

Designation: NACE/ASTM G193 – 22



Standard Terminology and Acronyms Relating to Corrosion¹

This standard is issued under the fixed designation NACE/ASTM G193; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This terminology and acronyms standard covers and defines commonly used terms and acronyms in the field of corrosion. Related terms may be found in Terminologies **D16**, **D4538**, **G40**, or other ASTM terminology standards.

1.2 This terminology and acronyms standard is a result of an agreement between NACE International and ASTM International Committee G01 on Corrosion of Metals and may not reflect the opinions of other ASTM committees.

1.3 In this terminology and acronyms standard, brackets are used for directives that follow a definition and are obviously not part of it, such as, “[see XXX]” and “[also known as XXX].” Brackets can also indicate the field of application or context of the definition or acronym.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

D16 Terminology for Paint, Related Coatings, Materials, and Applications

D2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor (Withdrawn 2022)³

D4538 Terminology Relating to Protective Coating and Lining Work for Power Generation Facilities

E10 Test Method for Brinell Hardness of Metallic Materials

E18 Test Methods for Rockwell Hardness of Metallic Materials

E92 Test Methods for Vickers Hardness and Knoop Hardness of Metallic Materials

G40 Terminology Relating to Wear and Erosion

2.2 NACE Standards:²

NACE No. 1/SSPC-SP 5 White Metal Blast Cleaning

NACE No. 2/SSPC-SP 10 Near-White Metal Blast Cleaning

NACE No. 3/SSPC-SP 6 Commercial Blast Cleaning

NACE No. 4/SSPC-SP 7 Brush-Off Blast Cleaning

2.3 SSPC Surface Preparation Standards:⁴

SSPC-SP 1 Solvent Cleaning

SSPC-SP 2 Hand Tool Cleaning

SSPC-SP 3 Power Tool Cleaning

SSPC-SP 8 Pickling

2.4 ISO Standards:⁵

ISO 6506-1 Metallic materials -- Brinell hardness test -- Part 1: Test method

ISO 6507-1 Metallic materials -- Vickers hardness test -- Part 1: Test method

ISO 6508-1 Metallic materials -- Rockwell hardness test -- Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)

3. Terminology

3.1 Definitions:

abrasion resistance—the ability of a material to resist being worn away and to maintain its original appearance and structure when subjected to rubbing, scraping, or wear.

abrasive—a solid substance that, owing to its hardness, toughness, size, shape, consistency, or other properties, is suitable for grinding, cutting, roughening, polishing, or cleaning a surface by friction or high-velocity impact.

abrasive blast cleaning—cleaning and roughening of a surface produced by the high-velocity impact of an abrasive that is propelled by the discharge of pressurized fluid from a blast

¹ This terminology and acronyms standard is under the jurisdiction of NACE/ASTM Committee J01, Joint Committee on Corrosion, and is the direct responsibility of Subcommittee J01.02, Working Group on Terminology.

Current edition approved Aug. 1, 2022. Published October 2022. Originally approved in 2009. Last previous edition approved in 2021 as G193-21. DOI: 10.1520/G0193-22.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website. For NACE standards, visit the The Association for Materials Protection and Performance (AMPP) website, <https://www.ampp.org/ampp-nace-store>.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from The Association for Materials Protection and Performance (AMPP), 800 Trumbull Drive, Pittsburgh, PA 15205, <https://www.ampp.org/ampp-sspc-store>.

⁵ Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <https://www.iso.org>.

nozzle or by a mechanical device such as a centrifugal blasting wheel. [also referred to as **abrasive blasting**]

abrasive blasting—see **abrasive blast cleaning**.

accelerator—a chemical substance that increases the rate at which a chemical reaction (for example, curing) would otherwise occur.

AC impedance—see **electrochemical impedance**.

acrylic—type of resin polymerized from acrylic acid, methacrylic acid, esters of these acids, or acrylonitrile.

activator—a chemical substance that initiates a chemical reaction (for example, curing). Heat and radiation may also serve as activators for some chemical reactions.

active—(1) a state of a metal surface that is corroding without significant influence of reaction product. (2) the negative direction of electrode potential.

active-passive cell—an electrochemical cell in which the anode is a metal in the active state and the cathode is the same metal in the passive state.

adduct curing agent—a material that is formed by prereacting the curing agent with a portion of the resin component of the coating.

adhesion—the state in which two surfaces are held together by chemical interfacial forces, mechanical interlocking forces, or both.

aeration cell—see **differential aeration cell**.

aging—(1) the process of exposing materials to an environment for an interval of time. (2) change in metallurgical properties that generally occurs slowly at room temperature (natural aging) and more rapidly at higher temperature (artificial aging).

air drying—process by which an applied wet coat converts to a dry coating film by evaporation of solvent or reaction with oxygen as a result of simple exposure to air without intentional addition of heat or a curing agent.

airless spraying—process of spraying coating liquids using hydraulic pressure, not air pressure, to atomize.

alkyd—type of resin formed by the reaction of polyhydric alcohols and polybasic acids, part of which is derived from saturated or unsaturated oils or fats.

alligatoring—pronounced wide cracking over the surface of a coating, which has the appearance of alligator hide.

alloy steel—an iron-based alloy containing carbon (usually less than 2.5 mass percent), manganese (usually greater than 0.25 mass percent), and specified minimum quantities of one or more alloying elements other than manganese, silicon, and copper, but does not contain 10.5 mass percent or greater chromium.

alternate immersion—exposure to environmental cycles, each involving immersion in a fluid for a period of time followed by removal from that fluid for another period of time.

amphoteric metal—a metal that is susceptible to corrosion in both acidic and alkaline environments.

anaerobic—absence of air or free (molecular) oxygen.

