Trade Math Three – Field Measuring and Fitting
Annotated Instructor's Guide

Module 04301-09

MODULE OVERVIEW

This module reviews common practices used for field measuring and layout. Trainees will learn how to solve field measuring problems and apply standard rules and practices for solving field measurement problems.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Sheet Metal Level One;* and *Sheet Metal Level Two.*

OBJECTIVES

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

1. Describe common practices used for field measuring and layout of ductruns and fittings.
2. Solve selected field measuring problems, applying standard rules and practices.

PERFORMANCE TASKS

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

1. Perform a field measuring task.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
Calculators with trigonometric functions
Plumb bob and chalk line
Module Examinations*
Performance Profile Sheets*

*Located in the Test Booklet

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.

Advanced Methods for Sheet Metal Work, William Cookson. Oxford: Technical Press.

Precision Sheet Metal: Blueprint Reading, Richard S. Budzik. Chicago: Practical Publications.

Sheet Metal Forming, Roger Pearce. Philadelphia, PA: Hilger.

Sheet Metal Workers Pocket Manual, Fred Schumacher and Claude Zinngrabe. Z/S Pocket Manuals.

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 *Trade Math Three – Field Measuring and Fitting*. 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; Field Measuring Techniques	
A. Introduction	_____
B. Field Measuring Techniques	_____
Session II. Measuring and Fitting Round Pipe Offsets and Elbows, Part One	
A. Round Elbows	_____
B. Measuring Offset Pipe Length	_____
Session III. Measuring and Fitting Round Pipe Offsets and Elbows, Part Two	
A. Calculating Offset Pipe Length Using Slant and Elbow Length Constants	_____
B. Calculating Offset Pipe Length Using Tables	_____
C. Study Problems	_____
Session IV. Measuring and Fitting Rectangular Offsets	
A. Miter Allowances in Offsets	_____
B. Plain Offsets	_____
C. Study Problems	_____
Session V. Measuring and Fitting Parallel Offsets and Change Joint Transitions	
A. Parallel Offsets	_____
B. Change Joint Transitions	_____
C. Study Problems	_____
Session VI. Review and Testing	
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from the NCCER.	
2. Record the testing results on Craft 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 Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

Air Systems
Annotated Instructor's Guide

Module 04302-09

MODULE OVERVIEW

This module reviews the different types of air systems, the equipment that is associated with each system, and the common applications for each system. Trainees will learn how to identify air system components and to explain how they function.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Sheet Metal Level One; Sheet Metal Level Two; Sheet Metal Level Three*, Module 04301-09.

OBJECTIVES

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

1. Explain the operating principles of different types of air systems.
2. Identify the components that make up an air system.
3. Describe the functions of air systems and their components.

PERFORMANCE TASKS

There are no performance tasks for this module.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard/chalkboard

Markers/chalk

Pencils and paper

Sample air terminals, including:
- Standard VVT air terminals
- Single-duct VAV air terminals
- Parallel fan-powered mixing box air terminals
- Series fan-powered mixing box air terminals

Supply outlets, including:
- Grilles and registers
- Ceiling diffusers
- Perforated ceiling panels
- Slot diffusers
- Fan coil heating units
- Concentric duct diffusers

Copies of your local code

News articles on sick building syndrome and/or other building-related illnesses

Copies of Figure 27 with the legend covered

Module Examinations*

*Located in the Test Booklet

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.

HVAC Systems: Operation, Maintenance, and Optimization. Samuel C. Monger. Englewood Cliffs, NJ: Prentice Hall.

HVAC Systems and Equipment Handbook, 2008. Atlanta, GA: American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).

