PREPARE A PLUMBING TAKEOFF LIST (PLUMBING I)
The plumbing takeoff list subcourse, part of the Plumber, MOS 51K, Skill Levels 1 and 2, course, is designed to teach the knowledge necessary to extract information from a construction drawing legend, identify plumbing symbols, and use plumbing material. The subcourse is presented in two lessons, each lesson corresponding to a terminal objective as indicated below.

Lesson 1: USE DRAWING LEGENDS AND PLUMBING SYMBOLS

OBJECTIVE: Describe the methods used to extract information from a construction drawing legend and to identify plumbing symbols.

TASK: 051-248-1001, Prepare a plumbing takeoff list.

CONDITIONS: Given subcourse booklet EN 5110 and an examination response sheet. You will work in your own environment without supervision.

STANDARDS: You should be able to complete this lesson and answer the practice exercises within approximately 4 hours.

Lesson 2: LIST PLUMBING MATERIALS

OBJECTIVE: List plumbing materials by type, size, and length from a construction drawing.

TASK: 051-248-1001, Prepare a plumbing takeoff list.
CONDITIONS: Given subcourse booklet EN5110 and an examination response sheet. You will work in your own environment without supervision.
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STUDENT INQUIRY SHEET (ADMINISTRATIVE) ......................... Following Examination

STUDENT INQUIRY SHEET (SUBCOURSE CONTENT) ................... Following Examination
INTRODUCTION

An important part of building construction is the ability to read and understand the information shown on a construction drawing or a set of construction drawings. The drawings show what plumbing facilities are required by using symbols and abbreviations to identify the real material items. The symbols and abbreviations on the construction drawing tell the plumber the location of water and waste pipelines, the type and size of pipe, the type of fittings for pipeline connections, and the location of all the fixtures required.

Once you can read and understand the information on a construction drawing, you can determine the lengths of pipe required by type and size, the number of different types of fittings by size, and the number of different types of fixtures. You will be able to make a list of plumbing materials needed to install any part of or all of the plumbing system.
Lesson 1/Learning Event 1

Lesson 1
USE DRAWING LEGENDS AND PLUMBING SYMBOLS

OBJECTIVE
At the end of this lesson, you will be able to describe the methods used to extract information from a construction drawing legend and to identify plumbing symbols.

TASK
Task 051-248-1001, Prepare a plumbing takeoff list.

CONDITIONS
Given subcourse booklet EN5110 and an examination response sheet. You will work in your own environment without supervision.

STANDARDS
You should be able to complete this lesson and answer the review exercise within approximately 4 hours. You must respond correctly to 70 percent of the examination questions pertaining to this lesson.

CREDIT HOURS
4.

REFERENCES
TM 5-551K, TM 5-704, FM 5-51K.

Learning Event 1
READ A CONSTRUCTION DRAWING

1. A plumber has to read and understand the information on a construction drawing. The drawing has two areas, the legend and the diagram. The legend contains general information and the scale of the drawing. The diagram contains plumbing symbols giving the location of the plumbing system in a building.

   a. General information is in the legend of a construction drawing. "Schedule of Drawings," part of a legend in figure 1-1 on page 2, identifies all the drawings by number, number of sheets per drawing, and title of each drawing. "General Notes," also part of a legend in figure 1-1, gives additional information that is needed. Items 3, 4, and 5 are for the plumber. Note: The legend of a construction drawing is in the lower right hand corner.
b. The scale of a drawing can be either a graphic or ratio scale. In figure 1-2, each segment of the line equals one foot in the building. In figure 1-3, 1/4 inch on the drawing equals one foot in the building.

2. The diagram is the part of the drawing that uses symbols to show the location of the water system, waste system, and fixtures. See figure 1-4.
FIGURE 1-4. CONSTRUCTION DRAWING DIAGRAM

NOT TO SCALE

CAST IRON PIPE
FIBER PIPE
4" FIBER ADAPTER

-5'-0"
10'-0"

11-Q
11-G
4" VTR
LATRINE

11-D

2" P-TRAP

2" P-TRAP
WASH ROOM

15-D

2" P-TRAP

3/4"

BENCH

11-X

2" STEEL

11-K

2" WATER SERVICE PLUGGED TEE

WH

11-M
3" CURB

DETAIL 1

DETAIL 2

W/P-TRAP

SHOWER ROOM

11-Q

AT CLG

4" VTR

11-O

4" SD

REMovable DUCKBOARDS OVER ENTIRE SHOWER ROOM FLOOR

9'-4"

