

AIR FORCE QUALIFICATION TRAINING PACKAGE (AFQTP)



FOR
STRUCTURAL
(3E3X1)

MODULE 29

FABRICATE AND INSTALL METAL COMPONENTS

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FABRICATE AND INSTALL METAL/FIBERGLASS COMPONENTS

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Career Field Education and Training Plan (CFETP) references from 1 August 2002 version.

OPR: HQ AFCESA/CEOF
(SMSgt Dan Sacks)
Supersedes AFQTP 3E3X1-28, 14 Jul 00

Certified by: HQ AFCESA/CEOF
(CMSgt Myrl F. Kibbe)
Pages: 21/Distribution F

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

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INTRODUCTION

Before starting this AFQTP, refer to and read the “[AFQTP Trainer/Trainee Guide](#)”

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. **It is important for the trainer and trainee to understand** that an AFQTP **does not** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:

AFQTP completion
Hands-on certification

Diamond task:

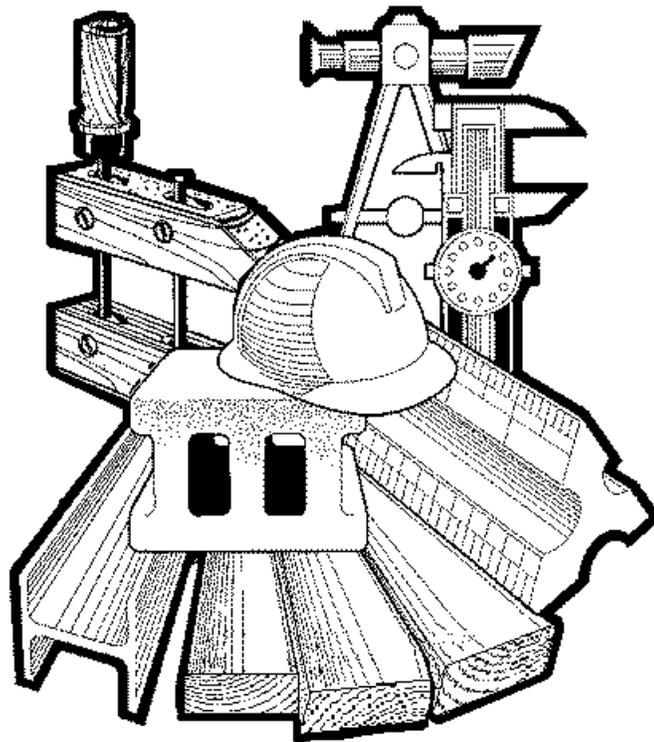
AFQTP completion
CerTest completion (80% minimum to pass)

Note: Trainees will receive hands-on certification training for Diamond Tasks when equipment becomes available either at home station or at a TDY location.

Put this package to use. Subject matter experts under the direction and guidance of HQ AFCESA/CEOF revised this AFQTP. If you have any recommendations for improving this document, please contact the Career Field Manager at the address below.

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LAY OUT METAL COMPONENTS USING:

MODULE 29

AFQTP UNIT 2

PARALLEL LINE DEVELOPMENT (29.2.2.)

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PARALLEL LINE DEVELOPMENT
Task Training Guide

STS Reference Number/Title:	29.2.2. – Lay out metal components using parallel line development.
Training References:	<ol style="list-style-type: none"> 1. Career Development Course (CDC) Structural Journeyman 3E351B, Volume 1, Unit 4; <i>Sheet Metal and Structural Steel Layout</i> 2. Commercial Manual, <i>Modern Metalworking</i> by John R. Walker, 1993.
Prerequisites:	<ol style="list-style-type: none"> 1. Possess as a minimum a 3E331 AFSC. 2. Review the following references: <ol style="list-style-type: none"> 2.1. CDC Structural Journeyman 3E351B, Volume1, <i>Units 2 through 4.</i> 2.2. Modern Metalworking, Unit 11, Sheet Metal.
Equipment/Tools Required:	<ol style="list-style-type: none"> 1. Steel Rules. 2. T-Square and Triangles. 3. Compass and Dividers. 4. Trammel Points. 5. Protractor. 6. French Curve. 7. Scratch Awl. 8. Sheet metal hammer 9. Sheet metal. 10. Gloves
Learning Objective:	Trainee should be able to layout square, round, and rectangular shaped ductwork using the parallel line development.
Samples of Behavior:	Trainee will be able to successfully use the parallel line development.
Notes:	

