Internal Corrosion Specialist

Exam Preparation Guide

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Introduction

The Internal Corrosion Specialist (ICS) Exam is designed to assess the knowledge and skills required to competently manage or supervise the design, implementation, and evaluation of internal corrosion programs across industries.

The ICS uses advanced knowledge and extensive experience to protect society, assets, and the environment from the adverse effects of internal corrosion.

The internal corrosion specialist:

- has an advanced understanding of internal corrosion mechanisms.
- analyzes and evaluates key environmental variables and operating conditions that promote internal corrosion.
- evaluates and communicates hazards, risks, and personnel safety associated with field activities.
- analyzes and assesses internal corrosion data trends and performs activities to identify and verify potential internal corrosion.
- evaluates and recommends an internal corrosion mitigation strategy based on environment and materials of the assets.
- recommends alternative design and monitoring options as appropriate.
- facilitates internal corrosion failure analysis and provides appropriate recommendations.
- supports internal corrosion root cause failure analysis.
- designs, implements, and manages internal corrosion control programs including periodic review.
- manages internal corrosion data, assessment, recommendations, or implementation.
- understands and communicates the importance of monitoring, mitigation, and record management, including legal/regulatory compliance.

Exam Overview

The Internal Corrosion Specialist Exam consists of 80 multiple-choice questions that require the candidate to demonstrate competency across the entire domain of knowledge and skills.

Exam Name	Internal Corrosion Specialist Exam
Exam Code	ICS
Time	300 minutes[1]
Number of Questions	80 (includes 5 unscored questions)[2]
Format	Computer Based Testing (CBT)

Note:

- A pass/fail grade is provided at the end of the exam.
- A course manual is NOT provided during the exam.
- Reference material is provided during the exam for questions that require an equation, conversion chart, or other reference (see *Reference Material*).

[1] Exam time includes 4 minutes for the non-disclosure agreement and 6 minutes for the system tutorial.
[2] Unscored exam questions are being evaluated for future exams.

Requirements

Internal Corrosion Specialist Certification Requirements	
	Certification Requirement
	• Active Senior Internal Corrosion Technologist certification
AND	
	Education and Work Experience
Option 1	• Bachelor's degree in physical science or engineering • 8 years of verifiable internal corrosion-related work experience in pipeline and associated facilities
Option 2	• 12 years of verifiable internal corrosion-related work experience in pipeline and associated facilities
AND	
	Course
	Successful completion of the Ethics for the Corrosion Professional course or an equivalent training
AND	
	Exam
	Certification exam – Internal Corrosion Specialist Exam (delivered through Pearson testing centers)

Exam Blueprint

The exam blueprint defines the content areas assessed on the exam and can be used as a framework to guide your preparation.

Internal Corrosion Specialist

1. Corrosion Mechanisms

1. Electrochemistry
    1. Evaluate the risk of corrosive species, and how they can affect the internal corrosion of the system.
    2. Analyze metallurgical influences on corrosion, electrochemical corrosion kinetics, behavior aspects, and failure mechanisms of alloyed elements and welded microstructures.
    3. Determine galvanic corrosion and polarization mechanisms including the essential factors that accelerate galvanic corrosion, and how they are controlled.
    4. Determine the involvement of factors in the acceleration of crevice corrosion.
    5. Apply fundamentals of electrochemistry.
    6. Apply thermodynamics and kinetics of corrosion.
    7. Evaluate instrumentation and determine proper electrochemical experimental procedures.
    8. Analyze fluid (electrolyte, oil, and gas) chemistry.
    9. Determine active-passive corrosion behavior and evaluate passive scaling and chemical film tendency.
2. Types of Corrosion and Morphology
    1. Categorize corrosion mechanisms and why they occur.
    2. Evaluate effect of corrosive species including concentration in the system.
    3. Explain the mechanism of internal corrosion that can occur in various types of service such as the upstream production system.
    4. Explain failure mechanisms of stray current on internal corrosion and understand where they may occur.
    5. Define metallurgical variables involved in dealloying corrosion.
    6. Explain the involvement of factors and their mechanisms in mechanically assisted metal degradation.
    7. Determine the role of material chemistry and microstructures in environmentally assisted cracking.
    8. Evaluate electrochemical and microbiological induced/influenced corrosion mechanisms.
    9. Recognize environmentally assisted cracking mechanisms.
    10. Evaluate flow induced degradation mechanisms.
    11. Understand metal manufacturing and joining processes and how those processes can affect corrosion and cracking.

