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This Technical Committee Report has been prepared by NACE International Task Group 211 on Cathodic Protection: Report on the Application of the 100 mV Polarization Criterion.*

One Hundred Millivolt (mV) Cathodic Polarization Criterion

Foreword

This NACE International technical committee report is intended for use by engineers during evaluation of criteria for levels of cathodic protection (CP). Throughout this report, reference is made to pertinent available standards. Of particular relevance are NACE SP0169[1] and TM0497[2] for pipelines, as well as numerous other standards for other types of structures, some of which are listed in the Summary section of this report. The report discusses the theoretical basis for the 100 millivolt (mV) cathodic polarization criterion, the effects of other factors such as temperature, mill scale, moisture, and anaerobic bacteria, measurement of the polarization, and the applicability of the criterion in situations such as areas susceptible to stress corrosion cracking, mixed-metal systems, and areas susceptible to stray currents. It also includes the results of an industry questionnaire on the use of the 100 mV polarization criterion and opinions on its effectiveness.

This technical committee report was prepared by Task Group (TG) 211—Cathodic Protection: Report on the Application of the 100 mV Polarization Criterion. This TG is composed of corrosion researchers, corrosion engineers, corrosion consultants, facility owners, and representatives of both industry and government. TG 211 is administered by Specific Technology Group (STG) 35—Pipelines, Tanks, and Well Casings. It is also sponsored by STG 05—Cathodic/Anodic Protection. This technical committee report is issued by NACE International under the auspices of STG 35.

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NACE technical committee reports are intended to convey technical information or state-of-the-art knowledge regarding corrosion. In many cases, they discuss specific applications of corrosion mitigation technology, whether considered successful or not. Statements used to convey this information are factual and are provided to the reader as input and guidance for consideration when applying this technology in the future. However, these statements are not intended to be recommendations for general application of this technology, and must not be construed as such.

Introduction

In February 2000, NACE Work Group T-10A-3b sent questionnaires to 49 CP practitioners and users regarding the use of the 100 mV cathodic polarization criterion.[3] In this report, a summary of the 14 responses to this questionnaire is included as Appendix A. The number of companies employing the 100 mV cathodic polarization criterion increased 300% in the 10 years prior to the questionnaire. While most report using this criterion for only a small percentage of their systems (11% on average), the trend toward more widespread use is clearly established when it offers advantages to users. As usage of this criterion has increased, however, so have questions pertaining to its validity and applicability. This report is intended to address these concerns on both a theoretical and empirical basis.

Definitions

Alkalization: The process of becoming more alkaline.

Amphoteric Metal: A metal that is susceptible to corrosion in both acid and alkaline environments.

Blister: An undesirable, dome-shaped projection on the surface of a coating resulting from the local loss of adhesion and lifting of the film from an underlying coat or from the base substrate.

Cathodic Blistering: Formation of coating blisters as the result of an alkaline environment under the coating caused by the cathodic reaction.

Cathodic Disbondment: The destruction of adhesion between a coating and the coated surface caused by products of a cathodic reaction.

Close-Interval Potential Survey (CIPS) (also Close-Interval Survey [CIS]): A potential survey performed on a buried or submerged metallic pipeline in order to obtain valid DC structure-to-electrolyte potential measurements at a regular interval sufficiently small to permit a detailed assessment.

Corrosion Potential (E_{corr}): The potential of a corroding surface in an electrolyte relative to a reference electrode under open-circuit conditions (also known as *rest potential*, *open-circuit potential*, or *freely corroding potential*).

Depolarization: The removal of factors resisting the current in an electrochemical cell. For the purposes of this report, *depolarization* refers to a reduction in the level of protection as a result of a reduction or elimination of CP current.

Depolarized Potential: The potential of a cathodically protected surface in an electrolyte relative to a reference electrode after influencing CP current sources have been turned off for a sufficient duration of time for *depolarization* to have occurred.

Depolarized Close-Interval Potential Survey: A CIS performed after influencing CP current sources have been turned off for a sufficient duration of time for depolarization to have occurred. This is often called a native-state CIS if it is performed prior to the initial application of CP.

Holiday: A discontinuity in a protective coating that exposes unprotected surface to the environment.

Native Corrosion Potential: The *Corrosion Potential* prior to application of CP.

Stray Current: Current through paths other than the intended circuit.

Telluric Current: Current in the earth as a result of geomagnetic fluctuations.

Theoretical Considerations

The validity of a 100 mV cathodic polarization criterion in reducing corrosion on ferrous structures in soils, immersion in natural waters, and in reinforced concrete is well supported by both thermodynamic and kinetic corrosion fundamentals, although the degree of effectiveness can vary.

Thermodynamic Considerations

The Pourbaix[4] equilibrium diagram shown in Figure 1 depicts the thermodynamic equilibrium for iron and its various oxides in a deaerated aqueous solution on a potential/pH format. In plotting a test electrode potential versus an applied current, the potential reading normally includes an error component referred to as the IR voltage