

Standard Recommended Practice

Standard Format for Collection and Compilation of Data for Computerized Material Corrosion Resistance Database Input

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Foreword

This NACE standard recommended practice defines data categories and specific data elements (fields) that are considered desirable or essential to accommodate search strategies and reliable data comparisons in computerized corrosion databases. It is intended to facilitate the recording of corrosion test results and does not imply or endorse any particular database design or schema. The data entries are designed to accommodate data relative to the basic forms of corrosion and to serve as a guide for structuring multiple-source database compilations with the capability of assessing compatibility of engineering materials (metals and nonmetals) for a wide range of environments and exposure conditions.

Utilization of the guidelines and format are designed for use with computerized database applications but may be useful for other applications in which systematic recording of corrosion data is desired. This standard should aid persons involved with the selection or evaluation of metallic or nonmetallic materials for various applications who desire to record corrosion data in a computerized format.

This standard was originally prepared in 1990 by Task Group T-3U-1 of Unit Committee T-3U on Computers in Corrosion Control (originally Task Group T-3-2 of Group Committee T-3). It was reaffirmed in 1998 by Unit Committee T-3U and in 2004 by STG 07 on Computer Applications. This standard is published under the auspices STG 07. Task group participants included representatives from materials groups from chemical and process industries, material suppliers, research institutions, technical associations, corrosion consulting firms, and government laboratories.

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, 4th ed., Paragraph 7.4.1.9. *Shall* and *must* are used to state mandatory requirements. The term *should* is used to state something good and is recommended but is not mandatory. The term *may* is used to state something considered optional.

**NACE International
Standard
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Contents

1. General..... 1

2. Standard Format Design Considerations 1

3. Corrosion Data Search Strategies..... 2

4. Data Entry Fields 2

Table 1—Standard Data Entry Format for Corrosion Database Development..... 2

References..... 11

Section 1: General

1.1 This standard presents guidelines for determination of data elements (fields) for data collection to aid in the development of computerized corrosion databases. These guidelines facilitate database structuring to (a) accommodate data from diverse sources, (b) provide comparisons between metals and nonmetals, (c) integrate data emphasizing various forms of corrosion, (d) ensure compatibility between various corrosion and other material property databases, and (e) permit data search strategies to meet specific user interests.

1.2 This standard is intended to be a general guide for designing data input formats. Certain specialized corrosion tests may require additional data elements to fully characterize the data recorded. This standard does not preclude these additions. Various standard guides developed by ASTM⁽¹⁾ Committees E 49 and G 01⁽²⁾ may be helpful.

1.3 Reliable comparisons of corrosion data from multiple sources are expedited if data are provided for as many of the listed fields as possible. When data are limited, some degree of uncertainty is present.

1.4 This standard is not directed toward recording data from electrochemical corrosion tests.

1.5 Data categories and fields listed for nonmetals emphasize identification and performance data for engineering polymers. Additional descriptors should be added when compiling data for ceramics, composites, or other types of nonmetals.

1.6 This standard provides a useful reference to be consulted before initiating a corrosion test to ensure plans are made to record relevant data.

Section 2: Standard Format Design Considerations

2.1 The following general categories for data collection should be considered:

2.1.1 Test identification: Unique code to identify groupings of multiple specimens exposed at the same time and under identical conditions.

2.1.2 Type of test: Standardized, laboratory, field tests; test relation to specific process or application (e.g., sulfide stress cracking test for sour gas production tubing).

2.1.3 Test emphasis: Specific form of corrosion or degradation being evaluated (e.g., pitting, corrosion fatigue, dimensional changes, etc.).

2.1.4 Test environment: Generic description, concentration, and state of principal components, contaminants, etc.

2.1.5 Exposure conditions: Duration, temperature, pH, hydrodynamic conditions, aeration, etc.

2.1.6 Material identification: Material class, subclass, and family, common name, standard designation, condition, manufacturing process, product form, etc.

2.1.7 Test specimen identification: Test specimen number, size, geometry, surface condition, composition, and properties.

2.1.8 Test specimen performance: Mass change, property change, localized attack, and performance relative to specific corrosion mechanism.

2.1.9 Data source or reference.

2.2 Supplementary notes may be used to document additional information considered important to interpret data.

⁽¹⁾ ASTM International (ASTM), 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959.