2. **Assessment**
    1. Threat Pre-Assessment
        1. Analyze how the operating conditions (e.g. temperature, pressure, flow) affect internal corrosion.
        2. Analyze how system design features such as dead legs, pipeline drips, etc. affect internal corrosion.
        3. Apply NACE SP0775 “Preparation, Installation, Analysis, and Interpretation of Corrosion Coupons in Oilfield Operations.”
        4. Utilize information and past experience with the pipeline to predict corrosion forms and rates.
        5. Apply direct-assessment methods (DG-ICDA, LP-ICDA, MP-ICDA, and WG-ICDA).
        6. Evaluate corrosion rate modeling results to calculate expected service life.
        7. Evaluate the impact of operating conditions and fluid chemistry on solubility of gases, chemicals, and solids.
        8. Evaluate water source, water chemistry and scaling tendencies.
        9. Evaluate flow rate calculations and flow rate measurement.
        10. Analyze the results from flow analytics and product compositions.
        11. Analyze the results from emulsion stabilities, and its impact on corrosion.
        12. Evaluate corrosion rate and determination methods.
        13. Analyze and apply results from online corrosion monitoring systems.
    2. Sampling, Testing, Data Collection
        1. Evaluate the typical commodities transported through transmission pipelines and explain their corrosive effects.
        2. Determine sample collection, handling and testing methods needed for solid/liquid/gas samples.
        3. Explain factors in selecting internal corrosion monitoring locations and sample points.
        4. Analyze and manage data related to internal corrosion monitoring.
        5. Apply microbiological monitoring methods and evaluate the results in accordance with current industry standards to evaluate their effectiveness.
        6. Explain the standard conditions and the conversion formula used for gas-flow rates in gas pipelines.
        7. Apply monitoring techniques, including spool piece, and inspection methods to evaluate internal corrosion status.
        8. Analyze results from energy dispersive spectroscopy (EDS), X-ray fluorescence (XRF), and X-ray diffraction (XRD) to analyze corrosion product.
        9. Apply proper real-time internal corrosion monitoring systems such as electrical-resistance (ER), linear-polarization resistance (LPR), electrochemical noise (ECN), electrical field mapping (EFM), ultrasonic testing (UT) probes.
        10. Apply various inspection methods such as visual inspection, magnetic flux leakage (MFL), ultrasonic testing (UT), etc. to detect and evaluate damaged areas.
        11. Support the implementation of procedures for (hydrostatic) pressure testing, in-line inspection, and direct assessment that can be used to assess the integrity of pipelines.

3. Analysis and Interpretation
    1. Assess and utilize risk evaluation tools, models, and methods.
    2. Evaluate the corrosive effects of gas, liquid, or solid constituents on a pipeline.
    3. Describe the characteristics of the mechanical and empirical corrosion-rate models and computational fluid dynamics (CFD) models.
    4. Analyze the results from monitoring to determine if internal corrosion is a problem.
    5. Evaluate corrosion rate trends for the system.
    6. Evaluate the extent of corrosion and interpret results within a pipeline using industry standard guidance.
    7. Utilize integrated data from various inspection methods to determine corrosion rate.
4. Risk Assessment and Evaluation
    1. Apply four step process of risk management to internal corrosion programs.
    2. Validate whether internal corrosion is a problem by analyzing the corrosion inspection/assessment results.
    3. Evaluate safe operating conditions using appropriate standards.

3. Mitigation of Internal Corrosion

1. Operational Factors
    1. Analyze the pipeline operations to apply internal corrosion mitigation program.
    2. Apply corrosion control and mitigation measures by controlling corrosive constituents.
    3. Apply the primary methods for gas dehydration such as Joule-Thompson Expansion, solid-desiccant, and liquid-desiccant methods.
    4. Design a corrosion mitigation strategy for a pipeline based on an initial assessment of the asset’s service, design, and operational requirements.
    5. Evaluate factors and mechanisms involved in corrosion processes in petroleum production operations.
    6. Evaluate corrosion problems and mitigation methods for enhanced recovery operations in petroleum industries.
    7. Evaluate mitigating factors influencing corrosion in distribution lines.
    8. Understand petroleum industry process operations, utility systems, cooling water, and wastewater systems.

