

Understanding What's Meant by "Intrinsically Safe"

Fire is a hazard in many industries. Sometimes the risk is quite evident, as when flammable gasses like hydrogen and propane are being produced or handled, but in other situations it is less obvious. In particular, dust can often be highly combustible.

A fire needs fuel, oxygen and an ignition source. Flammable gasses, vapors and dust provide the fuel, oxygen is present in most environments, and ignition can come from a spark or hot surface. Every fire is dangerous, but in more extreme cases combustion is so rapid as to cause an explosion. OSHA has many reports of devastating fires and explosions across a wide range of industries.

Preventing fire and explosions is a top priority as no business or organization wishes to be responsible for causing death and injury. Additionally, the direct financial penalties of such events – punitive fines and increased insurance premiums—can cripple a previously successful operation.

Engineers needing to install equipment in areas where fire is a risk have two options: employ explosion-proofing techniques or adopt an "intrinsically safe" design approach (and these are not mutually exclusive). This White Paper from OMEGA Engineering answers the question, "what is intrinsic safety?" Individual sections address:

- Understanding Intrinsic Safety (IS)
- Choosing the right pressure transducer or load cell for IS environment
- Installation and risk management considerations
- General Q&A

After reading this paper engineers and other technical specialists should understand the intrinsic safety concept and the benefits of applying it in their work.

UNDERSTANDING INTRINSIC SAFETY

Intrinsic Safety (IS) is an approach to the design of equipment going into hazardous areas. The idea is to reduce the available energy to a level where it is too low to cause ignition. That means preventing sparks and keeping temperatures low.

The alternatives are to design systems so oxygen is excluded (by purging with inert gas) or to isolate possible sources of ignition. This can be done either by putting equipment in enclosures strong enough to contain an explosion or by moving it outside the hazardous area.

WHEN IS INTRINSIC SAFETY EQUIPMENT NECESSARY?

Whenever equipment is being installed in an area where combustible material is present it is essential to take steps to minimize the risk of ignition. OSHA accepts IS design as an appropriate approach, although requires that the whole system be designed accordingly. It is not sufficient to just use IS certified components.

An exception to the need for certification is made in the case of "simple apparatus". This is the term used for very low power or passive devices that will not cause ignition. Good examples are thermocouples and RTD's.

DEFINITIONS OF HAZARDOUS AREAS

The National Fire Protection Association, (NFPA) publishes codes intended to minimize fire risks. NFPA 70 sets out the National Electrical Code, often referred to as the NEC. Section 500 and 505 provide definitions of hazardous areas. The reason for the duplication is that 505 is the newer version, structured to harmonize the definitions with those used outside the United States.

Section 500 of the NEC defines Class 1, 2 and 3 locations. Class 1 relates to gases and vapors, Class 2 to dust, and Class 3 to fiber. Within each Class are two divisions. A Division 1 designation means the hazard can exist under normal conditions or could exist because of maintenance work or because of leakage or breakdown. Division 2 denotes a location where gases or vapors are confined and only escape due to accidental rupture or breakdown, where build-up is prevented through positive ventilation. Class III locations are those which are hazardous because of the presence of easily ignitable fibers or flyings.

Section 505 follows the same principles but uses Zones rather than Classes and Divisions. A Zone 0 location is one where "ignitable concentrations of flammable gases or vapors are present continuously ... or are present for long periods of time." A Zone 1 designation denotes that, "...ignitable concentrations ... are likely to exist under normal operating conditions," or as a result of leakage or repair operations. Designating a location as Zone 2 indicates that ignitable concentrations "are not likely to occur in normal operation, and if they do occur will exist only for a short time." For dust, the corresponding zones are 20, 21 and 22.

HOW DOES INTRINSIC SAFETY EQUIPMENT WORK?

Avoiding ignition entails minimizing both the available power and the maximum temperatures. Defining the maximum level of available power is complex, but in general terms can be considered as meaning voltage less than 29V and under 300 mA. A simpler view is to say that power must be less than 1.3 W. (Note that much instrumentation requires 24V and can often be designed to draw less than 500 mA; sufficient to meet IS certification in many situations).

Six classes define temperature levels. In general, equipment meeting the T4 designation is considered intrinsically safe because temperatures will not exceed 135°C (275°F) (equipment dissipating less than 1.3 W generally stays below this temperature).

WHAT TYPES OF INTRINSIC SAFETY EQUIPMENT ARE AVAILABLE?

A wide range of industrial equipment, such as flashlights, cameras, gas detectors and even radios, are available in intrinsically safe forms. In terms of instrumentation the biggest need is for pressure and weight measurement. Temperature measurement generally meets the “simple apparatus” rule although temperature transmitters may be needed to send thermocouple signals over longer distances.



