust are prone to spontaneous combustion. The ignition of layers results in burning which can subsequently translate into an explosion. Layers have the potential to be disturbed and form clouds. Ignition data for dusts is given for clouds and layers. Typically, dust in a cloud form is harder to ignite than gas either by a hot surface or a spark. The maximum allowable surface temperature for equipment present in dust clouds is de-rated from the actual surface temperature of ignition of the dust.

The allowable surface temperature for layers is subject to further de-rating where layers exceed 5mm thick and extra heavy layers require special laboratory investigation by the specifier or user. When installing floodlights, care must be taken to ensure that the face of the glass is positioned at such an angle that dust cannot settle. Ignitable atmospheres caused by dust may also be prevented from arising by ventilation, containment and by good housekeeping.

Area Classification

The area classification for dust is similar to that for gas, namely, Zone 20, Zone 21 and Zone 22, depending on the likelihood of a hazardous dust atmosphere being present (refer to table 2). As a generality, the zones are smaller than those for gas. Equipment may be marked as suitable for both gas and dust hazards.

If the equipment carries marking for both dust and gas this does not mean both at the same time.

Where an explosive gas atmosphere and a combustible dust atmosphere are or may be present at the same time, the simultaneous

presence of both shall be considered and may require additional protective measures. The potential for ignition must be investigated by a qualified person.

Protection Methods

The enclosure method, where dust is effectively excluded and the external surface temperature defined, is generally used for lighting. In the product data this is referred to as "dust protected enclosure". This is now standardized as tD with sub-division into Practice A and Practice B. The next edition of IEC 60079-14 shall align with the protection concepts and include ta, tb and tc with Practice A and Practice B combined. Sub divisions of Ex m; maD and mbD, Ex i; iaD and ibD also Ex p; pD have been introduced. The dust ignition protection method is by surface temperature limitation and enclosure to IP6X or IP5X as appropriate. IP6X is required for ATEX Category 1 and 2 and for conducting dusts in any Category. Ingress of a conducting dust can cause incendive insulation failure. IP5X is a minimum for Category 3. The surface temperature is limited to a given value in °C.

The table below outlines the difference between practices A and B.

Practice A - Performance Based	Practice B - Performance Based and Prescriptive
Maximum surface temperature is determined with 5 mm layer of dust and installation rules require 75K margin between the surface temperature and ignition temperature of a particular dust.	Maximum surface temperature is determined with 12.5 mm layer of dust and installation rules require 25K margin between the surface temperature and ignition temperature of a particular dust.
A method of achieving the required dust ingress protection by the use of resilient seals on joints and rubbing seals on rotating or moving shafts or spindles and determining dust ingress according to IEC 60529 - IP code.	A method of achieving the required dust ingress protection by specified widths and clearances between joint faces and, in the case of shafts and spindles, specified lengths and diametrical clearances and determining dust ingress by a heat cycling test.

Table 7: Comparison of Practice A and B For Dust Protected Enclosures

The IEC Ex Scheme

The IEC Ex scheme is an international certification scheme based on the use of IEC standards. This is now well established and has a large group of participants including all the major manufacturing countries. In each member country, test laboratories and certification bodies have been vetted and joined the scheme. These organizations now accept each other's test reports prepared under the scheme and issue certificates of conformity with IEC standards. The certificates will carry the IEC certification mark. The ultimate objective is the acceptance of one certificate regardless of origin to show that explosion protected equipment is safe for use. A fundamental requirement of the scheme is that participating countries align their national standards with IEC.

International Standards

Two distinct groups of equipment standards used world-wide are the IEC/EN (Euronorm) series of standards and those used in the USA and areas influenced by US practice. A large proportion of work on hazardous area and equipment standards is now being carried out at IEC level and almost all EN's are identical with IEC.

Many countries which have their own national standards have adopted the IEC standards in their entirety or incorporated material from them. The practice in the US has developed differently. The US engineering practice, legal requirements, regulations and the use of approval organizations such as UL, FM and ETL mean that, while the safety principles are much the same as in the rest of the world, the detail is significantly different. The US code of practice is the *National Electrical Code* (NEC) and the 'standard' exclusively used, until recently, for luminaires is ANSI/UL844. This standard integrates the designation of the hazardous area in which equipment is designed to be used and the protection method. For lighting purposes the types of protection are a flameproof type and a non-sparking type. These are used in Class 1 Division 1, and Class 1 Division 2 areas which are broadly equivalent to Zone 1 and Zone 2 respectively. Dust and fiber hazards are Classes II and III.

The construction and testing of dust protected enclosures is different to EN but is currently partially incorporated as an additional alternative in the IEC standards. In both codes the gases and compounds are classified by surface temperature of ignition and grouped into ignition groups for the dimensioning of flameproof joints and for intrinsic safety. The classification and grouping are broadly similar to IEC but differ in detail. The classification and protection cannot be mixed and must be used as complementary pairs.

A general comparison between IEC and NEC practice for gas hazard protection is shown in Tables 8 and 9. The US standards are also influenced by the use of conduit wiring systems which, in contrast to cable, form a flameproof distribution method for Class 1 Division 1 and a damage and ingress protected distribution method for Division 2.

NEC - Zone Classification

The NEC has now introduced the Zone classification concept for gas hazards as an alternative to the Division method. To support this UL and ISA have Introduced ANSI Standards based on the IEC Standards.

Where products comply with the US ANSI Standards based on IEC, the designation AEx is applied on the marking.

North American Temperature Code	IEC/CENELEC/NEC 505 Temperature Classes	Maximum Temperature	
		˚C	˚F
T1	T1	450°C	842°F
T2	T2	300°C	572°F
T2A	—	280°C	536°F
T2B	—	260°C	500°F
T2C	—	230°C	446°F
T2D	—	215°C	419°F
T3	T3	200°C	392°F
T3A	—	180°C	356°F
T3B	—	165°C	329°F
T3C	—	160°C	320°F
T4	T4	135°C	275°F
T4A	—	120°C	248°F
T5	T5	100°C	212°F
T6	T6	85°C	185°F

Table 8: Comparison of Surface Temperature Classification IEC and NEC

Representative Gas	Explosion Group IEC 60079-0	Explosion Group National Electrical Code
Acetylene	IIC	A
Carbon disulphide	IIC	B
Hydrogen	IIC	B
Ethylene oxide	IIB	B
Hydrogen sulphide	IIB	C
Ethylene	IIB	C
Acrylo-nitrile	IIA	D
Industrial methane	IIA	D
Propane	IIA	D
Ethyl acetate	IIA	D

Table 9: Comparison of Representative Gases in IEC and NEC Gas Groups

Resistance to Mechanical Protection

The standards usually contain two levels of impact resistance these being appropriate to high and low risk of impact. The selection will depend on the mounting position. If the equipment is only suitable for low impact the certificate is suffixed X or the information is included in the installation information. The tests are conducted at both below the lowest permitted ambient temperature and above the highest. 10 Joules is equivalent to 1 Kilogram dropped from a height of 1 meter. A 25 mm diameter hemispherical steel impact piece is used.

Part of apparatus tested	Impact energy in Joules IEC 60079-0	
	High Risk of Mechanical Danger	Low Risk of Mechanical Danger
Enclosures and Guards	7	4
Light transmitting parts without guard	4	2
Light transmitting parts with guard when tested without guard	2	1

Table 10: Impact Energy Requirements IEC 60079-0 Group II Equipment

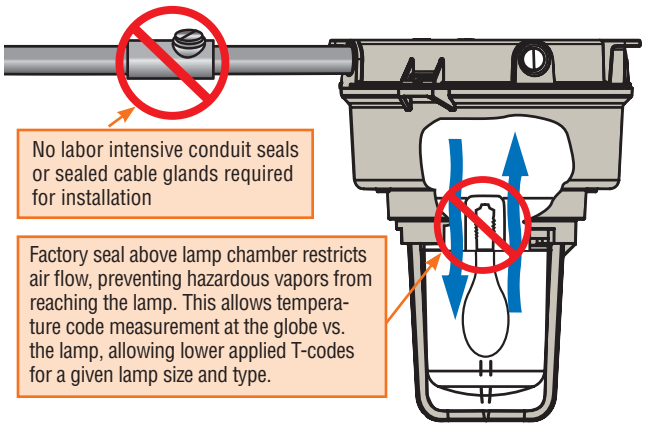
Operational Temperatures T_{amb}

The operational temperature limits, T_{amb}, are based on both product function and the Ex protection standards. As a general guide the normal upper limit is 40°C but some equipment is rated at other temperatures which may be linked to the surface temperature rating or the temperature limit of operation. The normal lower limit for Ex products is -20°C unless otherwise noted on the certificate or data. -20°C to 40°C is the standard level given in IEC 60079-0 and if these are the limits, the product does not need to be marked with the T_{amb}.

Where the range is other than -20°C to 40°C the upper and lower limits are both marked. The lowest certified T_{amb} is not always the actual lowest temperature for functional operation, especially for luminaires where the lamp may not be suitable because of temperature limitation. In some cases the lowest temperature for Ex use is lower than a temperature at which the lamp will start or the product will function properly. The lower limits of operation and starting for lamps and for batteries can be obtained from the manufacturer. A guide is -40°C for HPS, -30°C for Metal halide, -25°C for Mercury vapor, -45°C for LED and as low as -30°C for fluorescent depending on the control gear used and -10°C for battery operated equipment.

Non-Metallic Control Stations

Non-Metallic Lighting Fixtures



Luminaire with Optional Restricted Breathing

Protection Classes of Enclosures (IP Code)

IP Codes are comparable to NEMA Enclosure Types.

The IP classification system designates, by means of a number, the degree of protection provided by an enclosure and the electrical equipment against physical contact, foreign bodies and water ingress.

The protection classes for electrical equipment in respect of:

I. Protection of persons against contact with live or moving parts. (Physical contact protection)
II. Protection against ingress of solid foreign bodies. (Foreign body protection)
III. Protection against ingress of water. (Water protection)

Structure and use of the IP Code:

I. If a code digit does not have to be given it should be replaced with the letter "X".
II. Additional and/or supplementary letters may be omitted without substitute letters.
III. If more than one supplementary letter is required, alphabetical order should be followed.

The numbering system and degree of protection follows:

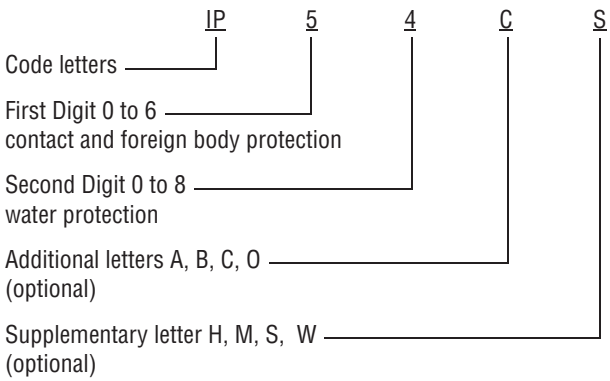
The additional (optional) letter concerns protection of persons and refers to information about protection against access to dangerous parts by:

I.	Back of the hand	letter A
II.	Finger	letter B
III.	Tool	letter C
IV.	Wire	letter O

The supplemental (optional) letter concerns protection of the equipment and provides supplementary information specially for:

I.	High voltage equipment	letter H
II.	Water-proofing during operation	letter M
III.	Water-proofing during standstill	letter S
IV.	Weather conditions	letter W

IP Code: Numbering System



Ingress Protection

The IEC standard for Ingress Protection is IEC 60529. The definitions of the IP code are summarized in Table 11. The US has a system using the ANSI/NEMA 250 code which is similar but also contains tests for corrosion resistance.

