

Safe electrical isolation of cathodically protected pipe

Cathodic protection is efficiently, uniformly applied when primary structure is electrically isolated

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Cathodic protection, a proven method of preventing corrosion of buried or submerged metallic structures, is most efficiently and uniformly applied when the primary structure is electrically isolated.

For pipe lines, cathodic isolation is a form of electrical isolation that maintains stringent electrical grounding requirements and confines the DC protective current at the surface of the structure. It provides all the advantages of electrical isolation by blocking the DC protective current at the electrical isolating device, such as across a pipe line isolating flange, while maintaining an effective grounding path to ensure personnel and equipment remain safely protected during all types of electrical disturbances, including AC fault currents, lightning, AC induction and power switching surge currents.

The general public, operating personnel and the buried pipe line remain fully protected by implementing cathodic isolation, utilizing proven protective devices such as Nickel-KOH polarization cell and electronic cathodic isolator systems.

The result, uniform cathodic protection can be safely achieved at a greatly reduced cost.

Polarization cell. Originally, batteries were used to safely decouple pipe lines to provide ionic current transfer to the grounding network for electrical disturbances. Batteries, of amphoteric metal and acid, provided

an extremely low impedance path to continuously pass AC, and to safely pass half second AC fault currents; while blocking DC current required for cathodic protection. Based on the need to keep them charged and regularly topped with electrolyte, batteries proved to be rather difficult and expensive to maintain.

In 1956, an electrical power physicist, R. C. Jacobsen, resolved this maintenance problem by devising the Nickel-KOH polarization cell system. In a paper at the NACE Corrosion

'57 Conference, he detailed how the ideal electrode proved to be commercially pure nickel. The next best candidates, in order, were mild steel, nickel plated copper, and stainless steel. The preferred electrolyte was an exact 30% solution by weight of pure potassium hydroxide in distilled water. These were the materials of choice for construction selected by R. C. Jacobsen, to devise the first polarization cell capable of passing a 26 kA AC fault current for half second (30 cycle) at 20°C (70°F), with a potential rise of less than 30 volts rms. Research and development may be never-ending work, but his original selection of construction materials remains the proven optimum for the Rustrol Nickel-KOH polarization cell system, as manufactured in accordance with Fig. 1.

Further product development has allowed the introduction of the electronic circuitry incorporated into the unique solid state Cathodic Isolator, introduced to the mar-



Protective equipment. Typical protective equipment installation across a monolithic isolating joint (and/or isolating flange).

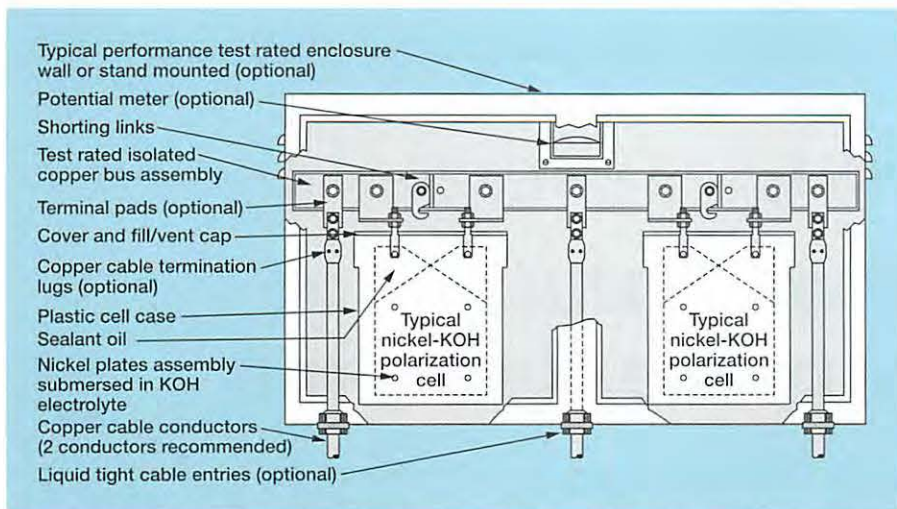


Fig. 1. Typical nickel-KOH polarization cell assembly in parallel arrangement.

ket in 1990. This device ensures acute sensitivity, instant response, fail-safe and maintenance-free operation in a non-electrolytic environment (Fig. 2).