2. Chemical Treatment
    1. Evaluate chemical treatments for compatibility and effectively apply them to mitigate and reduce potential corrosion.
    2. Evaluate chemical treatment applications including continuous injection and batch treatment.
    3. Evaluate corrosion-inhibitor properties and effective application for end-user applications.
    4. Recognize factors that can affect the effectiveness of corrosion inhibitors.
    5. Evaluate the benefits and drawbacks of different chemical treatment approaches for effective corrosion control and applications.
    6. Evaluate different applications of biocides and their effect on microbial populations.
    7. Evaluate the role of water treatments in the prevention of corrosion and apply them.
    8. Define factors affecting corrosion behaviors and their mitigation strategies.
3. Cleaning and Other Mitigations
    1. Evaluate the impact of the primary methods for liquid hydrocarbon dewatering on internal corrosion.
    2. Evaluate methods to remove or reduce the amount of potentially corrosive constituents.
    3. Evaluate applicability of utilizing internal linings, and/or claddings to mitigate internal corrosion.
    4. Evaluate the selection and implementation of chemical and mechanical cleaning program for removing solids.
    5. Develop a pigging program and evaluate the program’s performance.
    6. Apply fundamentals, types, and aspects of anodic and cathodic protection for electrochemical corrosion control.
    7. Evaluate material selection and design processes, and maintain the systems for corrosion control, based on potential corrosion failure mechanism.
    8. Apply the principles, selection and application of equipment, models and processes to optimize corrosion control.
    9. Evaluate the effectiveness of mitigation and prevention of internal corrosion (developing a mitigation strategy, options: prevent corrosive conditions, materials selection, corrosion inhibitors, biocides, cleaning and pigging, monitoring the effectiveness of treatments).
    10. Understand designing for corrosion control (materials selection, eliminating corrosive species, flow characteristics, physical design, linings).
    11. Understand control of the corrosive environment (process layout, design for inspection, monitoring, chemical treatment, pigging; water mixing, electrical isolation, oxygen exclusion and removal, dehydration of gas, deposit control, controlling microbiologically influenced corrosion, water injection, hydrotest water, mothballing, lay-up, decommissioning, preservation).

4. Management of Internal Corrosion Programs

1. Data Integration and Reliability
    1. Evaluate reliability of direct or indirect monitoring techniques for application.
    2. Apply an internal corrosion data management program.
    3. Determine the most cost-effective approach for monitoring, inspection, and in-service mitigation.
    4. Establish key performance indicator (KPIs) in effective corrosion monitoring and control.
    5. Understand operating procedures of the pipe manufacturers and their manufacturing processes.
    6. Understand major standards for line pipe design, manufacturing and testing.
    7. Evaluate the life cycle aspects of facility and pipeline infrastructure management including abandonment.
    8. Evaluate risk, corrosion, and integrity management for both onshore and offshore systems.
    9. Periodically evaluate the effectiveness and performance of mitigation methods by monitoring and inspection.
2. Management and Documentation
    1. Support management of change (MOC) and communicate it with cross-functional teams.
    2. Apply the basic terms of economics used for internal corrosion management.
    3. Assess the economic value of a risk-management plan and associate mitigation methods for pipeline operations with internal corrosion damage.
    4. Evaluate roles and responsibilities related to an internal corrosion management program.
    5. Implement continual improvement processes, including old and new products, for corrosion monitoring, profiling, and pipe loops to validate performance and prevent unintended consequences.
    6. Recognize the need for a failure investigation and analysis.
    7. Develop strategies and implement plans to conduct periodic review of corrosion data and integration programs.
    8. Evaluate corrosion control programs and economics (corrosion control programs, integrated corrosion control programs, corrosion risk, cost of corrosion).
    9. Implement a risk management plan using the bow-tie technique and risk-matrix methodology.