First Digit Numeral	Degree of Protection (Foreign Bodies)	Second Digit Numeral	Degree of Protection (Liquids)
0	No protection	0	No protection
1	Protection against ingress of large solid foreign bodies	1	Protection against drops of water
2	Protection against ingress of medium sized solid foreign bodies	2	Protection against drops of liquid falling at any angle up to 15° from vertical
3	Protection against ingress of small solid foreign bodies greater in diameter than 2.5mm	3	Protection against rain falling at any angle up to 60° from the vertical
4	Protection against ingress of small solid foreign bodies greater in diameter than 1mm	4	Protection against splashing. Liquid splashed from any direction shall have no harmful effect
5	Protection against ingress of dust in an amount sufficient to interfere with satisfactory operation of the enclosed equipment	5	Protection against water projected by nozzle from any direction
6	Complete protection against ingress of dust	6	Protection against powerful water jets
		7	Protection against temporary immersion in water
		8	Protection against indefinite immersion in water. Tests to be agreed between supplier and customer.

Table 11: Definition of Ingress Protection

NEMA Type Enclosures

Definitions Pertaining to Nonhazardous Locations

Type 1 Enclosures

Type 1 Enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling dirt.

Type 2 Enclosures

Type 2 Enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling water and dirt.

Type 3 Enclosures

Type 3 Enclosures are intended for outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust; and damage from external ice formation.

Type 3X Enclosures

Type 3X Enclosures are constructed for either indoor or outdoor used to provide a degree of protection against access to hazardous parts; to provide a degree of protection for equipment inside the enclosure against ingress from solid foreign objects such as falling dirt and windblown dust, and from the ingress of water, rain, sleet or snow. These enclosures also provide an increased level of protection against corrosion and that will be undamaged by the external formation of ice on the enclosure.

Type 3R Enclosures

Type 3R Enclosures are intended for outdoor use primarily to provide a degree of protection against rain, sleet; and damage from external ice formation.

Type 3RX Enclosures

Type 3RX Enclosures constructed for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection for equipment inside the enclosure against ingress from solid foreign objects such as falling dirt and from the ingress of water, rain, sleet or snow. These enclosures also provide an increased level of protection against corrosion and that will be undamaged by the external formation of ice on the enclosure.

Type 3S Enclosures

Type 3S Enclosures are intended for outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust; and to provide for operation of external mechanisms when ice laden.

Type 3SX Enclosures

Type 3SX Enclosures are constructed for either indoor or outdoor used to provide a degree of protection against access to hazardous parts; to provide a degree of protection for equipment inside the enclosure against ingress from solid foreign objects such as falling dirt and windblown dust, and from the ingress of water, rain, sleet or snow. These enclosures also provide an increased level of protection against corrosion and the external mechanism(s) remain operable when ice laden.

Type 4 Enclosures

Type 4 Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, hose directed water; and damage from external ice formation.

Type 4X Enclosures

Type 4X Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, hose directed water; and damage from external ice formation.

Type 5 Enclosures

Type 5 Enclosures are intended for indoor use primary to provide a degree of protection against settling airborne dust, falling dirt, and dripping noncorrosive liquids.

Type 6 Enclosures

Type 6 Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against hose directed water, the entry of water during occasional temporary submersion at a limited depth; and damage from external ice formation.

Type 6P Enclosures

Type 6P Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against hose-directed water, the entry of water during prolonged submersion at a limited depth; and damage from external ice formation.

Type 12 Enclosures

Type 12 Enclosures are intended for indoor use primarily to provide a degree of protection against circulating dust, falling dirt, and dripping noncorrosive liquids.

Type 12K Enclosures

Type 12K Enclosures with knockouts are intended for indoor use primarily to provide a degree of protection against circulating dust, falling dirt, and dripping noncorrosive liquids.

Type 13 Enclosures

Type 13 Enclosures are intended for indoor use primarily to provide a degree of protection against dust, spraying of water, oil, and noncorrosive coolant.

Definitions Pertaining to Hazardous (Classified) Locations

Type 7 Enclosures

Type 7 Enclosures are intended for indoor use in locations classified as Class I, Groups A, B, C, or D, as defined in the *National Electrical Code®*.

Type 8 Enclosures

Type 8 Enclosures are for indoor or outdoor use in locations classified as Class I, Groups A, B, C, or D, as defined in the *National Electrical Code®*.

Type 9 Enclosures

Type 9 Enclosures are intended for indoor use in locations classified as Class II, Groups E, F, and G, as defined in the *National Electrical Code®*.

Type 10 Enclosures

Type 10 Enclosures are constructed to meet the applicable requirements of the Mine Safety and Health Administration.

* Refer to NEMA Standards Publication No. 250 Enclosures for Electrical Equipment (1000 Volts Maximum) or other third party certification standards for specific requirements for product construction, testing and performance such as Underwriters Laboratories Inc.®, Standard UL 50 “Standard for Enclosures for Electrical Equipment”.

Comparison of Specific Applications of Enclosures for Indoor Nonhazardous Locations

Provides a Degree of Protection Against the Following Environmental Conditions	Type of Enclosure									
	1*	2*	4	4X	5	6	6P	12	12K	13
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X	X	X	X
Falling dirt	X	X	X	X	X	X	X	X	X	X
Falling liquids and light splashing	-	X	X	X	X	X	X	X	X	X
Circulating dust, lint, fibers, and flyings**	-	-	X	X	-	X	X	X	X	X
Settling airborne dust, lint, fibers, and flyings**	-	-	X	X	X	X	X	X	X	X
Hosedown and splashing water	-	-	X	X	-	X	X	-	-	-
Oil and coolant seepage	-	-	-	-	-	-	-	X	X	X
Oil and coolant spraying and splashing	-	-	-	-	-	-	-	-	-	X
Corrosive agents	-	-	-	X	-	X	-	-	-	-
Occasional temporary submersion	-	-	-	-	-	X	X	-	-	-
Occasional prolonged submersion	-	-	-	-	-	X	-	-	-	-

* These enclosures may be ventilated. However, Type 1 may not provide protection against small particles of falling dirt when ventilation is provided in the enclosure top.

** These fibers and flyings are nonhazardous materials and are not considered as Class III type ignitable fibers or combustible flyings. For Class III type ignitable fibers or combustible flyings see the *National Electrical Code®*, Article 500.

Comparison of Specific Applications of Enclosures for Indoor and Outdoor Nonhazardous Locations

Provides a Degree of Protection Against the Following Environmental Conditions	Type of Enclosure						
	3	3R***	3S	4	4X	6	6P
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X
Rain, snow, sleet*	X	X	X	X	X	X	X
Sleet**	-	-	X	-	-	-	-
Windblown dust	X	-	X	X	X	X	X
Hosedown	-	-	-	X	X	X	X
Corrosive agents	-	-	-	-	X	-	X
Occasional temporary submersion	-	-	-	-	-	X	X
Occasional prolonged submersion-	-	-	-	-	-	-	X

* External operating mechanisms are not required to operate when the enclosure is ice covered.

** External operating mechanisms are operable when the enclosure is ice covered.

*** These enclosures may be ventilated.

Comparison of Specific Applications of Enclosures for Indoor Hazardous (Classified) Locations

Provides a Degree of Protection Against Atmospheres Typically Containing Hazardous Gases, Vapors, and Dusts ***		Type of Enclosure NEMA 7 & 8 Class I Groups**				Type of Enclosure NEMA 8 Class II Groups**			
	Class	A	B	C	D	E	F	G	10
Acetylene	I	X	-	-	-	-	-	-	-
Hydrogen, manufactured gases	I	-	X	-	-	-	-	-	-
Diethyl ether, ethylene, cyclopropane	I	-	-	X	-	-	-	-	-
Gasoline, hexane, butane, naptha, propane, acetone, toluene, isoprene	I	-	-	-	X	-	-	-	-
Metal dusts	II	-	-	-	-	X	-	-	-
Carbon black, coal dust, coke dust	II	-	-	-	-	-	X	-	-
Flour, starch, grain dust	II	-	-	-	-	-	-	X	-
Fibers, flyings *	III	-	-	-	-	-	-	X	-
Methane with or without coal dust	MSHA	-	-	-	-	-	-	-	X

* Due to the characteristics of the gas, vapor, or dust, a product suitable for one Class or Group may not be suitable for another Class or Group unless so marked on the product.

** For Class III type ignitable fibers or combustible flyings refer to the *National Electrical Code®* Article 500.

*** For a complete listing of flammable liquids, gases, or vapors refer to NFPA 497 - 1997 (Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas and NFPA 325 - 1994 (Fire Hazard Properties of Flammable Liquids, Gasses, and Volatile Solids). Reference also NFPA 499 – 1997 Classifications of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas or refer to Appendix A and B.

NEMA Enclosure Types vs. IEC Classification Designation

NEMA Enclosure Type Number	IEC Enclosure Classification
1	IP20
2	IP 22
3	IP55
3X	IP55
3R	IP24
3RX	IP24
3S	IP55
3SX	IP55
4	IP66
4X	IP66
5	IP53
6	IP67
6P	IP68
12	IP54
12K	IP54
13	IP54

(Cannot be used to convert IEC Classification Designations to NEMA Type Numbers)

Refer to NEMA Standards Publication No. 250 for complete information on NEMA Enclosure Types.

Definitions and Terms

Adequately Ventilated Area.

An adequately ventilated area is an area that has a ventilation system (natural or artificial) that, as a minimum, prevents the accumulation of gases or vapors to an explosive level. Most standards and recommended practices recommend preventing levels in excess of 25 percent of the Lower Flammable Limit, LFL.

AEx.

Required marking prefix for equipment meeting one or more types of protection in ANSI/ISA-60079-0 or ANSI/ISA-61241-0.

Approved.

Acceptable to the authority having jurisdiction.

Associated Apparatus.

Apparatus in which the circuits are not intrinsically safe themselves but affect the energy in the intrinsically safe circuits and are relied upon to maintain intrinsic safety. Associated electrical be either:

a) electrical apparatus that has an alternative type of protection for use in the appropriate hazardous (classified) location, or

b) electrical apparatus not so protected that shall not be used within a hazardous (classified) location.

ATEX, ATEX Directive.

European Directive 94/9/EC (also referred to as ATEX 95 or 100a Directive) for electrical and mechanical equipment used in hazardous locations. A parallel directive for use, 1999/92/EC (also referred to as ATEX 137 Directive), requires zoning and risk assessment in the workplace.

Combustible Dust.

Any finely divided solid material that is 420 microns (0.017 in.) or smaller in diameter (material passing a U.S. No. 40 Standard Sieve) and presents a fire or explosion hazard when dispersed and ignited in air.

Bonding.

The permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.

Certified.

Generic term referring to equipment that has been evaluated by a recognized testing agency and confirmed to be in compliance with the applicable standard(s).

Degree of Protection (IP).

a system of rating standard levels of protection provided by equipment for the protection of persons against contact with live or moving parts inside the equipment, as well as the protection provided by equipment against ingress of solids and/or liquids. This type of protection classification is in addition to (and not an alternative to) the types of protection necessary to ensure protection against ignition in hazardous (classified) locations. Definitions are found in IEC Publication 60529.

Device.

A unit of an electrical system that carries or controls electric energy as its principal function.