⁽²⁾ ASTM Committees E 49 (Computerization of Materials Property Data) and G 01 (Corrosion of Metals), ASTM, West Conshohocken, PA.

Section 3: Corrosion Data Search Strategies

- 3.1 This standard provides a format to search for and identify the following data:

 - 3.1.1 Multiple test specimens included in the same test (i.e., exposed in the same or companion test rack under identical conditions in the same or companion test vessel).
 - 3.1.2 Different materials included in same test.
 - 3.1.3 Materials evaluated by standard test methods (by specification number).
 - 3.1.4 Materials exposed to specific environments with environments defined by generic description (e.g., sour gas) or by specific components (e.g., hydrocarbon + H₂S).
- 3.1.5 Specific materials, defined by class (e.g., aluminum [Al]), standard designation (UNS⁽³⁾ designation, ASTM specification), common name, or material type (e.g., Al-Cu alloy).
 - 3.1.6 Specific application or process (e.g., sour gas production tubing, pulp bleaching).
 - 3.1.7 Type of corrosion or degradation mechanism (e.g., pitting, corrosion fatigue, softening, etc.).
 - 3.1.8 Results from a specific reference or source.
- 3.2 Additional data may be required to facilitate supplementary search requirements. This guide does not preclude these additions.

Section 4: Data Entry Fields

- 4.1 Data entry fields defined to meet the recommendations of Sections 2 and 3 are listed in Table 1. The first three digits of the reference numbers refer to the related paragraph numbers in Section 2 of this standard.
- 4.2 Category sets are a controlled set of descriptive terms used as data entries. Field type specifies numerical, character string, or date entries.

Table 1:
Standard Data Entry Format for Corrosion Database Development

Reference No.	Field Name/Description	Category Sets/Field Type/Units ^(A)
TEST IDENTIFICATION		
2.1.1	Individual test no. to identify grouping of test specimens tested concurrently; see 2.1.2.1 for test method.	String
TYPE OF TEST		
2.1.2.1	Standard test specification	String NONE for Not Applicable
2.1.2.2	Field or laboratory test	(1) F—field (2) L—laboratory
2.1.2.3	Date test started	Date

⁽³⁾ Metals and Alloys in the Unified Numbering System (latest revision), a joint publication of ASTM International (ASTM) and the Society of Automotive Engineers Inc. (SAE), 400 Commonwealth Dr., Warrendale, PA 15096.

TEST EMPHASIS

2.1.3.1	Type(s) of corrosion evaluated, metals (examples: general corrosion, stress corrosion cracking, pitting, crevice corrosion, heat flux effects, fretting, stray current, weld corrosion, corrosion fatigue, galvanic corrosion, microbiologically influenced corrosion)	String
2.1.3.2	Type(s) of corrosion evaluated, nonmetals (examples: volume change, moisture absorption, mechanical property change, chemical dissolution)	String

CHEMISTRY OF TEST ENVIRONMENT

2.1.4.1	Generic description	String
2.1.4.2	Component—common name	String
2.1.4.3	<i>Chemical Abstracts</i> ^(B) registry no.	String
2.1.4.4	Concentration	g/L (lb/gal)
2.1.4.5	Component form	(1) solid (2) liquid (3) gaseous (4) aqueous solution (5) nonaqueous solutions or emulsions

NOTE: Many environments contain multiple components. Reference numbers 2.1.4.1 through 2.1.4.5 should be repeated for each component and no restrictions should be placed on the number of components to be reported.

2.1.4.6	Inhibitors	String
2.1.4.7	Ionic species	String

EXPOSURE CONDITIONS

2.1.5.1	Exposure duration	Days, hours
2.1.5.2	Temperature—minimum	°C (°F)
2.1.5.3	Temperature—maximum	°C (°F)
2.1.5.4	Temperature—average	°C (°F)
2.1.5.5	Heat transfer between test specimen and environment; if YES, describe in 2.1.5.6.	(1) Y—yes (2) N—no
2.1.5.6	Heat transfer conditions	String
2.1.5.7	pH—minimum	Numeric
2.1.5.8	pH—maximum	Numeric
2.1.5.9	pH—average	Numeric
2.1.5.10	Total alkalinity (total concentration of bases)	mol/L

