Approved by GBCI for 1 CE Hour

Course Approval Number is 0090009310

Domestic Hot Water Recirculation

James M. Pleasants Company

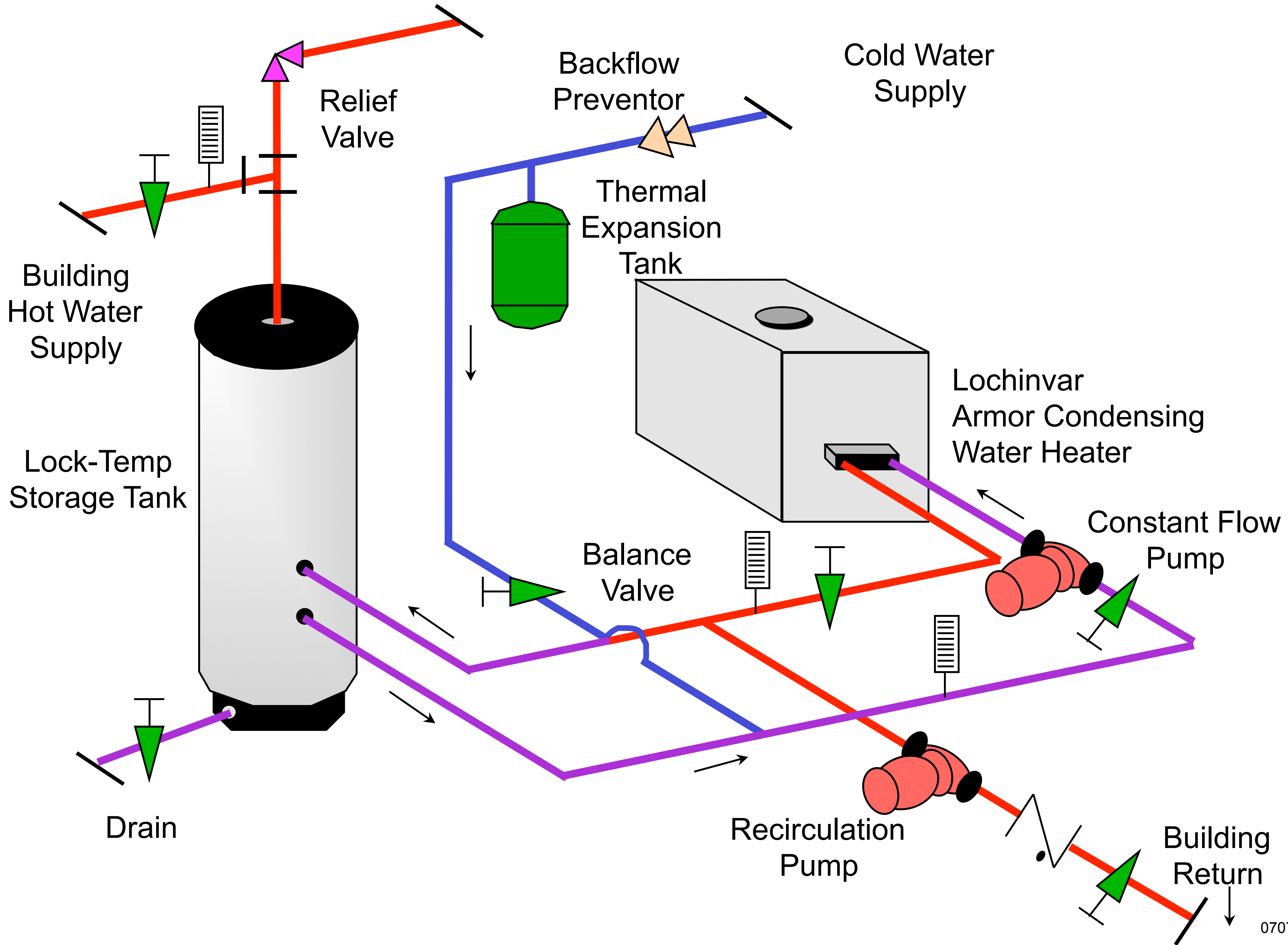
www.jmpco.com

Domestic **Hot Water** Recirculation **Learning Objectives**

In this seminar you will learn to:

1. Describe why conserving water is important.
2. Calculate the recirculation flow rate.
3. Identify recirculation trouble areas.
4. Design a recirculation system with a sizing example.
5. Apply special design considerations for instantaneous water heater applications.
6. Identify ways to balance multiple riser flows.
7. Identify ways to recirculate buildings with pressure reducing valve.

Condensing Water Heater



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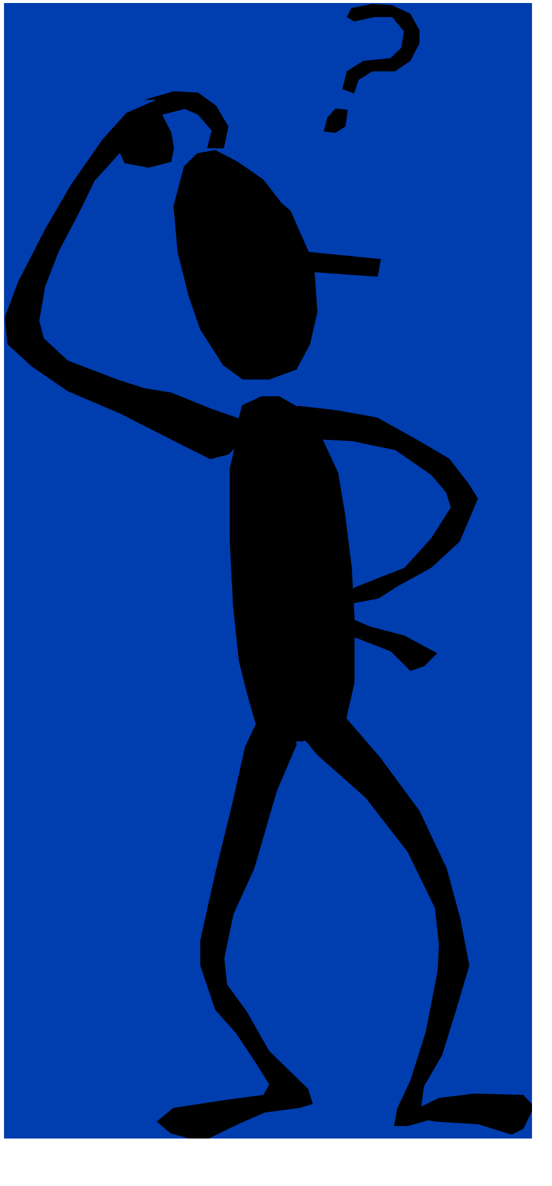
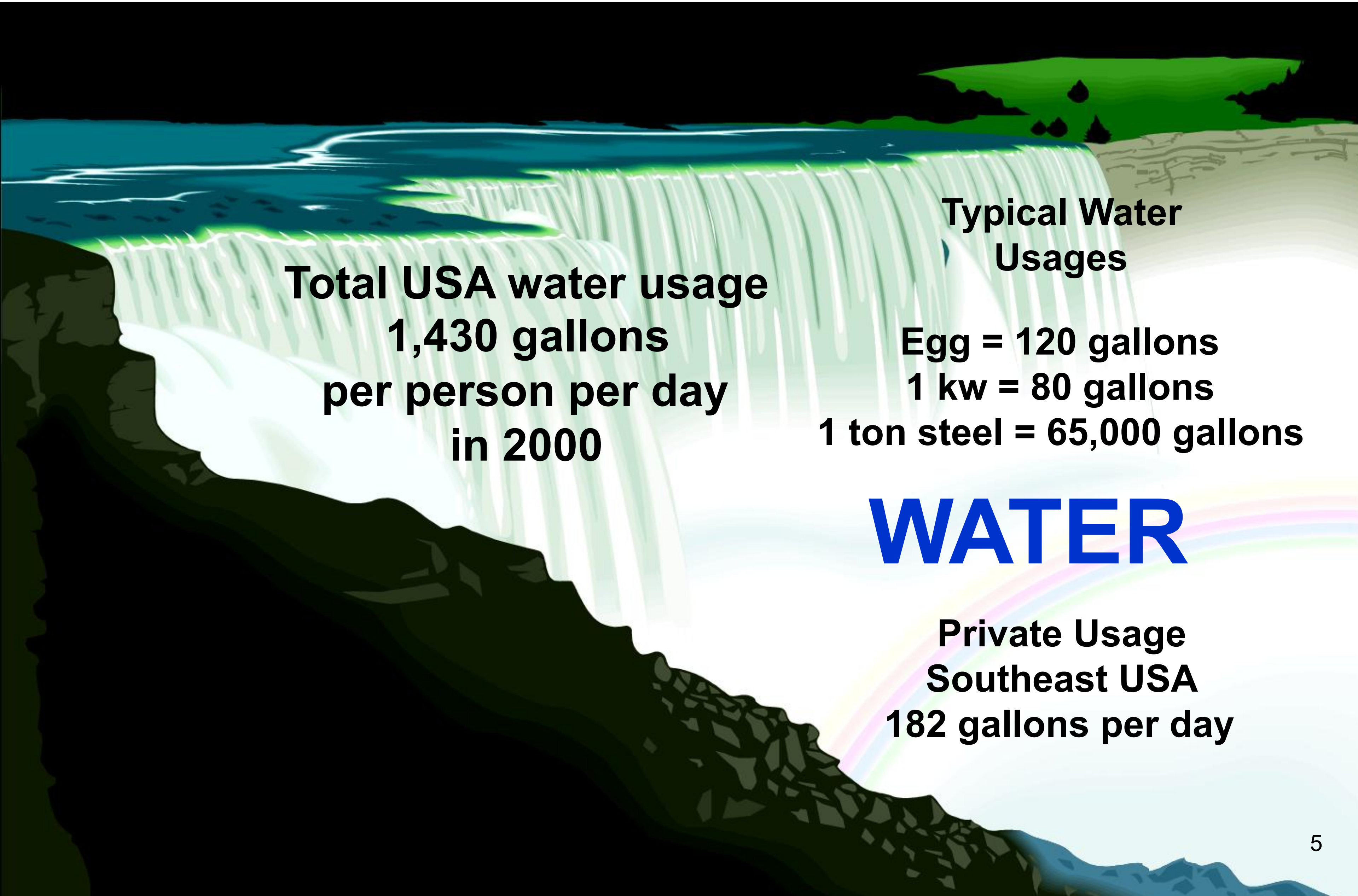
Why?





Total USA water usage
1,430 gallons
per person per day
in 2000

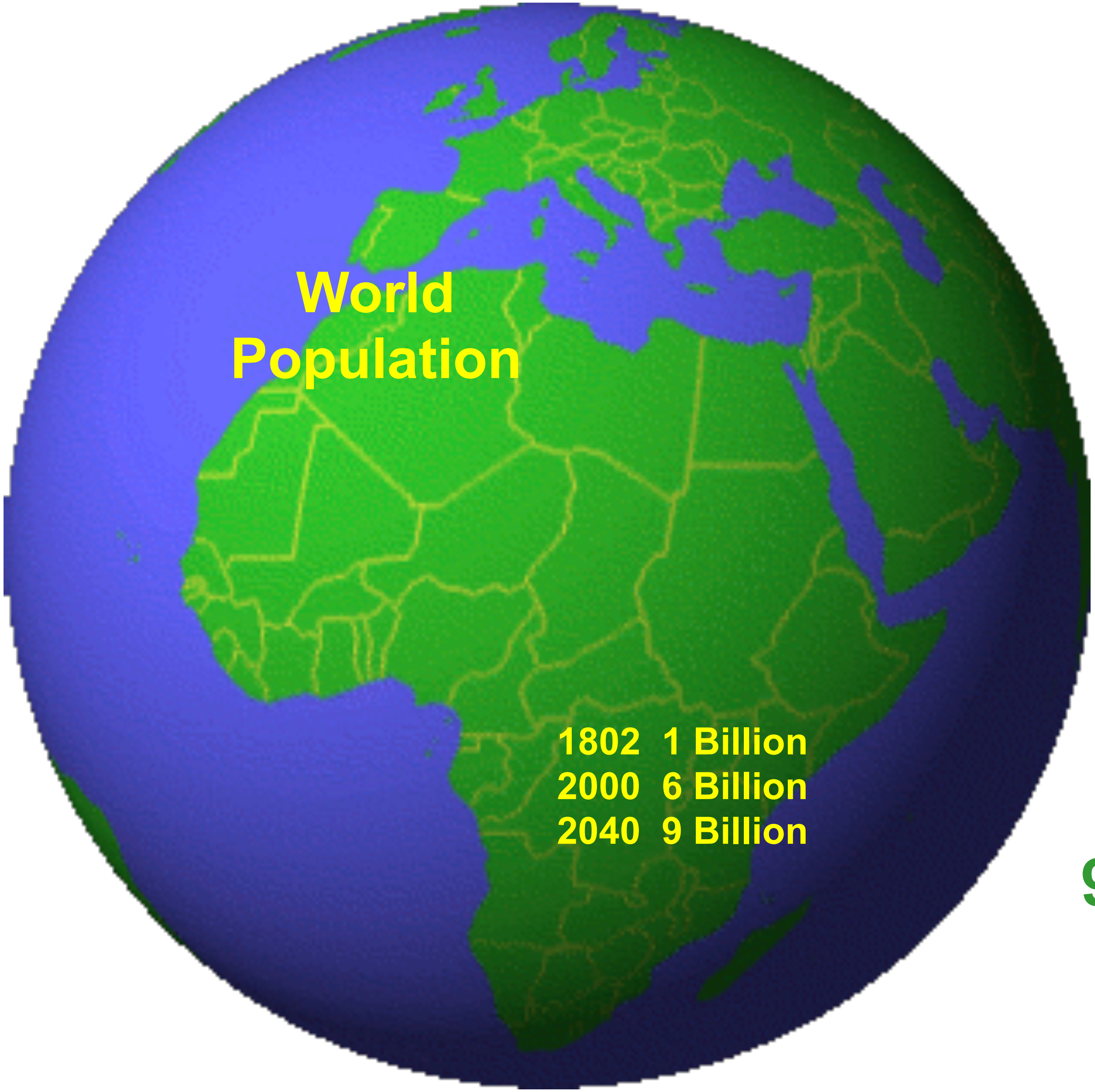
Typical Water Usages

Egg = 120 gallons
1 kw = 80 gallons
1 ton steel = 65,000 gallons

WATER

Private Usage
Southeast USA
182 gallons per day


WATER



Water covers
more than
70%
of the
earth's surface.

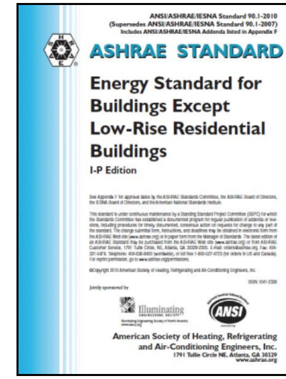
about
97% is salty water
3% **fresh** water

What Is The **Purpose** of Hot Water Recirculation?

To Conserve Water By Providing Hot Water At The Fixture More Quickly

CHAPTER 7
SERVICE WATER HEATING

SECTION 7.4
Mandatory Provisions



7.4.4 Service Water Heating System Controls

7.4.4.2 Temperature Maintenance Controls. *Systems* designed to maintain usage temperatures in hot-water pipes, such as recirculating hot-water *systems* or *heat trace*, shall be equipped with ***automatic* time switches or other *controls*** that can be set to switch off the usage temperature maintenance *system* during extended periods when hot water is not required.

7.4.4.3 Outlet Temperature Controls. Temperature controlling means shall be provided to **limit the maximum temperature** of water delivered from lavatory faucets in *public facility restrooms* to **110°F**.

7.4.4.4 Circulating Pump Controls. When used to maintain storage tank water temperature, recirculating pumps shall be equipped with *controls* limiting operation to a period from the start of the heating cycle to **a maximum of five minutes after the end of the heating cycle**.

Following is from section III, Chapter 7 of OSHA's technical manual.
(http://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_7.html#5)

C. DOMESTIC HOT-WATER SYSTEMS.

1. **Background.** Domestic hot-water systems are frequently **linked to Legionnaires' outbreaks.**

Water heaters that are **maintained below 60°C (140°F) and contain scale and sediment tend to harbor the bacteria** and provide essential nutrients for commensal micro-organisms that foster growth of *L. pneumophila.*

2. **Design.** Water systems **designed to recirculate water** and minimize dead legs will **reduce stagnation.**

3. **Maintenance.**

a. To **minimize the growth of Legionella** *in the system, domestic* hot water should be **stored at a minimum of 60°C (140°F)**

c. Domestic hot-water **recirculation pumps should run continuously.** They should be excluded from energy conservation measures.

post-gazette.COM
Pittsburgh Post-Gazette

Third vet's death tied to Legionnaires'

His wife blames water from VA hospital in Oakland

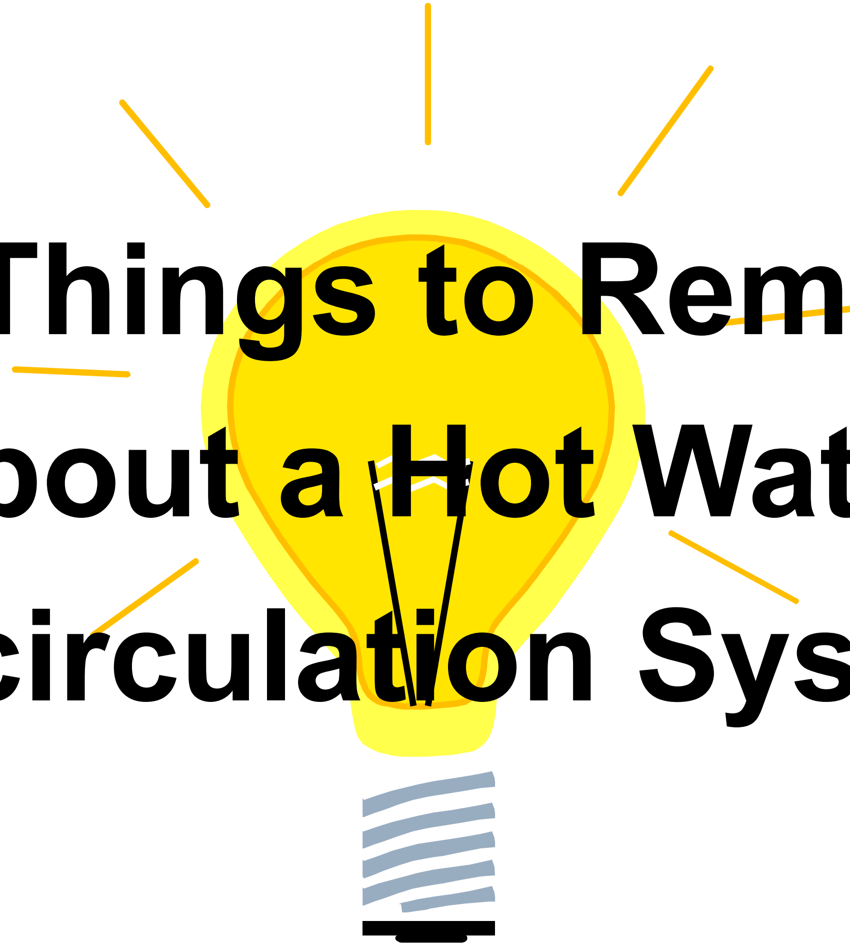
December 4, 2012 12:11 am

By Sean D. Hamill / Pittsburgh Post-Gazette

The wife of a Vietnam War Army veteran who died Oct. 23 in Erie believes her husband may have died after contracting Legionnaires' disease from the water system at the VA hospital in Oakland.