Dust-ignitionproof.

A term used to describe an enclosure that will exclude dust and that, when installed in accordance with the original design intent, will not permit arcs, sparks, or heat otherwise generated or liberated inside the enclosure to cause ignition of exterior accumulations or atmosphere suspensions of a specified dust in the vicinity of the enclosure.

Dust Layer, Combustible.

Any surface accumulation of combustible dust that is thick enough to propagate flame or will degrade and ignite.

Dust-protected Enclosure.

A term describing an enclosure in which the ingress of dust is not totally prevented, but dust does not enter in sufficient quantity to interfere with the safe operation of the equipment or accumulate in a position within the enclosure where it is possible to cause an ignition hazard.

Dust-tight Enclosure.

An enclosure so constructed that dust will not enter the enclosing case under specified test conditions.

Electrical Equipment.

Items applied as a whole or in part for the utilization of electrical energy. These include, among others, equipment for the generation, transmission, distribution, storage, measurement, regulation, conversion, and consumption of electrical energy and items for telecommunication.

Ex.

Designation of explosion-protected electrical equipment complying with EN 50014.

NOTE: When EN 50014 was replaced by EN 60079-0, the marking was replaced with just Ex.

Energized.

Electrically connected to a source of potential difference

Equipment Protection Level EPL.

Level of protection assigned to equipment based on its likelihood of becoming a source of ignition and distinguishing the differences between explosive gas atmospheres, explosive dust atmospheres, and the explosive atmospheres in mines susceptible to firedamp (Annex A).

Ex Component.

Part of electrical equipment for explosive atmospheres which is not to be used alone in such atmospheres and which requires additional evaluation of any electrical equipment with which it is used.

IEC Ex Scheme.

An international system of certification for explosion-protected electrical equipment administered by the IECEx Management Committee and described by IECEx 01. The goal of this scheme is that a manufacturer of hazardous location electrical equipment would be able to obtain a single 'IEC Ex' Certificate of Conformity from one Certification Laboratory and provide that product in ANSI/ISA-12.01.01-2009 - 16 - any participating country without legal or technical obstacle and without the need to get it recertified locally.

Explosionproof.

A term used to describe an enclosure that is capable of withstanding an explosion of a specified gas or vapor that may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and that operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby. (NEC)

Explosive Atmosphere.

A mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapor, mist, or dust in which, after ignition, combustion spreads throughout the unconsumed mixture.

Fibers and Flyings.

These are materials not normally in suspension in air; and are of larger particle size than dusts. Fibers and flyings include materials such as cotton linters, sawdust, textile fibers, and other large particles that are usually more a fire hazard than an explosion hazard.

Flameproof.

A type of protection of electrical equipment in which an enclosure will withstand an internal explosion of a flammable mixture which has penetrated into the interior, without suffering damage and without causing ignition, through any joints or structural openings in the enclosure, of an external explosive atmosphere consisting of one or more of the gases or vapors for which it is designed. This type of protection is referred to as "d."

Flammable Limits.

The flammable limits of a gas or vapor are the lower (LFL) and upper (UFL) flammable limit, stated in percent by volume of gas in a gas-air mixture, between which a flammable mixture is formed.

Flammable Liquid.

Any liquid having a flash point below 37.8 °C (100 °F) and having a vapor pressure not exceeding 275 kPa (40 psia) at 37.8 °C (100 °F).

Flammable Gas or Vapor.

A gas or vapor which, when mixed with air in certain proportions, will form a flammable gas atmosphere.

Flash Point.

The minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid, as specified by test.

Ground.

A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

Grounded (Earthed).

Connected to earth or to some conducting body that serves in place of earth.

Hazardous (Classified) Location.

A location in which fire or explosion hazards may exist due to an explosive atmosphere of flammable gases or vapors, flammable liquids, combustible dust, or easily ignitable fibers or flyings.

High Temperature Equipment.

As specified by NEC, Articles 501.5 and 505.16, the term "high temperatures" is to be interpreted as those where the maximum operating temperature (including ambient temperature effect) exceeds 80 percent of the autoignition temperature in degrees Celsius (°C) of the gas or vapor involved.

Ignition (Autoignition) Temperature (AIT).

The minimum temperature required to initiate or cause self-sustained combustion of a solid, liquid, or gas independently of the heating or heating elements.

Ignition Capable.

Equipment or wiring that under normal conditions, or under specified abnormal conditions, can release sufficient electrical or thermal energy (including electrostatic, frictional sparking or hot surfaces) to cause ignition of a specific explosive atmosphere.

Intrinsic Safety.

A type of protection in which a portion of the electrical system contains only intrinsically safe equipment, circuits, and wiring that is incapable of causing ignition in the surrounding atmosphere. No single device or wiring is intrinsically safe by itself (except for battery-operated, self-contained equipment such as portable pagers, transceivers, gas detectors, etc., which are specifically designed as intrinsically safe self-contained devices) but is intrinsically safe only when employed in a properly designed intrinsically safe system. This type of protection is referred to as "i."

Intrinsically Safe System.

An assembly of interconnected intrinsically safe equipment, associated apparatus, other equipment, and interconnecting cables in which those parts of the system that may be used in hazardous (classified) locations are intrinsically safe circuits.

Labeled.

Equipment or materials with a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

NOTE: Some agencies use the term approved, listed, or certified to indicate compliance with the applicable standard.

Liquid, Combustible.

A liquid having a flash point at or above 37.8 °C (100 °F). Combustible liquids are subdivided as follows:

a) Class II liquids include those having flash points at or above 37.8 °C (100 °F) and below 60 °C (140 °F).

b) Class IIIA liquids include those having flash points at or above 60 °C (140 °F) and below 93 °C (200 °F).

c) Class IIIB liquids include those having flash points at or above 93 °C (200 °F).

NOTE: For additional information, refer to NFPA 30. It should also be noted that these classes have no relation to the hazardous location classes

Listed.

Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets appropriate designated standards or has been tested and found suitable for use in a specified manner.

Maintenance, Corrective.

Any maintenance activity that is not normal in the operation of equipment and requires access to the equipment's interior. Such activities are expected to be performed by a qualified person. Such activities typically include locating causes of faulty performance, replacement of defective components, adjustment of internal controls, and the like.

Maintenance, Operational.

Any maintenance activity, excluding corrective maintenance, intended to be performed by the operator and required in order for the equipment to serve its intended purpose. Such activities typically include the correcting of zero on a panel instrument, changing charts, record keeping, adding ink, and the like.

Maximum Surface Temperature.

The highest temperature attained by a surface accessible to flammable gases, vapors, or combustible dusts under conditions of operation within the ratings of the equipment (including specified abnormal conditions).

Minimum Cloud Ignition Temperature.

The minimum temperature at which a combustible dust atmosphere will autoignite and propagate an explosion.

Minimum Dust Layer Ignition Temperature.

The minimum temperature of a surface that will ignite a dust on it after a long time (theoretically, until infinity). In most dusts, free moisture has been vaporized before ignition.

Minimum Explosive (Dust) Concentration.

The minimum concentration of a dust cloud that, when ignited, will propagate a flame away from the source of ignition.

Minimum Ignition Energy (MIE).

The smallest amount of energy that can ignite the most easily ignitable mixture of a specific gas or vapor-in-air mixture or dust-in-air mixture.

Maximum Experimental Safe Gap (MESG).

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.

Minimum Igniting Current Ratio (MIC Ratio).

The ratio derived by dividing the minimum current required from an inductive spark discharge to ignite the most easily ignitable mixture of a gas or vapor by the minimum current required from an inductive spark discharge to ignite methane under the same test conditions.

Nonhazardous (Unclassified) Location.

A location in which fire or explosion hazards are not expected to exist specifically due to the presence of flammable gases or vapors, flammable liquids, combustible dusts, or ignitable fibers or flyings. Such a location may also be referred to as a safe area.

Normal Conditions.

Equipment is generally considered to be under normal conditions when it conforms electrically and mechanically with its design specifications and is used within the limits specified by the manufacturer.

Qualified Person.

One familiar with the construction and operation of the equipment and the hazards involved.

Restricted Breathing.

A protection technique in which the tightness of an enclosure is assured so that short-term presence of a flammable gas or vapor cloud around the enclosure will not cause the concentration inside the enclosure to reach the LFL/LEL because of breathing or diffusion. This type of protection is referred to as "nR."

Seal, Cable, Explosionproof.

A cable termination fitting filled with compound and designed to contain an explosion in the enclosure to which it is attached or to minimize passage of flammable gases or vapors from one location to another. A conduit seal in combination with a cable termination fitting may also be used as a cable seal.

Seal, Conduit, Explosionproof.

A sealing fitting, filled with a poured potting compound, designed to contain an explosion in the enclosure to which it is attached and to minimize passage of flammable gases or vapors from one location to another.

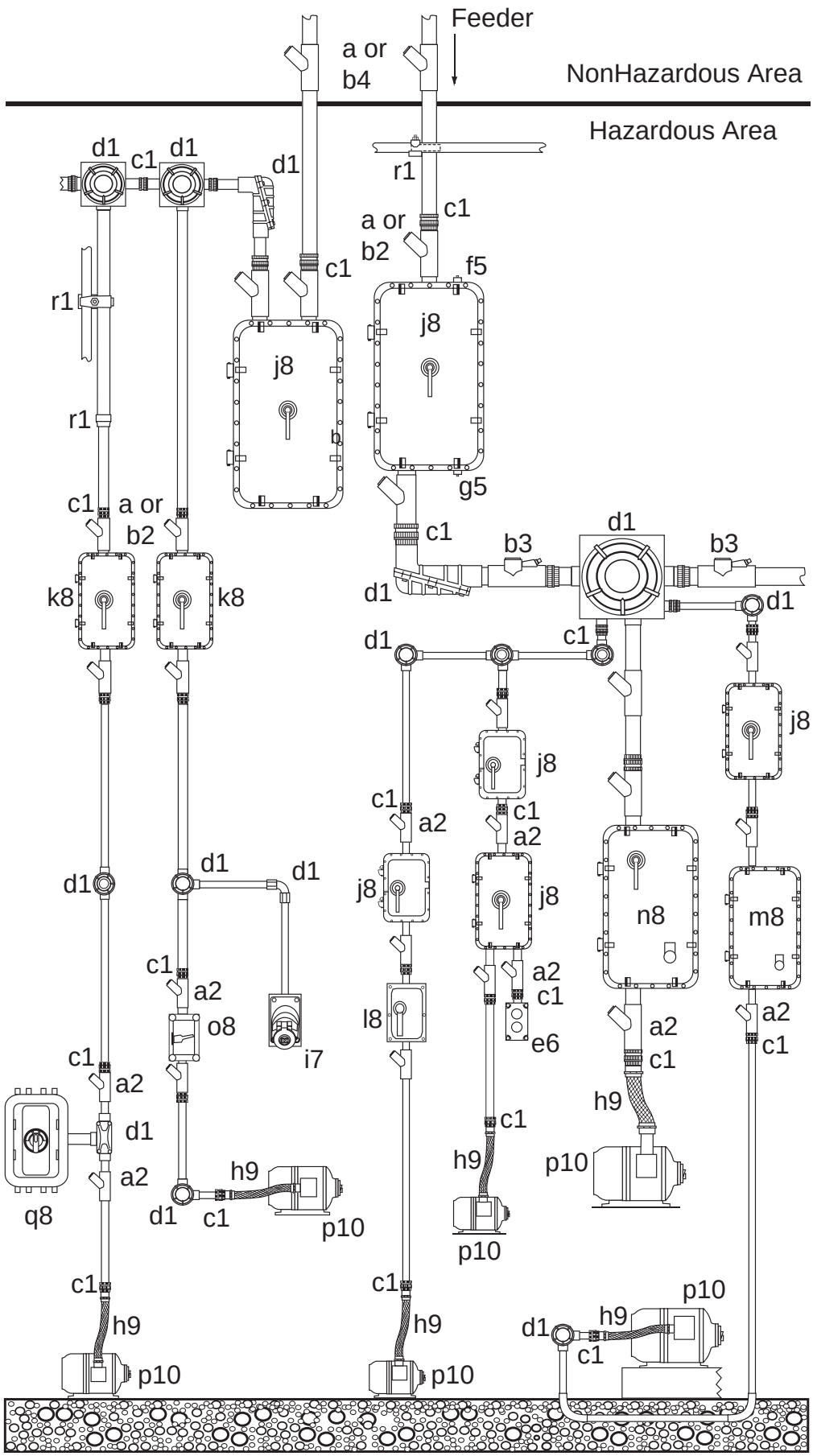
Seal, Factory.