10'-8"

20'-0"
Lesson 1/Learning Event 2

Learning Event 2
IDENTIFY WATER SYSTEM PIPELINES

3. Cold, hot, and tempered water lines are identified by symbols.
   a. Figure 1-5 shows water pipeline symbols.

   FIGURE 1-5. WATER PIPELINE SYMBOLS

<table>
<thead>
<tr>
<th>Symbols/Abbreviations</th>
<th>Meaning</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COLD WATER LINES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HOT WATER LINES</td>
<td></td>
</tr>
<tr>
<td>-T-----T-</td>
<td>TEMPERED WATER LINES</td>
<td></td>
</tr>
</tbody>
</table>

   b. The arrows on the diagram in figure 1-4 show the location and direction of the cold water line.
FIGURE 1-6. ARROWS SHOWING DIRECTION --
COLD WATER
Lesson 1/Learning Event 2

c. The arrow on the diagram in figure 1-7 shows the location and direction of the hot water line.
Lesson 1/Learning Event 2

d. The arrows in the diagram in figure 1-8 show the location and direction of the tempered water line.

FIGURE 1-8. ARROWS SHOWING DIRECTION—TEMPERED WATER

4. Fittings connect and change the directions of water line pipe runs. These fittings are identified by symbols.
Lesson 1/Learning Event 2

a. Figure 1-9 shows water-pipe-fitting symbols.

<table>
<thead>
<tr>
<th>Symbols/Abbreviations</th>
<th>Meaning</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELBOW TURNED DOWN</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ELBOW TURNED UP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ELBOW SIDE OUTLET UP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ELBOW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEE, OUTLET DOWN</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEE, OUTLET UP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEE, SIDE OUTLET UP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEE, SIDE OUTLET DOWN</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FLANGED</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SCREWED</td>
<td></td>
</tr>
</tbody>
</table>
b. Figure 1-10 shows water-pipe-fitting symbols used on a diagram.
Lesson 1/Learning Event 2

Self-Check Exercise

Match the following water-pipe-fitting symbols with their descriptions.

1. 
2. 
3. 
4. 

A. Tee  
B. Elbow turned down  
C. Tee, outlet up  
D. Elbow turned up

Self-Check Exercise Solutions

Did you match 1 through 4 as follows?

1. B. Elbow turned down  
2. C. Tee, outlet up  
3. D. Elbow turned up.  
4. A. Tee

If you failed to match 1 through 4 above correctly, go back and review the water-pipe-fitting symbols before continuing the lesson. If you matched 1 through 4 above correctly, good work! Continue with the lesson.
5. Valves control the flow of water. Gate valves turn water flow on or off. Globe valves control flow of water. Faucets turn water on and off at a fixture such as lavatory or sink.

a. Figure 1-11 shows symbols used for valves.

FIGURE 1-11. VALVE SYMBOLS

<table>
<thead>
<tr>
<th>Symbols/Abbreviations</th>
<th>Meaning</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GATE VALVE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GATE VALVE ANGLED</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GLOBE VALVE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GLOBE VALVE ANGLED</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FAUCET, PLAIN BIBB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FAUCET, HOSE BIBB</td>
<td></td>
</tr>
</tbody>
</table>
Lesson 1/Learning Event 2

b. Figure 1-12 shows valve symbols used on a diagram.

FIGURE 1-12. DIAGRAM SHOWING TYPES OF VALVES

GENERAL NOTES

1. REFER TO TM5-303 FOR BUILDING SHELL REQUIREMENTS
2. FOR FSIN BILL OF MATERIALS - REFER TO TM5-303 BY FACILITY NUMBER
3. FOR DETAIL NO. 1, "MIXING CONTROL FOR GROUP SHOWER & DETAIL NO. 2, "SHOWER HEAD & CONTROL VALVE." REFER TO DWG NO. 72-35, SHEET 1 OF 1
4. T- INDICATES TEMPERED WATER
5. INSTALL 45° Y-BRANCH WITH PLUG FOR C.O. ABOVE FLOOR WITH RISE FOR V.T.R.
Lesson 1/Learning Event 2

Self-Check Exercise

Match the following valve symbols with the valve descriptions.

1. [Diagram]
   - A. Faucet, hose bibb
   - B. Gate valve
   - C. Globe valve

2. [Diagram]

3. [Diagram]

   A. Faucet, hose bibb
   B. Gate valve
   C. Globe valve
Lesson 1/Learning Event 3

Self-Check Exercise Solutions

How did you do? Check your responses with those below.

