

## TRAINING PROGRAM





# Hazardous Location Primer





### Hazardous Location Primer

- ▲ This primer (prim'-er) module is meant to introduce some of the basics of hazardous (classified) locations as contained in Article 500 of the NEC<sup>®</sup> (National Electrical Code<sup>®</sup>\*).
- ▲ It is for the non-professional and those in the electrical industry who are "exposed" to these products— but who do not have the time, opportunity or resources for indepth study.
- ▲ Contrary to what many think, explosion-proof equipment does not prevent an explosion but "contains" it when it occurs in an electrical enclosure.
- Hazardous and classified locations are essentially the same. When an area is "classified" the hazardous gas, vapor or dust is identified and put in a specific Class and Group.
- Hazardous Area– View Bar This bar is placed in the title area on selected pages



for a quick identification of product Class and Division ratings. A  $\bigcirc$  in any area indicates non suitability. The Appleton general catalog is the final and official source for all Class, Division and Group compliance statements.

- ▲ Once so identified, only electrical equipment approved for that Class, Group and Division can be installed.
- ▲ The subject is serious. Safety of lives and property is at stake. Specific hazardous areas are designated by professionals, insurance companies and "authorized" experienced persons. No one else.
- \* NEC<sup>®</sup> and National Electrical Code<sup>®</sup> are registered trademarks of the National Fire Protection Association, Inc. Quincy, MA 02269



## NEC DEFINITION

### Hazardous Locations- Identified

- Areas with Flammable Vapors: defined as Class I
  - Refineries and chemical plants
  - Paint/spray areas
  - Sewage treatment facilities
  - Natural gas handling, storage
  - Food processing (some)
  - Printing press areas
  - Pharmaceutical plants
- Areas with Flammable Dusts: defined as Class II
  - Grain storage, processing
  - Coal handling, storage
  - Metal grinding and working
  - Pharmaceutical plants
- Areas with Fibers & Flyings: defined as Class III
  - Textile
  - Mattress
  - Clothing
  - Cotton mills, wool processing
  - Batting facilities
  - Wood cutting, pulverizing







Dusts



Flyings



## CLASS I, GASES/VAPORS



## Class I- Hazardous (Classified) Location

### ▲ In Class I



- ▲ The enclosure then must:
  - contain the explosion
  - slowly release cooled gases to prevent the internal explosion from igniting the outside flammable atmosphere



## CLASS I, DIVISION 1 AND 2

Class I

Div. 2

Div. 1

Class I- Division 1 and 2, Groups A,B,C and D

Class I is further divided by the NEC<sup>®</sup> and NFPA into Groups and Divisions.



Primary Gas by Group

Gas
Acetylene
Hydrogen
Ethylene
Gasoline



### Class I– Division 1, Groups A,B,C and D

All Class I gases/vapors are not the same. They "explode" at different temperatures and intensities. Below are the most common gases in Class I and how they differ by ignition temperature and explosive pressure.

Class I	NFPA Group	°C Ignition Temp	Hydrostatic Pressure*
Acetylene	А	305	6,000 PSI
Hydrogen	В	500	6,000 PSI
Ethylene	С	450	1,200 PSI
Gasoline	D	280	600 PSI

- Note: Group A and B gases are difficult to contain and require more stringent construction parameters than Group C and D gases.
- There are hundreds of gases NFPA and other groups have tested to determine flash point, ignition temperature, etc.
- Classification" of a Class I hazardous area is done only by qualified personnel after close evaluation of the gas/vapors involved. Such personnel could be an "in house" engineer, insurance company, or electrical inspector.
- \* Typical tested hydrostatic pressure required for electrical fittings such as unions, elbows, seals, etc.





Class I

#### Class I- Division 1

- ▲ Electrical systems are not air tight.
- In Class I, Division 1 areas, hazardous gases/vapors are normally present.
- ▲ Heat and cold, joint expansion and contraction suck moisture and vapors into electrical enclosures/equipment.
- ▲ Flammable vapors can be inside the whole electrical system: motors, switches, fixtures, etc.





- Class I, Division 1 represents only 3-5% of all hazardous locations.
- ▲ All electrical equipment here must be "explosion-proof"; tested and listed\* for the specific gas/vapor in the area.
- ▲ All raceways must be of rigid conduit, IMC, MI or listed MC cable with listed termination fittings.
- \* By third party testing organizations.



▲ The internal explosion "containment" is controlled by:

• Tensile strength of enclosure. Materials commonly used are:

Material	Tensile Strength
Malleable iron	50,000 PSI
Aluminum	30,000 PSI
Gray iron	30,000 PSI

- Enclosure cover type
  - 1. Bolted cover



Hot flaming gases

Only cooled gases

Internal Pressure

2. Threaded cover





CLASS

HP98-8



#### Class I, Div. 1 Arcing Devices– Sealing Requirements

▲ In Class I, Division 1, all electrical equipment and wire terminations must be enclosed in "explosion proof" enclosures. In addition all conduit containing arcing devices such as switches that are not "factory sealed" must be sealed.



