Chapter 2

Definitions

- **Battery of Fixtures.** A group of two or more similar, adjacent fixtures that discharge into a common horizontal waste or soil branch.
- **Branch.** A part of the piping system other than a main, riser, or stack.
- **Building Supply.** The pipe carrying potable water from the water meter or other source of water supply to a building or other point of use or distribution on the lot.
- **Fixture Branch.** A water supply pipe between the fixture supply pipe and the water distribution pipe.
- **Fixture Supply.** A water supply pipe connecting the fixture with the fixture branch.

Chapter 2

Definitions

- **Fixture Unit.** A quantity in terms of which the load-producing effects on the plumbing system of different kinds of plumbing fixtures are expressed on some arbitrarily chosen scale.
- **Flush Tank.** A tank located above or integral with water closets, urinals, or similar fixtures for the purpose of flushing the usable portion of the fixture.
- **Remote Outlet.** Where used for sizing water piping, it is the furthest outlet dimension, measuring from the meter, either the developed length of the cold-water piping or through the water heater to the furthest outlet on the hot-water piping.

Chapter 2

Definitions

- **Flushometer Tank.** A tank integrated within an air accumulator vessel that is designed to discharge a predetermined quantity of water to fixtures for flushing purposes.
- **Flushometer Valve.** A valve that discharges a predetermined quantity of water to fixtures for flushing purposes and is actuated by direct water pressure.


**Chapter 2**

**Definitions**
- **Potable Water.** Water that is satisfactory for drinking, culinary, and domestic purposes and that meets the requirements of the Health Authority Having Jurisdiction.
- **Remote Outlet.** Where used for sizing water piping, it is the furthest outlet dimension, measuring from the meter, either the developed length of the cold-water piping or through the water heater to the furthest outlet on the hot-water piping.

**610.0 Size of Potable Water Piping**
- Water pipe sizing has two primary objectives—
  - Maintaining flow velocities at a level that is appropriate for the type of pipe being installed and matching pipe sizes to the residual pressure of the system.
  - Matching these two principles together will allow for a water supply distribution system
  - That will deliver the appropriate amount of water volume at the appropriate pressures
  - To allow the fixtures or appliances to perform their functions without causing damage to the system, fixture or appliance.

**610.0 Size of Potable Water Piping**
- The size of each water meter and each potable water supply pipe shall be based on the total demand.
- Shall be determined according to the methods and procedures outlined in this section.
- Shall be designed to ensure that the maximum velocities allowed by the code and the applicable standard are not exceeded.

**610.0 Size of Potable Water Piping**
- The fixture supplies are then typically connected to a fixture fitting or valve that will mix the cold and hot water and distribute it to a common opening or port.
- The size of this opening is commonly the same size or smaller than a single, required fixture branch size to the lavatory.
- It is for this reason that we will not add the separate hot and cold fixture unit values to determine the total demand for sizing the meter and water service or main. See Section 610.8.

**Sizing Water Piping**
- Four things must be known before starting to size a water pipe system:
  1. Total fixture units in building: (Use Table 610.3)
  2. Distance from the meter to the most remote outlet in the system
  3. Elevation above the meter to the highest cold-water outlet in the system: (½ lb. per ft. rise)
  4. Available pressure at peak demand: minimum available pressure
Section 610.7
On a proposed water piping installation sized using Table 610.4, the following conditions shall be determined:

1. Total number of fixture units as determined from Table 610.3, Equivalent Fixture Units, for the fixtures to be installed.
2. Developed length of supply pipe from meter to most remote outlet.
3. Difference in elevation between the meter or other source of supply and the highest fixture or outlet.
4. Pressure in the street main or other source of supply at the locality where the installation is to be made.
5. In localities where there is a fluctuation of pressure in the main throughout the day, the water piping system shall be designed on the basis of the minimum pressure available.

610.6 Friction and Pressure Loss.

- Except, pipe material used and the water characteristics are such that no decrease in capacity due to length of service (age of system) is expected, friction-loss data shall be obtained from the "Fairly Rough" or "Rough" charts in Appendix A.
- Pressure losses through water-treating equipment, backflow prevention devices or assemblies, or other flow-restricting devices shall be computed in accordance with Section 610.2.

