



**Using Flange Isolation Kits and Monolithic Isolation  
Joints in Your Pipeline  
Integrity Management System**

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## Using Flange Isolation Kits and Monolithic Isolation Joints in Your Pipeline Integrity Management System

The United States has more than 2.6 million miles of pipelines that are essential for the nation's economy. Pipelines deliver hundreds of billions of tons per mile of liquid petroleum products and trillions of cubic feet of natural gas safely each year, which is well beyond the safe capacity of other forms of transportation. The United States also contains over 1.3 million miles of water pipelines and 1,600 miles of hydrogen pipelines.

Hazardous liquid pipelines transport crude oil; refined petroleum products such as gasoline, jet fuel, diesel and home heating oil; highly volatile liquids or natural gas such as methane, ethane, propane and butane; carbon dioxide; and anhydrous ammonia. Others transport water.

Unfortunately, there are approximately 50 pipeline failures and leaks every year – many of which are associated with corrosion issues. According to Statista, pipeline failures in the United States cost nearly \$340 million in damages in 2020 alone – and that's only in oil and gas pipelines. The most common failure mode for a pipeline is, by far, corrosion. Corrosion occurs naturally when a metal reacts with the environment such as oxygen or water. To learn more about pipeline corrosion, read: [An Intro to Pipeline Corrosion and Protection Methods](#).

### Types/Causes of Corrosion

Various types of corrosion have been reported for pipelines, with the most common being:

- **Uniform corrosion**, which occurs uniformly over the entire metal surface.
- **Galvanic corrosion**, which occurs when two metals of different chemistry are in contact with each other and moisture is present.
- **Crevice corrosion**, which is a localized attack adjacent to the gap or crevice between two joining surfaces such as at a flange joint.
- **Microbiologically induced/influenced corrosion (MIC)**, which occurs directly or indirectly from the activity of microorganisms.

To learn more about types of corrosion that most commonly affect pipelines, read:

[21 Types of Pipe Corrosion & Failure](#).

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## Corrosion Prevention for Pipelines

To reduce the risk of a pipeline corrosion failure, two approaches can be used: coatings or [cathodic protection](#). The former, coatings, can be divided into two major categories: external coatings and internal coatings.

The following section explores coatings and cathodic protection slightly more in-depth.

### External Coatings

To block the pipeline from coming in contact with the electrolyte, external coatings are applied to the exterior of the pipe to form a barrier between the pipe and soil/environment. Typical external coatings can consist of bitumastic materials such as coal tar, asphalt or bitumen or epoxies and other polyester materials. Requirements for external coatings include chemical resistance, UV resistance and low moisture permeability. Hot coal tar is a common coating material that is often covered with a paper wrap to protect it from damage prior to insertion into the ditch.

### Internal Coatings

Oil and gas fluids can contain solid particulates such as sodium chloride, potassium chloride, carbonates, sulfates, and partially polymerized oils that can remain in suspension. These particulates might travel at speeds approaching 200 mph and can then become aggressively erosive/corrosive projectiles. Internal coatings tend to be liquid epoxy or internal fusion-bonded epoxy with low frictional resistance for increased hydraulic efficiency and corrosion resistance to the fluid/gas constituents in the pipeline. To learn more about epoxy coatings, read:

[New Advances in Epoxy Protective Coatings.](#)

### Cathodic Protection

[Cathodic protection](#) is a technique where a buried pipeline is made the cathode and another metal is used as a sacrificial anode that preferentially gets corroded by the electrochemical process rather than the pipe metal. The pipeline's corrosion rate can be decreased by bringing the galvanic potential of metal to the immune state to be protected. To learn more about cathodic protection, read: [The Basics of Cathodic Protection.](#)

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## Risk Assessment of a Pipeline

While both coatings and cathodic protection can minimize corrosion issues in a buried pipeline, another layer of protection is to combine the coating with cathodic protection and reduce the potential for corrosion and subsequent leakage. Adding an isolation device provides even further protection by eliminating stray current from affecting the entire pipeline. This is where monolithic insulation joints (MIJs) and/or flange isolation kits (FIKs) come in. Integrating MIJs and FIKs into the pipeline is an excellent technique for controlling stray electric currents, which can increase the effectiveness of the cathodic protection system as well as reduce the cost of the electricity that is required to protect the pipeline.

