Chapter 6
Corrosion Control For Pipelines

APPALACHIAN UNDERGROUND CORROSION SHORT COURSE

INTERMEDIATE

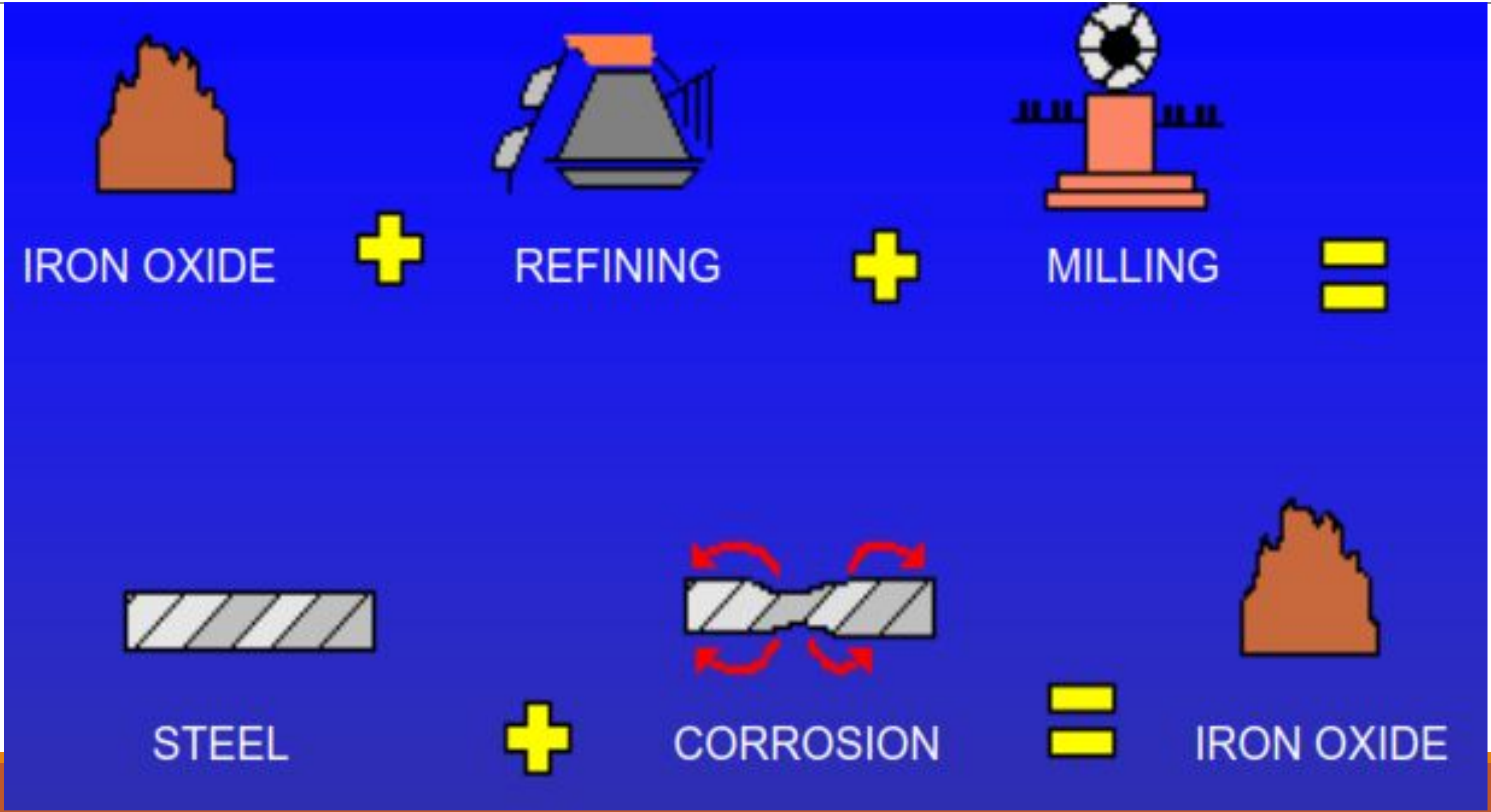
PRESENTED BY MIKE NORDSTROM, CORRPRO

Introduction

Corrosion control measures are taken into account during the initial stages of the design of a pipeline system, and should be taken into account during the construction and installation of the piping system.

This chapter will discuss design and installation practices which should be implemented to ensure that the piping system meets its designed service life.

Corrosion



History of the Use of Coating Systems

Pipelines were laid bare (uncoated) in the early 20th century. As a result, deterioration of the uncoated system was rapid. This sparked research for practical corrosion control methods, which resulted in the development of coating systems.

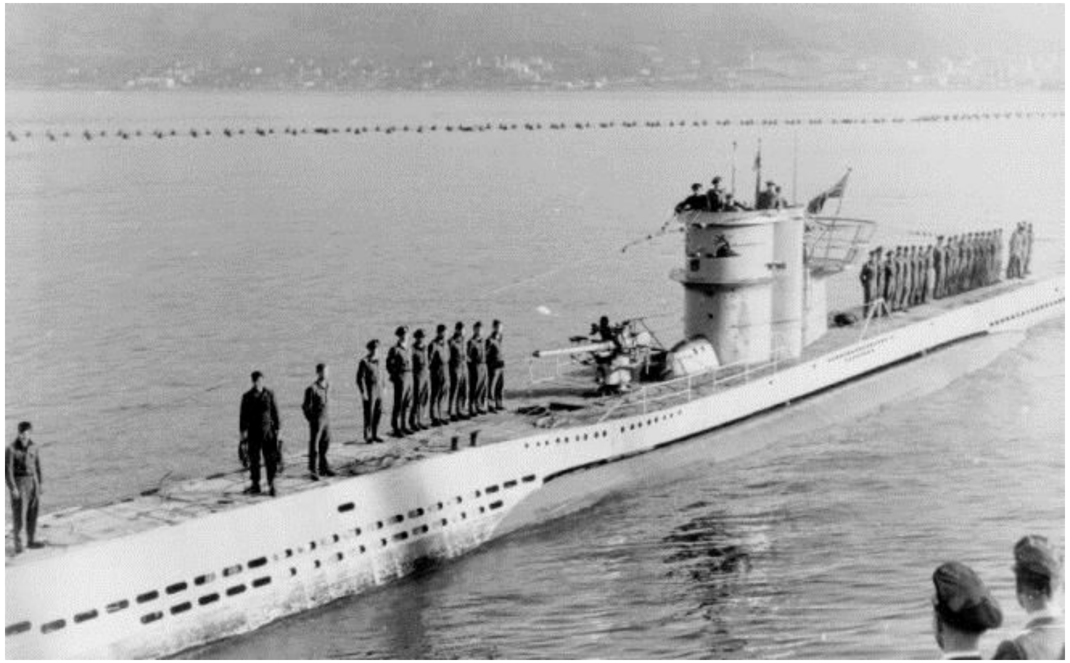
History of the Use of Coating Systems

In the 1920’s and 1930’s, greases and coal tars were commonly used without cathodic protection. The reasoning behind the use of coating systems is that if the pipeline metal can be isolated from the surrounding earth, no corrosion would occur.

Many of the coatings were exp-erimental. It is also important to note that there was no set coating standard at that time.

History of the Use of Coating Systems

During World War II, there were many instances where pipe was installed bare. Transporting energy quickly for the wartime effort was of primary importance.



History of the Use of Coating Systems

In the mid 1940’s, plant-applied coal-tar enamel became the standard. Many of the coating plants were located in the eastern U.S. near steel mills. Coating mills were better able to economically source the coal-tar pitch, which is a by-product of coke used in the manufacturing of steel.

Around 1956, the X-Tru-Coat process of coating pipe was developed by Republic Steel.

Over-the-ditch polyethylene tape was introduced in the 1950’s, originally in the western areas of the U.S. and Canada, where the weren’t a lot of coating mills, and where terrain was flat. The polyethylene tape system consisted of an innerwrap (coating), and an outerwrap (mechanical). Typically, the coating system was applied with a motorized, over-the-ditch wrapping machine.

History of the Use of Coating Systems

The application cost associated with installing over-the-ditch cold-applied polyethylene tape was very minimal. Over-the-ditch tape with primer was far cheaper than any other coating system. Eventually, once coating plants got the proper tooling and experience, they could properly apply tape in a cost-effective manner.

Corrosion Control - Coating

A coating will be completely effective as a means of stopping corrosion if:

1. The coating material is an effective electrical insulator
2. It is applied with no breaks (holidays) whatsoever, and will remain so during the backfilling process
3. It constitutes and initially perfect film, and will remain so with time

Perfect Coating = No Corrosion

Corrosion Control - Coating

A properly selected and applied coating will provide all the protection necessary on most of the pipeline surface to which it is applied. On a typical well-coated pipeline, this should be better than 99%. (But not 100%.)

The right coating material properly used will make all other aspects of corrosion protection relatively easy. A mistake in the coating material or application can make corrosion protection a lot more difficult.

Since no coating is perfect, a good practice in modern pipeline corrosion control work comprises the use of good coatings in combination with cathodic protection.

Corrosion Control - Coating

The most important characteristic to design a coating for is stability.

1. The coating combination will have a high resistance after the pipeline has been installed and the backfill has stabilized.

2. The coating combination will have the least reduction in electrical resistance over time.

Corrosion Control - Coating

The four fundamental elements of a successful coating system involve:

1. Material selection
2. Specification
3. Application
4. Inspection

The characteristics of a coating system will be discussed further.

Corrosion Control – Coating

The best method of protecting a structure, whether it is made of steel, concrete, wood, or other construction material, is by the use of protective paints and coatings.

Paints and protective coatings provide protection in one of three ways:

1. Providing a barrier between the substrate and the environment
2. By inhibitive action changing the environment into a less aggressive environment
3. Providing cathodic protection by sacrificing themselves to protect the more noble structure

Corrosion Control - Coating

- Atmospheric Coatings
- Transition Coatings – Air-to-Soil
- Underground Coatings
- Internal Coatings

Corrosion Control - Coating

Atmospheric Coatings are used to protect surfaces that are exposed to the atmosphere. Various types of coatings are specified, depending on service requirements – industrial, marine, urban, high temperature, etc.

What works well for atmospheric corrosion control may not perform well underground.

Corrosion Control – Coating

Transition Area Coatings are used to transition an underground coating to aboveground service. These coatings normally cover up the underground coating to protect it from ultraviolet lights, abrasion, ground movement, etc. and transition from about 6 inches above ground to 12 inches below ground.

Corrosion Control – Coating

Linings and **Internal Coatings** can be broken down:

Linings – Used for internal corrosion control and product quality inside tanks and vessels

Internal Coatings – Used for corrosion control or improved flow in pipelines

Corrosion Control – Coating

Underground Coatings are used to provide a barrier coating between the pipeline and the electrolyte. Without the application of a protective coating (or cathodic protection) to the metallic surfaces, the surfaces will corrode if they are in contact with a conductive electrolyte, such as soil or water. Corrosion will occur due to the formation of galvanic cells on the surface of the metal, which will have anodic and cathodic areas.

If the metallic surfaces are coated with an isolating type coating, it will not be in contact with the electrolyte, and no corrosion will take place.