610.7 Conditions for using Table 610.4.

- Water piping installation sized using Table 610.4, the following conditions shall be determined:
  1. Total number of fixture units as determined from Table 610.3, Equivalent Fixture Units, for the fixtures to be installed.
  2. Developed length of supply pipe from meter to most remote outlet.
  3. Difference in elevation between the meter or other source of supply and the highest fixture or outlet.
  4. Pressure in the street main or other source of supply at the locality where the installation is to be made.
  5. In localities where there is a fluctuation of pressure in the main throughout the day, the water piping system shall be designed on the basis of the minimum pressure available.

Establishing Most Remote Outlet

- Section 610.7
- On a proposed water piping installation sized using Table 610.4, the following conditions shall be determined:
  - (2) Developed length of supply pipe from meter to most remote outlet.
- What does the code mean when it says:
  - "the most remote outlet"
- How do you find the most remote outlet?

Definition Review

- Remote Outlet
  - Where used for sizing water piping, it is the furthest outlet dimension, measuring from the meter, either the developed length of the cold-water piping or through the water heater to the furthest outlet on the hot water piping.
  - The above definition is interpreted to mean whichever is the longest run:
    - Either the developed length of the cold-water piping or;
    - Through the water heater to the furthest outlet on the hot water piping.

Water Pipe Sizing

How do you establish distance to the most remote outlet?

Distance In Feet

- 1. Total number of fixture units as determined from Table 610.3, Equivalent Fixture Units, for the fixtures to be installed.
- 2. Developed length of supply pipe from meter to most remote outlet.
- 3. Difference in elevation between the meter or other source of supply and the highest fixture or outlet.
- 4. Pressure in the street main or other source of supply at the locality where the installation is to be made.
- 5. In localities where there is a fluctuation of pressure in the main throughout the day, the water piping system shall be designed on the basis of the minimum pressure available.
The size of the meter and the building supply pipe shall be determined as follows:

1. Determine the available pressure at the water meter or other source of supply.
2. Add or subtract depending on positive or negative elevation change, 1/2 psi (3.4 kPa) for each foot (305 mm) of difference in elevation between such source of supply and the highest water supply outlet in the building or on the premises.
3. Use the "pressure range" group within which this pressure will fall using Table 610.4.
4. Select the "length" column that is equal to or longer than the required length.

5. Follow down the column to a fixture unit value equal to or exceeding the total number of fixture units required by the installation.
6. Having located the proper fixture unit value for the required length, sizes of meter and building supply pipe as found in the two left-hand columns shall be applied.

- No building supply pipe shall be less than 3/4 of an inch (20 mm) in diameter.

Determining Effective Pressure
610.8 (2) a Closer Look

- Take the minimum psi at the meter
- Subtract ½ psi for each foot of elevation

- Given:
  - Minimum psi at meter is 70
  - Elevation of highest outlet above meter is 30'

- The effective pressure is:

<table>
<thead>
<tr>
<th>Table 610.3 Water Supply Fixture Units (WSFU) and Minimum Fixture Branch Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
</tr>
<tr>
<td>Using Table 610.4, find the correct Pressure Range Table to use.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
</tr>
<tr>
<td>The street service/meter and the building supply must be sized first.</td>
</tr>
<tr>
<td>This step establishes the largest pipe size required for the building.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
</tr>
<tr>
<td>Starting at the most remote cold-water outlet in the system, size the main line back towards the meter, adding in the demand for each branch until the main line size equals the established building supply size.</td>
</tr>
<tr>
<td>At this point the main line sizing is completed.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
</tr>
<tr>
<td>Size each branch and fixture supply (Stay in same Length Column)</td>
</tr>
</tbody>
</table>

Size of Branches.

- Where Table 610.4 is used:
  - The minimum size of each branch shall be determined by the total fixture units served by that branch
  - Then following the steps in Section 610.8.
  - No branch piping shall exceed the total demand in fixture units for the system computed from Table 610.3.
Hose Bibb Sizing

What is the fixture load for hose bibbs?

Flushometer Sizing

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What fixture units do we assign for each section of piping?

What is the fixture unit load at Section M??

Should be 214 FU's ??

Correct fixture unit load at M is

Four water closets per Table 610.3 are

40 + 30 + 20 + 15 = 105

Four urinals are

20 + 15 + 10 + 8 = 53

Four lavs are

1 + 1 + 1 + 1 = 4

TOTAL Load at M is 162 not 214

What is the fixture unit load at Section T?