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PARALLEL LINE DEVELOPMENT

1. Background. As a structural journeyman you will be tasked to layout duct systems. There are three methods of layout: parallel, radial, and triangulation. The easiest and most often used method of layout is the parallel line layout. It is important to know this one of three methods in order to fabricate certain duct components. With out this knowledge you will not be able to fabricate certain duct components.

2. Parallel Line Development. The layout method is determined by what type of duct system you are tasked to fabricate. In this method your duct components would have to have parallel and perpendicular sides. The true length or the actual dimensions of the measurements are called element lines. These element lines are critical in parallel line development. They indicate the true length of the duct section. Before starting this task make sure you have fully read all materials covered in the prerequisites. By doing this, it will help you better understand this tasking. There are three patterns that you can layout using the parallel line method: square, rectangular (Figure 2-1), and round ducts (Figure 2-2).

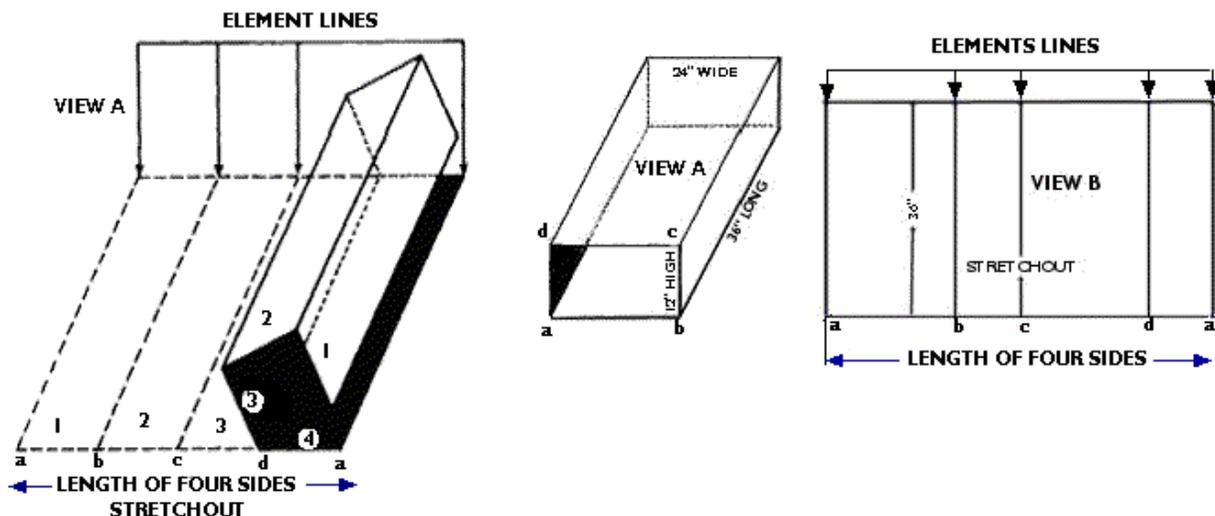
3. Procedures.

3.1. Follow these steps to layout square and rectangular ducts:

NOTE TO TRAINER/CERTIFIER:

If a sheet metal duct layout and fabrication job is not available, then the minimum required for upgrade training is the following: give trainee a scenario based on the steps below. Have the trainee lay out three 12”H x 24”W x 36”L sections of rectangular duct.

Figure 2-1. Parallel Line Development For A Square And Rectangular Duct.



Step 1: Gather sheet metal and required tools to fabricate like figure 1 shown above.

HINT:

Remember to allow for your seams and joints when laying out ductwork.

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Step 2: On the left edge of the sheet metal, draw two parallel lines 36” apart and equal to the perimeter of the four sides. In our example, both lines will be 72” long plus whatever the seam allowances will be to connect this duct together. This will be the stretch out of your duct.

