

Module Overview

This module discusses the use of equivalent and conversion tables and explains how to use right angle trigonometry to calculate takeouts. The module also explains how to calculate the weight of objects that boilermakers may have to install.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Use tables of equivalents.
2. Use unit conversion tables.
3. Perform right angle trigonometry.
4. Calculate the weight of objects.
5. Calculate takeouts using trigonometry.

Performance Tasks

This is a knowledge-based module. There are no performance tasks.

Materials and Equipment

Multimedia projector and screen
Boilermaking Level Four
PowerPoint® Presentation Slides
(ISBN 978-0-13-292170-1)
Computer
Whiteboard/chalkboard
Markers/chalk
Pencils and paper

Straight-edge rulers
A selection of basic right triangle exercises
(with answers for the instructor)
A selection of piping-based math exercises
(with answers for the instructor)
A selection of object weight math exercises
(with answers for the instructor)
Scientific calculators

Module Examinations*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

Applied Construction Math, Latest Edition. NCCER. Upper Saddle River, NJ: Prentice Hall.

Pipe Fitter's Math Guide, 1989. Johnny Hamilton. Clinton, NC: Construction Trade Press.

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Advanced Mechanical Trade Math*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic	Planned Time
Session I. Introduction; Tables of Equivalents; Unit Conversion Tables	
A. Introduction	_____
B. Tables of Equivalents	_____
C. Unit Conversion Tables	_____
Sessions II–IV. Trigonometry	
A. Trigonometry	_____
1. Pythagorean Theorem	_____
2. Trigonometric Functions	_____
3. Triangle Calculation	_____
4. Determining Angles When Side Lengths Are Known	_____
5. Interpolation	_____
6. Law of Sines	_____
Session V. Calculating Takeouts Using Trigonometry; Calculating the Weight of an Object	
A. Calculating Takeouts Using Trigonometry	_____
1. Takeouts	_____
2. Odd Angles	_____
B. Calculating the Weight of an Object	_____
Session VI. Review and Testing	
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70% or higher to receive recognition from NCCER.	
2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.	

Module Overview

Boilermakers often work with heavy equipment and components that must be lifted into place. This module introduces the principles of load and stability and their effect on rigging. This module explains how to determine the center of gravity and use various types of rigging equipment.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Explain how the center of gravity of the load affects the rigging.
2. Explain how the weight of the load and the position of the crane boom affect the capacity of the crane.
3. Explain how cribbing is used to support loads.
4. Select the appropriate spreader bars or equalizer beam for a given load.
5. Demonstrate the ability to determine the center of gravity for an asymmetrical load.
6. Given a particular load, select the appropriate sling(s) for a lift.
7. Describe how grip hoists and skids are used to move loads laterally.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Select the appropriate spreader bars or equalizer beam for a given load.
2. Determine the center of gravity for an asymmetrical load.
3. Select the appropriate sling(s) for a given lift.

Materials and Equipment

Markers/chalk
Pencils and paper
Whiteboard/chalkboard
Boilermaking Level Four PowerPoint® Presentation Slides (ISBN 978-0-13-292170-1)
Multimedia projector and screen
Computer
Appropriate personal protective equipment
A saw horse, suitable length of board, and several books or bricks

Selection of slings
A cardboard box and books to give it weight, several appropriate slings
Bill of Lading
Selection of spreader bars and equalizer beams
Wire rope, grip hoists, and a safety hook
Module Examinations*
Performance Profile Sheets*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on rigging, especially with heavy equipment. Emphasize the importance of proper housekeeping.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

Bob's Rigging and Crane Handbook, Latest Edition. Leawood KS: Pellow Engineering Services.

IPT's Crane and Rigging Handbook, Latest Edition. Edmonton, Alberta, Canada: IPT Publishing and Training.

