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Standard Guide for Formats for Collection and Compilation of Corrosion Data for Metals for Computerized Database Input[1]

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1. Scope

1.1 This guide ~~defines~~covers the data categories and specific data elements (fields) considered necessary to accommodate desired search strategies and reliable data comparisons in computerized corrosion databases. The data entries are designed to accommodate data relative to the basic forms of corrosion and to serve as guides for structuring multiple source database compilations capable of assessing compatibility of metals and alloys for a wide range of environments and exposure conditions.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

E 8 Test Methods for Tension Testing of Metallic Materials

~~E527Practice for Numbering Metals and Alloys (UNS)~~

E 399 Test Method for Linear-Elastic Plane-Strain Fracture Toughness K_{Ic} of Metallic Materials

E 527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

E 647 Test Method for Measurement of Fatigue Crack Growth Rates

E 1314 Practice for Structuring Terminological Records Relating to Computerized Test Reporting and Materials Designation Formats (Discontinued 2000)

E 1338 Guide for ~~the~~ Identification of Metals and Alloys in Computerized Material Property Databases

G 1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens

G 15 Terminology Relating to Corrosion and Corrosion Testing

G 34 Test Method for Exfoliation Corrosion Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO Test)

G 46 Guide for Examination and Evaluation of Pitting Corrosion

G 49 Practice for Preparation and Use of Direct Tension Stress-Corrosion Test Specimens

G 78 Guide for Crevice Corrosion Testing of Iron-Base and Nickel-Base Stainless Alloys in Seawater and Other Chloride-Containing Aqueous Environments

3. Terminology

3.1 *Definitions*—For definitions of terms applicable to this guide see Practice E 1314 and Terminology G 15.

4. Significance and Use

4.1 The guide is intended to facilitate the recording of corrosion test results and does not imply or endorse any particular database design or schema. It provides a useful reference to be consulted before initiating a corrosion test to be sure plans are made to record all relevant data.

4.2 Corrosion tests are usually performed following a prescribed test procedure that is often not a standard test method. Most corrosion tests involve concurrent exposure of multiple specimens of one or more materials (refer to 6.1.1).

4.3 This guide is designed to record data for individual specimens with groupings by separate tests (as contrasted to separate test methods) as described in 4.2 and 6.1.1. Consequently, some of the individual fields may apply to all of the specimens in a single test, while others must be repeated as often as necessary to record data for individual specimens.

4.4 The guidelines provided are designed for recording data for entry into computerized material performance databases. They may be useful for other applications where systematic recording of corrosion data is desired.

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[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* ~~, Vol 03.01.~~volume information, refer to the standard's Document Summary page on the ASTM website.

4.5 Reliable comparisons of corrosion data from multiple sources will be expedited if data are provided for as many of the listed fields as possible. Comparisons are possible where data are limited, but some degree of uncertainty will be present.

4.6 Certain specialized corrosion tests may require additional data elements to fully characterize the data recorded. This guide does not preclude these additions. Other ASTM guides for recording data from mechanical property tests may be helpful.

4.7 This guide does not cover the recording of data from electrochemical corrosion tests.

4.8 These material identification guidelines are compatible with Guide E 1338.

5. Categorization of Corrosion Data

5.1 This guide considers nine general categories for use in documenting corrosion data. Categories, with input examples, are as follows:

5.1.1 *Test Identification*—Unique code to identify groupings of multiple specimens exposed at the same time and under identical conditions.

5.1.2 *Type of Test*—Standardized, laboratory, field tests; test relation to specific process or application (for example, sulfide stress cracking test for sour gas production tubing).

5.1.3 *Test Emphasis*—Specific form of corrosion or degradation (for example, pitting, corrosion-fatigue, crevice corrosion, etc.).

5.1.4 *Environment*—Generic description; identification, concentration, and state of principal components; contaminants, etc.