A construction where components capable of initiating an internal explosion due to arcing, sparking, or thermal effects under normal conditions are isolated from the wiring system by means of factory installed flameproof seal or joint for the purpose of eliminating the need for an external, field-installed conduit seal and, in some cases, a field-installed cable seal.

Temperature, Ambient.

The temperature of air or other media where electrical equipment is to be used.

Power (Rigid Conduit) Installation, Class I, Division 1



Power (Rigid Conduit) Installation, Class I, Division 1

Product Key

(a) EY, ENY, EYD, or EYS Sealing fittings used with vertical conduits

(b) ENY or EYS Sealing fittings used with vertical or horizontal conduits

(c) GUF/UNF Female-Female or GUM/UNY Male-Female Unions

(d) Explosionproof Junction boxes Series GE, GEB, X, XALB, GR, JL, JAL or Elbow

(e) XCS Non Factory Sealed or FXCS Factory Sealed Push-button, Pilot Light or other Control Station

(f) KDB or KB1B Breather

(g) KDB or KB1D Drain

(h) ECF or EKJ Explosionproof Flexible Coupling

(i) UGR/UGP Factory Sealed Acceptor Receptacle

(j) B7C Prism Circuit Breaker

(k) XEC Circuit Breaker

(l) XMSW, XSD, XSX, Non-Factory Sealed or FXSD, FXSX Factory Sealed Manual Motor Starting Switches

(m) B7 Series Prism Magnetic line starter

(n) B7 Series Prism combination magnetic motor starter.

(o) XS or XSX Non-Factory Sealed or FXS or FXSX Factory Sealed Switch or Manual Motor Starter

(p) Hazardous Location rated Motor

(q) Compact B7NFD Disconnect Switch or B7MSN2P Manual Motor Starter

(r) Conduit Clamp or Reducer

N.E.C. References

1) 501.10(3) Boxes and Fittings Shall be Approved for Class I, Division 1. 500.8 (E) Equipment. (E) Threading. Supply entry connection entry thread form shall be NPT or Metric.

2) 501.15 Sealing and Drainage. (1) A conduit seal shall be in each entry into an explosionproof enclosure that contains high temperatures or apparatus that is considered to be an ignition source in normal operation.

3) 501.15 Sealing and Drainage. (A)(1) Entering Enclosures (2) The entry is metric designator 53 (trade size 2) or larger and the enclosure contains terminals, splices or taps.

4) 501.15 Sealing and Drainage. (4) Class I, Division 1 Boundary. The sealing fitting shall be permitted on either side of the boundary within 3.05m (10ft.).

5) 501.15 Sealing and Drainage. (F) Drainage. (1) Control Equipment. An approved means shall be provided to prevent accumulation or permit draining of liquid or condensed vapor.

6) 501.115 Switches, Circuit Breakers, Motor Controllers, and Fuses. (A) Class I, Division 1. Pushbuttons and similar devices shall be inside enclosures identified to be a complete assembly for use in Class I Locations. According to Exception 501.15(A)(1)(1) Seals shall not be required for conduit entering an enclosure where the switches are inside a factory sealed enclosure.

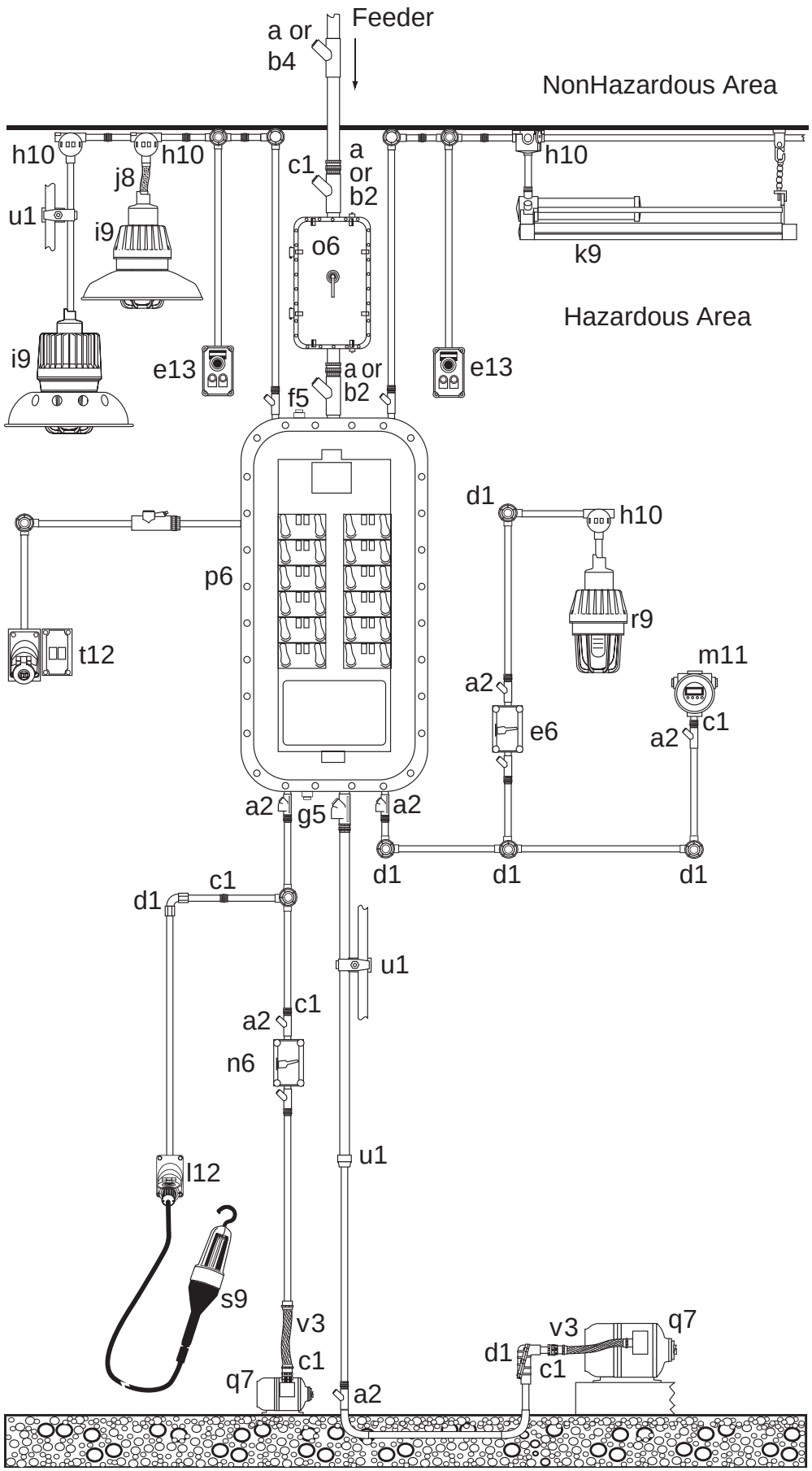
7) 501.145 Receptacles and attachment Plugs, Class I, Divisions 1 and 2. Shall be of a type providing for connection to an equipment grounding conductor and shall be identified for the location. According to Exception 501.15(A)(1)(1) Seals shall not be required for conduit entering an enclosure where the switches are inside a factory sealed enclosure.

8) 501.115 Switches, Circuit Breakers, Motor Controllers, and Fuses. (A) Class I, Division 1. Circuit Breakers, Manual Motor Starters, Magnetic Motor Starters, Disconnect Switches and similar devices shall be inside enclosures identified to be a complete assembly for use in Class I Locations.

9) 501.10(A) Wiring Methods Class I, Division 1. (2) Flexible Connections. Where necessary to employ flexible connections as at motor terminals, flexible couplings shall be listed for the location.

10) 501.125 Motors and Generators. Motors shall be one of the types described in this section.

Lighting (Rigid Conduit) Installation, Class I, Division 1



Lighting (Rigid Conduit) Installation, Class I, Division 1

Product Key

(a) EY, ENY, EYD, or EYS Sealing fitting used with vertical conduits

(b) ENY or EYS Sealing fittings used with vertical or horizontal conduits

(c) GUF/UNF Female-Female or GUM/UNY Male-Female Series Explosionproof Unions

(d) Explosionproof Junction Boxes Series GE, GEB, X, XALB, GR, JL, JAL, or Elbow

(e) XS Non-Factory Sealed or FXS Factory Sealed Switch or Factory Sealed Control Station

(f) KDB or KB1B Breather

(g) KDB or KB1D Drain

(h) HXB or XFH Fixture Hanger

(i) EMI/EBF LED, Medium Base H.I.D and PL Fluorescent or EZ Mogul Base H.I.D.

(j) EKJ Flexible Fixture Hanger

(k) HFX LinearLite Fluorescent Fixture

(l) UGR/UGP Acceptor Plug and Receptacle

(m) HK Instrument Enclosure

(n) XSD, XSX, Non-Factory Sealed or FXSD, FXSX Factory Sealed Manual Line Starter