Six water closets are

40 + 30 + 20 + 15 = 105

Six Urinals are

20 + 15 + 10 + 8 + 5 + 5 = 63

Six Lav's equal 6 FU

125 + 63 + 6 Equals 194

NOT 321 (=107+107+107)
Water Pipe Sizing
Exercises

Complete the drawings by sizing all sections of piping according to the following instructions:

1. The example drawing is completed to show what is required.
2. The information regarding developed length, low and high-water pressure, and elevation are given for each drawing.
3. Cold water piping is shown in solid lines.
4. Hot water piping is shown in dashed lines.
5. Use the tables and procedure described in the Uniform Plumbing Code for sizing of cold and hot water piping.
6. Show sizes for all sections of piping.

Calculating Total Demand

Calculating Pipe Size at Meter and Effective Pressure

<table>
<thead>
<tr>
<th>Category</th>
<th>Unit</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Closet (WC)</td>
<td></td>
<td>2.5 x 4 = 10.0</td>
</tr>
<tr>
<td>Lavs</td>
<td></td>
<td>1.0 x 3 = 3.0</td>
</tr>
<tr>
<td>Showers</td>
<td></td>
<td>2.0 x 3 = 6.0</td>
</tr>
<tr>
<td>Laundry Sink</td>
<td></td>
<td>1.5 x 1 = 1.5</td>
</tr>
<tr>
<td>Kitchen Sink</td>
<td></td>
<td>1.5 x 1 = 1.5</td>
</tr>
<tr>
<td>Hose Bibb</td>
<td></td>
<td>2.5 x 1 = 2.5</td>
</tr>
<tr>
<td>Each additional hose bibb</td>
<td></td>
<td>1.0 x 1 = 1.0</td>
</tr>
<tr>
<td>Total Demand</td>
<td></td>
<td>29.5 fu</td>
</tr>
</tbody>
</table>

Effective Pressure:
- 60 psi (minimum at meter)
- 50 psi (head loss)

From Table 610.4
- 40 to 60 pressure range
- 160' column
- Max. Units
- Effective Pressure:
  - 60 psi (minimum at meter)
  - 50 psi (head loss)
Given:
- Developed length = 95 ft
- Water pressure = 50 psi minimum
  = 78 psi maximum
- Elevation of highest outlet above meter = 30 ft
- Water closets are 1.6 gpf gravity tank
- Effective pressure = min pressure - 0.5 psi for each foot in elevation.
  
  \[ 30 \times 0.5 = 15 \text{ psi loss} \]
  
  \[ 50 - 15 = 35 \text{ psi} \]

- Length to be used = 100 ft

**Determine Total Demand Fixture Units**

*Use Table 610.3, Don’t forget the Notes*

<table>
<thead>
<tr>
<th>Fixtures</th>
<th>Total Fixtures</th>
<th>Fixture Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>WC</td>
<td></td>
<td>5 FU</td>
</tr>
<tr>
<td>Lavs</td>
<td></td>
<td>2 FU</td>
</tr>
<tr>
<td>Bathub</td>
<td></td>
<td>4 FU</td>
</tr>
<tr>
<td>Showers</td>
<td></td>
<td>2 FU</td>
</tr>
<tr>
<td>Kitchen Sink with Dishwasher</td>
<td></td>
<td>1.5 FU</td>
</tr>
<tr>
<td>Hose Bibb</td>
<td></td>
<td>2.5 FU</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>17.0 FU</strong></td>
</tr>
</tbody>
</table>

**Total Demand**

*Determine Total Demand Fixture Units*

**Using Table 610.4**

**Size the Drawing and Fill in the Blanks**
Entire Group Exercise - Answers

Sizing Water Pipe

Shower

WC

LAV

Most Remote Water Heater

HB

Dishwasher

Kitchen Sink

Bathtub

½" valve

WC

LAV

2fu ½"

4fu ¾"

6fu ¾"

1fu ½"

7fu ¾"

1fu ½"

8fu ¾"

2.5fu ½"

10.5fu ¾"

2.5fu ½"

13fu 1"

1.5fu ½"

14.5fu 1"

4fu ¾"

2fu ½"

6fu ¾"

2fu ½"

8fu ¾"

1.5fu ½"

9.5fu ¾"

24fu 1"

2.5fu ½"

9.5fu ¾"

21.0fu 1"

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• Asterisk denotes fixture unit value in excess of originally established demand for building.

• This inflated value is the result of adding the hot water fixture unit demand back into the cold-water demand serving the water heater.

• Section 610.9 states... No branch piping is required to be larger in size than that required by Table 610.4 for the building supply pipe.