RP0690-2004

2.1.5.11	Total acidity (total concentration of acids)	mol/L
2.1.5.12	Conductivity	siemens (S)
2.1.5.13	Pressure (absolute)	kPa abs. (psia)
2.1.5.14	Velocity	m/s (ft/s)
2.1.5.15	Reynolds No.	Numeric
2.1.5.16	Flow	(1) none (2) laminar (3) turbulent (4) forced convection
2.1.5.17	System configuration at test sample	String
2.1.5.18	Aeration (sparging)	(1) deaerated (2) none—less than saturated, open to air (3) oxygen saturated (4) air saturated (5) air enters at upsets
2.1.5.19	Agitation	(1) none (2) stirred (3) shaken
2.1.5.20	Test conducted in standard laboratory atmosphere (see ASTM D 543 ¹ —chemical resistance tests for plastics)	(1) Yes (2) No
2.1.5.21	Exposure zone	(1) continuous immersion (2) splash zone (3) waterline (4) condensate zone (5) gaseous phase (6) cyclic exposure—describe in 2.1.5.22
2.1.5.22	Cyclic exposure cycle (immersion/air exposure, etc.)	String
2.1.5.23	Process relation (examples: pulp bleaching, sour gas production, solvent extraction, gas scrubbing, etc.)	String
2.1.5.24	Application relation (examples: heat exchanger tubing, fasteners, pumps, valves, scrubber ducting, etc.)	String
2.1.5.25	Ratio of test specimen surface area to corrosive volume (mm ² /L [in. ² /L])	Numeric

MATERIAL IDENTIFICATION—GENERIC

2.1.6.1	Material class	String
2.1.6.2	Subdivision of class	String
2.1.6.3	Finer subdivision of class	String

2.1.6.4	Common name	String
2.1.6.5	Material designation—UNS No.	String
2.1.6.6	Specification/standard	String

NOTE: Reference numbers 2.1.6.1 through 2.1.6.6 are basic fields for material identification in databases. For more detail, refer to ASTM Committee E 49 for generic guidelines for material identification in computerized material property databases.

MATERIAL IDENTIFICATION—PRODUCT

2.1.6.7	Product shape	(1) pipe/tube (2) plate (3) sheet/strip (4) wire/rod
2.1.6.8	Product production method (metals)	(1) extrusion (2) forging (3) casting (4) rolling (5) powder compaction (6) other
2.1.6.9	Description of (6) in 2.1.6.8	String
2.1.6.10	Heat/lot identification	String
2.1.6.11	Heat/lot chemical analysis	String

TEST SPECIMEN IDENTIFICATION—METALS

2.1.7.1	Test specimen thickness	mm (in.)
2.1.7.2	Test specimen width/diameter	mm (in.)
2.1.7.3	Test specimen length	mm (in.)
2.1.7.4	Test specimen surface area	mm ² (in. ²)
2.1.7.5	Density	kg/m ³ (g/mm ³)
2.1.7.6	Welded test specimen	(1) Y—yes (2) N—no
2.1.7.7	Type of weld (see 2.1.7.8 for details)	(1) autogenous (2) matching filler (3) dissimilar metal weld
2.1.7.8	Weld details (examples: welding process, preheat, heat input, number of passes, joint shape, cover gas, weld chemistry, etc.)	String
2.1.7.9	Welds ground or machined	(1) ground (2) machined (3) as deposited (4) glass-bead blasted
2.1.7.10	Metallurgical condition	(1) standard temper—describe in 2.1.7.11 (2) annealed (3) normalized

		(4) sensitized (5) as cold worked (6) as hot worked (7) other heat treatment/ processing— describe in 2.1.7.11
2.1.7.11	Description for (1) or (7) in 2.1.7.10	String
2.1.7.12	Final reduction step	(1) cold worked—give % reduction in 2.1.7.13 (2) hot worked (includes extrusion and forging)
2.1.7.13	% cold reduction	%
2.1.7.14	Ultimate tensile strength	kPa (psi)
2.1.7.15	Yield strength	kPa (psi)
2.1.7.16	% offset for yield strength	%
2.1.7.17	Hardness	Numeric
2.1.7.18	Hardness measurement scale	Character
2.1.7.19	Surface condition	(1) as produced (2) scaled (3) machined/ground (4) chemically cleaned (5) sand/grit blasted (6) other
2.1.7.20	Surface treatment	(1) none (2) nitrided (3) carburized (4) plated (5) clad (6) anodized
2.1.7.21	Plating of cladding material in 2.1.7.20	String
2.1.7.22	Condition of edges	(1) as cut (2) as sheared (3) ground (4) machined
2.1.7.23	Test specimen orientation relative to rolling direction	(1) longitudinal (2) transverse (3) short transverse
2.1.7.24	Stress corrosion cracking test specimen type	(1) double-cantilever-beam (DCB) test specimen (2) wedge open loaded (WOL) test specimen (3) bent beam—2 pt. loaded (4) bent beam—3 pt. loaded (5) bent beam—4 pt. loaded (6) standard tension specimen (ASTM E 8 ²) (7) subsize tension specimen (ASTM E 8)

