

Considering IR Drop

Nebraska Pipeline Safety Seminar

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State Regulations/DOT PHMSA

- State regulations in Nebraska reference those of PHMSA.
- PHMSA regulations in CFR 49, Part 192 reference information from NACE regarding how to measure pipe to soil values for corrosion control in 192.463, Cathodic protection level according to **Appendix D** criteria
- The specific document referenced in Appendix D is RP0169 – 2002.

192.463

**§192.463 External corrosion control:
Cathodic protection.**

(a) Each cathodic protection system required by this subpart must provide a level of cathodic protection that complies with one or more of **the applicable criteria contained in Appendix D of this part**. If none of these criteria is applicable, the cathodic protection system must provide a level of cathodic protection at least equal to that provided by compliance with one or more of these criteria.

192.463 continues

- (b) If amphoteric metals are included in a buried or submerged pipeline containing a metal or different anodic potential—
- (1) The amphoteric metals must be electrically isolated from the remainder of the pipeline and cathodically protected; or
 - (2) The entire buried or submerged pipeline must be cathodically protected at a cathodic potential that meets the requirements of Appendix D of this part for amphoteric metals.
- (c) The amount of cathodic protection must be controlled so as not to damage the protective coating or the pipe.
- [Amdt. 192-4, 36 FR 12297, June 30, 1971]

192 Appendix D

Appendix D—Criteria for Cathodic Protection and Determination of Measurements

I. Criteria for cathodic protection—

A. Steel, cast iron, and ductile iron structures.

(1) A negative (cathodic) voltage of at least 0.85 volt, with reference to a saturated copper-copper sulfate half cell. Determination of this voltage must be made with the protective current applied, and **in accordance with sections II and IV of this appendix.**

Appendix D II and IV

II. *Interpretation of voltage measurement.*

Voltage (IR) drops other than those across the structure electrolyte boundary must be considered for valid interpretation of the voltage measurement in paragraphs **A(1) and (2) and paragraph B(1) of section I of the appendix.**

IV. *Reference half cells.*

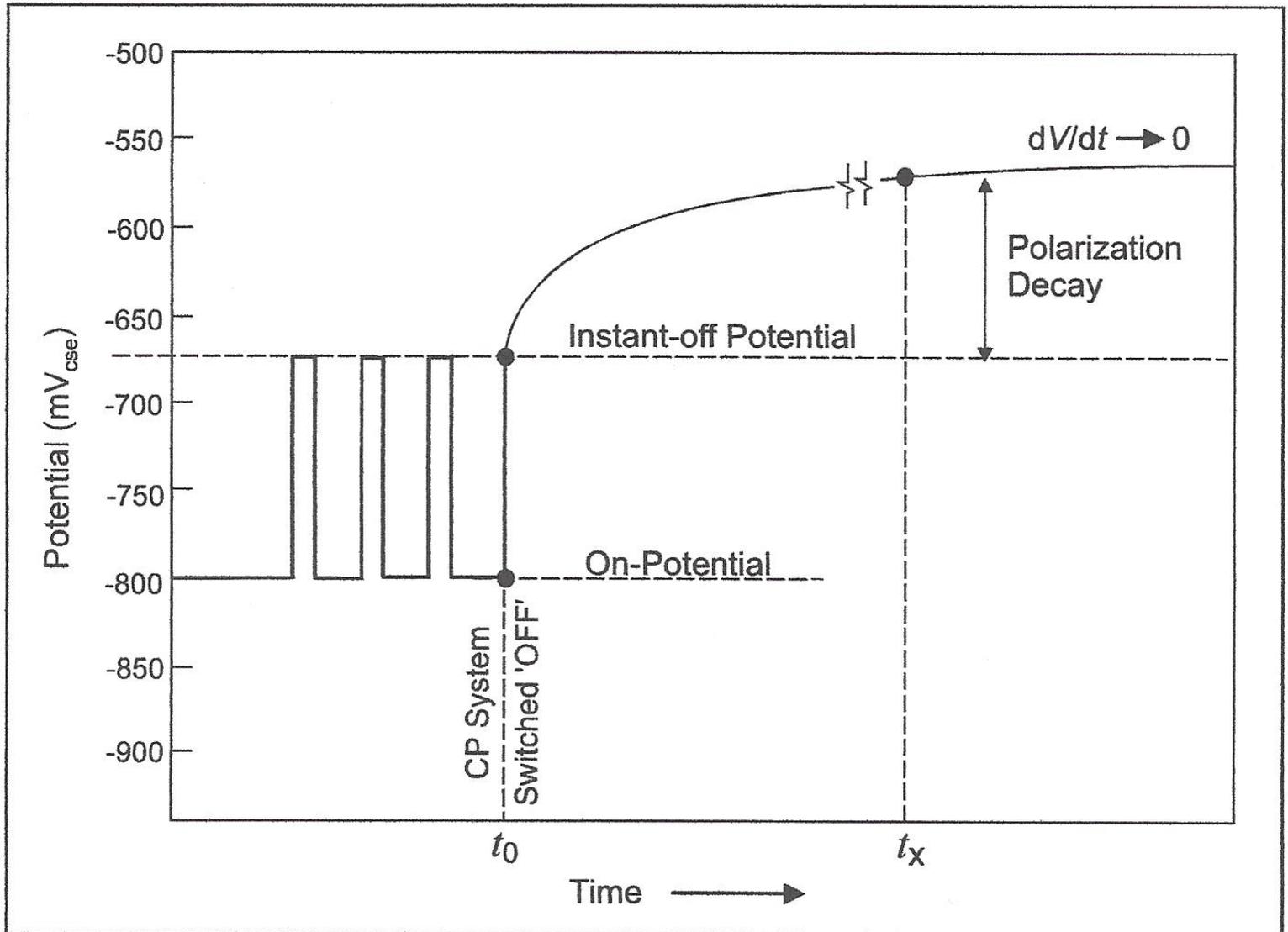
A. Except as provided in paragraphs B and C of this section, negative (cathodic) voltage must be measured between the structure surface and a saturated copper-copper sulfate half cell contacting the electrolyte.