5.1.5 *Exposure Conditions*—Duration, temperature, pH, hydrodynamic conditions, aeration, etc.

5.1.6 *Material Identification*—Material class, subclass, and family, common name, standard designation, condition, manufacturing process, product form, etc.

5.1.7 *Specimen Identification*—Specimen number, size, geometry, surface condition, composition, properties.

5.1.8 *Specimen Performance*—Mass change, property change, performance relative to specific corrosion, or degradation mechanism.

5.1.9 *Data Source or Reference*.

5.2 This guide permits supplementary notes to document supplementary information considered important in interpreting data.

6. Data Searching

6.1 This guide considers data to accommodate searches for identifying and locating data and metadata in eight specific areas as follows:

6.1.1 Multiple specimens of one material included in same test (that is, exposed in same or companion test rack exposed under identical conditions in same or companion test vessel).

6.1.2 Different materials included in same test.

6.1.3 Material evaluated by specific standard test methods (by standardized test number).

6.1.4 Materials exposed to specific environments with environments defined by generic description (for example, sour gas) or by specific components (for example, hydrocarbon + H_2S).

6.1.5 Specific materials, defined by class (for example, metals), subclass (for example, wrought aluminum), family (for example, Al-Si alloys), standard designation (UNS No. (see Practice E 527), ASTM specification), or common name.

6.1.6 Specific application or process (for example, sour gas production tubing, pulp bleaching).

6.1.7 Type of corrosion or degradation mechanism (for example, pitting, corrosion fatigue, etc.).

6.1.8 Results from a specific reference or source.

6.2 Additional information may be required to facilitate supplementary search requirements. This guide does not preclude these additions.

7. Data Entry Fields

7.1 Data entry fields are listed in Table 1. The table contains the following information:

7.1.1 The reference number is a unique number the first three digits of which refer to the relevant paragraph numbers in this guide.

7.1.2 The field name or object tag is a concise label for the field. Tags are made up of one or more character strings separated by periods. The first character in each string must be alphabetic (a–z, A–Z,"). Thereafter the characters may be alphanumeric (a–z, A–Z,", 0–9).

7.1.2.1 Periods are used to separate subdivisions inherent in the information, for example "Component.Name," "Component-.Conc."

7.1.2.2 Tags are case insensitive although mixed case is suggested for readability. Mixed case is used when a tag's meaning forms a single concept, for example "FlowRegime."

7.1.3 The field description is a textual description of the field.

7.1.4 The field type describes the format and allowed contents for the field. The field may be one of the following types:

7.1.4.1 *String (STRING)*—A string is an undifferentiated series of characters. Strings may contain punctuation characters except for a tab, new line, or leading semicolon.

7.1.4.2 *Quantity (QUANT)*—A quantity is a data aggregate made of a real number and a unit. The last column of the table gives suggested units for the field. Alternative units may be used.