		(8) C-ring (9) stressed ring sample (10) U-bend (11) other
2.1.7.25	Stress corrosion cracking test specimen—test area	(1) smooth (2) notched (3) precracked
2.1.7.26	Direct tension stress corrosion cracking test specimen—applied stress (ASTM G 49 ³)	(1) constant load (2) dynamic load (3) constant strain
2.1.7.27	Stress corrosion cracking test specimen—stress level (% of yield strength at test temperature)	%
2.1.7.28	Stress corrosion cracking test specimen—stress level (absolute)	kPa (psi)
2.1.7.29	Strain rate for slow strain rate test	mm/s (in./s)

TEST SPECIMEN IDENTIFICATION—NONMETALS

2.1.7.30	Monomer or blend composition	String
2.1.7.31	Manufacturer's designation/trade name	String
2.1.7.32	Virgin or reprocessed	(1) virgin (2) reprocessed
2.1.7.33	Manufacturer	String
2.1.7.34	Molecular/crystal structure	String
2.1.7.35	Test specimen	(1) molded (2) extruded (3) sheet (4) as cast (5) machined
2.1.7.36	Modifiers—fillers, curing agents, catalysts, reinforcements, special purpose additives	String
2.1.7.37	Test specimen conditioning	(1) Yes (2) No
2.1.7.38	Specifying properties	String
2.1.7.39	Standard test specimen (ASTM D 618 ⁴)	(1) nonstandard (2) 50-mm (2-in.) dia. x 3.18-mm (0.125-in.) thick (3) 25-mm x 76-mm (1.0-in. x 3.0-in.) cut sheet (4) other standard
2.1.7.40	If nonstandard or unlisted test specimen, describe	String

TEST SPECIMEN PERFORMANCE—METALS

2.1.8.1	Mass loss	g or mg
2.1.8.2	Mass loss—unit area basis	mg/mm ² (mg/in. ²)

RP0690-2004

2.1.8.3	Corrosion rate	mm/y (mpy)
2.1.8.4	Corrosion potential	mV
2.1.8.5	Reference electrode for 2.1.8.4	String
2.1.8.6	Reduction in elongation	%
2.1.8.7	Reduction in tensile strength	%
2.1.8.8	Reduction in yield strength	%
2.1.8.9	Nature of corrosion products	String
2.1.8.10	Visible corrosion	(1) corroded (2) no visible corrosion
2.1.8.11	Maximum depth of pits—perpendicular to surface	mm (in.)
2.1.8.12	Average depth of five deepest pits	mm (in.)
2.1.8.13	Pitting density (ASTM G 46 ⁵)	number/m ² (number/in. ²)
2.1.8.14	Maximum depth of crevice corrosion	mm (in.)
2.1.8.15	Type of crevice (see ASTM G 78 ⁶)	String
2.1.8.16	Weld-related corrosion	(1) fusion line (2) base metal (3) weld metal (4) heat-affected zone
2.1.8.17	Stress corrosion cracking test—severity of attack	(1) no cracking (2) microcracks (3) total fracture (complete separation)
2.1.8.18	Stress corrosion cracking mode	(1) transgranular (2) intergranular (3) mixed mode (4) ductile
2.1.8.19	Crack propagation rate	m/s (ft/s)
2.1.8.20	Hydrogen damage	(1) hydrogen blistering (2) hydrogen embrittlement (3) hydride formation
2.1.8.21	Dealloying	(1) plug (2) laminar
2.1.8.22	Exfoliation corrosion—ASTM G 34 ⁷	(1) superficial (2) moderate (3) severe (4) very severe
2.1.8.23	Intergranular corrosion, maximum depth of attack	mm (in.)
2.1.8.24	Galvanic corrosion—material coupled to	String
2.1.8.25	Galvanic corrosion—area ratio of test material/ coupled material	Numeric

