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Standard Practice

Impressed Current Cathodic Protection of Reinforcing Steel in Atmospherically Exposed Concrete Structures

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Foreword

The purpose of this NACE standard practice is to present guidelines for impressed current cathodic protection of reinforcing steel in atmospherically exposed concrete structures. This standard is aimed at owners, engineers, architects, contractors, and all those concerned with rehabilitation of corrosion-damaged reinforced concrete structures.

For more information on design, maintenance, and rehabilitation of reinforcing steel in concrete, refer to NACE Standard RP0187[1] and NACE Standard RP0390.[2] For a state-of-the-art overview regarding the use of reference electrodes for atmospherically exposed reinforced concrete structures, refer to NACE International Publication 11100.[3] For a state-of-the art overview on criteria for cathodic protection of prestressed concrete structures, refer to NACE International Publication 01102.[4]

This standard was originally prepared in 1990 by NACE Task Group T-3K-2, a component of Unit Committee T-3K on Corrosion and Other Deterioration Phenomena Associated with Concrete. It was revised by Work Group T-11-1a in 2000, and reaffirmed by Specific Technology Group (STG) 01 in 2007. It is issued by NACE International under the auspices of STG 01 on Reinforced Concrete.

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*, 4th ed., Paragraph 7.4.1.9. *Shall* and *must* are used to state mandatory requirements. The term *should* is used to state something good and is recommended but is not mandatory. The term *may* is used to state something considered optional.

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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 normally provides the steel with excellent corrosion protection. The corrosion protection is the result of the highly alkaline Portland cement that allows a stable, corrosion-mitigating passive oxide film to form and be maintained on the surface of the encased steel. If the film does not form, or is weakened or destroyed so that it does not protect the steel, corrosion can occur. The protective oxide film does not form or is destroyed if (1) excessive amounts of chloride or other aggressive ions are present, (2) alkalinity is lost by reaction with aggressive gases, or (3) the concrete does not fully encase the steel.

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, where the electric current is electron flow; and an electrolyte (concrete), where the electric current is ion flow in an aqueous medium. The anodic and cathodic areas occur as a result of coupling dissimilar metals or exposure to differential environmental conditions. If any one of the four elements of the electrochemical cell is eliminated, corrosion can be prevented.

1.2 Cathodic Protection

1.2.1 The basic principles of corrosion can be used to understand the theory of cathodic protection. Cathodic protection is defined as a technique to reduce the corrosion of a metal surface by making that surface the cathode of an electrochemical cell.

1.2.2 Cathodic protection is a proven technique for controlling corrosion of steel in existing chloride-contaminated concrete structures. However, cathodic protection will neither replace lost steel nor return corroded reinforcement to its original cross-sectional area and strength. There may be areas of the reinforced concrete structure that appear sound by traditional inspection techniques that are, in fact, corroding and experiencing corrosion-related tensile stress near the rupture levels. Such distressed areas may crack, spall, or delaminate subsequent to the application of cathodic protection.

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 International as a Corrosion Specialist or certified as a Cathodic Protection Specialist. The person's professional experience should include suitable experience in cathodic protection of reinforced concrete structures. Under certain circumstances, a cathodic protection system may either become a structural component or significantly affect the serviceability and structural performance of a reinforced concrete structure; therefore, review of such impact by the cathodic protection system should be made by a qualified registered Structural Engineer or the equivalent.

1.3.2 The guidelines presented here are limited to impressed current cathodic protection systems for new or existing atmospherically exposed reinforced concrete and are not applicable to prestressed concrete.

Section 2: Definitions

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

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

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.

Design Specifications: A set of documents that, in aggregate, form the nucleus for well-founded, understandable, and equitable contract documents. These documents include written specifications and drawings.

Drying Effect: Migration of water molecules away from the anode as a result of current flow.

Electrical Continuity: A closed circuit (unbroken electrical path) between metal components under consideration.

Electrical Isolation: The condition of being electrically separated from other metallic structures or the environment.