NACE INTERNATIONAL
THE CORROSION SOCIETY

NACE Standard RP0274-98
Item No. 21010

Standard
Recommended Practice

High-Voltage Electrical Inspection of Pipeline Coatings

This NACE International standard represents a consensus of those individual members who have reviewed this document, its scope, and provisions. Its acceptance does not in any respect preclude anyone, whether he has adopted the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not in conformance with this standard. Nothing contained in this NACE International standard is to be construed as granting any right, by implication or otherwise, to manufacture, sell, or use in connection with any method, apparatus, or product covered by Letters Patent, or as indemnifying or protecting anyone against liability for infringement of Letters Patent. This standard represents minimum requirements and should in no way be interpreted as a restriction on the use of better procedures or materials. Neither is this standard intended to apply in all cases relating to the subject. Unpredictable circumstances may negate the usefulness of this standard in specific instances. NACE International assumes no responsibility for the interpretation or use of this standard by other parties and accepts responsibility for only those official NACE International interpretations issued by NACE International in accordance with its governing procedures and policies which preclude the issuance of interpretations by individual volunteers.

Users of this NACE International standard are responsible for reviewing appropriate health, safety, environmental, and regulatory documents and for determining their applicability in relation to this standard prior to its use. This NACE International standard may not necessarily address all potential health and safety problems or environmental hazards associated with the use of materials, equipment, and/or operations detailed or referred to within this standard. Users of this NACE International standard are also responsible for establishing appropriate health, safety, and environmental protection practices, in consultation with appropriate regulatory authorities if necessary, to achieve compliance with any existing applicable regulatory requirements prior to the use of this standard.

CAUTIONARY NOTICE: NACE International standards are subject to periodic review, and may be revised or withdrawn at any time without prior notice. NACE International requires that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of initial publication. The user is cautioned to obtain the latest edition. Purchasers of NACE International standards may receive current information on all standards and other NACE International publications by contacting the NACE International Membership Services Department, P.O. Box 218340, Houston, Texas 77218-8340 (telephone +1 [281]228-6200).

Reaffirmed 1993, 1998-25-03
Approved 1974-08
NACE International
P.O. Box 218340
Houston, Texas 77218-8340
+1 (281) 228-6200

ISBN 1-57590-064-5

Foreword

Detection and correction of defects in protective coatings are important factors in an effective corrosion-control program. High-voltage electrical inspection of pipeline coatings is one commonly used method of detecting such defects. Before the first issuance of this standard recommended practice, there had not been a national standard for electrical inspection of pipeline coatings other than AWWA[1] Standard C 203-66,[2] Section 3.13, which is applicable to coal-tar coatings only. Several specifications have been written by operating companies for high-voltage electrical inspection of protective coatings, but these apply only to specific coatings.

Adherence to the principles of this standard shall improve holiday detection of pipeline coatings. This standard is intended to be used by personnel in pipeline operating companies, pipeline contractors, pipeline inspection services, and pipeline coating mills.

This standard was originally prepared in 1974 by NACE International Task Group T-10D-9 on Coating Inspection and Work Group T-10D-9a on Electrical Inspection, components of Unit Committee T-10D on Protective Coating Systems. It was reaffirmed with editorial revisions in 1993 and 1998. This standard was developed through the joint efforts of representatives of coating manufacturers, coating applicators, holiday detector manufacturers, corrosion specialists, and other personnel concerned with the construction of underground pipeline facilities. This standard is issued by NACE International under the auspices of Group Committee T-10 on Underground Corrosion Control.

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, 3rd ed., Paragraph 8.4.1.8. *Shall* and *must* are used to state mandatory requirements. *Should* is used to state that which is considered good and is recommended but is not absolutely mandatory. *May* is used to state that which is considered optional.

[1] American Water Works Association (AWWA), 6666 W. Quincy Avenue, Denver, CO 80235.

[2] AWWA C 203-66 (latest revision), "Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied" (Denver, CO: AWWA).

NACE International Standard Recommended Practice

High-Voltage Electrical Inspection of Pipeline Coatings

Contents

Section 1: General

1.1 Electrical inspection (holiday detection) is a test of the continuity of a protective coating. This type of inspection does not provide information concerning coating resistance, bond, physical characteristics, or the overall quality of the coating, nor is it intended to do so. It detects bubble or blister-type voids, cracks, thin spots, and foreign inclusions or contaminants in the coating that are of such size, number, or conductivity as to lower the electrical resistance or dielectric strength of the coating significantly.

1.2 Use of a holiday detector should be at the discretion of the coating inspector. An initial holiday inspection, performed as soon after the application of the coating as practicable, serves to check the materials and the application procedures. A final coating inspection, performed before lowering-in operations, will disclose any defect or damage (except disbonding) that has occurred during the construction period.

1.3 This standard presents acknowledged techniques for the use of holiday detectors currently used on pipeline coatings and presents a table of recommended voltages for various coating thicknesses. The recommendations contained herein do not apply to thin-film coatings (i.e., coating materials usually applied by a fusion-bonding process). Thin-film pipeline coatings are generally applied to a dry-film thickness less than 0.5 mm (20 mils).

Section 2: Definitions

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

Holiday detector: A device for locating discontinuities in a coating.