Pressure Transmitter
PX51-IS



Pancake Style Load Cell
LCHD-IS

IS INTRINSIC SAFETY CERTIFIED EQUIPMENT MORE EXPENSIVE THAN NON-CERTIFIED VERSIONS?

Typically IS equipment is slightly more expensive than non-certified versions. This results more from obtaining and maintaining the approval than from the cost of additional or uncommon components. The basic design of an IS barrier uses Zener Diodes to limit voltage, resistors to limit current and a fuse, none of which are expensive.

WHAT ARE THE BENEFITS?

When electrical equipment and instrumentation must be placed in a hazardous environment, IS offers several benefits.

1. It helps ensure a safe work environment and protects those nearby from explosion risks.
2. It avoids the cost and bulk of explosion proof enclosures. Additional cost savings accrue from the ability to use standard instrumentation cables.
3. Maintenance and diagnostic work can be performed without shutting down production and ventilating the work area.
4. Insurance premiums may be lower as a result of the reduction in risk.

CHOOSING PRESSURE TRANSDUCERS OR LOAD CELL FOR INTRINSIC SAFETY ENVIRONMENTS

When flammable gases are being handled, or flammable liquids, especially if there’s a possibility of vapors forming, then IS protection is clearly needed. However, the need may be less obvious in conditions of dust or fibers.



DIN Connector
PX539-IS

Mini-DIN
Connector
PX519-IS

Cable with
Flying Leads
PX509-IS

M12 Connector
PX559-IS

NFPA 70 defines combustible dust as particles smaller than 500 microns while OSHA 1910.399 states “Combustible dusts that are electrically nonconductive include dusts produced in the handling and processing of grain and grain products, pulverized sugar and cocoa, dried egg and milk powders, pulverized spices, starch and pastes, potato and wood flour, oil meal from beans and seed, dried hay, and other organic materials which may produce combustible dusts when processed or handled. Dusts containing magnesium or aluminum are particularly hazardous.”

For equipment to qualify as IS it must be certified as such. In the United States two institutions providing such certification are UL and FM Global. Instrumentation meeting IS standards displays the “FM Approved” mark. Equipment without such marking must not be used in hazardous environments unless other appropriate precautions are taken.

INSTALLATION AND RISK MANAGEMENT CONSIDERATIONS

Installation is easier than setting up explosion proof enclosures. It is important to note that the whole system must be designed to be intrinsically safe. It is not sufficient just to purchase pressure sensors or load cells with IS certification.

A system designed to be intrinsically safe requires full documentation of all the components and wiring employed. Immediately following installation there will be an inspection, followed by periodic inspections through the life of the equipment. This is to identify any deterioration or damage that may have occurred and any unapproved or unauthorized replacement of IS system components.

Insulation and ground testing normally form part of an electrical inspection. However, such practices are not normally compatible with the IS concept. Specialist advice should be sought if these tests are needed.

GENERAL Q&A

Does Intrinsically Safe equipment replace explosion proofing or pressurization?

No, intrinsically safe apparatus cannot replace these methods in all applications due to the reliance on low power and temperature. Where it is possible it often leads to significant savings in installation and maintenance costs.

Does Intrinsic Safety affect the performance of the certified device?

No, the performance is the same as the as the non-certified with higher reliability. These devices use the same parts as the non-certified device but have been designed to limit the energy stored and heat generated in case of an internal fault condition.

Protecting People and Property

Many industrial, chemical and process environments have significant explosion risks, either due to the presence, actual or possible, of flammable gases and vapors, dusts or fibers. Such environments are termed “hazardous” and it is essential that they are designed so as to eliminate the possibility of igniting the flammable material.

Often it's necessary to incorporate instrumentation of an electrical nature in such environments. When this is unavoidable there are three possible approaches: put the equipment in an explosion proof enclosure, purge the enclosure with inert gas, or adopt Intrinsic Safety design principles.

IS design minimizes power and heat creation. Equipment must be independently certified as IS, and the whole system must be designed to IS standards before entering service. However, adopting IS design can simplify installation, save money, enable maintenance on live equipment, and most importantly, makes for a safer workplace.

Source

Combustible Dust in Industry: Preventing and Mitigating the Effects of Fire and Explosions—Safety and Health Information Bulletin SHIB 07-31-2005:
<https://www.osha.gov/dts/shib/shib073105.html>

From OSHA 1910.399:
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9976

NFPA 70® National Electrical Code® 2014 Edition:
<http://www.nfpa.org/Assets/files/AboutTheCodes/70/70-14-toc.html>