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 *Air Systems.* 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; Types of Air Systems; Duct Systems

A. Air Systems _____
   1. Single-Zone Constant Volume Systems _____
   2. Multizone Constant Volume Systems _____
   3. Variable Volume, Variable Temperature Systems _____
   4. Variable Air Volume Systems _____

B. Duct Systems _____
   1. Classification _____
   2. Layout _____
   3. Condensation _____
   4. Materials _____
   5. Construction _____

Session II. Supply Outlets and Air Terminals; Typical Air System; Zoning

A. Supply Outlets and Air Terminals _____
   1. Air Terminals _____
   2. Supply Outlets _____

B. Typical Air System _____

C. Zoning _____

Session III. Air Source Equipment; Air Systems and Outdoor Air; Air Handlers

A. Air Source Equipment _____
   1. Packaged Equipment _____
   2. Packaged Equipment Components _____
   3. Packaged Unit Accessories _____
   4. Modifying VAV Unit Output _____

B. Air Systems and Outdoor Air _____
   1. Return Fans _____
   2. Economizers _____
   3. Heating _____

C. Air Handlers _____
   1. Packaged Air Handler _____
   2. Basic Air Handler Makeup _____

Session IV. Air Handler Components and Controls; Review and Testing

A. Basic Air Handler Component Descriptions _____

B. Controls _____

C. Review _____

D. Module Examination _____
   1. Trainees must score 70 percent or higher to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

Principles of Airflow
Annotated Instructor's Guide

Module 04303-09

MODULE OVERVIEW

This module reviews the principles of airflow as they affect ductrun systems. Trainees will learn to identify the components in an air distribution system and to recognize problems with duct installations.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Sheet Metal Level One; Sheet Metal Level Two; Sheet Metal Level Three*, Modules 04301-09 and 04302-09.

OBJECTIVES

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

1. Explain the principles of airflow that affect the design and sizing of ductrun systems.
2. Identify the components of an air distribution system.
3. Define the terms related to airflow in ducts.
4. Describe the effects of duct sizes, duct shapes, and duct fittings on airflow.

PERFORMANCE TASKS

There are no performance tasks for this module.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard / chalkboard
Markers / chalk
Pencils and paper
Copies of your local code
Duct calculators
Calculators
Module Examinations*

*Located in the Test Booklet

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.

ACCA Manual D. Hank Rutkowski. Arlington, VA: Air Conditioning Contractors of America.

ACCA Manual J: Residential Load Calculation. Arlington, VA: Air Conditioning Contractors of America.

HVAC Control in the New Millennium. Michael F. Hordeski. Lilburn, GA: Fairmont 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 22½ hours are suggested to cover *Principles of Airflow.* 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; Diffuser Selection; Fan Performance	
A. Introduction	_____
B. Diffuser Selection	_____
C. Fan Performance	_____
Session II. Duct Pressure and Leakage, Part One	
A. Static and Velocity Pressure	_____
B. Total Pressure	_____
C. Static Regain	_____
Session III. Duct Pressure and Leakage, Part Two	
A. Leakage	_____
Session IV. Duct Pressure and Leakage, Part Three	
A. Fitting Losses	_____
Session V. Duct Sizing	
A. Duct Sizing	_____
B. Laboratory Trainees practice using duct calculators.	_____
Session VI. Fitting Design Standards, Part One	
A. Transitions	_____
Session VII. Fitting Design Standards, Part Two	
A. Offsets	_____
B. Radius and Square Elbows	_____
C. Split Fittings	_____
Session VIII. Fitting Design Standards, Part Three	
A. Exact Split by CFM	_____
B. Approximate Split by Duct Size	_____
Session IX. Review and Testing	
A. Review	_____
B. Module Examination 1. Trainees must score 70 percent or higher to receive recognition from the NCCER. 2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	_____

Louvers, Dampers, and Access Doors
Annotated Instructor's Guide

Module 04304-09

MODULE OVERVIEW

This module reviews the function and use of louvers, dampers, and access doors. Trainees will learn how to properly select and install louvers, dampers, and access doors.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Sheet Metal Level One; Sheet Metal Level Two; Sheet Metal Level Three,* Modules 04301-09 through 04303-09.