TABLE *Continued*

Reference Number	Field Name or Object Tag	Description	Field Type	Category Set/Suggested Units/Column Definition
5.1.1	Test No	individual test number to identify grouping of specimens tested concurrently. See subsequent entries of test method	STRING	
		TYPE OF TEST		
5.1.2.1	Standard	standard test specification	STRING	
5.1.2.2	Location	field or laboratory test	SET	(1) F - field (2) L - Laboratory
5.1.2.3	Date	date test started	DATE	
		TEST EMPHASIS		
5.1.3.1	CorrosionType	type(s) of corrosion evaluated examples: general corrosion, stress corrosion, pitting, crevice corrosion, hot or cold wall effects, fretting, stray current, weld corrosion, corrosion-fatigue, galvanic corrosion, microbiological corrosion	STRING	
		CHEMISTRY OF ENVIRONMENT		
5.1.4.1	Environment	generic description of environment	STRING	
5.1.4.2	Component	component—common name	STRING	
5.1.4.3	Component.Registry	chemical abstracts registry number	STRING	
5.1.4.4	Component.Conc	concentration (liquids)	QUANT	g/L
5.1.4.5	Component.Press	partial pressure (gases)	QUANT	N/m^2, psi
5.1.4.6	Component.Form	component form	SET	(1) solid (2) liquid (3) gaseous (4) aqueous liquid (5) non-aqueous solutions or emulsions
5.1.4.7	IonicSpecies	ionic species	STRING	
5.1.4.8	Inhibitor	inhibitors	STRING	
		Note: many environments contain multiple components. Reference numbers 5.1.4.1 through 5.1.4.8 should be repeated for each component and no restrictions should be placed on the number of components to be described for any given environment. <<<Needs resolution>>>		
		EXPOSURE CONDITIONS		
5.1.5.1	Duration	exposure duration	QUANT	days
5.1.5.2	MinTemp	temperature—min	QUANT	°C, °F
5.1.5.3	MaxTemp	temperature—max	QUANT	°C, °F
5.1.5.4	AvgTemp	temperature—av	QUANT	°C, °F
5.1.5.5	HeatTransfer	heat transfer between specimen and environment. If YES, describe conditions in 5.1.5.6	SET	(1) Y—yes (2) N—no
5.1.5.6	HeatTransfer.Description	heat transfer conditions	STRING	
5.1.5.7	MaxPH	pH—minimum	QUANT	
5.1.5.8	MinPH	pH—maximum	QUANT	
5.1.5.9	AvgPH	pH—avg	QUANT	
5.1.5.10	Alkalinity	total alkalinity (total concentration of bases)	QUANT	moles/l
5.1.5.11	Acidity	total acidity (total concentration of acids)	QUANT	moles/l
5.1.5.12	Conductivity	conductivity	QUANT	mhos/m
5.1.5.13	Pressure	pressure (absolute)	QUANT	Pa, psi
5.1.5.14	Velocity	velocity	QUANT	m/s, ft/s
5.1.5.15	ReynoldsNo	reynolds number	QUANT	
5.1.5.16	FlowRegime	flow	SET	(1) none (2) laminar (3) turbulent (4) forced convection
5.1.5.17	Geometry	system geometry at test sample	STRING	
5.1.5.18	Sparging	sparging	SET	(1) deaerated (vacuum, inert gas) (2) none—less than saturated (open to air) (3) air (4) oxygen (5) inert gas
5.1.5.19	Agitation	agitation	SET	(1) none (2) stirred (3) shaken (4) shaken but not bruised
5.1.5.20	ExpZone	exposure zone	SET	(1) continuous immersion (2) splash zone (3) waterline (4) condensate zone (5) gaseous phase (6) cyclic exposure describe in 5.1.5.21
5.1.5.21	ExpZone.Cycle	cyclic exposure cycle (immersion/air exposure, etc.)	STRING	