Corrosion Control – Coating

If a conductive type coating is used that contains a metallic pigmentation anodic to the substrate, it will provide cathodic protection to the substrate where the coating pigmentation is damaged all the way to the metallic surface, thus preventing corrosion of the substrate.

To obtain the best of both systems, a conductive inhibitive primer can be used, which is in turn a top coated with an isolation type coating.

In general, each generic class of coating, such as epoxy, urethane, chlorinated rubber, vinyl, etc., provides performance characteristics that should be considered during the coating selection process.

Types of Underground Coatings

Since the start of large scale piping installation, there has been, and will continue to be, many developments in coating materials and protective coating systems.

Advancements continue to be made in the technology. Detailed information on each type may be obtained directly from the manufacturers.

Enamels
Fusion-Bonded Epoxy (FBE)
Extruded Plastic Coatings
Hot Applied Mastics
Cold Liquid Coatings
Two Part Epoxy Coatings
Hot Applied Waxes
Cold Applied Waxes
Prefabricated Films and Tapes
Heat Shrink Sleeves and Tapes

Coating Types – Enamels

Enamels is usually applied to hot-applied coatings of coal tar or asphalt, both of which have been used for many years. Only coal tar enamel is available today. These coatings are formulated from coal tar pitches or petroleum asphalts by combining the processed base materials with inert mineral fillers for improved mechanical strength and impact and deformation resistance. Application for this coating system requires the use of heating equipment. Hot enamels are applied to an overall thickness of 3/32” (94 mils) to 5/32” (156 mils) by mill, yard, or over-the-ditch methods.

The over-the-ditch application (“granny rag”) is only used for tie-in welds and repairs due to the hot coating and the toxic fumes.

Coating Types – Enamels

ADVANTAGES

Over 90 years of experience

Minimum holiday susceptibility

Low current requirements for cathodic protection

Good resistance to cathodic disbondment

Good adhesion to steel

DISADVANTAGES

Reduced availability

Air quality problems during application

Subject to hydrocarbon attack

Not recommended for above ground use

Cracking problems at low temperatures

Not recommended for high temperatures

Coating Types – Fusion Bonded Epoxy (FBE)

First formulations of FBE were introduced in 1959, and became commercially available in 1961. Of all coating types, FBE is most resistant to hydrocarbons, acids, and alkalis. One advantage of the coating is that it does not cover up pipe surface defects, due to the thinness of the film. This permits excellent inspection of the pipe after coating.

To properly apply the coating, FBE requires proper surface cleanliness, removal of non-visible surface contaminants, proper heating, atmospheric control, uniform application of coating, adequate cure, and effective holiday detection.

Each FBE product has its own individual application requirements and tolerances that must be adhered to.

Coating Types – Fusion Bonded Epoxy (FBE)

ADVANTAGES

Over 40 years of experience

Good resistance to cathodic disbondment

Wide operating temperature: -40°F to 180°F

Excellent adhesion to steel

Excellent resistance to hydrocarbons

Permits excellent inspection

DISADVANTAGES

Requires high application temperature of the pipe (450°F)

Difficult to apply consistently

Surface preparation is critical

Surface temperature of pipe is critical

Coating Types – Fusion Bonded Epoxy (FBE)

Electrical inspection should be performed, as required by NACE RP0274 “High-voltage electrical inspection of pipeline coatings prior to installation”.

Pipe requiring limited repair (holidays), due to surface defects or coating imperfections and other minor defects is repaired by a two part epoxy patching compound, or a 100 percent solids, liquid epoxy material.

For more information on FBE, see NACE Recommended Practice RP0394, “Application, Performance, and Quality Control of Plant-Applied, Fusion-Bonded Epoxy External Pipe Coating”.

Coating Types – Extruded Plastic Coatings

Extruded plastic coatings usually consist of high density polyethylene or polypropylene extruded over the surface of the pipe. Normal coating thickness ranges from 30 mils to 50 mils, and the coating is applied over 10 mils of hot applied thermoplastic modified rubber adhesive by a specialized yard coating process.

Coating repairs in the field are normally made using plastic tapes or heat shrinkable sleeves made of the same basic materials.

Coating Types – Extruded Plastic Coatings

ADVANTAGES

Minimum holiday susceptibility

Wide operating temperature range

Self-healing adhesive

Non-polluting, low energy required for application

Ease of application

Excellent handling properties – high impact strength

DISADVANTAGES

Difficult to remove coating

Higher initial cost

Weld joint coatings can be problematic

Coating Types – Hot Applied Mastics

Mastics are commonly referred to as materials which are formulated with selected sands and other inert materials bound with an insulating compound, which is usually asphalt. Usually applied hot over basic tar cutback primers by a continuous pressure extrusion process at stationary coating yards, and are normally thicker than other common coatings. Typical thickness ranges from 1/2” (500 mils) to 5/8” (625 mils).

Hot mastics are used because of good coating integrity and performance resulting primarily from their greater than normal thickness.

Coating Types – Hot Applied Mastics

ADVANTAGES

70 years experience

Thickest corrosion coating

Reduces concrete weight requirements

Minimum holiday susceptibility

Excellent resistance to cathodic disbondment

Operating temperature range: 40°F to 125°F

DISADVANTAGES

Higher initial cost

Higher freight costs because of its weight

Subject to hydrocarbon attack

Not recommended for above ground use

Requires torch for patching

Reduced flexibility in below-freezing temperatures

Poor bonding to steel substrate

Coating Types – Cold Liquid Coatings

Coatings in this category include materials which are applied in a cold liquid form and solidify either by solvent or chemical cure. Evaporative setting coatings include solvent cutbacks of tar and asphalt. Known as natural asphalts. These natural asphalts, which are mined in the form of gilsonite stock. Used to make coatings which generally have higher electrical strength than coatings, using petroleum-based asphalts.

May be applied with or without primers and fiberglass reinforcement. Normal application thickness ranges from 40 mils to 60 mils.

Coating Types – Cold Liquid Coatings

ADVANTAGES

70 years experience

DISADVANTAGES

Long cure time – 24 hours

Subject to hydrocarbon attack

Not recommended for aboveground use

Reduced flexibility in below-freezing temperatures

Poor bonding to steel substrate

Coating Types – Chemically Cured Coatings

Chemically cured coatings include materials such as combinations of epoxy resins and coal tar, or other chemical compounds of similar nature. Usually received as two components – one of which is a chemical hardener.

Normal application thickness may be up to 20 mils, depending on the material used.

Coating Types – Chemically Cured Coatings

ADVANTAGES

Over 50 years of experience

Good resistance to cathodic disbondment

Wide operating temperature: -40° to 180° F

Excellent adhesion to steel

Excellent resistance to hydrocarbons

Permits excellent steel inspection

DISADVANTAGES

Difficult to apply consistently unless sprayed

Surface preparation is critical

Surface temperature of pipe is critical

Coating Types – Two Part Epoxy Coatings

These coatings include materials which are applied in a hot or cold liquid form, and solidify either by solvent or chemical cure. Evaporative setting coatings include solvent cutbacks of coal tar. These coal tar epoxies are used to make coatings which generally have higher electrical strength than coatings using non epoxy-based coal tars.

These coatings may be applied with or without primers and fiberglass reinforcement. Normal application thickness ranges from 20 to 40 mils.

Coating Types – Two Part Epoxy Coatings

ADVANTAGES

Over 70 years of experience

DISADVANTAGES

Long cure time – 24 hours or more for the coal tar epoxies

Not recommended for above ground use

Reduced flexibility in below-freezing temperatures

Coating Types – Hot Applied Waxes

Hot applied petroleum or microcrystalline wax is a refined and blended long-chain solid hydrocarbon mixture centrifuged from heavy oil stocks. Coating can be used with or without primer. However, when specified, primer must be compatible with the coating system. Coating application minimum average thickness should be no less than 20 mils.

When wax coatings are applied at a coating mill, an outer wrap is normally applied to provide additional protection during storage. This outer wrap is usually a layer of Kraft paper, rag felt, or plastic film.

Coating Types – Hot Applied Wax

ADVANTAGES

Over 90 years of experience

Minimum holiday susceptibility

Low current requirements for cathodic protection

Good resistance to cathodic disbondment

Good adhesion to steel

DISADVANTAGES

Subject to hydrocarbon attack

Not recommended for aboveground use

Not good at high temperatures

Coating Types – Cold Applied Waxes

Cold applied waxes are grease type materials formulated by blending petroleum wax with plasticizers and inhibitors. These systems are hand-applied to the pipe surface without primer and over wrapped with a component wrapper, similar to that used for the hot applied wax system. Coating application thickness is normally a minimum of 20 mils.

Coating Types – Cold Applied Wax

ADVANTAGES

Over 90 years of experience

Minimum holiday susceptibility

Low current requirements for cathodic protection

Good resistance to cathodic disbondment

Good adhesion to steel

DISADVANTAGES

Subject to hydrocarbon attack

Not good at high temperatures

Coating Types – Films and Tapes

Tape materials are being used frequently as a full coating system. Tapes normally used are plastic films of polyvinyl chloride (PVC) or polyethylene with a self-adhesive backing applied to primed pipe surfaces, or plastic films with butyl rubber backings, and plastic films with various bituminous backings or combinations of bituminous material and chemical resins.

Best protective results are obtained with applications ranging from 15 to 35 mils, with a ¾” to 1” overlap.

Coating Types – Films and Tapes

ADVANTAGES

Over 60 years of experience

Minimum holiday susceptibility

Low current requirements for cathodic protection

Good resistance to cathodic disbondment

Good adhesion to steel

DISADVANTAGES

Subject to hydrocarbon attack

Not good at high temperatures

Coating Types – Heat Shrink Sleeves and Tapes

Heat shrinkable polyethylene sleeves and tapes for field application became popular in the mid 1980’s, particularly the type with an irradiated cross linked polyethylene backing. They do not generally require a primer, and have exceptionally high dielectric strength (greater than 500 volts per mil).

Sleeves are used for weld joints and repairing defect areas. Surface preparation consists of proper cleaning.

Types of Coatings – Heat Shrink Sleeves and Tapes

Coating Types – Heat Shrink Sleeves and Tapes

ADVANTAGES

Over 30 years of experience

Minimum holiday susceptibility

Low current requirements for cathodic protection

Good resistance to cathodic disbondment

Good adhesion to steel

DISADVANTAGES

Subject to hydrocarbon attack

Not good at high temperatures

Directional Drilled Crossings

Many pipelines today are installed via horizontal directional drilling (HDD). Corrosion control considerations for drilled crossings include the use of a corrosion coating and the use of an Abrasion Resistant Overlay (ARO), or sacrificial coating over the corrosion coating.

The overlay coating or sacrificial coating must bond to the corrosion coating and provide protection for the corrosion coating during the pipe installation process. The most common types of overlay coatings are FBE over FBE, 2 part epoxy over FBE, or 2 part epoxy over 2 part epoxy.

Desired Coating System Qualities

1. Electrical Resistance

An underground coating system should have good dielectric strength to assure high electrical resistance per square foot of coated area. This resistance value should not change appreciably over time.

Since corrosion of the pipe is an electrochemical process, resulting from current flowing away from the pipe, the insulating properties of the coating will lessen the probability of corrosion occurring.

Additionally, high dielectric properties is desirable because this lowers the current required to protect the piping system.