3. Communications and Collaboration
    1. Support documentation according to a proper protocol and validate data traceability.
    2. Describe different aspects of facility inspection programs, including their purpose at various stages and the importance of data collection and management.
    3. Collaborate with vendors including chemical service providers, Inspection (NDE) Services, ILI service providers, etc. for corrosion management.
    4. Coordinate with stakeholders for business development and planned expansions.
    5. Communicate internal corrosion control assessment outcomes and critical issues with stakeholders including company management and establish communication protocol.
    6. Communicate the need of maintenance and integrity programs for the facility and pipeline infrastructure with upper management and stakeholders.

5. Safety, Standards, and Compliance

1. Safety, Standards, and Compliance
    1. Evaluate whether a pipeline has been assessed for internal corrosion, taking into consideration local regulations and company policy.
    2. Apply Hazard Identification (HAZID) and Hazard and Operability (HAZOP) processes to specific locations, tasks, or processes.
    3. Support regulatory compliance.
    4. Support stakeholders to meet regulatory compliance including audits.
    5. Provide support and overview for local and governmental regulations.
    6. Manage internal corrosion documents for regulatory compliance and audits.
    7. Understand industry standards and practices related to chemical treatment, testing, and evaluation of corrosion rates (e.g. NACE 1D-182, etc.)
    8. Understand international standards and industry practices related to direct assessment. (e.g. NACE SP0206, etc.)
    9. Understand how to utilize internal corrosion related standards (e.g. NACE SP0106, etc.)
    10. Understand the safety issues of black powder in gas pipeline systems.
    11. Develop risk assessment matrix.

Recommended Study Material

Books

Association for Materials Protection and Performance (AMPP), *Course Manual: Internal Corrosion for Pipelines – Level 2*

Association for Materials Protection and Performance (AMPP), *Course Manual: Internal Corrosion for Pipelines – Advanced.*

Byars, H. G., *Corrosion Control in Petroleum Production*, 2nd ed., Gulf Professional Publishing, 1999.

Eckert, R. B., *Field Guide to Internal Corrosion Mitigation and Monitoring for Pipelines*, 1st ed., 2016.

Standards[3]

SP0102-2026. *In-Line Inspection of Pipelines.* NACE International, 2026.

SP0110-2024. *Wet Gas Internal Corrosion Direct Assessment (WG-ICDA) Methodology for Pipelines.* NACE International, 2024.

SP0116-2022. *Multiphase Flow Internal Corrosion Direct Assessment (MP-ICDA) Methodology for Pipelines.* NACE International, 2022.

SP0206-2016. *Internal Corrosion Direct Assessment Methodology for Pipelines Carrying Normally Dry Natural Gas (DG-ICDA).* NACE International, 2016.

SP0775-2023. *Preparation, Installation, Analysis, and Interpretation of Corrosion Coupons in Hydrocarbon Operations.* NACE International, 2023.

TR3T199-2020. *Techniques for Monitoring and Measuring Corrosion and Related Parameters in Field Applications.* NACE International, 2020.

[3] Where appropriate, the candidate may have access to all or part of this reference material as part of the exam.

Provided Exam Resources

Candidates will have access to the reference material needed during the exam. This can include such items as:

- industry standards
- equations and conversion charts (See *Reference Material*)
- other materials where appropriate

Note: AMPP course manuals <u>are not available</u> as part of the resources provided for this exam.

Exam Calculator

Candidates will have access to a digital TI-108 Standard and TI-30XS Scientific calculator for use during the Certification Exam. During the exam, you may have to switch or select one of these calculators for use. Candidates will not be able to use their own calculator for this exam.

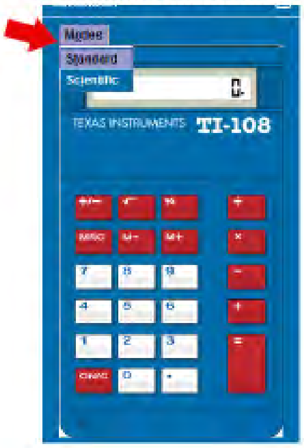
Prior to attending your exam session:

- It is highly recommended that candidates review how the calculator operates and how it is used.
- The exam scientific calculator may be used for trigonometric hyperbolic functions such as:

  $$\sinh x = \frac{e^{x} - e^{-x}}{2}$$

- Key stroke example for sinh x is: 2nd, hyperbolic (hyp), sin, enter number,) , enter.