anchor pattern—see **surface profile**.

anion—a negatively charged ion.

anneal—heat to and hold at a temperature appropriate for the specific material and then cool at a suitable rate, for such purposes as reducing hardness, improving machinability, or obtaining desired properties.

anode—the electrode of an electrochemical cell at which oxidation occurs. (Electrons flow away from the anode in the external circuit. It is usually the electrode where corrosion occurs and metal ions enter solution.)

anode cap—an electrical insulating material placed over the end of the anode at the lead wire connection.

anode corrosion efficiency—the ratio of the actual corrosion (mass loss) of an anode to the theoretical corrosion (mass loss) calculated from the quantity of electricity that has passed between the anode and cathode using Faraday's law.

anodic inhibitor—a corrosion inhibitor whose primary action is to reduce the rate of the anodic reaction, producing a positive shift in corrosion potential.

anodic polarization—(1) the change of electrode potential caused by an anodic current flowing across the electrode/electrolyte interface. (2) a forced noble (positive) shift in electrode potential. [See **polarization**.]

anodic protection—a technique to reduce the corrosion rate of a metal surface by polarizing that surface to a more oxidizing potential.

anodizing—an electrochemical oxidation process that converts the surface of a metal (such as aluminum or titanium) to an oxide coating.

anolyte—the electrolyte adjacent to the anode of an electrochemical cell.

antifouling—preventing fouling. [See **fouling**.]

atmospheric zone—the portion of a marine structure that extends upward from the splash zone and is exposed to sun, wind, water spray, and rain.

attenuation—electrical losses in a conductor caused by current flow in the conductor.

Auger electron spectroscopy—analytical technique in which the sample surface is irradiated with low-energy electrons and the energy spectrum of electrons emitted from the surface is measured.

austenite—the face-centered cubic crystalline phase of iron or iron-based alloys.

austenitic/ferritic stainless steel—see **duplex stainless steel**.

austenitizing—forming austenite by heating iron or iron-based alloys to a temperature in the transformation range (partial austenitizing) or above the transformation range (complete austenitizing).

auxiliary electrode—see **counter electrode**.

backfill—material placed in a hole to fill the space around the anodes, vent pipe, and buried components of a cathodic protection system.

Barcol hardness—a hardness value obtained by measuring the resistance of rubbers, plastics, or coatings to indentation by a steel impressor under spring load in accordance with Test Method **D2583**.

barrier coating—(1) a coating that has a high resistance to permeation of liquids and/or gases. (2) a coating that is applied over a previously coated surface to prevent damage to the underlying coating during subsequent handling.

barrier pigment—a pigment that impedes permeation through an organic coating solely by its physical presence [contrast with **corrosion-inhibitive pigment** and **sacrificial pigment**].

beach marks—the characteristic markings on the fracture surfaces produced by fatigue crack propagation. [also known as *arrest marks*, *clamshell marks*, and *conchoidal marks*]

beta curve—a plot of dynamic (fluctuating) interference current or related proportional voltage (ordinate) versus the corresponding structure-to-electrolyte potentials at a selected location on the affected structure (abscissa).

binder—the nonvolatile portion of the vehicle of a formulated coating material.

bituminous coating—an asphalt or coal-tar compound used to provide a protective coating for a surface.

blast angle—(1) the angle of the blast nozzle with reference to the surface during abrasive blast cleaning. (2) the angle of the abrasive particles propelled from a centrifugal blasting wheel with reference to the surface being abrasive blast cleaned.

blister—a dome-shaped projection on the surface of a coating resulting from the local loss of adhesion and lifting of the film from an underlying coat or from the base substrate.

blooming—see **blushing**.

blowdown—(1) the injection of air or water under high pressure through a tube to the anode area for the purpose of purging the annular space and possibly correcting high resistance caused by gas blockage. [cathodic protection use] (2) the process of discharging a significant portion of the aqueous solution in order to remove accumulated salts, deposits, and other impurities. [boiler or cooling water tower use]

blushing—whitening and loss of gloss of a coating, usually organic, caused by moisture. [also known as **blooming**]

bracelet anode—a galvanic anode with geometry suitable for direct attachment around the circumference of a pipeline. This may be a half-shell bracelet consisting of two semicircular sections or a segmented bracelet consisting of a large number of individual sections.

braze—(1) a bond produced as the result of heating an assembly to the brazing temperature greater than 450 °C [840 °F] and less than the solidus temperature of the base metal using a brazing filler metal distributed and retained between the closely fitted faying surfaces of the joint by capillary action. (2) the act of creating a braze.

breakdown potential—the least noble potential at which pitting or crevice corrosion, or both, will initiate and propagate in a specific environment.

Brinell hardness—hardness value, measured in accordance with ISO 6506-1 or Test Method **E10**, using a 1 mm to 10 mm diameter tungsten carbide ball and a force of approximately 9.807 N to 29.420 N (1 kgf to 3000 kgf).

brittle fracture—fracture that occurs with little or no plastic deformation of the material. [contrast with **ductile fracture**]

brush-off blast cleaned surface—an abrasive blast cleaned steel surface that is free of all visible contaminants and foreign matter but may have some tightly adherent mill scale, rust, or coating. [See NACE No. 4/SSPC-SP 7 for detailed specification.]

burnish—process of smoothing surfaces using frictional contact between the material and some other hard pieces of hard material (for example, hardened steel balls).

calcareous coating—a layer consisting of calcium carbonate and other salts deposited on the surface. When the surface is cathodically polarized as in cathodic protection, this layer is the result of the increased pH adjacent to the protected surface.

calcareous deposit—see **calcareous coating**.