2.1.8.26	Corrosion fatigue test	(1) rotating beam (2) cantilever beam (3) cyclic loaded tensile specimen
2.1.8.27	Corrosion fatigue test—crack initiation/failure	(1) crack initiation (2) failure (3) no cracking
2.1.8.28	Corrosion fatigue test—maximum stress level	kPa (psi)
2.1.8.29	Time to crack initiation	s
2.1.8.30	R ratio—minimum/maximum load or stress intensity	Numeric
2.1.8.31	Corrosion fatigue test—cycles	Numeric
2.1.8.32	Corrosion fatigue test—crack growth rate (average over period of crack growth measurement, not at failure point)	m/s (ft/s)
2.1.8.33	Threshold stress intensity range, $-K$	$\text{Pa}\sqrt{\text{m}}$ (psi $\sqrt{\text{in.}}$)

NOTE: Refer to NACE Standard TM0177⁸ and ASTM Standards E 399⁹ and E 647¹⁰ for additional detail on formats for reporting and storing fracture and fatigue data.

MATERIAL PERFORMANCE—NONMETALS

2.1.8.34	Degradation type	(1) cracking (2) crazing (3) delamination (4) blistering (5) softening (6) scission (7) dissolution (8) oxidation (9) thermal degradation (10) hardening/embrittlement (11) fiberglass prominence (12) permeation (13) pitting (14) loss of gloss (15) swelling
2.1.8.35	Performance—visual change	String
2.1.8.36	Performance—mass change	in x months
2.1.8.37	Performance—width	%
2.1.8.38	Performance—length	%
2.1.8.39	Performance—thickness change	%
2.1.8.40	Performance—volume change	%
2.1.8.41	Performance—tensile or flexural strength change	%
2.1.8.42	Performance—flexural strength change	%
2.1.8.43	Performance—modulus change	%

RP0690-2004

2.1.8.44	Performance—elongation change	%
2.1.8.45	Performance—hardness change	Points
2.1.8.46	Performance—impact (brittleness) change	Points

DOCUMENTATION

2.1.9.1	Documentation—data source	String
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SUPPLEMENTARY NOTES

2.2.1	Supplementary notes	String
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^(A) Data should be reported in the units that the original measurements were made. Subsequent conversions are at the discretion of database developers. Units listed are nonmandatory examples.

^(B) Chemical Abstracts, American Chemical Society (ACS), 1155 16th St. NW, Washington, DC 20036.

References

1. ASTM D 543 (latest revision), "Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents" (West Conshocken, PA: ASTM).
 2. ASTM E 8 (latest revision), "Standard Test Methods for Tension Testing of Metallic Materials" (West Conshocken, PA: ASTM).
 3. ASTM G 49 (latest revision), "Standard Practice for Preparation and Use of Direct Tension Stress-Corrosion Test Specimens" (West Conshocken, PA: ASTM).
 4. ASTM D 618 (latest revision), "Standard Practice for Conditioning Plastics for Testing" (West Conshocken, PA: ASTM).
 5. ASTM G 46 (latest revision), "Standard Guide for Examination and Evaluation of Pitting Corrosion" (West Conshocken, PA: ASTM).
 6. ASTM G 78 (latest revision), "Standard Guide for Crevice Corrosion Testing of Iron-Base and Nickel-Base Stainless Alloys in Seawater and Other Chloride-Containing Aqueous Environments" (West Conshocken, PA: ASTM).
 7. ASTM G 34, "Standard Test Method for Exfoliation Corrosion Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO Test)" (West Conshocken, PA: ASTM).
 8. NACE Standard TM0177 (latest revision), "Laboratory Testing of Metals for Resistance to Sulfide Stress Cracking and Stress Corrosion Cracking in H₂S Environments" (Houston, TX: NACE).
 9. ASTM E 399 (latest revision), "Standard Test Method for Plane-Strain Fracture Toughness of Metallic Materials" (West Conshocken, PA: ASTM).
 10. ASTM E 647 (latest revision), "Standard Test Method for Measurement of Fatigue Crack Growth Rates" (West Conshocken, PA: ASTM).
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RP0690-2004

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