Standard Calculator



Standard Mode Functions

Add	[+]	
Subtract	[-]	
Multiply	[X]	
Divide	[÷]	
Negative	[(-)]	
Percentage	[%]	
Square Root	[√]	Example: 4[√]
Reciprocal (Inverse)	x	Example: 1[÷]2[=]
Store value to variable	[M+]	Example: 3[*]5[=][M+]
Access variable	[MRC]	Example: 7[+][MRC][=]
Clear variable	[M-][MRC]	

Scientific Calculator

Scientific Mode Functions

Add	[+]	
Subtract	[-]	
Multiply	[X]	
Divide	[÷]	
Negative	[(-)]	
Percentage	[2nd] [%]	
Square Root	[√]	Example: [2nd][√]4[enter]
Reciprocal (Inverse)	[X^{-1}]	Example: 2[X^{-1}][enter]
Store value to variable	[sto▶] [X^{yzt}]	Example: 3[*]5[enter][sto▶][X^{yzt}][enter]
Access variable	[X^{yzt}] or [2nd] [recall]	Example: 7[+][2nd][recall][enter][enter]

Numeric Notation

Standard (Floating Decimal) Notation (digits to the left and right of decimal	mode menu options **NORM** SCI ENG e.g. 123456.78 FLOAT 0 1 2 3 **4** 5 … e.g. 123456.7800
Scientific Notation (1 digit to the left of decimal and appropriate power of 10)	mode menu options NORM **SCI** ENG e.g. 1.2345678*105
Engineering Notation (numer from 1 to 999 times 10 to an integer power that is a multiple of 3)	mode menu options NORM **SCI** ENG e.g. 123.45678*103

Fractions

Simple fractions	n/d	
Mixed numbers	2nd [Un/d]	
Conversion b/w simple fraction and mixed number	2nd [n/d ◄► Un/d]	
Conversion b/w fraction and decimal	2nd [f ◄► d]	

Powers, roots, and inverses

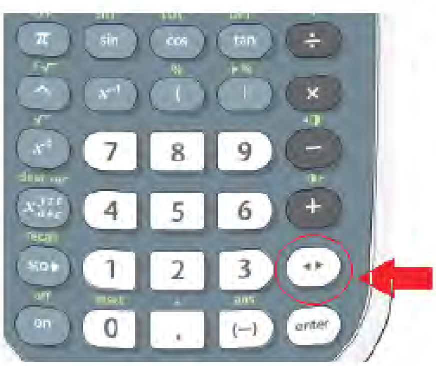
Square a value	x^2	
Cube a value	^	
Raise value to specified power	^	Example (2^4) 2 ^ 4
Square root	2nd [√]	Example (√16): 2nd [√] 16
Reciprocal	x^{-1}	Example (n^{th} root): 5^{th} root of 8: 5 2nd [^{x}√] 8

Pi

PI (π)	π	

Toggle

The scientific calculator might show the results of certain calculations as a fraction – involving pi or a square root. To convert this kind of result to a single number with a decimal point, you will need to use the “toggle answer” button circled in the picture below. Pressing this button will change the display from a fractional to a decimal format.



Answer Toggle

◄►

Press the ◄► key to toggle the display result between fraction and decimal answers, exact square root and decimal, and exact pi and decimal.

Example

Answer toggle	2nd [√] 8 enter	√8 2√2
	◄►	√8 2√2 2√2► 2.828427125

If you find this onscreen calculator difficult to use, raise your hand and ask the Test Administrator to provide you with a hand-held calculator. Depending on the testing center, the test administrator may be able to provide you with either the scientific or non-scientific calculator model as referenced above.

Reminder: *Candidates will not be able to use their own calculator for this exam*.