(o) B7C Prism Circuit Breaker

(p) B7L or B7P Prism Panelboard

(q) Hazardous Location rated Motor

(r) ESXR Strobe Light

(s) XHL Explosionproof Handlamp

(t) UGRF GFI Protected Receptacle

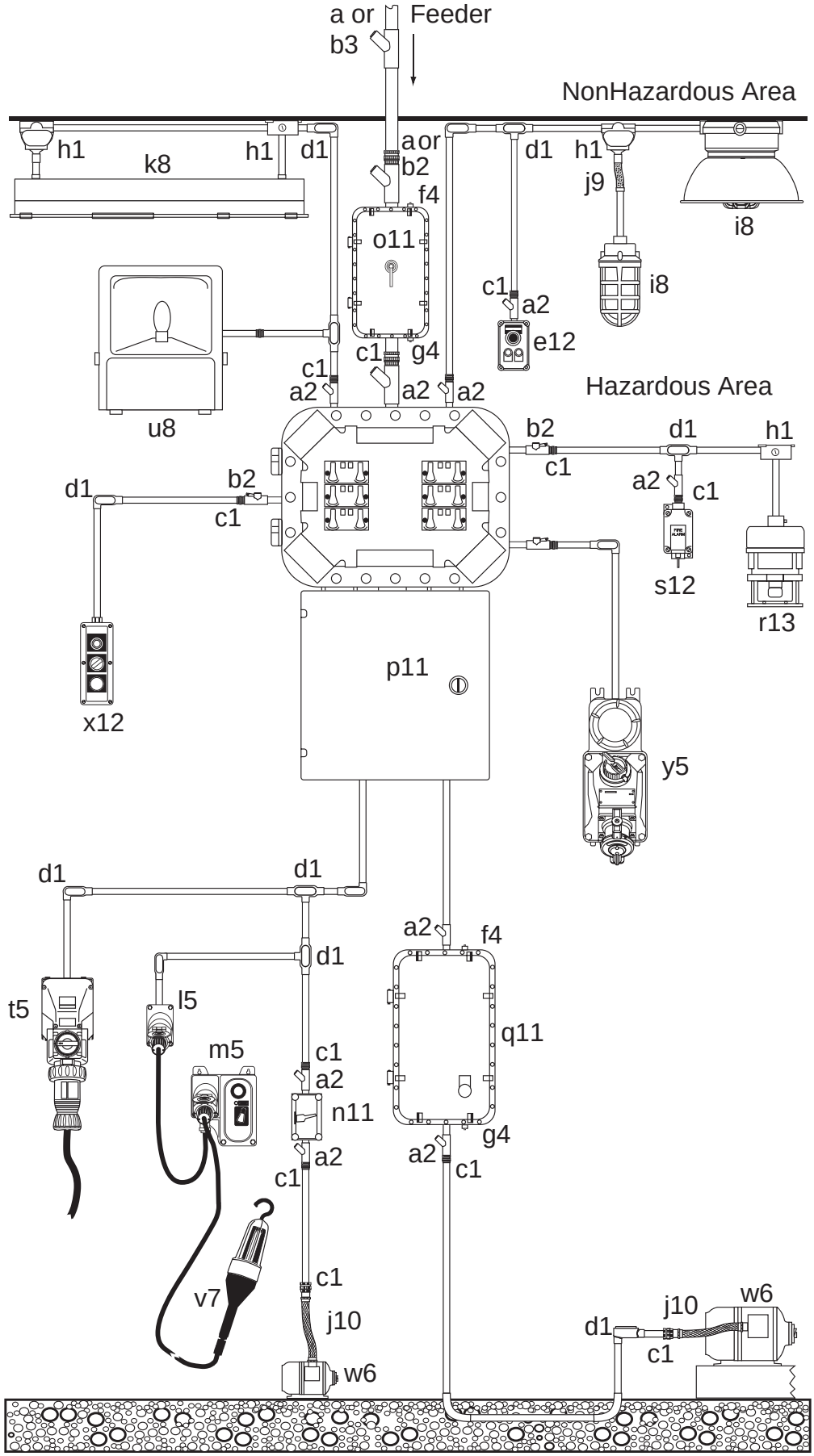
(u) Conduit Clamp or Reducer

(v) ECF or EKJ Explosionproof Flexible Coupling

N.E.C. References

1) 501.10(3) Boxes and Fittings Shall be Approved for Class I, Division 1. 500.8 (E) Equipment. (E) Threading. Supply entry connection entry thread form shall be NPT or Metric.
2) 501.15 Sealing and Drainage. (1) A conduit seal shall be in each entry into an explosionproof enclosure that contains high temperatures or apparatus that is considered to be an ignition source in normal operation.
3) 501.10A Wiring Methods Class I, Division 1. (2) Flexible Connections. Where necessary to employ flexible connections as at motor terminals, flexible couplings shall be listed for the location.
4) 501.15 Sealing and Drainage. (4) Class I, Division 1 Boundary. The sealing fitting shall be permitted on either side of the boundary within 3.05m (10ft.).
5) 501.15 Sealing and Drainage. (F) Drainage. (1) Control Equipment. An approved means shall be provided to prevent accumulation or permit draining of liquid or condensed vapor.
6) 501.115 Switches, Circuit Breakers, Motor Controllers, and Fuses. (A) Class I, Division 1. Circuit Breakers, Manual Motor Starters, Magnetic Motor Starters, Disconnect Switches and similar devices shall be inside enclosures identified to be a complete assembly for use in Class I Locations.
7) 501.125 Motors and Generators. Motors shall be one of the types described in this section.
8) 501.130. (A)(3) Pendant Luminaires. Shall be suspended by threaded joints provided with set screws or other means to prevent loosening. Flexibility in the form of a fitting or flexible connector identified for Class I, Division 1 shall be provided not more than 12 inches from the point of attachment to the supporting box or fitting.
9) 501.130 (A)(1) Luminaires. Shall be identified as a complete assembly for Class I, Division 1 and shall be clearly marked to indicate the maximum wattage of lamp for which it is identified. Luminaires intended for portable use shall be specifically listed as a complete assembly for that use.
10) 501.130 (A)(4)Supports. Boxes, box assemblies, or fittings used for the support of luminaires shall be identified for Class I, locations.
11) 501.105 (A) In Class I, Division 1 locations, meters and instruments shall be provided with enclosures identified for Class I, Division 1 locations. These include explosionproof enclosures.
12) 501.145 Receptacles and attachment Plugs, Class I, Divisions 1 and 2. Shall be of a type providing for connection to an equipment grounding conductor and shall be identified for the location. According to Exception 501.15(A)(1)(1) Seals shall not be required for conduit entering an enclosure where the switches are inside a factory sealed enclosure.
13) 501.115 Switches, Circuit Breakers, Motor Controllers, and Fuses. (A) Class I, Division 1. Pushbuttons and similar devices shall be inside enclosures identified to be a complete assembly for use in Class I Locations. According to Exception 501.15(A)(1)(1) Seals shall not be required for conduit entering an enclosure where the switches are inside a factory sealed enclosure.

Power & Lighting (Rigid Conduit) Installation, Class I, Division 2



Power & Lighting (Rigid Conduit) Installation, Class I, Division 2

Product Key

(a) EY, ENY, EYD, or EYS Sealing fitting used with vertical conduits

(b) ENY or EYS Sealing fittings used with vertical or horizontal conduits

(c) GUF/UNF Female-Female or GUM/UNY Male-Female Explosionproof Unions

(d) Junction Boxes or Conduit Fitting Series GE, GEB, X, XALB, GR, JL, JAL, or O Series or Duraloy 5, 7, 8.

(e) XS Non-Factory Sealed or FXS Factory Sealed Switch or Factory Sealed Control Station

