Technical News Bulletin

The National Institutes of Health | Division of Technical Resources | Office of Research Facilities

Issue 161
June
2026

Galvanic Corrosion in Design and Construction

Introduction

Galvanic corrosion occurs when two dissimilar metals are electrically connected in the presence of an electrolyte such as water, condensation, or salts. The less noble metal acts as the anode and corrodes preferentially, while the more noble metal is protected. The driving force for galvanic corrosion increases with the potential difference between the metals in the galvanic series. Eliminating any one of the three required conditions disrupts the corrosion process and forms the basis of corrosion control strategies.

The American Institute of Steel Construction (AISC) provides guidance on isolating dissimilar metals and avoiding direct contact between materials with high galvanic potential (e.g., carbon steel/aluminum, copper/aluminum, etc.) in wet environments by using nonconductive gaskets, shims, sleeves, coatings, and sealants. This is especially important in environments exposed to exterior moisture, multilevel parking structures, and rooftop mechanical support framing.

In complex institutional environments, the following risks are amplified: carbon steel framing fastened with stainless hardware, aluminum cladding attached to steel structures across mechanical rooms, roof assemblies, and building exteriors. Corrosion compatibility must be evaluated with the same engineering rigor applied to structural loads.

Engineering Standards and Study Requirements

When galvanic corrosion is identified, a professional engineering assessment is required in accordance with ASTM and the Association for Materials Protection and Performance (AMPP; formerly NACE) standards. Key applicable references include ASTM G82 (galvanic series prediction), ASTM G71 (galvanic corrosion testing), and MIL-STD-889D (federal dissimilar metals compatibility). The assessment shall include visual condition documentation, materials identification via as-builts or x-ray fluorescence (XRF) spectroscopy, galvanic potential evaluation against ASTM G82 data (a small anode coupled to a large cathode significantly increases corrosion current density), and structural integrity evaluation of load-bearing elements.

Risk Assessment Methodology

Risk is defined as the probability of failure multiplied by the consequence of failure. Probability is driven by five factors: galvanic potential difference between coupled metals, anode-to-cathode area ratio, electrolyte conductivity, coating condition, and environmental aggressivity. Consequence is assessed across four dimensions: structural/safety impact, mission continuity, environmental release, and cost/schedule disruption.

Risk findings map to a four-tier response protocol: LOW (monitor and re-inspect within five years); MODERATE (Engineer-of-Record review and corrective action within two years); HIGH (licensed Professional Engineer [PE] or AMPP Corrosion Specialist assessment within 60 days); and CRITICAL (immediate assessment by a licensed PE, interim controls within 30 days, and full remediation within 12 months).

Mitigation follows this hierarchy:

- Eliminate the galvanic couple through compatible material selection. The use of similar metals is required wherever possible.
- Interrupt the electrical pathway with dielectric unions, isolation sleeves, or non-conductive gaskets.
- Apply barrier coatings where material substitution and electrical isolation are not fully achievable. Coatings require ongoing inspection and maintenance to remain effective.
- Deploy sacrificial anodes or impressed-current cathodic protection.

Potential Corrosion Example

A potential galvanic corrosion failure scenario that could occur at the NIH campus involves the premature failure of the galvanized carbon steel cold water piping months after installation due to the use of yellow brass ball valves. Brass is significantly more noble than the zinc coating on galvanized steel. Copper, the primary constituent of brass, sits far higher in the galvanic series than zinc, making the zinc coating the active anode. In a facility such as the Central Utility Plant, where persistent humidity from steam and water systems create a continuous electrolyte environment, this high-potential couple can strip the zinc coating rapidly and initiate corrosion of the underlying carbon steel well within the expected service life.

Such a failure could have significant operational consequences. Field material substitutions performed without a formal corrosion compatibility review represent a well-documented pathway for galvanic corrosion failures. To mitigate this risk, design submittals shall include explicit identification of base alloy compositions, and installed materials shall be verified against approved specifications.

Conclusion

Galvanic corrosion is predictable, preventable, and manageable when addressed at the design stage. The cost of proactive corrosion control measures, including compatible material selection and isolation hardware, is far lower than the cost of post-failure remediation. Where the use of dissimilar metals is unavoidable, designers and engineers shall select appropriate materials, coatings, and isolation methods to minimize galvanic corrosion and ensure long-term durability. A centralized Corrosion Finding Register is being maintained by the Technical Support Branch (TSB) to ensure every identified finding carries a risk classification, a required action date, and a verified resolution before closure. The Office of Research Facilities (ORF) will incorporate galvanic compatibility reviews into the forthcoming 2026 *Design Requirements Manual* (*DRM*) Chapter 5 revision, as well as into commissioning spot-check protocols and mandatory engineering evaluation. All projects will be required to comply with the established galvanic corrosion prevention requirements, including material compatibility reviews, dissimilar-metal isolation requirements, and documented engineering evaluations where galvanic exposure conditions exist.

References

1. ASTM International. ASTM G82 – Standard Guide for Development and Use of a Galvanic Series for Predicting Galvanic Corrosion Performance.
2. MIL-STD-889D Department of Defense Galvanic Compatibility of Electronically Conductive Materials.
3. ASTM G71 – Standard Guide for Conducting and Evaluating Galvanic Corrosion Tests in Electrolytes.
4. American Institute of Steel Construction (AISC). Steel Construction Manual, 15th Edition.
5. National Association of Corrosion Engineers (NACE). Corrosion Basics: An Introduction.