Reference Material - Formulas

Density from Reynolds number

$Re = (\rho \cdot V \cdot D) / \mu$

$\rho = (Re \cdot \mu) / (V \cdot D)$

Where:

- Re = Reynolds number (dimensionless)
- ρ = fluid density (kg/m^3)
- V = average fluid velocity (m/s)
- D = pipe internal diameter (m)
- μ = dynamic viscosity (Pa·s)

Inhibitor volume required for water phase treatment

$Q_{water} = Q_{total} \cdot WC$

$V_{inhib}/day = Q_{water} \cdot (Dose_{ppm} / 10^6)$

Where:

- Q_{total} = total liquid flow rate (e.g., gal/day)
- WC = water cut (fraction, e.g., 15% = 0.15)
- Q_{water} = water phase flow rate (same units as Q_{total})
- $Dose_{ppm}$ = target inhibitor dose to water phase (ppm, v/v unless otherwise specified)
- V_{inhib}/day = inhibitor volume required per day (gal/day)

CO_2 partial pressure

$$P_{CO2} = y_{CO2} \cdot P_{total(abs)}$$

$$P_{total(abs)} = P_{gauge} + P_{atm}$$

Where:

- P_{CO2} = CO_2 partial pressure (same pressure units as P_{total})
- y_{CO2} = CO_2 mole fraction (mol% / 100)
- $P_{total(abs)}$ = total absolute pressure
- P_{gauge} = gauge pressure (psig or kPag)
- P_{atm} ≈ 14.7 psi (≈ 101.3 kPa)

Inhibitor efficiency

IE(%) = [(CR_un-inh − CR_inh) / CR_un-inh] · 100

Where:

- IE(%) = inhibitor efficiency, percent
- $CR_{un\text{-}inh}$ = corrosion rate without inhibitor (e.g., mpy or mm/y)
- CR_{inh} = corrosion rate with inhibitor (same units as $CR_{un\text{-}inh}$)

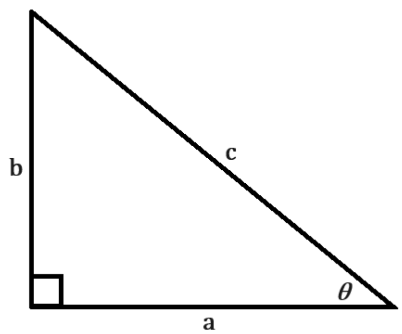
Risk equation

Risk = (Estimated Cost of Failure) · (Probability of Failure)

Ryznar Stability Index (RSI)

RSI = $2pH_s - pH$

Trigonometric Definitions



$$sin\theta \ = \frac{b}{c}$$

$$cos\theta \ = \frac{a}{c}$$

$$tan\theta \ = \frac{b}{a}$$

$$cosec\theta \ = \frac{c}{b}$$

$$sec\theta \ = \frac{c}{a}$$

$$cot\theta = \frac{a}{b}$$

Table / Scale References

NOTE: All references, including equations, were taken from original sources and may differ from those used in course manuals and presentations

METRIC PREFIXES

Prefix	Symbol	Factor	Power
tera	T	1 000 000 000 000	10^{12}
giga	G	1 000 000 000	10^{9}
mega	M	1 000 000	10^{6}
kilo	k	1 000	10^{3}
hecto	h	100	10^{2}
deca	da	10	10^{1}
(none)	(none)	1	10^{0}
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	μ	0.000 001	10^{-6}
nano	n	0.000 000 001	10^{-9}
pico	p	0.000 000 000 001	10^{-12}

CONVERSIONS

EMF	electromotive force – any voltage unit
E or e	any voltage unit
V	volts
mV	millivolts
μV	microvolts
I	any amperage unit
mA	milliamperes or milliamps
μA	microampere or microamps
R or Ω	Resistance

1,000,000 volts	= 1 megavolt
1,000 volts	= 1 kilovolt
1.0 volt	= 1000 millivolts
0.100 volt	= 100 millivolts
0.010 volt	= 10 millivolts
0.001 volt	= 1 millivolt
0.000001 volt	= 1 microvolt

1,000,000 amperes	= 1 mega-ampere
1,000 amperes	= 1 kiloampere0 ampere
= 1000 milliamperes	
0.100 ampere	= 100 milliamperes
0.010 ampere	= 10 milliamperes
0.001 ampere	= 1 milliampere
0.000001 ampere	= 1 microampere

1,000,000 ohms	= 1 mega-ohm
1,000 ohms	= 1 kilo-ohm
1.0 ohms	= 1000 milliohms
0.100 ohm	= 100 milliohms
0.010 ohm	= 10 milliohms
0.001 ohm	= 1 milliohm
0.000001 ohm	= 1 micro-ohm