carbon steel—alloy of carbon and iron containing up to 2 mass percent carbon and up to 1.65 mass percent manganese and residual quantities of other elements, except those intentionally added in specific quantities for deoxidation (usually silicon and/or aluminum).

carburizing—the absorption and diffusion of carbon in iron or an iron-based alloy in contact with a suitable carbonaceous environment at elevated temperature.

case hardening—hardening a ferrous alloy so that the outer portion, or case, is made substantially harder than the inner portion, or core. Typical processes are carburizing, cyaniding, carbonitriding, nitriding, induction hardening, and flame hardening.

casein paint—water-thinned paint with vehicle derived from milk.

cast iron—a generic term for a large family of cast ferrous alloys in which the carbon content exceeds the solubility of carbon in austenite at the eutectic temperature, or about 2

mass percent. Most cast irons also contain silicon, and may contain other alloying elements and impurities.

casting—(1) a component formed at or near its finished shape by the solidification of liquid material in a mold; (2) the creation of such a component.

catalyst—a chemical substance, usually present in small amounts relative to the reactants, that increases the rate at which a chemical reaction (for example, curing) would otherwise occur, but is not consumed in the reaction.

cathode—the electrode of an electrochemical cell at which reduction is the principal reaction. (Electrons flow toward the cathode in the external circuit.)

cathodic corrosion—corrosion of a metal when it is a cathode, usually caused by the reaction of an amphoteric metal with the alkaline products of electrolysis.

cathodic disbondment—the destruction of adhesion between a coating and the coated surface caused by products of a cathodic reaction.

cathodic inhibitor—a corrosion inhibitor whose primary action is to reduce the rate of the cathodic reaction, producing a negative shift in corrosion potential.

cathodic polarization—(1) the change of electrode potential caused by a cathodic current flowing across the electrode/electrolyte interface. (2) a forced active (negative) shift in electrode potential. [See **polarization**.]

cathodic protection—a technique to reduce the corrosion rate of a metal surface by making that surface the cathode of an electrochemical cell.

catholyte—the electrolyte adjacent to the cathode of an electrochemical cell.

cation—a positively charged ion.

caustic cracking—cracking of a metal or alloy under the combined action of tensile stress and corrosion in the presence of a strongly basic solution (for example, sodium hydroxide, potassium hydroxide).

caustic embrittlement—an obsolete term referring to **caustic cracking**.

cavitation—the formation and rapid collapse of cavities or bubbles of vapor or gas within a liquid resulting from mechanical or hydrodynamic forces.

cavitation-corrosion—the conjoint action of cavitation and corrosion.

cavitation damage—the degradation of a solid body resulting from its exposure to cavitation. (This may include loss of material, surface deformation, or changes in properties or appearance.)

cavitation-erosion—the conjoint action of cavitation and erosion.

cell—see **electrochemical cell**.

cementation—the introduction of one or more elements into the surface layer of a metal or alloy by diffusion at high temperature. (Examples of cementation include carburizing [introduction of carbon], nitriding [introduction of nitrogen], and chromizing [introduction of chromium].)

cementite—iron carbide (Fe_3C) when referred to as a microstructural constituent of steel.

chalking—the development of loose, removable powder (pigment) at the surface of an organic coating, usually caused by weathering.

checking—the development of slight breaks in a coating that do not penetrate to the underlying surface.

chemical conversion coating—an adherent, reaction-product layer on a metal surface formed in situ by reaction with a suitable chemical, used for protective, decorative, or functional purposes. (It is often used to provide greater corrosion resistance or prepare the surface prior to the application of an organic coating.)

chevron pattern—a V-shaped pattern on a fatigue or brittle-fracture surface. The pattern can also be one of straight radial lines on cylindrical specimens.

chipping—(1) removing coating and surface contaminants from a substrate in small pieces by cutting, striking, or applying mechanical force; (2) a failure mechanism in which small pieces or fragments of a material or coating are removed by mechanical damage, loss of adhesion, or both. [contrast with **peeling**]

chloride stress corrosion cracking—cracking of a metal under the combined action of tensile stress and corrosion in the presence of an electrolyte containing dissolved chlorides.

cleavage fracture—fracture that occurs along planes determined by the crystal structure of the material. (It is typically associated with a brittle fracture.)

coat—one layer of a coating system applied to a surface in a single continuous application to form a uniform film when dry.

coating—(1) a liquid, liquefiable, or mastic composition that, after application to a surface, is converted into a solid protective, decorative, or functional adherent film. (2) (in a more general sense) a thin layer of solid material on a surface that provides improved protective, decorative, or functional properties.

coating system—the complete number and types of coats applied to a substrate in a predetermined order. (When used in a broader sense, surface preparation, pretreatments, dry film thickness, and manner of application are included.)

cold cracking—cracking of a weld during or after cooling to ambient temperature, sometimes after a considerable time delay. (It usually occurs at temperatures less than 205 °C [400 °F] for metals, and less than the glass transition temperature for plastics.)

cold lap—a linear discontinuity with rounded edges at exposed surfaces that is caused by solidification of the meniscus of a partially cast metal or alloy (for example, an anode used for cathodic protection) as a result of interrupted flow of the casting stream or the joining of two casting streams at too low a temperature.

cold shut—horizontal surface discontinuity caused by solidification of a portion of a meniscus during the progressive filling of a mold, which is later covered with more solidifying metal as the molten metal level rises. Cold shuts generally occur at corners remote from the point of pour.

cold working—deforming metal plastically under conditions of temperature and strain rate that induce strain hardening, usually, but not necessarily, performed at room temperature [contrast with **hot working**]

commercial blast cleaned surface—an abrasive blast cleaned steel surface that is free of all visible contaminants and foreign matter but may have some random staining on no more than 33 percent of the surface area. [See NACE No. 3/SSPC-SP 6 for detailed specification.]