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover *Advanced Rigging*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Sessions I and II. Introduction; Load Dynamics	
A. Introduction	_____
B. Load Dynamics	_____
1. Rotational Forces or Moments	_____
2. Crane Stability	_____
C. PT/Laboratory	_____
Have trainees determine the center of gravity for an asymmetrical load. This laboratory corresponds to Performance Task 2.	
Sessions III and IV. Special Equipment Used in Heavy Rigging; Slings	
A. Special Equipment Used in Heaving Rigging	_____
1. Cribbing	_____
2. Inclined Planes	_____
B. Slings	_____
1. Sling Types	_____
2. Sling Angles	_____
3. Sling Stress	_____
4. Derating Factors of Slings	_____
5. Rigging Symmetrical Loads	_____
6. Rigging Asymmetrical Loads	_____
7. Basket Hitches	_____
8. Choker Hitches	_____
C. PT/Laboratory	_____
Have trainees select the appropriate sling(s) for a lift. This laboratory corresponds to Performance Task 3.	

Module Overview

This module covers P&IDs, plan views, section views, isometric drawings, and spool drawings. It teaches the trainee to work through a set of drawings and extract the information from one drawing that is necessary to interpret other drawings. It explains how to use plan views to draw isometrics and use isometrics to put together spools. The supplied drawings fit together to design a main steam line for a power plant.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Identify symbols and abbreviations on piping and instrumentation drawings (P&IDs).
2. Identify piping arrangement drawings.
3. Read and interpret the following:
 - GPS coordinates, control points, and elevation
 - P&IDs, plan views, and section views
 - Isometric drawings
 - Spool drawings taken from isometric drawings
 - Boiler plan views, section views, and details
4. Draw isometric drawings.
5. Calculate the total line length from an ISO.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Calculate the total line length from an ISO.
2. Sketch an ISO from a plan view.

Materials and Equipment

Multimedia projector and screen

Boilermaking Level Four

PowerPoint® Presentation Slides
(ISBN 978-0-13-292170-1)

Computer

Whiteboard/chalkboard

Markers/chalk

Pencils and paper

A selection of distance-measuring tools

ISO drawing paper

Access to all types of level-checking tools

Access to an operational GPS system

Access to a selection of building/structural drawings

Access to all types of boiler-related drawings

Module Examinations*

Performance Profile Sheets*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

Process Piping Drafting. 1986. Rip Weaver. Houston, TX: Gulf Publishing Company, Book Division.

Blueprint Reading for Construction. 2nd Edition. 2003. James A. S. Fatzinger. Upper Saddle River, NJ: Prentice Hall.

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover *Advanced Boilermaking Construction Drawings*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Sessions I and II. Introduction; Block Diagrams; Piping and Instrumentation Drawings	
A. Introduction	_____
B. Block Diagrams	_____
C. Piping and Instrumentation Drawings	_____
1. Process Piping	_____
2. Piping Components	_____
3. Process Equipment	_____
4. Instrumentation	_____
Sessions III and IV. Piping Arrangement Drawings; Reading and Interpreting P&IDs and Piping Arrangement Drawings; Reading and Interpreting Isometric Drawings	
A. Piping Arrangement Drawings	_____
1. General Arrangement Drawings	_____
2. As-Built Drawings	_____
3. Piping and Instrumentation Drawings (P&IDs)	_____
4. Sectional View Drawings	_____
5. Other Piping Arrangement Drawings and Aids	_____
B. Reading and Interpreting P&IDs and Piping Arrangement Drawings	_____
1. Mechanical Symbolology Page	_____
2. Instrumentation Symbolology Page	_____
3. General Arrangement Pages	_____
C. Reading and Interpreting Isometric Drawings	_____
1. Isometrics	_____
2. Spool Drawings	_____
3. Vessel or Unit Drawings	_____