Desired Coating System Qualities

2. Moisture Absorption

The moisture absorption of the coating is related to its high dielectric strength. The presence of a water solution is required to initiate and support the electrochemical attack on buried metallic structures in conjunction with the corrosive elements on the soil. Therefore, if the structure could be effectively isolated from the surrounding soil moisture, the corrosion process can be controlled or eliminated. Low moisture absorption properties of the coating would therefore limit the influence of the electrolyte on the buried structure.

Desired Coating System Qualities

3. Resistance to Water Vapor Transmission

Another desirable coating property is **resistance to water vapor transmission**. All coating materials, regardless of type, have a characteristic water vapor transmission rate. When selecting a coating, the higher the degree of impermeability, the better the protective coating material.

Desired Coating System Qualities

4. Impact and Abrasion Resistance

It is desirable to have a coating system that has the ability to withstand physical damage. Its ability to withstand physical damage depends largely on its impact, abrasion, and ductile properties.

Any damage or holidays on the coated surface would tend to concentrate corrosion activity at those locations, and also increase the amount of cathodic protection current required to protect the pipeline.

Desired Coating System Qualities

5. Deformation Resistance

Soil surrounding the coated pipeline can impose stresses on the coating as the earth expands and contracts, and as it absorbs and dissipates moisture. Some soils may exhibit sufficient gripping action (soil stress) to actually pull the coating from the pipe surface. A good coating should be able to withstand such stresses without serious damage.

The operating temperature of the pipeline affects the deformation resistance. If the pipe is operating near the softening point of the coating, it will be more susceptible to deformation by soil movement.

Desired Coating System Qualities

6. Bond Strength

In order for a pipe coating to perform satisfactorily, it must possess strong and permanent adhesion properties. Poor bonding or adhesion to the pipe surface may allow moisture to accumulate between the pipe and coating, thus creating a possible corrosive environment.

Bonding strength must be sufficient to prevent the flexing and handling of the pipe during installation without the loss of adhesion.

Desired Coating System Qualities

7. Compatibility with Cathodic Protection

Coating systems used in conjunction with cathodic protection systems must possess some resistance to electrical potentials to prevent disbanding of the coating due to hydrogen evolution between the structure and the coating.

Coatings must also be compatible with the alkaline environment, which is usually present with the use of cathodic protection systems.

Desired Coating System Qualities

8. Environmental Contaminants

Coating systems used in conjunction with cathodic protection systems must possess some resistance to electrical potentials to prevent disbanding of the coating due to hydrogen evolution between the structure and the coating.

Coatings must also be compatible with the alkaline environment, which is usually present with the use of cathodic protection systems.

Desired Coating System Qualities

9. Bacterial Organisms

Organisms, such as fungi and bacteria are commonly found in soils. The severity of coating deterioration and resulting corrosion damage attributed to bacterial activity is a controversial issue.

Bacterial activity can be arrested by the application of cathodic protection, which increases the pH level of the soil around the pipe, creating an environment in which bacteria cannot exist.

Desired Coating System Qualities

10. Weather Resistance

Coating systems must have some resistance to ultraviolet rays and extreme temperature changes. These conditions may be encountered by the coated pipe section during storage or shipping, and therefore must be considered.

Desired Coating System Qualities

11. Ease of Application

A good coating system must be easy to apply. A system, which has all the properties previously discussed but is difficult to apply or required highly specialized equipment to apply, may not be considered a good coating system from an economic standpoint. The application of the coating system must be as holiday-free as possible.

15 Minute Break

Surface Preparation

The “foundation” for a protective coating system is the surface preparation. To obtained planned and predictable results, one must start with a controlled, uniform, and known foundation.

Surface preparation is the most critical part of the performance for all coated surfaces.

Types of Surface Preparation

1. Dry abrasive blasting with sand of mineral abrasives

2. Grit blasting

3. Shot blasting

4. Abrasive blasting with shot/grit mixtures

5. Acid pickling

6. Wet abrasive blasting

(continued)

Types of Surface Preparation

7. Weathering off the mill scale

8. High pressure water blasting with water containing chemical neutralizers or rust converter additives

9. Solvent cleaning

10. Power tool cleaning (needle guns, buffers, etc.)

11. Hand tool cleaning (scrapers, wire brushes, etc.)

12. High pressure water jetting

Degrees of Cleanliness

1. SSPC-SP5 / NACE No. 1 – White Metal Blast Cleaning
2. SSPC-SP10 / NACE No. 2 – Near-White Metal Blast Cleaning
3. SSPC-SP6 / NACE No. 3 – Commercial Blast Cleaning
4. SSPC-SP8 – Pickling
5. SSPC-SP7 / NACE No. 4 – Brush-Off Blast Cleaning

(continued)

Degrees of Cleanliness

6. High pressure water blast to remove all loose material

7. Solvent clean to remove oil and grease, and hand tool and power tool cleaning to remove all loose particles, SSPC-SP1, -SP2, and –SP3

8. Water wash with additives if needed, to remove or neutralize any chemical contaminants

9. SSPC-SP 14 / NACE No. 8 – Industrial Blast Cleaning

Coating Specification

Corrosion control personnel should consider many factors when choosing the type of coating to specify for a project.

1. Condition of the bare pipe

2. Handling and storage of the pipe

3. Atmospheric conditions (In the mill or in the field)

4. Surface preparation

(Continued)

Coating Specification

5. Application

6. Inspection

7. Post Installation Evaluation

The key to any good coating job is the design and specification of the system

Handling Coated Steel Pipe

Pipe sections should be handled carefully during loading for delivery by truck or rail so that damage will be kept to a minimum. Pipes should be padded and adequately secured in order to avoid coating damage during normal shipping conditions.

If extended outside storage may be required, the piping should be protected from UV exposure.

Handling Coated Steel Pipe

When the trucks arrive at the job site, facilities must be available for placing the coated pipe sections on the ground. Sections should not be dumped directly from the truck.

Pipe sections should only be placed directly on the ground if the area is free of materials.

Preferably, sections should be placed with skids or supports.

Handling Coated Steel Pipe

Pipe Coating Over or In the Ditch

Coating pipe sections in the field should be done in strict accordance with coating specifications.

When performing recoating or coating repair in the ditch, the same constraints for weather, environment, temperature, etc. are applied. Pipe will be coated to the same or better quality than original and inspected and tested to ensure the quality.

Holiday Detection and Repair

Holidays or flaws in the coating may be detected by visual inspection or through the use of a holiday detector.

On new pipelines, the best practice is to perform the holiday test upon receipt of the pipe.

Holiday Detection and Repair

Holiday detector is a device which impresses an electrical voltage across the coating. An electrode is passed over the entire coating surface. As the electrode passes over a coating defect, there is an electrical discharge between the electrode and a pipe. This discharge or spark actuates a signaling device which alerts the operator that a holiday is detected.

Procedures for Laying Coated Pipe

Before laying the pipe in the trench, the bottom of the trench must be cleared of any large stones or foreign material which may damage the pipe coating.

Piping should be lowered into the trench by means of belt slings or similar means, which would enable the pipe to be lowered slowly and carefully into the trench to avoid coating damage.

Holiday Detection After Backfilling

There are various techniques that can be used to detect coating defects after backfilling.

Pearson Survey – Consists of measuring the leakage of an audio signal from the pipeline at coating holidays.

Direct Current Voltage Gradient (DCVG) – performed by interrupting the CP system, or other DC source, and measuring the DC voltage gradients over the pipe. DC voltage gradients will be present at coating holidays.

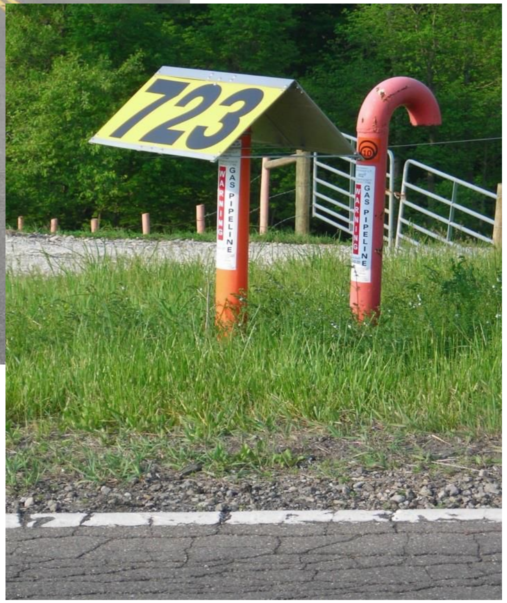
Alternating Current Voltage Gradient (ACVG) – performed by inducing AC on the pipeline and measuring AC voltage gradients over the pipe. AC voltage gradients will be present at coating holidays.

Cased Crossings

A cased crossing is a point where a pipeline is routed through another pipe (usually steel).

The casing is used to provide mechanical protection to the pipeline.

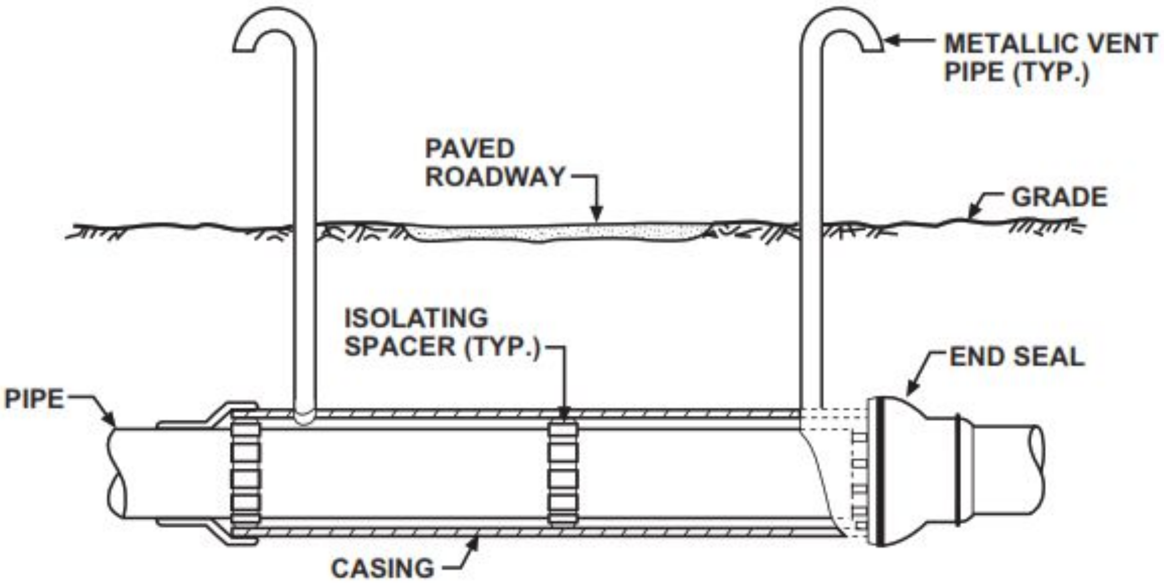
Casings are sometimes installed where pipelines cross under roadways or railways.



