

Over-Voltage Protection of Insulated Joints in Pipelines



Application Note 1A

Introduction

Insulated joints in pipelines may be subject to over-voltage failure due to lightning and, in some applications, AC voltage. When a pipeline is near an electric transmission line, it can be subject to significant AC voltage if a phase-to-ground fault occurs. Over-voltage protection against both lightning and AC fault current is possible using appropriately rated products.

Application Codes

When the voltage across an insulated joint exceeds the voltage withstand level, arcing will occur either through or around the joint insulation and current will flow. Arcing can cause carbonization of the insulating materials, thereby shorting out the joint, or in the event of a leak at the joint, a combustible atmosphere may be present and may be ignited by the arc (assuming the pipeline is carrying a flammable material). To protect against this possibility, Section § 192.467 (e) and (f) of the U.S. Pipeline Safety Regulations requires protective measures to prevent arcing across insulated joints, both for lightning and AC fault current. These protective measures require the installation of a suitable over-voltage protective device across the insulated joint.

Before describing the factors that must be considered in selecting a protective device, another code issue must be addressed. The U.S. Pipeline Safety Regulations also incorporate other codes "by reference." Referenced codes are an integral part of the regulations. For example, Section 192 of the Pipeline Safety Regulations incorporates NFPA 70 (the U.S. National Electrical Code) "by reference." Therefore, products selected for the above application should be third-party listed by a recognized agency to the

appropriate sections of NFPA 70. One exception is that products specified by electric power utilities in the U.S. come under a different code which enables them to conduct their own product evaluation for many applications.

Product Selection

DEI offers a large choice of products specifically designed to provide over-voltage protection of other equipment (such as insulated joints) in cathodically protected systems. These products (except one product used primarily by power utilities) are third-party listed to all of the appropriate sections of NFPA 70, including hazardous location listings. For an excellent reference as to what constitutes a hazardous location, refer to an American Gas Association article entitled "Classification of Gas Utility Areas for Electrical Installations, XF0277."

To aid in selecting the most appropriate product for a given application, refer to the product selection guide on the Dairyland website.

Guidelines

One very important installation guideline, independent of which product is selected to provide over-voltage protection, is as follows: when the primary concern is over-voltage protection from lightning, it is extremely important that the device be connected across the insulated joint with the shortest possible leads for optimum protection. When lightning current flows through a lead, a voltage drop is developed in the lead. This voltage can be on the order of 1kV to 3kV per foot (3kV to 10kV per meter) and it adds directly to the voltage drop that is developed across the terminals of the protective device selected. All DEI products

can, and should, be installed with no more than about 6" to 8" (150 to 200 mm) of lead for optimum protection. Some products are offered with custom mounting options to aid in minimizing lead length. Refer to the DEI catalog or call for assistance. Lead length is not of concern if only providing over-voltage protection for AC voltage because the rate of rise of current under AC fault conditions does not produce a significant voltage drop in the leads.

Some other guidelines for selecting a protective product for insulated joints are as follows.

1. For typical insulated joints, such as at meter, regulator, or compressor stations, where there is no induced AC voltage present across the joint and the primary concern is over-voltage protection from lightning, the products of choice are the OVP or OVP2.
2. Given the above scenario but with induced AC voltage across the joint, the products of choice are the PCR or SSD, assuming the joint is classified as an ordinary or a Division 2 hazardous location. If the joint is in a below grade vault or in a building it is likely a Division 1 hazardous location, thereby requiring a PCRH. To determine the steady-state AC current rating needed for the site, measure the current in a temporary bond across the insulated joint, and select a product rating that meets or exceeds this value.
3. It is common to encounter stations that may have a number of insulated joints with induced AC voltage present. Sometimes the appropriate use of a PCR or SSD can eliminate the induced AC voltage across the other joints, thereby enabling them to be protected with the lower cost OVP or OVP2. A PCR connected from a pipeline (with induced voltage) to ground will mitigate the induced voltage without affecting the cathodic protection voltage on the pipeline.
4. If the insulated joint to be protected is in a natural gas line serving an electric power plant, some special considerations apply. In this application, it is common for the pipeline going into the plant to be in or near the same corridor as the electric transmission line going out. In this case, the pipeline outside of the plant can be subject to significant AC voltage in the event of a line-to-ground fault in the electric transmission line. This may raise the voltage suf-

ficiently so as to cause flashover of the insulated joint, thereby providing a return fault current path to its source via the pipeline. To select an appropriate product and rating, it is necessary to determine the magnitude of the fault current that is available to flow back to the plant via the pipeline, and its time duration. This will often be considerably less than the total fault current available on the transmission line because the current will often have multiple paths back to its source. Request this information from the electric power utility.

Another consideration regarding this same application is that the gas piping inside of the power plant will likely be either (1) solidly grounded to the plant and not cathodically protected; or (2) cathodically protected, and not grounded to the plant. In the first case, a protective device across the insulated joint protects the joint and provides a return current path directly to the plant grounding system. In the second case, two protective devices are recommended, one directly across the insulated joint (to protect the joint) and one from the pipeline to plant ground (to complete the fault current return path). Ideally, the protective device connected from the pipeline to plant ground grid would be connected to the pipeline on the outside (i.e., non-plant side) of the insulated joint. Only one device would be required if the only concern were protecting the joint from the effects of an AC fault condition and not lightning.

When providing over-voltage protection for any insulated joint, consider how the current being conducted around the joint (i.e., through the protective device) is going to be dissipated so as not to cause secondary problems.

Where both sides of an insulated joint are cathodically protected (i.e., isolated from ground) it may be desirable to provide a current path to ground so as to minimize the amount of current continuing along the pipeline. This would require a user installed grounding system that is then connected to the pipeline through an appropriately rated decoupler. This provides a grounding path without any affect on CP levels.

Where the piping on one side of the joint is not cathodically protected, such as inside of many stations, it is suggested that a solid bond be established between that piping and station ground if one does not already exist. This will help to minimize damage to electrical equipment inside of the station.