OBJECTIVES

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

1. Explain the purpose of selected louvers, dampers, and access doors.
2. Install selected louvers, dampers, and access doors.

PERFORMANCE TASKS

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

1. Perform two of the three following tasks:
   - Properly install an exterior louver.
   - Properly install an opposed-blade damper.
   - Properly install an access door.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard/chalkboard

Markers/chalk

Pencils and paper

Appropriate personal protective equipment

NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems

Copies of your local code

Copies of indoor air quality laws

Plans and design specifications

Damper with UL Fire Damper label

Design drawings that show fire dampers and fire doors

Samples of manufacturers' data sheets for combination fire and smoke dampers

Adjustable and stationary louvers

Stationary and adjustable louver blades, sills, jambs, and headers

Various sizes and shapes of dampers

Caulking gun and caulk

Necessary tools to install louvers, dampers, and access doors

Module Examinations*

Performance Profile Sheets*

* Located in the Test Booklet

SAFETY CONSIDERATIONS

Ensure that trainees are equipped with appropriate personal protective equipment. Emphasize the importance of following all safety precautions and procedures when working with power tools. Always work in a clean, well-lit, appropriate work area.

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.

Fundamentals of Mechanical Ventilation: A Short Course on the Theory and Application of Mechanical Ventilators, 2003. Robert L. Chatburn. Cleveland Heights, OH: Mandu Press Ltd.

Industrial Ventilation Design Guidebook, 2001. Howard Goodfellow and Esko Tahti, eds. San Diego, CA: Academic Press.

NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems, 2008. Quincy, MA: National Fire Protection Association.

Practical Sheet Metal Layout: Round Fittings Used Today Including Methods and Techniques of Fabricating Round Work, 1990. Richard S. Budzik. Chicago, IL: Practical Publications.

Practical Sheet Metal Layout: Specialty Items Used Today Including Methods of Design and Fabrication and Important Trade Topics, 1987. Richard S. Budzik. Chicago, IL: Practical Publications.

Ventilation of Buildings, 2003. Hazim B. Awbi. New York: Taylor & Francis.

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 *Louvers, Dampers, and Access Doors.* 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; Ventilation, Part One	
A. Introduction	_____
B. Ventilation and Ventilators	_____
C. Natural and Forced Ventilation	_____
Session II. Ventilation, Part Two	
A. Ventilation Specifications	_____
B. Roof Ventilators	_____
C. Rectangular Gooseneck Gravity Ventilators	_____
Session III. Louvers, Part One	
A. Louver Frames and Sills	_____
C. Stationary Louvers	_____
D. Adjustable Louvers	_____
Session IV. Louvers, Part Two	
A. Laboratory Trainees practice installing an exterior louver. This laboratory corresponds to Performance Task 1.	_____
B. Laboratory Trainees practice sealing louver installations.	_____

Session V. Dampers, Part One

A. Dampers _____
B. Fire Dampers _____
C. Combination Fire and Smoke Dampers _____

Session VI. Dampers, Part Two

A. Manual Balancing and Control Dampers _____
B. Damper Installation _____
C. Laboratory _____

Trainees practice installing a damper. This laboratory corresponds to Performance Task 1.

Session VII. Access Doors

A. Access Doors _____
B. Laboratory _____

Trainees practice installing an access door. This laboratory corresponds to Performance Task 1.

Session VIII. Review and Testing

A. Review _____
B. Module Examination _____
   1. Trainees must score 70 percent or higher to receive recognition from the NCCER.
   2. Record the testing results on Craft 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 Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

Comprehensive Plan and Specification Reading
Annotated Instructor's Guide

Module 04305-09

MODULE OVERVIEW

This module reinforces and expands on plan and specification reading skills, and applies those skills to a specific job site. Trainees will learn how to identify wall, floor, and roof opening sizes and locations, as well as how to generate project timelines, material takeoffs, and buyout lists.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Sheet Metal Level One; Sheet Metal Level Two; Sheet Metal Level Three,* Modules 04301-09 through 04304-09.