Module Overview

This module presents various piping offsets: three-line, 45-degree, equal spread offsets around a vessel, and three-line, 45-degree, unequal offsets. It also covers how to fabricate tank coils; three, four, and five-piece mitered turns; 45-degree laterals using both references; and contour markers, dummy legs out of both pipe and structural steel, and mitering procedures.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Calculate simple piping offsets.
2. Calculate three-line, 45-degree, equal-spread offsets around a vessel.
3. Calculate three-line, 45-degree, unequal-spread offsets.
4. Fabricate tank heating coils.
5. Perform mitering procedures.
6. Lay out three- and four-piece mitered turns.
7. Lay out 45-degree laterals, using references or a calculator.
8. Fabricate dummy legs and trunions out of pipe, using references.
9. Perform geometric layout of pipe laterals and supports.
10. Lay out and fabricate a fishmouth.
11. Lay out and fabricate a wye.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Solve a simple piping offset.
2. Calculate a three-line, 45-degree, equal-spread offset.
3. Calculate a three-line, 45-degree, unequal-spread offset.
4. Calculate and lay out a tank coil.
5. Lay out and fabricate a three-piece mitered turn, degree to be determined by the instructor.
6. Lay out and fabricate a four-piece, 90-degree, mitered turn.
7. Lay out and fabricate a 45-degree lateral, using reference charts.
8. Lay out and fabricate a type 1 pipe support.
9. Lay out a 45-degree lateral by performing geometric layout.
10. Lay out and fabricate a fishmouth.
11. Lay out and fabricate a wye.

Materials and Equipment

Multimedia projector and screen

Boilermaking Level Four

PowerPoint® Presentation Slides
(ISBN 978-0-13-292170-1)

Computer

Whiteboard/chalkboard

Markers/chalk

Pencils and paper

Appropriate personal protective equipment

14-inch half-round bastard files

24-inch spirit levels

Angle iron

Ball-peen hammers

Center punches

Channel lock pliers

Combination tri squares

Contour markers

Framing squares

Hacksaws

Jack stands

Oxyacetylene cutting equipment

Pipe Fitters Blue Book

Pipe vises

Portable grinders

Scientific calculators

Soapstones

(continued)

Tape measure	3-, 4-, 6-, and 8-inch, carbon steel, schedule 40
Torpedo levels	pipe
Wraparounds	Butt weld elbows
Ruler	PVC pipe and fittings
T-square	PVC cement and application tools
45-degree right triangle	Quick Quiz*
Compass	Module Examinations**
Dividers	Performance Profile Sheets**
Horseshoe	

* Located at the back of this module

**Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires that trainees fabricate pipe. Ensure all trainees are briefed on fire safety. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

Additional Resources

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

- www.sosmath.com/trig/trig.html
- www.analyze-math.com/trigonometry.html
- www.counton.org/alevel/pure/purtuttri.htm

Teaching Time For This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 50 hours are suggested to cover *Advanced Pipe Fabrication*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction and Calculating Simple Offsets	
A. Introduction	_____
B. Determining Pipe Offsets	_____
C. PT/Laboratory	_____
Have trainees practice solving a simple piping offset. This laboratory corresponds to Performance Task 1.	
Sessions II and III. Calculating Three-Line Offsets I	
A. Calculating Three-Line, 45-Degree, Equal-Spread Offsets	_____
B. PT/Laboratory	_____
Have trainees practice calculating three-line, 45-degree, equal-spread offsets. This laboratory corresponds to Performance Task 2.	

Sessions IV and V. Calculating Three-Line Offsets II

A. Calculating Three-Line, 45-Degree, Unequal-Spread Offsets _____

B. PT/Laboratory _____

Have trainees practice calculating three-line, 45-degree, unequal-spread offsets. This laboratory corresponds to Performance Task 3.

Sessions VI and VII. Laying Out and Fabricating Tank Heating Coils

A. Laying Out and Fabricating Tank Heating Coils _____

B. PT/Laboratory _____

Have trainees practice laying out and fabricating tank heating coils. This laboratory corresponds to Performance Task 4.

Sessions VIII and IX. Fabricating Miter Turns I

A. Laying Out Ordinate Lines _____

B. Laying Out Cutback Lines _____

C. Laying Out Mitered Turns _____

D. Laying Out and Fabricating Three-Piece Mitered Turns _____

E. PT/Laboratory _____

Have trainees practice laying out and fabricating a three-piece mitered turn. This laboratory corresponds to Performance Task 5.