1. is a gate valve. It is used to turn water flow on or off.

2. is a globe valve. It is used to control the flow of water.

3. is a faucet, hose bibb. It is used to turn water on or off at fixtures such as a lavatory.

If you had a hard time, review valve symbols and their uses again. If you got them all correct, good work. Continue with the lesson.

Learning Event 3
IDENTIFY FIXTURE SYMBOLS

6. The fixture symbols in a construction drawing show the type of fixture and its location.

   a. Figure 1-13 shows fixture symbols.
**FIGURE 1-13. FIXTURE SYMBOLS**

<table>
<thead>
<tr>
<th>Symbols/Abbreviations</th>
<th>Meaning</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>WH</td>
<td>LAVATORY, WALL HUNG</td>
<td>![Lavatory Symbol]</td>
</tr>
<tr>
<td>SS</td>
<td>SINK, SERVICE WALL HUNG</td>
<td>![Sink Symbol]</td>
</tr>
<tr>
<td></td>
<td>WATER CLOSET, WALL HUNG, WITH TANK</td>
<td>![Water Closet with Tank]</td>
</tr>
<tr>
<td>LT</td>
<td>WATER CLOSET, LOW TANK</td>
<td>![Water Closet]</td>
</tr>
<tr>
<td>WH</td>
<td>WATER CLOSET, WITH WALL HUNG</td>
<td>![Water Closet]</td>
</tr>
</tbody>
</table>
Lesson 1/Learning Event 3

**FIGURE 1-13. FIXTURE SYMBOLS (CONTINUED)**

<table>
<thead>
<tr>
<th>Symbols/Abbreviations</th>
<th>Meaning</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>URINAL, WALL HUNG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>URINAL, STALL TYPE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>URINAL, TROUGH TYPE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TU</td>
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</tbody>
</table>
FIGURE 1-13. FIXTURE SYMBOLS (CONTINUED)

<table>
<thead>
<tr>
<th>Symbols/Abbreviations</th>
<th>Meaning</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>WH</td>
<td>WATER HEATER</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SHOWERS, GANGED</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ELEVATION</td>
<td></td>
</tr>
</tbody>
</table>
b. Figure 1-14 shows fixture symbols used on a diagram.
Match the following fixture symbols with the fixture descriptions.

1.  

2.  

3.  

4.  

A. Water closet  
B. Urinal, wall-hung  
C. Sink service, wall-hung  
D. Water heater
Lesson 1/Learning Event 4

Self-Check Exercise Solutions

Check your answers.

1. D. Water heater
2. A. Water closet, either wall-hung tank or with close-coupled tank
3. B. Urinal, wall-hung
4. C. Sink service, wall-hung

If you had any trouble, review the fixture symbols until you are confident. Then continue with the lesson.

Learning Event 4
IDENTIFY WASTE SYSTEM PIPELINES

7. Waste system pipelines are identified by a symbol.

   a. Figure 1-15 shows the waste pipeline symbol.

   ![Figure 1-15. Waste Pipeline Symbol](image)
b. The arrows in the diagram in figure 1-16 show the location and direction of the waste pipeline.

FIGURE 1-16. ARROWS SHOWING DIRECTION—WASTE PIPELINE
8. Fittings connect and change the direction of waste line pipe. These fittings are identified by symbols.

a. Figure 1-17 shows waste-pipe-fitting symbols.

<table>
<thead>
<tr>
<th>Symbols/Abbreviations</th>
<th>Meaning</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Y-BRANCHES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>90° REGULAR T-Y</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>90° REDUCING T-Y</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>90° THROUGH DOUBLE Y</td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>45° REGULAR LATERAL Y</td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>45° REDUCING LATERAL Y</td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td>Symbols/Abbreviations</td>
<td>Meaning</td>
<td>Illustration</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>BENDS</td>
<td>90° REGULAR 1/4 BEND</td>
<td><img src="image1" alt="Illustration" /></td>
</tr>
<tr>
<td></td>
<td>45° REGULAR 1/8 BEND</td>
<td><img src="image2" alt="Illustration" /></td>
</tr>
<tr>
<td></td>
<td>1/4 BEND SHORT SWEEP</td>
<td><img src="image3" alt="Illustration" /></td>
</tr>
<tr>
<td></td>
<td>1/4 BEND LONG SWEEP</td>
<td><img src="image4" alt="Illustration" /></td>
</tr>
<tr>
<td>OFFSETS</td>
<td></td>
<td><img src="image5" alt="Illustration" /></td>
</tr>
<tr>
<td>REGULAR OFFSET</td>
<td></td>
<td><img src="image6" alt="Illustration" /></td>
</tr>
</tbody>
</table>
FIGURE 1-17. WASTE-PIPE-FITTING SYMBOLS (CONTINUED)