- ▲ Factory sealed devices are safer and installed cost is lower.
- ▲ Conduit seals restrict passage of flames to area where internal explosion occurs– controls "pressure piling".







### Class I, Div. 1– Heat Producing Equipment

- ▲ "Heat producing" equipment has additional design requirements over straight arcing devices.
- ▲ Fixtures and motors are primary items producing "heat".
- Class I, Division 1 fixtures are "factory sealed" no conduit seals required.\*
- ▲ In Class I, Division 1, requirements for fixtures are:



- \*\* A "T" number is assigned to every fixture after thorough temperature testing. A high "T" number means a cool running fixture.
- \* Code-Master Jr. for Group B does require seal.



## CLASS I, DIVISION 2



Class I, Div. 2– Groups A,B,C and D

- In Class I, Division 2, hazardous vapors are not normally present. They are "contained" in vessels or pipes.
- ▲ 95% of hazardous locations are Class I, Division 2.



- ▲ Rules for wiring and equipment here in Division 2 are:
  - 1. Arcing equipment- non factory sealed devices must be in Class I, Division 1 (explosion proof) enclosures.
  - 2. Factory sealed arcing devices (push buttons, etc.) can be in general purpose enclosures (except receptacles, which must be "explosion-proof").
  - 3. Heat producing equipment (fixtures) must be tested and approved- need not be explosion-proof, but limit temperature on lamp "hot spot".
  - 4. Junction boxes, fittings, etc. need not be explosionproof. Conduit and fittings must have 3 to 3-1/2 threads.



## CLASS I, DIVISION 2



### Class I, Division 2

- ▲ Class I, Division 2 is separated from Class I, Division 1 by:
  - Distance– In outdoor areas, traditionally Division 1 and Division 2 areas are adjacent to each other. Division 1 is nearest to point of vapor release.



 Ventilation– In some installations forced air ventilation assures "cleaning" of hazardous vapors.



 Separation- by wall or other solid means isolating the Class I, Division 1 area from adjacent Class I, Division 2 area.



Class I, Div. 1 Class I, Div. 2



## CLASS I, DIVISION 2



### Class I, Division 2– Lighting Fixtures

- ▲ In Class I, Division 2, explosion-proof fixtures are not required. Fixtures are basically the enclosed and gasketed type with the following requirements:
  - Set screw in Gasketed joint to mounting hood keep out moisture, dirt, dust etc. Label must show maximum "Hot spot" on lamp approved wattage must not exceed the and T-number ignition temperature of hazardous vapors Fixture must be present protected by guard or by location Fixture assembly must withstand vibration testing
- ▲ A "T" number is assigned to every fixture after thorough temperature testing. A high "T" number means a cool running fixture.

#### ▲ Example

Hazardous substance	Gasoline
Gasoline ignition temp	280°C
MMIII fixture	100W HPS with globe
Example Fixture tested "T" number	T2A- see note below

Note: Per NEC<sup>®</sup>, T2A has a temperature range of 261 to 280°C. Since the example fixture does not exceed 280°C, it is suitable for use in a gasoline vapor area.



### Condensed Guide to Sealing Requirements

▲ Classes I, II, III; Divisions 1 and 2, Groups C, D, E, F and G

Application	Class I Div. 1	Class I Div. 2	Class II Div. 1,2	Class III Div. 1,2
In conduit as it enters or leaves the area	R	R	NR	NR
In "Listed" cable <sup>†</sup> – as it enters or leaves the area unbroken	NR	NR	NR	NR
At factory sealed arcing devices- conduit fed	NR	NR	NR	NR
At factory sealed arcing devices- cable <sup>†</sup> fed	R*	R*	NR	NR
At non-factory sealed arcing devices- conduit fed	R	R	NR	NR
At non-factory sealed arcing devices- cable† fed	R*	R*	NR	NR
At fixtures "Listed" for area	NR	NR	NR	NR
At receptacles factory sealed "Listed" for area	NR	NR	NR	NR
At receptacles non-factory sealed "Listed" for area	R	R	NR	NR
At service station- as conduits emerge from ground	R	R	NA	NA

R= Seals required by NEC<sup>®</sup>, NR= Seals not required

\* Use listed cable fittings that have built in potting (sealing capabilities)

† Jacketed metal clad cable



## CLASS II, DIVISION 1



### Class II

- Dust-ignitionproof is the formal name for Class II equipment and requires the following:
  - 1. enclosed in a manner to exclude dusts
  - enclosure will not permit interior arcs, sparks or generated heat to cause ignition of dusts on, or in vicinity of enclosure
- ▲ In Class II, Division 1





## CLASS II, DIVISION 1



#### Class II

- Class II enclosures need not "contain" an explosion as in Class I enclosures.
- Construction is basically "enclosed and gasketed" with the following requirements:



▲ In Class II, Division 1 all entrances to enclosures must exclude any dust entry. Exterior of enclosure must remain cool (below ignition temperature of the dust).