compressive strength—the maximum compressive stress a material is capable of withstanding without sustaining permanent deformation.

concentration cell—an electrochemical cell, the electromotive force of which is caused by a difference in concentration of some component in the electrolyte. (This difference leads to the formation of discrete cathodic and anodic regions.)

concentration polarization—that portion of polarization of an electrochemical cell produced by concentration changes resulting from current flowing through the electrolyte.

conductive coating—(1) a coating that conducts electricity. (2) an electrically conductive, mastic-like material used as an impressed current anode on reinforced concrete surfaces.

conductive concrete—a highly conductive cement-based mixture containing coarse and fine coke and other material used as an impressed current anode on reinforced concrete surfaces.

conductivity—(1) a measure of the ability of a material to conduct an electric charge. (2) the current transferred across a material (for example, coating) per unit area per unit potential gradient. (Conductivity is the reciprocal of resistivity.)

contact corrosion—see **galvanic corrosion**.

continuity bond—a connection, usually metallic, that provides electrical continuity between structures that can conduct electricity.

continuous anode—a single anode with no electrical discontinuities.

conversion coating—see **chemical conversion coating**.

copper sulfate test—(1) a test method in which a solution of copper sulfate, and possibly other ingredients, in water is

swabbed onto the surface of certain metals to determine the presence of metals more active (anodic) than copper. (2) a spot test method in which a 5 to 10 percent solution of copper sulfate in water is swabbed onto a steel surface to determine whether mill scale is present. (The appearance of copper indicates that mill scale is not present.)

corrosion—the deterioration of a material, usually a metal, that results from a chemical or electrochemical reaction with its environment.

corrosion-inhibitive pigment—a pigment that has the property of minimizing corrosion of the metal substrate to which the coating is applied by directly reducing the anodic or cathodic reactions, or both [contrast with **sacrificial pigment** and **barrier pigment**].

corrosion fatigue—the process wherein a metal fractures prematurely under conditions of simultaneous corrosion and repeated cyclic loading at lower stress levels or fewer cycles than would be required to cause fatigue of that metal in the absence of the corrosive environment.

corrosion fatigue strength—the maximum repeated stress that can be endured by a metal without fracture under definite conditions of corrosion and cyclic loading for a specific number of stress cycles and a specified period of time.

corrosion inhibitor—a chemical substance or combination of substances that, when present in the proper concentration and forms in the environment, reduces the corrosion rate.

corrosion potential—(represented by the symbol E_{corr}) the potential of a corroding surface in an electrolyte measured under open-circuit conditions relative to a reference electrode. [also known as **electrochemical corrosion potential**, **free corrosion potential**, **open-circuit potential**]

corrosion rate—the time rate of change of corrosion. (It is typically expressed as mass loss per unit area per unit time, penetration per unit time, etc.)

corrosion resistance—ability of a material, usually a metal, to withstand corrosion in a given environment.

corrosion under insulation—deterioration that occurs on an insulated component such as a pipe, vessel, or structural member as a result of water or other corrodents being trapped against the component by the insulating material.

DISCUSSION—Insulating materials may include, but are not limited to, thermal insulation, electrical insulation, acoustic insulation, and fireproofing.

corrosiveness—the tendency of an environment to cause corrosion.

counter electrode—the electrode in an electrochemical cell that is used to transfer current to or from a working electrode.

counterpoise—a conductor or system of conductors arranged beneath a power line, located on, above, or most frequently,

below the surface of the earth and connected to the footings of the towers or poles supporting the power line.

couple—see **galvanic couple**.

coupon—a portion of a material or sample, usually flat, but occasionally curved or cylindrical, from which one or more specimens can be taken for testing.

crack—(1) a partial split or break. (2) a split or break in a coating that penetrates to the substrate.

cracking—fracture of a material along a path that produces a linear discontinuity (without complete separation).

crater—(1) a metal surface anomaly consisting of a bowl-shaped cavity with the minimum dimension at the opening greater than the depth. [contrast with **pit**] (2) a small, rounded dish or bowl-like depression in a wet-applied coating. [contrast with **fish eye**]

cracking—a network of checks or cracks appearing on the surface of a coating.

creep—time-dependent strain occurring under stress.

creep strength—that stress which, when applied to a material at a specific temperature, will cause a specified amount of elongation in a specified time.

crevice corrosion—localized corrosion of a metal or alloy surface at, or immediately adjacent to, an area that is shielded from full exposure to the environment because of close proximity of the metal or alloy to the surface of another material or an adjacent surface of the same metal or alloy.

critical anodic current density—the maximum anodic current density observed in the active region for a metal or alloy electrode that exhibits active-passive behavior in an environment.

critical humidity—the relative humidity above which the atmospheric corrosion rate of a specific metal or alloy increases sharply.

critical pitting potential—(represented by the symbol E_p or E_{pp}) the least noble potential at which pitting corrosion will initiate and propagate in a specific environment. [See **break-down potential**.]

curing—process of developing the intended properties of a coating or other material (for example, resin) over a period of time.

curing agent—a chemical substance used for curing a coating or other material (for example, resin). [also referred to as **hardener**]

curing time—the minimum period between application and the time at which the applied material attains its intended physical properties.

current—(1) a flow of electric charge. (2) the amount of electric charge flowing past a specified circuit point per unit time, measured in the direction of net transport of positive

charges. (In a metallic conductor, this is the opposite direction of the electron flow.)

current density—the electric current flowing to or from a unit area of an electrode surface.

current efficiency—the ratio of the electrochemical equivalent current density for a specific reaction to the total applied current density.