<table>
<thead>
<tr>
<th>Symbols/Abbreviations</th>
<th>Meaning</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/8 OFFSET</td>
<td><img src="image1" alt="1/8 OFFSET Illustration" /></td>
</tr>
<tr>
<td>TRAPS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P-TRAP HUB TYPE</td>
<td><img src="image2" alt="P-TRAP HUB TYPE Illustration" /></td>
</tr>
<tr>
<td>DRAINS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P-TRAP TUBULAR TYPE</td>
<td><img src="image3" alt="P-TRAP TUBULAR TYPE Illustration" /></td>
</tr>
<tr>
<td></td>
<td>FLOOR DRAIN</td>
<td><img src="image4" alt="FLOOR DRAIN Illustration" /></td>
</tr>
</tbody>
</table>
b. Figure 1-18 shows waste-pipe-fitting symbols used on a diagram.
Lesson 1/Learning Event 4

_________________________Self-Check Exercise_________________________

1. What does the symbol below represent?

[Diagram]

2. How about this one?

[Diagram]

_______________________Self-Check Exercise Solutions_____________________

How did you do? Did you answer 1 as 90 degree through double Y? For 2, did you answer P-trap, hub type? If you incorrectly answered either of the above, go back and review the waste-pipe-fitting symbols. If you had no problem, good luck. Keep it up, and continue with the lesson.
9. Vents are used in the waste system to keep foul odors caused by waste disposal from entering the building. The types are drain waste vents (DWV) and vents through the roof (VTR).

   a. Figure 1-19 shows the vent abbreviations and symbol.
Lesson 1/Learning Event 4

b. Figure 1-20 shows vent to roof identified by symbol on a diagram.
How many VTRs are in the vent system in figure 1-20?
Did you find both of them? That's right. There are two VTRs. One is on the end run of the water closets, and the other is in the shower room.
Lesson 1/Review Exercise

REVIEW EXERCISE

Check your understanding of lesson 1 by completing this review exercise. Try to answer all of the questions without looking back at the lesson. When you are finished, turn to the solutions at the end of the lesson and check your responses. If you missed any of the questions, go back and restudy the place in the lesson where the information is given.

1. Which symbol identifies a cold water line?
   A. ______________
   B. _______ _ _ __
   C. __________ _ __
   D. ___________

2. Which symbol identifies a waste line?
   A. _______ _ _____
   B. ______________
   C. _____________
   D. _______ _ _ ___

3. Which symbol identifies a hot water line?
   A. _______ _ _____
   B. ______________
   C. _ _ _ _ _ _ _ _
   D. _______ _ _ ___
Lesson 1/Review Exercise

4. Which symbol identifies an elbow turned down?
   A. 
   B. 
   C. 
   D. 

5. Which symbol identifies a tee, outlet down?
   A. 
   B. 
   C. 
   D. 

6. Which symbol identifies an elbow turned up?
   A. 
   B. 
   C. 
   D. 

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Lesson 1/Review Exercise

7. Which symbol identifies a tee, outlet up?
   A. 
   B. 
   C. 
   D. 

8. Which symbol identifies a gate valve?
   A. 
   B. 
   C. 
   D. 

9. Which symbol identifies a globe valve?
   A. 
   B. 
   C. 
   D. 

Lesson 1/Review Exercise

10. Refer to figure 1-21. How many water closet symbols does the drawing show?

   A. 1
   B. 3
   C. 6
   D. 8

11. Refer to figure 1-21. How many urinal symbols does the drawing show?

   A. 2
   B. 3
   C. 4
   D. 5

12. Refer to figure 1-21. How many water heaters does the drawing show?

   A. 1
   B. 2
   C. 3
   D. 4
Lesson 1/Review Exercise

13. Which symbol identifies a 90 degree regular T-Y branch?
   A. 
   B. 
   C. 
   D. 

14. Which symbol identifies a 1/8 regular bend?
   A. 
   B. 
   C. 
   D. 
15. Which symbol identifies a P-trap?
   A. 
   B. 
   C. 
   D. 