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Water Pipe Sizing

<table>
<thead>
<tr>
<th>Fixture</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shower</td>
<td>2</td>
</tr>
<tr>
<td>WC</td>
<td>1</td>
</tr>
<tr>
<td>LAV</td>
<td>3</td>
</tr>
<tr>
<td>Bathtub</td>
<td>2</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1</td>
</tr>
<tr>
<td>Laundry</td>
<td>1</td>
</tr>
<tr>
<td>Dish</td>
<td>1</td>
</tr>
<tr>
<td>Total Demand</td>
<td>27.0 fu</td>
</tr>
</tbody>
</table>

From Table 610.4

Effective Pressure: 48 psi (minimum at meter) - 5 psi (head loss) = 43 psi

Calculating Pipe Size at Meter and Effective Pressure

<table>
<thead>
<tr>
<th>Pressure Range</th>
<th>Max. Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>46 to 60 psi</td>
<td>37 fu</td>
</tr>
<tr>
<td>36 fu</td>
<td>36 fu</td>
</tr>
<tr>
<td>33 fu</td>
<td>17 fu</td>
</tr>
<tr>
<td>5 fu</td>
<td>5 fu</td>
</tr>
</tbody>
</table>

Sizing Water Pipe – Exercise 1

Table 610.4

Exercise 1 Answers

* Asterisk denotes fixture unit value in excess of originally established demand for building. This inflated value is the result of adding the hot water fixture unit demand back into the cold-water demand serving the water heater. Section 610.9 states... No branch piping is required to be larger in size than that required by Table 610.4 for the building supply pipe.
Water Pipe Sizing – Exercise 2

Public Use

Effective Pressure:
62 psi (minimum at meter) – 12 psi (head loss)
50 psi

Demand (From Table 610.3 and 610.10)

Water Closet (WC) – 2.5 x 6 = 15.0
Lavs – 1.0 x 4 = 4.0
Urinals – 15.0 + 20.0 = 35.0
Hose Bibb – 2.5 x 1 = 2.5
Hose Bibb – 1.0 x 1 = 1.0
Hose Bibb – 1.0 x 1 = 1.0

Total Demand = 57.5

Calculating Pipe Size at Meter and Effective Pressure

Sizing Water Pipe

From Table 610.4

46 to 60 pressure range 100’ column
Max. Units

¾” meter & 1 ¼” main = 37
1” branch = 36
1” branch = 33
¾” branch = 17
½” branch = 5

(see note 2)

Exercise 2 Answers

Review Code Section 610.10 for sizing flushometers valves

Water Closet (WC)
Lavs
Showers
Washfountains
Urinals
Hose Bibb
Hose Bibb
Hose Bibb

Total Demand = 192.5

Calculating Pipe Size at Meter and Effective Pressure

Sizing Water Pipe – Exercise 3

Public Use

Effective Pressure:
62 psi (minimum at meter) – 20 psi (head loss)
40 psi

Demand (From Table 610.3 and 610.10)

Water Closet (WC) – 115.0 + 20 = 135.0
Lavs – 1.0 x 2 = 2.0
Showers – 2.0 x 4 = 8.0
Wash fountains – 4.0 x 2 = 8.0
Urinals – 20.0 + 15.0 = 35.0
Hose Bibb – 2.5 x 1 = 2.5
Hose Bibb – 1.0 x 1 = 1.0
Hose Bibb – 1.0 x 1 = 1.0

Total Demand = 192.5

Table 610.4
Exercise 3 Answer

<table>
<thead>
<tr>
<th>Pipe Section Units</th>
<th>Pipe Size</th>
<th>Pipe Section Units</th>
<th>Pipe Size</th>
<th>Pipe Section Units</th>
<th>Pipe Size</th>
<th>Pipe Section Units</th>
<th>Pipe Size</th>
<th>Pipe Section Units</th>
<th>Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>x</td>
<td>10</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>x</td>
<td>50</td>
<td>20</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>x</td>
<td>100</td>
<td>40</td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>

Sizing Water Pipe – Exercise 3

Water Pipe Sizing – Exercise 4

| Private Use |

Sizing Water Pipe – Exercise 4

Calculating Pipe Size at Meter and Effective Pressure

Demand

(From Table 610.3)