\* "Close fitting" cover without gasket allowed if entry of dust is excluded.



### Class II- Dusts

▲ All Class II, dusts are not the same. Common dusts and how they differ as tested by NFPA are:

Dust	NFPA Group	Min. Layer* Ignition Temp	Division(s)
Magnesium	E <sup>†</sup>	430°C**	Div. 1 only
Coal	F	180°C**	Div. 1 and 2
Wheat	G	165°C**	Div. 1 and 2

- \* "Dust Cloud" is also a factor to be considered. A dust cloud may exist without any layering. Consult experts and professionals to establish Group and Division for a specific dust area.
- † Group E dusts are considered to be electrically conductive and has no Division 2 classification.
- \*\* However NEC® Table 500-3(f) generalizes saying– "maximum allowable temperatures" by Groups are: E 200°C, F 200°C and G 165°C. Marking of equipment in excess of "maximum allowable temperature" is allowed as long as temperature marking does not exceed ignition temperature of the specific dust involved.
- ▲ These elements must be considered in all Class II areas:
  - 1. dust tightness of enclosures
  - 2. type of dust
  - 3. probability that a dust cloud or dust layer may exist; producing inflated equipment temperatures
  - 4. assign "T" number to all equipment based on ignition temperature of a particular dust



## CLASS II, DIVISION 1 AND 2



### Class II– Lighting Fixtures

- Class II fixtures are "enclosed and gasketed" units that are approved for Class II applications and are clearly marked with the maximum wattage, dust group and "T" number.
- ▲ In Class II, lighting fixtures are the same for both Division 1 and Division 2. Fixtures produce heat which must be controlled by limiting lamp wattage ("T" rating).



▲ A "T" number is assigned to every fixture after thorough temperature testing. A high "T" number means a cool running fixture.

#### ▲ Example

Hazardous substance	Wheat (Group G)
Wheat ignition temp	165°C
MMIII fixture	100W HPS with globe
Example Fixture tested "T" no. for Group G	T3B- see note below

Note: Per NEC<sup>®</sup>, T3B has a temperature range of 161 to 165°C. Since the example fixture does not exceed 165°C, it is suitable for use in a wheat dust area.



### Class III – Fibers and Flyings

- Class III locations are those where easily ignitable fibers and flyings are present, but not likely to be in suspension in air. Class III locations overlap those in Class II.
- ▲ Generally, Class III materials pose a fire hazard NOT an explosion hazard as exists in both Class I and Class II.
- ▲ In Class III Division 1:







### Class III- Ignitable Fibers and Flyings

- Typical Class III areas are: textile, clothing, mattress, cotton, batting, rayon, cotton seed, woodworking, and industries processing similar products.
- Easily ignitable fibers and flyings are: rayon, cotton, sisal, jute, hemp, cocoa fibers, oakum, Spanish moss, excelsior and other similar materials.
- ▲ Electrical equipment in these areas should be installed to prevent heat buildup or entrance of fibers or flying into enclosures where a spark could ignite them– causing fire.
- Dust-ignitionproof equipment is not required in Class III. Boxes and fittings must be dusttight.
- ▲ Class III has Division 1 and 2 as follows:







### Class III- Ignitable Fibers and Flyings

▲ Typical Class III electrical equipment requirements:

- Conduit bodies and boxes
   – shall have gasketed covers which must be dusttight.
- Junction boxes- can be cast, sheet metal, plastic, with gasketed covers\*. Use approved dusttight hub or cable connectors for cable or conduit entrance. Must be dusttight.
- Lighting fixtures– shall prevent entrance of fibers and flyings. Label must show maximum wattage. External fixture temperature shall not exceed 165° C.
- Receptacles and attachment plugs must be of grounding type and designed to minimize accumulation or entry of fibers/flyings

  – and prevent escape of sparks.
- Motors and generators
   – shall operate at full rating and if not subject to overload, shall not exceed external temperature of 165° C. If subject to overload, shall not exceed 120°C.

\* "Close fitting" cover without gasket allowed if dust entry is excluded.



### Zone Classification

- ▲ The 1996 NEC<sup>®</sup> introduced an alternate method of hazardous classification called the "zone" method. It is used by countries with IEC based standards (mostly European).
- ▲ The U.S. uses the "Division" system, but per the 1996 NEC<sup>®</sup>, use of the Zone system as an alternate is now allowed.
- ▲ The chart below is a broad comparison of the Division and Zone classifications.