16. Which symbol identifies a VTR?
   A. 
   B. 
   C. 
   D. 
Lesson 1/Review Exercise

REVIEW EXERCISE SOLUTIONS

1. C (para 3a)
2. C (para 7a)
3. D (para 3a)
4. C (para 4a)
5. 5 (para 4a)
6. A (para 4a)
7. C (para 4a)
8. A (para 5a)
9. A (para 5a)
10. D (See para 6a for symbol)
11. A (See para 6a for symbol)
12. A (See para 6a for symbol)
13. A (para 8a)
14. C (para 8a)
15. B (para 8a)
16. B (para 9a)
Lesson 2/Learning Event 1

Lesson 2
LIST PLUMBING MATERIALS

OBJECTIVE
At the end of this lesson, you will be able to list plumbing materials by type, size, and length from a construction drawing.

TASK
Task 051-248-1001, Prepare a plumbing takeoff list.

CONDITIONS
Given subcourse booklet EN 5110, paper, pencil, ruler, divider, and an examination response sheet. You will work in your own environment without supervision.

STANDARDS
You should be able to complete the lesson and answer the review exercise within approximately 8 hours. You must respond correctly to 70 percent of the examination questions pertaining to this lesson.

CREDIT HOURS
8.

REFERENCES
TM 5-551K, TM 5-704, FM 5-51K.

Learning Event 1
MEASURE PIPE RUN LENGTHS

1. A plumber is often required to make a list of plumbing materials from a construction drawing or a set of construction drawings. The list must contain all the materials by type, size, and length to install a part of or the complete plumbing system.

2. Horizontal pipe run lengths are measured using either graphic or ratio construction scales.
Lesson 2/Learning Event 1

a. To make graphic scale measurements with a divider, first spread the divider from the center of one fitting to the center of the next fitting to get the length of the pipe run (fig 2-1). Then place one end of the divider on 0 (fig 2-2). Where the other end falls on the scale is the pipe run length.

FIGURE 2-1. DIVIDER ON DIAGRAM

FIGURE 2-2. DIVIDER ON SCALE
b. To make graphic scale measurements with the straightedge of a piece of paper, place the straightedge along the pipe run and mark the center of each fitting (fig 2-3) on the paper. Then place one mark on 0 (fig 2-4). Where the other mark falls on the scale is the pipe run length.
c. To make ratio scale measurements with a ruler, place the zero of the ruler at the center of one fitting and the measuring edge along the pipe run. Read the ruler mark at the center of the other fitting. See figure 2-5. If the ratio scale is 1/4 inch = 1 foot, the reading of 1 5/8 inches on the diagram means 6 feet 6 inches of pipe.

FIGURE 2-5. USE OF RULER WITH RATIO SCALE
3. Vertical water-pipe lengths are computed using simple math. The pipe run can come down from the ceiling level or up from below the floor level.

   a. To determine a pipe run length from the ceiling level, use the floor-to-ceiling measurement, the distance the pipe hangs from the ceiling, and the fixture's rough-in measurements. To find the length of pipe X in figure 2-6, make the following computation:

   Floor to ceilings -- 7 feet 11 inches.
   Pipe hangs from ceiling -- 0 feet 2 inches.
   Fixture rough-in measurement -- 4 feet 6 inches.
   7 feet 11 inches minus 0 feet 2 inches = 7 feet 9 inches.
   7 feet 9 inches minus 4 feet 6 inches = 3 feet 3 inches.

   The length of pipe X is 3 feet 3 inches
Lesson 2/Learning Event 1

b. To find a pipe run length from below floor level to ceiling, use the floor-to-ceiling measurement, the distance the pipe hangs from the ceiling, and the distance the pipe is below the floor. To find the length of pipe Z in figure 2-7, make the following computation:

Floor to ceiling -- 7 feet 11 inches.
Pipe hang from ceiling -- 0 feet 2 inches.
Pipe below floor -- 0 feet 4 inches.
7 feet 11 inches minus 0 feet 2 inches -- 7 feet 9 inches.
7 feet 9 inches plus 0 feet 4 inches -- 7 feet 13 inches or 8 feet 1 inch.

The length of pipe Z is 8 feet 1 inch.

FIGURE 2-7. PIPE RUN FROM BELOW FLOOR TO CEILING
Lesson 2/Learning Event 1

c. To find a pipe run length from below floor level to a fixture, use the distance the pipe hangs below the floor and the fixture's rough-in measurements. To find the length of pipe Y in figure 2-8, make the following computation:

Pipe hangs from floor -- 3 inches.
Fixture rough-in measurement -- 11 inches.
11 inches plus 3 inches = 14 inches.

