TECHNICAL UPDATE - TU-4013

SUBJECT: Wiring Methods for Hazardous Locations

Analyzer applications that require routing through or terminating in hazardous (classified) locations have required changes in the way analyzer umbilical bundles are designed and built.
The biggest change comes in the type, number, and size of instrument, control, and sensor wires that can be used in the bundle.
This update will attempt to clarify the requirements and assist the Analyzer Designer to choose the proper wires and wiring methods.
This update will deal only with the wiring types, methods, and restrictions described in the United States National Electric Code (NEC), NFPA 70, 2002 edition[1].
Applications discussed will be in areas classified as Class I Division 1 or 2, Groups B, C, or D Hazardous Areas per Article 500.5 of the NEC; and Class I Zone 0, 1, or 2, Material Groups IIC, and IIB Hazardous Areas per Articles 505.5 and 505.6 of the NEC.

Design Requirements

Until recently, little thought was given to the instrument and control wires present in many electrically heated bundles used for analyzer applications. The two main reasons for this were the location of the installation as noted above, and the wording of the NEC, which suggests that these bundles are not required to follow the Code (Article 300.1(B)). However, local inspectors and safety authorities, are more likely to accept wiring methods that follow the NEC, so the trend has been to use standard wiring methods and materials even though they may not be required.
There are two main areas of concern when designing bundles for use in hazardous locations (outside of the consideration of the electrical heating element): the wiring method to be used and the temperature rise caused by current flow in the wire.
The wiring method must be one that is listed in the NEC as approved for use in the hazardous area where the bundle is to be installed. Some wiring methods and materials may be totally suitable for one area but not in another.
The temperature rise is critical because the combined effect of the electrical heat tracing and the heat rise from current flow cannot exceed the requirements for maximum sheath temperature allowed for the hazardous area.
The sections below will discuss each of these concerns in detail. A table is presented at the end listing wiring methods and areas of use.

Wiring Method

The wiring methods discussed below are only those that can be installed in flexible heat traced analyzer bundles. Methods like Rigid Metal Conduit (NEC Article 344) are also approved for use in hazardous areas, but cannot be installed in bundles. These methods are suited only for field-fabricated systems.
The Article Number in parenthesis shown with each title refers to the NEC Article describing the wiring method.

The cables listed below are all marked in some manner to show their cable type. There are cables and conduits that look similar to those listed, but are not approved. Only products tested and approved by a reputable agency (UL, ETL, CSA, TUV, and so on) should be used.

Type AC Cable (320)
Type AC cable is a fabricated assembly having an outer armor fabricated from flexible metal tape containing fabric-covered wire conductors.
Type AC cable can only be used in hazardous locations if it is used in an intrinsically safe system.

Type MC Cable (330)
Type MC cable is similar to Type AC in that it can be fabricated from flexible metal tape. In Type MC, the armor is interlocked, so it cannot separate when the cable is bent. It can also be fabricated using a smooth or corrugated metal sheath. When fabricated in this manner, it could also be listed as Type MC-HL cable.
Type MC cable can be used in Class I Division 2, and Class I Zone 2 areas.
Type MC-HL can be used in Class I Division 1, and Class I Zone 1 areas.

Type MI Cable (332)
Type MI cable has a tubular metallic sheath covering the conductors. The electical insulation is typically magnesium oxide (MgO). The MgO is compressed during assembly to form a tight barrier around the conductors, insulating them from the outer sheath and each other. Type MI cable requires special procedures and fittings when it is terminated. The insulation material absorbs water rapidly. Improper termination can render the cable useless. Type MI cable is not suitable for applications where there may be repeated bending. It is, however, the most rugged wire construction available.
Type MI cable can be used in Class I Division 1 and 2, and Class I Zone 1 and 2 hazardous areas.