DC decoupling device—a device used in electrical circuits that allows the flow of alternating current in both directions and stops or substantially reduces the flow of direct current.

deactivation—the process of prior removal of the active corrosive constituents, usually oxygen, from a corrosive liquid by controlled corrosion of expendable metal or by other chemical means, thereby making the liquid less corrosive.

dealloying—a corrosion process whereby one constituent of an alloy is preferentially removed, leaving an altered residual structure. [also known as **parting**, **selective dissolution**, or **selective leaching**]

decomposition potential—the potential of an electrode surface at which the electrolyte, or a component thereof, decomposes by electrolysis.

decomposition voltage—see **decomposition potential**.

deep groundbed—one or more anodes installed vertically at a nominal depth of 15 m (50 ft) or more below the earth's surface in a drilled hole for the purpose of supplying cathodic protection current.

delamination—(1) separation of layers in a material. (2) a separation between one or more coats from another coat within a coating system. [contrast with **disbondment**] (3) a separation of the concrete (usually in layers) from the reinforcing steel at their interface, usually as a result of corrosion.

delayed cracking—(1) cracking in a metal occurring after plating or pickling, sometimes after a considerable time delay. (2) not a preferred term for **cold cracking**.

depolarization—(not a preferred term) the removal of factors resisting the current flow in an electrochemical cell. [See **polarization**.]

deposit corrosion—localized corrosion under or around a deposit or collection of material on a metal surface. [also called **poultice corrosion**] [See also **crevice corrosion**.]

dezincification—dealloying that results in the selective removal of zinc from copper-zinc alloys.

dielectric coating—a coating that does not conduct electricity.

dielectric shield—an electrically nonconductive material, such as a coating, sheet or pipe, that is placed between an anode and an adjacent cathode, usually on the cathode, to improve current distribution in a cathodic protection system.

differential aeration cell—a concentration cell caused by differences in oxygen concentration along the surface of a metal in an electrolyte. [See **concentration cell**.]

diffusion-limited current density—the current density that corresponds to the maximum transfer rate that a particular species can sustain because of the limitation of diffusion [often referred to as **limiting current density**]

disbondment—the loss of adhesion between a coating and the substrate.

discontinuity—(1) an interruption in the normal physical structure or configuration of a coating such as cracks, laps, seams, inclusions, porosity, or holidays. (A discontinuity does not necessarily affect the usefulness of the coating.) (2) a condition in which the electrical path through a structure is interrupted by a device that acts as a dielectric or insulating fitting.

dissimilar metals—different metals that could form an anode-cathode relationship in an electrolyte when connected by an electron-conducting (usually metallic) path.

double layer—the interface between an electrode or a suspended particle and an electrolyte created by charge-charge interaction leading to an alignment of oppositely charged ions at the surface of the electrode or particle. The simplest model is represented by a parallel plate condenser.

doubler plate—an additional plate or thickness of metal used to provide extra strength or thickness to a structure locally (for example, at the point of anode attachment to an offshore structure).

drainage—conduction of electric current from an underground or submerged metallic structure by means of a metallic conductor.

driving potential—difference in potential between the anode and the steel structure.

dry film thickness—the thickness of a dried film, coating, or membrane.

dry spray—a rough, powdery noncoherent film produced when atomized coating particles partially dry before reaching the surface.

dry to handle—stage of drying or curing of an applied coating at which time the coated object can be carefully handled without damage.

dry to recoat—stage of drying or curing of an applied coating at which time a subsequent coat can be applied satisfactorily.

dry to touch—stage of drying or curing of an applied coating at which time it no longer adheres to a finger that is lightly touched or rubbed across the surface and does not show a fingerprint at the point of contact.

drying—the process in which a liquid film is converted to a solid film by evaporation of volatile components.

drying oil—an oil capable of conversion from a liquid to a solid by slow reaction with oxygen in the air.

drying time—minimum time required for an applied coating to reach the desired stage of drying or curing.

ductile cast iron—cast iron that has been treated while molten with an element (usually magnesium or cerium) that spheroidizes the graphite. [also called **nodular cast iron**].

ductile fracture—fracture that occurs with appreciable plastic deformation of the material. [contrast with **brittle fracture**]

ductility—the ability of a material to withstand plastic deformation prior to fracture. (It is usually measured by the permanent elongation or reduction in the cross-sectional area of a fractured tensile test specimen.)

duplex stainless steel—stainless steel whose microstructure at room temperature consists primarily of a mixture of austenite and ferrite. [also called **austenitic/ferritic stainless steel**].

elastic deformation—changes of dimensions of a material upon the application of a stress within the elastic range. Following the release of an elastic stress, the material returns to its original dimensions without any permanent deformation.

elasticity—the property of a material that allows it to recover its original dimensions following deformation by a stress below its elastic limit.

elastic limit—the maximum stress to which a material may be subjected without retention of any permanent deformation after the stress is removed.

electrical interference—any electrical disturbance on a metallic structure in contact with an electrolyte caused by stray current(s).

electrical isolation—the condition of being electrically separated from other metallic structures or the environment.

electrochemical admittance—the reciprocal of the electrochemical impedance, $\Delta I/\Delta E$.

electrochemical cell—(1) an electrochemical reaction involving two half reactions, one of which involves oxidation of the reactant (product) and the other of which involves reduction of the product (reactant). (The equilibrium potential of the electrochemical cell can be calculated from the change in free energy for the overall electrochemical reaction. The equilibrium potential of the electrochemical cell can be measured by separating the oxidation and reduction half reactions into individual compartments and measuring the voltage that develops between them under conditions that virtually no charge passes between them.) [thermodynamic use] (2) an electrochemical system consisting of an anode and a cathode in metallic contact and immersed in an electrolyte. (The anode and cathode may be different metals or dissimilar areas on the same metal surface.) [common use]

electrochemical corrosion potential—see **corrosion potential**.