Cased Crossings

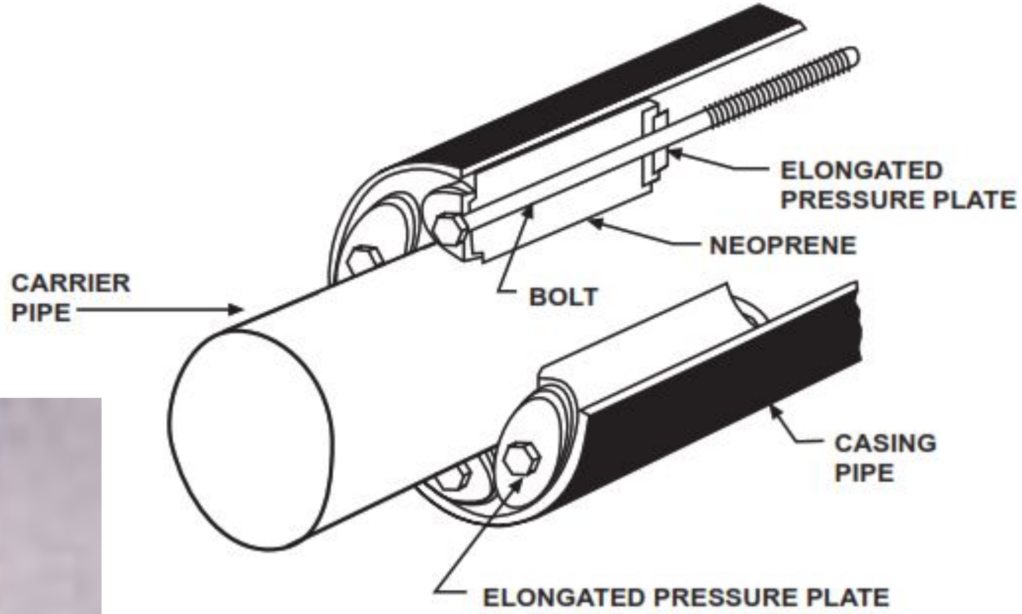
Casing pipe is usually steel. The size of the casing should be a minimum of two sizes larger than the pipeline being protected.

Isolating spacers are used to electrically isolate the pipe from the casing. Spacers are available in various designs, ranging from all plastic types to models having isolating blocks secured to steel bands.



Cased Crossings

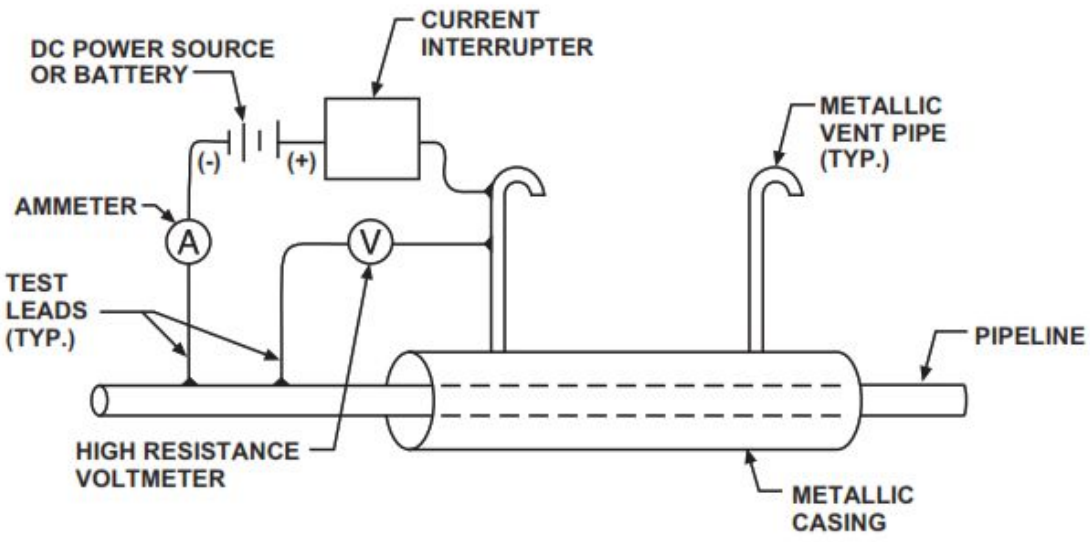
End Seals are installed at each end of the casing. They are designed to provide protection from the entry of water, soil, or other backfill material which may short the pipe to the casing, or cause corrosion in the annular space.



Testing Cased Crossings for Electrical Isolation

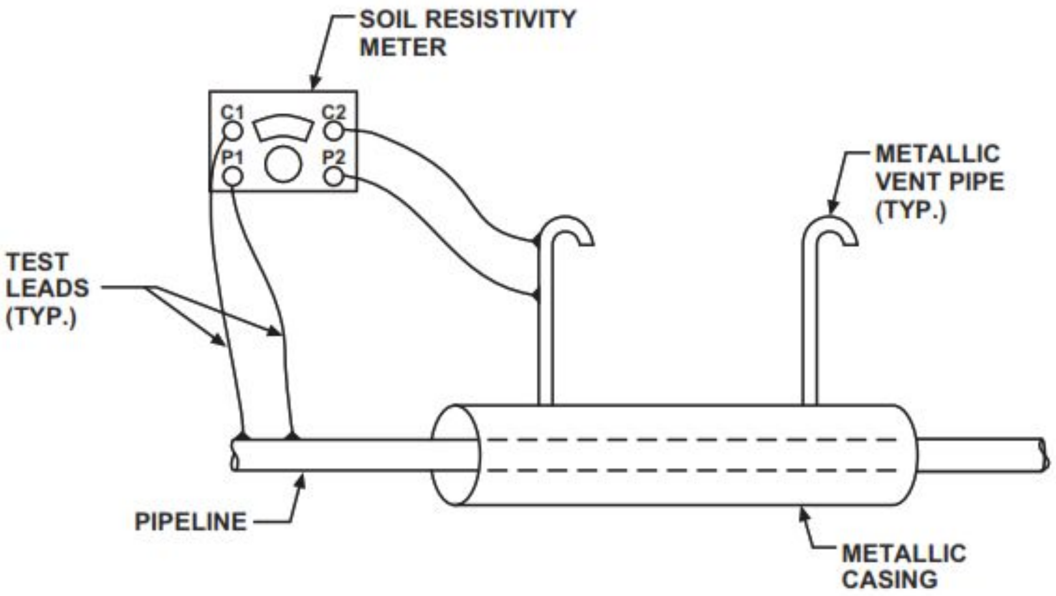
After the installation of a cased crossing is completed, the isolation between the pipe and the casing should be checked before backfilling. The cost of repairs will be less if they are made prior to backfill of the crossing area.

One method of testing the isolation of the pipe from the casing is by measuring the resistance between the two structures. This resistance can be measured and calculated using an ammeter, a voltmeter, and an external DC power supply.



Testing Cased Crossings for Electrical Isolation

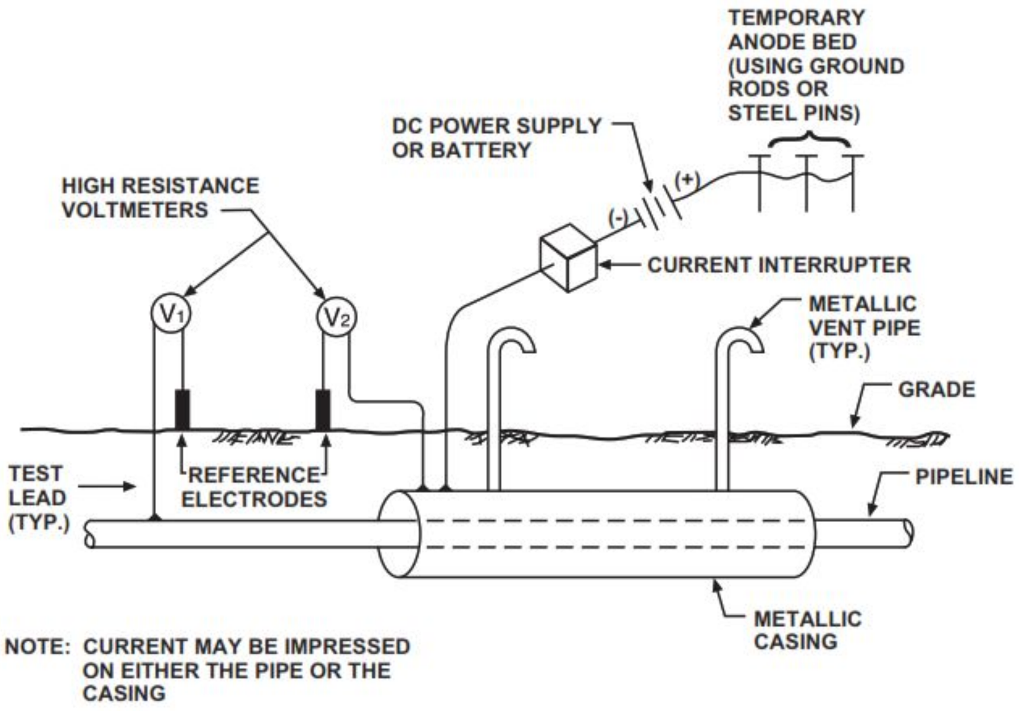
Another way of testing the resistance is by using a soil resistivity meter connected between the casing and the pipe.



Testing Cased Crossings for Electrical Isolation

An alternate method of testing the isolation is by measuring the pipe-to-soil and casing-to-soil potentials with respect to a portable reference electrode contacting the soil above the pipeline.

A current should be impressed on one of the two structures using an interruptible DC source



Testing Cased Crossings for Electrical Isolation

Casings should be periodically checked using test stations installed at the cased crossings. Casings may be properly isolated just after installation, but in time may become shorted due to one or more of the following conditions:

1. Too much strain on the pipe when final tie-in was made.

2. Earth movement or settlement.

3. Movement of the casing.

4. Movement of the pipeline due to expansion, contraction, or internal pressure stresses.

5. Casing isolators being placed too far apart, or made of inferior materials.

Isolating Joints

Isolating joints (isolating flanges, dielectric unions, monolithic joints, etc.) are used to electrically isolate various components of a pipeline system.