If John McChesney, 63, did die after contracting the pnemonia-like disease at the University Drive facility, that potentially makes him the third patient in the past two years to die after getting Legionnaires' disease there.

Four Things to Remember about a Hot Water Recirculation System



Number 1

The recirculation flow rate will be established by **supply piping heat loss** to the **farthest faucet or riser** at a **given delta temperature**

Number 2

Recirculation **return** line **heat loss need not be considered**

Number 3

The **required** flow to **compensate** for the **heat loss** of insulated copper pipe is typically a **low GPM** flow rate

Number 4

The **recirculation return** line will be (most of the time) **equal** in length to **supply main** length

Potential **recirculation trouble** areas are:

- Water Heater Temperature Control
- Unbalanced Riser Flows
- Recirculation with Reducing Valves

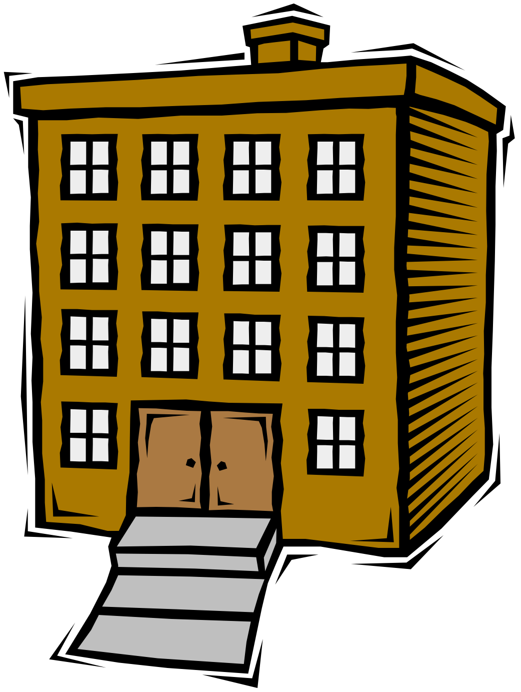
Recirculation Pump and Its Control

Domestic HW recirculation pumps must be constructed so that all working parts exposed to **domestic water** are **brass**, **bronze**, **stainless steel** or **non-ferrous** in order to resist the **corrosive** attack of **oxygenated fresh water**. Conventional iron body Hydronic System pumps **should not be used!**

Basic Recirculation Design Procedures

- Determine **Required** Recirculation Flow Rate.
  (based on **heat loss** of supply pipe)
- **Size** Recirculation Line
- Determine **Flow-Friction Head Loss** in Recirculation Line, Heater, Supply Pipe and etc.
- Select Pump Based on **Flow Requirement** and **Head Loss**.

Apartment Sizing Example

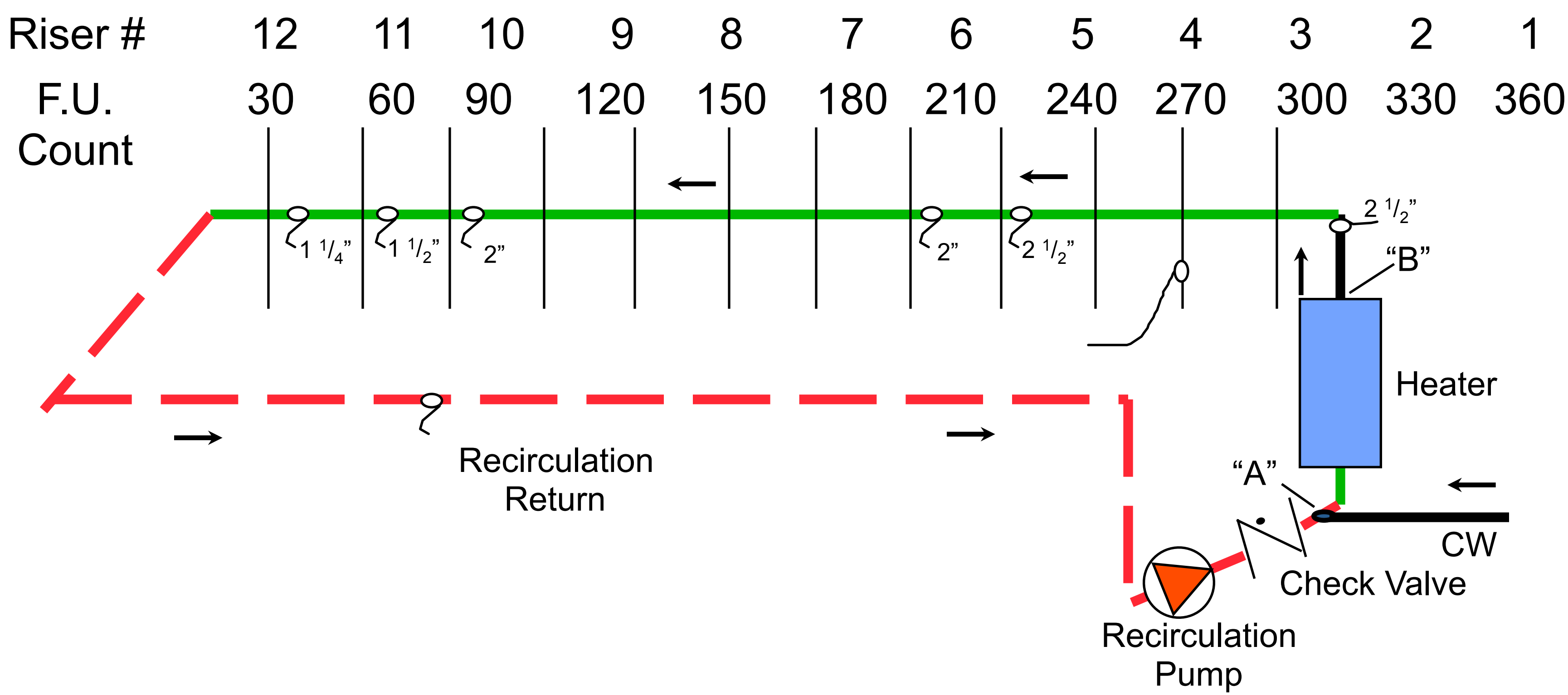


Example Problem: Apartment Building

- Each Apartment Requires 3.75 FU
- Eight (8) Apartments per riser and Twelve (12) risers
- Each Riser 30 FU X 12 Risers = 360 FU
- 360 FU = 100 GPM
- There is 25 ft. between each riser for a total of 300 feet of supply piping

Apartment Building Example

(Supply pipe 300 feet long)



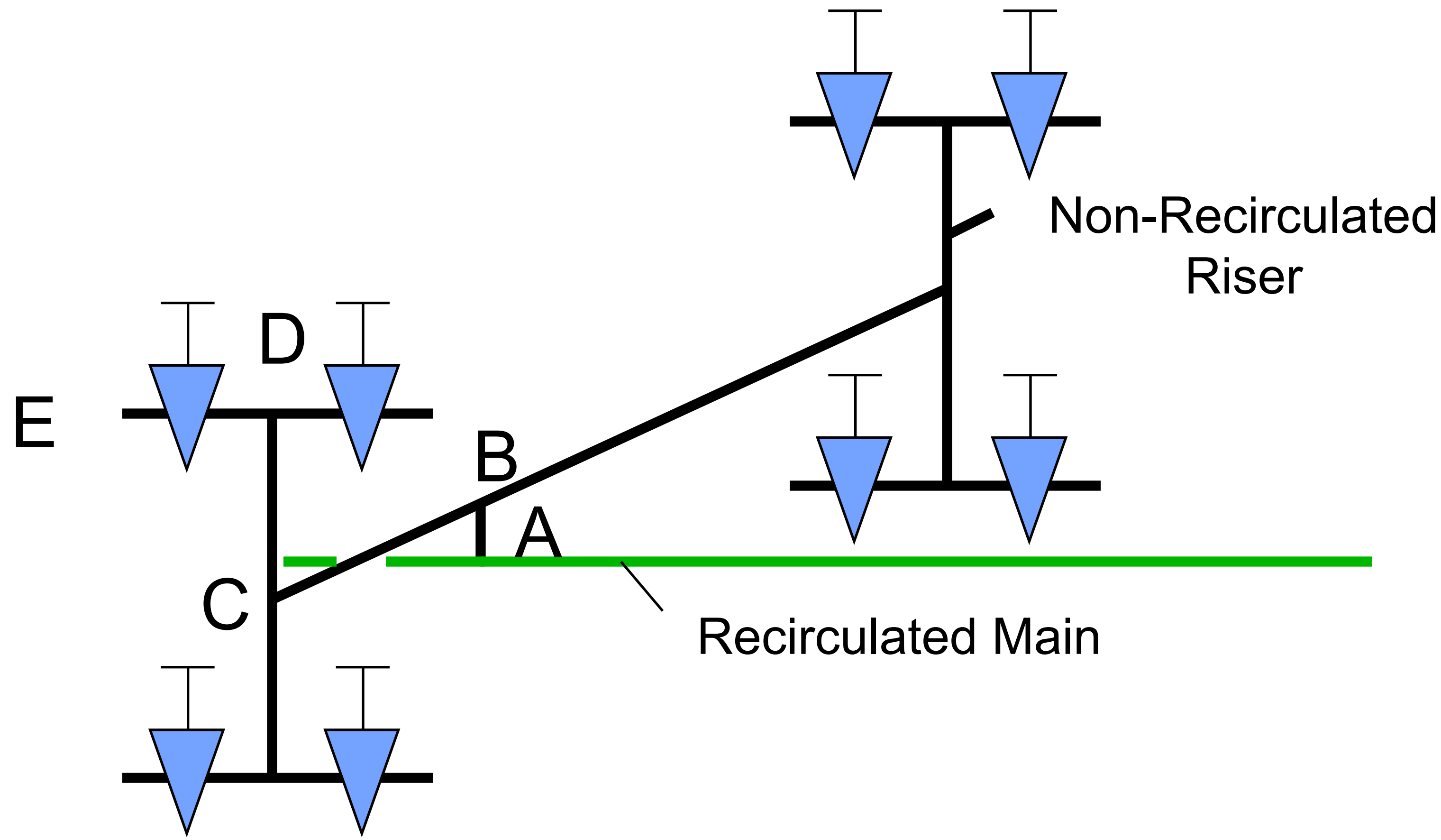
Simple Recirculation System

The Heating Load for Hot Water Recirculation

Load (BTU/Hr) = GPM x 500 x ΔT

What is design temperature Drop?

(10^{o} ΔT Good Design)



Simple Recirculation System with Non-Recirculated Riser; Riser Run-out Length (A, B, C, D, E) Should Not Exceed Approximately 50 Ft.

SECTION 607
HOT WATER SUPPLY SYSTEM

607.2 Hot water supply temperature maintenance. Where the developed **length of hot water piping** from the source of hot water supply to the farthest fixture **exceeds 100 feet** (30 480 mm), the hot water supply system shall be provided with a method of **maintaining the temperature** in accordance with the *International Energy Conservation Code.*

[E] 607.2.2 Hot water system controls. Automatic circulating hot water system **pumps or heat trace** shall be arranged to be conveniently turned off, automatically or manually, when the hot water system is not in operation.

607.2.3 Recirculating pump. Where a **thermostatic mixing valve** is used in a system with a hot water recirculating pump, the hot water or tempered water return line shall be **routed to the cold water inlet pipe** of the water heater **and the cold water inlet pipe** or the hot water return connection of the thermostatic mixing valve.

CHAPTER 6

WATER USE EFFICIENCY

6.3 Mandatory Provisions

6.3.2.2 Appliances

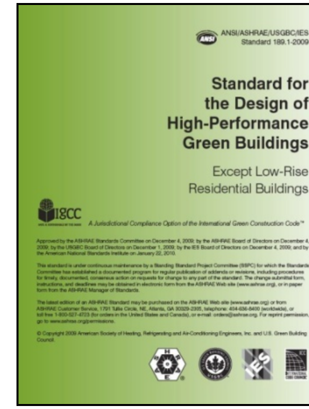


TABLE 6.3.2.1 Plumbing Fixtures and Fittings Requirements

Plumbing Fixture	Maximum
Water closets (toilets) - flushometer valve type	Single flush volume of 1.28 gal (4.8 L)
Water closets (toilets) - flushometer valve type	Effective dual flush volume of 1.28 gal (4.8 L)
Water closets (toilets) - tank-type	Single flush volume of 1.28 gal (4.8 L)
Water closets (toilets) - tank-type	Effective dual flush volume of 1.28 gal (4.8 L)
Urinals	Flush volume of 0.5 gal (1.9 L)
Public lavatory faucets	Flow rate - 0.5 gpm (1.9 L/min)
Public metering self-closing faucet	0.25 gal (1.0 L) per metering cycle
Residential bathroom lavatory sink faucets	Flow rate - 1.5 gpm (5.7 L/min)
Residential kitchen faucets	Flow rate - 2.2 gpm (8.3 L/min)
Residential showerheads	Flow rate - 2.0 gpm (7.6 L/min)
Residential shower compartment (stall) in dwelling units and guest rooms	Flow rate from all shower outlets total of - 2.0 gpm (7.6 L/min)

Low Flow Fixture Problem

Public metering self-closing faucet **0.25 gal** (1.0 L) per metering **cycle**.

Will you **ever get hot water** if light usage?

(.35 ft/sec in a .5 inch copper pipe)

Common Problem because of **low flow**!

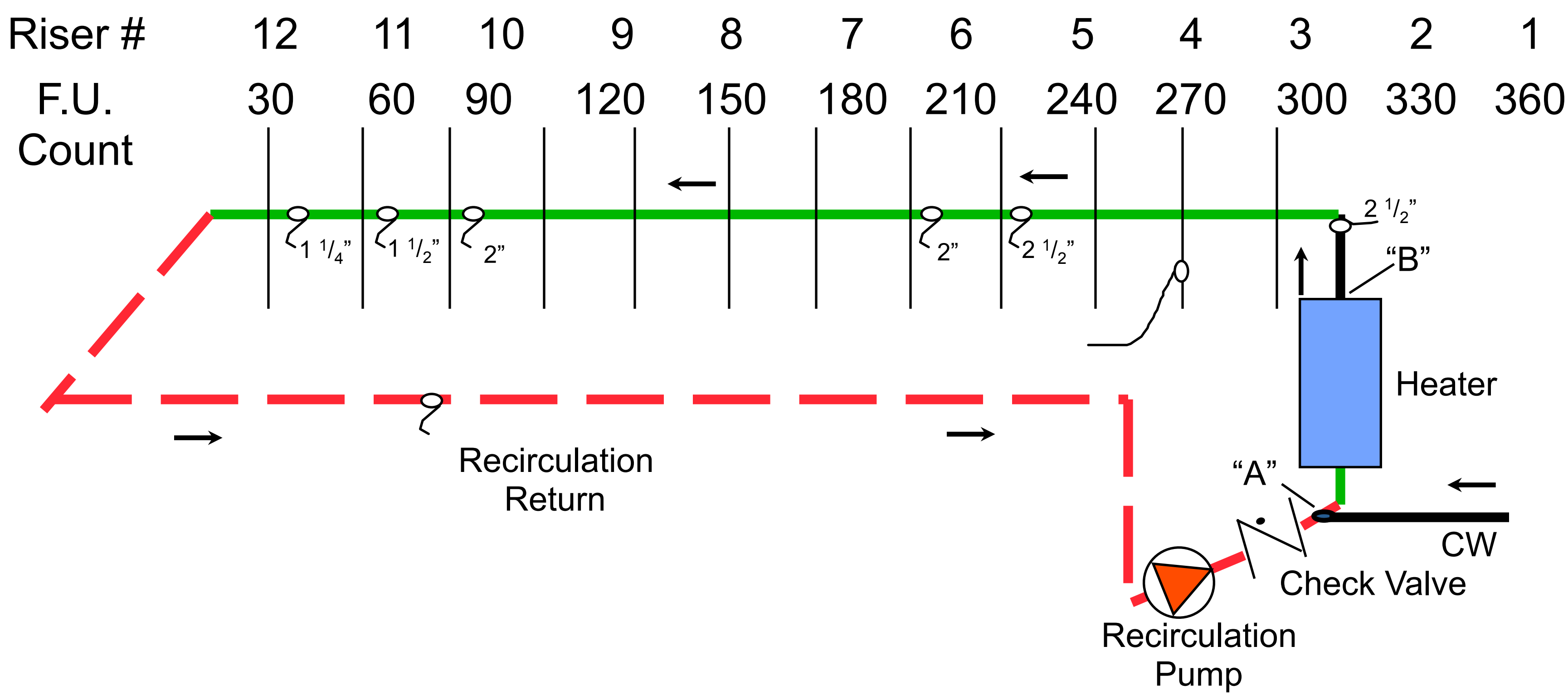
Shorter Run out lengths? (less 50 ft)

Electric heat trace the run outs?

6.3.4 Hot Water Distribution

6.3.4.1 Efficient Hot or Tempered Water Distribution Systems. For the purposes of this section, sources of hot or tempered water include water heaters, boilers, hot water circulation loops, and electrically heat-traced pipe. The volume of water in the piping between water heaters or boilers and fixture fittings the serve shall not exceed 32 ounces (0.945 L). The volume of water contained in fixture branch piping that connects to a hot water circulation loop or electrically heat- traced pipe **shall not exceed 16 ounces** (0.47 L). The volume shall be calculated in accordance with Table 6-3.

What is heat loss of **supply pipe**?



Simple Recirculation System

Temperature Drop	BTU/GPM Relationship
10^o	5,000 B/Hr. = 1 GPM
15^o	7,500 B/Hr. = 1 GPM
20^o	10,000 B/Hr. = 1 GPM

BTUH heat loss per 100 ft for tubing and steel pipe.