### The Need for Isolation Joints in Conjunction with Cathodic Protection

Both **monolithic isolation joints (MIJ)** and **flange** isolation kits (FIK) will isolate segments of the pipeline; but MIJs are typically used for buried pipelines while the FIK is installed in above ground pipelines. The concept is for MIJ and FIK to prevent electric current from flowing beyond a specific distance with the objective of optimizing the cathodic protection. In addition, this approach disrupts the stray current from dissimilar metals which stops electrochemical reaction or galvanic corrosion between connected dissimilar metals.

Note that galvanic corrosion requires electrical conductivity between dissimilar metals; thus, even if the dissimilar metals are not in contact but there is electrical conductivity such as by a stray current, they are susceptible to causing stray current corrosion of the less noble metal. Dissimilar metal parts in the pipeline include for example, valves, compressors, pumps, and meters. Their small differences in chemistry for these components compared to the pipe metallurgy can be sufficient for the potential of galvanic corrosion. Therefore, inclusion of MIJ or FIK between the metal component and the pipe or at pipe-pipe connections is critical for eliminating the stray current and mitigating the potential corrosion.

In addition, the incorporation of MIJs and FIKs into the pipeline can allow for a reduction in electricity required for the cathodic protection that will result in less tendency for coating **disbondment** and hydrogen induced type corrosion, as well as cost savings from the reduced energy consumption.

## Monolithic Isolation Joints

Monolithic isolation joints are most commonly used in buried pipeline applications and when a pipe comes from underground to aboveground. MIJs can also be used aboveground to limit the possibility of electrical bridging across the joint where it is girth welded between two pipe sections. The use of MIJs eliminates the source of a short circuit by removing bolts, sleeves and washers. Since there are no flanges, gaskets, washers, sleeves, or bolts, field assembly is not required, which prevents any improper assembly. The joint consists on one side of a pipe segment with a beveled end for welding to the pipeline and on the other side is a welded bottomless flange for encapsulating the isolating and filler material. Because there are no threaded components, they cannot be disassembled in the field.



From NACE RP0286

### Construction and Design of Monolithic Isolation Joint

NACE RP0286 Standard Recommended Practice Electrical Isolation of Cathodically Protected Pipelines describes the typical design of MIJ for high pressure applications (over 150 psi) with double sealing rings and low pressure applications (below 150 psi) with a single sealing ring as shown above. MIJs are designed to match the metallurgy and service conditions.

A good practice is to use an MIJ that meets the appropriate ASME code, such as ASME B31.3 Process Piping Guide, ASME B31.4 Pipeline Transportation Systems for Liquids and Slurries, ASME B31.8 Gas Transmission and Distribution Piping, and if the pipeline is considered pressure containing ASME VIII Division 1 Rules for Construction of Pressure Vessels. The dielectric isolation material is typically a high temperature thermosetting fiberglass epoxy.

Note that not all epoxies have the same thermal mechanical properties. As shown in Table 1, the softening of the epoxy at a specific temperature also referred to as the glass transition temperature determines the strength or viscoelastic properties of the material at elevated temperatures and establishes the maximum operating temperature. The ring seal can be a dual static, self-energized O-ring seal housed in an accurately machined groove that is fully protected from cavitation. Maximum temperature of operation will determine the selection of the polymer for the elastomeric O-ring seal. Exceeding the temperature rating of the polymer can result in compression set or permanent deformation, where the seal will not properly interface with the sealing surface as intended and thus creating a leak path. Typical upper temperature ratings for various common seals are provided in Table 3.

