White Paper

Hazardous area classifications and protection methods

Keith Riley

Executive Summary

A paper which describes what the hazardous area classifications are and what specific protection methods truly mean. It will demystify the common third party approvals. This paper will also include how and when you can use a specific approval rating as well as what is and is not required to be supplied.

About the Author

Keith Riley has been a Product Business Manager with Endress+Hauser since April 2008. Prior to this, he has been a Product Manager and Regional Sales Manager with L.J. Star Incorporated as well as a Product Manager for Penberthy (Tyco Valves). Overall, he has over 15 years of sales, marketing and application experience in the process industry.
Class who?  
Division where?  
Group what?  

This paper is intended to demystify third party approvals. Included is information addressing what the common hazardous area classifications are for a facility and what a specific protection method truly means. It also includes how and when you can use a certain approval rating as well as what the instrument supplier is and is not required to supply.

First, let’s begin with definitions of the various Class, Divisions and Groups you will likely encounter.

**Class:** A type of hazardous location segmented and defined by the materials present.

- **I** An area in which flammable gases or vapors may be present in the air in sufficient quantities to be explosive or ignitable.
- **II** An area in which combustible dust may be present in sufficient quantities to be explosive.
- **III** An area in which easily ignitable fibers or flyings are present. These do not have to be airborne but may also accumulate on or near the instrument.

**Division:** This is the condition under which the hazard identified by the Class rating is present.

- **I** Normally present. You can expect the hazard to be present in sufficient quantities to be explosive or ignitable every day during normal operation.
- **II** Abnormally present. This identifies a situation where the hazardous material would typically be confined in a container or system. However in the event of a failure or accidental rupture it would be released into the area in quantities sufficient to be explosive or ignitable.

**Group:** Categorize and identify the nature of the hazardous materials that could be present in the hazardous location that has been identified.

- **A, B, C & D** Refer to gases and vapors covered under Class I locations. The segmentation between the groups is based upon ignition temperature, explosion pressure and other flammable characteristics.
  - **Group A** Acetylene
  - **Group B** Hydrogen and similar materials
  - **Group C** Ether, Ethylene and similar materials
  - **Group D** Hydrocarbons, fuels and solvents such as propane

- **E, F & G** Are used to segment the various hazardous substances in a Class II area. The groupings are based upon ignition temperature and conductivity of the material in question.
  - **Group E** Metal dusts (conductive and explosive) such as aluminum and magnesium
  - **Group F** Carbon dusts (some conductive and all explosive) such as carbon black, coal and coke
  - **Group G** Grain, plastic or chemical dusts (explosive) such as flour or starch

Is there more than one protection method for instruments that can be utilized for a given hazardous area classification?

Typically, the use of Class, Zone, Group is the European method of hazardous area classification. However, recent changes in the United States acknowledge the use of the Class, Zone, Group method. The classification of Class, Division, Group is based upon Article 500 of the NEC (National Electric Code). The U.S. version of Class, Zone, Group is based upon Article 505. While technically acceptable, the use of Class, Zone, Group has not been widely embraced by the United States.

This section will address the definition of and differences between the most common protection methods utilized in the United States; XP, IS, NI and DIP.

Let’s start with the two Division 1 protection methods people are most familiar with; explosion proof and intrinsically safe.
**Explosion Proof (US acronym – XP):**
This protection method is based upon a containment strategy. We are not trying to prevent contact between the hazardous environment and the electrical energy of the instrument. It is assumed that at some point this is inevitable. Instead the intention is to insure the system is capable of containing and controlling a subsequent explosion. This is accomplished through a combination of the physical strength of the enclosure and proper sealing procedures. Sealing procedures either prevent the escape of flames and/or hot gases or direct the same to controlled flame paths. These flame paths help relieve pressure from the explosion and allow the gases time to cool before they reach the atmosphere. The explosion proof protection method is intended for use in a Class I, Division 1, Group A thru D hazardous area classifications.

When dealing with an explosion proof rated device, the use of proper wiring practices is automatically implied. Specifically this means following the standards and procedures outlined in NEC [National Electric Code] Article 501. This includes, but is not limited to, the use of explosion proof rated conduit and a flame path seal-off installed within 18” of the instrument enclosure. Since these standard wiring practices must be employed for all XP rated instruments, manufacturer supplied control drawings detailing proper installation procedures are not required. The inclusion of control drawings is at the manufacturers discretion.

**Intrinsically Safe (US acronym – IS):**
This protection method is based upon the concept of energy limitation. Here again it is assumed contact between the hazardous environment and the energy of the instrument is inevitable. Consequently, the strategy is to prevent ignition of the hazardous environment by limiting the amount of energy allowed to enter the hazardous area. This includes direct or stored electrical energy as well as heat. The intrinsically safe protection method is intended for Class I, II, III; Division 1; Groups A thru G hazardous area classifications.