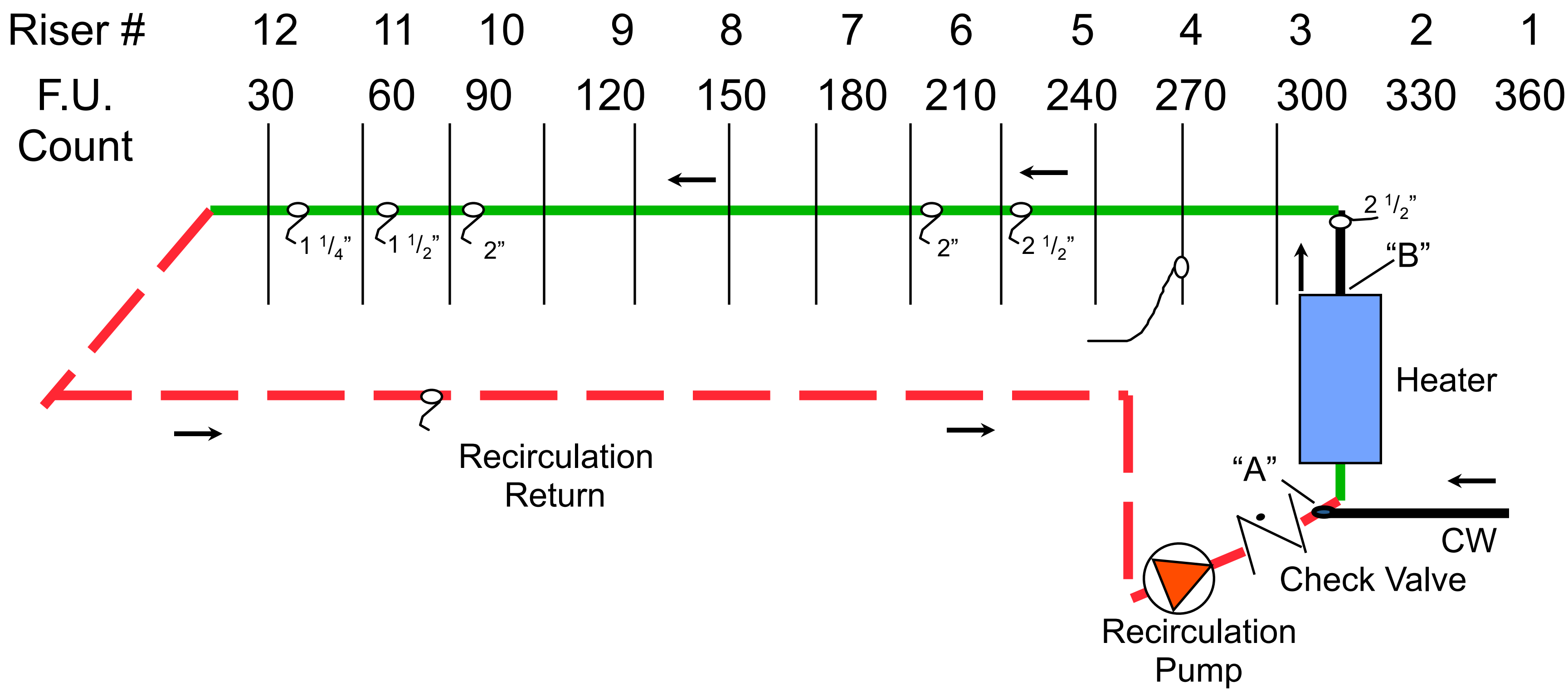
Pipe or Tube Size	Insulated Copper Tube or Steel Pipe	Non-Insulated Steel Pipe	Non-Insulated Copper Pipe
$^1/_2$”	1600	4,000	2,300
$^3/_4$”	1800	5,000	3,000
1”	2000	6,000	4,000
1 $^1/_4$”	2400	7,500	4,500
1 $^1/_2$”	2600	8,500	5,500
2”	3000	11,000	6,500
2 $^1/_2$”	3400	12,000	8,000
3”	4000	15,000	9,500
4”	4800	19,000	12,000
5”	5700	22,500	
6”	6600	26,000	

Using insulated copper tube, 25 ft. length between riser take-off points, supply line heat loss to the farthest riser take-off is as follows:

				Heat loss, BTUH
B - #1	2-1/2”	30 ft.	3400/100	3400 x 30/100 = 1020
#1 - #4	2-1/2”	75 ft.	3400/100	3400 x 75/100 = 2550
#4 - #10	2”	150 ft.	3000/100	3000 x 150/100 = 4500
#10 - #11	1-1/2”	25 ft	2600/100	2600 x 25/100 = 650
#11 - #12	1-1/4”	25 ft	2400/100	2400 x 25/100 = 600

TOTAL SUPPLY LINE HEAT LOSS = **9320 BTUH**

Supply Pipe Heat Loss is 9,320 BTUH



Simple Recirculation System

Required Water Flow:

WATER TEMP: 140 DEG From Water Heater
130 DEG At Farthest riser
10 DEG Delta Temperature

1 gpm flow Will Convey 5000 BTUH

Recirculation return flow need =
9320 / 5000 = 1.87 gpm

A 3/4” copper line is the proper size selection for 1.9 gpm

The friction loss will be about 1.4 ft per 100 ft.

Required Pump Head:

Recirculation line Length = 300 ft

Pipe Pressure Drop = 300 ft x 1.4 / 100 = 4.2 ft

Check valve pressure drop = 1.0 ft.

Supply Pipe (negligible) = 0

Heater loss (negligible) = 0

Total friction head loss = 5.2 ft.

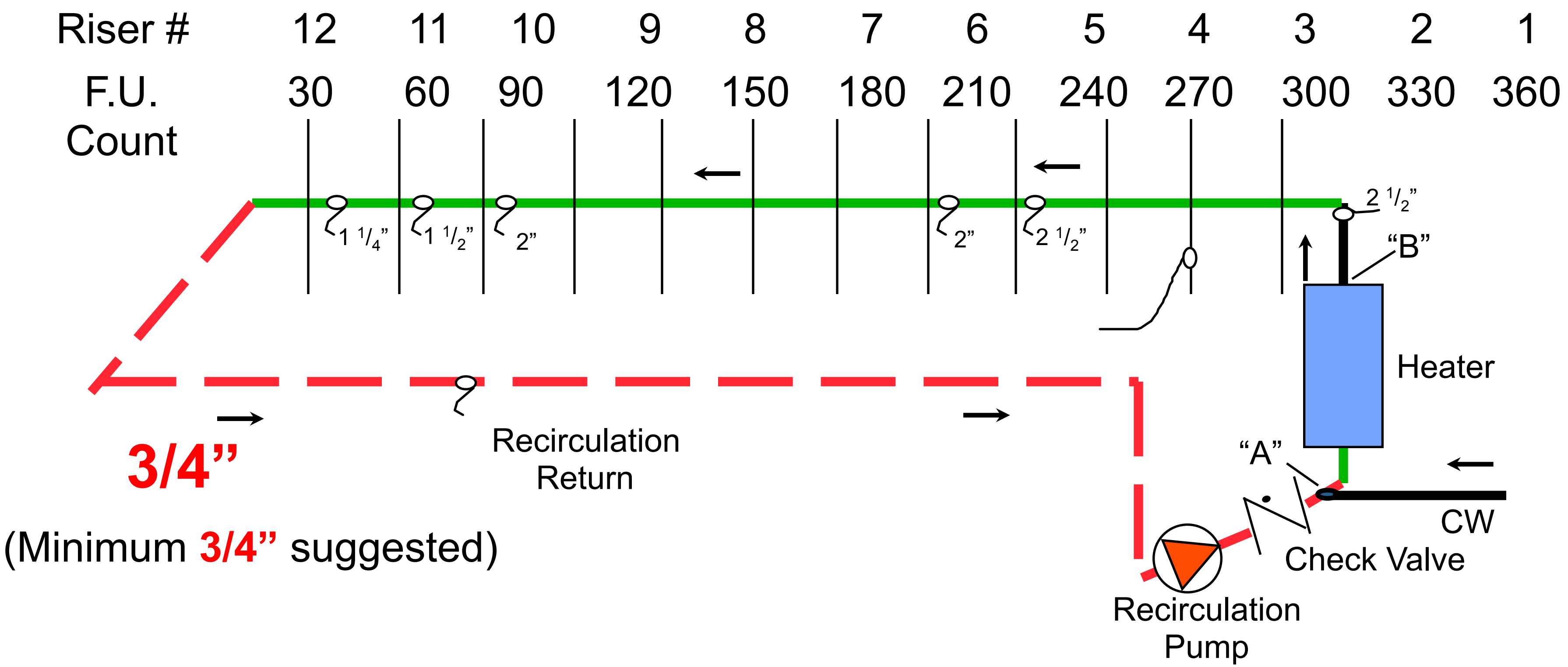
Select Bronze or Stainless pump for 1.9 gpm @ 5.2' Hd

Note: The heat loss chart is based on **140°F water** and **70°F ambient air**. To convert to approximate pipe heat loss at other water temperatures by using hot water to air difference.

For example, determine heat loss for 2-1/2" insulated copper pipe using 120°F water:

$$3400 \times \frac{(120 - 70)}{(140 - 70)} = 3400 \times \frac{50}{70} = 2431 \text{ BTUH / 100 ft.}$$

Recirculation Return Line



Simple Recirculation System

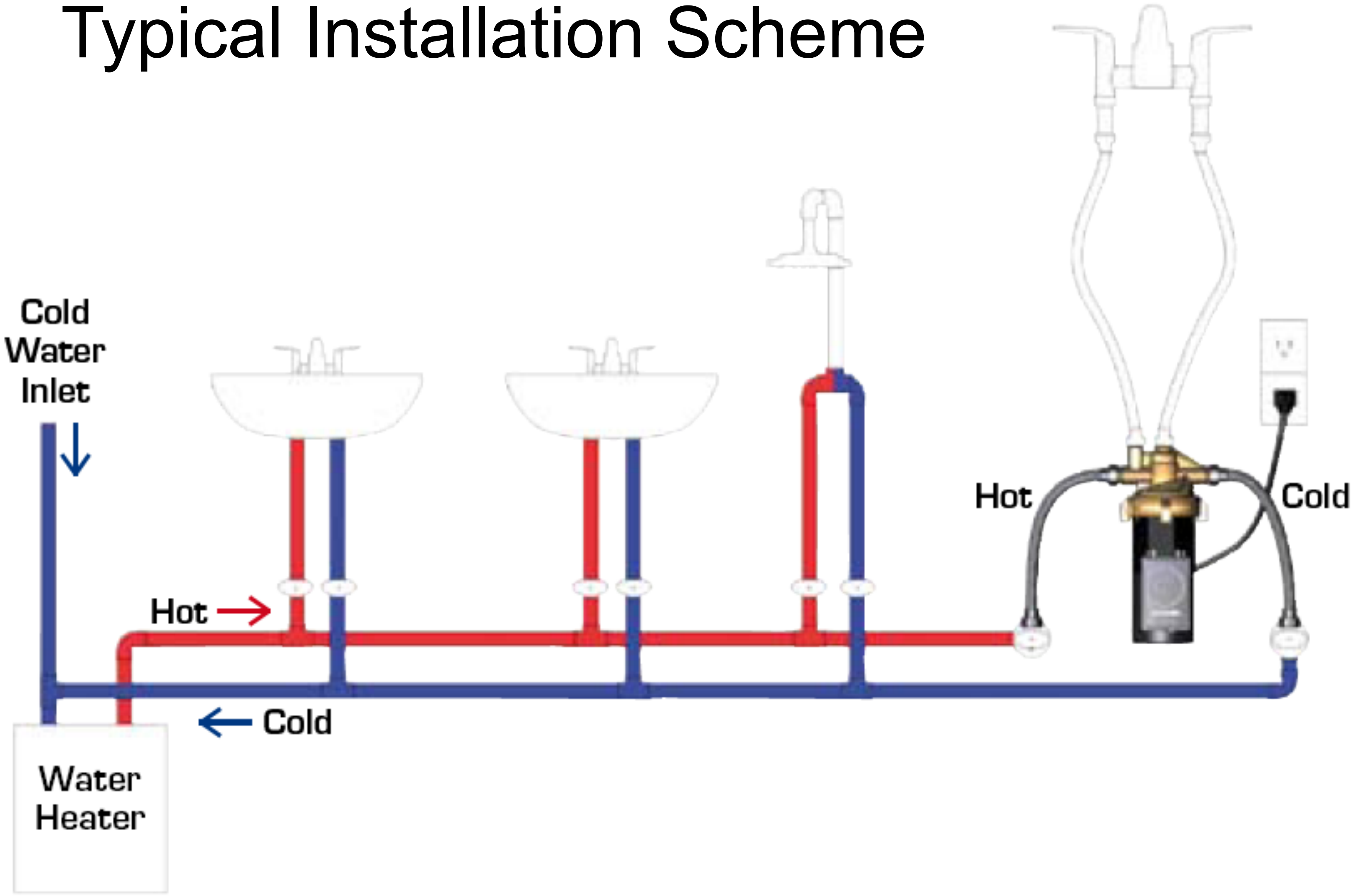
Simple Recirculation System Selection Table

	Recirculation Return Series Supply Main Which is Longer Than	But Shorter Than	For Supply Main Length Shown Use Recirculation Pipe or Tube Size Shown & **small recirculation pump** With Appropriate Flange Size.
Insulated Supply Main	0’	190’	$^1/_2$”
	190’	300’	$^3/_4$”
	300’	580’	1”
	580’	820’	$1^1/_4$”
	820’	1,150’	$1^1/_2$”
Non Insulated Supply Main	0’	75’	$^1/_2$”
	75’	145’	$^3/_4$”
	145’	240’	1”
	240’	375’	$1^1/_4$”
	375’	400’	$1^1/_2$”

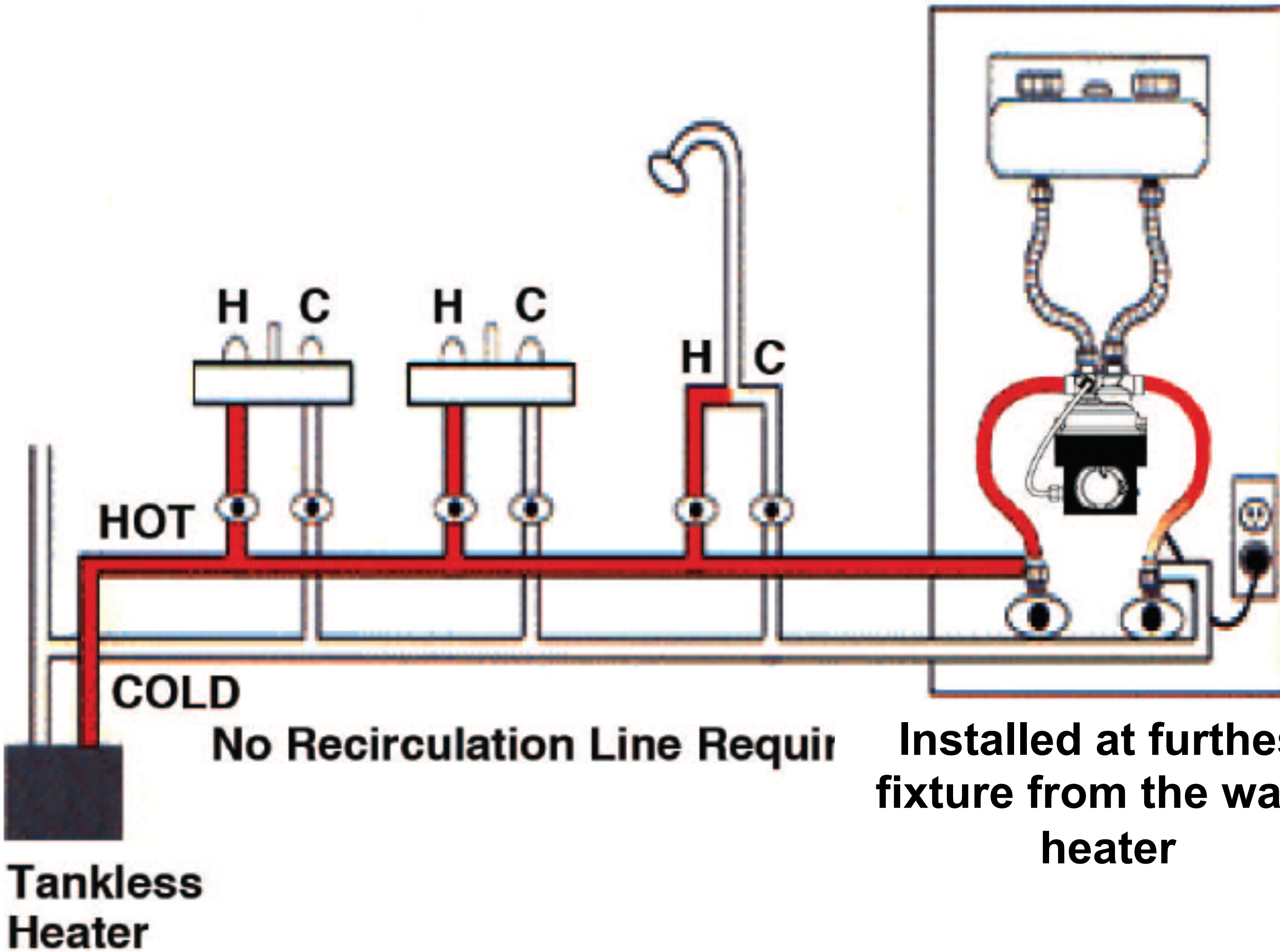
Recirculating With No Return Line

No Return Line Required!