The MIJ may be coated both internally and externally at the factory with a non-conductive epoxy for corrosion protection. All metallic components should be supplied with certified material test reports to confirm their physical and chemical properties and selected with the same metallurgy and yield strength as the pipe. For sour gas service (presence of H<sub>2</sub>S) the maximum hardness allowed for steel pipe is 248HV (RC22) to prevent sulfide stress cracking or hydrogen cracking. Typical quality assurance testing to ensure no failure of the MIJ during operation should include electric insulation testing at for example 5 kv and 25 Mohm (lower voltages can be used but with higher resistance), hydrostatic testing at 150% of operating pressure and ultrasonic or magnetic particle non-destructive testing for weld cracks (ASME Section V).

Table 1: Glass Transition Temperature for Commonly Used Glass Reinforced Epoxy

Material NEMA LI 1	Glass Transition Temperature (°F)
G10	240
G11	355
FR4	265
G400	410

Table 2: Maximum Operating Temperature for MIJ Seals

Material	Maximum Operating Temperature (°F)
Nitrile (NBR)	250
Fluoroelastomer (FKM)	400
Perfluoroelastomer (FFKM)	500
Ethylene Propylene Diene Monomer (EPDM)	300

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## Installation at Site

Since MIJs are fully factory assembled and ready for installation, they are factory inspected, which includes electrical isolation and leak testing. Thus, they cannot be disassembled or easily modified in the field.

An MIJ is typically wrapped with a volatile corrosion inhibitor and/or coated with a corrosion inhibitor prior to shipment to site. MIJs must be treated carefully during handling and transportation to prevent any mechanical damage or deformation as well as damage to the internal and external coatings. During installation, the joint must be well supported with strapping on both sides of the hub to prevent damage or deformation, which can then stress the joint after welding the MIJ into the pipeline. During welding of the MIJ into the pipeline, the joint should be kept cool with the body kept below about 212°F or below the maximum operating temperature for the seal gaskets, isolating rings and coatings.

Resin and gaskets are sensitive to hard impacts from applied stresses and thus striking the joint to align the pipe should be avoided. Each joint has a traceable serialized heat code identification, which should be recorded in the appropriate log book. There is no preferred installation direction with respect to fluid direction and can be installed horizontally or vertically. When installed in the vertical orientation, the MIJ should be positioned with the side with the silicone filter facing downward.

## Flange Isolation Kits

Flange isolation kits (FIK) are another approach for sealing and electrically insulating from static current metal to metal contact in a pipeline and thus mitigating corrosion by galvanic action when used in conjunction with cathodic protection.

A FIK consists of gaskets to separate flanges in the pipeline along with non-conductive sleeves and washers to prevent the flow of electric current across the connection. Materials of construction are very dependent on service conditions. For example, a fire safe FIK is required if the pipeline is carrying a flammable material such as methane. Chemical compatibility of the isolation kit with chemicals added to the fluid/gas to reduce microbial colonies from forming, to reduce scale formation such as iron sulfide, or surfactants must be fully investigated in order to select the appropriate materials of construction.

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## Types of Flanged Isolation Kits and Materials of Construction

A FIK consists of one washer for each nut, one full length insulating sleeve for each bolt, a gasket and thick plated steel washers for each nut. There are four major types of gasket isolation kits, designated as F, E, D, and O with each kit fitting flanges with specific faces. The flange face is the surface that hosts the gasket. The specific faces include raised face flange, flat face flange or ring joint flange and each requires a different gasket to prevent leakage at the joint. Different flange types should never be mated because they cannot be sufficiently tightened to prevent leaking. For example, a flat faced flange should never be mated with a raised face flange since such a joint would most likely leak. Flat or raised flanges can have finishes that are smooth, stock or serrated. Flange finish is often referred to as arithmetic average roughness height, which is the average roughness height values and can be used to determine the combination and selection of flanges and gasket materials.

