



APPLICATION GUIDE

AIRPORT FUELING SYSTEMS



PROBLEMS ENCOUNTERED ON FUELING SYSTEMS

Airport fueling systems rely on an extensive network of tanks, piping, and electrical equipment to deliver jet fuel to the destination on the tarmac. Piping buried under substantial concrete cover represents a valuable asset to be protected against corrosion and damage. Cathodic protection (CP) is a key system applied to buried piping networks to minimize or prevent corrosion of the coated steel pipe, in an effort to extend the life of the system. Rectifiers and anode beds are typical components in CP systems that supply the needed DC current to provide protection on this isolated system. Isolation is achieved through the use of high resistance pipe coatings and electrical isolation joints at pipe flanges and electrical equipment.

Isolation assists in minimizing the cathodic protection current required and achieving the corrosion industry criteria for potentials. However, electrical isolation raises other operational and safety issues unless accompanied by a means of mitigating these risks. Isolation joints are subject to over-voltage stress and failure when exposed to AC faults and lightning events and can support static build-up. Lightning strikes and AC system faults can apply high voltage, which breaks down the joint insulation and can damage the steel flange and piping due to arcing and heating from excessive current flow. Protection against over-voltage conditions is needed on fueling systems to assure continued operation and minimizing personnel risks.

SOLID-STATE OVER-VOLTAGE PROTECTION SOLUTIONS

Overvoltage protection against both lightning and AC fault conditions is possible using appropriately selected and rated products, providing a defense for both equipment and personnel. Dairyland is the clear leader in solid-state protection for pipeline systems.

Various types of isolation joints are available in the market; however, most airport applications involve the bolted flange type. A Dairyland solid-state protection device connected across the isolation joint will limit the voltage to safe levels and provide a conduction path around the joint, protecting the insulation system. Dairyland devices switch into this protective mode during an electrical event and then automatically switch back into the OFF state to isolate the cathodic protection system.

Dairyland offers a large selection of products specifically designed to provide over-voltage protection for isolation joints in various markets. The solid-state Dairyland products offer numerous benefits over alternatives including: Fail-safe construction for assured safety grounding, maintenance-free operation, high ratings for AC fault current and lightning, safe turn-on (threshold) voltage level, and extensive third-party certification to safety codes. Dairyland is also known for outstanding technical support to aid clients in product selection.



Dairyland OVP connected across isolation joint

SAFETY REGULATIONS CONCERNING ISOLATION JOINTS

Various codes and regulations may apply to isolation joint protection. Below, several common scenarios involving fueling systems are summarized.

Codes and Regulations in the United States Including Military Use

Most fuel piping applications in the US involving an isolation joint occur in a classified hazardous location. Either the construction is already in a facility that has been classified as a hazardous location, or the presence of the isolation joint creates such a designation. Typically, the mere presence of an isolation joint creates a Class I, Division 2 area, unless already in a facility that has been classified as Division 1. Protection products must be selected to match or exceed the hazardous location classification of the site. Dairyland manufactures certified products for both Div 2 and Div 1 applications. This Class/Division certification is applicable in any jurisdiction that recognizes this classification system, even if outside the US. For example, Canada has harmonized standards with the US for Class/Div product certification. Other countries may also recognize products certified to this system.

Military airport facilities are constructed to the requirements of the Department of Defense UFGS standard 33 52 43.13 for aviation fuel piping, section 2.1.5.4 on isolating gasket kits and surge protector devices. Dairyland's OVP and OVP2 were designed to specifically meet this requirement and have been used extensively around the world on US military bases, or other locations where DOD specifications are applied.

Codes and Regulations - International

Numerous other countries do recognize and use products certified to the Class/Division system. In foreign locations with a US military presence, often the above DOD specification will be applied.



Other international standards and systems that apply to isolation joint protection cover the following hazardous location schemes:

- ATEX – for European (EU) application
- IECEx – for extensive world-wide use
- EAC – EurAsian Conformity, covering countries in the Eurasian Economic Union

Dairyland products meet all of these requirements, although it must be noted that some certification systems, namely EAC, require a product purchased specifically for such application, due to the unique requirements. Consult the Dairyland website for detailed product and application information on these and other codes and regulations covered.