Step 3: Starting on the left side of your stretch out (the two parallel lines you drew in Step 1), scribe your first element line (which in this case will be 36” long) perpendicular to the stretch out lines.

Step 4: Next, from the first element line you have scribed go to the right 24” then scribe another element line parallel to the first element line scribed.

Step 5: Then go to the right 12” and scribe another element line parallel with the first two element lines.

Step 6: Repeat steps 3 and 4. Make sure the element lines are parallel to each other.

Step 7: Next, wear your gloves (safety from cut metal) and begin cutting out the pattern.

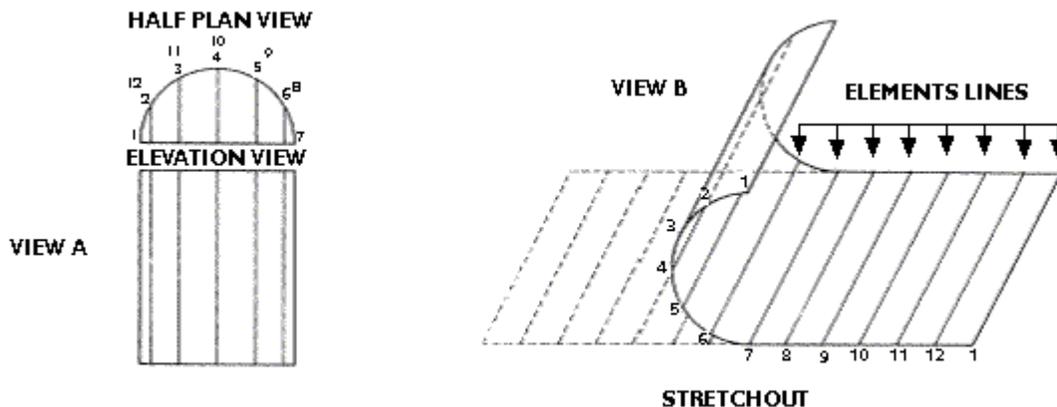
Step 8: Lastly begin folding the pattern on the element lines you scribed. Then connect the rectangular duct together.

3.2. Follow these steps to layout a round duct:

NOTE TO TRAINER/CERTIFIER:

If a sheet metal round duct layout and fabrication job is not available, then the minimum required for upgrade training is the following: give trainee a scenario based on the steps below. Have the trainee layout a 6” high and 5” diameter duct.

Figure 2-2. Parallel Line Development For A Cylinder.



Step 1: Gather sheet metal and required tools.

Step 2: Scribe the plan view (looking at a 3-D object from the top down) of a 5” diameter duct with your compass. For simplicity scribe a half plan view versus a full plan view.

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Step 3: With a T-square, come down from the sides of your plan view and scribe the length of duct that you want (6") as seen in above figure. Draw the elevation view (looking at a 3-D object from the sides or end) of the pipe.

Step 4: Next, divide the half plan view into 12 equal parts as shown above. Refer to page 4-4 of prerequisite CDC.

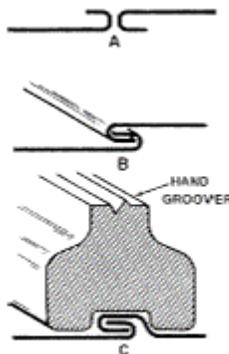
Step 5: Next, figure out the stretch out of your round duct. To get the stretch-out multiply the diameter (5") by pi (3.1416). The total will be the length of your stretch-out plus your seam allowance (15 $\frac{3}{4}$ ").

Step 6: Next, draw the stretch out view. It should be drawn to the height of the pipe in this case 6" high and whatever number (15 $\frac{3}{4}$ ") you got for the diameter times pi. Then divide this stretch out view into 12 equal parts. Make sure to add your seam allowances before cutting.

Step 7: Next, wear your gloves and begin cutting out the pattern.

Step 8: Lastly, begin forming the sheet metal to a round duct and connect it together with a groove seam (Figure 2-3).

Figure 2-3. Making A Grooved Seam With Hand Tools.