Typical Installation Scheme



Typical Installation “Tankless Water Heater”



Installed at furthest fixture from the water heater

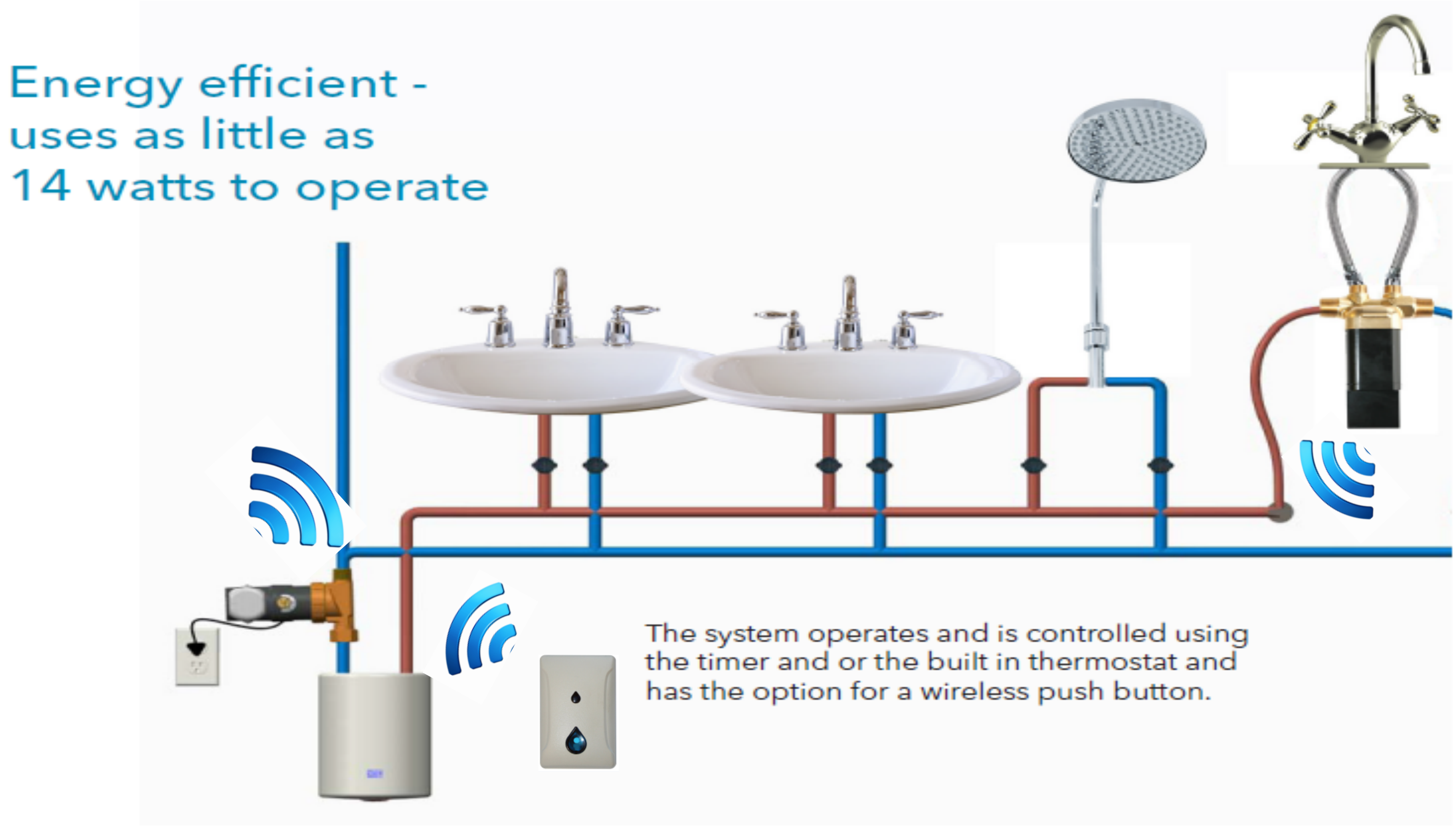
wireless

Automatic hot water recirculation through use of temp set point and wireless demand signaling of pump by valve

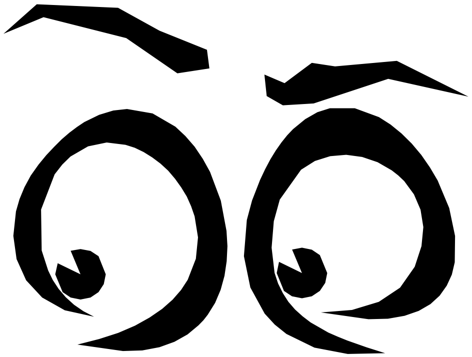
Features:
• Temperature and timer controlled
• Operated via wireless RF communication, ranging approximately 150 Ft between the pump & valve
• Valve operates using two (2 AA batteries)
• Optional push button start

Benefits:
• Easy installation
• No electrical outlet required under the sink

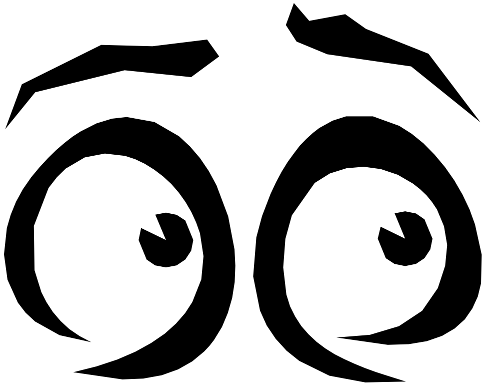
wireless….how it works!



Automatic hot water recirculation through use of temp set point and wireless demand signaling of pump by valve



Watch out for water heater temperature control



Nothing Beats Storage

Domestic hot water recirculation: I

Reprinted from the October 1985 issue of HEATING/PIPING/AIR CONDITIONING.

By: Gil Carson,
Director, Technical Services,
ITT Fluid Handling Div.,
Skokie, Ill.


Reprinted from the October 1985 issue of HEATING/PIPING/AIR CONDITIONING.

Domestic hot water recirculation : I

Avoid flow short circuits and "starving" in a multi-circuited domestic hot water recirculation system

By **GIL CARLSON**,
Director, Technical Services,
ITT Fluid Handling Div.,
Skokie, Ill.

Domestic hot water recirculation has a "Jekyl and Hyde" nature. For the majority of hot water recirculation systems, the pumping application is not complicated. Simple selection tables for both pump and pipe sizing can be used. In a few cases, however, domestic hot water recirculation pump applications can be very difficult and result in unworkable designs unless one is careful.

It is the purpose of this and a subsequent article to define the differences between the various types of systems. This will allow the plumbing design engineer to apply simple time-saving tabulated design techniques when suitable and, more importantly, will "red flag" potential trouble areas when simple design techniques must be abandoned in favor of more protective design procedures.

Potential recirculation trouble areas are:
- Water heater temperature control.
- Unbalanced riser flows.
- Recirculation with reducing valves.

Recirculation need

When domestic hot water (HW) is not recirculated, HW in the distribution piping will reduce to space temperature during the no-draw period. Initial draw from the HW faucet will be cold, and building occupants will find it necessary to wait for a time period while HW fills the distribution piping. Considerable water wastage must occur and tenants complain; a minute spent waiting for HW seems much longer. In addition, shower head temperature control becomes much less stable, which further increases tenant complaints.

A properly designed and installed recirculation system will provide instantaneous HW at the faucet. In addition, recirculation establishes the entire HW piping system as "storage." Recirculation thus provides a stored heat mass that tends to compensate for over- and undershooting of the HW control. Piping mass at 140 F will cool down supply HW provided at a temperature higher than 140 F before it reaches the faucet and vice versa.

Shower temperature control stability is increased by the compensating heat mass provided by recirculation while the recirculation "mix" at the heater provides for an easing of the basic temperature control problem, especially during difficult light load draw conditions.

Recirculation pump control

Domestic HW recirculation pumps must be constructed so that all working parts exposed to domestic water are brass or bronze to resist the corrosive attack of oxygenated water. Conventional iron body hydronic system pumps *should not be used!*

As a general rule, recirculation pumps should be operated continuously. The only time recirculation pumps can be operated on/off as a function of return water temperature is when the pump serves a simple single line distribution system (as to a bank of showers, a residence, etc.). Even in this instance, however, on/off operation would not be warranted because of the minor cost savings.

Aquastat controlled on/off pump operation should not be employed for large multiple circuited recirculation systems for two reasons:
- Light load heater control will be unstable.
- Flow balance: When the pump is off, gravity recirculation may occur. Short circuiting flow may then establish a satisfactory return temperature at the aquastat but without providing required HW temperatures at the "far" using points. Unstable operating conditions will result.

Recirculation pumps are available as both in-line and base-mounted. Line-mounted pumps are more com-

This is the first of two articles on domestic hot water recirculation. The second in the series will appear in the December 1985 issue of Heating/Piping/Air Conditioning.

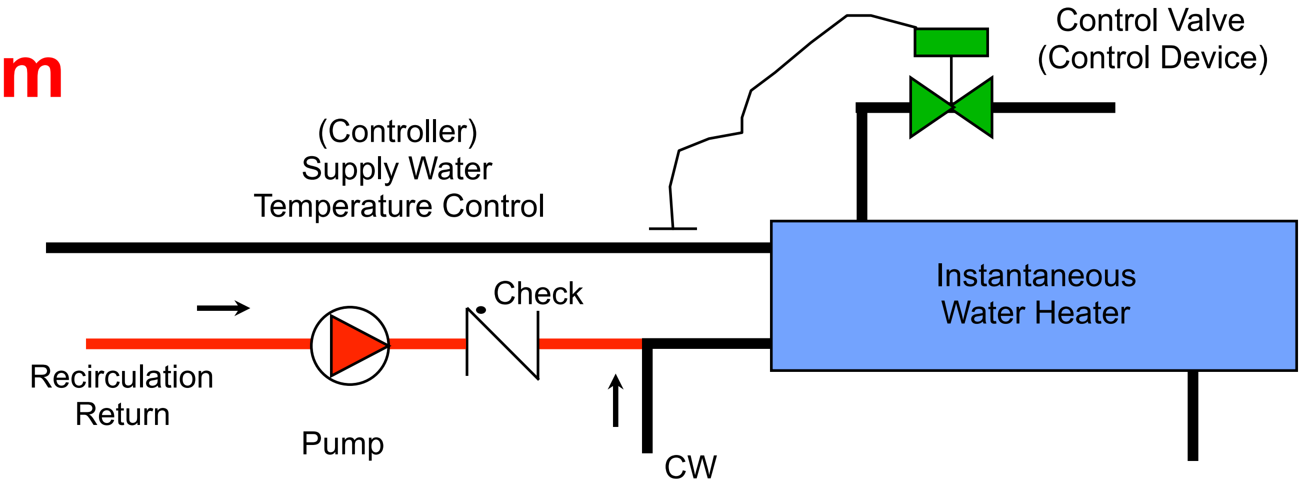
An **increase in instantaneous heater flow rate** during the **light load draw** will increase light load temperature **control stability**. This is because with a high flow rate, the controller needs only to measure temperature change to establish the load set point for the control device.

Instantaneous heater flow rate during periods of light load draw **should be increased to about 25 percent** of the expected Hunter flow rate.

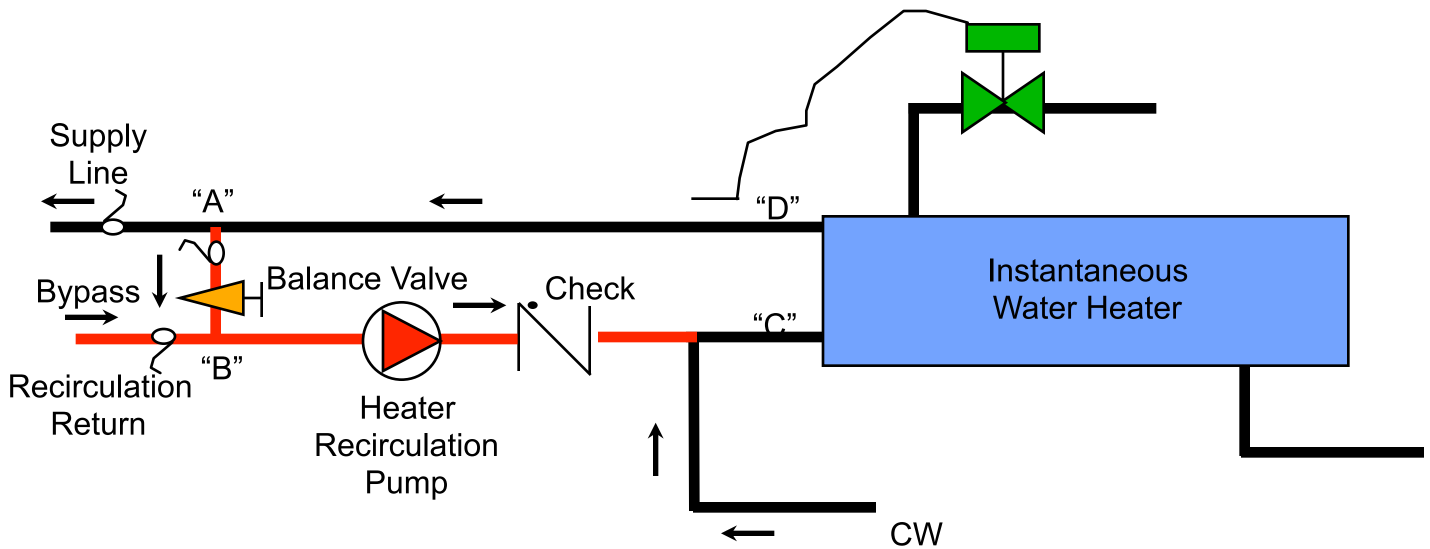
Dead End Service Main Steam Valves
(Leak a little)

- Dead end service Steam Control valves are allowed a small amount of leakage!
- Maximum allowed is .01% of max capacity to meet standard for tight shut off
- Can be controlled or reduced by lapping the seats of the valve
- Small amount of steam but can be a problem if more than radiant heat loss of station
- **ASME Relief valves may relieve under no-flow or no loan conditions**
- Domestic Water applications **may see elevated out of control supply temperatures**

Minimum 25% Flow

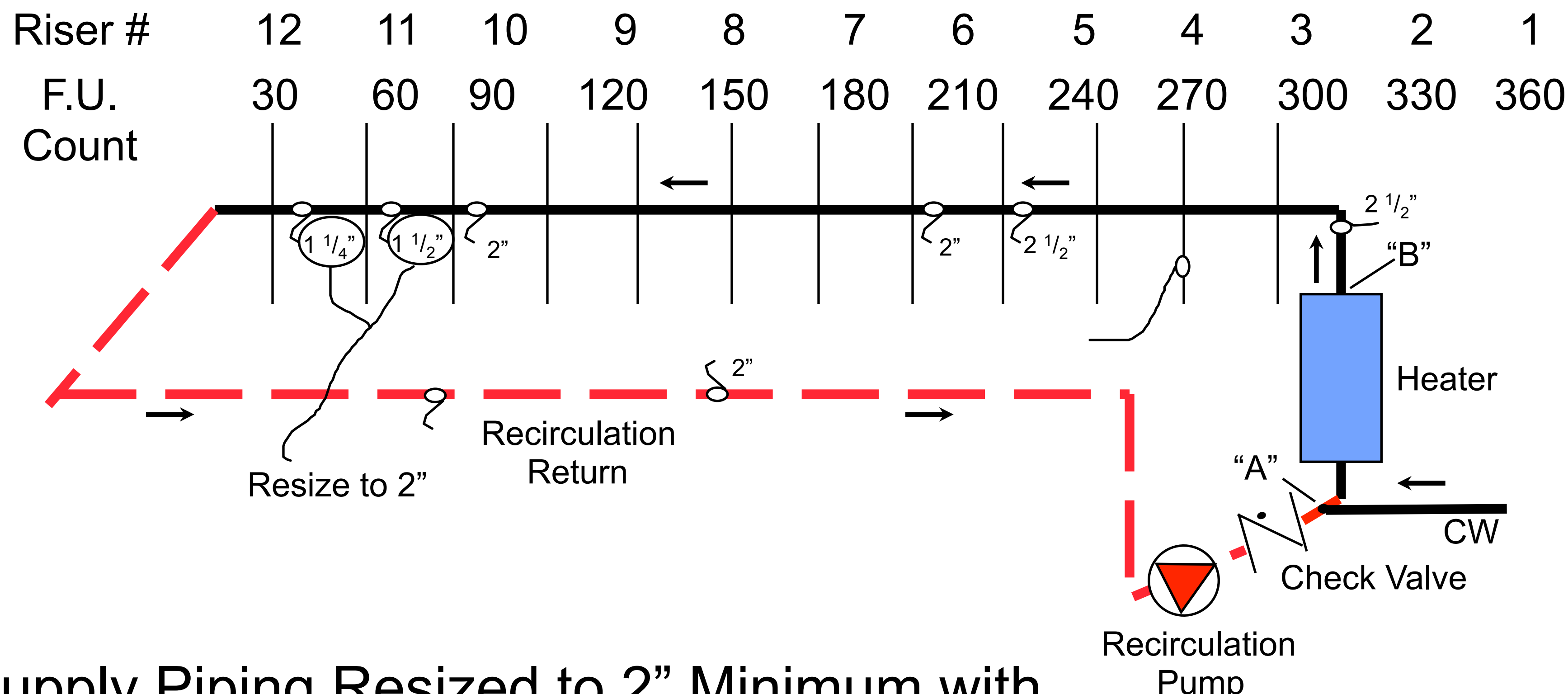


Instantaneous Heater May Need Flow Increase Over Minimal Required Recirculation Flow For Light Load Draw Temperature Control.



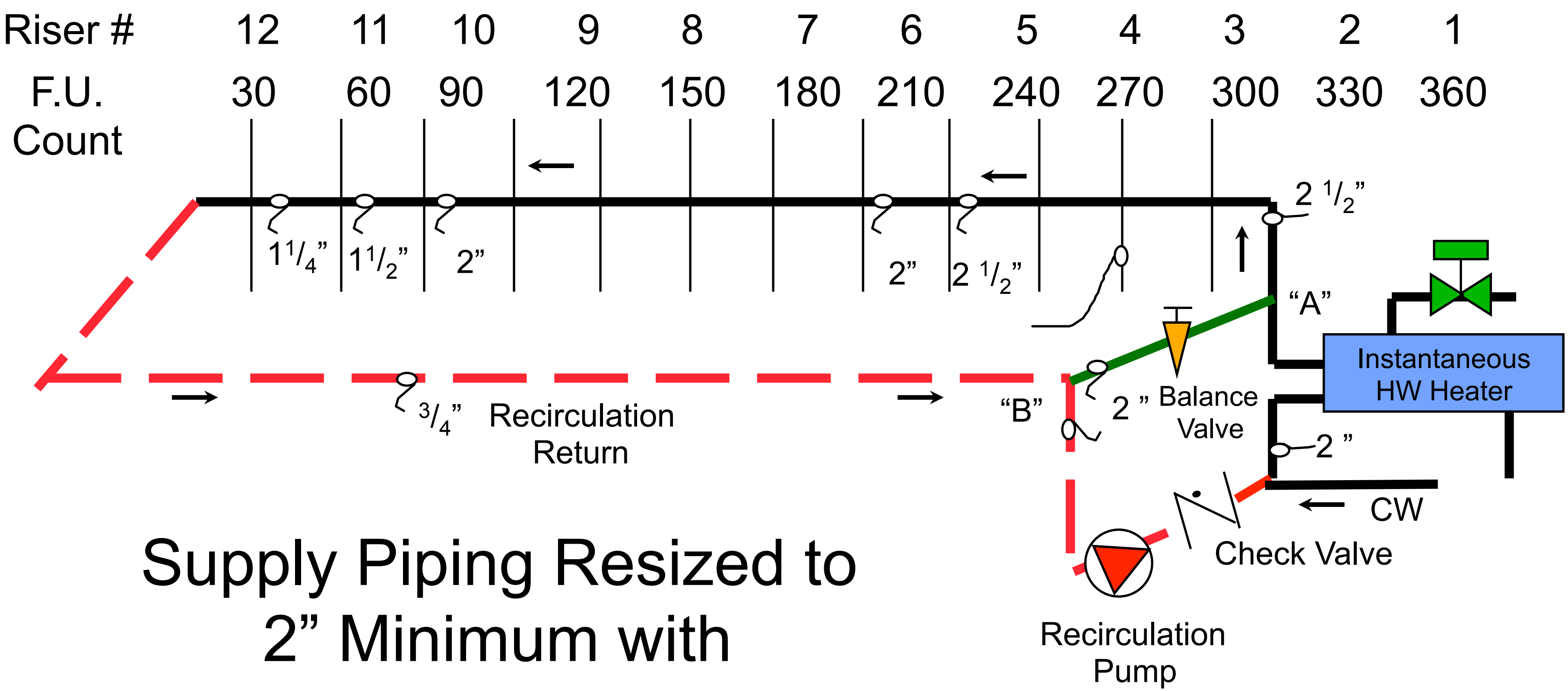
Pump With **Bypass Increases** Heater Flow Without Need For Increased Recirculation Flow