The second significant difference between XP and IS protection methods is the use of Associated Apparatus (approved third party equipment). An associated apparatus is a device that regulates the voltage and current available to the intrinsically safe rated instrument. Every intrinsically safe rated instrument will utilize an associated apparatus. In most cases the associated apparatus is an intrinsically safe barrier that is physically located outside of the hazardous area. One exception to the location restriction would be if the associated apparatus is mounted in an explosion proof rated enclosure. This could allow the associated apparatus to be located inside the hazardous area with approval from the proper authoritative body.

For an intrinsically safe rated device, a manufacturer supplied control drawing is mandatory. The instrument’s intrinsically safe rating is dependent upon it being properly connected to the associated apparatus. Since correct wiring procedures can vary between instruments, instrument specific instructions must be provided.

The answer is Yes! If you have an area classified as Class I, Division 1, Groups A thru D, it is possible to employ either an explosion proof or intrinsically safe rated instrument. Assuming all of the proper wiring practices and/or associated apparatus are utilized, either protection method would be allowed and considered equally safe. The choice of which protection method to use will rest with the facility and their preferred method of installation.

**Do Not Make the Mistake of Thinking All XP and IS Rated Devices are Interchangeable!** The applicability of protection methods is area classification specific. If the area classification in question was anything other than Class I, an XP rated instrument could not be used but an IS rated instrument could.

In the next section, we will address two of the remaining protection methods employed for instrumentation, Dust Ignition Proof (DIP) and Non-Incendive (NI).
practices must be employed, manufacturer supplied control drawings are not required for DIP rated instruments. The inclusion of control drawings is at the manufacturer’s discretion.

**Non-Incendive and Non-Incendive Field Wiring Apparatus (US acronyms – NI and NIFW):** Both NI and NIFW are strictly Division 2 protection methods. They share the common feature that any electrical or thermal energy contained within the instrument’s circuits is incapable of igniting the combustible material in the hazardous area under normal* operating conditions. The instrument housing is not intended to exclude the flammable atmosphere or contain an explosion for either protection method. This means the housing and wiring requirements are less stringent and costly than for Division 1 protection methods. This is where the similarity between NI and NIFW ends.

A **Non-Incendive** rating means that under normal* conditions the instruments circuits are incapable of causing ignition of the hazardous atmosphere. This is accomplished without any special wiring consideration assuming the manufacturer’s published specifications are met. Consequently, control drawings are not required for NI rated instruments.

A **Non-Incendive Field Wiring Apparatus** rating means under normal* conditions the instrument’s circuits are incapable of causing ignition of the hazardous atmosphere. However, a NIFW rated instrument is dependent upon an Associated Non-Incendive Field Wiring Apparatus [ANIFW]. This is a third party device that controls the current and voltage available to the instrument. In most cases an ANIFW rated power supply located outside of the hazardous area is used for this purpose. An ANIFW power supply is different from and less expensive than an intrinsically safe barrier used for IS rated instruments. As you can probably guess since the instruments NIFW rating is dependent upon an ANIFW rated device, control drawings are mandatory.

Let’s review our questions from the beginning of this section.

**How does a DIP protection method differ from a XP protection method?**

1. DIP is a valid protection method for Class II & III (dust, fibers, any flyings) hazardous area classifications while XP is a valid protection method for Class I (gases and vapors) hazardous area classification.

2. A DIP rated instrument contains the electrical and thermal energy within the housing in such a way as to preclude contact with the hazardous area and prevent ignition. A XP rated instrument assumes contact with the hazardous area is inevitable and is designed to contain and/or control the subsequent explosion within the housing.

**How does a NI or NIFW protection method differ from XP or IS?**

1. NI and NIFW protection methods are limited in use to areas with a Division 2 classification. Both XP and IS protection methods are primarily intended for use in areas with a Division 1 classification.

2. The NI wiring requirements per NEC Article 501 for a Class I, Division 2 hazardous area classification are less stringent and less expensive than for a Class I, Division 1 hazardous area classification. Example: A conduit seal within 18 inches of the enclosure is not required.

Now let’s look at two additional questions that many of you are probably asking.

**Why would someone use a NI or NIFW protection method versus XP or IS?**

The primary reason is cost! If the physical area in question has been designated with a Class I, Division 2 classification the potential savings to the facility from using a NI or NIFW rated instrument in terms of reduced wiring and installation cost can be significant.

**Isn’t a NI or NIFW protection method “less safe” than a XP or IS? NO!** They are dealing with different area classifications (Class I, Division 2 versus Class I, Division 1). The protection methods for Division 1 and Division 2 classifications are simply based upon a different set of operational parameters and probabilities that dictate different strategies to maintain a safe environment. This in turn affects the associated cost, not the overall safety.

The next section is common to all of the protection methods we have discussed: Temperature Classifications and Temperature Class Ratings. This will then be followed by frequently asked questions and a short discussion on Nationally Recognized Testing Laboratories.