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**REVIEW QUESTIONS
FOR
PARALLEL LINE DEVELOPMENT**

QUESTION	ANSWER
1. Round, Square and Rectangular are the three patterns you can use in parallel line development.	a. True. b. False.
2. What is the first view to layout using parallel line development in round duct?	a. Plan view. b. Elevation view. c. Detail view.
3. True length lines are important because they indicate the true length of the duct system.	a. True. b. False.

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PARALLEL LINE DEVELOPMENT

PERFORMANCE CHECKLIST

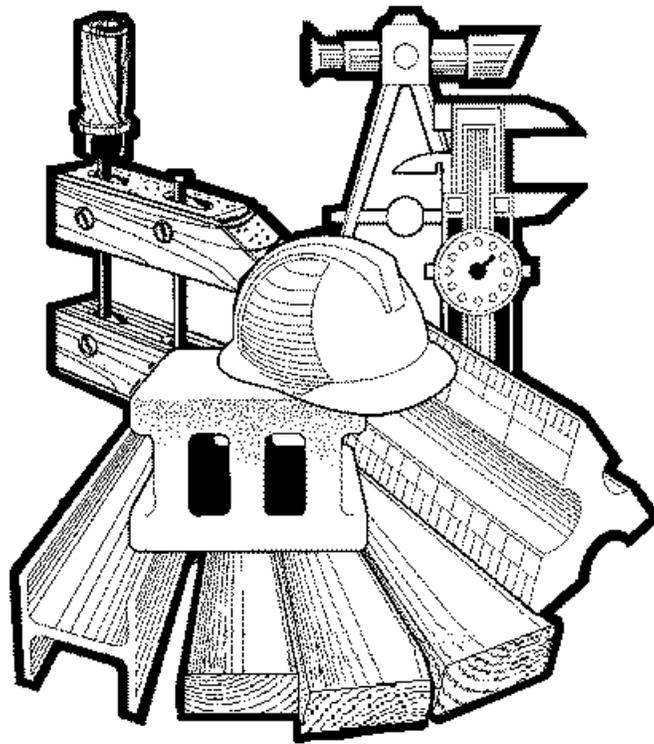
INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE....	YES	NO
1. layout all 3 patterns using parallel line development?		
2. establish a plan view for a round duct layout?		
3. layout the true length lines the same length of the ductwork?		
4. wear gloves for safety		

FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer/certifier.

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INSTALL DUCT SYSTEMS

MODULE 29

AFQTP UNIT 4

SHEET METAL DUCT (29.4.1.1.)

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INSTALL SHEET METAL DUCTS
Task Training Guide

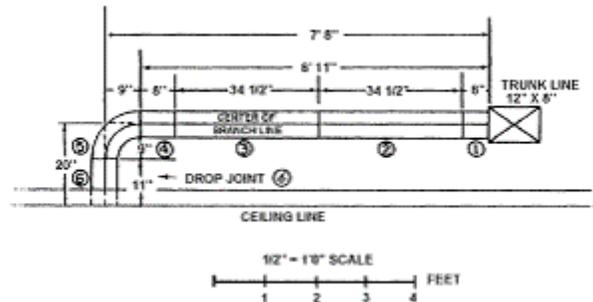
STS Reference Number/Title:	29.4.1.1. – Install sheet metal ducts.
Training References:	Career Development Course (CDC) Structural Journeyman 3E351B, Volume 2, Unit 2; <i>Sheet Metal Duct Systems</i> .
Prerequisites:	<ol style="list-style-type: none"> 1. Possess as a minimum a 3E331 AFSC. 2. Review CDC Structural Journeyman 3E351B, Volume 2, Units 1 through 2.
Equipment/Tools Required:	<ol style="list-style-type: none"> 1. Electric drill. 2. Ladder. 3. Gloves. 4. Hammer. 5. Hearing protection. 6. Eye protection. 7. Aviation snips. 8. Ductwork.
Learning Objective:	Trainee should be able to install ductwork with no supervision.
Samples of Behavior:	Trainee will be able to successfully install metal ductwork.
Notes:	
It usually will take two or more people when installing ductwork.	

