Using Engineer and Architect Scales

Note: When printing this document from Adobe Acrobat or another PDF reader, select "actual size" (or equivalent) in your printer settings to ensure the sample drawings measure accurately.

Introduction

Using and interpreting information from engineer (civil) and architect scales is an important fire protection engineering skill. Construction and fire protection equipment drawings must be interpreted with a high degree of accuracy.

Student performance objective

Given an architect or engineer scale and a set of scaled drawings, you will be able to select the correct scale (tool) and interpret dimensions with 100% accuracy.

Enabling objectives

1. You will be able to identify the difference between engineer (civil) and architect scales.
2. Using a scale, you will be able to measure objects shown on civil engineering plans and architectural renditions of buildings and structures.
3. You will be able to interpret the results of the measurements.

Scales

Before they are built or assembled, roads, water mains, structures and fire protection systems are designed in accordance with nationally recognized standards. The design concept is transferred to a set of plans (drawings) that provide a 2- or 3-dimensional representation of the project.

Since it would be impractical to create full-size drawings for these objects, they are reduced to a manageable size (scale) so they can be studied. A set of plans may include a variety of different scales, depending upon what objects are being rendered. The selected scale normally is found in the title block in the lower right-hand corner of the drawings but may be found anywhere on the plans. You may find more than one scale on a single sheet when there are "details," parts of the objects that are enlarged for clearer explanation.

To interpret the size of what the renderings represent, the plan reviewer must use a tool called a "scale." The word "scale" is used synonymously to represent the tool and the size reduction in the drawing. The scale tool provides a quick method for measuring the object and interpreting its eventual size when finished.

Selecting the correct tool

Traditional scales are prism-shaped tools that look similar to the rulers you may have used in elementary school. There are 2 types of drafting scales used in design and construction:

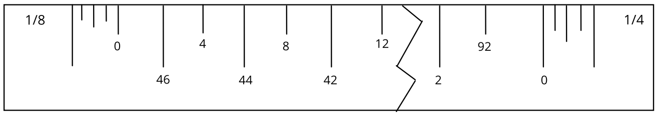
1. **Engineer, or civil, scales,** such as 1˝ = 10´ or 1˝ = 50´, are used for measuring roads, water mains and topographical features. The distance relationships also may be shown as 1:10 or 1:50.
2. **Architect scales,** such as 1/4˝ = 1´0˝ (1/48 size) or 1/8˝ = 1´0˝ (1/96 size), are used for structures and buildings. They are used to measure interior and exterior dimensions such as rooms, walls, doors, windows and fire protection system details.

Other scale tools include flat scales and rolling scales. Rolling scales have the advantage of being able to measure travel distances easily, an important feature when evaluating means of egress.

1. Look closely at the dimensions shown on the faces of the tools.
   - Architect scales have numbers that run incrementally both from **left to right** and from **right to left**. A whole number or fraction to the left or right of the number line indicates the scale those numbers represent.
   - Engineer scales have numbers that run incrementally from **left to right**. The whole number to the left of the number line indicates the scale those numbers represent.
2. **Architect scales** use fractions and have the following dimensional relationships:

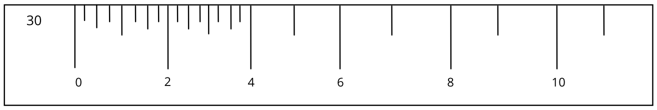
3/32 = 1 foot	1/4 = 1 foot	3/4 = 1 foot
3/16 = 1 foot	3/8 = 1 foot	1 inch = 1 foot
1/8 = 1 foot	1/2 = 1 foot	1 1/2 inches = 1 foot

   - The scale marked “16” is a standard ruler.
   - You must learn to read both from **left to right** and **right to left**. Note in the example below that the numbers on the 1/8-inch scale increase from **left to right**. The numbers on the 1/4-inch scale increase from **right to left**.
   - Note that the “0” point on an architect scale is not at the extreme end of the measuring line. The numbers “below” the “0” represent fractions of 1 foot.



3. **Engineer scales** have the following dimensional relationships:

1 inch = 10 feet	1 inch = 40 feet
1 inch = 20 feet	1 inch = 50 feet
1 inch = 30 feet	1 inch = 60 feet



   - When using the engineer scale, you must multiply the value you identify by 10.
   - The small lines between the whole numbers represent individual feet, so a point that falls 2 marks to the right of the whole number 4 is interpreted as 42 feet.

Using the tool and interpreting the results

You should never use your scale to draw lines. It should be used **only** for measuring.