Isolating Joints

Applications:

1. Isolating old pipe from new pipe.

2. Isolating coated pipe from bare pipe.

3. Isolating dissimilar metals.

4. Connecting two pipelines of different ownership.

5. Isolating distribution lines from transmission lines.

6. Isolating compressor, regulator, and distribution piping from the main line.

7. Isolating river crossing sections of pipelines.

8. Isolating sections of piping to reduce the magnitude and effects of stray currents.

9. Facilitating the location of contacts in congested areas.

10. Protecting metering devices by isolating the section of pipe on which the meter is installed from the meter itself.

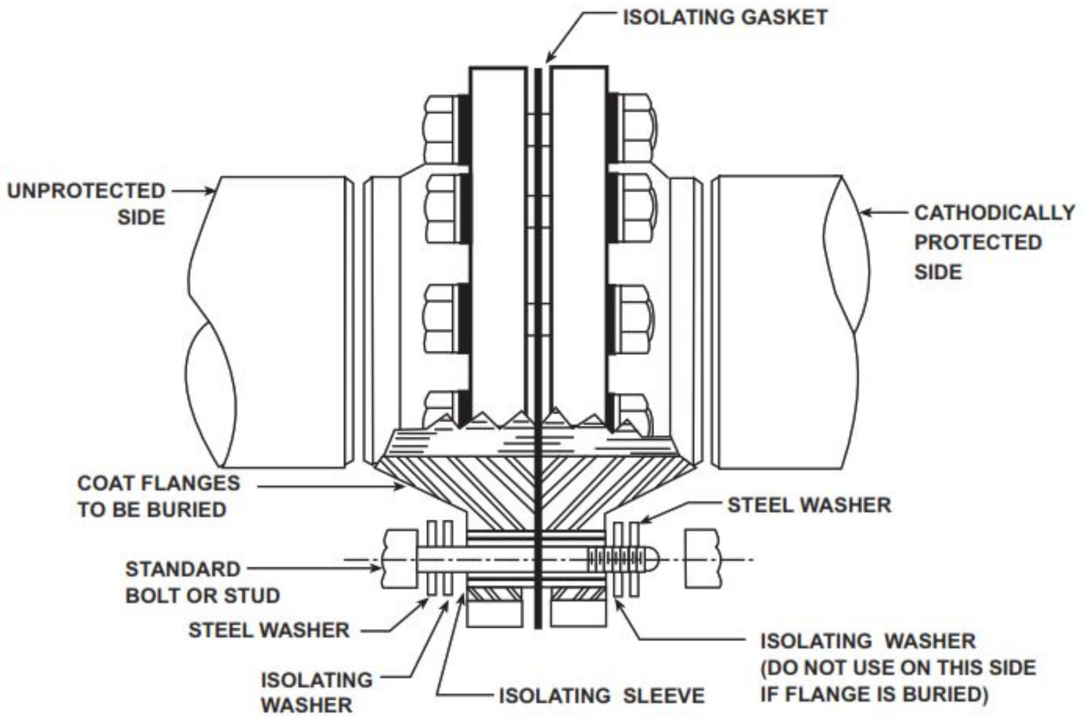
11. Isolating protected pipes from unprotected pipes.

Isolating Joints

The most commonly used isolating join is the isolating flange.

Available in various sizes and configurations and materials.

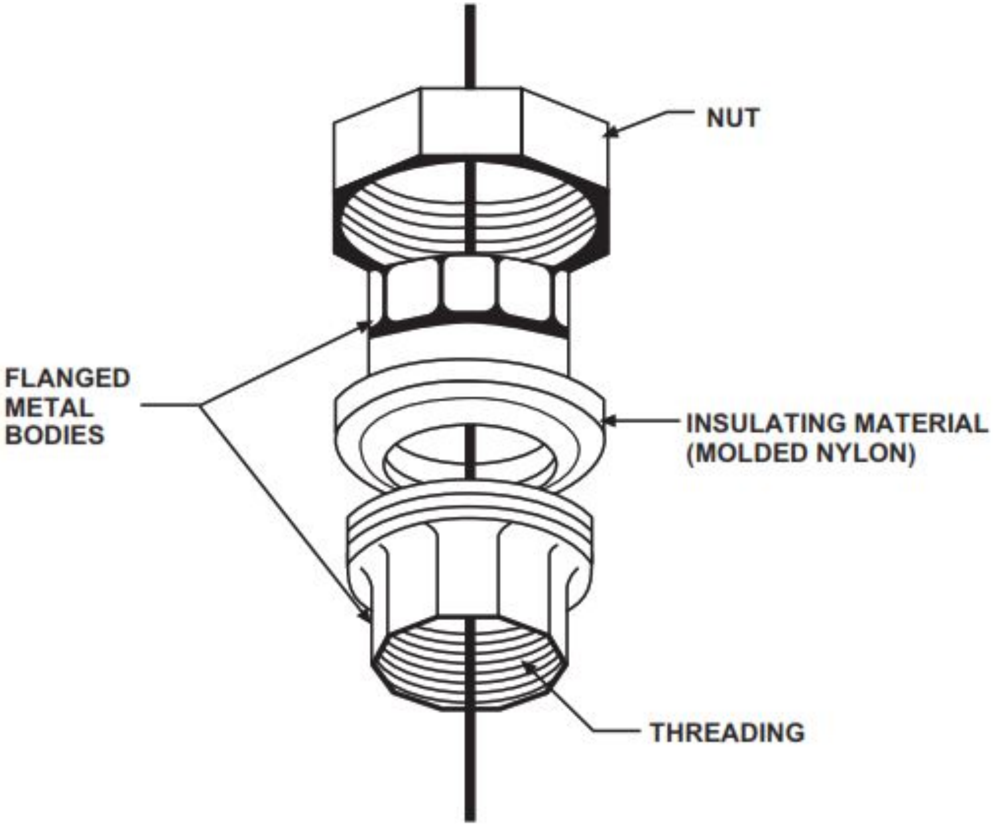
Three components: Gaskets, Sleeves, Washers



Isolating Joints

Isolating unions are generally installed aboveground to provide electrical isolation for regulator stations, processing plants, gauge lines, fuel supply lines, water lines, and other pipeline applications.

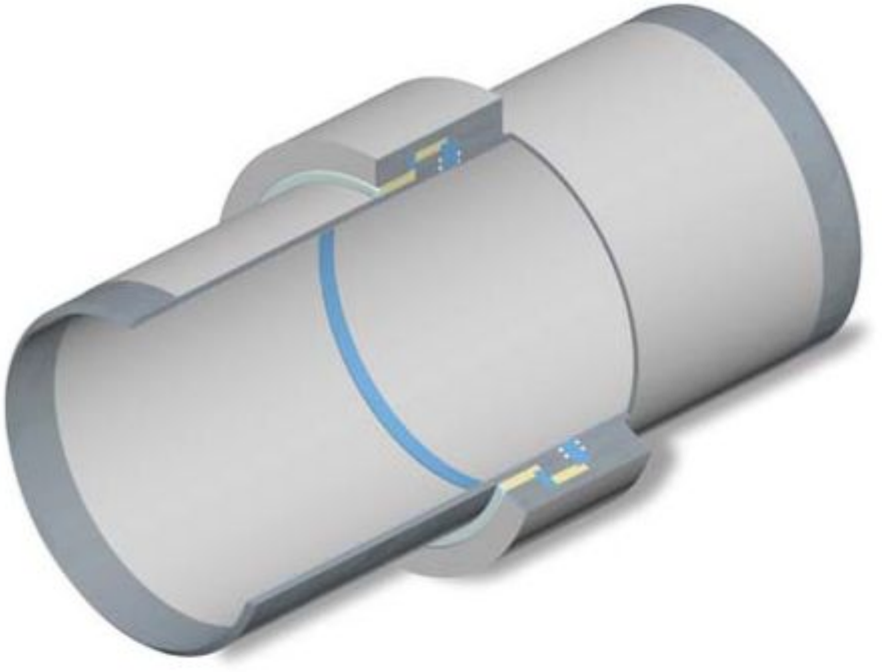
Two flanged bodies which are screwed into the end of the pipes to be joined. One flanged end of each body is externally threaded, enabling the two sections to be joined using a nut. The nut is isolated from one of the flanged ends through the use of a dielectric material.



Isolating Joints

Monolithic isolation joint is a complete factory assembled and factory tested fitting. Only two welds are required for installation.

May be installed above ground or below ground.



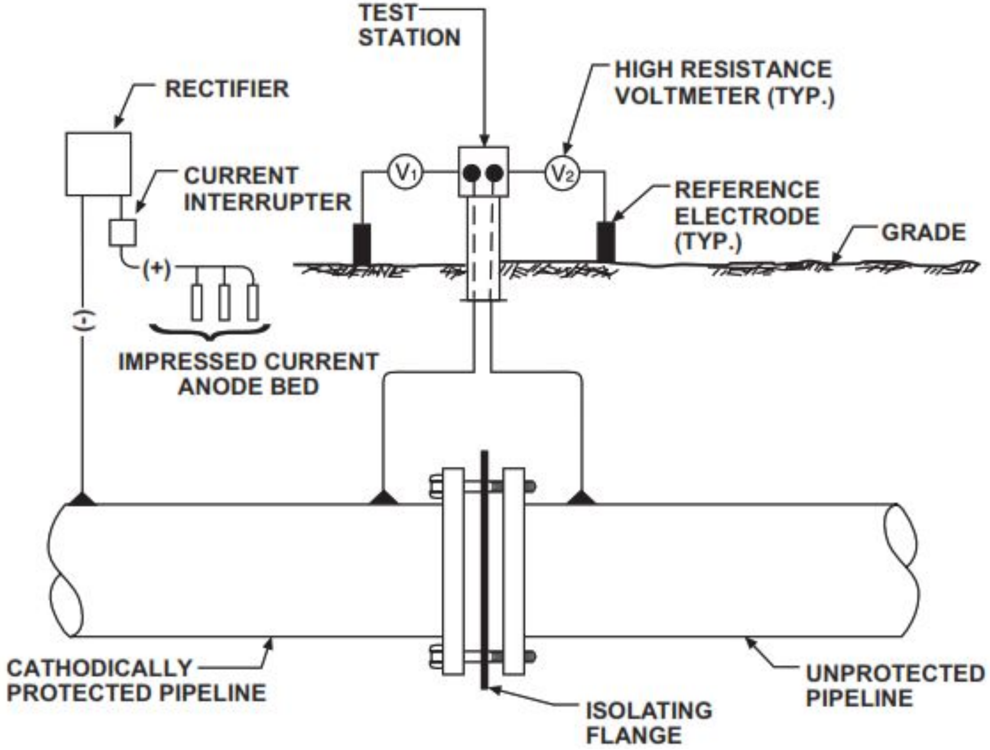
Testing Isolating Joints

Method 1 – Interrupting CP Source

Can set up a temporary CP source or use an existing CP source.

Measure pipe-to-soil potential on each side of the joint while interrupting the current source.

If the isolation is effective, the potential on the side of the joint that is connected to the CP system will change as the source is interrupted, while the potential of the opposite side will remain constant.



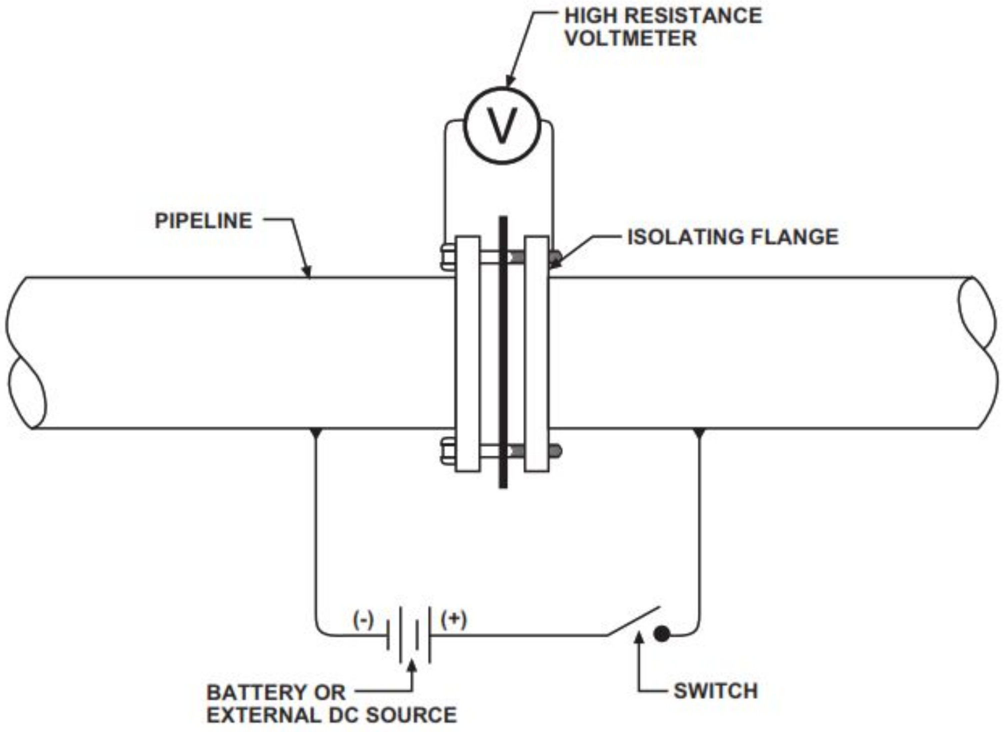
Testing Isolating Joints

Method 2 – Testing shorted bolts using voltmeter

A temporary DC source is connected across the isolating joint.