OBJECTIVES

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

1. Read architect's plans and specifications.
2. Interpret specification documents and apply them to the plans.
3. Provide schedule timelines for successful project completion.
4. Coordinate with other trades to identify and prevent potential project conflicts.
5. Interpret shop drawings and apply them to the plans and specifications.
6. Describe a submittal, its derivation, routing, and makeup.
7. Establish and lay out all wall, floor, and roof openings without conflicting with the work of other trades.
8. Establish accurate material takeoffs and buyout lists for the project.
9. Develop cut lists for ductruns as shown on shop drawings and develop elevations of installations.
10. Develop a set of as-built drawings.

PERFORMANCE TASKS

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

1. Identify opening sizes and locations.
2. List five examples of how you will work with other trades, and how you will resolve potential conflicts.
3. Generate the material takeoff and buyout lists for a project.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard / chalkboard

Markers / chalk

Pencils and paper

Drawing package included with this module

Copies of your local code

Sample critical path method diagram

Sample Request for Information (RFI) form

Blank Request for Information (RFI) forms

Samples of manual- and computer-generated cut lists

Sample material takeoff list

Sample of a standard takeoff sheet

Sample material buyout list

A complete set of plans, including examples of:

- Architectural drawings
- Mechanical drawings
- Structural drawings

Module Examinations*

Performance Profile Sheets*

* Located in the Test Booklet

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.

Blueprint Reading for Construction, 1998. James A. S. Fatzinger. Upper Saddle River, NJ: Prentice Hall.

Construction Blueprint Reading. Robert Putnam. Upper Saddle River, NJ: Prentice Hall.

Drawing Interpretation and Plan Reading. Washington, DC: International Pipe Trades Joint Training Committee.

Introduction to Construction Drawings, Contren® Learning Series, Core Curriculum.

Introduction to Electrical Blueprints, Contren® Learning Series, Electrical Curriculum.

Introduction to Plumbing Blueprint Reading, Contren® Learning Series, Plumbing Curriculum.

Reading Architectural Work Drawings, 1996. Edward J. Muller. Upper Saddle River, NJ: Prentice Hall.

Reading Plans and Elevations, Contren® Learning Series, Carpentry Curriculum.

Sheet Metal Shop Drawings. Howard Bretz. New York, NY: Industrial Press, Inc.

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 30 hours are suggested to cover *Comprehensive Plan and Specification Reading.* 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; Reading Plans, Part One	
A. Introduction	_____
B. Reading Plans	_____
1. Site Plan	_____
2. Plan Views	_____
3. Elevation Drawings	_____
Session II. Reading Plans, Part Two	
A. Schedules	_____
B. Detail Drawings	_____
C. Section Drawings	_____
Session III. Reading Plans, Part Three	
A. Plumbing Plans	_____
B. Mechanical Plans	_____
C. Electrical Plans	_____
Session IV. Reading Specifications	
A. Specifications	_____
1. Special and General Conditions	_____
2. Technical Aspects	_____
3. Format	_____
Session V. Project Scheduling	
A. Project Scheduling	_____
1. Critical Path Method	_____
2. Gantt Chart	_____
3. Project Schedule Timeline	_____

Session VI. Coordination with Other Trades, Part One

A. Coordination with Other Trades _____

1. Verifying Exterior Wall Openings _____
2. Verifying Floor Openings _____
3. Verifying Interior Wall Openings _____

Session VII. Coordination with Other Trades, Part Two

A. Verifying Roof Openings _____

B. Laboratory _____

Trainees practice sizing and locating openings. This laboratory corresponds to Performance Task 1.

Session VIII. Coordination with Other Trades, Part Three

A. Verifying Takeoffs _____

Session IX. Coordination with Other Trades, Part Four

A. Identifying Areas of Congestion _____

B. Laboratory _____

Trainees provide practical examples of how to resolve conflicts when working with other trades. This laboratory corresponds to Performance Task 2.