1. Identify the scale shown on the plans by the architect, engineer or fire protection contractor (e.g., 1/8 = 1 foot; 1:40).
2. Select the object you wish to measure, and select the appropriate **architect** or **engineer** scale (tool).
3. Align your scale tool with the selected scale to verify that they match. During blueprint reproduction, the image size may be adjusted to fit the paper so it may not precisely represent the scale the designer intended to use.
4. Correctly align the "0" with one end of the object as a starting point, and identify the object's end point. The corresponding number on the scale tool represents the object's length when built.

Example No. 1:

The drawings state that the scale is 1/8 inch equals 1 foot. Using your **architect** scale, select the face of the tool with the 1/8 mark in the upper left-hand corner. Lay the "0" point at the extreme left end of this line and read the corresponding value at the right end of the line.

You should see the value "32" on your scale. Given a 1/8-inch scale, this line represents a 32-foot-long object.

Example No. 2:

Using the same line, measure the distance using a 1/4-inch to 1-foot scale. In this example, you will lay the "0" end of the tool on the right end of the line.

The left end of the line should correspond to the "16" on your scale. This line represents a 16-foot-long object even though the line on the paper is the same length as the one above: that is the influence of "scale."

If the object's end point does not align exactly with a corresponding foot mark, slide the scale right or left until the fractional mark aligns, then take your reading. Translate the fraction into inches (e.g., the 1/2 mark equals 6 inches, the 3/4 mark equals 9 inches).

Example No. 3:

Using the same line, measure the distance using a 3/8-inch to 1-foot scale. Lay the "0" at the left end of the scale on the left end of the line.

You will see that the right end of the line falls between 10 and 11 feet. Slide the scale to the right until the 10-foot mark aligns with the right end of the line.

Now, look at the marks on the left end of the line, left of the "0." The left end of the line corresponds to the ninth mark left of the "0," which in this case represents 9 inches. Thus, in a scale of 3/8 inch to 1 foot, this line represents an object 10 feet, 9 inches long.

Example No. 4:

Use the same line, but this time you are measuring a "water main" and the plans show a scale of 1 inch equals 20 feet. Use the **engineer** scale to measure this water line.

Lay the engineer scale marked "20" on the left end of the line. The right end of the line should align with the number "8." Remember to multiply that value by 10 to get an answer of "80 feet."

Try the activities on the next pages to test your new skills. The answers are found on the last page.

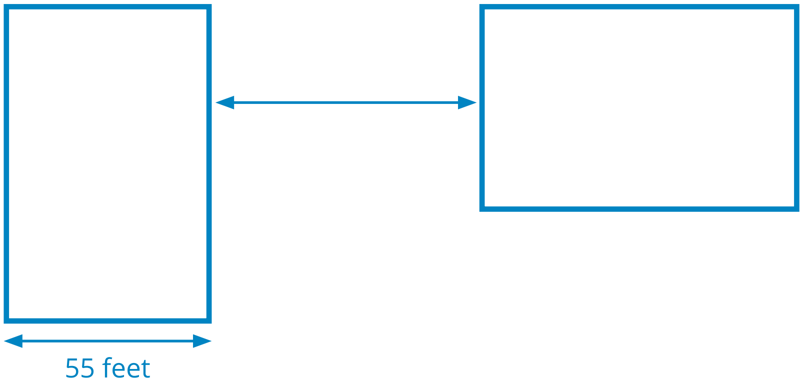
1. Measure the height and width of this rectangle. The scale is 1/4 inch equals 1 foot.