Sessions X and XI. Fabricating Mitered Turns II

A. Laying Out and Fabricating Four-Piece Mitered Turns _____

B. PT/Laboratory _____

Have trainees practice laying out and fabricating a four-piece mitered turn. This laboratory corresponds to Performance Task 6.

Sessions XII and XIII. Fabricating Mitered Turns III

A. Laying Out Miters Using a Horseshoe _____

B. Mitering a Wye _____

C. PT/Laboratory _____

Have trainees practice laying out and fabricating a wye. This laboratory corresponds to Performance Task 11.

Session XIV. Fishmouth

A. Laying Out and Fabricating a Fishmouth _____

B. PT/Laboratory _____

Have trainees practice laying out and fabricating a fishmouth. This laboratory corresponds to Performance Task 10.

Session XV and XVI. Fabricating Using Charts

A. Determining Lateral Dimensions _____

B. PT/Laboratory _____

Have trainees practice laying out and fabricating a 45-degree lateral using reference charts. This laboratory corresponds to Performance Task 7.

C. Fabricating Dummy Legs and Trunions Out of Pipe _____

Session XVII and XVIII. Performing Geometric Layout

A. Laying Out Laterals _____

B. PT/Laboratory _____

Have trainees practice laying out a 45-degree lateral by performing geometric layout. This laboratory corresponds to Performance Task 9.

Module Overview

This module introduces the trainee to thermal expansion and how to calculate it. The trainee will learn types of misalignment and its causes, and procedures for stress relief in welded boiler equipment.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Explain and calculate thermal expansion.
2. Describe stress-relief procedures.
3. Explain types of misalignment.

Performance Task

Under the supervision of the instructor, the trainee should be able to do the following:

1. Calculate the thermal expansion on materials given by the instructor.

Materials and Equipment

Markers/chalk

Pencils and paper

Whiteboard/chalkboard

Boilermaking Level Four

PowerPoint® Presentation Slides
(ISBN 978-0-13-292170-1)

Multimedia projector and screen

Computer

Appropriate personal protective equipment

Typical alignment devices

Typical WPS

Table of coefficient values

Sections of small piping, an oxyfuel torch, and a burner

Module Examinations*

Performance Profile Sheets*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on heated weldments and using clamping and bracing tools for stability. Emphasize the importance of proper housekeeping.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

ASME Boiler and Pressure Vessel Code, Section I, Rules for Construction of Power Boilers, 2010 edition. New York, NY.

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover *Stress Relieving*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction; Distortion from Welding; Distortion from Thermal Growth; Calculating Thermal Expansion	
A. Introduction	_____
B. Distortion from Welding	_____
1. Causes of Distortion	_____
2. Correlation of Metal Properties and Distortion	_____
3. Controlling Distortion	_____
C. Distortion from Thermal Growth	_____
D. Calculating Thermal Expansion	_____
E. PT/Laboratory	_____
Have trainees calculate the thermal expansion on materials given by the instructor. This laboratory corresponds to Performance Task 1.	
Sessions II and III. Relieving Pipe Stress; Performing Stress Relief	
A. Relieving Pipe Stress	_____
1. Flexibility in Layout	_____
2. Installing Expansion Loops and Joints	_____
3. Cold-Springing Pipe	_____
B. Performing Stress Relief	_____
1. Preheat Temperature	_____
2. Interpass Temperature	_____
3. Postheating	_____
Session IV. Review and Testing	
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70% or higher to receive recognition from NCCER.	
2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.	
C. Performance Testing	_____
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.	
2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.	

Module Overview

This module introduces the trainee to the codes and standards that apply to boilers and welding boiler parts and fittings. It explains weld defects, how to identify them, and their causes. Trainees will also be introduced to common methods of destructive testing.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Identify and explain codes governing welding and boilers.
2. Identify and explain weld imperfections and their causes.
3. Identify and explain nondestructive examination practices.
4. Identify and explain welder qualification tests.
5. Explain the importance of quality workmanship.
6. Identify common destructive testing methods.
7. Perform a visual inspection of fillet welds.