(f) KDB or KB1B Breather

(g) KDB or KB1D Drain

(h) Fixture Hanger HXB, XFH, FHC, FKA, JL or JAL

(i) V Series LED, MB/MBF Med. Base H.I.D or LED or VM Mogul Base H.I.D. or LED

(j) ECF or EKJ Explosionproof Flexible Coupling

(k) DBF or LZ2N or LZ2S Fluorescent Fixture

(l) UGR/UGP Acceptor Plug and Receptacle

(m) GFCI Protected Acceptor Receptacle Adapter

(n) XSD, XSX, XMSW Non-Factory Sealed or FXSD, FXSX Factory Sealed Manual

(o) B7C Prism Circuit Breaker

(p) D2L Series Factory Sealed Circuit Breaker Panelboard

(q) B7 Magnetic Motor Starter

(r) NVS Signal Luminaire

(s) XAL Fire Alarm Station

(t) VSI Switched Receptacles

(u) KFP or KFS Floodlight

(v) XHLF Fluorescent Handlamp

(w) Hazardous Location Rated Motor

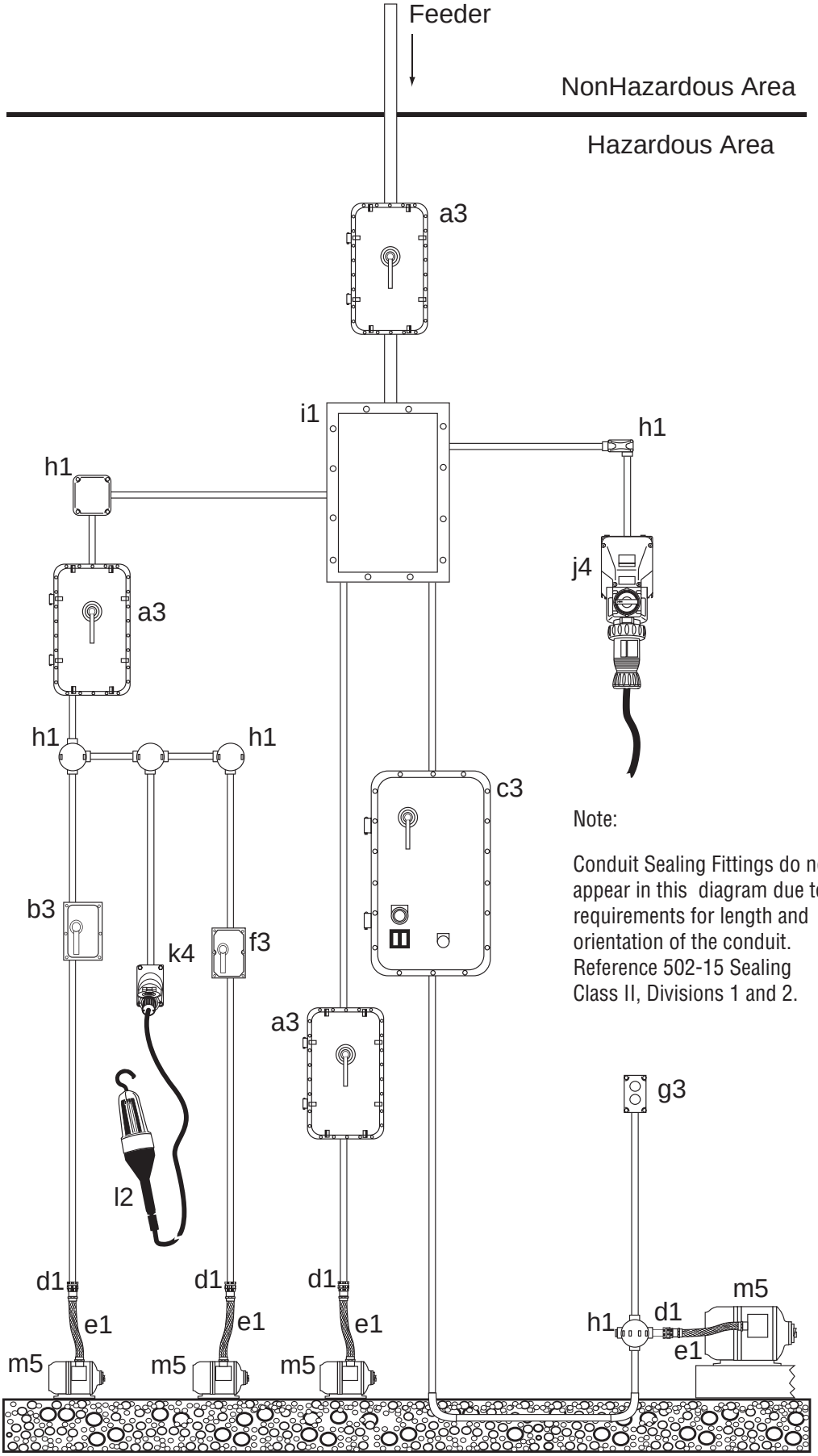
(x) Duratech Control Station

(y) VSQ Factory Sealed Interlocked Switched Receptacle

N.E.C. References

1. 501.10(B)(4) All boxes and fittings are not required to be explosionproof. 501.130.(B)(3) Pendant Luminaires. Shall be supported by approved means.
2. 501.15 (B)(1). For connections to enclosures that are required to be explosionproof, a conduit seal shall be provided in accordance with the requirements for Class I, Division 1.
3. 501.15 (B)(2). A seal shall be required within 3.05m (10 ft) on either side of the Class I, Division 2/Unclassified boundary.
4. 501.15 Sealing and Drainage. (F) Drainage. (1) Control Equipment. An approved means shall be provided to prevent accumulation or permit draining of liquid or condensed vapor.
5. 501.145 Receptacles and attachment Plugs, Class I, Divisions 1 and 2. Shall be of a type providing for connection to an equipment grounding conductor and shall be identified for the location. According to Exception 501.15(A)(1)(1)Seals shall not be required for conduit entering an enclosure where the switches are inside a factory sealed enclosure, or the switch is explosionproof.
6. 501.125(B) Motors must be identified for Class I, Division 2, or nonexplosionproof motors such as squirrel-cage induction motors without brushes , switching mechanisms, or similar arc-producing devices that are not identified for use in Class I, Division 2 shall be permitted.
7. 501.130 (B)(1) Luminaires. Luminaires intended for portable use shall be specifically listed as a complete assembly for that use. Shall be identified as a complete assembly for Class I, Division 1 and shall be clearly marked to indicate the maximum wattage of lamp for which it is identified.
8. 501.130 (B) Shall comply with (1) through (6) of this section. Under normal operating conditions, if the surface temperature of the luminaire reaches 80% of the ignition temperature of the gas or vapor involved the luminaire must meet the requirements of Class I, Division 1 or be tested to determine the marked operating temperature or Temperature Code.
9. 501.130(B)(3) An identified flexible fitting can be used. Flexible fittings meeting the requirements of 501.130 (A)(3) would be suitable.
10. 501.10A Wiring Methods Class I, Division 1. (2) Flexible Connections. Where necessary to employ flexible connections as at motor terminals, flexible couplings shall be listed for the location.
11. 501.115(B) Switches, Circuit Breakers, Motor Controllers, and Fuses. (A) Class I, Division 1. Circuit Breakers, Manual Motor Starters, Magnetic Motor Starters, Disconnect Switches and similar devices shall be inside enclosures identified to be a complete assembly for use in Class I Locations. According to Exception 501.15(A)(1)(1)Seals shall not be required for conduit entering an enclosure where the switches are inside a factory sealed enclosure.
12. 501.115 (B) Pushbuttons and similar devices shall be inside enclosures identified to be a complete assembly for use in Class I Locations. According to Exception 501.15(A)(1)(1) Seals shall not be required for conduit entering an enclosure where the switches are inside a factory sealed enclosure, or the switch is explosionproof.
13. 501.130(B)(5) Switches inside luminaires. Shall comply with the Class I, Division 2 requirements for switches, 501.115(B).

Power (Rigid Conduit) Installation, Class II, Divisions 1 and 2



Note:

Conduit Sealing Fittings do not appear in this diagram due to requirements for length and orientation of the conduit. Reference 502-15 Sealing Class II, Divisions 1 and 2.

Power (Rigid Conduit) Installation, Class II, Divisions 1 and 2

Product Key

(a) B7C or XCBW Circuit Breaker

(b) XEDS Disconnect Switch

(c) B7C Prism Combination Starter and Circuit Breaker

(d) GUF/UNF Female-Female or GUM/UNY Male-Female Unions

(e) ECF or EKJ Flexible Coupling

(f) XMSW XSD, XSX, Non-Factory Sealed or FXSD, FXSX Factory Sealed Manual Motor Starter

(g) XCS Non-Factory Sealed or FXCS Factory Sealed Pushbutton Station

(h) Junction Boxes and Fittings GEB, GR, X, GRR, GE, JL, JAL, Y, FF, MM

(i) Junction Box DB Dust-Ignitionproof

(j) VSI Switched Plug and Receptacle

(k) UGR/UGP Acceptor Plug and Receptacle

(l) XHLF Fluorescent Handlamp

(m) Hazardous Location Rated Motor

N.E.C. References

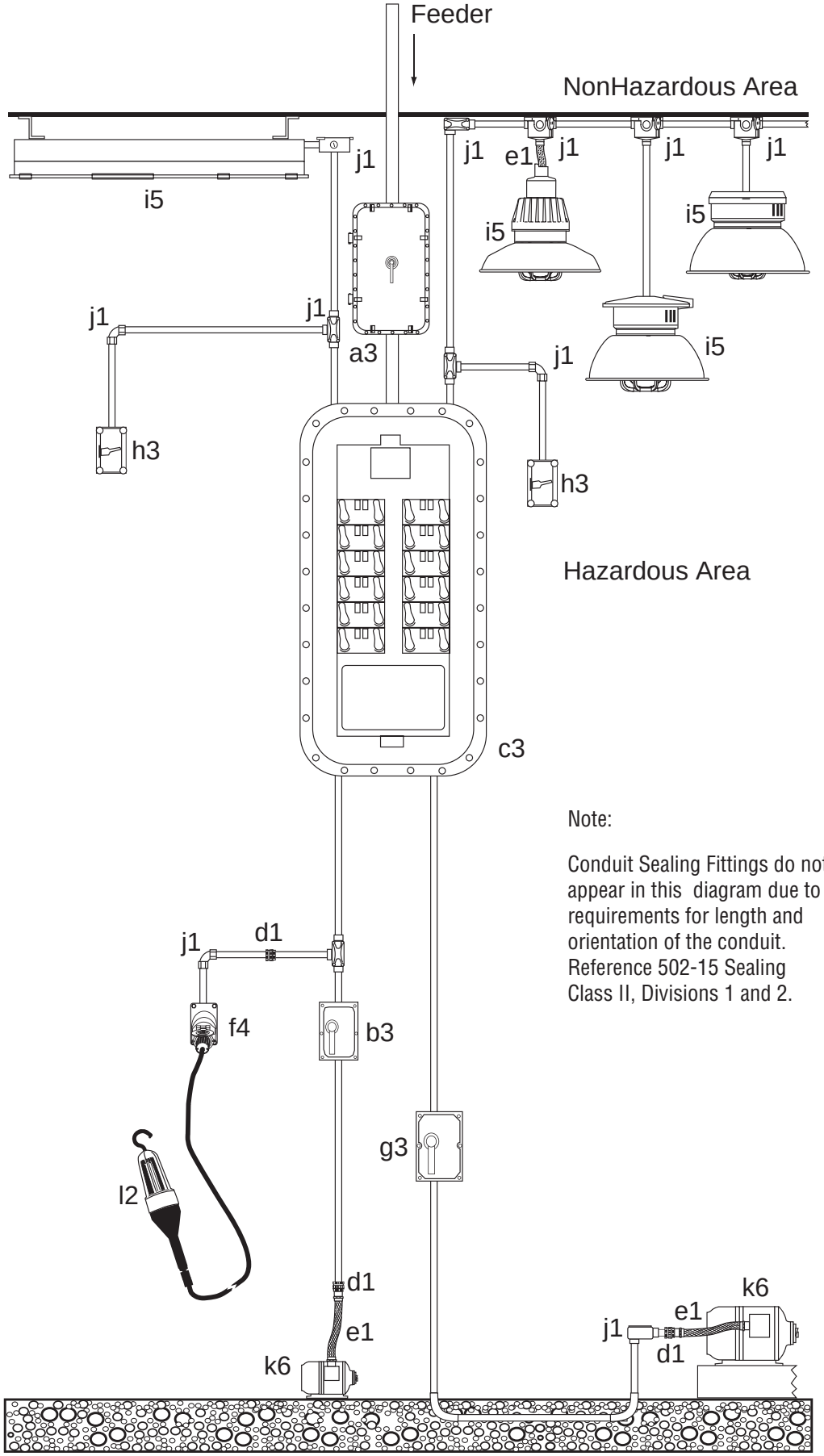
1. 502.10(A)(4). Boxes and fittings shall be identified for Class II locations or be dusttight. Explosionproof equipment and wiring shall not be required and shall not be acceptable in Class II locations unless also identified for such locations.
2. 502.130(A) and 502.130 (B)(4). Portable luminaires shall be identified for the location and shall be clearly marked to indicate the maximum wattage of the lamp for which it is designed.
3. 502.115 (A) Class II, Division 1. Switches, Circuit Breakers, Motor Controllers and similar devices shall be provided with enclosures identified for the loction.

   (B) Class II, Division 2. Shall be in dusttight enclosures or otherwise identified for the location.
4. 502.145(A) Receptacles and Attachment Plugs. Class II, Division 1. Shall be of a type providing for connection to the equipment grounding conductor of the flexible cord and shall be identified for Class II locations.

   (B) Class II, Division 2. Shall be of a type that provides for connection to the equipment grounding conductor of the flexible cord, and shall be designed so that connection to the supply circuit cannot be made or broken while live parts are exposed.
5. 502.125 (A) Class II, Division 1. Motors shall be either identified for the location or totally enclosed pipe-ventilated meeting the required temperature limitations.

   (B) Class II, Division 2. Motors shall be totally enclosed non-ventilated, totally enclosed pipe-ventilated, totally enclosed water-air-cooled, totally enclosed fan-cooled or dust-ignitionproof for which the temperature shall be in accordance with 500.8(D)(2) for normal operation in free air (not dust blanketed) and shall have no external openings.

Lighting (Rigid Conduit) Installation, Class II, Divisions 1 and 2



Note:

Conduit Sealing Fittings do not appear in this diagram due to requirements for length and orientation of the conduit. Reference 502-15 Sealing Class II, Divisions 1 and 2.

Lighting (Rigid Conduit) Installation, Class II, Divisions 1 and 2

Product Key

(a) B7C or XCBW Circuit Breaker

(b) XEDS Disconnect Switch

(c) B7L or B7P Prism Panelboard

(d) GUF/UNF Female-Female or GUM/UNY Male-Female Unions

(e) ECF or EKJ Flexible Coupling

(f) UGR/UGP Factory Sealed Acceptor Receptacle

(g) XMSW, XSD, XSX, Non-Factory Sealed or FXSD, FXSX Factory Sealed Manual Motor Starter

(h) XS Non-Factory Sealed or FXS Factory Sealed Switch

(i) VM or MB/MBF, EML/EBF, EZ,or DBF Luminaires; LED, Fluorescent and H.I.D.

