

Overview of Hazardous Locations as They Relate to Solenoid Valves

Defined:

Hazardous Location - "where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings."

National Electrical Code

Classes:

There are three defined classes in the *NEC*. These three classes establish the type of location based on the medium that may be suspended in the air or collected on or around the environment where the solenoid valve is located.

Class I Locations – (Gas Vapors) may be defined as locations that contain flammable gases or vapors in sufficient quantities to be explosive or ignitable.

Examples:

- Petroleum refineries, and gasoline storage and dispensing areas;
- Dry cleaning plants where vapors from cleaning fluids can be present;
- Spray finishing areas;
- Aircraft hangars and fuel servicing areas; and
- Utility gas plants, and operations involving storage and handling of liquefied petroleum gas or natural gas.

Class II Locations – (Dust) may be defined as locations that contain dust in sufficient quantities to be explosive or ignitable.

- Grain elevators;
- Flour and feed mills;
- Plants that manufacture, use or store magnesium or aluminum powders;
- Producers of plastics, medicines and fireworks;
- Producers of starch or candies;
- Spice-grinding plants, sugar plants and cocoa plants; and
- Coal preparation plants and other carbon handling or processing areas.

Class III Locations – (Fibers) may be defined as locations that contain fibers or flyings in sufficient quantities to be ignitable.

- Textile mills, cotton gins;
- Cotton seed mills, flax processing plants; and
- Plants that shape, pulverize or cut wood and create sawdust or flyings.

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Division:

There are two defined divisions in the *NEC*. These two conditions describe the way in which the hazardous material can exist.

Division 1 – (Normal) may be defined as an expected or intended hazard

Examples:

- Generator that runs in a pure hydrogen environment;
- Dry cleaning plants where vapors from cleaning fluids can be present.

Division 2 – (Abnormal) may be defined as an unexpected or unintended hazard

Examples:

- Storage drum that leaks due to a faulty seal;
- Release of acetylene due to rupture of welding line.

Group:

There are seven defined groups in the *NEC*. These seven properties define a combination of the medium's ignition temperature, explosive pressure, and flammable characteristics. The gases and vapors from Class I are defined in groups A-D and the dust from Class II are defined in groups E-G.

Group A – (Acetylene) the only gas defined in this group.

Group B – (Hydrogen) hydrogen and other similar gases.

Group C – (Ethylene) ethylene and other similar gases.

Group D – (Propane) common flammable substances like gasoline and propane.

Group E – (Magnesium) metal dusts.

Group F – (Coal) carbon black, charcoal and similar dusts.

Group G – (Grain) flour, starch and similar dusts.

Review:

Summary of Class I, II, III Hazardous Locations			
CLASSES	GROUPS	DIVISIONS	
		1	2
I Gases, vapors, and liquids (Art. 501)	A: Acetylene B: Hydrogen, etc. C: Ether, etc. D: Hydrocarbons, fuels, solvents, etc.	Normally explosive and hazardous	Not normally present in an explosive concentration (but may accidentally exist)
II Dusts (Art. 502)	E: Metal dusts (conductive,* and explosive) F: Carbon dusts (some are conductive,* and all are explosive) G: Flour, starch, grain, combustible plastic or chemical dust (explosive)	Ignitable quantities of dust normally are or may be in suspension, or conductive dust may be present	Dust not normally suspended in an ignitable concentration (but may accidentally exist). Dust layers are present.
III Fibers and flyings (Art. 503)	Textiles, wood-working, etc. (easily ignitable, but not likely to be explosive)	Handled or used in manufacturing	Stored or handled in storage (exclusive of manufacturing)

Solenoid Valve Considerations:

- *Ignition Source*

Arcs and sparks produced by the normal operation of a solenoid valve or related components such as switch or position indicator can ignite a hazardous location atmosphere.

The high temperatures of some solenoid valve coils can ignite flammable atmospheres if they exceed the ignition temperature of the hazardous material. The National Electrical Code requires special marking of hazardous location solenoid valves with coil enclosure temperatures above 100°C (212°F).

Electrical equipment failure is another way an explosion could be set off. A burn out or

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shorting of a solenoid coil could lead to ignition. Design considerations in the various standards for hazardous location equipment will address this failure.

- *Design Considerations*

The first requirement for a **Class I** solenoid enclosure is *strength*. The solenoid valve must be strong enough to contain an explosion within. The walls of the valve body must be thick enough to withstand the internal strain. The solenoid valve coil enclosure must be explosion-proof in case gas or vapors get inside. Secondly, the solenoid valve coil must function at a temperature below the ignition temperature of the surrounding atmosphere.

In some coil enclosures there must also be a way for the burning gases to escape from the enclosure as they expand during an internal explosion, but only after they have been cooled off and their flames quenched. This escape route for the exploding gases is provided through several types of *flame paths*.