The length of pipe Y is 14 inches.

FIGURE 2-8. PIPE RUN FROM BELOW FLOOR TO FIXTURE
Lesson 2/Learning Event 1

Self-Check Exercise

1. Use the graphic scale given in figure 2-9. What is the length, in feet, of line X?

   ![FIGURE 2-9. USE OF GRAPHIC SCALE](image)

   Did you get 7 1/2 feet? If not, read Lesson 1, paragraph 1b, again. If you did get 7 1/2 feet, good work. Continue with the lesson.

2. Use the ratio scale in figure 2-10. What is the length, in feet, of line Z?

   ![FIGURE 2-10. USE OF RATIO SCALE](image)

   Did you get 8 feet? If you did, good work. Continue with the lesson. If not, read Lesson 1, paragraph 1b, again until you understand ratio scales.

3. Refer to figure 2-11. Compute the length of pipe Z.

46
How did you do? Did you get 3 feet 8 inches for the length of pipe Z? Let’s see how we got this answer.

Floor to ceiling -- 8 feet 0 inches.
Pipe hangs from ceiling -- 4 inches.
Fixture rough-in measurement -- 4 feet 0 inches.
8 feet 0 inches minus 4 inches = 7 feet 8 inches.
7 feet 8 inches minus 4 feet 0 inches = 3 feet 8 inches.

Therefore, the length of pipe Z is 3 feet 8 inches. If you have any problems with this computation, study the example closely. Get your squad leader or platoon sergeant to assist you if you need additional help. Then continue with the lesson.
Lesson 2/Learning Event 1

4. Vertical waste-system-pipe lengths are computed in the same way as vertical water pipe.

   a. To find a waste-pipe-run length from below the floor level to a fixture, use the distance from the center of the bend to the floor and the fixture's rough-in measurements. To find the length of pipe needed in figure 2-12, make the following computation:

      Bend to floor -- 6 inches.
      Rough-in measurement -- 17 inches.
      6 inches plus 17 inches = 23 inches.

The length of pipe required is 23 inches.

FIGURE 2-12. VERTICAL WASTE PIPE
Lesson 2/Learning Event 1

b. To find a waste-pipe length from below the floor up through the roof, use the total of all measurements from the bend below the floor to VTR. To find the length of pipe needed in figure 2-13, make the following computation:

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bend to floor</td>
<td>8</td>
</tr>
<tr>
<td>Floor to ceiling</td>
<td>7 feet 11</td>
</tr>
<tr>
<td>Ceiling to roof</td>
<td>2 feet 2</td>
</tr>
<tr>
<td>Roof to top of VTR</td>
<td>1 foot 0</td>
</tr>
<tr>
<td>Total</td>
<td>10 feet 21</td>
</tr>
</tbody>
</table>

The length of waste pipe required is 10 feet 21 inches or 11 feet 9 inches.

FIGURE 2-13. VERTICAL WASTE PIPE TO VTR
Refer to figure 2-14. Compute the length of the vent through the roof (VTR) shown.
FIGURE 2-14. VTR MEASUREMENT
Lesson 2/Learning Event 1

____________________ Self-Check Exercise Solution ____________________

That was easy, wasn't it? Did you get 12 feet 1 inch? Let's see how we arrived at that answer.

<table>
<thead>
<tr>
<th></th>
<th>Feet</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bend to floor</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Floor to ceiling</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Ceiling to roof</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Root to top of VTR</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>01</td>
</tr>
</tbody>
</table>

If you had any problems with this exercise, look at the drawing again until you understand. Continue with the lesson.
Learning Event 2
LIST WATER AND WASTE LINE FITTINGS

5. Fitting sizes are determined by the sizes of the pipe going to and from the fitting. This holds true for all water and waste line fittings.

a. Water line elbows are listed with the largest opening first. See figure 2-15.

![FIGURE 2-15. METHOD OF LISTING ELBOWS](image)

b. Water line tees are listed with the run first, starting with the largest opening, and then the outlet. See figure 2-16.

![FIGURE 2-16. METHOD OF LISTING TEES](image)
c. For waste fittings, list bend sizes with the largest opening first. See figure 2-17. List Y branches with the run first, starting with the largest opening, and then the outlet.

![FIGURE 2-17. METHOD OF LISTING WASTE FITTINGS](image)

6. Obtain a list of water line fittings from the construction drawing diagram, rough-in information for each fixture and any other information indicated on the drawing.

   a. The type and size of some fittings can be taken directly from the drawing. Fitting sizes are shown by the sizes of pipe going to and from a fitting. See examples in figure 2-18.

   b. List the number of fittings by type and size.

