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Alternating Current Corrosion on Cathodically Protected Pipelines: Risk Assessment, Mitigation, and Monitoring

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ABSTRACT

This standard practice presents guidelines and procedures for use during risk assessment, mitigation, and monitoring of corrosion on underground, cathodically protected steel piping systems caused by proximity to alternating current (AC) power supply systems.

As shared right-of-way and utility corridor practices become more common, AC influence on adjacent metallic structures has greater significance, and corrosion due to AC influence becomes of greater concern. This standard is not intended to supersede or replace existing corrosion control standards, but rather to complement these standards when the influence of AC-powered systems becomes significant.

The effects of lightning and AC power transmission systems on human safety are not covered by this standard. However, the mitigation measures implemented for safety and system protection, as outlined in NACE SP0177, can also be used for AC corrosion control and are cited whenever feasible.

KEYWORDS

Cathodic protection, alternating current (AC), pipeline, corrosion.

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Foreword

In NACE standards, the terms **<u>shall</u>, <u>must</u>, <u>should</u>,** ***and*** **<u>may</u>** ***are used in accordance with the definitions of these terms in the*** **NACE Publications Style Manual.** ***The terms*** **<u>shall</u>** ***and*** **<u>must</u>** ***are used to state a requirement, and are considered mandatory. The term*** **<u>should</u>** ***is used to state something good and is recommended, but is not considered mandatory. The term*** **<u>may</u>** ***is used to state something considered optional.***

This standard practice presents guidelines and procedures for use during risk assessment, mitigation, and monitoring corrosion on underground, cathodically protected steel piping systems caused by proximity to alternating current (AC) power supply systems. This standard is not intended to supersede or replace existing corrosion control standards, but rather to complement these standards when the influence of AC-powered systems becomes significant.

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The effects of lightning and AC power transmission systems on human safety are not covered by this standard. However, the mitigation measures implemented for safety and system protection, as outlined in NACE SP0177, can also be used for AC corrosion control and are cited whenever feasible.[1]

The original technical background for this standard is the NACE Technical Committee Report "AC Corrosion State-of-the-Art: Corrosion Rate, Mechanism, and Mitigation Requirements" prepared by NACE Task Group 327 and published by NACE in January 2010.[2] Supplements to the current understanding of AC corrosion and criteria for this have been made in PRCI[(1)] reports[3,4] published in October 2016.

This standard addresses typical power transmission frequencies up to 60 Hz only.

This standard was prepared by Task Group (TG) 430 on "AC Corrosion on Cathodically Protected Pipelines: Risk Assessment, Mitigation, and Monitoring" in 2018. TG 430 is administered by Specific Technology Group (STG) 05 on Cathodic/Anodic Protection and sponsored by STG 35 on Pipelines. This standard is issued by NACE under the auspices of STG 05.

[(1)]Pipeline Research Council International (PRCI), 1401 Wilson Blvd., Ste. 1101, Arlington, VA 22209.

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Section 1: General

1.1 AC (alternating current) corrosion is defined as corrosion initiated and propagating under the influence of alternating current. AC corrosion on cathodically protected underground pipelines is commonly the result of a combined action of the AC voltage, the cathodic protection conditions, a coating defect—usually small—and the chemical and physical conditions of the soil. If the AC component is either entirely removed or limited to a certain level, the corrosion will be mitigated.

AC corrosion is also influenced by direct current (DC). As such, in addition to mitigation by limiting the AC component, AC corrosion can be reduced by adjusting the DC-component – through the cathodic protection (CP) system.

1.2 An AC corrosion evaluation process (Figure 1) should include an analysis which results in development and implementation of a mitigation strategy, development of a monitoring strategy, and implementation of that monitoring strategy. If subsequent monitoring indicates risk of AC corrosion, the analysis as such should be reviewed, the mitigation strategy should be improved, or—in case values of the monitoring parameter are violated but it is documented that this does not lead to corrosion—the monitoring strategy can be modified.

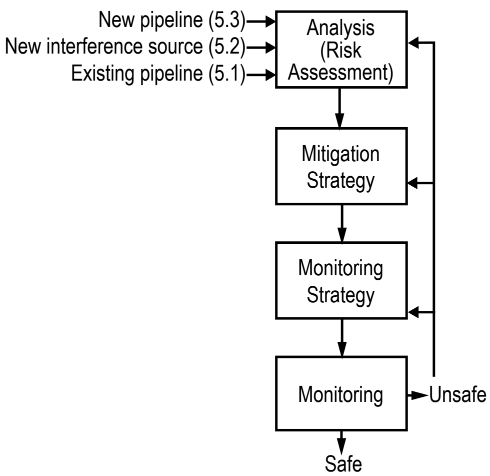

Figure 1: AC Corrosion Evaluation Process

1.3 The provisions of this standard should be applied under the direction of competent persons, who, by reason of knowledge of the physical sciences as well as the principles of engineering and mathematics, acquired by education and related practical experience, are qualified to engage in the practice of corrosion control of buried ferrous piping systems. Such persons may be registered professional engineers or persons recognized as corrosion specialists or CP specialists by NACE if their professional activities include suitable experience in external corrosion control on buried ferrous piping systems and AC interference and mitigation.

1.4 This standard should be used in conjunction with the references contained herein.

Section 2: Definitions

AC Corrosion: Corrosion initiated and propagating under the influence of alternating current.

AC Current Density (J_{AC}): Unit: A/m^2. The AC current density in a coating defect or in a coupon or probe used to simulate a coating defect of a certain area.

AC-Voltage (U_{AC}): Unit: V. Difference in AC potential between the pipeline and the earth. The AC voltage is the ultimate driving force for the AC current density at a coating defect —which may cause corrosion—or the AC current density at grounding devices (including galvanic anodes) installed for mitigation purposes. The AC voltage is not a constant value since:

- it will change over time primarily due to intermittent conditions in the AC power system, for instance because household power consumption is different during daytime and nighttime.
- it will change along the length of the pipeline since the induced voltage depends on characteristics of the pipeline, characteristics of the interfering AC power system, as well as the geometrical and geographical alignment.

AC Voltage Survey: Measurements along the pipeline designed to provide evidence of the actual level of AC pipe to electrolyte potentials or Coating Stress Voltage resulting from existing AC interference sources.