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INSTALL SHEET METAL DUCTS

1. Background. It is important to know the procedures for installing duct components, as it will be the conduit for heating and cooling airflow. Ductwork that is hung improperly will cause several problems. The airflow will not be smooth thus causing your heating and cooling unit to work harder. Also, it may increase the noise level, as airflow will be moving roughly through the ductwork.

Figure 4-1. Elevation View of Six-Inch Branch Line.



2. Installing Ducts. It's very important that a centerline is established, before any hangers are installed. This is an imaginary line that passes through the horizontal and vertical center of your duct system. The horizontal centerline is determined from the elevation view drawing, and the vertical centerline is determined from the plan view. Once the centerline is established, it is time to install hangers followed by installing the duct components. To help with this tasking ensure you have read all prerequisites.

NOTE TO TRAINER/CERTIFIER:

Describe below is the process of a complete beginning to finish installation of a duct system. For training purposes, this task may be too large for hands on, so a smaller tasking has been provided to fulfill this tasking. The below reading can be skipped if trainee can describe to you the overall installation procedure. If applicable skip to paragraph 4 for exercise tasking.

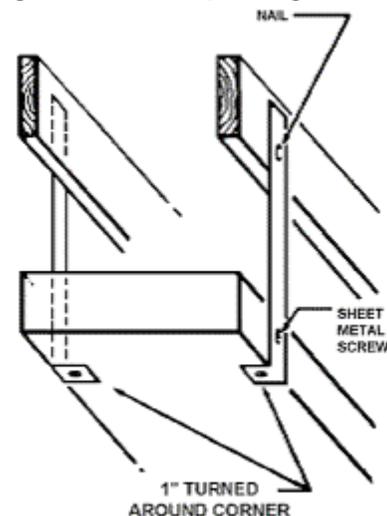
3. Procedures. Follow these steps to install sheet metal ducts:

Step 1: Determine the centerline. Use the ceiling or ceiling joist as a reference point to measure your centerline, see figure below. Once the centerline has been determined from the elevation and plan views, run a string line to mark the height of the imaginary centerline. This string line will assist in the proper installation of hangers.

Figure 4-2. Strap Hangers.

NOTE:

The size of the hangers depends on the size, shape, and weight of the duct. These hangers are usually made of strips of metal that are nailed to the rafters or other structures in the attic. Some are even made of steel or angle iron; again this all depends on the duct component. Refer to blueprints for proper fabrication of hangers.



Step 2: Fabricate hangers according to blueprints.

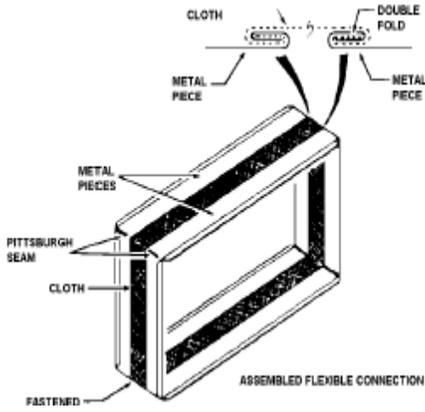
Install the hangers. Refer to the blueprints for proper hanger spacing. If repairing or removing hangers and there are no blueprints use the spacing already established by the existing hangers.

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HINT:

It is much easier to insulate the ductwork on the ground before you install it.

Figure 4-3. Flexible Connector In Trunk Line.



Step 3: After the hangers are in place it's time to hang the duct.

3.1. Attach a flexible connector to the plenum. This will aid in eliminating vibrations. This connector is made of metal and cloth.

3.2. Continue with the main trunk line, making sure that the centerline is always on the mark.

3.3. Ensure that you have enough drives and S-slips to do the entire job. Drives and S-slips are metal components that enable the duct components to be connected together. Refer to 3E351B Volume 1 pages 5-15 through 5-23.

