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Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems

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Foreword

This standard practice presents guidelines and procedures for use during design, construction, operation, and maintenance of metallic structures and corrosion control systems used to mitigate the effects of lightning and alternating current (AC) power transmission systems. This standard is not intended to supersede or replace existing electrical safety standards. As shared right-of-way and utility corridor practices become more common, AC influence on adjacent metallic structures has greater significance, and personnel safety becomes of greater concern. This standard addresses problems primarily caused by proximity of metallic structures to AC-powered transmission systems.

The hazards of lightning and AC effects on aboveground pipelines, while strung along the right-of-way prior to installation in the ground, are of particular importance to pipeline construction crews. The effects of AC power lines on buried pipelines are of particular concern to operators of aboveground appurtenances and cathodic protection (CP) testers, CP designers, safety engineers, as well as maintenance personnel working on the pipeline.

Some controversy arose in the 1995 issue of this standard regarding the shock hazard stated in Section 5, Paragraph 5.2.1.1 and elsewhere in this standard. The reason for a more conservative value is that early work by George Bodier[1] at Columbia University and by other investigators has shown that the average hand-to-hand or hand-to-foot resistance for an adult male human body can range between 600 ohms and 10,000 ohms. A reasonable safe value for the purpose of estimating body currents is 1,500 ohms hand-to-hand or hand-to-foot. In other work by C.F. Dalziel[2] on muscular contraction, the inability to release contact occurs in the range of 6 to 20 mA for adult males. Ten mA hand-to-hand or hand-to-foot is generally established as the absolute maximum safe let-go current. Conservative design uses an even lower value. Fifteen volts of AC impressed across a 1,500 ohm load would yield a current flow of 10 mA; thus, the criterion within this standard is set at 15 volts. Prudent design would suggest an even lower value under certain circumstances.

Many are now concerned with AC corrosion on buried pipelines adjacent to or near overhead electric transmission towers. This subject is not quite fully understood, nor is there an industry consensus on this subject. There are reported incidents of AC corrosion on buried pipelines under specific conditions, and there are also many case histories of pipelines operating under the influence of induced AC for many years without any reports of AC corrosion. The members of NACE Task Group (TG) 025 agreed that criteria for AC corrosion control should not be included in this standard. However, the mitigation measures implemented for safety and system protection, as outlined in this standard, may also be used for AC corrosion control.

This standard was originally published in July 1977 by Unit Committee T-10B on Interference Problems and was technically revised in 1983 and 1995, and reaffirmed in 2000 by T-10B. NACE continues to recognize the need for a standard on this subject. Future development and field experience should provide additional information, procedures, and devices for Specific Technology Group (STG) 05, "Cathodic/Anodic Protection," to consider in future revisions of this standard. This standard was revised in 2007 and 2014 by TG 025, "Alternating Current (AC) Power Systems, Adjacent: Corrosion Control and Related Safety Procedures to Mitigate the Effects." It is sponsored by STG 03, "Coatings and Linings, Protective—Immersion and Buried Service," and STG 35, "Pipelines, Tanks, and Well Casings." This standard is issued by NACE under the auspices of STG 05.

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.

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Section 1: General

1.1 This standard presents acknowledged practices for the mitigation of AC and lightning effects on metallic structures and corrosion control systems.

1.2 This standard covers some of the basic procedures for determining the level of AC influence and lightning effects to which an existing metallic structure may be subjected and outlines design, installation, maintenance, and testing procedures for CP systems on structures subject to AC influence, primarily caused by proximity of metallic structures to AC power transmission systems. However, this standard is not intended to be a design guide or a "how-to" engineering manual to perform AC interference studies or mitigation designs.

1.3 This standard does not designate procedures for any specific situation. The provisions of this standard should be applied under the direction of competent persons, who, by reason of knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, are qualified to engage in the practice of corrosion control on metallic structures. Such persons may be registered professional engineers or persons recognized as being qualified and certified as corrosion specialists by NACE, if their professional activities include suitable experience in corrosion control on metallic structures and AC interference and mitigation.

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

Section 2: Definitions

2.1 Definitions presented in this standard pertain to the application of this standard only. Reference should be made to other industry standards when appropriate.

AC Exposure: Alternating voltages and currents induced on a structure because of the AC power system.

AC Power Structures: The structures associated with AC power systems.

AC Power System: The components associated with the generation, transmission, and distribution of AC.

Affected Structure: Pipes, cables, conduits, or other metallic structures exposed to the effects of AC or lightning.

Bond: A low-impedance connection (usually metallic) provided for electrical continuity.

Breakdown Voltage: A voltage in excess of the rated voltage that causes the destruction of a barrier film, coating, or other electrically isolating material.

Capacitive Coupling: The influence of two or more circuits upon one another, through a dielectric medium such as air, by means of the electric field acting between them.

Circular Mil: A unit of area of round wire or cable equal to the square of the diameter in mils (1 mil = 0.0254 mm = 25.4 µm).

Coating Stress Voltage: Potential difference between the metallic surface of a coated structure and the earth in contact with the outer surface of the coating.

Coupling: The association of two or more circuits or systems in such a way that energy may be transferred from one to another.

Dead-Front Construction: A type of construction in which the energized components are recessed or covered to preclude the possibility of accidental contact with elements having electrical potential.

Electric Field: One of the elementary energy fields in nature. It occurs in the vicinity of an electrically charged body.

Electric Potential: The voltage between a given point and a remote reference point.