Electronic cathodic isolator. The electronic cathodic isolator device is designed to safely and continuously conduct AC-induced voltages while blocking the DC current required for cathodic protection. When the potential across the electrical isolating device, such as an isolating flange,

exceeds the set voltage threshold circuit parameters (typical range 2.5 to 20 volts), the electronic cathodic isolator responds instantly. AC fault currents, lightning, power switching surges, or any other electrical disturbances are free to conduct.

Characteristics of the electronic cathodic isolator device provide the following:

- High impedance to the flow of DC current under the influence of DC voltage levels normally associated with

cathodically protected structures.

- Low impedance to the flow of AC current associated with power system faults and other conditions arising from the operation of AC power systems, including static electricity, mitigation of induced AC voltage, et al.

The electronic cathodic isolator device incorporates several components. AC modules conduct the nominal induced AC voltages until the potential exceeds the set voltage threshold required for firing the thyristor circuitry, typically activated by AC fault current exposures. When the cathodic isolator device senses a lightning surge, both AC and DC strays are conducted and the hermetically sealed gas gap clamps the surge.

Cathodic isolation design. Cathodic protection systems often are designed to safeguard against the possibility of a power system AC fault current exposure. In the case of a high-voltage pipe-type cable system, the low impedance provided by the pipe jacket almost guarantees that some of the fault current will return via the metallic pipe. Likewise, when an oil or gas pipe line is buried near an overhead high-voltage transmission line, or runs parallel for a distance, the pipe line may serve as a low impedance route for AC fault currents.

Fault current exposure for pipe-type cable installations is mentioned since this electrical structure is more prone to fault currents from a power system than many oil or gas pipe lines. Companies that have oil or gas pipe line segments paralleling electrical power line corridors can take advantage of the same techniques to mitigate induced AC voltages and provide AC fault current protection for their pipe lines using ionically conducting protective equipment.

The combination of absolute AC continuity to the grounding network and nominal DC blockage for cathodic protection is referred to as "cathodic isolation". Electrical protection equipment, which has proven the best medium to provide both of these functions, is the polarization cell system or the recently developed electronic cathodic isolator device. These devices maintain safety standards for effective grounding within the National Electrical Codes and conform to the need for safe operating "step/touch" potentials accepted worldwide (not to exceed 15 volts rms).