Measure the potential between the two ends of each bolt while momentarily closing the switch.

If a potential swing is noted when the switch is closed, this indicates that the bolt is shorted.

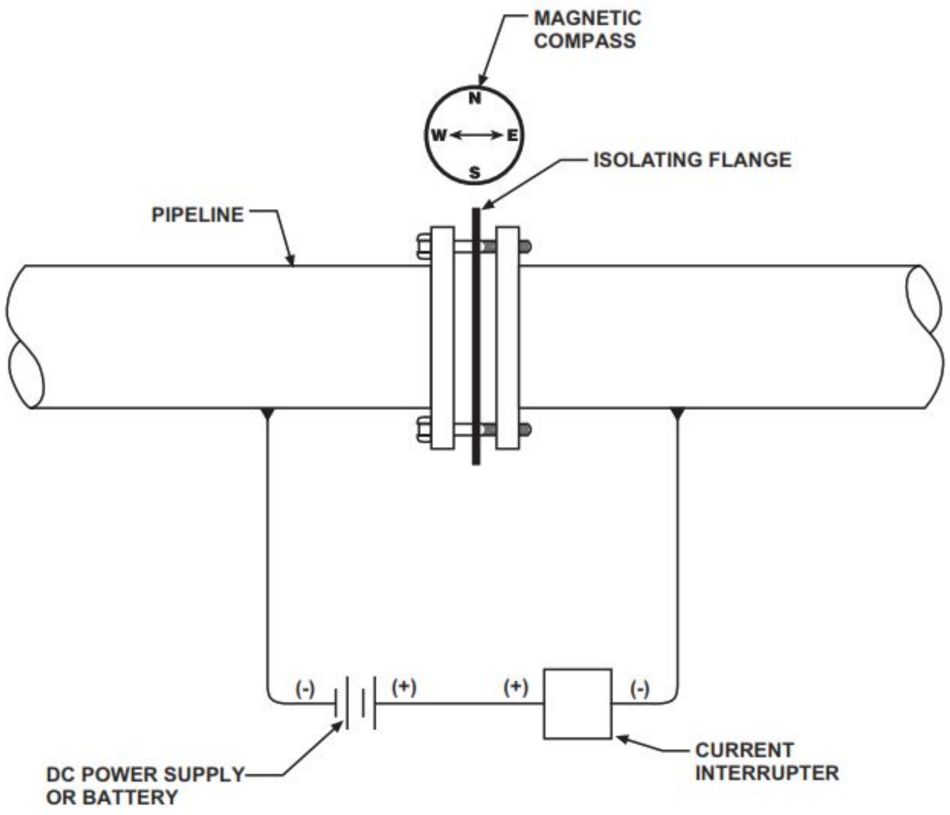


Testing Isolating Joints

Method 3 – Testing shorted bolts using a compass

Similar to Method 2, instead of using a voltmeter across each bolt, place a compass across the flange, and move it from bolt to bolt.

The compass needle will be deflected at a shorted bolt because of the magnetic field surrounding the bold through which current is flowing.



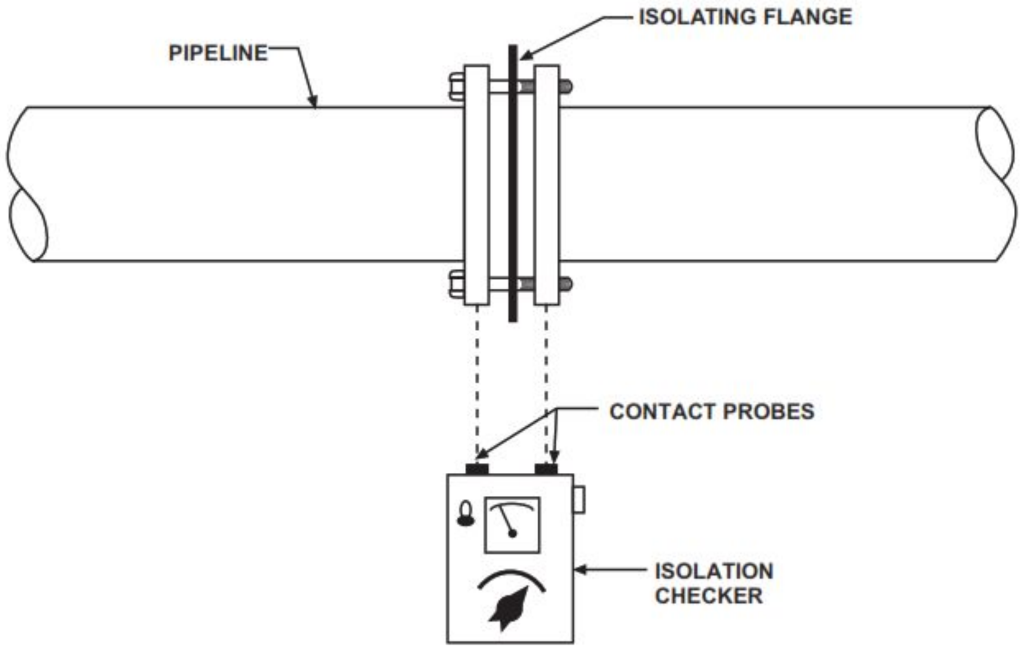
Testing Isolating Joints

Method 4 – Isolation Checker

The isolation checker has two probes which are placed across the isolating joint.

A full scale deflection (high reading) indicates that the joint is effectively isolated.

If the joint is shorted, the meter pointer will be deflected to near zero.



Repairing a Shorted Isolating Flange

If an isolating flange is found to be shorted or defective, it may be possible to repair it without tanking the line out of service. This is possible if the short is due to an isolating bolt sleeve which has broken down or improperly installed.

If this is the case, the shorted bolt can be removed and the isolating replaced or properly installed.

If the flange gasket is the cause for the short, the line must be taken out of service and the gasket replaced.

Before taking the flange apart, visually inspect the joint. The inspection may lead to the discovery of foreign material between the flange faces, or the existence of a metallic conductor across the flanges.

Cathodic Protection Test Points

Cathodic protection test points are used to electrically contact a buried pipeline to facilitate the monitoring of cathodic protection levels and conducting tests associated with corrosion control.

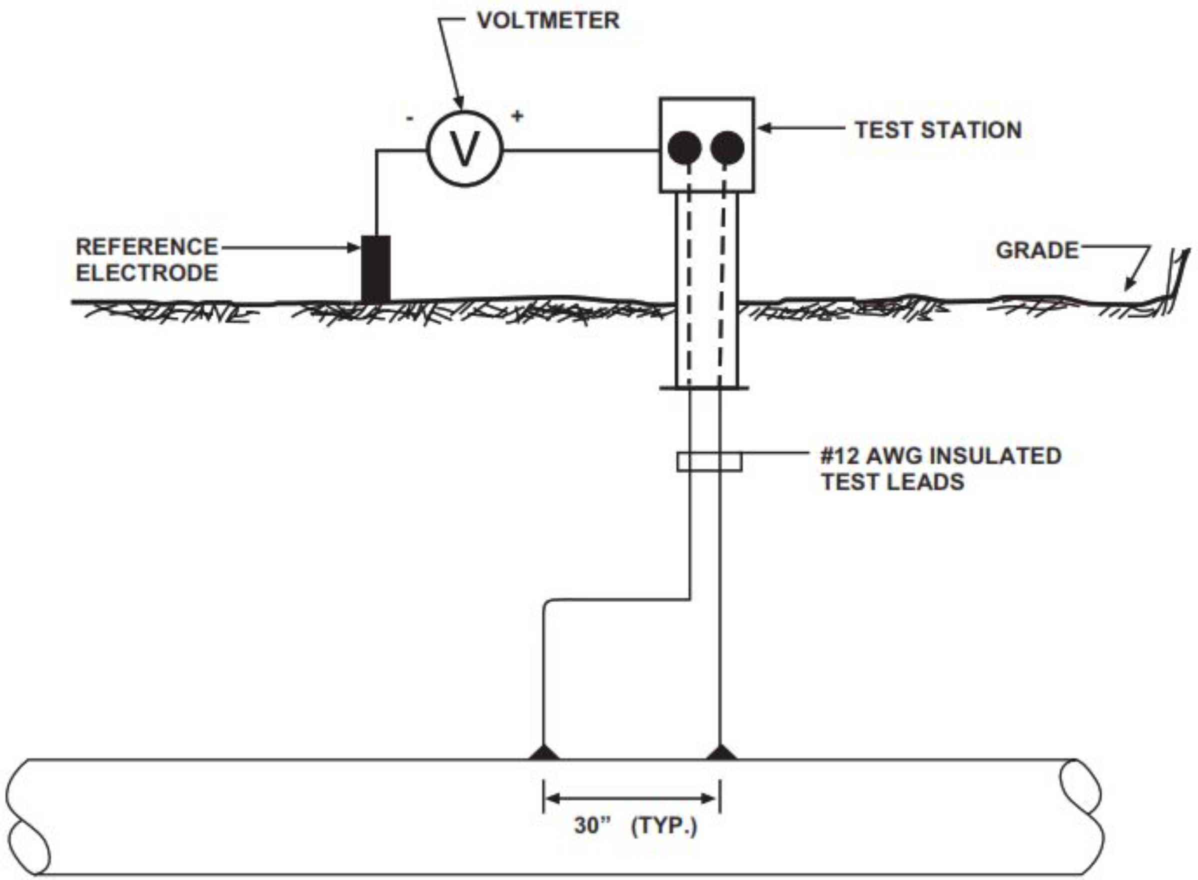
Ideally, test points should be conveniently located and well-constructed to provide years of reliable service.

Types of Test Points

Two Wire Test Station

- Basically used for contacting the structure.

