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Standard Practice

Cathodic Protection of Reinforcing Steel in Buried or Submerged Concrete Structures

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Foreword

The purpose of this NACE standard practice is to present guidelines for cathodic protection (CP) of reinforcing steel in buried or submerged concrete structures. These guidelines provide corrosion control personnel with information to control corrosion of conventional reinforcing steel in portland cement concrete structures through the application of CP.

For more information on design, evaluation, maintenance, and rehabilitation of reinforcing steel in concrete, refer to NACE SP0187,[1] SP0390,[2] and SP0308.[3] CP of reinforcing steel in atmospherically exposed concrete is described in NACE SP0290.[4] For a state-of-the-art overview on criteria for CP of prestressed concrete structures, refer to NACE Publication 01102.[5] For more information on CP of prestressed concrete cylinder pipelines, refer to NACE SP0100.[6]

This NACE standard was originally prepared in 2008 and revised in 2014 by Task Group (TG) 048, "Reinforced Concrete: Review and Revise as Necessary SP0408-2008." To provide the necessary information on all aspects of the subject and to provide input from all interested parties, TG 048 included corrosion consultants, consulting engineers, architect-engineers, CP engineers, researchers, structure owners, and representatives from industry and government. TG 048 is a component of Specific Technology Group (STG) 01, "Reinforced Concrete," and is sponsored by STG 05, "Cathodic/Anodic Protection." It is published by NACE under the auspices of STG 01.

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

NACE International
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Contents

1. General 1
2. Definitions 1
3. Criteria 3
4. Design of Cathodic Protection Systems 4
5. Installation Practices 8
6. Energizing and System Adjustment 8
7. Post-Energization Operation and Maintenance of Cathodic Protection Systems 9
8. Records 11
References 12
Bibliography 12
Appendix A: Additional Information Useful for Design (Nonmandatory) 13
Appendix B: Test Equipment (Nonmandatory) 15
Figure 1: Typical Polarization Decay and Development Curves 4

Section 1: General

1.1 Background

1.1.1 Reinforcing steel is compatible with concrete because of similar coefficients of thermal expansion and because concrete usually provides the steel with excellent corrosion protection. The corrosion protection is the result of the formation of a passive oxide film on the surface of the reinforcing steel by highly alkaline portland cement contained in the concrete. This passive oxide film can be compromised by (1) excessive amounts of chloride or other corrosive ions and gases, or (2) the steel not being sufficiently encased by the concrete.

1.1.2 Corrosion occurs as a result of the formation of an electrochemical cell. An electrochemical cell consists of four components: an anode, where oxidation occurs; a cathode, where reduction occurs; a metallic path electrically connecting the anode and cathode, where electrons flow; and an electrolyte (concrete), where ions flow. The anodic and cathodic areas can occur as a result of coupling dissimilar metals, exposure to different environmental conditions, or both. If any one of the four elements of the electrochemical cell is eliminated, corrosion is prevented.

1.2 Cathodic Protection

1.2.1 The basic principles of corrosion can be used to understand the theory of CP. CP reduces the corrosion of a metal surface by making the corroding surface the cathode of an electrochemical cell.

1.2.2 CP is a proven technique for controlling corrosion of steel in chloride-contaminated concrete structures. However, CP neither replaces lost steel nor returns corroded reinforcing steel to its original cross section.

1.2.3 CP of reinforcing steel in atmospherically exposed concrete is described in NACE SP0290. Many of the practices described in that standard are relevant to buried and submerged elements. Other anode types are also applicable to buried and submerged elements, as the soil or water provides a somewhat homogenous medium for the anode system, which need not be attached directly to the concrete. The application of CP to prestressed concrete cylinder pipelines is described in NACE SP0100.

1.3 Scope and Limitations

1.3.1 The provisions of this standard should be applied under the direction of a registered Professional Engineer or a person certified by NACE as a Corrosion Specialist or a CP Specialist. The person's professional experience shall include suitable experience in CP of conventionally reinforced and prestressed concrete structures. Under certain circumstances, a CP system may either become a structural component or significantly affect the serviceability and structural performance of a reinforced concrete structure; therefore, such impact by the CP system should be reviewed by a qualified registered structural engineer or the equivalent.

1.3.2 The guidelines presented in this standard are limited to CP systems for new or existing buried or submerged reinforced concrete elements.

1.3.3 When the reinforcing steel is bonded to the facility's grounding, as is commonly required by the National Fire Protection Association's[(1)] (NFPA) NFPA 70, *National Electrical Code*,[7] the resulting galvanic corrosion cell and the possible adverse effects on the quantity and distribution of CP current to the reinforcing steel shall be considered.

Section 2: Definitions

Attenuation: Electrical losses in a conductor caused by current flow in the conductor.

Cathodic Protection: A technique to reduce the corrosion rate of a metal surface by making that surface the cathode of an electrochemical cell.

[(1)] National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471.