Performance Task

Under the supervision of the instructor, the trainee should be able to do the following:

1. Perform a visual inspection of fillet welds.

Materials and Equipment

Markers/chalk	Appropriate welding specification and a sample of an undercut weld
Pencils and paper	Selection of acceptable and unacceptable fillet weld samples
Whiteboard/chalkboard	Selection of welding gauges, welding specifications, and various kinds of welds
<i>Boilermaking Level Four</i>	If possible, provide a magnetic particle yoke, magnetic powder, and a ferromagnetic part with a defective weld
PowerPoint® Presentation Slides (ISBN 978-0-13-292170-1)	If possible, provide a portable UT and monitor and several welds with appropriate discontinuities
Multimedia projector and screen	Copy of Section IX of the <i>ASME Boiler and Pressure Vessel Code</i>
Computer	Module Examinations*
Appropriate personal protective equipment	Performance Profile Sheets*
Filled out welding procedure and PQR	
Samples of welds with discontinuities:	
Porosity discontinuities	
Inclusions	
Metal and base cracks	
Incomplete joint penetration	
Incomplete fusion	

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on boilers and with welding equipment. Emphasize the importance of proper housekeeping.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

AWS B1.10: Guide for the Nondestructive Inspection of Welds, 2009. Miami, FL: The American Welding Society.

AWS B1.11: Guide for the Visual Inspection of Welds, 2000. Miami, FL: The American Welding Society.

OSHA Standard 1926.351, Arc Welding and Cutting.

Welding Handbook, Volume 1 (2001) and *Volume 2* (2004). Miami, FL: The American Welding Society (AWS).

AWS D3.5-93R: Guide for Steel Hull Welding, 1993. Miami, FL: The American Welding Society (AWS).

AWS D3.6M: Specification for Underwater Welding, 2010. Miami, FL: The American Welding Society (AWS).

AWS D3.7: Guide for Aluminum Hull Welding, 2004. Miami, FL: The American Welding Society (AWS).

The Procedure Handbook of Arc Welding, 2000. Cleveland, OH: The Lincoln Electric Company. www.lincolnelectric.com.

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover *Quality Assurance*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction; Codes Governing Welding; Governing Organizations' Jurisdictions; Basic Elements of Welding Procedure Specifications	
A. Introduction	_____
B. Codes Governing Welding	_____
1. American Society of Mechanical Engineers	_____
2. National Board of Boiler and Pressure Inspectors	_____
3. American Welding Society	_____
4. American Petroleum Institute	_____
5. American National Standards Institute	_____
6. Nuclear Regulatory Commission	_____
7. National Fire Protection Association	_____
C. Governing Organizations' Jurisdictions	_____
D. Basic Elements of Welding Procedure Specifications	_____
1. Welder Performance Qualification	_____
2. Welding Procedure Qualification	_____
3. Welder Operator Qualification	_____

Session II. Weld Discontinuities and Their Causes

A. Weld Discontinuities and Their Causes

1. Porosity
2. Inclusions
3. Cracks
4. Incomplete Joint Penetration
5. Incomplete Fusion
6. Undercut
7. Arc Strikes
8. Spatter
9. Acceptable and Unacceptable Weld Profiles

B. PT/Laboratory

Have trainees perform a visual inspection of fillet welds. This laboratory corresponds to Performance Task 1.

Session III. Nondestructive Examination (NDE) Practices; Destructive Testing; Welder Performance Qualification Tests; Quality Workmanship

A. Nondestructive Examination (NDE) Practices

1. Visual Inspection
2. Liquid Penetrant Inspection
3. Magnetic Particle Inspection
4. Radiographic Inspection
5. Ultrasonic Inspection
6. Electromagnetic (Eddy Current) Inspection
7. Leak Testing

B. Destructive Testing

C. Welder Performance Qualification Tests

1. Welding Positions Qualification
2. AWS Structural Steel Code
3. ASME Code
4. Welder Qualification Tests

D. Quality Workmanship

1. Typical Site Organization
2. Chain of Command

Session IV. Review and Testing

A. Review

B. Module Examination

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.