Session X. Shop Drawings

A. Shop Drawings _____

1. Cut Lists _____
2. General Procedure _____

Session XI. Submittals, Takeoffs, and Ductwork

A. Submittals _____

B. Takeoffs _____

C. Laboratory _____

Trainees practice generating material takeoff and buyout lists. This laboratory corresponds to Performance Task 3.

D. Ductwork

Session XII. As-Built Drawings; Review and Testing

A. As-Built Drawings _____

B. Review _____

C. Module Examination _____

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

D. 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 Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

Fabrication Three – Triangulation
Annotated Instructor's Guide

Module 04306-09

MODULE OVERVIEW

This module introduces the principle of triangulation for laying out selected ductrun fittings. Trainees will learn to develop, lay out, and fabricate selected fittings by completing a variety of triangulation tasks.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Sheet Metal Level One; Sheet Metal Level Two; Sheet Metal Level Three,* Modules 04301-09 through 04305-09.

OBJECTIVES

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

1. Describe the principles of triangulation used to determine measurements for ductrun fittings.
2. Use the principles of triangulation for laying out selected ductrun fittings.
3. Develop, lay out, and fabricate selected ductrun fittings.

PERFORMANCE TASKS

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

1. Lay out and fabricate the following:
   - Square-to-round two-way offset fitting
   - Two-way offset transition
   - Y-branch rectangular transition
   - 90-degree transition change elbow, radius or square
   - Tapered duct section with one straight side
   - Square-to-round at an angle or pitch fitting
   - Round-to-round Y-branch with branch pipes at 45-degree angles

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard/chalkboard

Markers/chalk

Pencils and paper

Appropriate personal protective equipment

Copies of your local code

Prick-punch

Framing square

Sheet metal gauge

24-gauge galvanized iron sheet metal

26-gauge galvanized iron sheet metal

Sample pattern layouts

Fabrication equipment, tools, and materials to lay out and fabricate the following:

- Square-to-round, two-way offset fitting
- Two-way offset transition
- Y-branch rectangular transition
- 90-degree transition change elbow, radius or square
- Tapered duct section with one straight side
- Square-to-round at an angle or pitch fitting
- Round-to-round Y-branch with branch pipes at 45-degree angles

Additional fabrication projects provided in Appendixes A through G (optional)

Module Examinations*

Performance Profile Sheets*

* Located in the Test Booklet

SAFETY CONSIDERATIONS

Ensure that trainees are equipped with appropriate personal protective equipment. Emphasize the importance of following all safety precautions and procedures when working with power tools. Always work in a clean, well-lit, appropriate work area.

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.

Hey, Lady! Your Tin Snips are Showing! 2002. Beth Szillagyi. SynergEbooks.

Mechanics of Sheet Metal Forming, Second Edition. 2002. J. Hu, Z. Marciniak, and J.L. Duncan. Butterworth-Heinemann.

Practical Sheet Metal Layout: Fittings Used Today That Require Triangulation, Including the Theory of Triangulation, 1996. Richard S. Budzik. Chicago, IL: Practical Publications.

Today's 40 Most Frequently-Used Fittings: Including Supplemental Sections of Other Fittings and Items, 1996. Richard S. Budzik. Chicago, IL: Practical Publications.