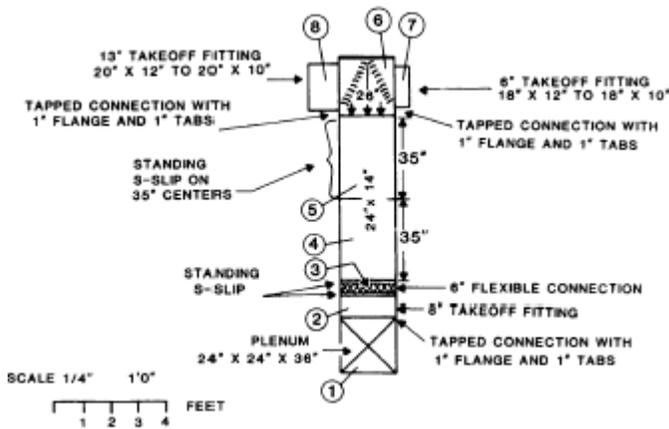


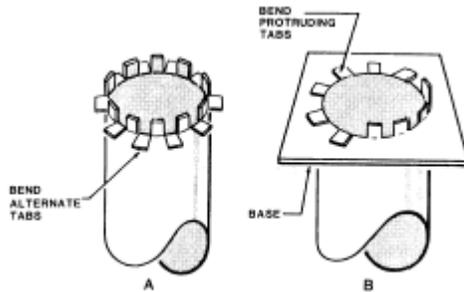
Figure 4-4. Drive Slip.

Figure 4-5: Duct Joints Connected With S And Drive Slips.



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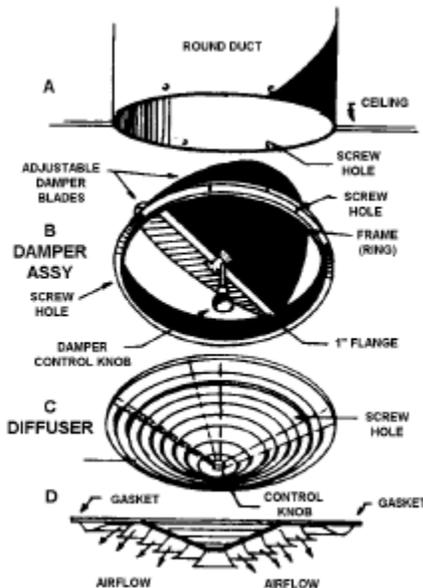
Figure 4-6. Dovetail Seam.



Step 4: Install the branch lines after the main trunk line is complete.

4.1. Attach the round take-off fittings to the main trunk line by means of a dovetail connection. Dovetailing is the process of cutting attachment tabs in the round duct. Refer to 3E351B Vol 1 pages 5-11 through 5-23.

Figure 4-7. Ceiling Diffuser And Volume Damper.



4.2. Continue the branch lines until you get to the diffuser positions. Diffusers are the last components of the duct run. This component directs the air into the rooms.

4.2.1. To install the diffusers, elbow the branch line down to the ceiling, stopping it just above the ceiling line. Then put the diffusers flush with the ceiling and attach it to the elbow with self-drilling screws.

4.2.2. If there are more main trunk lines to install follow the procedures outlined above.

NOTE TO TRAINER/CERTIFIER:

If a sheet metal duct installation job is not available, then the minimum required for upgrade training is the following: give trainee a scenario based on the steps below.

4. Project Exercise. Follow these steps to install the three pieces of duct that were fabricated in Unit 2.

SAFETY:

WEAR GLOVES AND HEARING PROTECTION WHILE ATTACHING AND CONNECTING DUCT COMPONENTS.

Step 1: Gather the three duct components previously built and all required tools for installation.

Step 2: Fabricate six hangars, two hangars for each duct component. Hangars used for these duct components need to be between 20- to 26-gauge sheet metal. Cut hangars 2" wide by 36" to 48" long, fold hangars length wise into 1" strips, and cut to required length for installation.

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Step 3: Locate an attic with a finished ceiling in your shop or any other area in which the three duct components can be installed.

Step 4: To layout the centerline, use the ceiling or a ceiling joist as a reference point. For this task go left 20" from your reference point and then right 20" from the reference point. Run a string line between these two points to guide the height of your hangars.

