NACE Internal Corrosion Technologist Theory Exam

Exam Preparation Guide

June 2020

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Introduction

The Internal Corrosion Technologist Theory exam is designed to assess whether a candidate has the requisite knowledge and skills that a minimally qualified Internal Corrosion Technologist must possess. The exam consists of 75 multiple-choice questions covering basic and intermediate-level areas of the Internal Corrosion Technologist Body of Knowledge (BOK).

Test Name	NACE ICT –Internal Corrosion Technologist Theory
Test Code	NACE-ICT-001
Time	2 ½ hours*
Number of Questions	75
Format	Computer Based Testing (CBT)

NOTE: A pass/fail grade is provided at the end of the exam.

Exam time includes 4 minutes for the non-disclosure agreement and 6 minutes for the system tutorial.

NOTE: The course manual is **NOT** provided in the exam. Reference material is provided as a PDF for conversions and applicable standards.

Target Audience

Internal Corrosion Technologists should have a thorough understanding of electrochemical and corrosion principals and be capable of performing the field tests required to appropriately monitor an internal corrosion control program. Candidates should also have sufficient knowledge and experience to determine corrective action for intermediate-level internal corrosion problems within a pipeline system and be able to select a mitigation method suitable for use on natural gas pipeline systems (taking into account all applicable variables related to a particular system). They should also be able to support the development and implementation of an internal corrosion integrity management program.

Successful candidates will understand corrosion theory, field investigation, internal corrosion mitigation, and internal corrosion integrity management.

Requirements

Internal Corrosion Technologist

- Work Experience + Course + 2 Core Exams + Application

Work Experience Requirement:
Choose one of the following work experience options:
4 years of verifiable internal corrosion-related work experience in a pipeline environment
Bachelor's Degree in Biology, Microbiology, Chemistry, Chemical Engineering, or Metallurgical Engineering **AND** 2 years of verifiable internal corrosion-related work experience in a pipeline environment
Course Recommendation:
Successful completion of NACE Internal Corrosion for Pipelines – Basic Course
Core Exam Requirements:
Internal Corrosion Technologist Theory Exam Internal Corrosion Technologist Practical Exam
Application Requirement:
Approved Internal Corrosion Technologist application

Note: Completion of course does not entitle the candidate to the certification.

Upon successful completion of requirements, the candidate will be awarded an Internal Corrosion Technologist certification.

NEXT LEVEL OF CERTIFICATION:
Senior Internal Corrosion Technologist

Internal Corrosion Technologist – Knowledge and Skill Areas Tested

NOTE: At the end of the CBT exam, the candidate will receive a bar chart of strengths and weaknesses that correspond to these domains.

1. **BASICS**

   A. Corrosion Theory

   1. Understand the composition of a basic corrosion cell and the electrochemical reactions.
   2. Understand and identify forms of corrosion, corrosion mechanisms, and corrosive species.
   3. Understand and identify the various operating conditions, environments, and facilities and how they impact the internal corrosion process.

2. **ASSESSMENT OF INTERNAL CORROSION**

   A. Indirect Methods

   1. Identify the components in a gas, liquid, or solid analysis used to assess the environment for internal corrosion.
   2. Identify the methods of analysis that can be used determine levels of constituents.
   3. Understand and apply the various models used to predict internal corrosion.
   4. Understand and utilize proper collection and preservation techniques of liquids and solid samples on internal surface of piping / components for field and laboratory testing.
   5. Understand the criteria for selecting an indirect assessment method / technique.

   B. Direct Methods

   1. Understand the factors for selecting the appropriate device for evaluating corrosion severity.
   2. Be familiar with the parameters used in designing monitoring systems.
   3. Understand and utilize the proper appropriate techniques used to preserve corroded/damaged piping components when conducting an investigation.
   4. Understand the limitations of corrosion detection devices commonly used.
   5. Be familiar with the types and purposes of corrosion coupons.
   6. Be familiar with the types and purposes of electronic probes.

   C. Locating Internal Corrosion Damage

   1. Identify parameters involved in hydrostatic testing.
   2. Understand the limitations of hydrostatic testing.
   3. Understand the criteria for selecting an inspection tool.
   4. Understand ICDA pre-assessment objectives.

5. Identify the factors considered in ICDA feasibility assessment.
6. Understand the application of flow models for system analysis and ICDA.
7. Understand the ICDA detailed examination process.

D. Monitoring Strategy and Techniques

1. Have knowledge of and understand the various methods and techniques used for monitoring a pipeline environment for internal corrosion.
2. Understand the criteria for selection of a monitoring method / technique.
3. Identify operating parameters that may contribute to internal corrosion and utilize this information in the selection process.
4. Be able to interpret data collected and recommend if corrective action is needed.

3. INTERNAL CORROSION MITIGATION

A. Mitigation Methods

1. Identify when design and operational parameters can be used to mitigate corrosion, including proper materials selection.
2. Recognize maintenance pigging as a form to control internal corrosion.
3. Have knowledge of the types of corrosion inhibitors commonly used.
4. Understand the conditions that influence the selection of chemicals and utilize this information when selecting a mitigation method.
5. Have knowledge of the type of biocides commonly used.

B. Selecting Appropriate Mitigation Methods

1. Understand the different of types of corrosion mitigation, including the criteria for selecting the most appropriate method for a given internal pipeline environment.