TABLE *Continued*

Reference Number	Field Name or Object Tag	Description	Field Type	Category Set/Suggested Units/Column Definition
5.1.5.22	Process	process relation examples: pulp bleaching, sour gas production, solvent extraction, gas scrubbing, etc.	STRING	
5.1.5.23	Application	application relation examples: heat exchanger tubing, fasteners, pumps, valves, scrubber ducting, etc.	STRING	
5.1.5.24	AV Ratio	ratio of specimen surface area to corrodent volume	QUANT	mm^2/L, $in.^2/L$
		MATERIAL IDENTIFICATION		
		reference numbers 5.1.6.1 through 5.1.6.6 are basic fields for use in material identification in database. Refer to Guide E 1338 on the identification of Metals and Alloys in computerized material property databases.		
5.1.6.1	Matl.Class	material class	STRING	
5.1.6.2	Matl.SubClass	sub-division of class	STRING	
5.1.6.3	Matl.SubSubClass	finer sub-division of class	STRING	
5.1.6.4	Matl.TradeName	common name/trade name	STRING	
5.1.6.5	Matl.UNSNo	material designation—UNS number	STRING	
5.1.6.6	Matl.Spec	specification/standard	STRING	
5.1.6.7	Shape	product shape	SET	(1)pipe/tube (2) plate (3) sheet/strip (4) wire/rod/bar (5) other—describe in 5.1.6.8
5.1.6.8	Shape.Description	description for (5) in 5.1.6.7	STRING	
5.1.6.9	ProdMethod	product production method		(1) extrusion (2) forging (3) casting (4) rolling (5) powder compaction (6) other—describe, in 5.1.6.10
5.1.6.10	ProdMethod.Description	description of (6) in 5.1.6.9	STRING	
5.1.6.11	Lot.ID	heat/lot identification	STRING	
5.1.6.12	Lot.Analysis	heat/lot chemical analysis	STRING	
		SPECIMEN IDENTIFICATION		
5.1.7.1	Specimen.Thickness	specimen thickness	QUANT	mm, in.
5.1.7.2	Specimen.Width	specimen width/diameter	QUANT	mm, in.
5.1.7.3	Specimen.Length	specimen length	QUANT	mm, in.
5.1.7.4	Specimen.Area	specimen surface area	QUANT	mm^2, $in.^2$
5.1.7.5	Density	density	QUANT	kg/m^3, $lb/in.^3$
5.1.7.6	Weld	welded specimen	SET	(1) Y—yes (2) N—no
5.1.7.7	Weld.Type	type of weld (see section 5.1.7.8 for additional detail)	SET	(1) autogenous (2) matching filler (3) dissimilar metal weld
5.1.7.8	Weld.Description	weld details examples: preheat, welding process, no. of passes, heat input, joint shape, cover gas, etc.		
5.1.7.9	Weld.Surface	welds ground or machined	SET	(1) ground (2) machined (3) as deposited (4) glass bead blasted
5.1.7.10	Thermomechanical	thermomechanical condition	SET	(1) standard temper—describe in 5.1.7.11 (2) annealed (3) normalized (4) sensitized (5) as cold worked (6) as hot worked (7) aged (8) other H.T./processing—describe in 5.1.7.11
5.1.7.11	Thermomechanical.Description	description for (1) or (7) in 5.1.7.10	STRING	
5.1.7.12	FinalReduction	final reduction step		(1) cold worked—give % reduction in 5.1.7.13 (2) hot worked (includes extrusion and forging)
5.1.7.13	Reduction	% cold reduction	QUANT	%
5.1.7.14	TensileStrength	ultimate tensile strength	QUANT	Pa, psi
5.1.7.15	YieldStrength	yield strength	QUANT	Pa, psi
5.1.7.16	YieldStrength.Offset	% offset for yield strength	QUANT	%
5.1.7.17	FractureDuctility	fracture ductility (strain)	QUANT	%
5.1.7.18	Hardness	hardness	QUANT	
5.1.7.19	Hardness.Scale	hardness scale	STRING	
5.1.7.20	SurfaceCondition	surface condition	SET	(1) as produced