electrochemical equivalent—the mass of an element or group of elements oxidized or reduced at 100 percent efficiency by the passage of a unit quantity of charge such as a Faraday (96,485 coulombs), ampere-hour, or coulomb.

electrochemical impedance—the frequency dependent, complex valued proportionality factor, $\Delta I/\Delta E$, between the applied potential (or current) and the response current (or potential) in an electrochemical cell. This factor becomes the impedance when the perturbation and response are related linearly (the factor value is independent of the perturbation magnitude) and the response is caused only by the perturbation. The value may be related to the corrosion rate when the measurement is made at the corrosion potential.

electrochemical noise—fluctuations of potential or current, or both, originating from uncontrolled variations in a corrosion process.

electrochemical potential—the partial derivative of the total electrochemical free energy of the system with respect to the number of moles of the constituent in a solution when all other factors are constant. (Analogous to the chemical potential of the constituent except that it includes the electrical as well as the chemical contributions to the free energy.)

electrode—a material that conducts electrons, is used to establish contact with an electrolyte, and through which current is transferred to or from an electrolyte.

electrode potential—the potential of an electrode in an electrolyte as measured against a reference electrode.

electrokinetic potential—a potential difference in a solution caused by residual, unbalanced charge distribution in the adjoining solution, producing a double layer. (The electrokinetic potential is different from the electrode potential in that it occurs exclusively in the solution phase. This potential represents the reversible work necessary to bring a unit charge from infinity in the solution up to the interface in question but not through the interface.) [also known as **zeta potential**]

electrolysis—production of chemical changes of the electrolyte by the current flowing through an electrochemical cell.

electrolyte—a chemical substance containing ions that migrate in an electric field.

electrolytic corrosion—not a proper term, but sometimes incorrectly used to refer to **galvanic corrosion**, **stray-current corrosion**, or any form of electrochemical corrosion.

electrolytic cleaning—a process for removing soil, scale, or corrosion products from a metal surface by subjecting the metal as an electrode to an electric current in an electrolytic bath.

electromotive force series—a list of elements arranged according to their standard electrode potentials, the sign being positive for elements whose potentials are more noble than

hydrogen such as gold and negative for those more active than hydrogen such as zinc. [not to be confused with **galvanic series**]

electro-osmosis—the migration of water through a semipermeable membrane as a result of a potential difference caused by the flow of electric charge through the membrane.

ellipsometry—an optical technique wherein plane-polarized light is focused on a surface and the reflected beam is analyzed to determine the phase shift of the components of the light to provide information on the properties of films that may be present on the surface.

embrittlement—reduction of ductility, or toughness, or both, of a material (usually a metal or alloy).

EMF series—see **electromotive force series**.

enamel—(1) a paint that dries to a hard, glossy surface. (2) a coating that is characterized by an ability to form a smooth, durable film.

end effect—the more rapid loss of anode material at the end of an anode, compared with other surfaces of the anode, resulting from higher current density.

endurance limit—the maximum stress that a material can withstand for an infinitely large number of fatigue cycles.

environment—the surroundings or conditions (physical, chemical, mechanical) in which a material exists.

environmental cracking—see **environmentally assisted cracking**.

DISCUSSION—Environmental cracking is a general term that includes the terms listed below. The definitions of these terms are listed elsewhere in this document: **caustic cracking**, **chloride stress corrosion cracking**, **corrosion fatigue**, **hydrogen embrittlement**, **hydrogen-induced cracking (stepwise cracking)**, **hydrogen stress cracking**, **liquid metal cracking**, **stress corrosion cracking**, **sulfide stress cracking**.

DISCUSSION—The following terms have been used in the past in connection with environmental cracking but are now obsolete and should not be used: **caustic embrittlement**, **delayed cracking**, **liquid metal embrittlement**, **season cracking**, **static fatigue**, **sulfide corrosion cracking**, **sulfide stress corrosion cracking**.

environmentally assisted cracking—cracking of a material wherein an interaction with its environment is a causative factor in conjunction with tensile stress, often resulting in brittle fracture of an otherwise ductile material.

epoxy—type of resin formed by the reaction of aliphatic or aromatic polyols (such as bisphenol) with epichlorohydrin and characterized by the presence of reactive oxirane end groups.

equilibrium potential—the potential of an electrode in an electrolyte at which the forward rate of a given reaction is exactly equal to the reverse rate. (The equilibrium potential can only be defined with respect to a specific electrochemical reaction.) [also known as **reversible potential**]

erosion—the progressive loss of material from a solid surface resulting from mechanical interaction between that surface and a fluid, a multicomponent fluid, or solid particles carried with the fluid.

erosion-corrosion—a conjoint action involving erosion and corrosion in the presence of a moving corrosive fluid or a material moving through the fluid, leading to accelerated loss of material.

exchange current density—the rate of charge transfer per unit area when an electrode reaches dynamic equilibrium (at its reversible potential) in a solution; that is, the rate of anodic charge transfer (oxidation) is exactly equal to the rate of cathodic charge transfer (reduction).

exfoliation corrosion—subsurface corrosion that proceeds laterally from the sites of initiation along planes parallel to the surface forming corrosion products that force metal away from the body of the material, giving rise to a layered appearance resembling the pages of a book.

external circuit—the wires, connectors, measuring devices, current sources, etc., that are used to bring about or measure the desired electrical conditions within an electrochemical cell. It is this portion of the cell through which electrons travel.

fatigue—the process of progressive localized permanent structural change occurring in a material subjected to fluctuating stresses less than the ultimate tensile strength of the material that may culminate in cracks or complete fracture after a sufficient number of fluctuations.