C. Performance Testing

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.

Module Overview

This module introduces the trainee to the materials and procedures involved in the maintenance of heat exchangers, and to the special safety precautions necessary when performing such work.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Identify exchangers and components.
2. Explain how to pull an exchanger bundle.
3. Explain the inspections and the types of testing used with exchangers.
4. Explain how to replace a flange and a nozzle on an exchanger.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify exchangers and components.
2. Tear down, inspect, clean, and reassemble a heat exchanger.
3. Remove and replace a heat exchanger flange or nozzle.

Materials and Equipment

Markers/chalk	Samples of packing and sealing rings
Pencils and paper	Access to torquing tools (both manual and pneumatic)
Whiteboard/chalkboard	Access to common mechanic's hand tools
<i>Boilermaking Level Four</i>	Access to heat exchanger tube-testing equipment
PowerPoint® Presentation Slides (ISBN 978-0-13-292170-1)	A supply of cleaning and drying materials
Multimedia projector and screen	Containers for waste liquids generated from heat exchanger testing
Computer	Lights for inspecting exchanger interiors and exteriors
Appropriate personal protective equipment	Access to tube-cutting and tube-rolling tools
Examples of different types of heat exchangers	Access to tube plugs
A collection of TEMA drawings of different types of shell-and-tube exchangers	A supply of heat exchanger replacement tubing
Examples of new and used heat exchanger components	A supply of heat exchanger nozzles and flanges
A collection of heat exchangers to be used for lab exercises	Access to welding machines suitable for heat exchanger tube welding
Samples of job safety analyses related to heat exchangers	Access to different heat exchanger repair drawings
Access to rigging, lifting, pulling, and transporting equipment for heat exchanger work	Module Examinations*
	Performance Profile Sheets*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on pre-engineered systems and the dangers involved in erecting them. Emphasize the importance of proper housekeeping.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

Steam, Its Generation and Use. S.C. Stultz and J.B. Kitto. Barberton, OH: The Babcock and Wilcox Company.

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 25 hours are suggested to cover *Advanced Exchangers*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Sessions I–III. Introduction; TEMA Standards; Identifying Exchangers/Condensers; Pulling and Installing Exchanger Bundles	
A. Introduction	_____
B. TEMA Standards	_____
C. Identifying Exchangers/Condensers	_____
1. Exchanger Types	_____
2. Exchanger Components	_____
D. Pulling and Installing Exchanger Bundles	_____
1. Preparations	_____
2. Lifting and Pulling Equipment	_____
E. PT/Laboratory	_____
Have trainees identify exchangers and components. This laboratory corresponds to Performance Task 1.	
Session IV. Swapping Out Heat Exchangers	
A. Swapping Out Heat Exchangers	_____
1. Preparing to Swap Out Heat Exchangers	_____
2. Removal of Connecting Piping	_____
3. Dismounting Exchangers	_____
4. Transporting Exchangers	_____
5. Installing a Replacement Exchanger	_____
6. Reconnecting Exchanger Piping	_____
7. Closing the Job	_____

Sessions V–IX. Heat Exchanger Testing; Performing Repair Work on Exchangers/Condensers

A. Heat Exchanger Testing

- 1. Positive Pressure Testing
- 2. Vacuum Testing
- 3. Hydro Testing

B. Performing Repair Work on Exchangers/Condensers

- 1. Cleaning and Inspections
- 2. Re-Rolling Tubes
- 3. Installing Plugs
- 4. Replacing Tubes
- 5. PT/Laboratory

Have trainees tear down, inspect, clean, and reassemble a heat exchanger. This laboratory corresponds to Performance Task 2.

- 6. Replacing Nozzles/Flanges
- 7. PT/Laboratory

Have trainees remove and replace a heat exchanger flange or nozzle. This laboratory corresponds to Performance Task 3.

Session X. Review and Testing

A. Review

B. Module Examination

- 1. Trainees must score 70% or higher to receive recognition from NCCER.
- 2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.