C. Implementing Mitigation Methods

1. Understand the various operating conditions that influence when implementation should occur.

D. Determining Effectiveness

1. Understand the various operating conditions that influence an effective program strategy.
2. Identify available technologies used to evaluate program effectiveness.

4. LONG-TERM INTEGRITY MANAGEMENT

A. Data Integration

1. Understand the significance of key data and data relationships.
2. Understand individual components of data interpretation.

Types of Questions

Description of Questions

This closed-book exam consists of multiple-choice questions where some questions may have multiple answers that require more than one answer choice, as well as matching items. The questions are based on the knowledge and skills required for an Internal Corrosion Technologist. While the NACE training course is an excellent method of preparation, it is not the only reference used in the development of the questions. Additional references can be found in the Reference section.

Sample Questions

The sample questions are included to illustrate the formats and types of questions that will be on the exam. Your performance on the sample questions should not be viewed as a predictor of your performance on the actual test.

1. Which of the following is an odorless, colorless gas that affects corrosion rate?

    A. Helium
    B. Nitrogen
    C. Methane
    D. Carbon dioxide

2. What temperature does 37° Celsius convert to on the Fahrenheit scale?

    A. 105.6°F
    B. 98.6°F
    C. 67.6°F
    D. 34.6°F

3. Which of the following are periodic facilities maintenance activities that may prevent internal corrosion?

SELECT ALL THAT APPLY

A. Pigging
B. Gas analysis
C. Line sweeping
D. Hydrostatic testing

Answer Key

1. D

2. B

3. A & C

Preparation

Recommended Training

NACE Internal Corrosion for Pipelines – Basic Course

Recommended Study Material—Course Manual

NACE Internal Corrosion for Pipelines – Basic Course

Standards

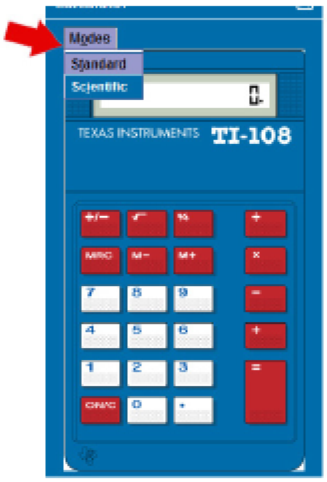
Latest editions should be used for all standards. Certain content from these standards is incorporated in the NACE Internal Corrosion for Pipelines – Basic Course materials and some of them are included in the course manual.

- "American National Standard for Use of the International System of Units (SI): The Modern Metric System" ASTM SI 10. (2002). ASTM.
- NACE International SP 0116 (2016). "Multiphase Flow Internal Corrosion Direct Assessment (MP-ICDA) Methodology for Pipelines." NACE International.
- NACE International SP 0206 (2016). "Internal Corrosion Direct Assessment Methodology for Pipelines Carrying Normally Dry Natural Gas (DG-ICDA)." NACE International.
- NACE International SP 0208 (2008). "Internal Corrosion Direct Assessment Methodology for Liquid Petroleum Pipelines." NACE International.
- NACE International SP 0775 (2018). "Preparation, Installation, Analysis, and Interpretation of Corrosion Coupons in Oilfield Operations." NACE International.
- NACE International TM 0194 (2014). "Field Monitoring of Bacterial Growth in Oil and Gas Systems." NACE International.

Calculators

Students will have access to either a TI Standard or TI Scientific calculator for use during the CBT Exam.

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

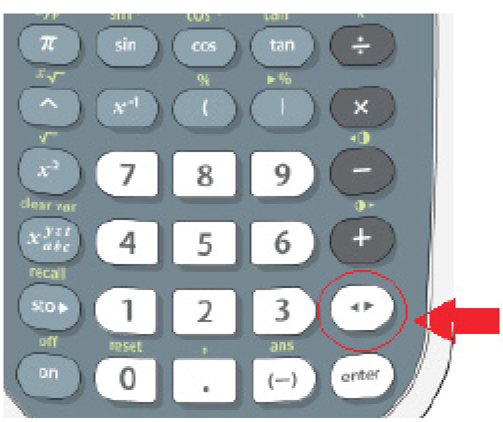
Square a value	x^2	
Cube a value	^	
Raise value to specified power	^	Example (2^4) 2 ^ 4
Square root	2nd [√]	Example (√16): 2nd [√] 16
Reciprocal	x^{-1}	Example (n^{th} root): 5^{th} root of 8: 5 2nd [ˣ√] 8

Pi

PI (π)	π

Toggle

The scientific calculator might show the results of certain calculations as a fraction - possibly 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

Note: 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. **If available,** you will be provided with a scientific or non-scientific calculator. Candidates are not permitted to bring their own calculator into the testing room.

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	microamperes 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 kiloampere
1.0 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 cm

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

“American National Standard for Use of the International System of Units (SI): The Modern Metric System” ASTM SI 10. (2002). ASTM.

REFERENCES & STANDARDS USED TO DEVELOP THE REFERENCE MATERIAL

"American National Standard for Use of the International System of Units (SI): The Modern Metric System" ASTM SI 10. (2002). ASTM.

NACE International SP 0116 (2016). "Multiphase Flow Internal Corrosion Direct Assessment (MP-ICDA) Methodology for Pipelines." NACE International.

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