- Pipe-to-Soil Potential Measurement

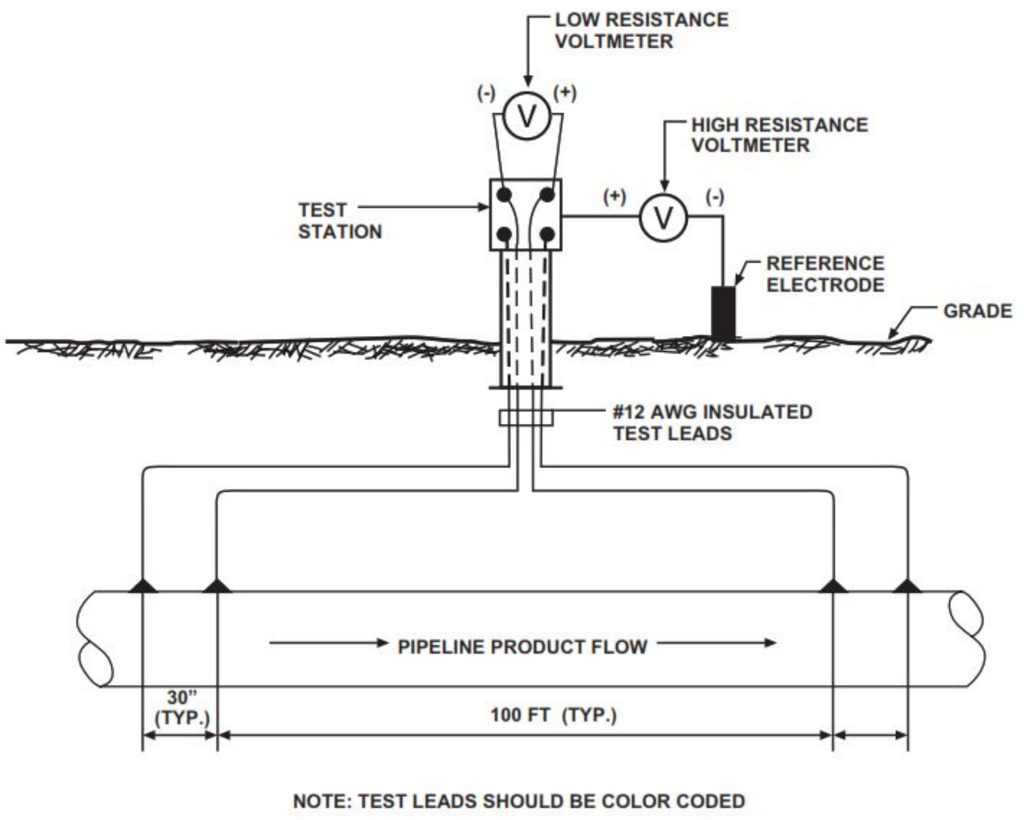


Types of Test Points

IR Drop, or Current Measuring Test Station

- Four wires required

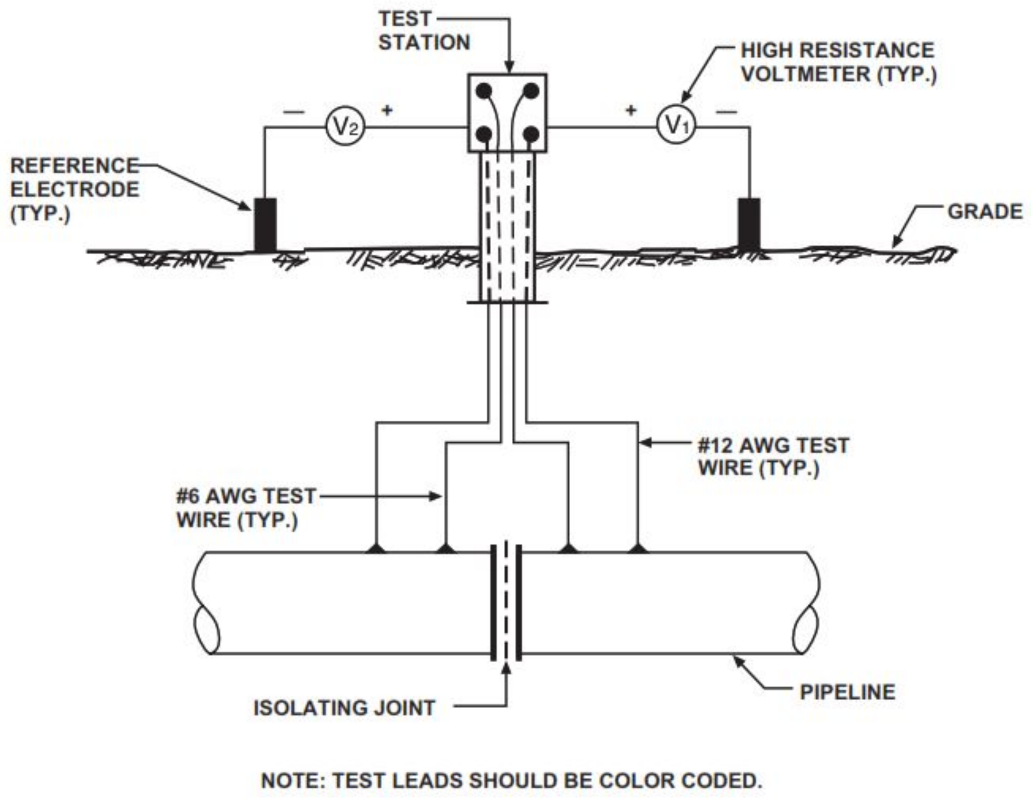
- Can be used to calculate the current through the pipe



Types of Test Points

Isolating Joint Test Point

- Pipe-to-soil potential measurement on each side of the joint.



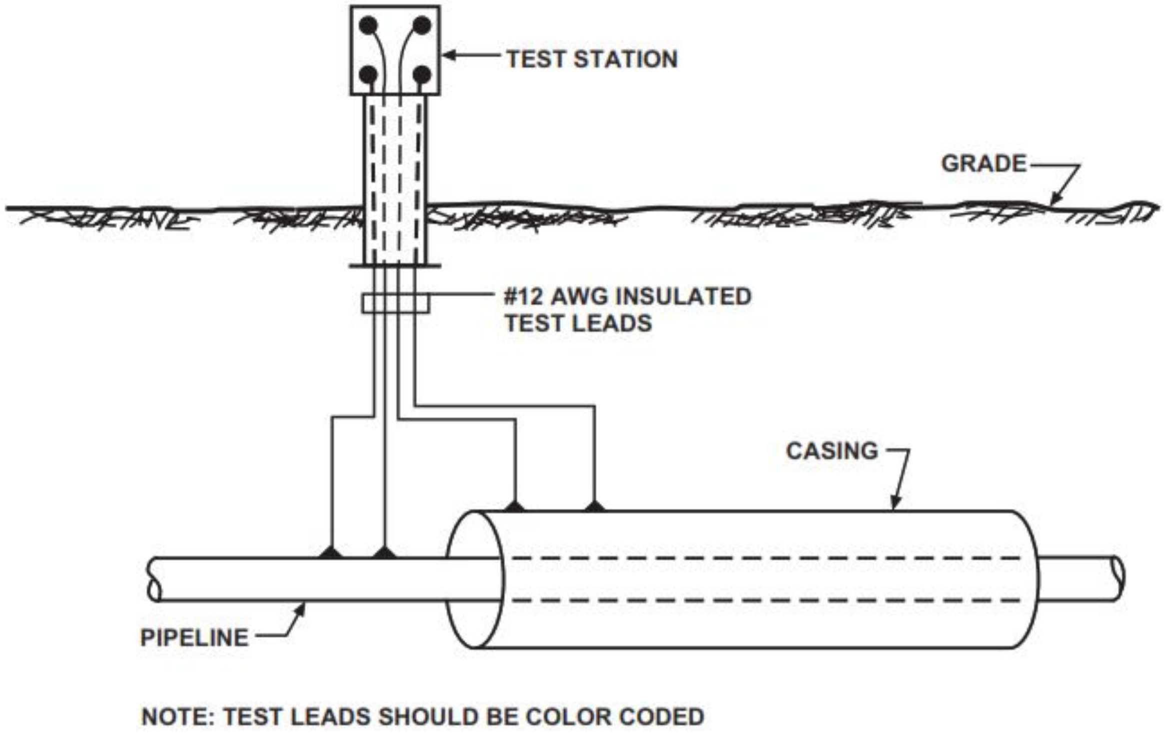
Types of Test Points

Pipeline Casing Test Station

 - Pipe-to-soil potential measurement

 - Casing-to-soil potential measurement

Some casings are installed with vent pipes. Sometimes the vent pipes are at one end only, and sometimes at both ends. The vent pipe can serve as one of the two wires connected to the casing.



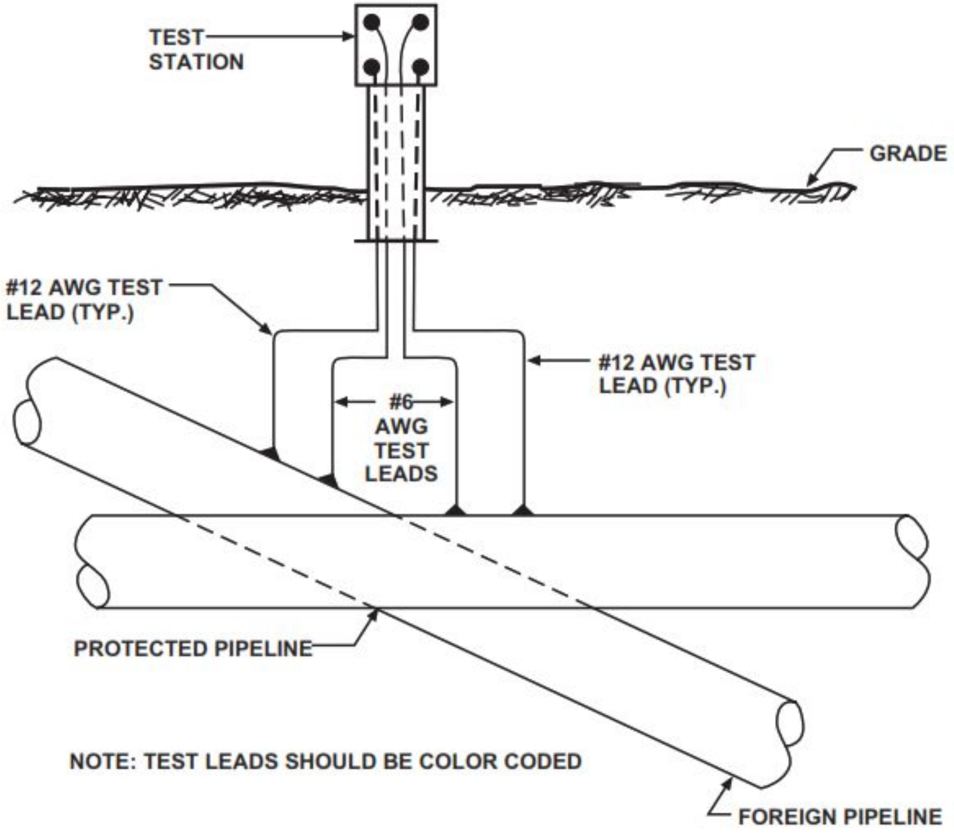
Types of Test Points

Foreign Line Crossing Test Station

- Pipe-to-soil potential measurement

- Foreign Line-to-soil potential measurement

The potential measurements should be made with the reference cell placed directly over the crossing.