C. Performance Testing

- 1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
- 2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.

Module Overview

This module introduces the trainee to the materials and procedures involved in the maintenance of distillation towers.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Identify types of towers and their components.
2. Explain how to install structured packing and random packing.
3. Explain how to make field repairs to trays.
4. Explain how to remove a distributor for maintenance.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Install and remove random packing.
2. Install and remove structured packing.
3. Make field repairs to distillation tower equipment.

Materials and Equipment

Multimedia projector and screen

Boilermaking Level Four

PowerPoint® Presentation Slides
(ISBN 978-0-13-292170-1)

Computer

Whiteboard/chalkboard

Markers/chalk

Pencils and paper

Access to PPE needed for distillation
tower/column work

Access to different types of distillation towers
(or tower simulators)

A collection of tower drawings showing
component locations

A collection of tower drawings showing how to
install tower and tray components

Examples of new and used distillation tower
components

Samples of job safety analyses related to
distillation tower/column work

Access to rigging, lifting, and transporting
equipment used for tower work

Access to common mechanic's hand tools

Access to torquing tools (both manual and
pneumatic)

Access to flanges fastened with bolts and nuts

Lights and power tools (drills, saws, and
grinders) for tower work

Heavy-duty extension (electrical) cords

Access to AC to DC converters

Access to welding machines suitable for tower
work (gouging and welding)

Module Examinations*

Performance Profile Sheets*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on distillation towers. Emphasize the importance of proper housekeeping.

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 25 hours are suggested to cover *Advanced Towers*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction; Identifying Types of Towers and Their Components; Distillation Tower Packing	
A. Introduction	_____
B. Identifying Types of Towers and Their Components	_____
1. Distillation Process	_____
2. Tower Types	_____
3. Tower Components	_____
4. Tower Safety	_____
C. Distillation Tower Packing	_____
1. Heat Transfers	_____
2. Flow Changes	_____
3. Structured Packing	_____
4. Random Packing	_____
5. Safety When Handling Packing Materials	_____
Sessions II and III. Hydraulic Torquing and Tensioning	
A. Hydraulic Torquing and Tensioning	_____
1. Torquing and Tensioning Basics	_____
2. Torquing and Tensioning Devices	_____
3. Torquing and Tensioning Hazards	_____
4. Maintenance of Torquing and Tensioning Tools	_____
Session IV. Tower Maintenance in General	
A. Tower Maintenance in General	_____
1. Manways	_____
2. Removing and Replacing Trays and Tray Manways	_____
3. Removing and Replacing Tray Weirs and Downcomers	_____
4. Removing and Replacing Tray Valves or Flappers	_____
5. Removing and Replacing Distributors	_____
6. Tower Cleaning	_____
Sessions V–IX. PT/Laboratory	
A. PT/Laboratory	
1. Have trainees install and remove random packing. This laboratory corresponds to Performance Task 1.	_____
2. Have trainees install and remove structured packing. This laboratory corresponds to Performance Task 2.	_____
3. Have trainees make field repairs to distillation tower equipment. This laboratory corresponds to Performance Task 3.	_____

Session X. Review and Testing

A. Review

B. Module Examination

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.

C. Performance Testing

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.

Module Overview

Today's leaders face a complex and challenging workforce, and having a capable leader is essential to the success of any team. This module introduces the trainee to the principles of leadership. Trainees will learn about:

- The construction industry today
- Business organizations
- Team building
- Gender and minority issues
- Communication
- Motivation
- Problem solving
- Decision making
- Safety
- Project control

Prerequisites

There are no prerequisites for this course.

Objectives

Upon completion of this course, the trainee will be able to:

1. Discuss current issues and organizational structure in industry today.
2. Understand and incorporate leadership skills into work habits, including communications, motivation, team building, problem solving, and decision-making skills.
3. Demonstrate an awareness of safety issues, including the cost of accidents and safety regulations.
4. Identify a crew leader's typical safety responsibilities.
5. Show a basic understanding of the planning process, scheduling, and cost and resource control.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Develop an estimate for a given work activity.
2. Develop and present a look-ahead schedule.