Type TC Cable (336)
Type TC cable is a factory assembly of insulated conductors with a non-metallic jacket. The insulation and jacketing materials vary and can be selected based upon the end application.
Since it has no metal jacket, Type TC cable is smaller, lighter, and more flexible than the metal clad cables. There are some limitations, however, in how it can be installed.
Type TC cable can be used in Class I Division 2 and Class I Zone 2 areas if the bundle is installed in cable tray. It can also be used in these areas and not mounted in cable tray if
it is protected as required in Article 336.10(6).

Flexible Metal Conduit (348)
Flexible Metal Conduit is a tubular metallic interlocked sheath. It is similar in construction to Type MC cable. The difference is that Type MC cable is a factory

assembly of the conductors and the outer sheath, where FMC is just the outer sheath with the insulated conductors supplied by the end user or the bundle manufacturer. Flexible Metal Conduit is approved for use in Class I Division 2 and Class I Zone 2 hazardous areas if used with approved fittings and terminations. The conductors used in this assembly must be an approved type.

Liquidtight Flexible Metal Conduit (350)
LFMC has a liquidtight, nometallic jacket over a flexible metal conduit. As with FMC, the insulated conductors are supplied by the end user or bundle manufacturer. LFMC is approved for use in Class I Division 2 and Class I Zone 2 hazardous areas if used with approved fittings and terminations. As with FMC, the conductors used in this assembly must be an approved type.

Type PLTC Cable (725)
Power Limited Tray Cable is similar in construction to Type TC cable but has smaller conductors. Its main use is for low-voltage signalling and instrumentation lines. Type PLTC cable is approved for use in power-limited circuits in Class I Division 2 and Class I Zone 2 hazardous areas.

Type ITC Cable (726)
Instrumentation Tray Cable is used for instrumentation and control circuits where the operating voltage is 150 VAC or less and the operating current is 5 amperes or less. It is similar in construction to Type PLTC cable.
Type ITC cable is approved for use in Class I Division 2 and Class I Zone 2 hazardous areas.

Nonincendive wiring (Class I Division 2, Class I Zone 2 only)
Bundle temperature sensors can be connected using any wiring method approve for use in general locations. Bundle temperature sensors for Class I Division 1, and Class I Zone 1 applications must use wiring methods that are approved for the hazardous area.

Temperature Rise

Current flowing in electrical conductors causes an increase in the conductor temperature. Temperature rise is a major factor when determining the size of conductor needed for a certain current and voltage. The current must be less than that which would cause the conductor temperature to rise above its temperature rating. The tables in Article 310 of the National Electric Code list the allowable current draw for many cable types and applications.
Three additional factors must be considered when designing heat traced bundles with power and control wires for use in hazardous locations:
1. The wires and cables are generally embedded in thermal insulation, so the temperature rise will be greater than that shown in the tables.

2. Heat traced bundles generally have more wires in close proximity than shown in the tables, so the temperature rise will be greater.
3. The combination of the electric heat tracing and the conductor temperature rise must not cause either the conductors or the heat tracing cable to rise above their maximum temperature ratings or above the maximum sheath temperature allowed for the hazardous area.

The effect of conductor current flow on bundle temperature must be developed by the bundle manufacturer. Reliance on established charts and graphs may lead to errors that effect the safety and reliability of the installation.

Usage Chart
The table below lists cable types and hazardous locations. Specific locations or applications may require special cables or designs that are not covered in this Technical Update. The local inspector or safety authority should be contacted to determine the requirements for the hazardous location.

Cable Type	Class I Division 1	Class I Zone 1	Class I Division 2	Class I Zone 2	Notes
AC	**no**	**no**	**no**	**no**	
MC	**no**	**no**	**yes**	**yes**	
MC-HL	**yes**	**yes**	**yes**	**yes**	
MI	**yes**	**yes**	**yes**	**yes**	
TC	**no**	**no**	**yes**	**yes**	**cable tray or supported**
FMC	**no**	**no**	**yes**	**yes**	
LFMC	**no**	**no**	**yes**	**yes**	
PLTC	**no**	**no**	**yes**	**yes**	**power limited**
ITC	**no**	**no**	**yes**	**yes**	**150V 5A max**
Non Incendive	**no**	**no**	**yes**	**yes**	**temp sensor only**