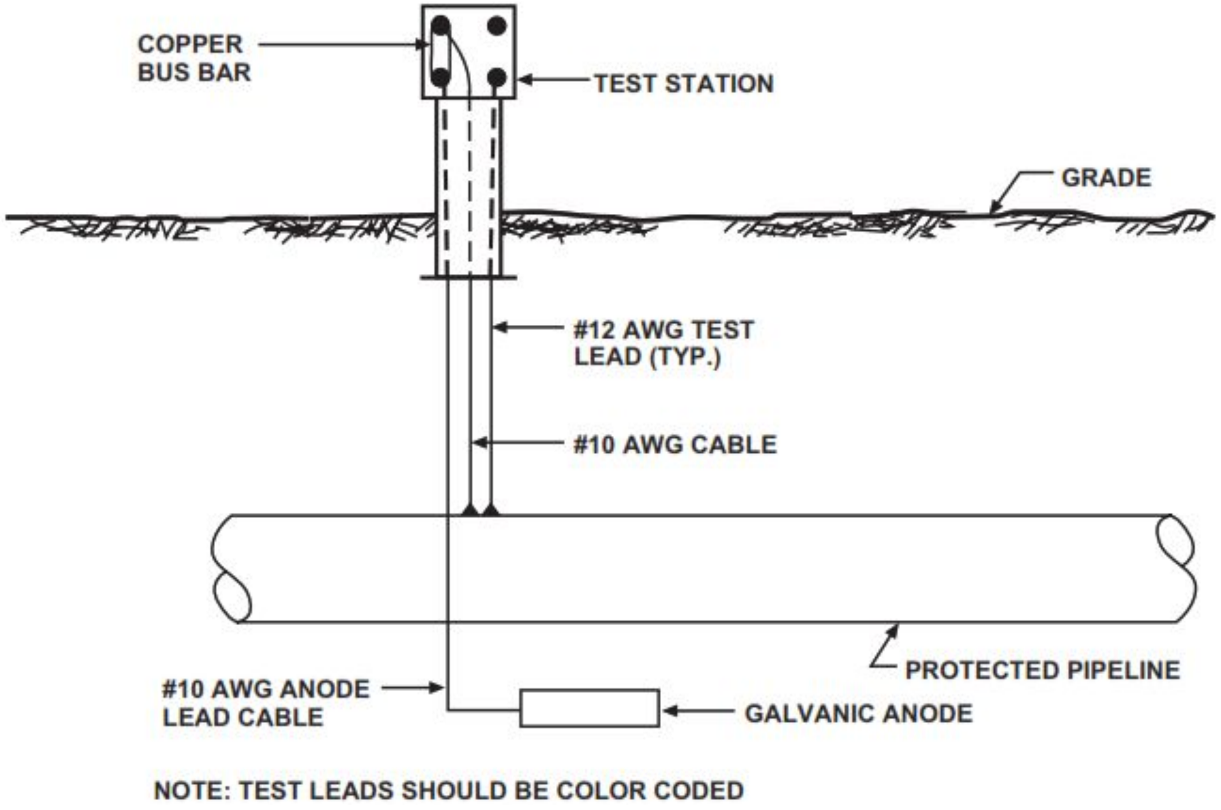


Types of Test Points

Galvanic Anode Test Station

- Pipe-to-soil potential measurement (with anode connected or disconnected)

- Anode current

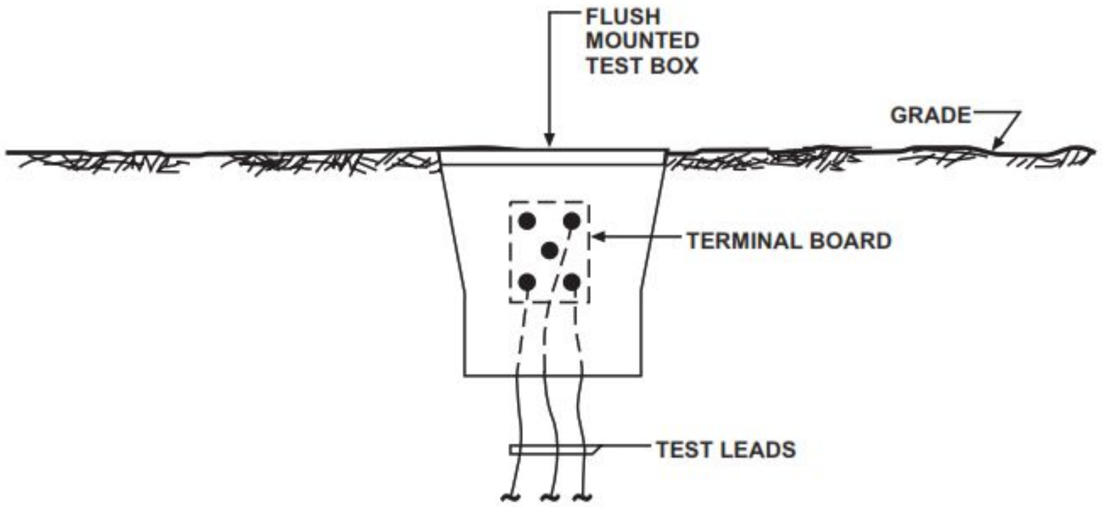


Installation of Test Points

Test points should be located so that they are readily accessible for testing.

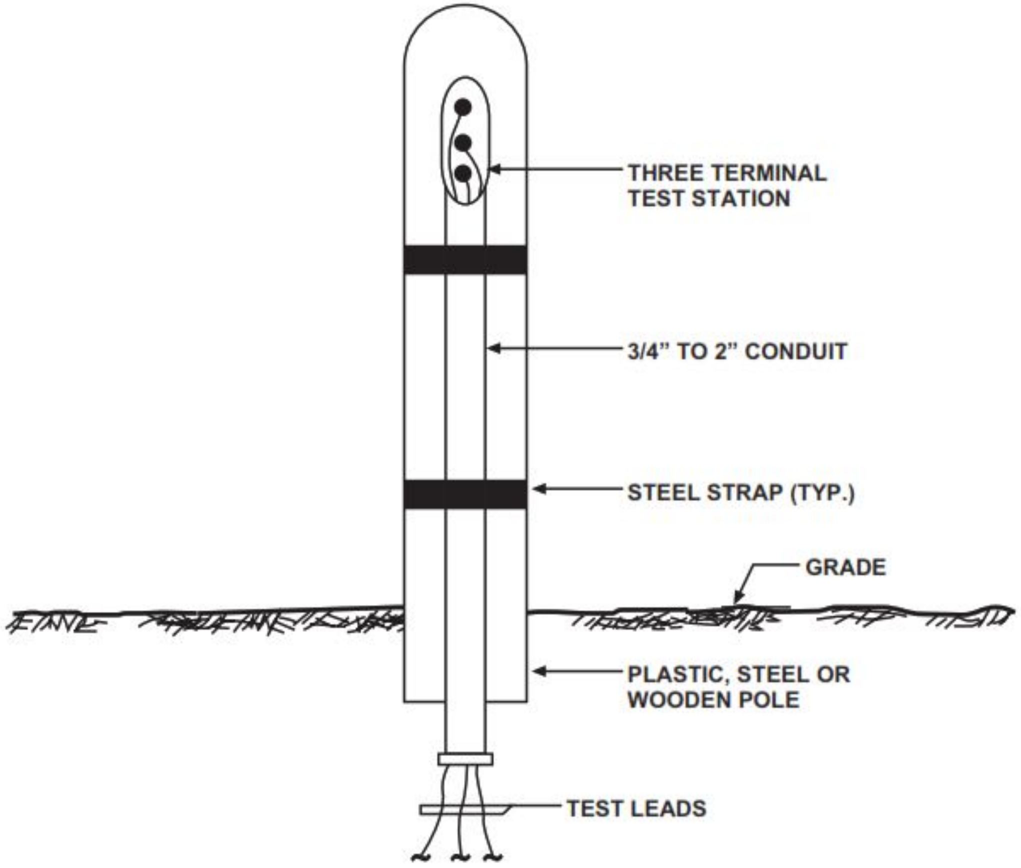
Flush mounted test stations are normally used in areas where an aboveground mounted test station may not be feasible due to vehicular traffic in the area, or due to right-of-way limitations.

Flush mounted test stations are less vulnerable to vandalism.



Installation of Test Points

Aboveground post-mounted test stations are normally used on cross-country pipeline installations to facilitate the locating of test points for testing.



Installation of Test Stations

1. Test stations should be located as close as possible to the pipeline being tested – preferably directly above it. This will reduce the chances of test leads being damaged by excavation activities in the area.

2. Test lead connections to a pipe should be made by using an exothermic welding process.

3. The weld and surrounding exposed pipe and wire should be coated with a coating system that is compatible with the existing coating.

4. Sufficient slack should be left in the test wires just below the test points to prevent any damage or breaks due to soil settlement after backfill.

Installation of Test Stations

5. Any damage to test wire insulation during installation must be repaired. Repairs should be made using two half-lapped layers of rubber electrical tape followed by two half-lapped layers of plastic electrical tape.

6. Approximately 9 inches of coiled test wire should be provided inside the test box so that the wires can be raised out of the box for testing.

7. Backfill for test wires should be free of stones larger than ¼-inch and other foreign material which may damage the wire insulation.

8. Accurate test station location drawings and electrical termination details should be prepared showing each test point. The importance of accurate records of the wire color coding and their positions/locations cannot be overemphasized.

Objectives of Cathodic Protection System

1. Provide sufficient distribution of current.
2. Minimize interference on foreign structures.
3. Achieve projected design life.
4. Provide allowance for anticipated changes in current requirements with time.
5. Install anodes, test stations, etc. in locations where possibility of damage is limited.
6. Install anodes, test stations, etc. in locations where installation is feasible.
7. Comply with regulatory requirements, electrical codes, NACE recommended practices, etc.

Useful Information for Cathodic Protection System Designs

1. Route maps / terrain
2. Whether new or existing pipeline
3. Water crossings – underground, under water, bridge, etc.
4. Locations of casings
5. Foreign pipelines and their CP Systems
6. AC power avialability
7. Performance of other CP systems in the area.
8. Easements for possible groundbed sites.
9. Future expansions of the pipeline system
10. Special environmental issues.
11. Possible AC interference concerns
12. Construction equipment access

Design Challenges

Pipeline route / terrain

Hills, trees, etc.

Road crossings

Design Challenges

Railroad crossings

Pipe casings

Design Challenges

River / Waterway crossings

Design Challenges

Construction equipment access

Conclusions

Counter corrosion methods should be considered when designing a new pipeline installation. Corrosion control measures should include the use of protective coatings. A knowledgeable coatings engineer should make the selection of the protective coating system to be used. Cathodic protection systems must be used in conjunction with a good protective coating to ensure that the pipeline meets its designed life expectancy.

Cased crossings are used for mechanical protection of a pipeline. Isolating joints are used to electrically separate sections of a pipeline. Both of these appurtenances can short out, and tests should be conducted to ascertain level of isolation. Test points are installed along the pipeline to allow for the conducting of tests.

Chapter 6
Corrosion Control For Pipelines

APPALACHIAN UNDERGROUND CORROSION SHORT COURSE

INTERMEDIATE

PRESENTED BY MIKE NORDSTROM, CORRPRO