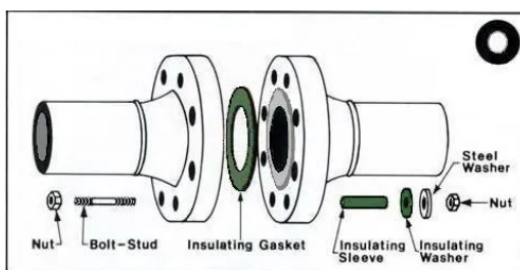
The higher the average roughness height, the more rough the surface and vice versa the smoother. Sealing performance for the flange gasket combination is directly related to the roughness, flange dimensions, and the applied pressure of the stud bolts. Further information about flanges can be found in ASME B16.5 Pipe Flanges and Flanged Fittings.

FIK F kits are designed with a raised flange face with the gasket designed to fit only on the raised portion of the flange. There are no bolt holes in the type F gasket; the inside diameter of the bolt hole circle is slightly smaller than the outside diameter of the gasket. This assures automatic positioning of the gasket in the flange assembly. Wrapping the flange to prevent foreign material from collecting and creating a bridge that shorts across the flange is often utilized. The type E gasket for FIK E kits is designed to fit only the full-faced flange and is designed with the same outside diameter as the flange. The precision cut and locations of the bolt holes facilitates the exact alignment of the gasket during installation and prevents foreign material from shortening the flange isolation. Both the type F and E gaskets are available in similar materials (phenolic, neoprene, or high temperature phenolics such as G-10 glass epoxy) and have a standard thickness of 1/8". Type D gaskets are designed specifically to fit into the ring groove of a FIK D ring type joint flange. Type D gaskets can be fabricated from a medium weave, fabric reinforced phenolic resin (CE phenolic, G-10 glass epoxy, or high temperature G-3 glass phenolic) and can be either of oval or octagonal cross-section.

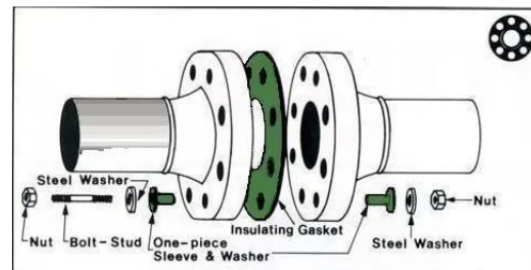
Type O gaskets for FIK O kits have a sealing element on each side of the gasket and are available in both type E and F gaskets. Sealing elements can be nitrile, Viton or PTFE with gaskets made of phenolic and G-10 glass epoxy and high temperature G-3 glass phenolic materials.

The specified gasket material is a function of the temperature of operation, corrosiveness of the fluid and pressure of the pipeline. For example, neoprene faced phenolic gaskets have a maximum operating temperature of 174°F while G-10 glass epoxy gaskets have a maximum temperature of operation of 285°F.

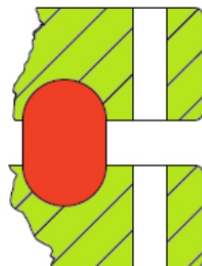
For aggressive environments, specialty gaskets should be specified. For example, GPT Industries offers a variety of specialty gaskets for specific types of environments. A VCS-ID Type F gasket has a 316 stainless steel core retainer laminated on both sides with a G-10 fiberglass reinforced laminate containing a patented, mechanically interlocking PTFE sealing element, which can accommodate either flat, raised or ring joint face flanges. The inclusion of patented overlapping and offsetting seal grooves into the gasket can create a chemically compatible barrier which ensures only PTFE comes in contact with the aggressive fluid in the pipeline. The Evolution® gasket, for example, is fully encapsulated and allows the gasket to be hydrotested and kept in the pipeline with virtually no loss of isolation properties for ring type joints. The proprietary coating is extremely abrasion, impact and chemically resistant to H<sub>2</sub>S, steam, CO and CO<sub>2</sub> and is rated 500°F when used with mica sleeves and washers.



