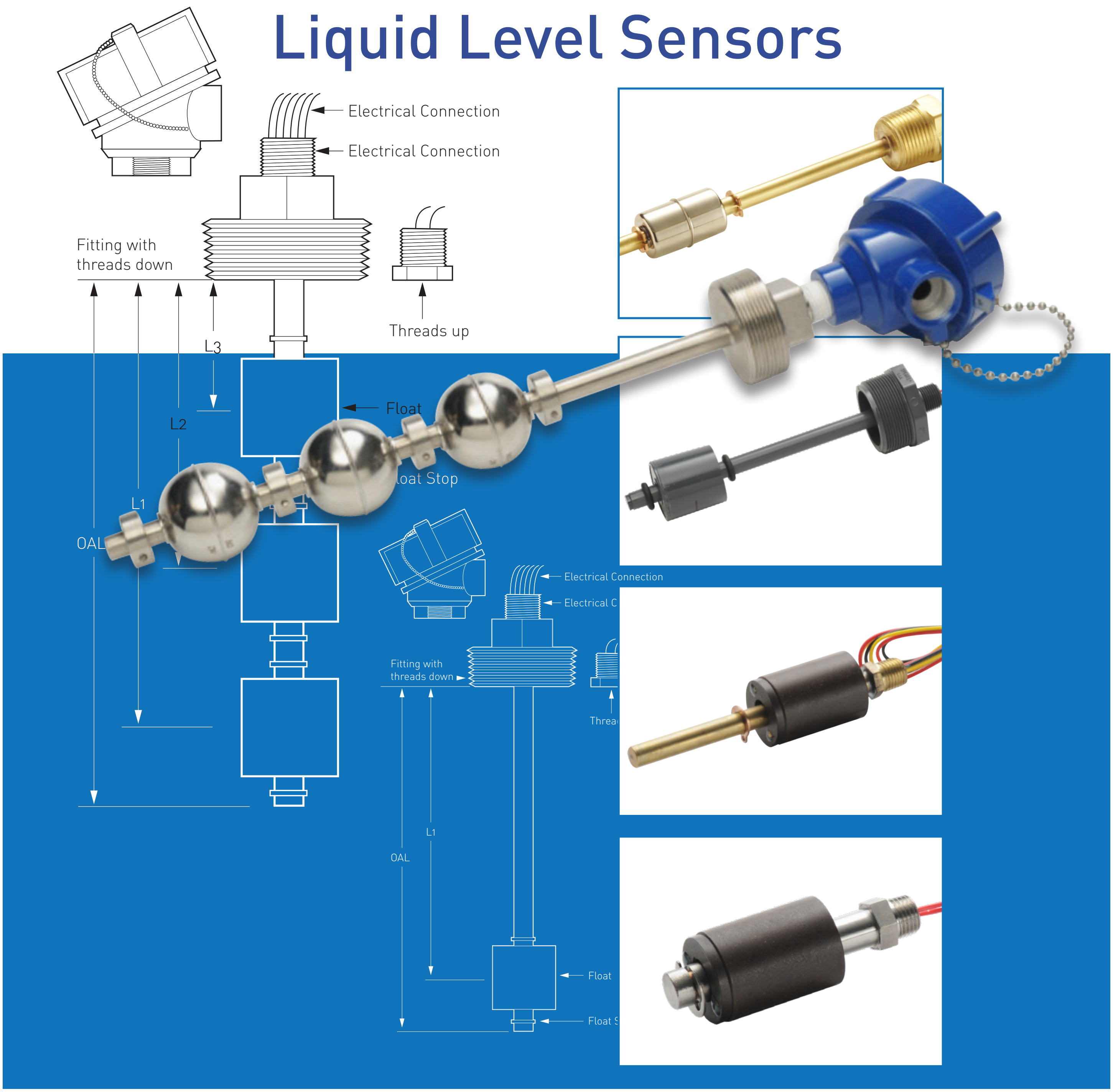
Rochester Sensors

The Ultimate Guide to Float Level Sensors:

Hazardous Location Guide to Liquid Level Sensors



APPENDIX 1: Hazardous location considerations

Note: This document is for informational purposes only. Associated apparatus must be installed in accordance with its manufacturers control drawing and Article 504 of the National Electrical Code (ANSI/NFPA 70) for installation in the United States, or Section 18 of the Canadian Electrical code for installations in Canada. Suitability for installation applications is at the discretion of the authority having jurisdiction (AHJ).

