

Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems

©2022 Association for Materials Protection and Performance (AMPP). All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise) without the prior written permission of AMPP.

Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems

This AMPP 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 or she has adopted this standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not in conformance with this standard. Nothing contained in this AMPP 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. AMPP assumes no responsibility for the interpretation or use of this standard by other parties and accepts responsibility for only those official AMPP interpretations issued by AMPP in accordance with its governing procedures and policies which preclude the issuance of interpretations by individual volunteers.

Users of this AMPP 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 AMPP 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 AMPP 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: AMPP standards are subject to periodic review and may be revised or withdrawn at any time in accordance with AMPP technical committee procedures. AMPP requires that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of initial publication and subsequently from the date of each reaffirmation or revision. The user is cautioned to obtain the latest edition. Purchasers of AMPP standards may receive current information on all standards and other AMPP/NACE/SSPC publications by contacting AMPP Customer Support, 15835 Park Ten Place, Houston, Texas 77057, 4-5145 (Tel: +1 281-228-6200, email: customersupport@ampp.org).

Document History

2022-01-14: Revised by AMPP Standards Committee (SC) 15, Pipelines & Tanks.

2018-09-21: Revised by Task Group (TG) 020, "Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems."

2012-06-23: Revised by TG 020, "Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems."

2002-04-11: Reaffirmed by TG 020, "Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems."

1997-12-22: Approved as TM0497 by T-10A-3, "Test Methods and Measurement Techniques Related to Cathodic Protection Criteria."

AMPP values your input. To provide feedback on this standard, please contact: standards@ampp.org

NACE TM0497-2022

©2022 Association for Materials Protection and Performance (AMPP). All rights reserved.

Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems

Document History	2
Foreword, Scope, and Rationale	4
Section 1 General	5
Section 2 Definitions and Acronyms	5
Section 3 Safety Considerations	9
Section 4 Instrumentation and Measurement Guidelines	10
Section 5 Structure-to-Electrolyte Potential Measurements	11
Section 6 Causes of Inaccurate Measurements	16
Section 7 Voltage Drops Other Than Across the Structure Metal/Electrolyte Interface	18
Section 8 Test Method 1—Structure-to-Electrolyte Potential of Metallic Piping with Cathodic Protection Applied	20
Section 9 Test Method 2—Polarized Structure-to-Electrolyte Potential of Metallic Piping	22
Section 10 Test Method 3—Cathodic Polarization of Metallic Piping	24
References	29
Bibliography	30
Appendix A Reference Electrodes (Mandatory)	32
Appendix B DC Cell-to-Cell Surface Potential Gradient Surveys (Nonmandatory)	34
Appendix C Using Coupons to Determine Adequacy of Cathodic Protection (Nonmandatory)	39
Appendix D Dynamic Stray Current (Nonmandatory)	41
Bibliography	44
Appendix E AC Corrosion: Testing, Decouplers and Interrupted Surveys (Nonmandatory)	45
Bibliography	46
Appendix F Evaluation of Potentials Considering Adequacy of Current Interruption (Nonmandatory)	47
Figures	
Figure 1(a) Instrument Connection (Polarity Option 1) Recommended	12
Figure 1(b) Instrument Connection (Polarity Option 2)	13
Figures 2(a) and (b) Structure-to-Electrolyte Potential Correction due to Pipe Current	19
Figure 3 Polarization Delay	26
Figure 4 Polarization Formation	28
Figure B1 Pot-Spot Survey	36
Figure B2 Side Drain Survey	37
Figure F1 Comparison of Potential versus Current Density from Research Studies	48
Tables	
Table A1 Common Reference Electrodes and Their Potentials and Temperature Coefficients	32
Table F1 Payer Research 2002 Average Test Results	47
Table F2 Husock Research 1980 Average Test Results	48

Foreword

This standard contains instrumentation and general measurement guidelines. It includes methods for voltage drop considerations when structure-to-electrolyte potential measurements are made and provides guidance to minimize incorrect data from being collected and used.

The measurement techniques provided in this standard were compiled from information submitted by committee members and others with expertise on the subject. Variations or other techniques not included may be equally effective. The complexity and diversity of environmental conditions may require the use of other techniques.

Appendix A (mandatory) contains information on the common types, use, and maintenance of reference electrodes. Appendix B (nonmandatory) contains information for direct current (DC) Cell-to-Cell Surface Potential Gradient Surveys. Appendix C (nonmandatory) contains information regarding the use of coupons to evaluate cathodic protection (CP). Appendix D (nonmandatory) contains information regarding Dynamic Stray Current testing. Appendix E (nonmandatory) contains information regarding AC Corrosion testing and interrupted surveys on pipelines with DC Decouplers and Appendix F (nonmandatory) contains information regarding Evaluation of Potentials Considering Adequacy of Current Interruption. As there is ongoing research into the nonmandatory procedures, the tester is advised to keep abreast of any revisions or improvements.

Scope

This NACE International standard test method provides descriptions of the measurement techniques and cautionary measures most commonly used on underground and submerged piping other than offshore piping to determine whether one or more selected criterion has been met at a representative test site, with consideration for special conditions. These methods are also applicable to many other underground or submerged metallic structures. Descriptions of measurement techniques and cautionary measures used on offshore pipelines and structures can be found in NACE SP0115/ISO 15589-2 for offshore pipelines and SP0176 for offshore structures.^{1,2} This standard includes only those measurement techniques that relate to the criteria or special conditions, such as a net protective current and alternating current (AC) corrosion testing.³

The measurement techniques described require that the measurements be made in the field. Because the measurements are obtained under widely varying circumstances of field conditions and pipeline design, this standard is not as prescriptive as those NACE standard test methods that use laboratory measurements. Instead, this standard gives the user latitude to make testing decisions in the field based on the technical facts available.

Rationale

This standard is intended for use by corrosion control personnel concerned with the corrosion of underground or submerged piping systems that transport oil, gas, water, or other fluids. This revision dated 2022-03-01 added definition and discussion of DC Decouplers primarily in Appendix E.

In AMPP standards, the terms *shall* and *must* are used to state requirements and are considered mandatory. The term *should* is used to state something that is recommended, but is not considered mandatory. The term *may* is used to state something considered optional.