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 47½ hours are suggested to cover *Fabrication Three – Triangulation.* 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; Triangulation; Layout Review	
A. Introduction	_____
B. Triangulation	_____
C. Layout Review Problem	_____
D. Layout Review	_____
Session II. Layout Problems; Square-to-Round Two-Way Offset	
A. Square-to-Round Two-Way Offset	_____
B. Laboratory Trainees practice laying out and fabricating a square-to-round two-way offset fitting. This laboratory corresponds to Performance Task 1.	_____
Session III. Rectangular-to-Round Ventilator Base	
A. Rectangular-to-Round Ventilator Base	_____
B. Laboratory Trainees practice laying out and fabricating a rectangular-to-round ventilator base.	_____
Session IV-V. Two-Way Offset Transition	
A. Two-Way Offset Transition	_____
B. Laboratory Trainees practice laying out and fabricating a two-way offset transition. This laboratory corresponds to Performance Task 1.	_____
Session VI-VII. Y-Branch Rectangular Transition	
A. Y-Branch Rectangular Transition	_____
B. Laboratory Trainees practice laying out and fabricating a Y-branch rectangular transition. This laboratory corresponds to Performance Task 1.	_____

Session VIII. 90-Degree Transition Change Elbow

A. 90-Degree Transition Change Elbow _____

B. Laboratory _____

Trainees practice laying out and fabricating a 90-degree transition change elbow. This laboratory corresponds to Performance Task 1.

Session IX-X. 90-Degree Transition Change Elbow, Alternate Method

A. 90-Degree Transition Change Elbow, Alternate Method _____

B. Laboratory _____

Trainees practice laying out and fabricating a 90-degree transition change elbow using the alternate method. This laboratory corresponds to Performance Task 1.

Session XI. 90-Degree Y-Branch with Different Size Branch Duct

A. 90-Degree Y-Branch with Different Size Branch Duct _____

B. Laboratory _____

Trainees practice laying out and fabricating a 90-degree Y-branch with different size branch duct.

Session XII-XIII. Tapered Duct Section with One Straight Side

A. Tapered Duct Section with One Straight Side _____

B. Laboratory _____

Trainees practice laying out and fabricating a tapered duct section with one straight side. This laboratory corresponds to Performance Task 1.

Session XIV-XV. Square-to-Round at an Angle or Pitch Fitting

A. Square-to-Round at an Angle or Pitch Fitting _____

B. Laboratory _____

Trainees practice laying out and fabricating a square-to-round at an angle or pitch fitting. This laboratory corresponds to Performance Task 1.

Session XVI. Rectangular-to-Round Elbow

A. Rectangular-to-Round Elbow _____

B. Laboratory _____

Trainees practice laying out and fabricating a rectangular-to-round elbow.

Session XVII. Y-Branch Round-to-Round

A. Y-Branch Round-to-Round _____

B. Laboratory _____

Trainees practice laying out and fabricating a Y-branch round-to-round fitting. This laboratory corresponds to Performance Task 1.

Session XVIII. Transition Duct

A. Transition Duct _____

B. Laboratory _____

Trainees practice laying out and fabricating a transition duct fitting.

Session XIX. Review and Testing

A. Review _____

B. Module Examination _____

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

Advanced Architectural Sheet Metal
Annotated Instructor's Guide

Module 04307-09

MODULE OVERVIEW

This module expands upon the skills learned in previous layout and fabrication modules. Trainees will learn how to properly lay out, fabricate, and install architectural sheet metal fabrications, focusing on roofing materials and flashing.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Sheet Metal Level One; Sheet Metal Level Two; Sheet Metal Level Three,* Modules 04301-09 through 04306-09.

OBJECTIVES

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

1. Lay out, fabricate, and install architectural fabrications.

PERFORMANCE TASKS

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

1. Lay out, fabricate, and install four of the following:
   - Stationary, adjustable, triangular, or round louver
   - Scupper
   - Gutter
   - Flashing and counter flashing
   - Decking
   - Cap flashing
   - Fascia
   - Wall pass-through
2. Install the roof slope stack flange (roof tall cone), storm collar, and weather cap built in *Fabrication Two – Radial Line Development*.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
Lifts, ladders, and/or scaffolds
Appropriate personal protective equipment
Safety harnesses and lanyards
Copies of your local code
Appropriate gauge and sufficient quantity of sheet metal