At times, sensors must be installed in areas where combustible dust, vapors and gases are used or may be present. These areas are commonly referred to as "hazardous locations," and are defined by the National Electrical Code (NEC) in the US, or the Canadian Electrical Code (CEC) in Canada. When equipment must be installed in hazardous locations, there are strict requirements to prevent inadvertent ignition of combustible dust, gases and vapors.

In North America, the categorization of hazardous areas is done in accordance with NEC article 500 and other associated articles. The class rating will tell you if the hazardous material is a gas or is dust. The division rating indicates the probability of the hazard being present; and the group reveals the type of the hazardous substance and its volatility.

Condition descriptions

There are three classes of hazardous conditions:

Class I Locations: Gases and Vapor	Class II Locations Combustible Dust	Class III Locations Fibers and Filings
• Petroleum refineries, and gasoline storage and dispensing areas • Dry cleaning facilities where vapors from cleaning fluids are present • Spray finishing areas • Aircraft hangars and fuel servicing areas • Utility gas plants and operations involving the storage and handling of liquefied petroleum gas or natural gas	• Grain elevators • Flour and feed mills • Plants that manufacture, use or store magnesium or aluminum powders • Plastic, medicine and firework manufacturers • Starch or candy producers • Spice-grinding plants, sugar plants and cocoa plants • Coal preparation plants and other carbon handling or processing areas	• Textile mills, cotton gins • Cotton seed mills, flax processing plants • Plants that shape, pulverize or cut wood and create sawdust or filings

Most hazardous locations for liquid level sensors are Class I locations. This guide will focus on Class I locations because the level sensors are mostly used in liquids that are typically hazardous when in a gas or vapor form.

Class I locations have two divisions of hazardous conditions:

Division 1: The gases or vapors are always present at sufficient concentrations to be an explosion hazard.

Division 2: The gases or vapors may be present, and if they are, they are likely to be in sufficient concentrations to be an explosion hazard.

In Class I locations there are four Groups (A, B, C, D) that are classifications of substances and their degree of volatility, with A being the most hazardous and D being the least volatile group for gases and vapors.

Group A: Acetylene

Group B: Hydrogen and manufactured gases containing hydrogen

Group C: Ethyl-ether vapors, ethylene, or cyclo-propane

Group D: Gasoline, hexane, naphtha, benzene, butane, propane, alcohol, acetone, benzol, lacquer

Basics of explosion risks

For an explosion to occur, there must be three basic conditions present:

1. A flammable liquid, vapor or combustible dust must be present in sufficient quantity
2. The flammable liquid, vapor or combustible dust must be mixed with air or oxygen in the proportions required to produce an explosive mixture
3. A source of energy must be applied to the explosive mixture.

In applying these principles, the quantity of the flammable liquid or vapor that may be present and its flammable characteristics must be recognized.

Sources of ignition

A source of energy is needed to create an explosion when flammable gases or combustible dusts are mixed in the proper proportion with air. Equipment such as switches, pushbutton stations, plugs and receptacles, can produce arcs or sparks in normal operation when contacts are opened and closed. This could easily cause ignition. Electrical safety, therefore, is of crucial importance. The electrical installation must prevent accidental ignition of flammable liquids, vapors and dusts released to the atmosphere.

The difference between intrinsically safe and explosion proof

The two most common methods of protecting a sensor circuit in a hazardous location are Intrinsically Safe and Explosion Proof.

When using “explosion-proof rating” to address the hazardous rating protection, the internals of the sensor and affiliated equipment must be engineered to contain an internal explosion and avert a much larger detonation.

An “intrinsically safe rating” means the electronics are designed and or controlled so that a spark does not create enough energy to ignite the substances in the hazardous location.

Intrinsically safe equipment

Intrinsic safety (I.S.) is a protection method for electrical equipment used in hazardous locations where the energy allowed into and stored within an area is limited to a level that is incapable of causing ignition. I.S. equipment is designed and evaluated to ensure that the amount of electrical energy stored within the device is reliably limited to predetermined safe levels.

The use of intrinsically safe equipment is suitable to process control instrumentation such as float switches and level transmitters because these electrical systems lend themselves to low energy requirements. An I.S. barrier must be used to limit the amount of energy entering the hazardous area and the I.S. barrier must be selected to be compatible with the connected IS equipment both from a safety and functional perspective.

Explosion proof enclosures

The explosion-proof protection method relies on equipment and wiring enclosures to prevent an internal ignition from escaping to the surrounding atmosphere. Such housings usually are made of cast aluminum or stainless steel and are of enough mass and strength to safely contain an explosion should flammable gases or vapors penetrate the housing and the internal electronics or wiring cause an ignition.