Why Not Use an Arrester?

Users may be aware of spark gap arresters marketed to address over-voltage concerns on isolation joints. Lightning arresters, including spark gap devices, have serious shortcomings compared to solid-state overvoltage protection devices and are not recommended for fueling system protection. The major considerations are summarized below.

Fail-Safe Construction

Dairyland devices are considered “fail-safe” and certified as such. If exposed to fault current values beyond their already high ratings, Dairyland devices will always fail safely and uneventfully in the shorted mode (fail as a dead-short), bonding the two points together for safety. This assures that over-voltage conditions will be addressed – whether the product is working or failed. (Failures are exceedingly rare due to the high energy capability of the products.) A gapped arrester has an open gap, which will always remain an open gap. If the arrester were to fail, it would be as an open circuit. After failure, an arrester provides no over-voltage protection and a potential safety hazard is created, as voltage can rise to unsafe levels. Where manufacturers have attempted to match Dairyland fail-safe characteristics, such arresters do not have energy capability to enable an assured failed-short result, as outlined in the next point.

AC Fault Current

By design, Dairyland devices have the ability and ratings to handle AC fault current, with published and tested rating data to assure long-lasting performance. Devices such as gapped arresters do not have published AC fault ratings (or have minimal ratings relative to the exposure) as they are not intended for such faults, which can result in failure.

Low Threshold Voltage

Dairyland devices have a low threshold voltage, typically 2 or 3V, and begin voltage clamping just above the blocking threshold voltage of the device. This assures that over-voltages will be clamped to the lowest levels, providing a significant advantage for personnel safety and for applications such as isolation joint protection. Arresters typically conduct at hundreds to low thousands of volts, when considering both lightning and AC fault conditions.

Lightning Capabilities

Dairyland devices will handle 75,000A or 100,000A (depending on model selected) of lightning surge current. The device goes into conduction at a much lower voltage than a gapped arrester, keeping the voltage across the isolation flange to a low value. For lightning surge conditions, after initial conduction at the several volt threshold, the voltage across the device is approximately 100V, including inductive effects. The voltage allowed across a gapped arrester, in comparison, will reach unsafe levels prior to conduction, exposing personnel and equipment to this voltage until the device fires.

Lifetime

Gapped arresters involve arcing between contacts, which results in a lifetime limitation related to the number of events and the energy involved. Erosion of arrester contacts results in diminishing performance over time, eventually resulting in failure. Dairyland devices utilize solid-state construction with no arcing, hence the device does not have a lifetime limitation for electrical events within the product ratings.

DAIRYLAND PRODUCT SELECTION

Guidelines for selecting a protective product for isolation joints are as follows.

Electrical Ratings

Induced AC

Airport settings are generally presumed to not have AC induction on piping, which is caused by current flow on nearby power lines. AC induction more typically is present on pipelines in a common right-of-way with overhead power transmission lines – a condition not expected at airports. Dairyland OVP and OVP2 products would be misapplied if connected to pipelines with induced AC present. Contact Dairyland for application guidance if such conditions exist.

AC Fault Current

The product AC-rms fault current rating should be selected above the expected site value. While users may not be aware of fault current exposure levels on site piping, past experience with this application has shown that a default 3.7kA AC-rms rated product will adequately address all typical conditions, unless other site data indicates that this value should be increased. Don't forget to select a conductor or attachment method that is also rated for this AC fault current. The Dairyland website contains guidance on relating conductor size to ampacity. Most typically, a Dairyland flange mounting kit, discussed below, addresses these issues.

Threshold Voltage

This voltage, measured between the product terminals, determines when the product changes from blocking DC to full conduction (switches ON) to provide over-voltage protection. Typical selection is the -2V to +2V rating, as these values exceed normal cathodic protection voltage present, and the symmetrical nature alleviates any issue with incorrect polarity upon installation.



Lightning Current

Product families have a default value for lightning current capability, which is typically 100kA peak (8x20µs waveform).