FIK type F



FIK type E (Drake Specialties drawing)



FIK D Ring Type. (MES Site)

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Isolating sleeves are typically made from high density polyethylene, NEMA grade phenolic, G10 glass epoxy or mylar. Material selection is based on temperature of operation for the pipeline. High density polyethylene has a maximum operating temperature of 105°F, NEMA grade phenolic of 225°F, G-10 glass epoxy of 285°F and mylar 300°F. Other high-temperature or specialty materials are also available.

There are, however, downsides to using high density polyethylene isolating sleeves. Namely, they are very unlikely to be able to hold up to the stresses imposed by a pipeline, which makes them very likely to crack.

### **Materials Selection Considerations**

Once the decision has been made as to the type of joint to use, materials of construction must be specified.

Operating conditions of temperature, corrosivity of the fluid/gas in the pipeline, corrosivity of the soil for a buried pipeline and pressure are critical parameters for selecting the gasket, sleeve and isolating washer materials for an FIK. With increasing temperature high density polyethylene, NEMA grade phenolic, G10 glass epoxy or mylar can be specified. Glass reinforced epoxy gaskets are not inherently fire safe and should not be used with flammable gasses. Another critical parameter is the dielectric strength or dielectric breakdown strength of the isolation components, which is the maximum electrical potential that a material can resist before the electrical current breaks through the material and is then no longer an insulator. Such electrical breakthroughs can come from stray current.

Stray current flows through paths that are not the intended circuit can result in corrosion at a specific endpoint. The isolation components must be sufficiently insulating to prevent such electrical breakdown from stray currents. Water absorption by the insulating components can assist the electrical breakthrough and should be as low as is possible. Although epoxy has low water absorption, the incorporation of glass fibers greatly enhances the water absorption, particularly during hydrostatic testing. There are new fully encapsulating isolation gaskets on the market today that have excellent high temperature properties, have excellent compatibility with process fluids and gasses and are fire safe. These new materials for FIKs allow them to

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The exact selection of isolation components should be done in consultation with the FIK supplier. It should be noted that the physical properties of the lowest-rated component are the weakest link and thus are the minimum physical properties of the entire combination. Note that not all generic plastic components are fabricated from the same grade of material. Material certification should be required and examined in detail prior to any installation. Replacement of an FIK should be with in-kind materials (as verified by material certification tests) as this can be a source of failure if alternative or lower quality materials are used.

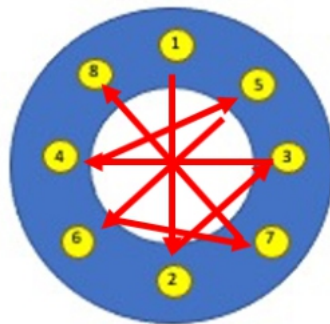
## **Installation**

Installing an FIK is fairly straightforward, as noted in ASME PCC-1 Guidelines for Pressure Boundary Bolted Flange Joint Assembly. Before anything else, the kit should be examined to confirm all parts are present and inspected to make sure that all parts are clean and defect-free. Then, take the following steps:

1. Inspect the flange surfaces to be joined for debris and defects such as warpage, radial scratches or hit marks. Remove any previously installed gaskets gently without scratching the flange face. A plastic scraper can assist in removal of a previously installed gasket without scratching the flange face; a screwdriver or steel scraper should not be used in order not to scratch or damage the flange face. Any defective components must be replaced. A good practice is to replace used gaskets, washers and sleeves with in-kind and not to re-install the used ones back in the pipeline.
2. Arrange the flanges so the bolt holes coaxially align with a minimum gap of about  $\frac{1}{4}$  to  $\frac{3}{8}$ " to prevent damage to the seal. Metal rods can assist in aligning the bolt holes. The gasket is to be carefully placed between the flange faces. Depending on the orientation of the gasket the use of untightened bottom bolts can assist in holding the gasket in place during further assembly and assisting in centering the gasket.
3. Apply non-metallic bolt lubricant to the bolt and nut threads, to the face of the nut to be tightened, and to the insulation washer and sleeve. Apply a nut to one end of the stud bolt, slide the steel backing washer over the bolt, slide the insulating washer over the bolt and then install the sleeve on the bolt. Insert the bolts with sleeves into the bolt holes by hand and do not force them taking care to not damage the sleeves. Overhang of sleeve should be per the manufacturer's specification since too much extension can damage the sleeve and too short cannot provide sufficient isolation. Non-metallic washers must be on the flange side and then the metallic washer in order to maintain electrical isolation. Hand tighten the bolts until the flange meets the gasket.

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4. Tighten the bolts with a torque wrench in accordance with the kit manufacturer's recommended torque. Good practice is to tighten each nut to initially 30%, 60% and then 100% of the recommended torque and to tighten in a star or cross-pattern as shown below to properly align the flange. Numbering the bolts makes it easier to perform the star tightening pattern for large diameter pipes. To make sure that all bolts are properly tightened, verify by checking each bolt in a clockwise direction. Overtightening the bolts can cause damage to the isolation gasket and sleeves with potential future loss of ability to provide adequate isolation and leading to a loss of corrosion protection. Proper installation of the FIK is to be verified by conducting isolation testing using an RF/IT meter per NACE RP0286 for every bolt to flange, flange to flange and gasket to flange. Ring type joints tend to be more difficult to install and may require skilled personnel.



Order of tightening

### **Comparison Between Monolithic Isolation Joints and Flange Isolation Joints**

As noted, pipelines carrying hazardous fluids/gasses and whether buried, above ground or underwater, require protection against corrosion from air, water, corrosive fluids and electrical currents caused by DC stray currents and lightning.

Flange isolation and monolithic isolation joints are two of the most widely used approaches as a part of an integrated corrosion protection system for preventing electrochemical reactions from occurring in a pipeline between two metals by breaking the metal path from traveling beyond the area protected by the cathodic protection system.

In the past, availability of MIJs has limited their being specified but this is no longer the situation.

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Pipeline operators now must balance the higher initial cost of the MIJ versus their life cycle and lack of required maintenance. MIJs usually have a higher dielectric strength than FIK. For those reasons, buried and underwater pipelines tend to have MIJs while those above ground tend to be FIK. FIKs also tend to be employed more between dissimilar metal piping. However, each has its advantages. An FIK can be used in higher temperature applications depending on the materials specified. Installation of an MIJ requires welding the joint into the pipeline by an experienced welder; while, for a FIK, a properly trained individual can assemble the joint in a relatively short period of time. However, care must be exercised in cleaning the flange face, centering the seal and gasket, properly installing the sleeves and washers, applying the requisite torque to the bolts so as not to crush the gasket and testing for electrical isolation. For the assembled FIK, RF/IT testing should be conducted to confirm proper installation and isolation. Nondestructive testing of the weld joints connecting the MIJ to the pipeline would be required for the MIJ. If a post-weld heat treatment is required between the MIJ and the pipe, special precautions must be taken to keep the temperature at the joint below 212°F. If buried below ground, the isolation joint must be protected by properly being coated or wrapped from soil degradation/attack such as by microorganisms. MIJs are designed to be at least as strong as the pipeline and are more resistant to high mechanical and thermal stresses than an equivalent FIK. A FIK is not earthquake resistant. A FIK can be disassembled for pipeline maintenance; when disassembled care must be exercised so as not to damage any of the components and replace all with exact in-kind components. The gasket for a FIK must be properly sized or there can be leakage or issues with a pig getting stuck.

Table 3 compares the advantages and disadvantages of MIJs and FIKs. Consultation with the supplier is highly recommended to obtain the required isolation joint for a specific environment of service.