<table>
<thead>
<tr>
<th>TEES</th>
<th>ELBOWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>one 2 x 3/4 x 3/4 inch</td>
<td>two 2 inches</td>
</tr>
<tr>
<td>one 2 x 3/4 inch</td>
<td>one 3/4 inch</td>
</tr>
<tr>
<td>three 2 inch</td>
<td></td>
</tr>
</tbody>
</table>
FIGURE 2-18. FITTING SIZES FOUND IN DIAGRAM

NOT TO SCALE

CAST IRON PIPE

FIBER PIPE

10'-0"

4" FIBER ADAPTER

5'-0"

4" VTR

LATRINE

11-G

11-D

3/4"

11-K

11-X

2" STEEL

11-O

AT CLG

4" VTR

10'-0"

2" WATER SERVICE

PLUGGED TEE

11-M

TEE 2" x 3/4" x 3/4"

3/4"

DETAIL 1

3" CURB

10'-0"

9'-4"

10'-8"

20'-0"

REMOVABLE DUCKBOARDS OVER ENTIRE SHOWER ROOM FLOOR
Lesson 2/Learning Event 2

c. Find some fitting sizes from the rough-in information for a fixture. See figure 2-19. Note: The water closet rough-in diagram is furnished by the manufacturer.
FIGURE 2-19. FITTING SIZES FOUND IN ROUGH-IN INFORMATION
d. Find some fitting sizes from other information indicated on the drawing. In figure 2-20, the breakout in 11-C shows the method of installing one water closet. This installation includes the water pipe and fitting going down to the flush tank. Note: This type of information is normally found on drawings for theater of operations (TO) buildings. The list of fittings by type and size required for the eight water closets is as follows:

<table>
<thead>
<tr>
<th>ELBOWS</th>
<th>TEES</th>
</tr>
</thead>
<tbody>
<tr>
<td>eight 3/4 x 3/8 inch</td>
<td>one 3/4 x 2 x 3/4 inch</td>
</tr>
<tr>
<td>two 3/4 inch</td>
<td>five 3/4 inch</td>
</tr>
</tbody>
</table>
FIGURE 2-20. FITTING SIZES FOUND ADDED TO DIAGRAM
Lesson 2/Learning Event 2

7. Obtain a list of water line valves by type and size from the construction drawing diagram and any other information indicated on the drawing. Valves are used in water lanes to start, control, and stop the flow of water. The water line going to and from the valve determines the size of the valve. A detailed breakout will show what is needed for installation. See detail 1 in figure 2-21. List valves and other fittings by type and size.

**VALVES**

three 2-inch gate valves
one 2-inch thermostatic mixing valve

**OTHER FITTINGS**

two 2-inch gate valves
one 2 1/2 x 2-inch bushing
FIGURE 2-21. VALVE SIZES FOUND IN DIAGRAM

Lesson 2/Learning Event 2
Lesson 1/Learning Event 2

8. Obtain a list of waste system fittings by size from the construction drawing and any other information indicated on the drawing.

   a. Some waste system fitting sizes by type can be taken directly from the drawing. See figure 2-22.

   b. List the number of fittings by type and size.

   LATERAL Y

   one 4-inch 45 degree regular
   two 4 x 2-inch 45 degree reducing

   BENDS

   one 4-inch 1/8 regular
   one 2-inch 1/8 regular

   P-TRAPS

   three 2-inch P-traps
   one 4-inch P-trap

   DRAIN

   one 4-inch SD
Lesson 2/Learning Event 2

FIGURE 2-22. WASTE SYSTEM FITTING SIZES FOUND IN DIAGRAM
Lesson 2/Learning Event 2

9. Prepare a plumbing takeoff list for all the materials needed by type, size, and length for water supply service from point Z to all water closet tanks. Use the graphic scale (fig 2-23), construction drawing (fig 2-24), and the water closet breakout 11-C in figure 2-24. Make all measurements using the straightedge on a piece of paper. When you have completed your takeoff list, check it with the information below.

10. The takeoff list from point Z to the water closet tanks is as follows:

STEEL PIPE

47 1/2 feet (approximately)

TEES

one 2 x 1 1/2 x 3/4 inch
one 3/4 x 1 1/2 x 3/4 inch
five 3/4 inch

ELBOWS

two 3/4 inch
eight 3/4 x 3/8 inch
Figure 2-24. Takeoff List Found in Diagram

Lesson 2/Learning Event 2

Figure 2-24 shows the layout of a latrine, wash basin, and water closet plumbing system. The diagram includes various pipes and fittings, with labels for different parts of the system. The takeoff list found in the diagram provides necessary information for construction or installation purposes.