In Class I, Division 1 and 2 locations, conventional relays, contactors and switches that have arcing contacts should be enclosed in explosion proof housings.

The NEC defines explosion proof apparatus as "apparatus 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." These enclosures must prevent the ignition of an explosive gas or vapor that may surround it. In other words, an explosion inside the enclosure must be prevented from starting a larger explosion on the outside.

Intrinsically safe versus explosion proof: Advantages and disadvantages

Explosion proof

Although an explosion proof system for liquid level sensor applications is generally considered somewhat simpler to design, it is generally more expensive to install because of the high cost of running field wiring inside a conduit, which must be sealed between the safe and hazardous areas. Explosion-proof equipment can also be more difficult to maintain since either the area must be known to be non-hazardous or the equipment must have the energy drained before covers can be removed.

Liquid level sensor explosion proof systems have their own hazards, particularly because they do not actually avoid creating an explosion. The housing is designed to contain the explosion. The risk is that with corrosion, nicks or cuts to the housing, or if screws are not screwed in all the way, a much larger explosion could occur outside the housing.

Intrinsically safe

Liquid level sensor intrinsically safe systems are commonly considered safer, less expensive, and easier to install and maintain. With intrinsically safe designs, system integrity is less of a concern because explosions cannot occur. Intrinsically safe liquid level sensor systems offer significant labor savings over traditional explosion proof protection methods because there are no heavy conduits or bolted enclosures. Material costs are typically less because a standard enclosure is the only major expense for mounting the barriers. And unlike most explosion protection methods, intrinsically safe systems operate seamlessly with retrofit applications and with modern technologies such as fieldbus. The affinity to newer technology is one reason intrinsically safe designs are becoming a preferred hazardous location protection method.

The main disadvantage of intrinsically safe systems is that it can be used for low power circuits. Typically, measuring and control instruments (like level sensors, level transmitters etc.) are low power circuits which makes them a good candidate for Intrinsically Safe designs.

Selecting the best choice

Intrinsically safe systems seem to be considered the preferred solution for low power sensor circuits including level switches, level transmitters, RTDs, pushbuttons, and low-power solenoids.

This approach is embodied in the principle of intrinsically safe systems where the sparks are prevented from ever causing an explosion. In contrast, the explosion proof method of protection is mitigative: when sparking happens in a hazardous area, the explosion does occur, but the effects are mitigated to some extent.

Designing Intrinsically safe sensor circuits using simple and non-simple apparatus'

Simple apparatus (switches) vs non-simple apparatus (transmitters)

An intrinsically safe apparatus is classified either as a simple apparatus or non-simple apparatus.

Simple apparatus is defined in paragraph 3.12 of ANSI/ISA-RP 12.6-1987 as any device which will neither generate nor store more than 1.2 volts, 0.1 amps, 25 mow or 20 µJ. Float switches, simple switches, contacts, thermocouples, and resistors are examples of a simple apparatus. These devices themselves do not need to be approved as intrinsically safe when connected to an approved intrinsically safe barrier.

A non-simple apparatus, on the other hand, can create or store levels of energy beyond what is listed above as safe and thus the device itself needs to carry an intrinsically safe rating and be connected to an approved intrinsically safe barrier. Typical examples are transmitters, transducers, and relays. These approved intrinsically safe devices will have a required control drawing that indicates the intrinsically safe barrier parameters and wiring requirements.

Float Switches

A float switch is considered a simple apparatus by UL's Hazardous Location approving agency. A simple apparatus does not require a special hazardous location rating (Class I, II or III); however, it does require connection to an appropriate intrinsically safe barrier. The intrinsically safe barriers have certifications that are extended to the attached simple apparatus when installed properly.

Transmitters

A continuous output transmitter is considered a non-simple apparatus by UL's Hazardous Location approving agency. A non-simple apparatus requires a hazardous location rating and needs to be connected to an appropriate intrinsically safe barrier. Refer to the control drawing below for an example of our continuous level sensor with intrinsically safe barrier.

Note: this document is for informational purposes only. Associated apparatus must be installed in accordance with its manufacturers control drawing and Article 504 of the National Electrical Code (ANSI/NFPA 70) for installation in the United States, or Section 18 of the Canadian Electrical code for installations in Canada. Suitability for installation applications is at the discretion of the authority having jurisdiction (AHJ).