TABLE *Continued*

Reference Number	Field Name or Object Tag	Description	Field Type	Category Set/Suggested Units/Column Definition
				(2) scaled (3) machined/ground (4) chemically cleaned (5) sand/grit blasted (6) other
5.1.7.21	SurfaceTreatment	surface treatment	SET	(1) None (2) nitrided (3) carburized (4) plated (5) clad (6) anodized (7) other
5.1.7.22	SurfaceTreatment.Material	if (4), (5) or (7) in 5.1.6.21, plating or cladding material or other surface treatment	STRING	
5.1.7.23	EdgeCondition	condition of edges	SET	(1) as cut (2) as sheared (3) ground (4) machined (5) other—describe in 5.1.7.24
5.1.7.24	EdgeCondition.Description	description of other edge condition	STRING	
5.1.7.25	Orientation	sample orientation relative to working direction	SET	(1) longitudinal (2) transverse (3) short transverse
5.1.7.26	SCC.Specimen	stress corrosion cracking (SCC) specimen type	SET	(1) double contilever beam (DCB) (2) wedge open loaded (WOL)—see 5.1.7.27 (3) bent beam—2 pt loaded (4) bent beam—3 pt loaded (5) bent beam—4 pt loaded (6) standard tension specimen (Test Method E 8) (7) subsize tension specimen (Test Method E 8) (8) C ring (9) stressed ring (10) U-bend (11) other
5.1.7.27	SCC.Wedge	material used for wedge in WOL specimen	STRING	
5.1.7.28	SCC.Insulation	was stressing device insulated from specimen	STRING	
5.1.7.29	SCC.Area	stress corrosion cracking specimen test area	SET	(1) smooth (2) notched (3) precracked
5.1.7.30	SCC.StressMethod	direct tension stress corrosion cracking specimen—applied stress (Practice G 49)	SET	(1) constant load (2) slowly increasing strain rate (3) constant deflection
5.1.7.31	SCC.StressLevel	stress corrosion cracking specimen-stress level (absolute)	QUANT	Pa, psi
5.1.7.32	SCC.StressPercent	stress corrosion cracking specimen-stress level (% of yield strength at test temperature)	QUANT	%
5.1.7.33	SSR.Rate	strain rate for slow strain rate test	QUANT	(mm/mm)/s-1
		SPECIMEN PERFORMANCE Refer to Test Methods E 399 and E 647 for additional detail on formats for recording fracture and fatigue data)		
5.1.8.1	MassLoss.Total	mass loss (Practice G 1)	QUANT	g
5.1.8.2	MassLoss.PerArea	mass loss—unit area basis	QUANT	g/mm^2, mg/in.^{2}
5.1.8.3	CorrosionRate	corrosion rate	QUANT	mm/yr, mpy
5.1.8.4	E_{oc}	corrosion potential	QUANT	mV
5.1.8.5	ReferenceElectrode	reference electrode for 5.1.8.4	STRING	
5.1.8.6	Elongation.Reduction	reduction in elongation	QUANT	%
5.1.8.7	FractureDuctility.Reduction	reduction in fracture ductility (strain)	QUANT	%
5.1.8.8	TensileStrength.Reduction	reduction in tensile strength	QUANT	%
5.1.8.9	YieldStrength.Reduction	reduction in yield strength	QUANT	%
5.1.8.10	CorrosionProducts	nature of corrosion products	STRING	
5.1.8.11	VisualCorrosion	visible corrosion?	SET	(1) corroded (2) no visible corrosion
5.1.8.12	Pitting.MaxDepth	max pit depth: depth measured perpendicular to surface (Guide G 46)	QUANT	mm, in.
5.1.8.13	Pitting.AvgDepth	average depth of five deepest pits (Guide G 46)	QUANT	mm, in.
5.1.8.14	Pitting.Density	pitting density (Guide G 46)	QUANT	number/m^2, number/in.^{2}
5.1.8.15	Crevice.Depth	max depth of crevice corrosion	QUANT	mm. in.
5.1.8.16	Crevice.Type	type of crevice (Guide G 78)	STRING	
5.1.8.17	Weld.CorrosionLocation	weld related corrosion	SET	(1) fusion line (2) base metal (3) weld metal (4) heat affected zone

