



WHITE PAPER

# Corrosion Resistant Electrical Conduit Systems in Hazardous Locations

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Incorporated

## *Rust as an Explosive Threat*

The risk of fire and explosion is a serious concern for personnel working in industrial facilities such as petroleum refineries and chemical processing plants. These facilities deal with the reality of day-to-day operation while in direct exposure to volatile materials. The threat of a catastrophic event is heightened by the presence of the electrical infrastructure in these facilities, as an inherent property of electricity is the capacity to produce arc and spark.

The Engineering and Construction communities have long acknowledged this circumstance and have developed materials, installation methodology, and codes such as the National Electrical Code (NEC®), to protect life and property.

One of the critical elements that pose a challenge to the safe operation of these facilities is corrosion. Corrosion can be characterized as the gradual destruction of materials, usually metals, by chemical reaction with their environments.

Corrosion has been determined to be at the cause of many serious explosions. Examples include:

- 2009. Silver Eagle Refinery, Utah
- 2011. CCRL Refinery, Saskatchewan
- 2012. Chevron Richmond Refinery, California
- 2013. Florida Gas Transmission, Louisiana



Surveillance footage of at the Silver Eagle Refinery. Source: U.S. Chemical Safety Board

Rigid metallic conduit (RMC) is a dependable solution for electrical raceways in hazardous environments. Accordingly, Manufacturers have developed fittings, enclosures, and accessories specifically for these systems which complement conduit for a safe and efficient installation.

Corrosion, however, is a challenge to the long-term safety and reliability of these assemblies. When RMC is installed in harsh environments, the corrosive atmosphere must be considered as a threat to the integrity of the complete installation.

There are two methods available to increase the resistance of an electrical raceway system to the destructive effects of corrosion:

### PVC Coated Conduit Fittings, and Accessories

Under this solution, Galvanized Rigid Conduit (GRC) and fittings are coated with specially formulated Polyvinyl Chloride (PVC) on the exterior. In addition, the interior is coated with a urethane, providing an additional line of defense against corrosion. The PVC Coated “system” includes integral PVC sleeves that overlap and seal all threaded joints to ensure the integrity of the installation. Calbond™, a division of Calpipe Industries, Inc., manufactures a full line of PVC coated conduit and fittings that meet the industries highest standards of corrosion resistance, as well as being compliant with NEC® requirements for hazardous locations.



Calbond™ PVC Coated Form 8 Conduit Body

### Stainless Steel Conduit, Fittings, and Accessories

Until recently, a stainless steel conduit raceway option was not available for use in hazardous environments. Calbrite™, a division of Calpipe Industries, Inc., now offers a package of stainless steel conduit and fittings suitable for use in hazardous locations. Fittings include Unions (Type UNY), Boxes (Type GUA), and Seals (Type EYS).



Calbrite™ UNY Union



Calbrite™ GUAT Box



Calbrite™ EYS Sealing Fitting

To appreciate the importance of this issue, we must consider the heightened safety function of conduit and conduit fittings in a hazardous location.

Under normal operating conditions, non-hazardous locations, a raceway installation will perform well, even in the presence of a limited amount of corrosive elements. The standard zinc plating on the iron substrate works as a sacrificial coating. The reaction of the zinc and iron to the corrosive results in a layer of iron oxide, commonly known as rust. The iron oxide becomes a deterrent to further deterioration of the iron, thus providing a safe long-term protective raceway for the electrical conductors contained therein.



Source: American Galvanizers Association

In a hazardous location, the conduit may be required to perform not only physical protection for the electrical conductors, but also to contain an explosive event which may include extreme pressure, and/or spark and flame. When installing a raceway system in a hazardous location, one must adhere to the material requirements referenced in Article 500 of the NEC®.

Article 500 takes into consideration the requirement to maintain separation between any possible arcing and sparking, in the electrical infrastructure, and the volatile atmosphere, which may be present. In the event that gasses or fumes migrate into the raceway, the design criteria is such that an ignition or explosion will be contained by the raceway system, thereby preventing any arc or spark from emerging into the surrounding atmosphere.

On occasions when an ignition originates at one end of a raceway, the flame front traveling through the conduit creates an effect known as 'pressure piling'. Pressure piling can result in an extreme pressure load being transmitted to the raceway and its components.

When conduit is installed in an area defined as both "Hazardous Location", and "Corrosive", special consideration must be given to the selection of materials, as the raceway may perform, as intended when first installed, however, the effect of corrosion on the integrity of the system may be disastrous.

As corrosion destroys the physical integrity of the conduit and/or fittings, a weak point may slowly develop. It is at this point, when the raceway system is called upon to contain an explosive event, the weakened raceway or fitting fails.

### Proper Fittings and Applicable Standards

The NEC<sup>®</sup>, published by the National Fire Protection Association (NFPA), has established guidelines for the identification of hazardous locations based on the specific material present and the likelihood of exposure. The basic structure of the guideline is broken down by Class, Division, & Group. It is critical that the materials chosen for installation in a hazardous location be site specific, that is, tested and approved for the applicable Class, Division, & Group.

SUMMARY OF CLASS I, II, and III HAZARDOUS LOCATIONS			
Class	Group	Division 1	Division 2
<b>I – Gasses, Vapors and Liquids (Art. 501)</b>	A. Acetylene B. Hydrogen, etc. C. Ether, etc. D. Hydrocarbons, Fuels, Solvents, etc.	Normally explosive and hazardous	Not normally present in an explosive concentration (but may accidentally exist)
<b>II - Dusts (Art. 502)</b>	E. Metal Dusts (conductive and explosive) F. Carbon Dusts (some are conductive and all are explosive) G. Flour, Starch, Grain, Combustible Plastic or Chemical Dust (explosive)	Ignitable quantities of dust that is normally or may be, in suspension or conductive dust may be present.	Dust not normally suspended in an ignitable concentration (but may accidentally exist). Dust layers are present.
<b>III – Fibers and Flyings (Art. 503)</b>	H. Textiles, Woodworking, etc. (easily ignitable, but not likely to be explosive)	Handled or used in manufacturing.	Stored or handled in storage (exclusive of manufacturing)
*Note: Electrically conductive dusts are dusts with a resistivity less than 105 OHM-centimeter.			

Sealing fittings or “Seal-offs” require special consideration in the design and specification of a raceway system in a hazardous environment. Sealing fittings are essentially a conduit coupling with an access port that allows the installer to pack & pour sealing compound into the fitting. This compound completely fills the void, in the fitting, around the conductors.

This seal serves several functions:

- Isolate conduit that terminates at an arcing/sparking apparatus
- Isolate large enclosures (potential accumulation of flammable gases)
- Create a boundary seal in a conduit passing from one area classification to another

The sealing fitting is called upon to perform all of the mechanical and electrical functions of the other raceway components, as well as prevent migration of flame or explosion within the raceway. It has been observed that seals are particularly vulnerable to corrosion, as the sealing compound acts as a dam within the raceway, potentially causing condensate to accumulate at a single point.

Calbrite™ Type EYS Stainless Steel sealing fittings are designed to be installed in both vertical and horizontal applications. Calbrite™ Stainless Steel sealing fittings eliminate the worry of a possible failure, in the future, due to corrosive deterioration.

Calbrite™ hazardous location fittings are made using 316 Stainless Steel, and meeting the highest industry standards. The Calbrite™ family of Stainless Steel Conduit, Fittings, and Accessories, for hazardous locations, give the electrical professional the highest level of defense against the danger of corrosive destruction.

For more information visit [calpipe.com](http://calpipe.com)