Table 3 Comparison between MIJs and FIKs

	MIJs	FIKs
Most common location for usage	Buried Under water	Above ground
Accessibility for repair/replacement/inspection	Extremely limited	High
Cost	Higher Factory fabricator	Lower
Parts for assembly	One piece design	Multiple pieces for assembly Gasket, sleeves, washers, bolts, nuts
Field Assembly	Requires welder for installation	Requires trained individual
Post assembly testing	Non-destructive testing of welds	Isolation test
Maintenance	Minimal	Regular inspections
Lead time	High	Low
Design Temperature	Limited	Varied based on selection of materials of construction
Design Pressure	NACE RP0286	Dependent on materials of construction ASME B16.5
Size Availability	Limited	Not limited

## Case Learnings

Isolation joints have been successfully used by pipeline operators combined with cathodic protection for many years to prevent catastrophic corrosion failures. Reports published in the technical literature of successful operation of isolation joints are rarely described. However, Weaver et al<sup>1</sup> details best practices for cathodic protection for a buried pipeline where the required isolation is primarily provided by MIJs.

Instead, reported leaks associated with isolation joints in pipelines can provide lessons learned and how to improve and make more robust the selection and application of isolation joints. Below are some recent published reports with lessons learned and best practices for improving the selection, design and maintenance of isolation joints.

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Keldsen<sup>2</sup> reports that many of the issues associated with flange isolation joints are the result of substitution of alternative materials than those originally specified or installed. The vast majority of these alternate materials have inferior properties and do not meet the requisite design specifications. In some instances, the defects should have been identified by field personnel; but because of inadequate training of component inspection for installing the FIK, the FIK had a premature failure. Reassembly of an FIK after maintenance requires diligence to ensure that all correct electrically isolating components are installed. To prevent such issues, ordering and installing FIKs from highly reputable manufacturers is critical for successful long-term operations. In addition, many pipeline operators do not fully document the materials of the FIK initially used; and thus, may not reorder a suitable replacement nor document the materials from the replacement FIK for future replacement. Installation date and expected longevity should also be included in the documentation.

Although glass reinforced epoxy gaskets have been widely and successfully used, they are prone under certain conditions to leak because of permeation through the gasket. GPT<sup>3</sup> has designed a proprietary, highly electrically isolating coating encapsulated metal core, which has tighter seal capabilities and thus eliminates the potential permeation.

Additionally, this type of gasket can provide fire safe operation, higher operating temperature, tight sealing and greater chemical resistance. At the 2014 NACE meeting, Doering et al<sup>4</sup> reported on the inadequacies of MIJs for severe service conditions of high temperature, high pressure, sour gas service and lack of adequate quality control by some manufacturers. In particular, they focused on materials selection, materials verification and documentation, and qualification processes. The authors commented that FIKs have “less robust designs have a long history of failure in Chevron and in the industry. Chevron only accepts isolation gaskets from one manufacturer for this reason and specifies coated metallic washers to ensure fire safety.”



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At the 2017 NACE meeting, Monica et al<sup>5</sup> responded with specific recommendations to address the issues raised. Since MIJs are sealed systems, identification and inspection of the individual components is not possible by the pipeline operator, where the inclusion of sub-standard components can lead to pipeline leaks and ruptures. To alleviate this issue, the authors recommended and have instituted at GPT to establish a contractual requirement that all MIJs and their components be individually tested and not batch tested, which at the time individual MIJ testing was not an industry practice by many MIJ suppliers. This requirement included:

Testing.

Materials traceability

Materials capability

Supplier auditing.

Weld certification.

The paper further demonstrated that generic materials, such as phenolics, glass reinforced epoxy or PTFE materials, are not all the same and can have varying properties that impact their performance. Thus, material specifications and certifications are critical for individual components and should be required by all pipeline operators. The paper provides a suggested MIJ supplier assessment survey as part of a supplier audit process that can ensure the supplied MIJ will provide robust service in the pipeline. This approach can also be implemented for FIKs so that materials verification and qualification for isolation gaskets, sleeves and washers meet the requisite materials specifications.