Height: ______ feet Width: ______ feet

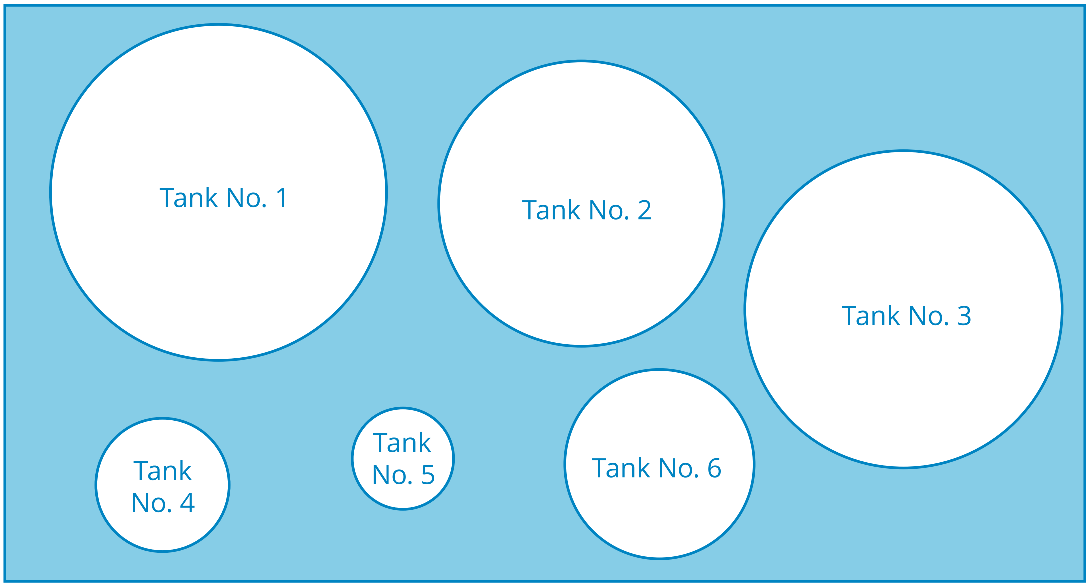
2. Measure the exterior dimensions of this rectangle. The scale is 1/8 inch equals 1 foot.

Height: ______ feet Width: ______ feet

3. In scale, how far apart are these 2 rectangles?



4. This drawing represents the plan view of a bulk tank facility. The scale is 1:60. What are the tank diameters in feet?



Tank No. 1 =_________feet

Tank No. 2 =_________feet

Tank No. 3 =_________feet

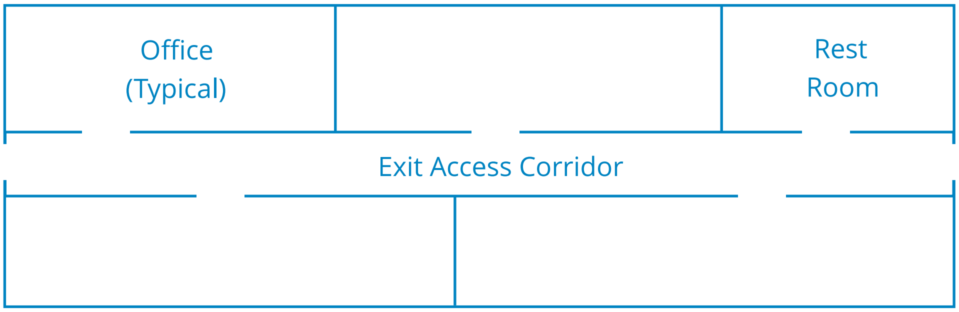
Tank No. 4 =_________feet

Tank No. 5 =_________feet

Tank No. 6 =_________feet

5. Given the above information, how far apart at their nearest edges are Tanks 1 and 6, measured in a straight line?

6. This drawing represents the floor plan of a small office. Given a scale of 3/32 equals 1 foot, how long in feet is the exit access corridor?



Scale versus dimensions

While using a scale tool is an important skill, there are times when the fire inspector must rely on other information.

When drawings are prepared with dimensions written on the plans, the **written dimensions always take precedence over scaled measurements.**

During blueprint reproduction, the image size may be adjusted to fit the paper, so it may not precisely represent the scale the designer intended to use. If the image was adjusted just a small amount, its accuracy would be in doubt. Therefore, the dimensions written on the plans should be used.

Example

A fire sprinkler contractor submits drawings with the branch lines marked as follows:

You apply your scale to verify the dimensions and discover the sprinklers are 10 feet apart based on your scale. How do you reconcile the difference?

The correct answer is 8 feet, 6 inches, because the **written dimensions always take precedence over scaled measurements.** In this example, you likely would obtain inaccurate scaled dimensions anywhere on the drawings when using your scale tool.

Activity answers

Note: Your answers may be slightly different from these due to margins of error among scale tools.

1. Height = 5 feet, width = 21 feet, 6 inches.
2. Height = 12 feet, width = 33 feet, 4 inches.
3. Using the engineer scale tool, you must first establish which scale was selected. By rotating the scale tool until you align it with a known dimension (55 feet), you will see that the selected scale is 1 inch = 50 feet. Applying the scale tool to the outer edges of the rectangles reveals they are spaced 70 feet apart.
4. Tank No. 1 = 105 feet.
   Tank No. 2 = 90 feet.
   Tank No. 3 = 99 feet.
   Tank No. 4 = 44 feet.
   Tank No. 5 = 32 feet.
   Tank No. 6 = 62 feet.
5. 86 feet.
6. 53 feet.