Oversized Return Line

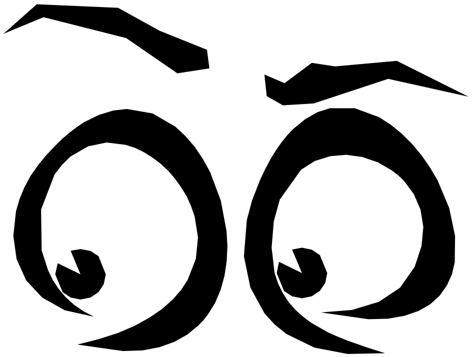


Supply Piping Resized to 2" Minimum with 2" Recirculation Return for 25 GPM Flow

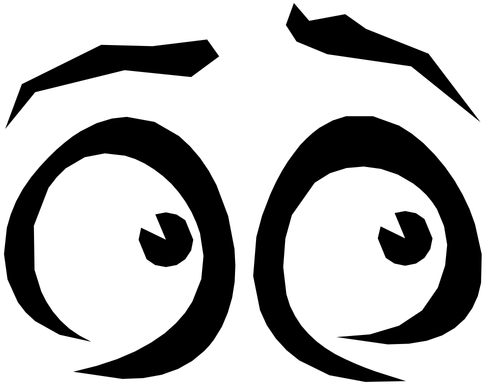
Bypass Line in Equipment Room



Supply Piping Resized to 2" Minimum with 2" Recirculation Return for 25 GPM Flow



Watch out for unbalanced riser flows



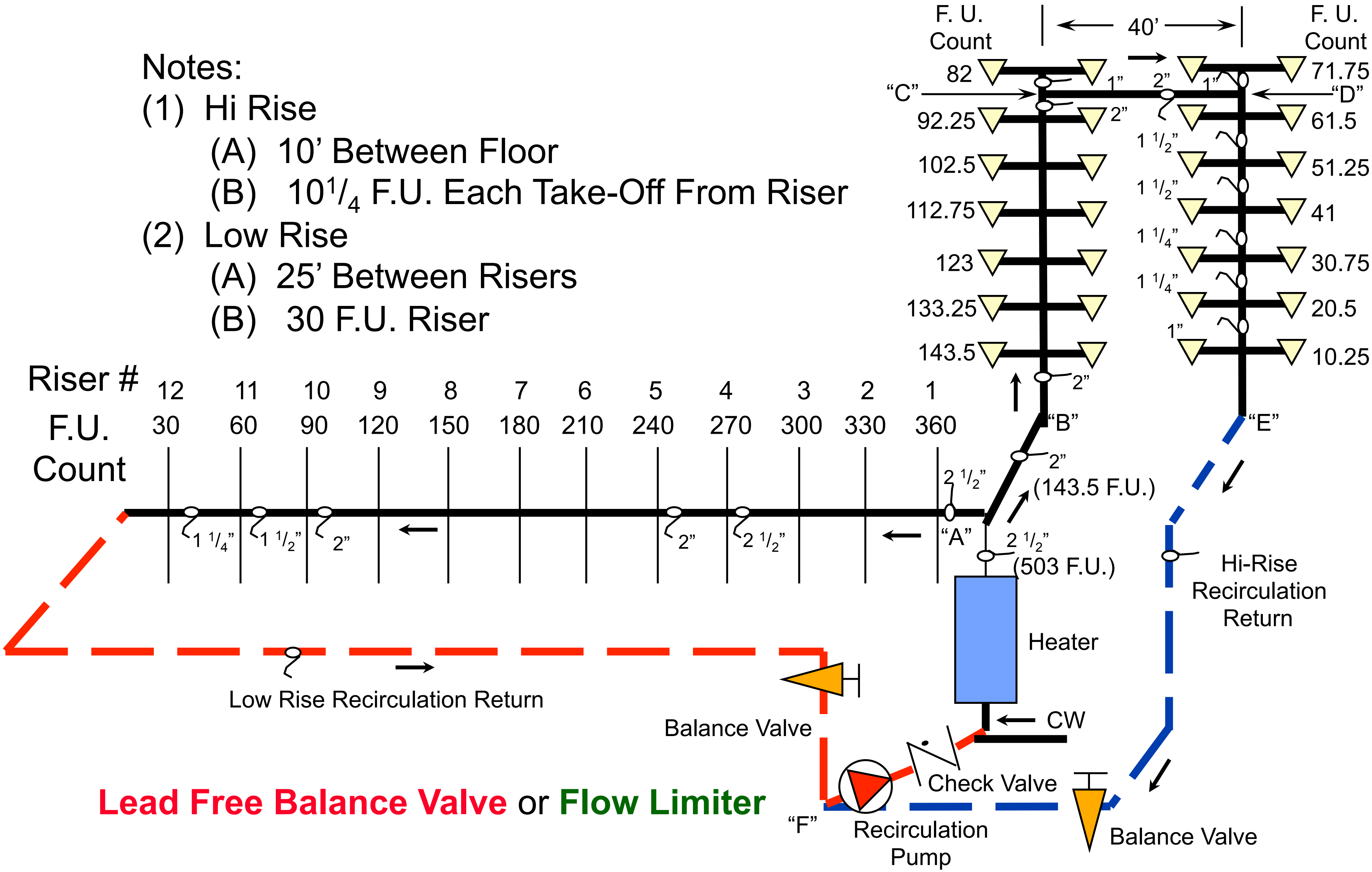
You must balance

Lead Free Balance Valve

Notes:

(1) Hi Rise
 (A) 10’ Between Floor
 (B) $10^1/_4$ F.U. Each Take-Off From Riser

(2) Low Rise
 (A) 25’ Between Risers
 (B) 30 F.U. Riser



Lead Free Balance Valve or **Flow Limiter**

Multi-Circuited Recirculation Main Example

Step 1. Determine Recir. Flow Rate:

Low-rise supply main is 300 ft.

As before, at 10 deg delta T

9320/5000 = 1.8 gpm

High-rise supply main is 220 ft.

6000/5000 = 1.3 gpm

Step 2. Size the Recirculation Lines

Low-rise: 3/4” for 1.9 gpm at 1.4ft/100 ft

High-rise: 1/2” for 1.3 gpm at 4.4ft/100 ft

Step 3: Determine Pump Head:

Low-rise return line 300 ft.
Pipe head loss = 300 x 1.4/100 = 4.2 ft
Check valve = 1.0 ft
Total head loss = 5.2 ft

Highest return line 70 ft.
Pipe head loss = 70 x 4.4/100 = 3 ft.
Check valve = 1 ft.
Total head loss = 4 ft.

Step 4. Select Recirculation Pump.

For pump serving both circuits, add flows and select the **highest head loss**.

Flow: 1.8 + 1.3 = 3.1 gpm

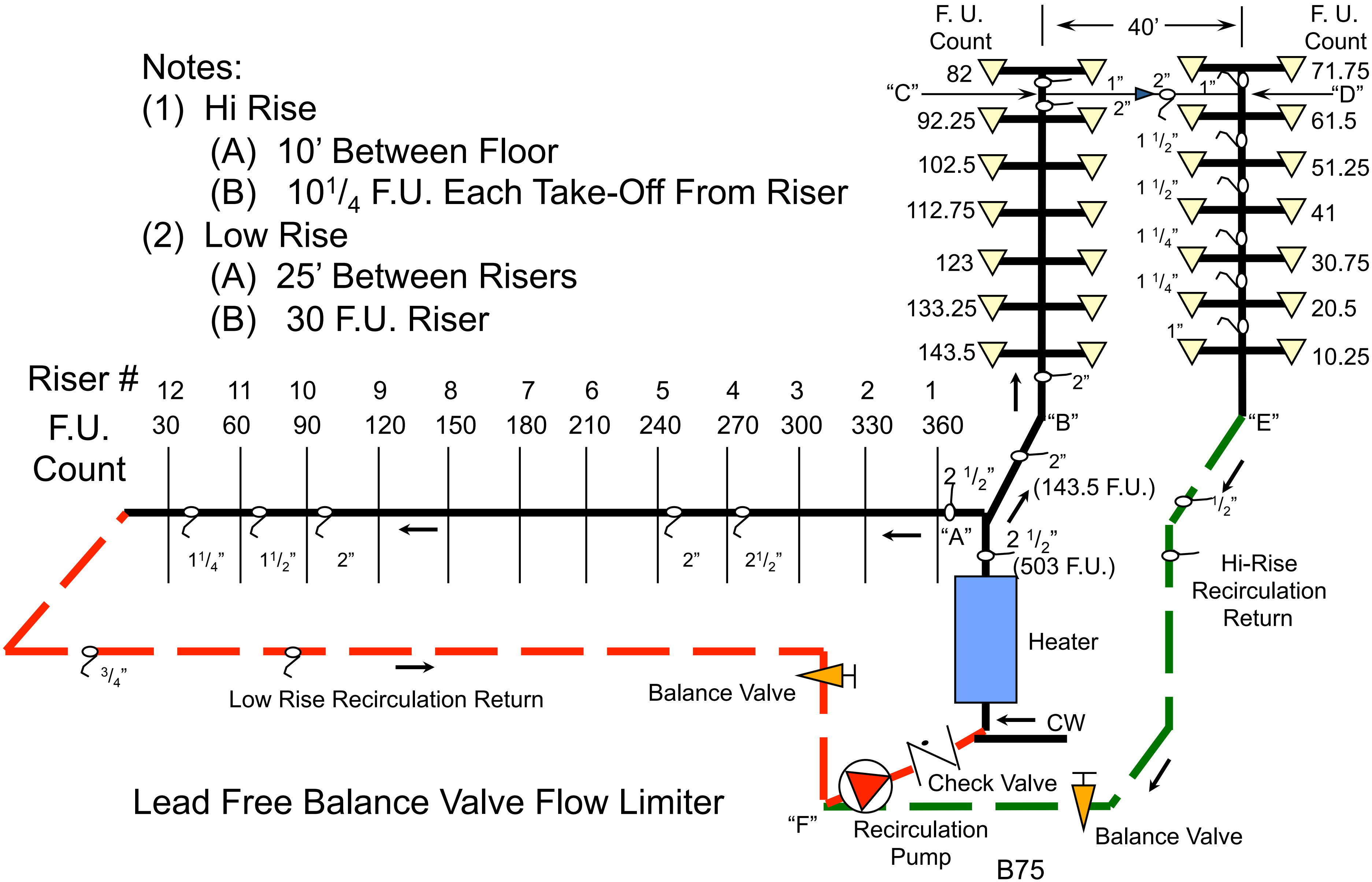
Head: Highest at 5.2 ft.

Pump capacity: 3.1 gpm @ 5.2 ft.

Notes:

(1) Hi Rise
- (A) 10' Between Floor
- (B) $10^{1}/_{4}$ F.U. Each Take-Off From Riser

(2) Low Rise
- (A) 25' Between Risers
- (B) 30 F.U. Riser



Lead Free Balance Valve Flow Limiter

Recirculation Line Sizing and Pump Selection

Even though the return line is 70 ft, the supply line is 220 ft. Based on head loss a 1/2” return line was selected. However, since the supply line is 220 ft, we **recommend a 3/4” return line** be used.

Notes:

(1) Hi Rise

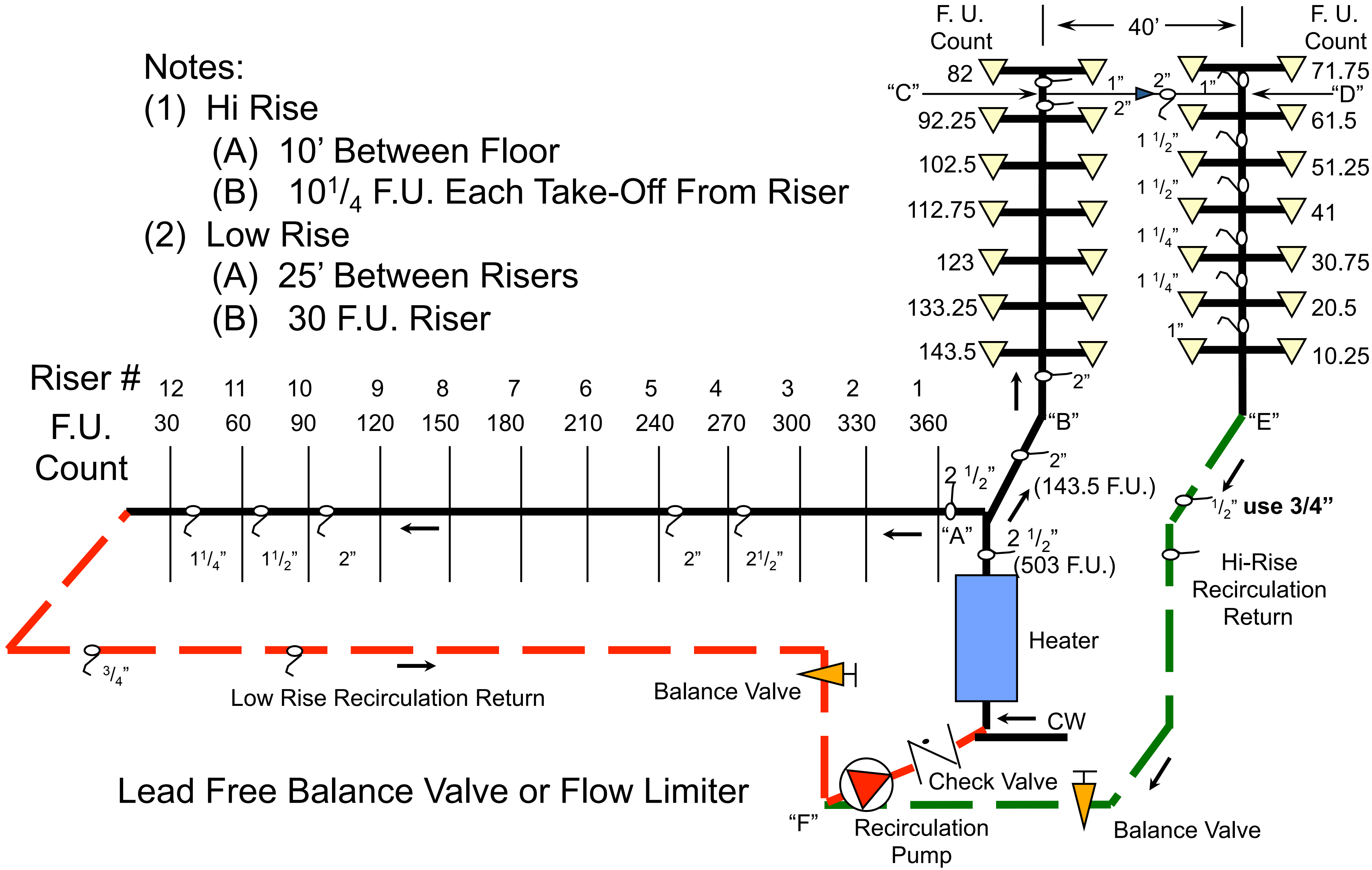
  (A) 10’ Between Floor

  (B) $10^{1}/_{4}$ F.U. Each Take-Off From Riser

(2) Low Rise

  (A) 25’ Between Risers

  (B) 30 F.U. Riser



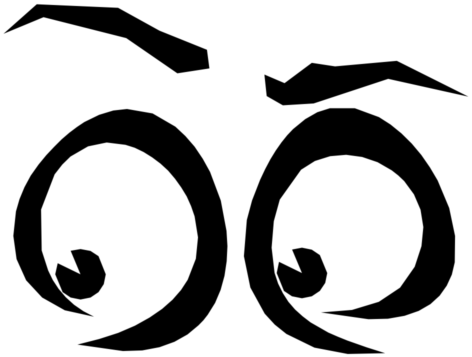
Lead Free Balance Valve or Flow Limiter

Recirculation Line Sizing and Pump Selection

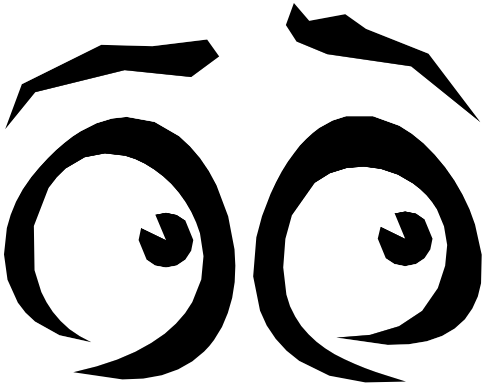
Two observations:

1. Many of the recirculation problems we have seen are on **multi-circuited recirculation** systems. A main HW loop and loops to remote showers or lavatories. These must be **balanced** if hot water is to ever **get to these fixtures**.

2. Do not use a 1/2” return line on any system of any size. A **minimum 3/4” return line size** will eliminate many problems.