TABLE *Continued*

Reference Number	Field Name or Object Tag	Description	Field Type	Category Set/Suggested Units/Column Definition
5.1.8.18	SCC.Severity	stress corrosion cracking (SCC) test—severity of attack	SET	(1) no cracking (2) microcracks (3) total fracture (complete separation)
5.1.8.19	SCC.Type	SCC Cracking mode	SET	(1) transgranular (2) intergranular (3) mixed mode (4) ductile
5.1.8.20	SCC.CrackRate	crack propagation rate	QUANT	m/s, ft/s
5.1.8.21	Hydrogen.Type	hydrogen damage	SET	(1) hydrogen blistering (2) hydrogen embrittlement (3) hydride formation
5.1.8.22	Dealloying.Type	Dealloying	SET	(1) plug (2) laminar
5.1.8.23	Exfoliation.Type	Exfoliation corrosion (Test Method G 34)	SET	(1) none (2) superficial (3) moderate (4) severe (5) very severe
5.1.8.24	Intergranular.Depth	intergranular corrosion, maximum depth of attack	QUANT	mm, in.
5.1.8.25	Galvanic.CoupleMaterial	galvanic corrosion—material coupled to	STRING	
5.1.8.26	Galvanic.AreaRatio	galvanic corrosion—area ratio of test material/coupled material	QUANT	
5.1.8.27	Fatigue.Method	corrosion fatigue test	SET	(1) rotating beam (2) cantilever beam (3) cyclic loaded tensile specimen
5.1.8.28	Fatigue.Type	corrosion fatigue test—initial crack detection/failure	SET	(1) crack detection (2) failure (3) no cracking
5.1.8.29	Fatigue.Level	corrosion fatigue test—stress level	QUANT	Pa, ksi
5.1.8.30	Fatigue.InitTime	time to initial crack detection	QUANT	s
5.1.8.31	Fatigue.InitLength	measured crack length at time of first detection	QUANT	mm, in.
5.1.8.32	Fatigue.DetnMethod	method used to detect initial cracking	STRING	
5.1.8.33	Fatigue.Rratio	R ratio—min/max load or stress intensity	QUANT	
5.1.8.34	Fatigue.Cycles	corrosion fatigue test-cycles	QUANT	
5.1.8.35	Fatigue.CrackRate	Corrosion fatigue test—crack growth rate (average over period of crack growth measurement, not at failure point)	QUANT	mm/cycle, in./cycle
5.1.8.36	Fatigue.Threshold	threshold stress intensity range	QUANT	mPa-m, ksi-in.
		DOCUMENTATION		
5.1.9.1	TestNumber	test number	STRING	
5.1.9.2	TestReference	published reference	STRING	
5.1.9.3	DataLocation	unpublished data—location	STRING	
5.1.9.4	TechReport	technical committee report/file	STRING	
5.1.9.5	Documentation	other documentation	STRING	
		SUPPLEMENTARY NOTES		
5.2.0.1	Notes	supplementary notes	STRING	

7.1.4.3 *Data (DATE)*—A date is a string of eight numeric characters encoding year, month, and day in the order YYYYMMDD.

7.1.4.4 *Time (TIME)*—A time is a string of six numeric characters encoding hour, minute and second in the order HHMMSS.

7.1.4.5 *Category Set (SET*—A category set is a closed list of values for a particular field. A database uses an integer value to record the member of the category set. Category sets should not be used for quantities. Use the quantity type, instead. The last column of the table gives a list of acceptable values and their meaning for each category set field.

7.1.4.6 *Tabular (TABLE)*—A tabular field is made up of a group of values. The last column gives the title and type of each value.

8. Keywords

~~8.1computerization; corrosion; data; database; material performance; metal~~

~~TABLE 1Standard Data Entry Fields for Corrosion Database Development~~

~~Reference Number~~	~~Field Name or Object Tag~~	~~Description~~	~~Field Type~~	~~Category Set/Suggested Units/Column Definition~~
~~5.1.1~~	~~Test No~~	~~individual test number to identify grouping of specimens tested concurrently. See subsequent entries of test method~~	~~STRING~~	
		~~TYPE OF TEST~~		
~~5.1.2.1~~	~~Standard~~	~~standard test specification~~	~~STRING~~	
~~5.1.2.2~~	~~Location~~	~~field or laboratory test~~	~~SET~~	~~(1) F - field (2) L - Laboratory~~