fatigue strength—the maximum stress that can be sustained for a specified number of cycles without fracture.

fault current—a current that flows from one conductor to ground or to another conductor as a result of an abnormal connection (including an arc) between the two. A fault current flowing to ground may be called a ground fault current.

feather edging—see **feathering**.

feathering—reducing the thickness of the edges of an undamaged coating film, such as adjacent to a damaged coating or rusted area, by abrasion or sanding to produce a smoothly tapered transitional area prior to recoating.

ferrite—the body-centered cubic crystalline phase of iron or iron-based alloys.

ferritic stainless steel—stainless steel whose microstructure at room temperature consists predominantly of ferrite.

ferritic steel—a steel whose microstructure at room temperature consists predominantly of ferrite.

fiberglass-reinforced plastic—a resin-rich coating or lining into which layers of fiberglass reinforcement have been incorporated to produce mechanical and physical properties superior to the base resin itself.

filiform corrosion—corrosion that occurs under some coatings in the form of randomly distributed threadlike filaments.

film—a thin, not necessarily visible layer of material.

finish coat—see **topcoat**.

fish eye—a small dimple or crater with a visible defect or contaminant in the central area resembling a fish eye that forms in a wet-applied coating. [see **crater**]

flash rust—an iron oxidation product that forms rapidly on a newly prepared ferrous metal surface exposed to moisture.

forced drainage—drainage applied to underground or submerged metallic structures by means of an applied electromotive force or sacrificial anode.

foreign structure—any metallic structure that is not intended as a part of a system under cathodic protection.

fouling—an accumulation of deposits. (This includes accumulation and growth of marine organisms on a submerged surface and the accumulation of deposits on heat exchanger tubing.)

fractography—descriptive treatment of fracture, especially in metals, with specific reference to photographs of the fracture surface.

fracture mechanics—a quantitative analysis for evaluating structural reliability in terms of applied stress, crack length, and specimen geometry.

free corrosion potential—see **corrosion potential**.

free machining—the machining characteristics of an alloy to which an ingredient has been introduced to give small broken chips, lower power consumption, better surface finish, and longer tool life.

fretting corrosion—deterioration at the interface between contacting surfaces as the result of corrosion and slight oscillatory slip between the two surfaces.

furan—type of resin formed by the polymerization or polycondensation of furfuryl, furfuryl alcohol, or other compounds containing a furan ring.

galvanic anode—a metal that provides sacrificial protection to another metal that is more noble when electrically coupled in an electrolyte. This type of anode is the electron source in one type of cathodic protection.

galvanic corrosion—accelerated corrosion of a metal because of an electrical contact with a more noble metal or nonmetallic conductor in a corrosive electrolyte.

galvanic couple—a pair of dissimilar conductors, commonly metals, in electrical contact in an electrolyte.

galvanic current—the electric current flowing between metals or conductive nonmetals in a galvanic couple.

galvanic series—a list of metals and alloys arranged according to their corrosion potentials in a given environment.

galvanized coating—(1) a coating of zinc on steel that contains an interfacial interdiffusion layer of zinc and iron, forming a metallurgical bond at the steel surface; (2) [not preferred] a coating of metallic zinc applied by hot-dipping, mechanical means, electroplating or other means.

galvanizing—(1) a galvanized coating. (2) process of applying a galvanized coating.

galvanodynamic—refers to a technique wherein current, continuously varied at a selected rate, is applied to an electrode in an electrolyte.

galvanostaircase—refers to a galvanostep technique for polarizing an electrode in a series of constant current steps wherein the time duration and current increments or decrements are equal for each step.

galvanostatic—refers to a technique wherein an electrode is maintained at a constant current in an electrolyte.

galvanostep—refers to a technique wherein an electrode is polarized in a series of current increments or decrements.

general corrosion—corrosion that is distributed more-or-less uniformly over the surface of a material.

grain—an individual crystal in a solid metal or alloy in which the atoms are arranged in an orderly pattern.

grain boundary—an interface separating two grains.

grain dropping—the dislodgement and loss of a grain or grains (crystals) from a metal surface as a result of intergranular corrosion.

graphitic corrosion—deterioration of cast iron wherein the metallic constituents are selectively leached or converted to corrosion products, leaving the graphitic particles intact. [should not be used as a term to describe **graphitization**]

graphitization—the formation of graphite in iron or steel, usually from decomposition of iron carbide at elevated temperatures. [should not be used as a term to describe **graphitic corrosion**]

gray cast iron—cast iron that displays a gray fracture surface as a result of the presence of flake graphite.

grit—small particles of hard material (for example, iron, steel, or mineral) with irregular shapes that are commonly used as an abrasive in abrasive blast cleaning.

grit blasting—abrasive blast cleaning using grit as the abrasive.

groundbed—one or more anodes installed below the earth's surface for the purpose of supplying cathodic protection current.

half cell—(1) the single oxidation or reduction half reactions in the complete electrochemical cell. (The potential of a half cell can only be calculated from the thermodynamic properties of its components.) [thermodynamic use] (2) commonly used in the field to refer to a **reference electrode**, but this is not a preferred use.

half-cell potential—the potential in a given electrolyte of one electrode of a pair relative to a standard state or a reference state. (Potentials can only be measured and expressed as the difference between the half-cell potentials of a pair of electrodes.)

hand tool cleaning—removal of loose rust, loose mill scale, and loose coating by hand chipping, scraping, sanding, and wire brushing. [See SSPC-SP 2.]

hardener—see **curing agent**.

hardness—(1) resistance of a material to plastic deformation, usually by indentation. (2) the concentration of inorganic polyvalent cations (generally calcium and magnesium) in water.