Layout tools, including:
- Scratch awls
- Felt-tipped markers
- Straightedge
- Flat steel square and combination square
- Prick punch and center punch
- Dividers
- Trammel points
- Marking gauge
- French curves
- Circumference rule
- ¼-inch tape measure

(continued)

Sheet metal brake
Sheet metal shear
Whitney hand punch
Beading, crimping, turning, slip-roll forming, and burring machines
Ring and circle shears
Bar folder
Bench plate and stakes
Electric spot welder
Hand seamer
C-clamps and parallel clamps
Sheet metal hammer and mallet
Sheet metal snips
Dimpler/button punch
Rivet set and hand groover
Drill bits and drill
Screwdrivers, wrenches, and pliers
Module Examinations*
Performance Profile Sheets*

*Located in the Test Booklet

SAFETY CONSIDERATIONS

Because many of the tasks in this module may require lifts, ladders, or scaffolding, ensure that trainees follow procedures for fall prevention and are equipped with appropriate personal protective equipment. Review the safety precautions and procedures for working with power tools. Always work in a clean, well-lit, appropriate work area.

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.

Architectural Sheet Metal Manual, Sixth Edition, 2003. Sheet Metal and Air Conditioning Contractors' National Association. Chantilly, VA.

Sheet Metal Workers Pocket Manual, 2002. Fred Schumacher and Claude Zinngrabe. Z/S Pocket Manuals.

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 12½ hours are suggested to cover *Advanced Architectural Sheet Metal*. 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; Flashing and Roof Panels, Part One	
A. Introduction	_____
B. Roof Edge Flashing	_____
C. Laboratory Trainees practice laying out, fabricating, and installing roof edge flashing. This laboratory corresponds to Performance Task 1.	_____
D. Roof Panels	_____
E. Laboratory Trainees practice laying out, fabricating, and installing the top, middle, and bottom rows of roof panels (decking). This laboratory corresponds to Performance Task 1.	_____

Session II. Flashing and Roof Panels, Part Two

A. Top Wall Roof Flashing and Counter Flashing _____

B. Laboratory _____

Trainees practice laying out, fabricating, and installing top roof flashing. This laboratory corresponds to Performance Task 1.

C. Standing Edge Cap Strips _____

D. Laboratory _____

Trainees practice laying out, fabricating, and installing standing edge cap strips. This laboratory corresponds to Performance Task 1.

E. Wall Cap Flashing _____

F. Laboratory _____

Trainees practice laying out, fabricating, and installing wall cap and side wall flashing, inner side edge flashing, and fascia. This laboratory corresponds to Performance Task 1.

G. Roof Ridge Cap _____

H. Roof Pitch Stack Flange and Weather Cap _____

I. Laboratory _____

Using their fabricated items from *Sheet Metal Level Two*, trainees install a roof stack flange, storm collar, and weather cap. This laboratory corresponds to Performance Task 2.

Session III. Roof Drainage Systems

A. Wall Pass-Through and Scupper _____

B. Wall Pass-Through without a Scupper _____

C. Laboratory _____

Trainees practice laying out, fabricating, and installing a wall pass-through with and without a scupper. This laboratory corresponds to Performance Task 1.

D. Gutter _____

E. Laboratory _____

Trainees practice laying out, fabricating, and installing a gutter. This laboratory corresponds to Performance Task 1.

Session IV. Louver Frames and Sills

A. Louver Frames and Sills _____

B. Stationary and Adjustable Louvers _____

C. Fabrication Tasks _____

D. Laboratory _____

Trainees practice laying out, fabricating, and installing stationary, triangular, round, and adjustable louvers. This laboratory corresponds to Performance Task 1.

Session V. Access Doors; Review and Testing

A. Access Doors _____

B. Laboratory _____

Trainees practice laying out, fabricating, and installing an access door.

C. Review _____

D. Module Examination _____

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

E. 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 Craft Training Report Form 200, and submit the results to the Training Program Sponsor.