One type of flame path is the ground surface flame path. Here the surfaces of the enclosure components are ground, mated, and held to a tolerance of 15 ten thousandths of an inch. This permits gases to escape the valve, but only after they've been sufficiently cooled, so they won't ignite the volatile surrounding atmosphere.

Another kind of flame path is the threaded flame path. After an explosion, the gas travels out the threaded joint of the enclosure, but as it does it cools off.

In **Class II**, the explosive dust is kept away from the internals of the coil enclosure so that no internal explosion can take place and there is no longer a need for explosion-containing enclosure construction, or flame paths. This difference explains why Class I, Division I solenoid valves can be called explosion-proof and Class II solenoid valves are called dust-ignition proof.

Class II solenoid valves have a different set of requirements:

- 1) The solenoid enclosure must seal out the dust.
- 2) The solenoid enclosure's surface temperature must operate below the ignition temperature of the hazardous substance.
- 3) The solenoid enclosure construction must allow for a dust blanket. A dust blanket is the build-up of dust collecting on top of the solenoid valve and enclosure that can cause it to run "hot" and ignite the surrounding atmosphere.

For **Class III** solenoid valves, there is very little difference in the design from Class II. Class III enclosures must minimize the entrance of fibers and flyings, prevent the escape of sparks, burning material or hot metal particles resulting from failure of the solenoid coil. The solenoid

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valve must operate at a temperature that will prevent the ignition of fibers accumulated on the valve.

There are many solenoid valves suitable for all three classes. This means that the valve meets the specifications for each individual type. A Class I solenoid valve which would contain an explosion of a specified gas would also have to prevent dust from entering the enclosure to be suitable for Class II. The close tolerance of the flame path in the valve which cools the burning gases is also close enough to keep explosive dust out so that a gasket would not be needed.

To properly install a solenoid valve in a hazardous location, the use of a **conduit seal** is necessary. Special fittings on the conduit or coil enclosure are required to keep hot gases from traveling through the conduit system igniting other areas if an internal explosion occurs in a Class I solenoid valve. Seals are also needed in certain situations to keep flammable dusts from entering dust-ignition-proof solenoid valves through the conduit.

Correlation to Non-US standards:

Equipment Groups, Categories and Divisions								
Description	Equipment Group ATEX		Equipment Category ATEX	Equipment Protection Level (IEC)	Presence or Duration of Explosive Atmosphere	G Flammable Gas / Vapor	Correlation with Hazardous Area Zones (ATEX, IEC)	Correlation with Divisions (USA,CANDA)
						D Combustible Dust Substances (ATEX)		
Explanation	I	Underground mines and associated surface installations	M1	Ma	Constant Risk Presence	Firedamp/Coal Dust		
			M2	Mb				
	II	All other surface installations	1	Ga	Continuous Presence	G	Zone 0	Division 1
				Da		D	Zone 20	
			2	Gb	Likely to Occur	G	Zone 1	Division 1
				Db		D	Zone 21	
			3	Gc	Unlikely to Occur	G	Zone 2	Division 2
				Dc		D	Zone 22	

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Classification and Groups				ATEX and IEC (Zones)			
Description	Classification		Apparatus Groups		Gas or Dust Groups		
	USA, CANADA	Flammable (Gas) or Combustible (Dust) Substances	USA, CANADA	Representative Gas / Dust / Fibers / Flyings	Flammable (Gas) or Combustible (Dust) Substances	ATEX/IEC	Representative Gas / Dust / Fibers / Flyings
Explanation	N/A	Gas	N/A	Methane (Gaseous Mines)	Gas	Group I	Methane (Gaseous Mines)
	Class I	Gas	Group A Group B Group C Group D	Acetylene Hydrogen Ethylene Propane	Gas	Group IIC	Acetylene Hydrogen
						Group IIB	Ethylene
						Group IIA	Propane
	Class II	Dust	Group E Group F Group G	Magnesium Coal Grain	Dust	Group IIIC	Non-conductive R \leq 103 Ω .m
						Group IIIB	Non-conductive R $>$ 103 Ω .m
						Group IIIA	Particle size $>$ 0,5mm
Class III	Fibers/Flyings	N/A	Cotton	Fibers	Group IIIA	Particle size $>$ 0,5mm	

		Flammable Material Present Continuously	Flammable Material Present Intermittently	Flammable Material Present Abnormally
IEC	IEC60079	Zone 0	Zone 1	Zone 2
EU	EN60079			
US	NEC 505	Zone 0	Zone 1	Zone 2
	NEC 500	Division 1		Division 2
CANADA	CEC Section 18	Zone 0	Zone 1	Zone 2
	CEC Annex J	Division 1		Division 2

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There are other methods of protection that are not covered in this overview.

- Intrinsic Safety
 - IEC60079-11
- Nonincendive Electrical Equipment
 - ANSI/ISA - 12.12.01-2011

References:

- [OSHA standard 1926.407](#)
- [National Electrical Code](#) (NFPA 70)
- [ANSI/ISA - 12.27.01-2003](#)
- [Canadian Electrical Code](#) (C22.1-12)

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