Watch out for unbalanced riser flows



You must balance

Lead Free Balance Valve

8 Story Hotel

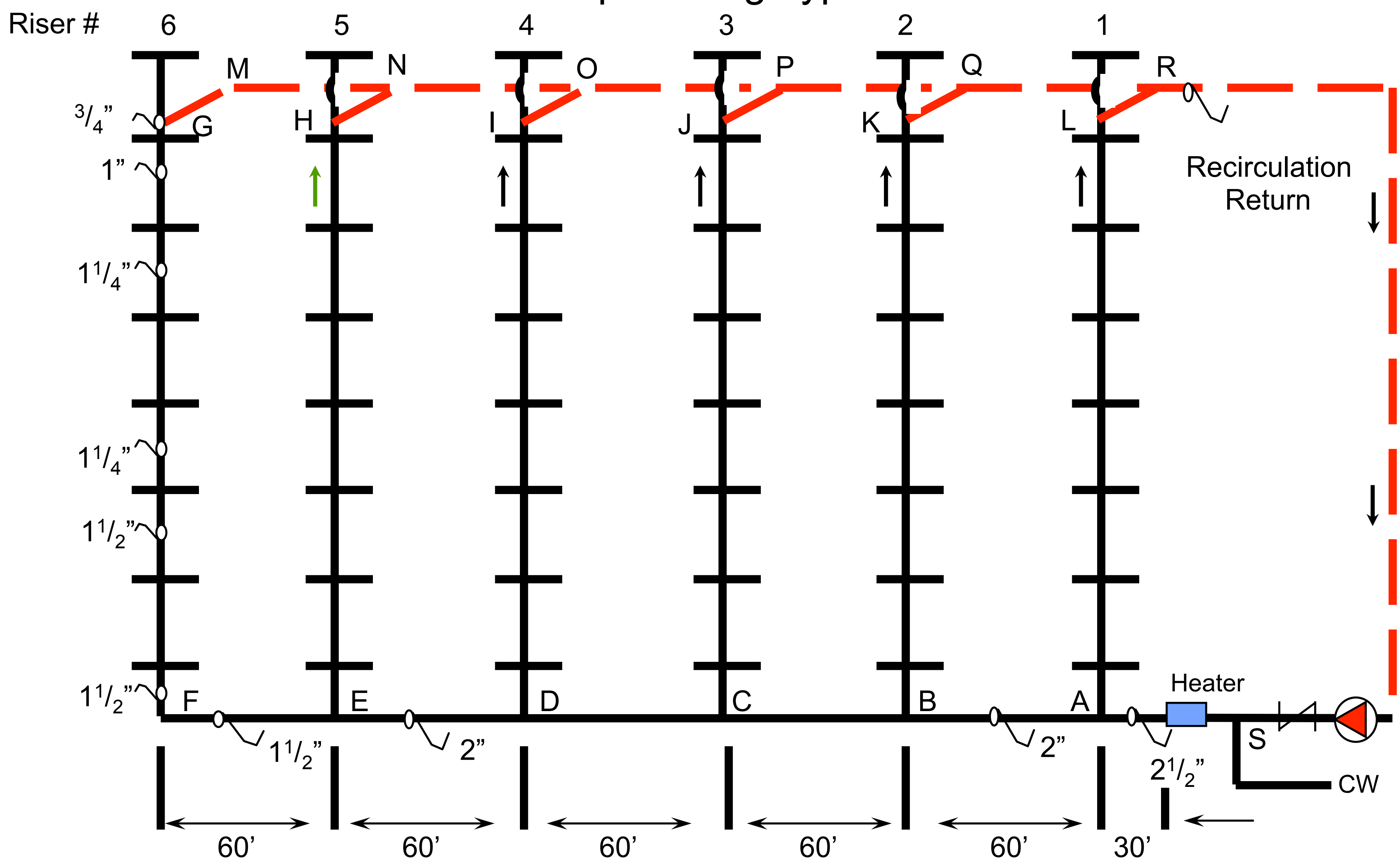
Alcoa, TN

Worlds Fair

(**No Balance Valves**) Startup Problems

Which is the Free Hotel Room?

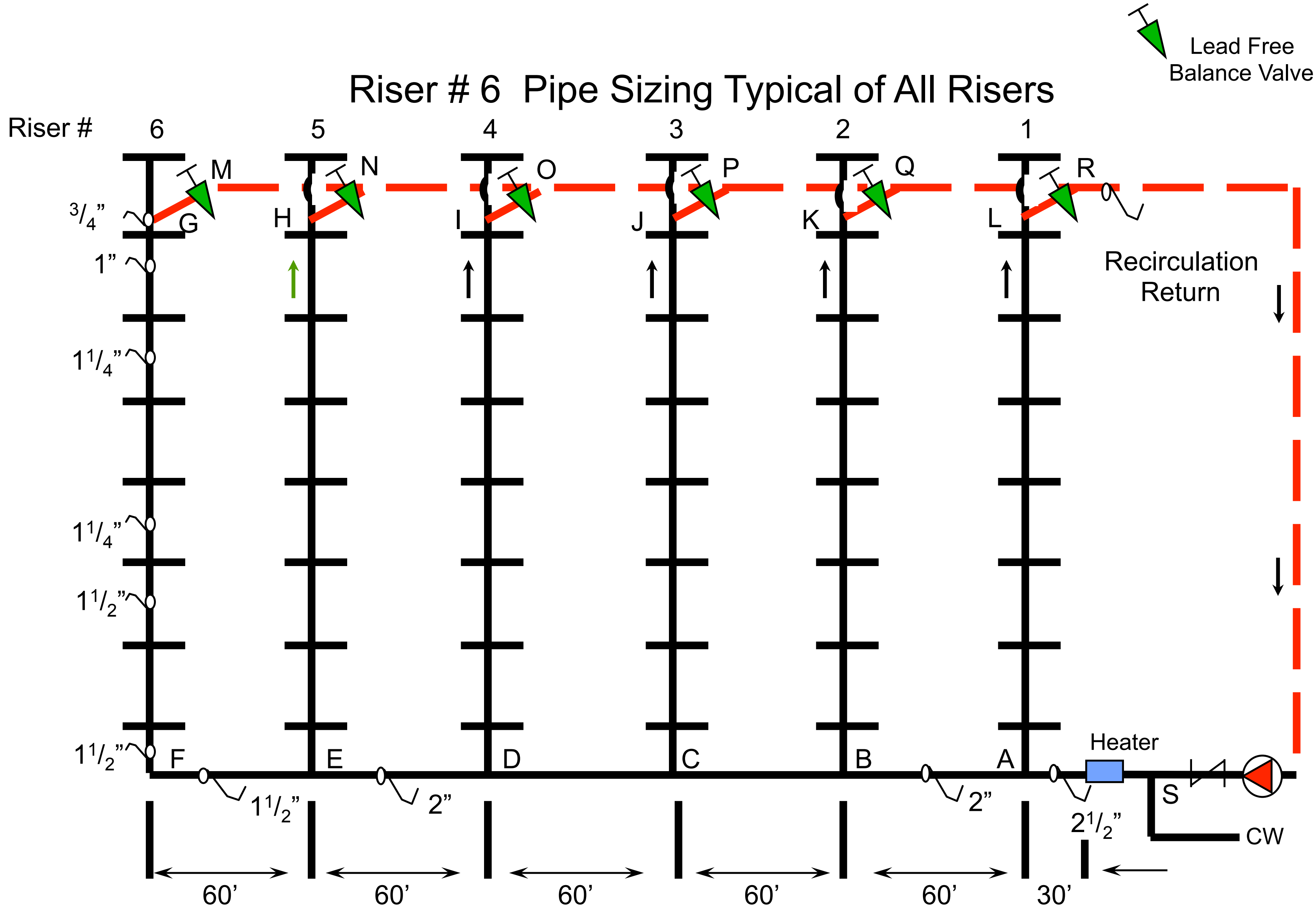
Riser # 6 Pipe Sizing Typical of All Risers



Balance

Multiple Riser Recirculation Example

Riser # 6 Pipe Sizing Typical of All Risers



Balance

Multiple Riser Recirculation Example

Use **Lead Free balance valve to balance** and control water flow in risers and/or distribution loops.

Use **flow limiter devices to balance** and control water flow in risers and/ or distribution loops.

Use **Thermal Setters (fixed or adjustable temperature) devices to balance** and control water flow in risers and/or distribution loops.

Lead Free AB1953

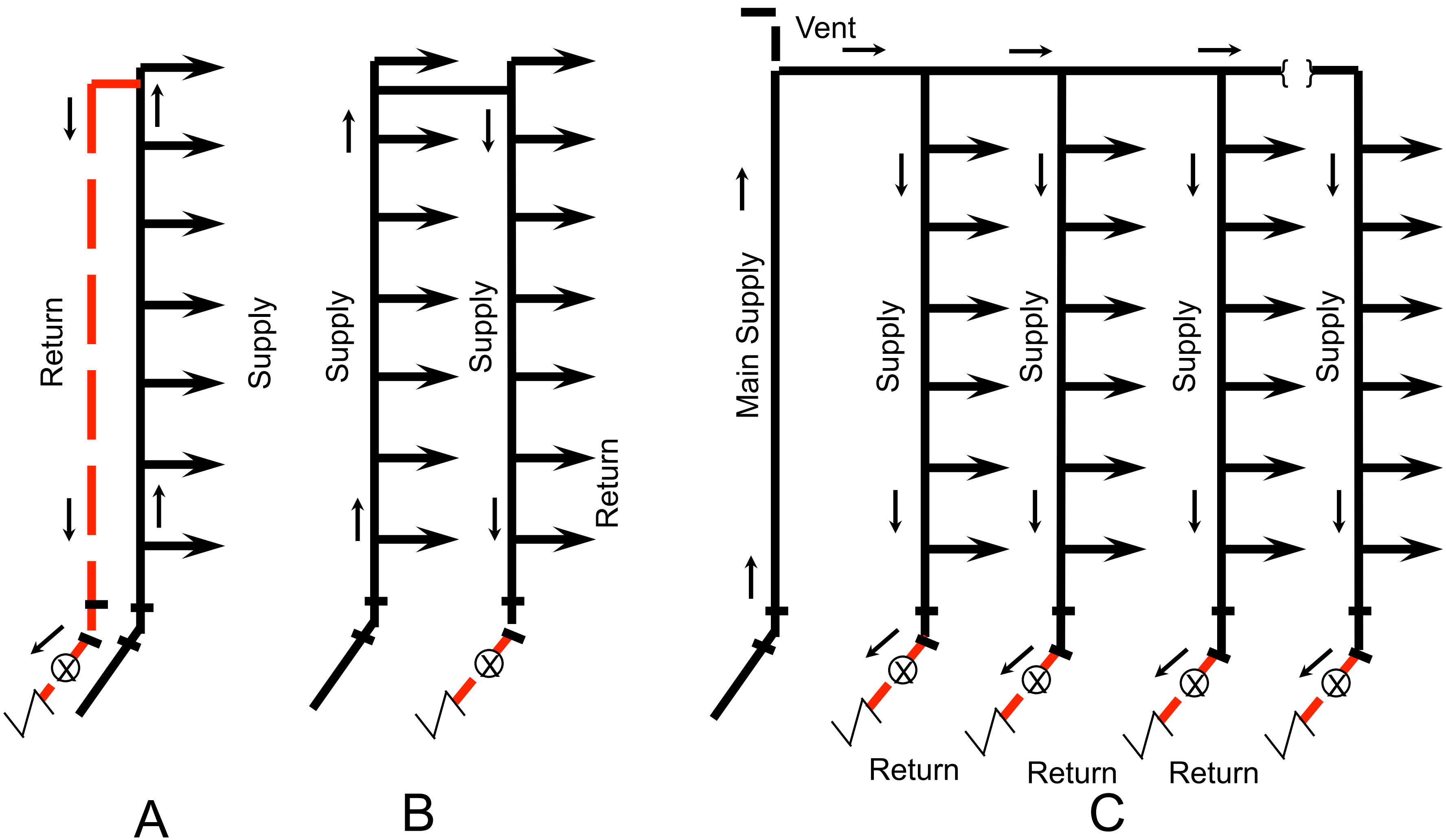
(California Assembly Bill 1953)

This bill would, commencing on January 1, 2010, revise this prohibition to apply to any pipe or plumbing fitting, or fixture intended to convey or dispense water for human consumption, but would exclude from this prohibition specified devices.

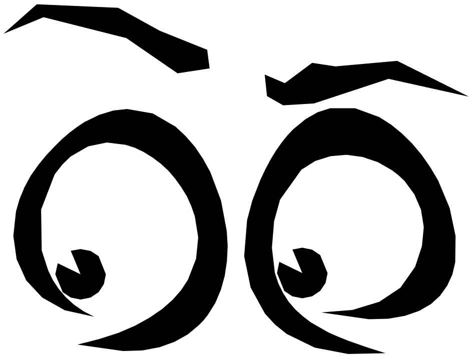
Existing law defines lead free as not more than 8% lead when used with respect to pipes and fittings and not more than 4% by dry weight with respect to plumbing fittings and fixtures.

This bill would, commencing on January 1, 2010, revise the term “lead free,” for purpose of manufacturing, industrial processing, and conveying or dispensing water for human consumption, to refer not to the lead content of pipes and pipe fittings, plumbing fittings, and fixtures but to a weighted average lead content of the wetted surface area of the pipes, fittings, and fixtures of not more than 0.25%, to be determined pursuant to a prescribed formula.

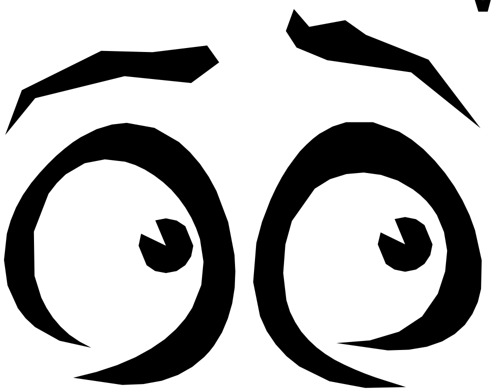
(Standard NSF-61 Annex G)



Arrangements of Hot Water Circulation Lines



Watch out for recirculation with reducing valves



Never recircuit across a pressure reducing valve

High Rise Hotel

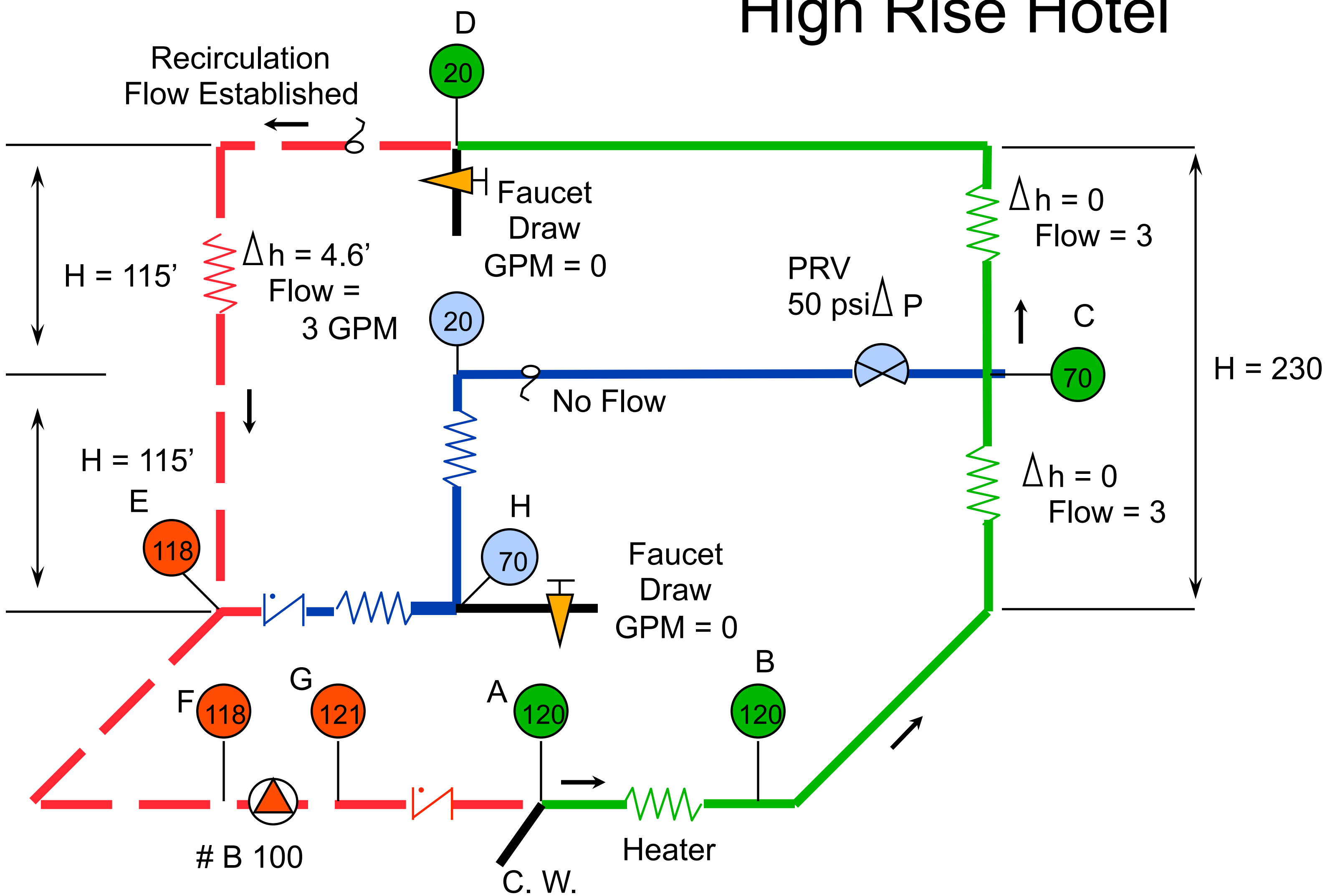
Knoxville, TN

Worlds Fair

(**Circulating across PRV**) Startup Problems

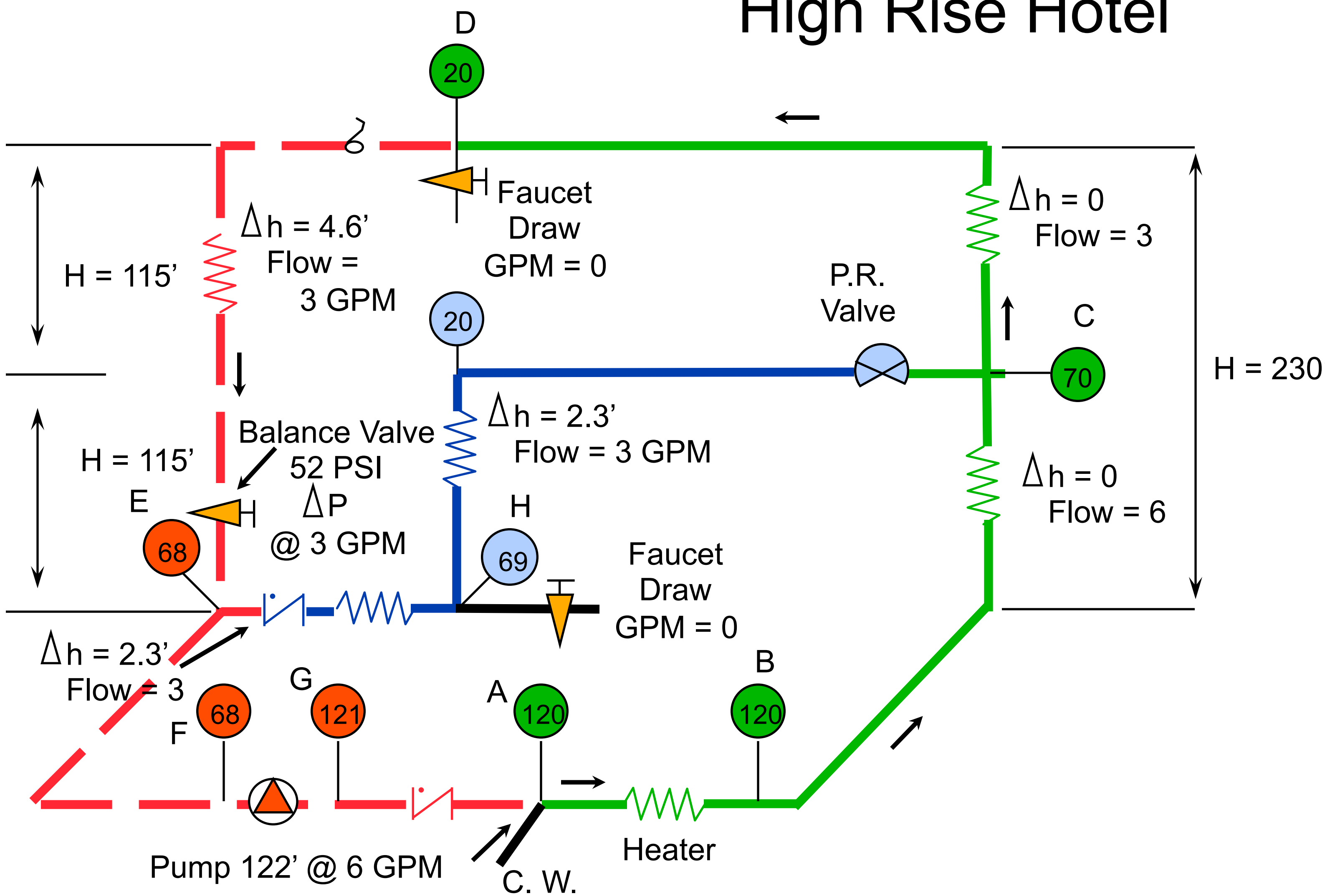
Which is the Free Hotel Room?

