

Consequences of Coating Failures as Related to Interaction with Cathodic Protection

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ABSTRACT

The purpose of this NACE International technical report is to provide basic information regarding the mechanisms involved with cathodic protection (CP) shielding for external coatings applied to carbon steel pipelines, and the manner in which the breakdown of coating systems may or may not contribute to CP shielding. It is intended to be a basic reference from which the tendency of a coating system to fail and shield CP may be understood on a conceptual basis. Non-corrosion-related pipeline protection systems, including concrete weight coating, polyethylene encasement, insulation, and mechanical pipeline protection systems, are outside the scope of this report. End users of this report may include pipeline designers, corrosion engineers, integrity management specialists, regulators, CP service providers, coating suppliers, coating service providers, equipment suppliers, and pipeline/facility owners.

KEYWORDS

Asphalt enamel coatings, barrier coatings, cathodic disbondment, cathodic protection (CP), coal tar enamel coatings, coatings, corrosion control system, external coatings, external corrosion direct assessment fusion-bonded epoxy coatings, galvanizing, gas transmission pipelines, heat shrink sleeve (HSS) systems, inhibitive coatings, integrity management of pipelines, internal corrosion direct assessment, NACE SP0169, NACE SP0185, Ohm's Law, petrolatum tape coatings, pipelines, pipeline corrosion, polyurethane, sacrificial coatings, shielding, stress corrosion cracking, TG 523, thermal spray aluminum (TSA), TR21447, ultrasonic testing (UT), zinc-chromate, 49 CFR Part 192.461.

Foreword

Coatings and cathodic protection (CP) are designed to work as a complementary corrosion control system for pipelines. As pipeline infrastructure ages, CP systems are expected to be maintained (in accordance with NACE SP0169,⁽¹⁾ but protective coating systems tend to physically and chemically degrade. The manner in which these coatings degrade is critical to maintaining the integrity of the pipeline, in particular the possibility of CP shielding. Coating damage or degradation leading to CP shielding can result in corrosion, stress corrosion cracking, or both on an operating pipeline.

NOTE: NACE SP0169 states that CP shielding can be caused by disbonded coatings, thermal insulation, loose wrappers, high-resistivity rock or soils, metal structures, or pipelines that are close to the structure being protected, and other man-made materials partially or completely surrounding the pipeline. The focus of this report is only on the first cause: shielding resulting from disbonded coatings.

Coatings and CP, historically, have proven to be highly effective for a large majority of operating pipelines. CP shielding problems are rare and usually considered an outlier in terms of occurrence. A report issued by the U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA),⁽¹⁾⁽²⁾ illustrated that over a 20-year period from 1988-2008, the number of incidents as a result of pipeline corrosion remained relatively constant and has not been adversely affected by aging of the infrastructure, which attests to the industry efforts in corrosion control.

The purpose of this report is to provide basic information regarding the mechanisms involved with CP shielding for external coatings applied to carbon steel pipelines, and the manner in which the breakdown of coating systems may or may not contribute to CP shielding. It is intended to be a basic reference from which the tendency of a coating system to fail and shield CP may be understood on a conceptual basis. Non-corrosion related in-line protection systems – including concrete weight coating, polyethylene (PE) encasement, insulation, and mechanical in-line protection systems – are outside the scope of this report.

End users of this report may include pipeline designers, corrosion engineers, integrity management specialists, regulators, CP service providers, coating suppliers, coating service providers, equipment suppliers, and pipeline/facility owners.

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NACE technical committee reports are intended to convey technical information or state-of-the-art knowledge regarding corrosion. In many cases, they discuss specific applications of corrosion mitigation technology, whether considered successful or not. Statements used to convey this information are factual and are provided to the reader as input and guidance for consideration when applying this technology in the future. However, these statements are not intended to be recommendations for general application of this technology and must not be construed as such.

⁽¹⁾ Pipeline and Hazardous Materials Safety Administration (PHMSA), U.S. Department of Transportation, 1200 New Jersey Avenue, SE, Washington, DC 20590.

Consequences of Coating Failures as Related to Interaction with Cathodic Protection

Introduction.....	4
Failure Mechanisms of Coatings and CP Interactions.....	8
Implications for Carbon Steel Pipe	12
Integrity Management of Pipelines with Disbonded Coatings	13
Risk Factors with Application Method and Quality Control	17
Summary/Conclusions.....	20
References	20
FIGURE and TABLES	
Figure 1: Historical Use of Pipeline Coatings	7
Table 1: Specific Coating Failure Modes	9
Table 2: Common Failure Modes for Different Coating Types.....	11