Environmental Ratings

Hazardous Location Classification

All Dairyland products for isolation joint application are certified for use in hazardous locations. To address world-wide use, products are certified to various international standards and have a Div 1 + Zone 1 rating, or a Div 2 + Zone 2 rating, which should be selected to match the classification of the specific installation point. If the location is “ordinary” (non-hazardous), then select a Div 2 + Zone 2 product by default. The Dairyland model OVP is certified for Div 1 and 2 as well as Zone 1 and 2, while the model OVP2 is certified for Div 2 and Zone 2. The typical Dairyland device includes all of the following certification schemes in one product: Class/Div, ATEX, and IECEx, making it applicable for numerous world-wide locations. A separate model addresses EAC certification. See product information for specific certifications and standards that apply.

Environmental and Water Ingress

Product placement should be very near the isolation joint, in order to minimize conductor length (see discussion below). This is typically accomplished by Dairyland supplying an appropriate flange mounting kit with the protection device. While most aviation fueling flange sites will be above grade, only requiring a NEMA 4X product, Dairyland recommends the models OVP and OVP2, both rated NEMA 6P (IP68) to address above and below grade applications. Such devices are rated for submersion.

TYPICAL PRODUCT RECOMMENDATIONS

In light of all considerations for aviation isolation joint protection, the following models are recommended for use:

- For Div 1 or Zone 1: Model OVP-2/2-3.7-100 and the FMFB mounting kit. Specify the ANSI flange class and diameter, or equivalent data.
- For Div 2 or Zone 2: Model OVP2-2/2-3.7-100 and the MTF mounting kit. Specify the ANSI flange class and diameter, or equivalent data.
- Note that the OVP ratings encompass the OVP2, and a user could standardize on the OVP to address all installations.



Dairyland over-voltage protectors: OVP, OVP2

INSTALLATION GUIDELINES

Connection Across Joint

Joint insulation can only be confidently protected from overvoltage conditions by connection of a protective product directly across the joint. Dairyland flange mounting kits make this task convenient. Although less common with aviation fueling applications, on occasion clients propose to connect a device from one side of an isolation joint to a grounding system, assuming that this will prevent flashover of the insulation, however, for reasons related to conduction path length (see discussion below), protection is not guaranteed.

Connections in Parallel

Where multiple isolation joints are in parallel, all joints should be protected. Local protection of each joint addresses inductive voltage effects during lightning events.

Other Comments

Note that while isolation joints should be protected by a device connected directly across each, this does not necessarily reference either flange side to ground. Typically, via a series of isolation joints, each with a Dairyland over-voltage protection device, all pipeline segments will be bonded and grounded during an electrical event. This presumes that the piping at each end of the run is solidly bonded to the site grounding system. Assure that each piping segment is referenced to an adjacent segment via a Dairyland over-voltage protector or is solidly grounded if not cathodically protected.

Conductor length: A Primary Concern For Lightning Protection

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 isolation joint with the shortest possible conductors, or with low inductance bus, for optimum protection. When lightning current flows in a conduction path, the inherent inductance of the conductor (or other conductive path or support) develops a large voltage, which appears between the two connection points. If this voltage is in excess of the insulation or coating strength, arcing will occur. This voltage can be up to approximately 3kV per foot (10kV per meter), depending on the lightning waveform, and it adds directly to the voltage drop that is developed across the terminals of the protective device selected. Dairyland devices have very low and safe threshold voltage settings and an inherently low inductance design. Therefore, under lightning conditions the resulting voltage across an isolation joint is almost exclusively the inductive voltage drop in the conductor or mounting system due to the fast-rising lightning waveform.



To address these potential hazards due to lightning, all Dairyland devices can, and should, be installed with no more than about 6" to 8" (150 to 200 mm) of conductor length for optimum protection. All products are offered with mounting options to aid in minimizing conductor length, including bus bar arrangements that have low inductance compared to conductors. Specific to aviation isolation flange protection discussed above, OVP and OVP2 mounting kits address these concerns and provide a convenient support means for the product.

Conductor 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 conductors.

SUMMARY

Appropriately rated Dairyland over-voltage protection products can defend isolation joints against both lightning and AC fault current, while at the same time maintaining cathodic protection on the piping system. Proper device selection and installation are key, resulting in long-term protection for aviation fueling systems. If you need assistance selecting the proper product for your pipeline application, please contact Dairyland technical support at techsupport@dairyland.com or call (608) 877-9900.