B. Other standard reference half cells may be substituted for the saturated copper-copper sulfate half cell. Two commonly used reference half cells are listed below along with their voltage equivalent to -0.85 volt as referred to a saturated copper-copper sulfate half cell

What is IR Drop?

- When a cathodic protection current flows to a structure the structure forms a polarization film on its surface that inhibits corrosion.
- The current flowing to maintain this film has a voltage component that is normally measured against a reference half cell.
- The half cell is normally placed on top of the soil directly over the pipeline.
- However, the soil between the half cell and the structure is added to the reading.
- This voltage is the IR Drop in the soil. The current is very small, and the voltage is usually small.

Where is the IR Drop?



Peabody on -0.850V On Criteria

This criterion has a number of limitations. The potential reading should be taken with the reference electrode contacting the electrolyte directly over the structure, **to minimize ohmic voltage drop errors** in the measurement and to minimize the extent of averaging over large areas of the structure.

Simply Stated

- IR Drop is the voltage in the half cell reading between the soil top and the surface of the polarized structure.
- How do you “consider” this as required by regulation?
- There is no prescribed method – your company is to establish your methodology of considering this voltage component.

Common Methods to Consider IR Drop

- Many use Interrupted Surveys to consider the IR Drop value.
 - When the cathodic protection system is turned off, there is an instantaneous positive increase in the potential measured with the reference half cell and if properly captured is considered the IR free value of the polarized potential.
 - These surveys are normally run on sections of pipelines using a CIS (Close Interval Survey) technique.
 - These surveys are sometimes run only at test leads.

Why Interrupted Readings at Test Leads?

- When test lead readings are taken without interruption, the measurements contain the IR component.
- If the survey is run with interruption on the cathodic protection system, some operators collect these readings and use them as consideration within the area.
- The values of the IR drop are then compared to the -850 polarized value to determine if the structure is protected.

Measurements at Risers

- Risers enable measurements with very little soil between the half cell and the pipe.
- The IR component is not eliminated, but reduced to an insignificant number.
- Practicality demands that when risers are measured, there are 2 readings taken...
 - One at the point of transition to air (minimum soil)
 - One at pipe depth from the riser down the pipeline
- These two readings then provide an IR free reading and a normal P/S value for evaluation.
- Again, these values would be used to evaluate the level of IR drop in the area.
- This method may not be useful if the riser has coating differences from that of the buried segment, moisture differences, or different soils.

Extrapolation

- Extrapolation of the IR component is based on a calculated value based on two readings.
- One is taken over the pipeline, the other perpendicular to the pipeline from the same spot.
- Using the Pythagorean formula $c^2 = a^2 + b^2$ the value of the measured potential at the pipe surface can be estimated.
- This method has many issues and has not been found to be practical or consistently replicated.

Soil Tubes

- Soil tubes are simply PVC pipes fitted over the pipeline with very little soil at the bottom covering the pipe.
- The reference half cell is dropped to the pipeline surface and essentially measures an IR free value.
- Since the soil tube requires a test lead nearby, the normal P/S value can also be taken and the local IR component evaluated.

Coupons

- Various manufacturers offer IR Free coupons that can be attached to the pipeline.
- These coupons can over time replicate the IR free potentials of the pipeline.
- Since coupons are installed permanently, they are adaptable to remote monitoring.
- Again the use of coupons can only be applied to average values in their areas to evaluate the IR component.

Summary

- Options to “consider” the IR drop component
 - Interrupted CIS
 - Interrupted Test Lead Surveys
 - Riser measurements
 - Extrapolations
 - Soil Tubes
 - Coupons
- Of these options, note that all are proactive methods to evaluate the IR component...

Soon Unacceptable

- The philosophy of using leak history as justification of only taking On Potential readings.
- The belief that the IR Drop component is built into the -850 On potential value.
- Doing nothing or having no company stated procedure or process.

Recommendations

- Assure your company has a written standard on how it considers the IR Drop component in cathodic protection readings.
- In areas of concern, where On potentials are borderline, take additional action to assure protection of the structure.
- In event of a failure, be prepared to justify your company point of view.

Recent Compliance Order (Liquids Line)

§ 195.571 What criteria must I use to determine the adequacy of cathodic protection?

Cathodic protection required by this Subpart must comply with one or more of the applicable criteria and other considerations for cathodic protection contained in paragraphs 6.2 and 6.3 of NACE SP 0169 (incorporated by reference, *see* § 195.3).

Compliance Order continued

The Notice alleged that KMCO₂ violated 49 C.F.R. § 195.571 by failing to ensure that all buried piping at its Blanco Station had adequate cathodic protection (CP), as provided by NACE SP 0169 (version 2007). Specifically, the Notice alleged that during PHMSA's inspection of the Blanco Station, KMCO₂ personnel conducted an interrupted CP survey that showed insufficient CP on the station bypass piping. PHMSA staff subsequently learned that the station piping was electrically isolated from the mainline with buried isolation unions and that during a 2008 construction project the rectifier lead cable to the station piping had been cut. The Notice further alleged that when PHMSA staff observed the configuration of the electrical connections at a rectifier junction box, it was apparent that the station bypass piping was electrically disconnected. PHMSA asserted that the bypass piping had inadequate CP and that the only current making it to the station bypass piping was stray cathodic current.

Questions?

- Contact your Fire Marshall or
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