High Rise Hotel



Building Gauge Pressures When Recirculation Pump Operates

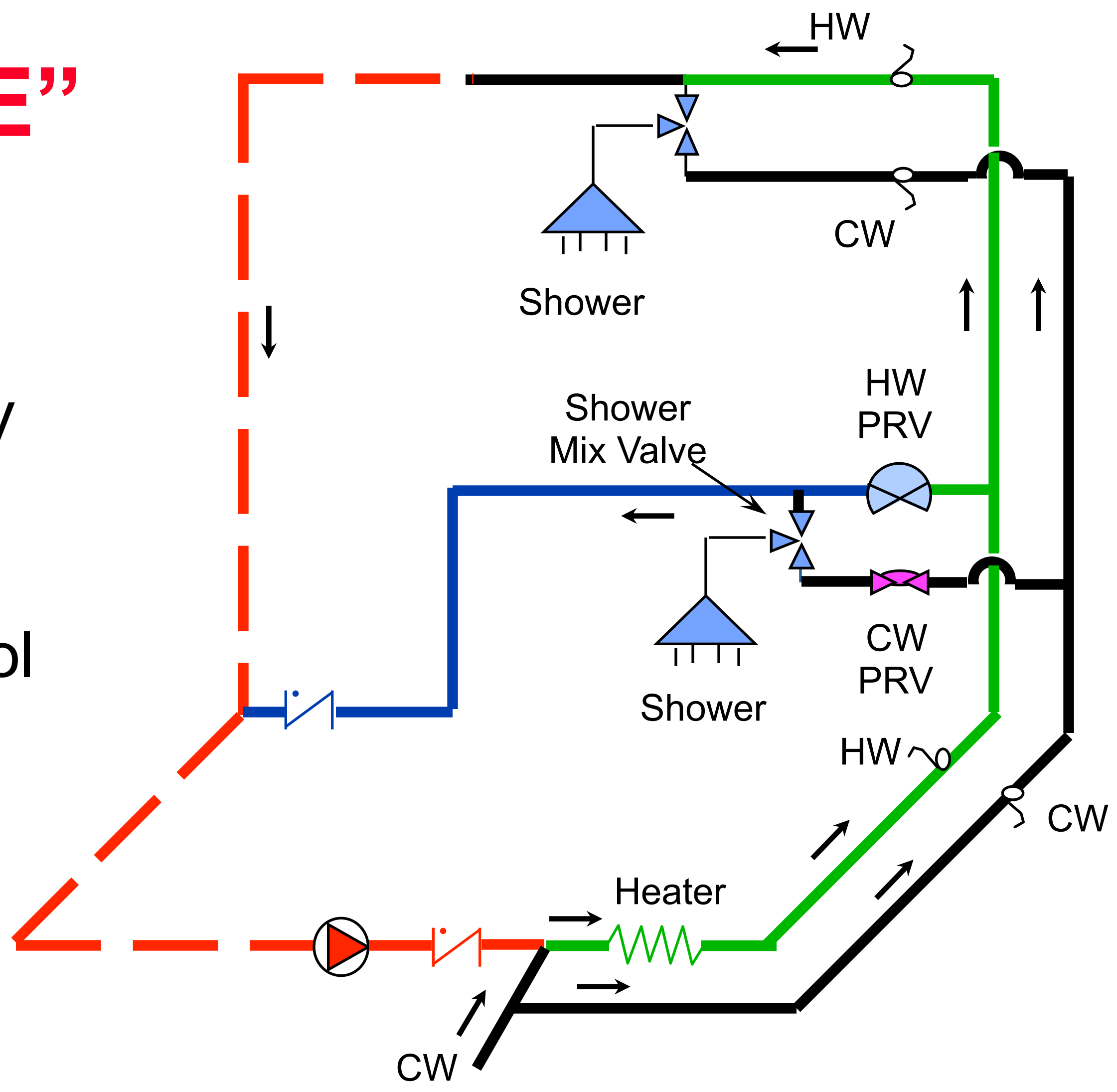
High Rise Hotel



Larger Pump May or May Not Solve Recirculation Problem

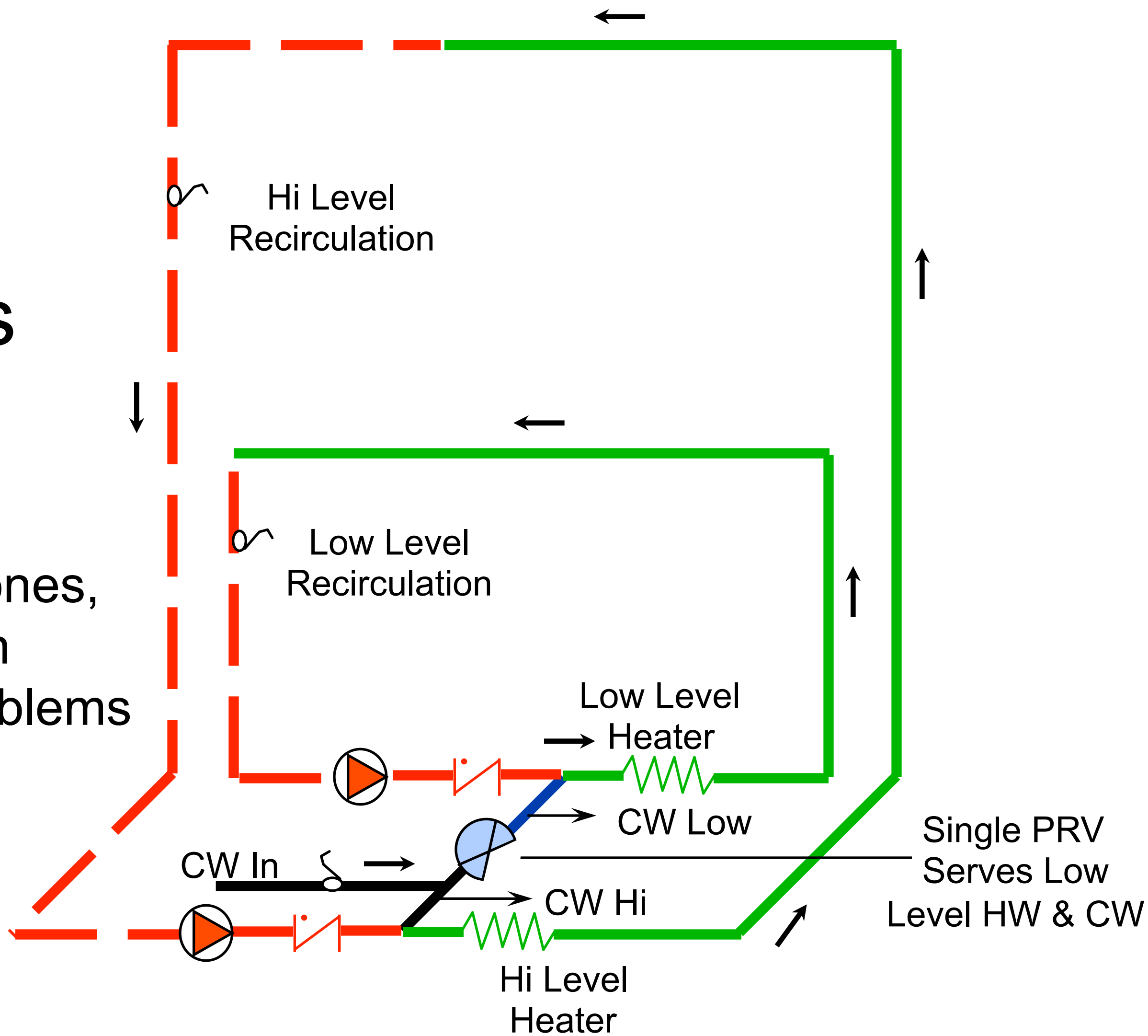
"TROUBLE"

HW & CW PRV
Used For
Lower Level
Pressure Control



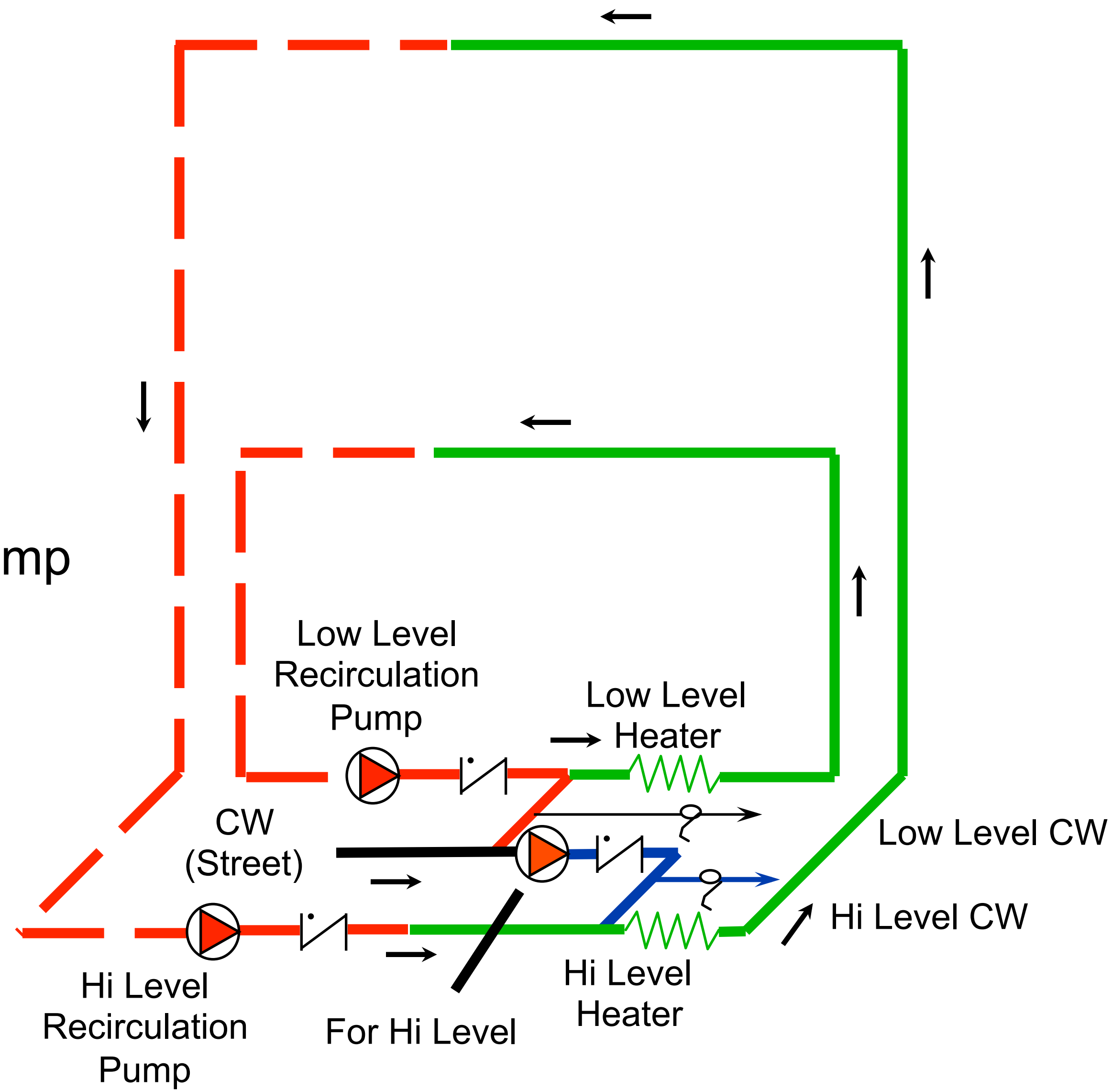
Two Heaters

Separate Pressure Zones,
Each With Its Own
HW Heater, Solves Problems

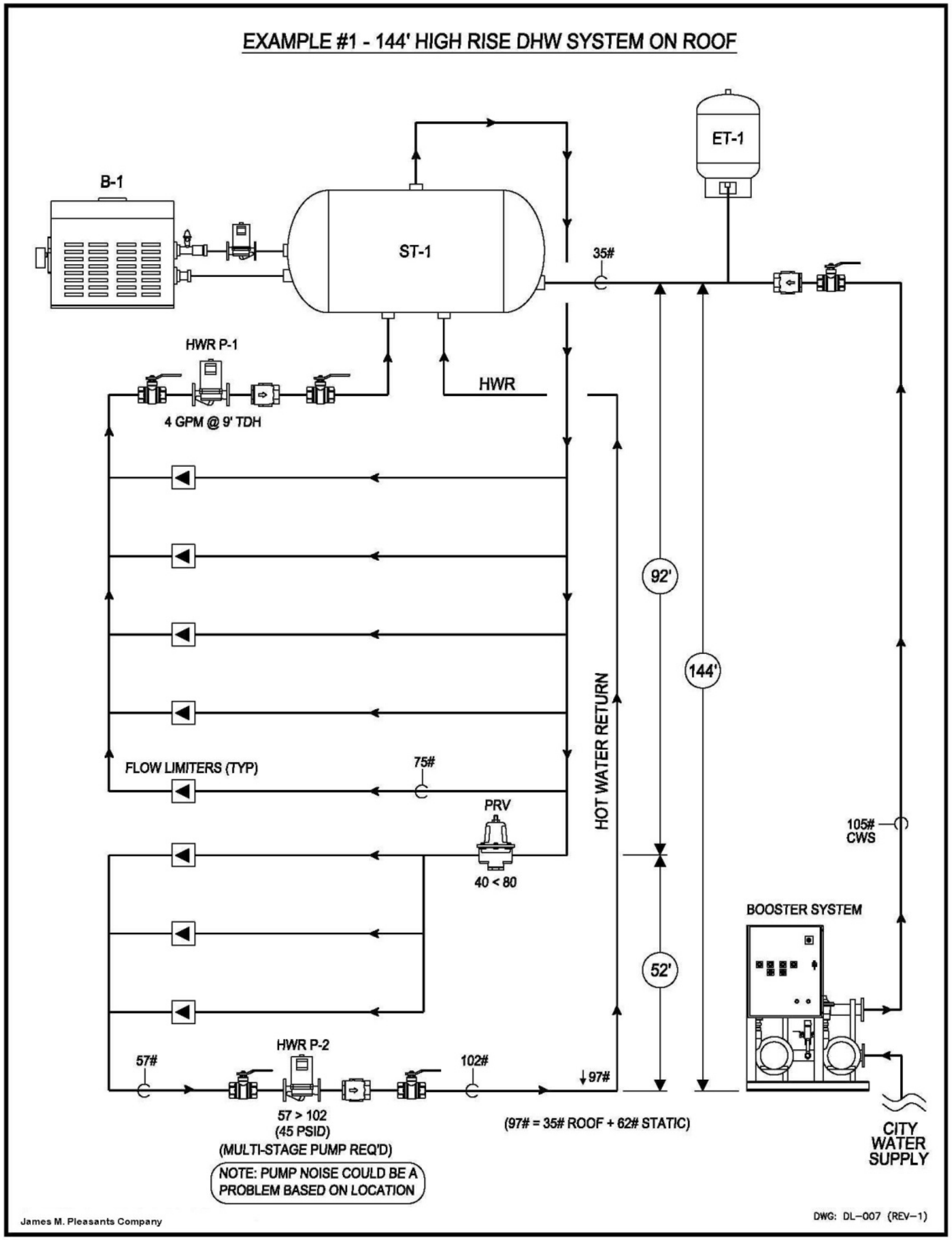


"A Good Solution"

Pressure Zones
Provided by
Street Pressure
and
Pressure Booster Pump



"A Good Solution"