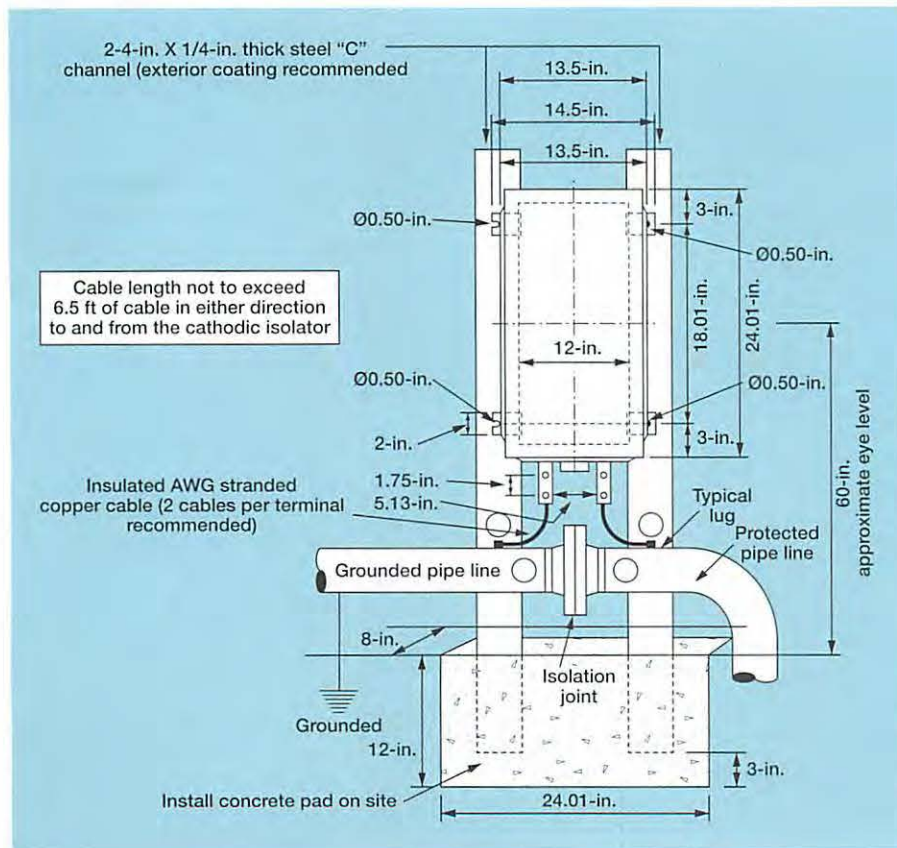


Fig. 2. Typical channel mounted installation of electronic cathodic isolator.

Sizing equipment. When sizing protective equipment for safe and effective grounding of a pipe line paralleling a power corridor, the AC fault current rating for the electrical protection equipment should be selected to match or exceed the largest available AC fault current exposure of the primary structure. The available AC fault current at any particular location can be determined by the "power utilities" technical staff. In most situations however, there are shield wires, thus the pipe line is unlikely to be exposed to the full AC fault current available at any one location as some of this current will return via the shield wires. Since it is difficult to determine the proportion of AC fault current which will be shared, it is wise to err a bit by safely designing on the conservative side.

Other parameters to be considered for a proposed polarization cell system or electronic cathodic isolator device is the amount of steady state AC current (at 50 or 60 Hz rms) required by the device to continuously conduct; including magnitude of surge/lightning exposure, AC/DC stray current interference, voltage

threshold operating parameters and other factors such as enclosure requirements (NEMA) temperature and exposure ratings.

Summary. The design and installation of AC protection equipment for pipe lines paralleling power lines can range from a simple, straight-forward solution to an extremely complex one. Usually, with the proper care and expertise applied to consider all predictable operating characteristics, a safe and cost-effective solution can be developed utilizing protective equipment.

Occasionally, for special situations, other protective devices may need to be considered. A coordinated design of the cathodic isolation system greatly reduces the CP cost. Also, by deleting the density of AC ionically passing through the soil/metal interface, a much more uniform and/or optimal polarized potential of the pipe line structure is obtained. The safety of operating personnel, operations, and of buried steel structures can remain fully protected by implementing cathodic isolation, utilizing proven protective devices (Nickel-

KOH polarization cell and electronic cathodic isolator systems). Cathodic protection remains uniform at a greatly reduced cost.

References

R. C. Jacobsen, Physicist, Ontario Hydro
R. W. Mock, Ontario Hydro
Abstracts From Various I.C.C.C. Reports/Papers.



The author

William B. Russell is vice president, operations of the Rustrol Group of Companies, which includes Interprovincial Corrosion Control Company Ltd., Ontario, International Corrosion Control Inc., New York and G. I. Russell & Company, Ltd., Ontario.

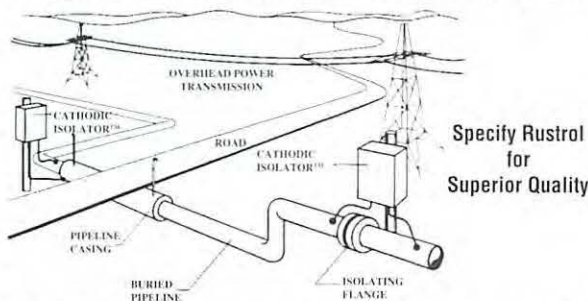
He has been involved in the cathodic protection industry since 1978 and is qualified in cathodic isolation/protection design criteria as well as in the analysis and mitigation of stray a.c. and d.c. currents in hostile electrolytes and underground environments.

Mr. Russell studied applied science and engineering at the university of Ottawa, majoring in physics. He has been an instructor at various corrosion short courses and is qualified to design, supervise and commission cathodic protection installations for all types of buried and immersed metallic structures.



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- HIGH BLOCKING VOLTAGE
- MAINTENANCE FREE



The Rustrol® Cathodic Isolator™ effectively blocks the current needed for cathodic protection, while providing a grounding path for AC fault currents, lightning, induced AC, including other electrical disturbances.

The Cathodic Isolator™ which features electronic/electrical construction throughout, responds instantly, the result: your personnel and equipment are safely protected against electrical shock hazards. Specify Rustrol® and be assured of safety.

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