Pulse-type detector: A type of holiday detector which supplies a high-voltage pulse of very short duration (e.g., a pulse duration of 0.0002 seconds at a rate of 30 pulses per second).

Section 3: Testing Voltages

3.1 All testing voltages in this standard refer to DC or peak AC values.

3.2 The minimum testing voltage for a particular coating thickness shall be within 20% of the value determined from one of the following formulas, or as shown in Table 1:

$$\text{Testing Voltage} = 7{,}900\sqrt{T}$$

where T = average coating thickness in mm;

$$\text{Testing Voltage} = 1{,}250\sqrt{T}$$

where T = average coating thickness in mils.

3.3 The testing voltage should be verified periodically as described in Section 7.

3.4 If a nonperforated outerwrap is applied over the primary coating, the thickness and dielectric strength of the outerwrap material must be considered when determining or specifying the testing voltage. Certain outerwrap material may have electrical insulating properties equal to or greater than those of the coating.

TABLE 1
Minimum Testing Voltage for Various Coating Thicknesses[A]

Coating Thickness			Testing Voltage
(mm)	($^1/_{32}$ in.)	(mils)	
0.51	0.64	20	6,000
0.79	1.0	31	7,000
1.6	2.0	62	10,000
2.4	3.0	94	12,000
3.2	4.0	125	14,000
4.0	5.0	156	16,000
4.8	6.0	188	17,000
13	16	500	28,000
16	20	625	31,000
19	24	750	34,000

[A] Thin-film coatings are not covered by this standard.

Section 4: Grounding

4.1 Grounding both the pipe metal and the ground terminal of the holiday detector is necessary to complete the circuit. This should be done through a direct-wire connection or by connecting both to earth as a common ground. If not in contact with the earth, the pipe metal should be connected to the earth by a driven ground rod or metal pin. In most cases, the holiday detector can be effectively grounded by the use of a flexible, bare wire of approximately 9 m (30 ft) in length that is connected to the ground terminal of the holiday detector and trailed along the earth.

4.2 In arid, sandy, or rocky areas of high electrical resistivity, a direct-wire connection between the pipe metal and detector ground terminal shall be maintained.

Section 5: Electrode

5.1 The electrode of the holiday detector is the means by which the electrical testing potential is applied to the surface of the coating.

5.2 The construction of the electrode shall be such that for each 1,000 volts of testing potential there will be no more than 0.25 mm (10 mils) lateral distance between the points where the electrode contacts the coated surface.

5.3 The electrode shall maintain contact with the coated surface at all times.

5.4 The electrode shall not adversely distort the coating.

5.5 To prevent causing a decrease in the coating thickness, the electrode should not be moved back and forth excessively on a soft coating.

5.6 The electrode should always be in motion when the testing voltage is applied.

Section 6: Electrode Travel Speed

6.1 Pulse-type detector: The pulse rate should be considered in the determination of the electrode travel speed over the coated surface. Higher pulse rates allow a higher speed of travel.

6.2 Nonpulse-type detector: The electrode travel speed is limited by the mechanics of application and the response time of the detector.

6.3 The proper electrode travel speed for a particular set of conditions should be determined by making holidays in the coating and attempting to detect the holidays at various electrode travel speeds.

Section 7: Voltage Measurements

7.1 Voltage measurements of nonpulse-type detectors shall be made with a high-resistance kilovolt meter, or with a high-resistance voltage divider in conjunction with a high-resistance voltmeter.

7.2 Voltage measurements of pulse-type detectors shall be made with a high-impedance peak-reading kilovolt meter or with a high-impedance capacitance or resistance voltage divider and suitable indicator, such as an oscilloscope or voltmeter.

7.3 The electrode must be in the normal operating position on the coated surface in a holiday-free area.

7.4 All components must be properly grounded.

7.5 The voltage shall be measured between the electrode and the pipe.

7.6 In the absence of a suitable means of voltage measurement, the operation of the holiday detector (but not necessarily the proper testing voltage) should be determined by making a small holiday in the thickest portion of the coating to be inspected. The holiday-detector voltage shall then be adjusted to locate this holiday at normal electrode travel speeds (see Paragraph 6.3).

Section 8: Condition of Coating Surface

8.1 Excessive moisture or any electrically conductive material in or on the surface of the coating system can cause appreciable leakage currents, which may lower the effective testing voltage or cause erroneous holiday indication. Drying and cleaning of the coated surface may be necessary (see Section 9).

8.2 Any surface condition that causes an increase in the distance between the electrode and the metal must be corrected (see Paragraphs 5.3 and 9.2).

Section 9: Care of Equipment

9.1 All parts of the holiday detector shall be kept clean and free of moisture at all times.

9.2 The electrode shall be kept free of coating material and in such mechanical condition as to maintain contact with the coated surface at all times.

9.3 All electrical contacts shall be kept clean and free of corrosion.

9.4 Trailing ground wire shall be kept free of coating material and in such condition as to maintain contact with the earth. The ground wire shall be of sufficient length to assure proper grounding (see Paragraph 4.1).

9.5 Batteries shall be maintained in accordance with manufacturer's recommendations.

9.6 Test-meter batteries and zero setting shall be maintained in accordance with the manufacturer's specifications.