Zone 0	Zone 1	Zone 2
Division 1		Division 2

- Direct comparison of the two systems is complicated. A detailed explanation of the Zone system can be found in the 1999 National Electrical Code<sup>®</sup>, Article 505.
- Most products from Appleton can be used in both Division and Zone areas. See chart below for Division and Zone equivalency.

Appleton Equipment Zone Equivalency		
Listed or Classified for:	is suitable for use in:*	
Class I, Div. 1	Class I, Zone 1	
Class I, Div. 1 or 2	Class I. Zone 2	
Class I, Div. 2	Class I, Zone 2	

\* Must be equivalent gas group

▲ The Zone system is used mainly by multinational corporations that want one standard to govern their facilities whether they be domestic (United States) or international.



#### Approved

Acceptable to the authority having jurisdiction.

#### **Classified Location**

Used interchangeably by many groups with term "Hazardous Location"– it defines an area that is divided into a Class, Division and Group (or into Class, Zone and Group) that may exist due to the presence of flammable gases, vapors, combustible dusts or ignitable fibers or flyings.

#### Dust-ignitionproof

Enclosed in a manner to exclude dusts, and will not permit arcs, sparks or heat generated inside the enclosure to cause ignition of dust accumulation or dust suspension outside the enclosure.

#### Dustproof

Apparatus or devices constructed so that dust will not enter the case under specified test conditions.

#### **Explosion-proof Apparatus**

Enclosed in a case capable of withstanding an explosion that might occur within it; and by containing and controlling release of hot gases and flames, prevents ignition of vapors outside the case.

#### Factory Sealed

Apparatus constructed in such a way as to contain any arcing within the apparatus itself. Listed factory sealed equipment does not require use of additional seal fittings. Factory sealing is normally accomplished by a combination of interior "potting", close tolerance shafts and/or use of "threaded" flame paths built into the device.

#### Labeled

Equipment with a label, symbol, or mark of an organization (UL, FM, ETL etc.) Label my indicate a specific use of the equipment.



#### Listed

Equipment included in a list published by an organization (UL, FM, ETL etc.) acceptable to the authority having jurisdiction.

#### Pressure Piling

Pre-pressurization of an unburned mixture ahead of a moving flame front (typically in rigid conduit).

#### Sealing Fitting

A fitting for conduit or cable, that when properly installed with approved sealing compound, will prevent the passing of flames/fire from one portion of an electrical installation to another. They also prevent transmission of gases/vapors within a conduit system.

#### "T" Number

Equipment that is heat producing (fixtures, motors, etc.) must be tested and marked with an Identification Number (T Number). Nameplate on such equipment must show class, group and operating temperature, based on operation in a 40°C ambient (see NEC<sup>®</sup> 500-3 for exceptions). Non-heat producing equipment does not have this requirement.



## PRIMER REVIEW

1. NEC Class II deals with hazardous areas having grain, coal or metal dusts.

True \_\_\_\_\_ False \_\_\_\_\_

- 2. Class I areas are divided into what 4 Groups?
- 3. What 3 elements make up the fire triangle?

b.\_\_\_\_\_ c.\_\_\_\_ a.\_\_\_\_

- 4. Select the best answer to complete this statement "explosion proof equipment..."
  - a \_\_\_\_ prevents any explosion from occurring.
  - b confines an explosion within enclosure.
  - c keeps hazardous vapors from entering "electrical system".
- 5. Factory sealed devices do not require field "sealing".

True \_\_\_\_\_ False \_\_\_\_\_

6. In Class I, Division 2 areas, fixtures must have a T number which is arrived at by measuring the external hot spot temperature.

True False

- 7. Name the 2 conditions in Class II areas to be concerned with a. Dust
  - b. Dust
- 8. The IEC Zone system and NEC Division System are identical.
  - True False
- 9. Conduit entering a junction box or fitting must have how many NPT threads engaged in the following hazardous areas.
  - a. Class I, Division 1 \_\_\_\_\_ threads engaged
  - b. Class I, Division 2 \_\_\_\_\_ threads engaged
  - c. Class II, Division 1 \_\_\_\_\_ threads engaged



## PRIMER REVIEW ANSWERS

Question No.	Answers
1	True
2	A, B, C, D
3	Fire, Fuel, Oxygen
4	b. confines an explosion within enclosure
5	True
6	False, measure internal hot spot
7	Dust <u>layers</u> , Dust <u>clouds</u>
8	False, Zones and Divisions are different
9	a 5 threads engaged
	b 3 threads engaged
	c 3-1/2 threads engaged