<table>
<thead>
<tr>
<th>Water Closet (WC)</th>
<th>1.0 x 3 = 3.0 fu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lavs</td>
<td>1.0 x 3 = 3.0 fu</td>
</tr>
<tr>
<td>Showers</td>
<td>2.0 x 3 = 6.0 fu</td>
</tr>
<tr>
<td>Bathtubs</td>
<td>4.0 x 1 = 4.0 fu</td>
</tr>
<tr>
<td>Laundry Sink</td>
<td>1.5 x 1 = 1.5 fu</td>
</tr>
<tr>
<td>Kitchen Sink</td>
<td>1.5 x 1 = 1.5 fu</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>1.5 x 1 = 1.5 fu</td>
</tr>
<tr>
<td>Clothes Washer</td>
<td>4.0 x 1 = 4.0 fu</td>
</tr>
<tr>
<td>Hose Bibb</td>
<td>2.5 x 1 = 2.5 fu</td>
</tr>
<tr>
<td>Hose Bibb</td>
<td>1.0 x 1 = 1.0 fu</td>
</tr>
</tbody>
</table>

Total Demand = 35.0 fu

Effective Pressure:

75 psi (minimum at meter) - 15 psi (head loss) = 60 psi

From Table 610.4

<table>
<thead>
<tr>
<th>Pressure range</th>
<th>Over 60 psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>100' column</td>
<td></td>
</tr>
<tr>
<td>Max. Units</td>
<td></td>
</tr>
<tr>
<td>¾&quot; meter &amp; 1 ¼&quot; main = 39 fu</td>
<td></td>
</tr>
<tr>
<td>½&quot; branch = 6 fu</td>
<td></td>
</tr>
</tbody>
</table>

Sizing Answers Exercise 4

* Asterisk denotes fixture unit value in excess of originally established demand for building. This inflated value is the result of adding the hot water fixture unit demand back into the cold-water demand serving the water heater. Section 610.9 states... "No branch piping is required to be larger in size than that required by Table 610.4 for the building supply pipe.

Protecting the Potable Water Supply

Case Studies in Cross-Connection Control
Looking to Add to Your Resume

Become Certificated in Backflow Prevention and Cross Connection

- BACKFLOW PREVENTION INSTITUTE
- The motto of the Backflow Prevention Institute® is safe water through plumbing code compliance. Proper training and certification are the keys to achieving that goal. IAPMO’s Backflow Prevention Institute is the industry’s resource for backflow prevention and cross-connection control. It provides professional training exceeding the industry standards established by the ASSE International.

Get Ready!

- Turn to page _____ in the handout.
- Read each case study
- Answer the questions following each case study

Let’s talk Cross-Connection

Image Courtesy of Backflow Prevention Institute

Case Study #1

- Is it backsiphonage or backpressure, a low or high hazard, continuous or non-continuous pressure cross connection situation?
- What type of backflow preventer would have prevented the situation, please list the approved standard number of that device and where should it be installed? (There may be more than 1 correct answer)
- Which cross connection control practice (isolation or containment) would you suggest for this situation, identify the device and where would you install it?

Case Study #2

- Is it backsiphonage or backpressure, a low or high hazard, continuous or non-continuous pressure cross connection situation?
- What type of backflow preventer would have prevented the situation, please list the approved standard number of that device and where should it be installed? (There may be more than 1 correct answer)
- What lesson or lessons can we learn from this situation, when installing backflow protectors?

Case Study #3

- Is it backsiphonage or backpressure, a low or high hazard, continuous or non-continuous pressure cross connection situation?
- What type of backflow preventer would have prevented the situation, please list the approved standard number of that device and where should it be installed? (There may be more than 1 correct answer)
Case Study #4

- Is it backsiphonage or backpressure, a low or high hazard, continuous or non-continuous pressure cross connection situation?
- What type of backflow preventer would have prevented the situation, please list the approved standard number of that device and where should it be installed? (There may be more than 1 correct answer)

Case Study #5

- Is it backsiphonage or backpressure, a low or high hazard, continuous or non-continuous pressure cross connection situation?
- What type of backflow preventer would have prevented the situation, please list the approved standard number of that device and where should it be installed? (There may be more than 1 correct answer)
- According to the article what did the water department fail to order the pest control company to do even though a backflow preventer was installed at the water service connection?

Case Study #6

- Is it backsiphonage or backpressure, a low or high hazard, continuous or non-continuous pressure cross connection situation?
- What is the standard number of the backflow preventer that was installed to prevent backflow, and identify the instructions for proper installation of this device?

Applying What You've Learned and More!

Find the Violations

Directions

- Please use the 2015 UPC for the following workshop drawing activities.
- Select a Spokesperson from your table for each drawing.
- You will be given 40 minutes to analyze your assigned UPC drawings for Code Compliance; if there are violations, using the entire code book give Code Sections.
- Spokesperson will be given an opportunity to present the findings of their group to the Workshop participants