Specifying Temperature Sensors in Hazardous Areas

A great concern to those who specify instruments is the safety of the installation in hazardous areas. This guide will help the user define these locations and specify the proper sensor enclosure in accordance to nationally accepted standards.

The following list of acronyms are a sampling of the testing laboratories and standard institutes in North America that deal with standards and testing of materials used in hazardous areas.

ANSI American National Standards Institute
CSA Canadian Standards Association
FM Factory Mutual Research Corporation
I. S. Intrinsically Safe
ISA Instrument Systems and Automation
NEC National Electric Code
NEMA National Electrical Manufacturers Association
NFPA National Fire Protection Association
UL Underwriters Laboratories

This guide is not intended to define hazardous locations. However it will provide insight to sensor enclosures designed to function in hazardous areas. In North America the NEC divides flammable gases in to three classes:

- **Gases**
- **Dusts**
- **Fibers**

The *classes* are further divided into *groups.* The *groups* are organized by the explosive potential of the material within the group. The following table lists the class with an example of some of the materials in the group.

Class I: Flammable gases and vapors	**Group A:** Acetylene
	Group B: Hydrogen, butadiene, ethylene oxide, propylene oxide
	Group C: Ethylene, coke oven gas, diethyl ether, dimethyl ether
	Group D: Propane, acetone, alcohols, ammonia, benzene, butane, ethane, ethyl acetate, gasoline, heptanes, hexanes, methane, octanes, pentanes, toluene.
Class II: Combustible dusts	**Group E:** Metal dust
	Group F: Coal, coke dust
	Group G: Grain, plastic dust
Class III: Combustible flyings and fibers	Wood flyings, paper fibers, cotton fibers

The third and final consideration of the standards is the probability of the presence of the materials as identified by the groups that are incorporated into the three classes. This area is broken down into two separate Divisions. Division identification is thorough and complicated but basically subscribes to the following guidelines:

Division I: Areas where hazardous materials may be present under normal operating conditions
Division II: Areas where hazardous materials may become present due to leaks, process upsets or failures

In reviewing the two areas the probability of an explosion is more prevalent where explosive gases or dust are present in the process. Consequently Division I is defined as a hazardous location by standard institutions.

Today's instrumentation is more consistent and reliable than instruments used a decade ago, greatly reducing the chances of a spill or process upset. Also specifications that call for non redundant technologies to prevent process upsets like spills have reduced the possibility of catastrophic occurrences in Division II areas. Although Division II areas are classified as nonhazardous, for safety reasons many users prefer to use Division I products in Division II areas. In general because of the low energy produced, non passive devices such as thermocouples and RTDs should be safe in Division II areas.

In summary there are three methods of protection for temperature sensors in Division I areas. They are:

- **Explosion proof housings**
- **Intrinsically safe loops**
- **Purged or safe instrument air**

This guide has pretty much described the hazardous area and the following are the enclosures (heads) available from Smart Sensors along with the NEMA rating and the areas that we recommend their use:

Explosion Proof
For use in:

Class I
Division I
Groups B, C, and D

Class II
Division I
Groups E, F, and G

NEMA - 4

NEMA - 4X

NEMA Protection Ratings

In North America, Equipment can be classified per the National Electrical Manufacturer's Association (NEMA) Enclosure Classifications. NEMA is a nonprofit trade organization composed of mainly U.S. manufacturers of electrical apparatus. NEMA created voluntary standards for electrical enclosures. These classifications describe the environment in which the product can be used due to the protection the enclosure provides. ("Enclosure" includes electrical and mechanical connections and external adjustments.) Among others, NEMA classifies enclosures based on the effects of external icing, rust and corrosion, or contamination from oil and coolants.