Industry Recognized Credentials

If you're training through an NCCER-accredited sponsor you may be eligible for credentials from NCCER's Registry. The ID number for this module is 46101-11. Note that this module may have been used in other NCCER curricula and may apply to other level completions. Contact NCCER's Registry at 888.622.3720 or go to nccer.org for more information.

Materials and Equipment

Markers/chalk
Pencils and scratch paper
Whiteboard/chalkboard
Boilermaking Level Four
PowerPoint® Presentation Slides
(ISBN 978-0-13-292-170-1)
Multimedia projector and screen
Computer
Several construction job descriptions, including
one that is very vague and one that is overly
detailed
Several MSDSs appropriate to the craft
Original and as-built drawings of the same
project
A redline drawing
Sufficient copies of a roofing formwork detail
drawing
Sufficient copies of the worksheet with entries

Examples of schedules:*

- Bar chart
- Network schedule
- Short-term or look-ahead schedule

Two or three typical job schedules
Two job plans and pictures of each site
Construction drawings of a work platform
with a concrete footing, including specifications,
to be built on site:

- Materials cost list including lumber, concrete,
and hardware
- Labor cost list including concrete finishers,
carpenters, and masonry workers
- Photographs of the planned site

Set of construction drawings
Module Examinations**
Performance Profile Sheets**

* Because this module may be used for different industries, materials such as project schedules should be appropriate to the craft where possible.

**Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

Aging Workforce News, www.agingworkforcenews.com.

American Society for Training and Development (ASTD), www.astd.org.

Architecture, Engineering, and Construction Industry (AEC), www.aecinfo.com.

CIT Group, www.citgroup.com.

Equal Employment Opportunity Commission (EEOC), www.eeoc.gov.

National Association of Women in Construction (NAWIC), www.nawic.org.

National Census of Fatal Occupational Injuries (NCFOTI), www.bls.gov.

National Center for Construction Education and Research, www.nccer.org.

National Institute of Occupational Safety and Health (NIOSH), www.cdc.gov/niosh.

National Safety Council, www.nsc.org.

NCCER Publications:

- *Your Role in the Green Environment*
- *Sustainable Construction Supervisor*

Occupational Safety and Health Administration (OSHA), www.osha.gov.

Society for Human Resources Management (SHRM), www.shrm.org.

United States Census Bureau, www.census.gov.

United States Department of Labor, www.dol.gov.

USA Today, www.usatoday.com.

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. This course is designed to be taught in one of two formats: two 8-hour sessions (such as all-day workshops) or eight 2-hour sessions (such as after-work training seminars). Because of this, each session below has a suggested time period of two hours. If leading 8-hour sessions, simply teach four of these 2-hour sessions both times your class meets. All instructors will need to adjust the time required for participant activities and testing based on class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Section One – The Basics	
A. Industry Today	_____
1. The Need for Training	_____
2. Impact of Technology	_____
B. Gender and Cultural Issues	_____
1. Communication Styles of Men and Women	_____
2. Language Barriers	_____
3. Cultural Differences	_____
4. Sexual Harassment	_____
5. Gender and Minority Discrimination	_____
C. Business Organizations	_____
1. Division of Responsibility	_____
2. Authority, Responsibility, and Accountability	_____
3. Job Descriptions	_____
4. Policies and Procedures	_____
Session II. Section Two – Leadership Skills, Part One	
A. Introduction to Leadership	_____
B. The Shift in Work Activities	_____
C. Becoming a Leader	_____
1. Characteristics of a Leader	_____
2. Functions of a Leader	_____
3. Leadership Styles	_____
4. Ethics in Leadership	_____
D. Communication	_____
1. Verbal Communication	_____
2. Nonverbal Communication	_____
3. Written or Visual Communication	_____
4. Communication Issues	_____
E. Motivation	_____
1. Employee Motivators	_____
2. Motivating Employees	_____
F. Team Building	_____
1. Successful Teams	_____
2. Building Successful Teams	_____