heat-affected zone—that portion of the base metal that is not melted during brazing, cutting, or welding, but whose microstructure and properties are altered by the heat of these processes.

heat treatment—heating and cooling a solid metal or alloy in such a way as to obtain desired properties. Heating for the sole purpose of hot working is not considered heat treatment.

high-pressure water cleaning—water cleaning performed at pressures from 34 MPa to 70 MPa (5000 psig to 10 000 psig).

high-pressure waterjetting—waterjetting performed at pressures from 70 MPa to 210 MPa (10 000 psig to 30 000 psig).

high-temperature hydrogen attack—a loss of strength and ductility of steel by high-temperature reaction of absorbed hydrogen with carbides in the steel, resulting in decarburization and internal fissuring.

holiday—a discontinuity in a protective coating that exposes unprotected surface to the environment.

holiday detection—testing of a coating system for holidays using an instrument that applies a voltage between the external surface of the coating and a conductive substrate.

hot corrosion—an accelerated corrosion of metal surfaces that results from the combined effect of oxidation and reactions with sulfur compounds and other contaminants, such as chlorides, to form a molten salt on a metal surface that fluxes, destroys, or disrupts the normal protective oxide.

hot-dip galvanizing—applying a coating of zinc by immersion in a bath of molten zinc.

hot working—deforming metal plastically under conditions of temperature and strain rate that recrystallization takes place simultaneously with the deformation, thus avoiding any strain hardening. [contrast with **cold working**]

hydrogen blistering—the formation of subsurface planar cavities, called hydrogen blisters, in a metal resulting from excessive internal hydrogen pressure. Growth of near-surface blisters in low-strength metals usually results in surface bulges.

hydrogen embrittlement—decrease of toughness or ductility caused by the presence of hydrogen within a metal or alloy.

hydrogen-induced cracking—brittle cracking in metals caused by the presence of hydrogen in the structure.

hydrogen overvoltage—overvoltage associated with the liberation of hydrogen gas.

hydrogen stress cracking—cracking of a metal or alloy under the combined action of tensile stress and the presence of hydrogen in the metal or alloy.

immunity—a state of resistance to corrosion of a metal in which the metal itself is more thermodynamically stable than its possible corrosion products. (In practical situations, immunity is assumed when the equilibrium concentration of corrosion products is negligible [typically less than 10^{-6} mol/L].)

impact resistance—ability of a material to resist damage from impact.

impingement corrosion—a form of erosion-corrosion generally associated with the local impingement of a high-velocity, flowing fluid against a solid surface.

impressed current—an electric current supplied by a device employing a power source that is external to the electrode system. (An example is direct current for cathodic protection.)

impressed current anode—an electrode, suitable for use as an anode when connected to a source of impressed current. (It is often composed of a substantially inert material that conducts by oxidation of the electrolyte and, for this reason, is not corroded appreciably.)

impulse dielectric test—a method of applying voltage to an insulated wire through the use of electric pulses (usually 170 to 250 pulses per second) to determine the integrity of the wire's insulation.

inclusion—a nonmetallic phase such as an oxide, sulfide, or silicate particle in a metal.

inorganic zinc-rich coating—coating containing a metallic zinc pigment (typically 75 mass percent zinc or more in the dry film) in an inorganic vehicle.

instant-off potential—the polarized half-cell potential of an electrode taken immediately after the cathodic protection current is stopped, which closely approximates the potential without IR drop (that is, the polarized potential) when the current was on.

intentiostatic—see **galvanostatic**.

intercrystalline corrosion—see **intergranular corrosion**.

interdendritic corrosion—corrosion of cast metals that progresses preferentially along paths between dendrites.

interference bond—an intentional metallic connection, between metallic systems in contact with a common

electrolyte, designed to control electrical current interchange between the systems.

interference current—see **stray current**.

intergranular corrosion—preferential corrosion at or adjacent to the grain boundaries of a metal or alloy.

intergranular stress corrosion cracking—stress corrosion cracking in which the cracking occurs along grain boundaries.

internal oxidation—the formation of isolated particles of oxidation products beneath the metal surface.

intumescence—the swelling or bubbling of a coating usually caused by heating. (The term is commonly used in aerospace and fire-protection applications.)

ion—an electrically charged atom or group of atoms.

IR drop—see **voltage drop**.

iron rot—deterioration of wood in contact with iron-based alloys.

isocorrosion curve—a line drawn linking all points on a graph that have equal corrosion rates.

isocorrosion diagram—a graph on which the axes represent environmental parameters (for example, concentration, temperature, pressure, velocity) and on which one or more isocorrosion curves are drawn.

knife-line attack—intergranular corrosion of an alloy along a narrow band adjoining or in contact with a weld.

lamellar corrosion—see **exfoliation corrosion**.

Langelier Saturation Index—a number calculated from total dissolved solids, calcium concentration, total alkalinity, pH, and solution temperature that shows the tendency of a water solution to precipitate or dissolve calcium carbonate, wherein an index less than -0.3 indicates that the water tends to be corrosive, while an index greater than $+0.3$ indicates scale forming potential. [also called *Langelier Index* or *Saturation Index*]

latex paint—a paint containing a stable aqueous dispersion of synthetic resin, produced by emulsion polymerization, as the principal constituent of the binder. (Modifying resins may also be present.)

leveling—(1) the process whereby a wet-applied coating flows out after application to minimize any surface irregularities produced by the process of application. (2) smoothing of a surface by electrochemical means to reduce surface roughness. (3) flattening of sheet or plate.

lifting—softening and raising or wrinkling of a previous coat by the application of a subsequent coat.

limiting current density—see **diffusion-limited current density**.

line current—the direct current flowing in a pipeline.