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This Technical Committee Report has been prepared by NACE International Task Group (TG) 297,[*] "Direct Current Operated Rail Transit Stray Current Mitigation."

Direct Current Operated Rail Transit Stray Current Mitigation

Foreword

Corrosion is a well-known electrochemical process that may be caused by the pickup and subsequent discharge into the earth of stray direct current (DC) from an underground metallic structure. Underground metallic structures can become part of the earth return for a DC rail transit system when the earth acts as a parallel path to the rails; the metallic structures are then subject to corrosion. The first electric railways in the U.S. were placed into operation during the latter half of the nineteenth century. Very early in the development of these systems, the running rails were used as conductors for returning traction current to the power source. Because most of these systems were street railways or trolleys, the areas in which the railways were built were also the areas most likely to have underground metallic structures, especially piping. It is reported that corrosion of underground metallic structures was attributed to streetcar return currents as early as 1891. Around 1900, corrosion of underground metallic structures from all causes was the topic of much research.

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All DC traction systems using rail return of traction current have a level of leakage that is dependent on both design and operating factors affecting the efficiency of the rail return path. This current leakage is known as stray current. Stray current can create safety hazards and have serious effects on utility structures and the community at large.

The purpose of this report is to present information on rail transit stray current as it concerns transit and utility engineers. The report is not a detailed text or "cookbook," but rather a report that gives guidance on the mitigation of transit system stray current.

This technical committee report was originally prepared by NACE Task Group T-10B-3, "Stray DC Traction Current Problems," a component of Unit Committee T-10B, "Interference Problems," and was published by Group Committee T-10, "Underground Corrosion Control," in 1989. It was revised in 2014 by Task Group (TG) 297, "Direct Current (DC) Operated Rail Transit and Mine Railroad Stray Current Mitigation—Review Report 10B189." The sections of this report on mine railroad stray current have been removed from the title and are included as Appendix A. This TG is administered by Specific Technology Group (STG) 05, "Cathodic/Anodic Protection," and is sponsored by STG 03, "Coatings and Linings, Protective—Immersion and Buried Service," and STG 35, "Pipelines, Tanks, and Well Casings." This report is issued under the auspices of STG 05.

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Introduction

In the interest of public safety, transit system operators have an obligation to cooperate willingly with utility operators in the mitigation of stray current created by transit operations and assist the utility corrosion engineer promptly in mitigating the adverse effects of these stray currents when these effects are properly demonstrated. Generally, all parties are represented on local corrosion control coordinating committees (see the sections titled "New Transit Systems" and "New Utility Systems") and fully cooperate with each other in sharing information about the operation of their respective systems.

Transit operators are normally aware of the technical and economic corrosion control requirements of the utilities and other owners and the laws and regulations under which they must operate. Likewise, utility operators, accustomed to controlling corrosion from older transit systems with drainage bonds, recognize the advances that have been made in stray current

control through the improved design and maintenance of the modern rail system. Installation of bonds to modern rail systems negates the benefits of corrosion mitigation measures designed into the rail systems.

If a significant stray current problem develops, the utility and transit engineers typically work together to attempt to mitigate the problem. To protect their own and neighboring structures, rail operators have an obligation to maintain the rail system in such a manner that does not compromise the built-in stray current control. In this report, utility operator refers to the owner or operator of any underground utility structure.

Definitions

Bus: A bar, usually made of copper, to which several electrical cables are connected.

Cathodic Corrosion: Corrosion of a metal when it is a cathode, usually caused by the reaction of an amphoteric metal with the alkaline products of electrolysis.

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

Cell: See *Electrochemical Cell.*

Correlation Testing: Testing involving simultaneous reading of voltages and current on structures affected by stray current.

Corrosion: The deterioration of a material, usually a metal, that results from a chemical or electrochemical reaction with its environment.

Corrosion Potential: (represented by the symbol E_{corr}) The potential of a corroding surface in an electrolyte measured under open-circuit conditions relative to a reference electrode. (Also known as *Electrochemical Corrosion Potential, Free Corrosion Potential, Open-Circuit Potential.*)

Depolarization: The removal of factors resisting the current flow in an electrochemical cell. (See *Polarization.*)

Disbondment: The loss of adhesion between a coating and the substrate.

Drainage: Conduction of electric current from an underground or submerged metallic structure by means of a metallic conductor.

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

Electrochemical Cell: A system consisting of an anode and a cathode immersed in an electrolyte so as to create an electrical circuit. The anode and cathode may be different metals or dissimilar areas on the same metal surface.

Electrode: A material that conducts electrons; is used to establish contact with an electrolyte and through which current is transferred to or from an electrolyte.

Electrolysis: Production of chemical changes of the electrolyte by the current flowing through an electrochemical cell.

Electrolyte: A chemical substance containing ions that migrate in an electric field.

Environment: The surroundings or conditions (physical, chemical, mechanical) in which a material exists.

Environmental Cracking: Environmental cracking refers to a brittle fracture of a typical ductile material where the environment's corrosive effect is the actual causing agent.

Exposure: Stray current discharge from the surface of a structure.

Film: A thin, not necessarily visible, layer of material.

Galvanic Anode: A metal that provides sacrificial protection to another metal that is more noble when electrically coupled in an electrolyte. This type of anode is the electron source in one type of cathodic protection.

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