(j) Junction Boxes and Fittings Series GEB, GR, X, GRR, GE, JL, JAL, Y, FF, MM, HXB, and XFH

(k) Hazardous Location Rated Motor

(l) XHLF Fluorescent Handlamp

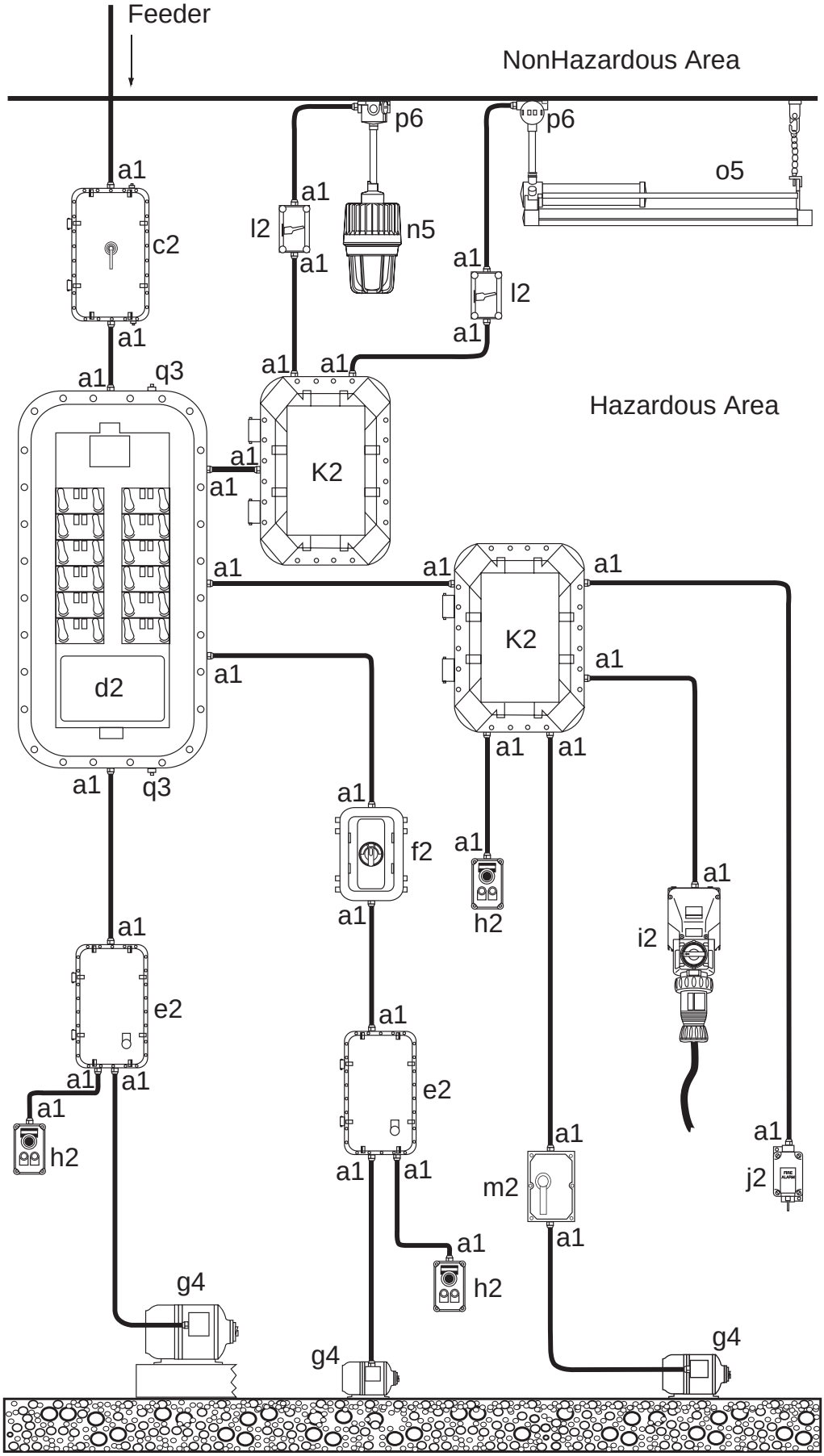
N.E.C. References

1. 502.10(A)(4). Boxes and fittings shall be identified for Class II locations or be dusttight. Explosionproof equipment and wiring shall not be required and shall not be acceptable in Class II locations unless also identified for such locations.
2. 502.130(A) and 502.130 (B)(4). Portable luminaires shall be identified for the location and shall be clearly marked to indicate the maximum wattage of the lamp for which it is designed.
3. 502.115 (A) Class II, Division 1. Switches, Circuit Breakers, Motor Controllers and similar devices shall be provided with enclosures identified for the location.
4. (B) Class II, Division 2. Shall be in dusttight enclosures or otherwise identified for the location.

   502.145(A) Receptacles and Attachment Plugs. Class II, Division 1. Shall be of a type providing for connection to the equipment grounding conductor of the flexible cord and shall be identified for Class II locations.(B) Class II, Division 2. Shall be of a type that provides for connection to the equipment grounding conductor of the flexible cord, and shall be designed so that connection to the supply circuit cannot be made or broken while live parts are exposed.
5. 502.130(A) (1) Luminaires. Shall be identified for the location and shall be clearly marked to indicate the maximum wattage of the lamp for which it is designed. (B) Class II, Division 2 (2) Fixed Lighting. Shall be provided with enclosures that are dusttight or otherwise identified for the location. Each luminaire shall be marked to indicate the maximum wattage of the lamp that shall be permitted without exceeding an expose surface temperature in accordance 500.8(D)(2) under normal conditions of use.
6. 502.125 (A) Class II, Division 1. Motors shall be either identified for the location or totally enclosed pipe-ventilated meeting the required temperature limitations.

   (B) Class II, Division 2. Motors shall be totally enclosed non-ventilated, totally enclosed pipe-ventilated, totally enclosed water-air-cooled, totally enclosed fan-cooled or dust-ignitionproof for which the temperature shall be in accordance with 500.8(D)(2) for normal operation in free air (not dust blanketed) and shall have no external openings.

Power & Lighting (Cable) Installation, Class I, Division 1



Power & Lighting (Cable) Installation, Class I, Division 1

Product Key

(a) Clencher CMX Explosionproof Metal Clad Cable Connector

(b) Clencher CMC Metal Clad Cable Connector

(c) B7C Prism Circuit Breaker

(d) B7L/B7P Prism Panelboard

(e) B7 Prism Magnetic line starter

(f) B7NFD Disconnect Switch

(g) Hazardous Location rated Motor

(h) XCS Non Factory Sealed or FXCS Factory Sealed Push-button, Pilot Light or other Control Station

(i) VSI Switched Plug and Receptacle

(j) XAL Fire Alarm Station

(k) EXB Junction Box with Terminal Boxes

(l) XS Non-Factory Sealed or FXS Factory Sealed Switch

(m) XMSW, XSD, XSX, Non-Factory Sealed or FXSD, FXSX Factory Sealed Manual Motor Starter

(n) EZ, EML, EBF, EMM, EMS, or EMH Series LED, Fluorescent, or H.I.D. Lighting Fixture

(o) HFX Series Fluorescent Lighting Fixture

(p) XFH, HXB, JL, or JAL Series Fixture Hangers

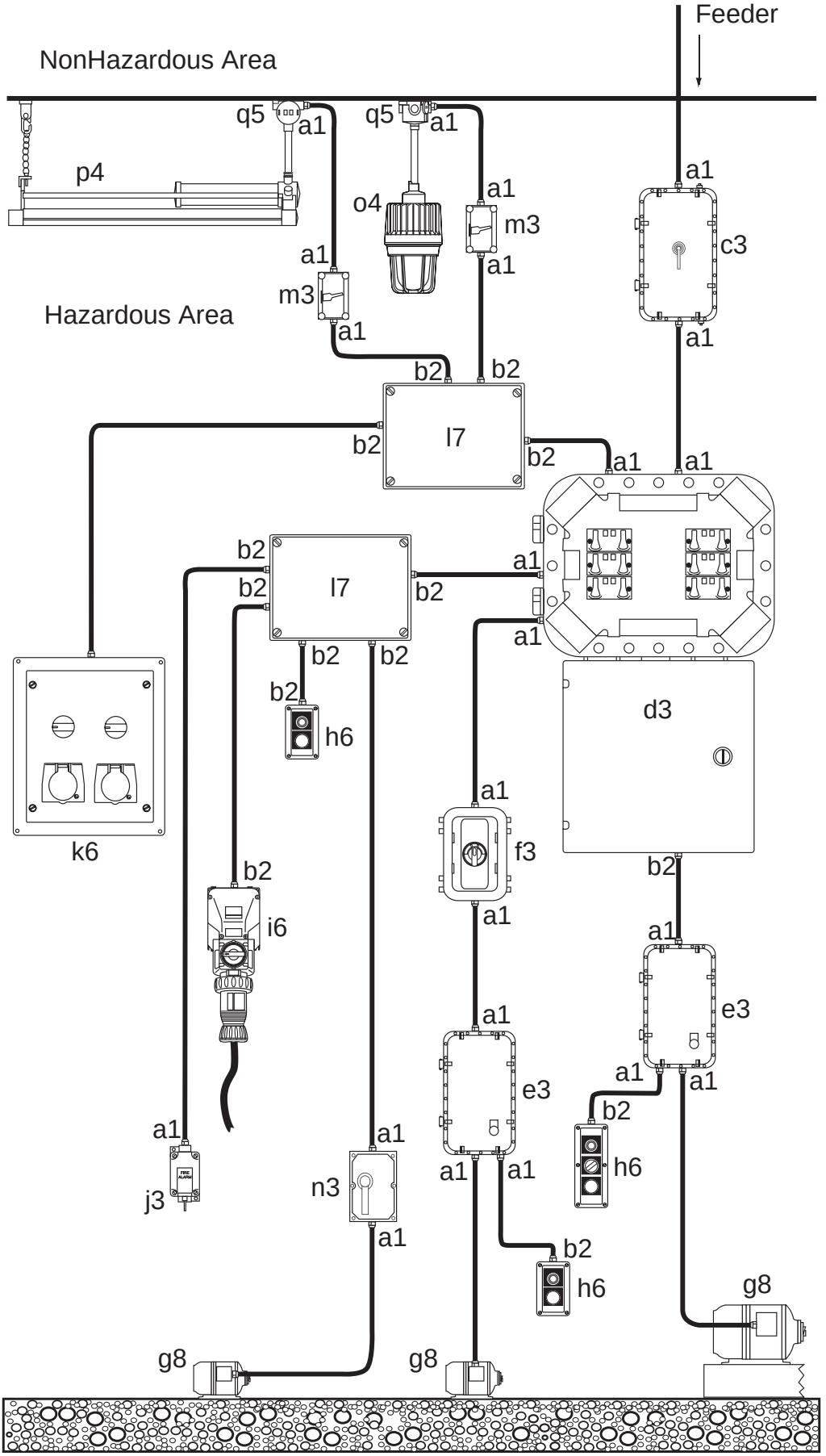
(q) KB1B Breather, KB1D Drain, or KDB-1 Combination Drain and Breather

(r) MC Type Metal Clad Cable Installation

N.E.C. References

1. 501.15(D)(1) Cable seals Class I, Division 1.Cable shall be sealed at all terminations.
2. 501.115 Switches, Circuit Breakers, Motor Controllers, and Fuses. (A) Class I, Division 1. Circuit Breakers, Manual Motor Starters, Magnetic Motor Starters, Disconnect Switches and similar devices shall be inside enclosures identified to be a complete assembly for use in Class I Locations.
3. 501.15 Sealing and Drainage. (F) Drainage. (1) Control Equipment. An approved means shall be provided to prevent accumulation or permit draining of liquid or condensed vapor.
4. 501.125 Motors and Generators. Motors shall be one of the types described in this section.
5. 501.130 (A)(1) Luminaires. Shall be identified as a complete assembly for Class I, Division 1 and shall be clearly marked to indicate the maximum wattage of lamp for which it is identified.
6. 501.130 (A)(4)Supports. Boxes, box assemblies, or fittings used for the support of luminaires shall be identified for Class I, locations.