Type 1	General Purpose	Indoor	accidental contact will not corrode
Type 2	Drip-proof	Indoor	limited amounts of falling water and dirt will not corrode
Type 3	Dust-tight, rain-tight	Outdoor	windblown dust, rain, sleet, and undamaged by external ice formation
Type3R	Dust-tight, rain-tight	Outdoor	same as type 3 above, plus diverts water from live parts, provision for drainage, will not corrode
Type 3S	Dust-tight, rain-tight	Outdoors	same as type 3 above, operation of external mechanism when ice laden, will not corrode
Type 4	Water-tight, dust-tight	Indoor/Outdoor	windblown dust and rain, splashing water, and hose directed water, undamaged by ice formation, will not corrode
Type 4X	Water-tight, dust-tight	Indoor/Outdoor	same as type 4 above, plus corrode resistant, will not corrode
Type 5	Dust-tight	Indoor	dust and falling dirt, will not corrode
Type 6	Water-tight/dust-tight	Indoor/Outdoor	temporary entry of water during limited submersion (6ft/2m for 30 Min), undamaged by formation of ice, will not corrode
Type 6P	Water-tight/dust-tight	Indoor/Outdoor	same as type 6 above plus prolonged submersion, will not corrode
Type 7	Explosion proof/Class I Groups A, B, C, D	Indoor	Hazardous Locations: Protection against corrosive effects of liquids and gases
Type 8	Explosion proof/Class I	Indoor/Outdoor	Hazardous Locations: protection against corrosive effects of liquids and gases; contacts or connections immersed in oil
Type 9	Explosion Proof/Class II Groups E or G	Indoor	Hazardous Locations: dust-tight, hazardous dust
Type 10	Hazardous Locations	Indoor	U.S. MSHA Mine Safety and Health Adm. per 30 C.F.R., Part 18
Type 11	Oil-tight/Corrode	Indoor	protection from corrosive effects of gases and liquid dripping, seepage and external condensation or corrosion, oil immersion
Type 12	Oil-tight/Dust-tight	Indoor	fibers, lint, dust and light splashing, seepage and dripping condensation or non-corrosive liquids
Type 12K		Indoor	same as type 12 above, enclosure has knockouts
Type 13	Oil-tight/Dust-tight	Indoor	dust, spraying of water, oil and corrosive coolant, oil resistant gaskets

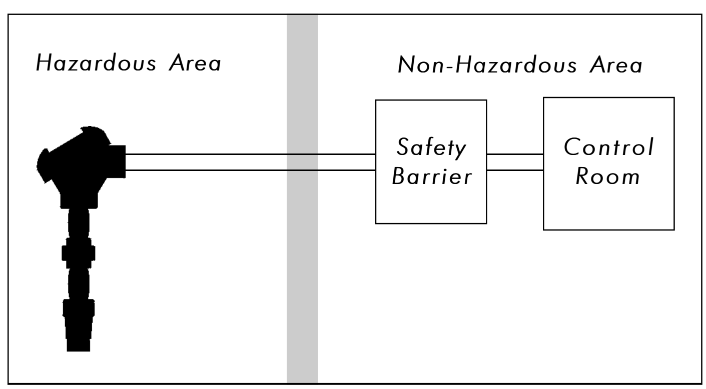
The final area for discussion regarding protection in hazardous areas is intrinsically safe loops.

Intrinsically safe equipment is defined as "equipment and wiring which is incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture in its most easily ignited concentration." (ISA-RP12.6) This is achieved by limiting the amount of power available to the electrical equipment in the hazardous area to a level below that which will ignite the gases.

Since RTDs and thermocouples are low energy devices they lend themselves useful in intrinsically safe loops. By definition these sensors do not possess the energy to ignite a material that could cause an explosion. A temperature loop is determined to be intrinsically safe if it is incapable of ignition under four conditions:

Normal power levels
Faults in the control room
Faults in the signal wiring
Faults in the sensor

No explosion proof housings are required in intrinsically safe temperature loops, consequently this can result in a significant cost savings to the user, However since most receiving instruments are AC powered, they can release stray voltage through the instrument wire to the field sensor. The use of Zener barriers prevents explosions due to this scenario and certifies the loop as intrinsically safe.



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