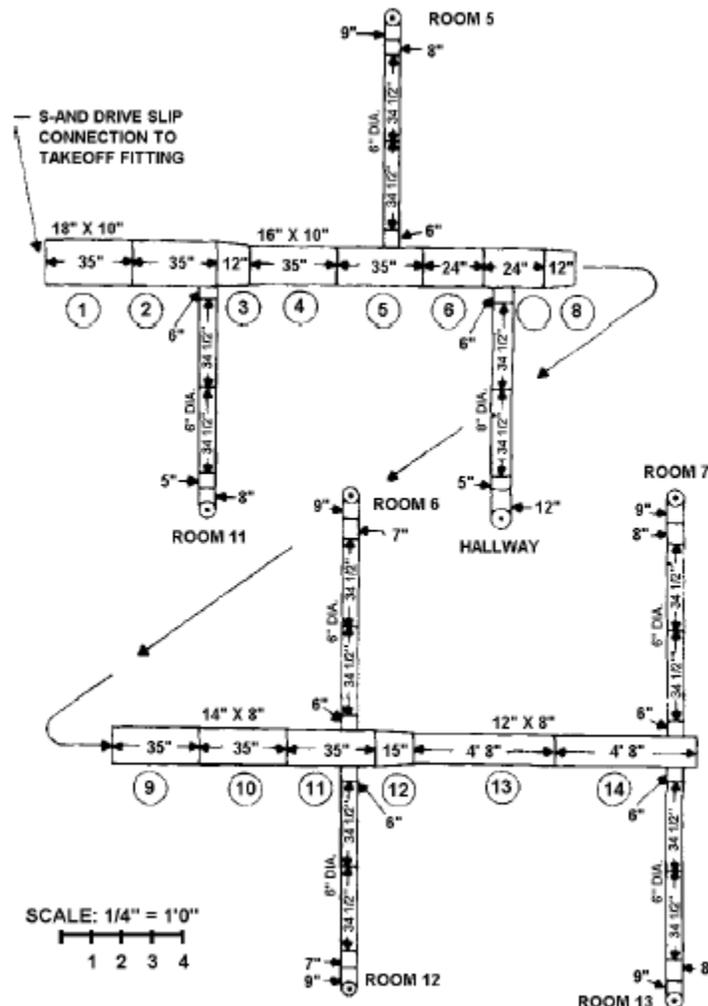
NOTE:

If there is not anything to attach the string line to, temporarily nail a 2" by 4" on the ceiling joists and stretch the string line between them.

Step 5: Install two hangars for each duct component. Since we are not working with blueprints, space hangars according to length of duct components.

Step 6: Start attaching duct components by screwing or pop riveting to the hangars. Once the first piece of duct is hung, attach the second piece with S-slips and drives, and then attach this duct to its set of hangars. Continue this process for the last duct section.

Figure 4-8. Typical Trunk and Branch Lines.



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**REVIEW QUESTIONS
FOR
INSTALL SHEET METAL DUCTS**

QUESTION	ANSWER
1. What is the first thing you do before you hang your duct?	a. Get the centerline of your duct. b. Put the duct together. c. Insulate your duct.
2. A centerline passes through the horizontal and vertical center of all your ducts?	a. True. b. False.
3. What do you attach the hangers to in the attic?	a. Rafters. b. Ceiling joist. c. Both a. and b.
4. A flexible connector should be attached to your unit before the ductwork can be installed.	a. True. b. False.

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INSTALL SHEET METAL DUCTS

PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE....	YES	NO
1. establish a centerline before hanging their duct system?		
2. fabricate hangars to specifications given?		
3. have enough drives and S-slips to complete the task?		
4. install duct components properly?		
5. comply with all safety requirements?		