1 meter	= 100 cm
1 meter	= 1000 mm
1 inch	= 2.54 cm
1 foot	= 30.48 c

U.S. Customary/Metric Conversion for Units of Measure Commonly Used in Corrosion-Related Publications

1 A/ft^2	= 10.76 A/m^2
1 acre	= 4,047 m^2 = 0.4047 ha
1 A·h/lb	= 2.205 A·h/kg
1 bbl (oil, U.S.)	= 159 L = 0.159 m^3
1 bpd (oil)	= 159 L/d = 0.159 m^3/d
1 Btu	= 1,055 J
1 Btu/ft^2	= 11,360 J/m^2
1 Btu/h	= 0.2931 W
1 Btu/h·ft^2	= 3.155 W/m^2 (K-factor)
1 Btu/h·ft^2·°F	= 5.678 W/m^2·K
1 Btu·in/h·ft^2·°F	= 0.1442 W/m·K
1 cfm	= 28.32 L/min = 0.02832 m^3/min
	= 40.78 m^3/d
1 cup	= 236.6 mL = 0.2366 L
1 cycle/s	= 1 Hz
1 ft	= 0.3048 m
1 ft^2	= 0.0929 m^2 = 929 cm^2
1 ft^3	= 0.02832 m^3 = 28.32 L
1 ft·lbf (energy)	= 1.356 J
1 ft·lbf (torque)	= 1.356 N·m
1 ft/s	= 0.3048 m/s
1 gal (Imp.)	= 4.546 L = 0.004546 m^3
1 gal (U.S.)	= 3.785 L = 0.003785 m^3
1 gal (U.S.)/min (gpm)	= 3.785 L/min = 0.2271 m^3/h
1 gal/bag (U.S.)	= 89 mL/kg (water/cement ratio)
1 grain	= 0.06480 g = 64.80 mg
1 grain/ft^3	= 2.288 g/m^3
1 grain/100 ft^3	= 22.88 mg/m^3
1 hp	= 0.7457 kW
1 microinch (µin)	= 0.0254 µm = 25.4 nm
1 in	= 0.0254 m = 2.54 cm = 25.4 mm
1 in^2	= 6.452 cm^2 = 645.2 mm^2
1 in^3	= 16.387 cm^3 = 0.01639 L
1 in·lbf (torque)	= 0.113 N·m
1 inHg	= 3.386 kPa
1 inH$_2$O	= 249.1 Pa
1 knot	= 0.5144 m/s
1 ksi	= 6.895 MPa
1 lb	= 453.6 g = 0.4536 kg
1 lbf/ft^2	= 47.88 Pa
1 lb/ft^3	= 16.02 kg/m^3
1 lb/100 gal (U.S.)	= 1.198 g/L
1 lb/1,000 bbl	= 2.853 mg/L
1 mA/in^2	= 0.155 mA/cm^2
1 mA/ft^2	= 10.76 mA/m^2
1 Mbpd (oil)	= 159 kL/d = 159 m^3/d
1 mile	= 1.609 km
1 square mile	= 2.590 km^2
1 mile (nautical)	= 1.852 km
1 mil	= 0.0254 mm = 25.4 µm
1 MMcfd	= 2.832 x 10^4 m^3/d
1 mph	= 1.609 km/h
1 mpy	= 0.0254 mm/y = 25.4 µm/y
1 oz	= 28.35 g
1 oz fluid (Imp.)	= 28.41 mL
1 oz fluid (U.S.)	= 29.57 mL
1 oz/ft^2	= 2.993 Pa
1 oz/gal (U.S.)	= 7.49 g/L
1 psi	= 0.006895 MPa = 6.895 kPa
1 qt (Imp.)	= 1.1365 L
1 qt (U.S.)	= 0.9464 L
1 tablespoon (tbs)	= 14.79 mL
1 teaspoon (tsp)	= 4.929 mL
1 ton (short)	= 907.2 kg
1 U.S. bag cement	= 42.63 kg (94 lb)
1 yd	= 0.9144 m
1 yd^2	= 0.8361 m^2
1 yd^3	= 0.7646 m^3