### Temperature Classifications/ Temperature Class Ratings

By now you can guess that Temperature Classifications are given to a hazardous area and Temperature Class Ratings are applied to instruments. Temperature Classifications and Temperature Class Ratings are utilized for all hazardous areas and protection methods. This is the manner used to quantify the level of thermal energy allowed in the area or produced by the instrument.

**Temperature Classification:** This classification identifies the minimum ignition temperature threshold for the hazardous area. In other words, in order for the explosive or combustible environment to ignite, it would need to be subjected to a temperature in excess of this value. The values applied to this classification run from T1 to T6. A classification of T1 means the minimum ignition temperature is >842°F (450°C). A classification of T6 means the minimum ignition temperature is >185°F (85°C).

**Temperature Class Rating:** This rating identifies the maximum surface temperature the instrument will produce at a given ambient environmental temperature (typically 104°F or 40°C). You may find higher ambient temperatures referenced in a rating but they need to be clearly identified in the instrument markings or certificate. The same T1 thru T6 values are utilized for Temperature Class Ratings as for Temperature Classifications. A rating of T1 means the maximum surface temperature generated by the instrument at 104°F or 40°C is 842°F or 450°C. A rating of T6 means the maximum surface temperature generated for the instrument is 185°F (85°C).

<table>
<thead>
<tr>
<th>Temperature Classification / Rating</th>
<th>Area</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min Ignition Temperature °F (°C)</td>
<td>Max Surface Temp °F (°C)</td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>&gt;842 (450)</td>
<td>842 (450)</td>
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<tr>
<td>T2</td>
<td>&gt;572 (300)</td>
<td>572 (300)</td>
</tr>
<tr>
<td>T3</td>
<td>&gt;392 (200)</td>
<td>392 (200)</td>
</tr>
<tr>
<td>T4</td>
<td>&gt;275 (135)</td>
<td>275 (135)</td>
</tr>
<tr>
<td>T5</td>
<td>&gt;212 (100)</td>
<td>212 (100)</td>
</tr>
<tr>
<td>T6</td>
<td>&gt;185 (85)</td>
<td>185 (85)</td>
</tr>
</tbody>
</table>

*In this context “normal” means with no circuitry component failure but possibly with user wiring errors.
Obviously a Temperature Class Rating of T6 means the instrument produces less thermal energy or does a better job of dissipating generated heat than does a rating of T1. The Temperature Class Rating of the instrument must be equal to or better than that Temperature Classification for the hazardous area. (Example: Area Classification = T4 / Instrument Rating must be T4 thru T6)

Questions?

At this point there is one question that seems to be on everyone’s mind.

Can a customer use a Division 1 rated instrument in a hazardous area with a Division 2 classification?

Yes you can. Assuming the associated Class and Temperature rating for the instrument are appropriate for the area, you can always use an instrument with a more stringent Division rating than required for the area. However, if you use a Division 1 rated instrument it must always be installed according to Division 1 wiring procedures, regardless of the hazardous area division classification. Doing so is typically more involved and will add to the overall expense of the installation versus using a Division 2 rated instrument.

Nationally Recognized Testing Laboratories (NRTL)

The subject of NRTLs (Nationally Recognized Testing Laboratories) has been a growing issue with respect to instrument ratings in recent years. You have all heard of the typical test agencies such as FM, UL and CSA. In the past the choice between which test agency to use was largely based upon customer or market preference. While this practice may still exist in small pockets, the trend is changing.

You may have noticed there has been no reference to a specific test agency up to this point. That is because OSHA makes no distinction between NRTLs. The test procedures are harmonized. Every NRTL tests to the same standards to evaluate an instrument for a given approval rating. As long as an agency is classified as a NRTL and testing within its scope of registration, they are considered equal. The NRTL mark (FM, UL, etc.) is not the instrument approval rating. The designation of Class, Division and Group is the approval rating. For this reason all reference to a specific test agency may one day disappear from a manufacturer’s literature. It could be replaced with a general statement that the instrument is NRTL certified to Class [X], Division [Y], Group [Z]. The only place the NRTL mark would be located is the official certificate the individual agency would issue.

While some people may equate the move to NRTLs to deregulation and sacrificing safety, nothing could be farther from the truth. All of the controls that have always been in place remain. What the change has and will continue to do is instill a greater sense of competition among test agencies. This ultimately benefits both the manufacturer and the customer.

For further information on the subject visit the OSHA website at: www.osha.gov/dts/otpca/nrtl/index.html.

Conclusion

Proper application of third party approved instruments can be confusing. Hopefully the information included within this paper has shed light on the subject. Ultimately your instrument manufacturer of choice should be able to answer any questions you may have regarding the proper use and installation of their device.

References

- www.osha.gov
- NFPA 70th