Key elements of the diagram include:
- **Cast Iron Pipe**
- **4" Fiber Pipe**
- **4" Fiber Adapter**
- **4" Fiber Pipe**
- **1-1/2" Pipe**
- **2" Water Service**
- **2" P-Trap**
- **Bench**
- **Wash Room**
- **Floor**
- **Front**
- **Side**
- **Wash Bench**
- **Below Fl**
- **Wash Basin**
- **Ceiling**
- **Wells**

No scale is provided for the diagram, indicating the drawing is not to exact proportions.
Lesson 2/Review Exercise

REVIEW EXERCISE

Check your understanding of lesson 2 by completing this review exercise. Try to answer all of the questions without looking back at the lesson. When you are finished, turn to the solutions at the end of the lesson and check your responses. If you missed any of the questions, go back and restudy the place in the lesson where the information is given.

1. Refer to figure 2-25. Using a ratio scale of 1/4 inch = 2 feet, find the pipe length.

   A. 6 feet 6 inches
   B. 8 feet 6 inches
   C. 10 feet 6 inches
   D. 13 feet 6 inches

FIGURE 2-25
2. Refer to figure 2-26. Using a graphic scale and a straightedged piece of paper, find the water pipe length.

A. 6 feet 6 inches
B. 7 feet 6 inches
C. 12 feet
D. 12 feet 6 inches
Lesson 2/Review Exercise

3. Refer to figure 2-27. What is the length of vertical pipe Z?

A. 3 feet 2 inches
B. 3 feet 4 inches
C. 3 feet 8 inches
D. 3 feet 10 inches

FIGURE 2-27.
Lesson 2/Review Exercise

4. Refer to figure 2-28. What is the length, in inches, of the vertical waste pipe required to install the fixture?

A. 16
B. 18
C. 20
D. 24

FIGURE 2-28.
Lesson 2/Review Exercise

5. Refer to figure 2-29. How is the size of the elbow listed?

A. 3/4 inch
B. 1/2 inch
C. 1/2 x 3/4 inch
D. 3/4 x 1/2 inch

FIGURE 2-29.
6. Refer to figure 2-30. How is the size of the tee listed?

A. 1 x 1 1/2 x 3/4 inch
B. 3/4 x 1 1/2 inch
C. 1 1/2 x 3/4 x 1 inch
D. 1 1/2 x 1 x 3/4 inch

FIGURE 2-30.
Lesson 2/Review Exercise

7. Refer to figure 2-31. How is the size of the waste fitting listed?
   A. 2 x 2 x 4 inch
   B. 2 x 4 x 2 inch
   C. 4 x 2 x 2 inch
   D. 4 x 2 inch

FIGURE 2-31.

Use the construction drawing diagram shown in figure 2-32 to respond to questions 8, 9, and 10.

8. Refer to figure 2-32. What is the size of the elbow at point X?
9. Refer to figure 2-32. What is the size of the tee at point Y?
10. Refer to figure 2-32. What is the size of the 45 degree regular T-Y at point Z?
Lesson 2/Review Exercise

11. Refer to figure 2-33. How many 3/4-inch tees are required and listed to install water service to the water closets?

A. 8  
B. 7  
C. 6  
D. 5

FIGURE 2-33.

12. Refer to figure 2-34. How many gate valves by size are required to be listed?

A. 2  
B. 3  
C. 4  
D. 5
Lesson 2/Review Exercise

FIGURE 2-34.

2" TEMPERED WATER (T)
2" HOT WATER
2" COLD WATER
GATE VALVE
GATE VALVE
NIPPLE
THERMOSTATIC WATER MIXING VALVE WITH UNION ANGLE CHECK VALVE AND STRainers
MIXING CONTROL FOR GROUP SHOWER DETAIL 1
Lesson 2/Review Exercise

REVIEW EXERCISE SOLUTIONS

1. D (para 2c)
2. C (para 2b)
3. 1 (para 3a)
4. D (para 4a)
5. D (para 5a)
6. D (para 5b)
7. C (para 5c)
8. 2 inch (para 6a)
9. 2 x 3/4 x 3/4 inch (para 6a)
10. 4" X 4" X 4" or 4" X 4" or 4" (para 8a)
11. D (para 6d)
12. B (para 7)