Power & Lighting (Cable) Installation, Class I, Division 2



Power & Lighting (Cable) Installation, Class I, Division 2

Product Key

(a) Clencher CMX Explosionproof Metal Clad Cable Connector

(b) Clencher CMC Metal Clad Cable Connector

(c) B7C Prism Circuit Breaker

(d) D2L Series Factory Sealed Circuit Breaker Panelboard

(e) B7 Prism Magnetic line starter

(f) B7NFD Disconnect Switch

(g) Hazardous Location rated Motor

(h) Duratech Control Station

(i) VSI Switched Plug and Receptacle

(j) XAL Fire Alarm Station

(k) Clean Room Receptacle Panel

(l) Techneterm Terminal Boxes

(m) XS Non Factory Sealed or FXS Factory Sealed Switch

(n) XMSW, XSD, XSX, Non-Factory Sealed or FXSD, FXSX Factory Sealed Manual Motor Starting Switches

(o) EZ, EML, EBF, EMM, EMS, or EMH Series LED, Fluorescent, or H.I.D. Lighting Fixture

(p) HFX Series Fluorescent Lighting Fixture

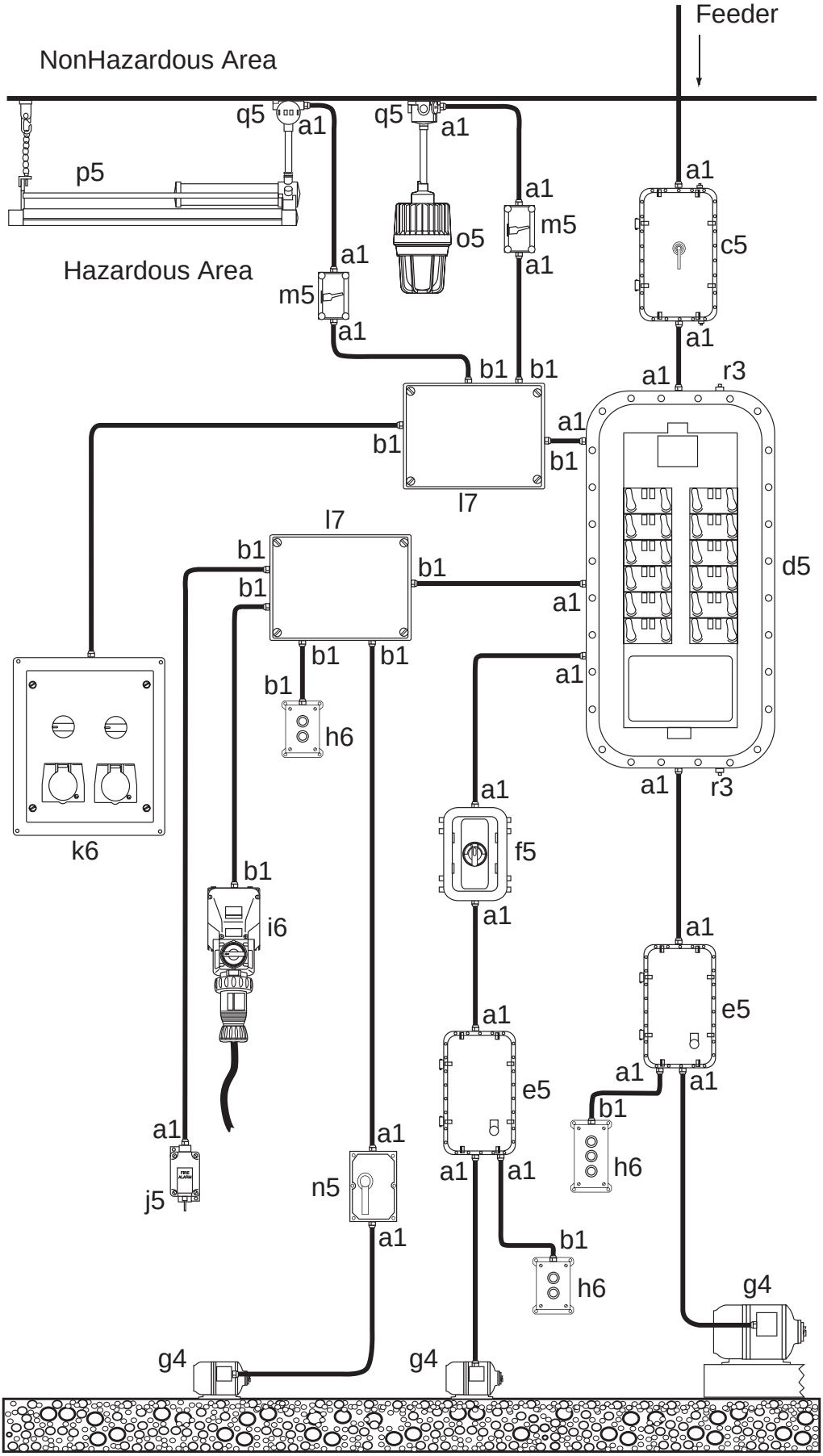
(q) XFH, HXB, JL, or JAL Series Fixture Hangers

(r) MC Type Metal Clad Cable Installation

N.E.C. References

1. 501.15 (E)(1). Cables entering enclosures that are required to be explosionproof shall be sealed at the point of entrance.
2. 501.10 (c). MC-HL cable shall be terminated with fittings listed for the application. The fittings connected to these enclosures are not required to be sealed.
3. 501.115(B) Switches, Circuit Breakers, Motor Controllers, and Fuses. (A) Class I, Division 1. Circuit Breakers, Manual Motor Starters, Magnetic Motor Starters, Disconnect Switches and similar devices shall be inside enclosures identified to be a complete assembly for use in Class I Locations. According to Exception 501.15(A)(1)(1) Seals shall not be required for cable entering an enclosure where the switches are inside a factory sealed enclosure.
4. 501.130 (A)(1). These Luminaires are listed for Class I, Division 1 and therefore are suitable for Class I, Division 2.
5. 501.10(B)(4) All boxes and fittings are not required to be explosionproof. 501.130.(B)(3) Pendant Luminaires. Shall be supported by approved means.
6. 501.115(B)(1)(3) Switches and similar devices shall be inside enclosures identified for Class I, Division 1 unless the interruption of current occurs within a factory sealed explosionproof enclosure as these devices are.
7. 501.10 (4) Boxes and Fittings are not required to be explosionproof unless they are requires by 501.105(B)(1), 501.115(B)(1) or 501.150(B)(1). The terminals inside these enclosures do not meet these requirements.
8. 501.125(B) Motors must be identified for Class I, Division 2, or non-explosionproof motors such as squirrel-cage induction motors without brushes , switching mechanisms, or similar arc-producing devices that are not identified for use in Class I, Division 2 shall be permitted.

Power & Lighting (Cable) Installation, Class I, Zones 1 and 2



Power & Lighting (Cable) Installation, Class I, Zones 1 and 2

Product Key

(a) Clencher CMX Explosionproof Metal Clad Cable Connector

(b) Clencher CMC Metal Clad Cable Connector

(c) B7C Prism Circuit Breaker

(d) B7L/B7P Prism Panelboard

(e) B7 Prism Magnetic line starter

(f) B7NFD Disconnect Switch

(g) Hazardous Location rated Motor

(h) CS Series Stainless Steel Control Stations

(i) VSI-FS Switched Plug and Receptacle

(j) XAL Fire Alarm Station

(k) Clean Room Receptacle Panel

(l) Techneterm Terminal Boxes

(m) XS Non Factory Sealed or FXS Factory Sealed Switch

(n) XMSW, XSD, XSX, Non-Factory Sealed or FXSD, FXSX Factory Sealed Manual Motor Starting Switches

(o) EZ, EML, EBF, EMM, EMS, or EMH Series LED, Fluorescent, or H.I.D. Lighting Fixture

(p) HFX Series Fluorescent Lighting Fixture

(q) XFH, HXB, JL, or JAL Series Fixture Hangers

(r) KB1B Breather, KB1D Drain, or KDB-1 Combination Drain and Breather

(s) MC Type Metal Clad Cable InstallationXS Non Factory Sealed or FXS Factory Sealed Switch

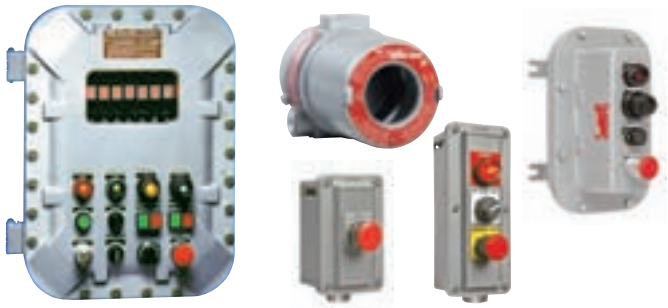
N.E.C. References

1. 505.16(B)(7) Cables Entering Enclosures. Cable seals shall be provided for each cable entering flameproof or explosionproof enclosures.
2. 505.15 (B)(b) MC-HL cable shall be terminated with listed for the application. According to 505.2, Increased Safety “e” does not produce arcs or sparks in normal application.
3. 505.16 (E)(a) Drainage Control Equipment. Where there is a probability that liquid or other condensed vapor may be trapped, approved means shall be provided to prevent accumulation or permit periodic draining of the liquid or condensed vapor
4. 505.22Increased Safety “e” Motors and Generators. In Class I, Zone 1 locations, Increased Safety motors of all voltage ratings shall be listed for Zone 1 locations.
5. 505.9 (C)(1) Division Equipment. Equipment identified for Class I, Division 1 or Class I, Division 2 shall be permitted to be marked Class I, Zone 1 or Class I, Zone 2. These products are explosion-proof, listed for Class I, Division 1.
6. 505.8 (A) and (E). These products contain flameproof/explosion-proof switches with Increased Safety “e” terminals that are listed for Class I, Zones 1 and 2. These enclosures do not require a sealed cable fitting.
7. 505.8 (E) Increased Safety “e”. The terminals inside these enclosures use the type of protection “e” that is permitted for equipment in Class I, Zone 1, or Zone 2 locations. Increased Safety “e” type of protection does not produce arcs or sparks under normal conditions. Additional measures are applied to increase security against the possibility of excessive temperatures or the occurrence of arcs or sparks.

Killark Product Range

Enclosures / OEM Solutions / Controls

Our extensive range of bolted and threaded enclosures are utilized daily for use with control, monitoring, detection, and automation products. The Killark product portfolio of control products come in both metallic and non-metallic designs. The size and depth of the control product range enable us to provide the best solutions to your control problems.



Distribution and Control Equipment

From lighting, trace heating and power distribution applications to complex PLC control systems, our applications engineers have a competence to take a project from conceptual to finished goods.From single point protection to rack applications, Killark provides cost effective solutions with high quality, reliability and ease-of-maintenance built in.

Lighting

Killark luminaires are suitable for extreme environments. Available in copper-free aluminum, fiberglass reinforced polyester, or stainless steel, they meet and exceed the requirements for corrosive, vibration, or explosive atmospheres. Killark's lighting products encompass the latest in long life energy and labor saving LED, Induction, and fluorescent technologies.

Plugs and Receptacles

Ranging from 20 Amp bladed style to 200 Amp pin & sleeve configurations, Killark provides numerous solutions for safely supplying power to fixed and portable equipment in hostile environments. Devices include plugs, receptacles, panel receptacles, and connectors to extend the reach of portable equipment. For personnel safety, ground fault protected receptacles, both portable and fixed, are available.

Connectors and Fittings

A major factor in all harsh and hazarous environments is the ability to provide reliable cable terminations and conduit connections. Copper-Free Aluminum Connectors are designed to terminate jacketed interlocked cables (MC), corrugated continuously welded metal clad cables (MC-HL) and non-armored cables (SO, TC). Iron and Aluminum Fittings for rigid and IMC conduit raceway systems.

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