AC interference for a pipeline can overwhelm the isolation joint and potentially result in corrosion of the metallurgy. AC can come for buried pipelines from overhead high voltage transmission lines or from lightning strikes for above ground pipelines. Over voltage protection devices connected across the isolation joint are designed to mitigate this failure mode and protect the isolation joint. Failure can still occur if the AC interference is too great. An initial survey for determining localized AC hot spots can be useful. Regularly inspecting such isolation joints is not always practical; remote monitoring devices and alarm notification are suggested<sup>6</sup> for continuous evaluation of pipeline integrity.

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Pimenta and Luqman<sup>7</sup> reported that a discharge was a result of corrosion from current leakage across the protected and unprotected sides of the MIJ. The isolation length used was incorrect and that models for these calculations require further studies to eliminate such issues.

Contributing factors to the discharge included bending stresses from improper installation and incorrect selection of materials for the requisite operation. These papers demonstrate the continuous improvement of the isolation joints based on field/service operations. Design and operation of a pipeline is quite complex but lessons learned leads to improved quality and durability of isolation joints resulting in increased operational reliability.



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## Conclusions

This paper is meant as a resource for pipeline owners, managers and staff that want a greater understanding of strategies for preventing pipeline corrosion and how flange isolation kits and monolithic isolation joints can further improve corrosion protection and thus minimize leaks and ruptures from corrosion.

Isolation joints eliminate metal-to-metal contact, halt static current flowing through the entire pipeline and aid cathodic protection of the piping system. MIJs and FIKs are integral and critical components for an effective corrosion mitigation system for pipelines. Combining them with cathodic protection and coatings results in a robust system for minimizing corrosion issues. Selection of a FIK or MIJ for a specific application should be based on operational, installation and maintenance requirements parameters.

Isolation joints can:

1. Eliminate metal-to-metal contact
2. Prevent static current corrosion
3. Aid in the cathodic protection of the piping system by segmenting the pipeline

Construction of isolation joints with high quality materials that have a high dielectric constant, low water absorption and high temperature property compatibility is required. Many pipeline isolation joint failures are the result of the installation of sub-par quality materials, improper installation or selection of isolation components that are not suitable or compatible with the process conditions. Critical parameters for consideration are fluid/gas temperature, pressure and corrosiveness, and external soil conditions. Documentation of the materials of construction for the FIKs during initial installation and reviewing that documentation prior to replacement can prevent potential leaks from installing inferior materials. A supplier audit is extremely useful for obtaining an isolation joint suitable for the requisite application. The audit should include examination of code compliance of the isolation joint and testing of individually installed components per standard methods (such as ASTM). For MIJs, each isolation joint should be tested for electrical insulation, for leakage by hydrostatic testing and by non-destructive testing for weld quality. Manufacturers of MIJs and FIKs continue to improve their longevity and functionality for ever more aggressive environments.

Further information can be obtained at [gptindustries.com](http://gptindustries.com)

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## Relevant Standards

NACE RP0286 Standard Recommended Practice Electrical Isolation  
of Cathodically Protected Pipelines

ASME B16.5 Pipe Flanges and Flanged Fittings

ASME B31.3 Process Piping Guide,

ASME B31.4 Pipeline Transportation Systems for Liquids and Slurries

ASME B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids

ASME B31.8 Gas Transmission and Distribution Piping

ASME VIII Division 1 Rules for Construction of Pressure Vessels

ASME PCC-1 Guidelines for Pressure Boundary Bolted Flange Joint Assembly

U.S. Code of Federal Regulations (CFR) Title 49. "Requirements for Corrosion Control." Part 192

U.S. Code of Federal Regulations (CFR) Title 49. "Corrosion Control." Part 195