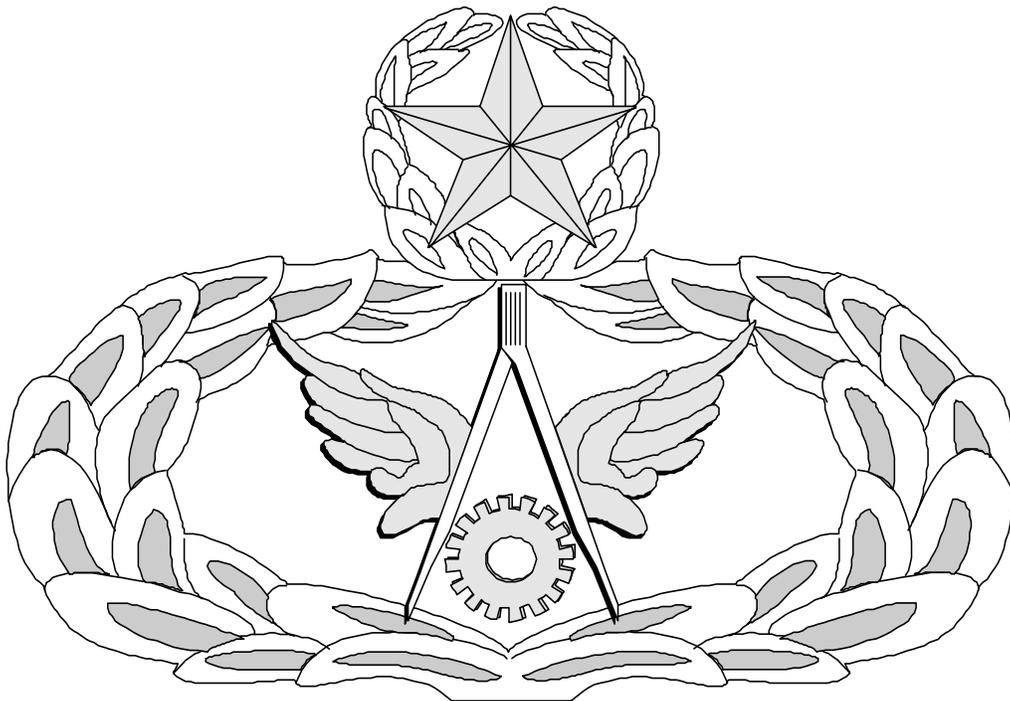
FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer/certifier.

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Air Force Civil Engineer

QUALIFICATION TRAINING PACKAGE (QTP)

REVIEW ANSWER KEY



FOR
STRUCTURAL
(3E3X1)

MODULE 29

FABRICATE AND INSTALL METAL COMPONENTS

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Key-1

PARALLEL LINE DEVELOPMENT
(3E3X1-29.2.2.)

QUESTION	ANSWER
1. Round, Square and Rectangular are the three patterns you can use in parallel line development.	a. True.
2. What is the first view to layout using parallel line development in round duct?	a. Plan view.
3. True length lines are important because they indicate the true length of the duct system.	a. True.

INSTALL SHEET METAL DUCTS
(3E3X1-29.4.1.1.)

QUESTION	ANSWER
1. What is the first thing you do before you hang your duct?	a. Get the centerline of your duct.
2. A centerline passes through the horizontal and vertical center of all your ducts?	a. True.
3. What do you attach the hangers to in the attic?	c. Both a. and b.
4. A flexible connector should be attached to your unit before the ductwork can be installed.	a. True.

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MEMORANDUM FOR HQ AFCESA/CEOF
139 Barnes Drive Suite 1
Tyndall AFB, FL 32403-5319

FROM:

SUBJECT: Qualification Training Package Improvement

1. Identify module.

Module # and title _____

2. Identify improvement/correction section(s):

- | | |
|--|--|
| <input type="checkbox"/> STS Task Reference | <input type="checkbox"/> Performance Checklist |
| <input type="checkbox"/> Training Reference | <input type="checkbox"/> Feedback |
| <input type="checkbox"/> Evaluation Instructions | <input type="checkbox"/> Format |
| <input type="checkbox"/> Performance Resources | <input type="checkbox"/> Other |
| <input type="checkbox"/> Steps in Task Performance | |

3. Recommended changes--use a continuation sheet if necessary.

4. You may choose to call in your recommendations to DSN 523-6445 or FAX DSN/Commercial 523-6488 or (850) 283-6488 or email ceof.helpdesk@tyndall.af.mil.

5. Thank you for your time and interest.

YOUR NAME, RANK, USAF
Title/Position