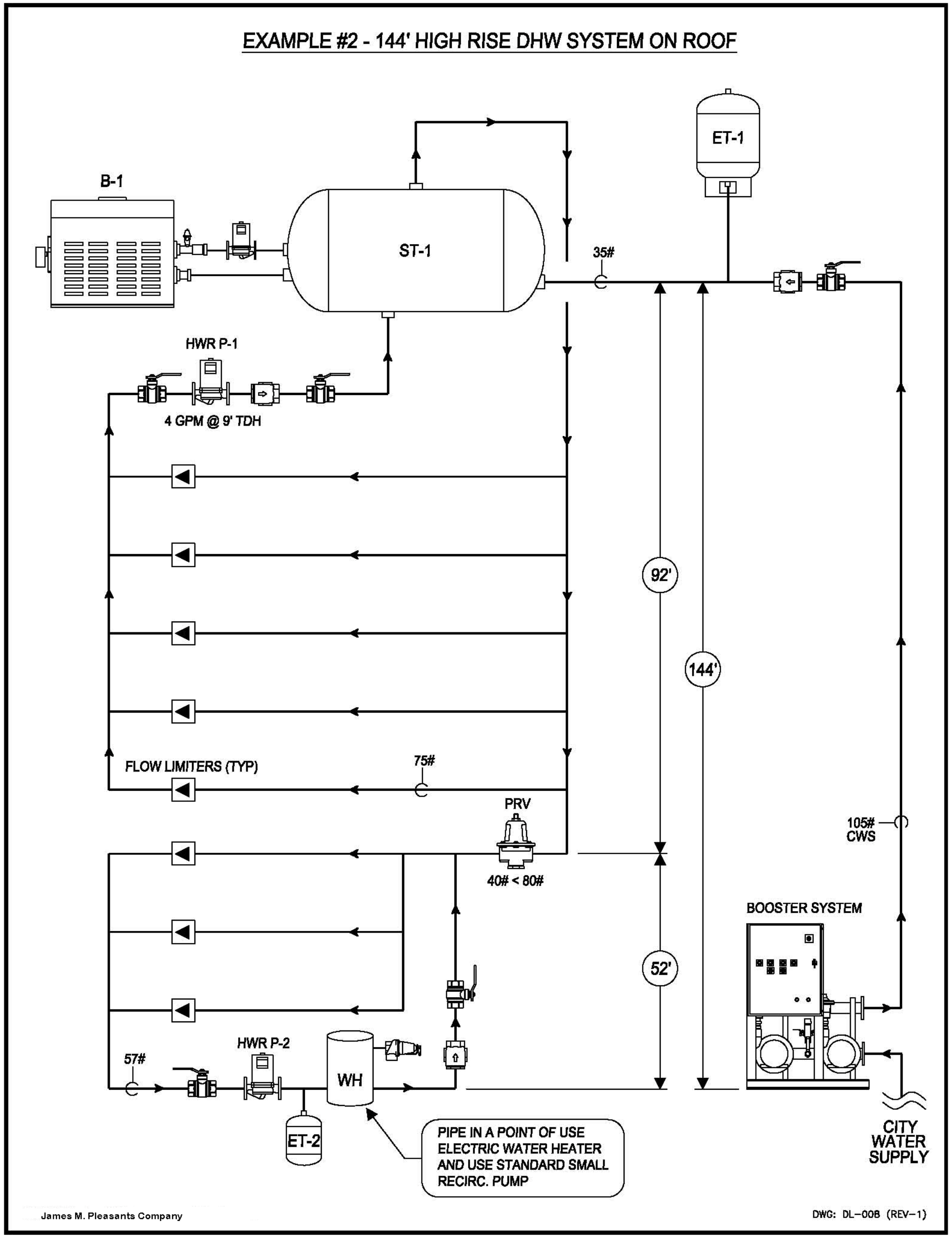


OPTION 1 - HOT WATER CIRCULATION IN HIGH RISE

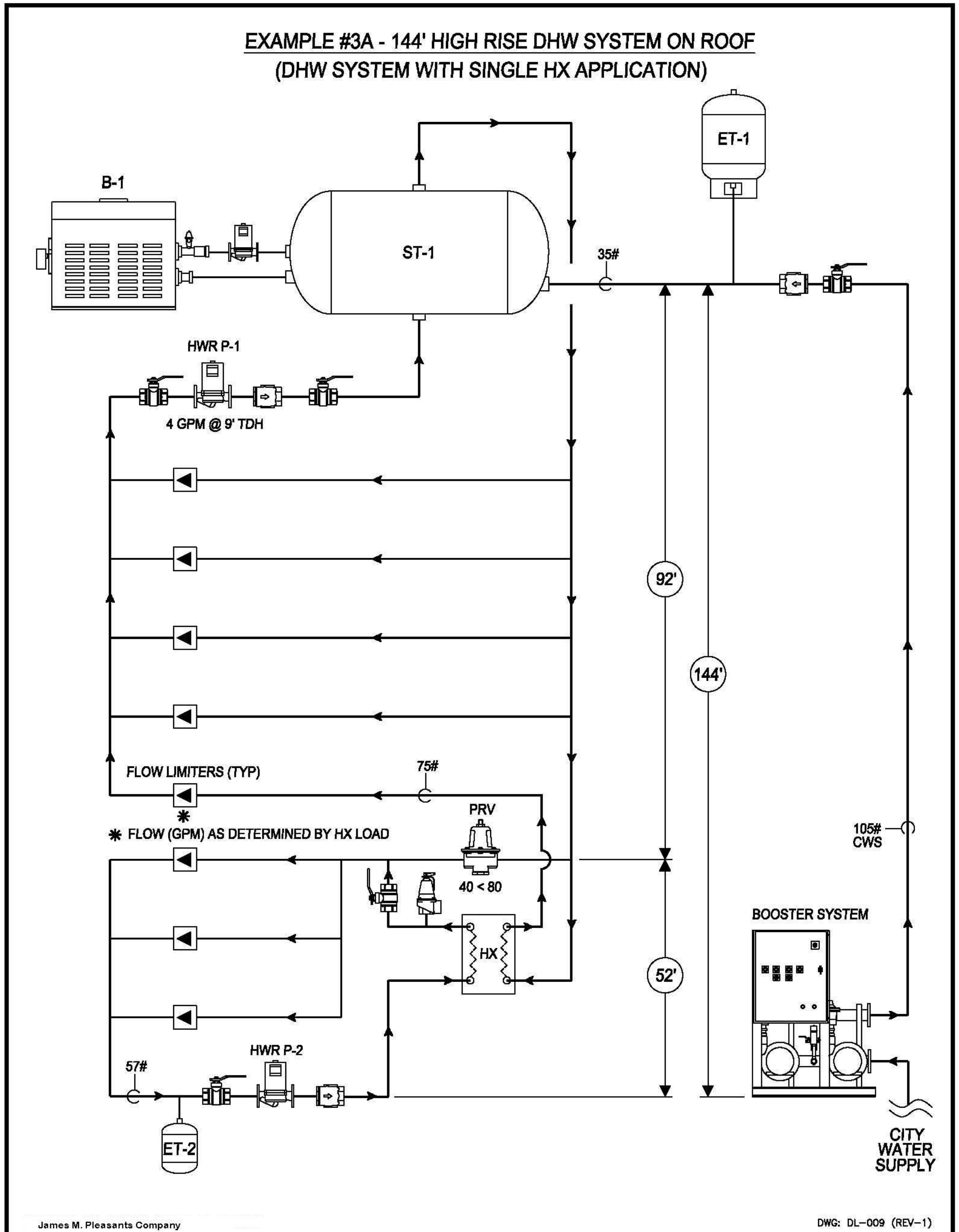
“Vue” Condos

Charlotte, NC

(60 Stories Plus)

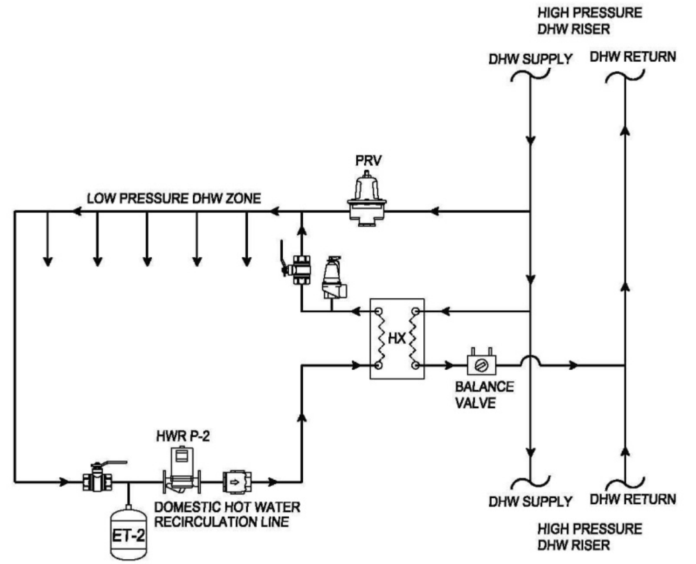


OPTION 2 - HOT WATER CIRCULATION IN HIGH RISE



OPTION 3A - HOT WATER CIRCULATION IN HIGH RISE

EXAMPLE #3B - HIGH RISE DHW RECIRCULATION
(HIGH PRESSURE DHW RISER WITH MULTIPLE HEAT EXCHANGERS)



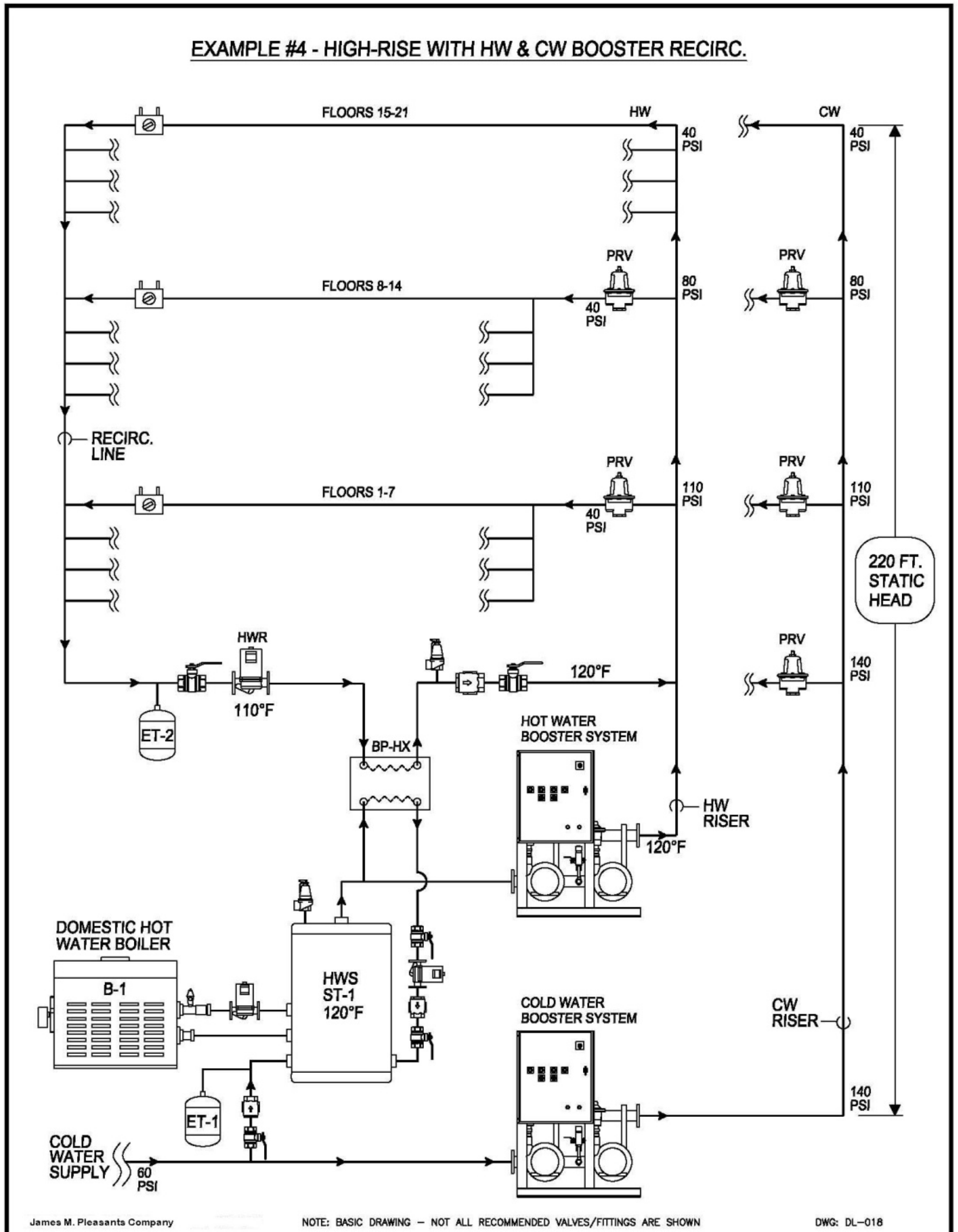
- PLUMBING APPLICATION -

- RECIRCULATION WITHIN LOW PRESURE ZONE USING STAINLESS STEEL BRAZED PLATE HEAT EXCHANGER
- ELIMINATES NEED FOR HIGH PRESSURE/HIGH HEAD RETURN PUMP.
- SERVICE/ISOLATION, CHECK VALVES RECOMMENDED AT PUMP & HEAT EXCHANGER.
- HEAT EXCHANGER RELIEF VALVE & THERMAL EXPANSION TANK AS REQUIRED PER LOCAL CODES.

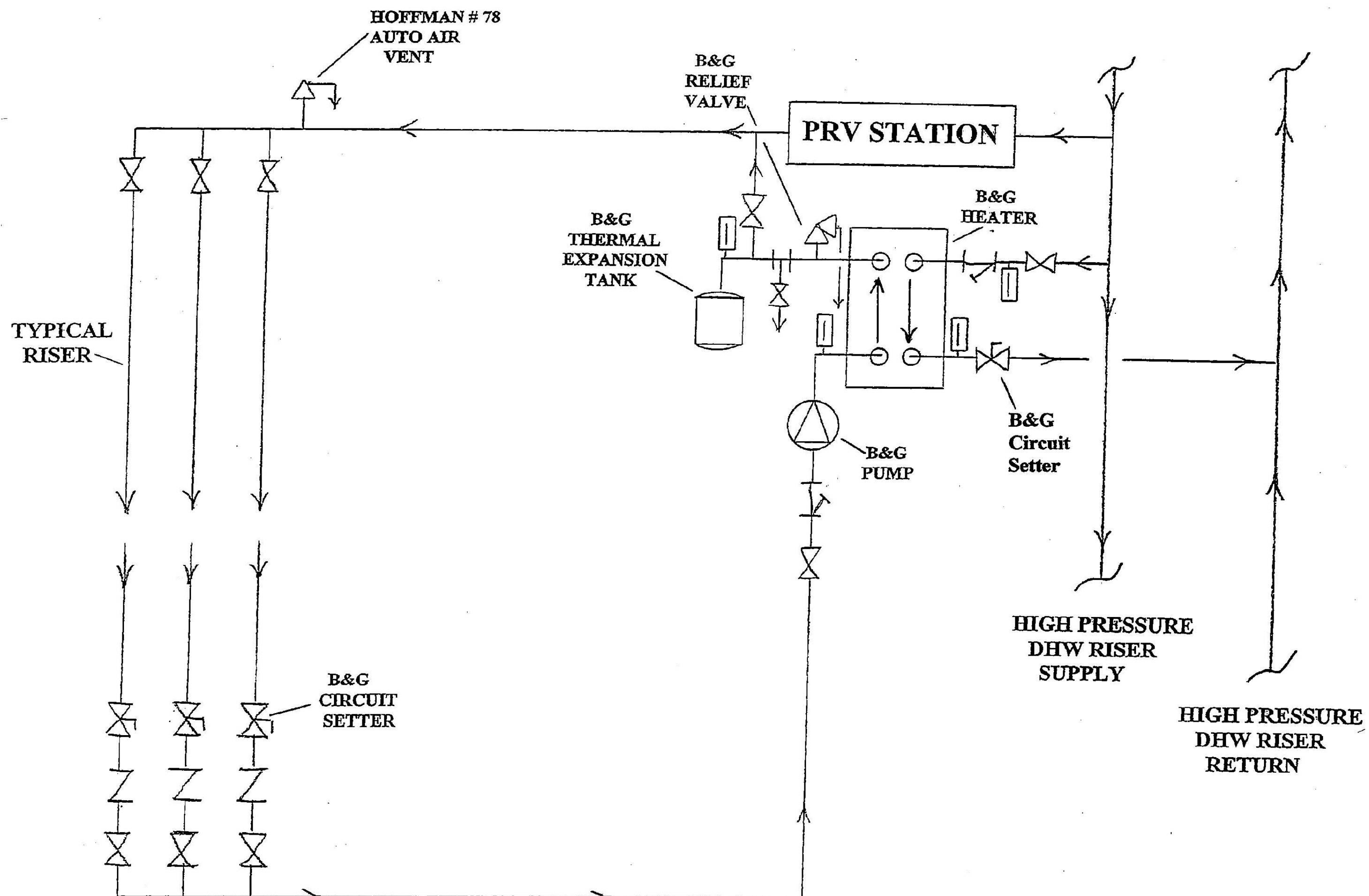
James M. Pleasants Company

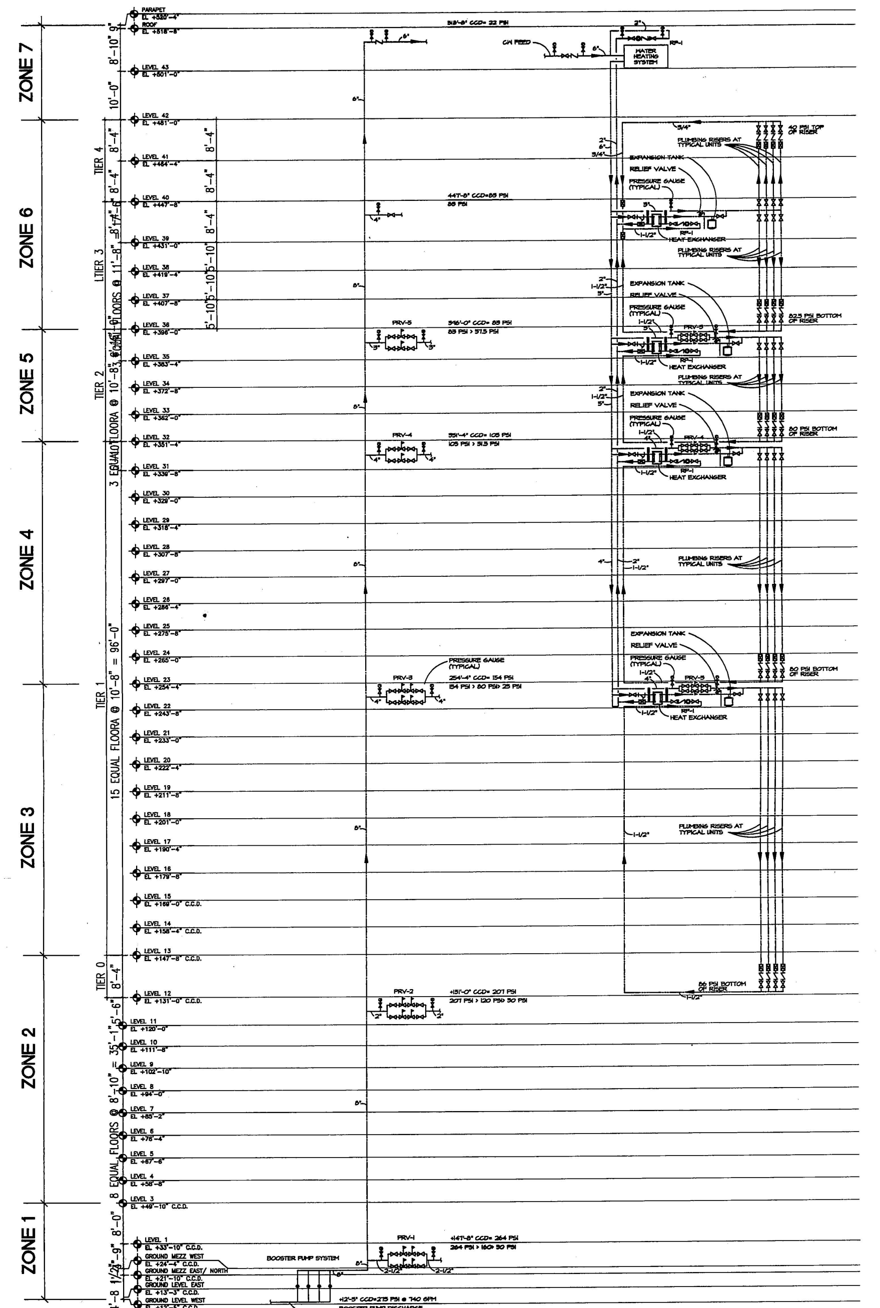
DWG: DL-017 (REV-A)

OPTION 3B - HOT WATER CIRCULATION IN HIGH RISE



OPTION 4 - HOT & COLD WATER CIRCULATION IN HIGH-RISE

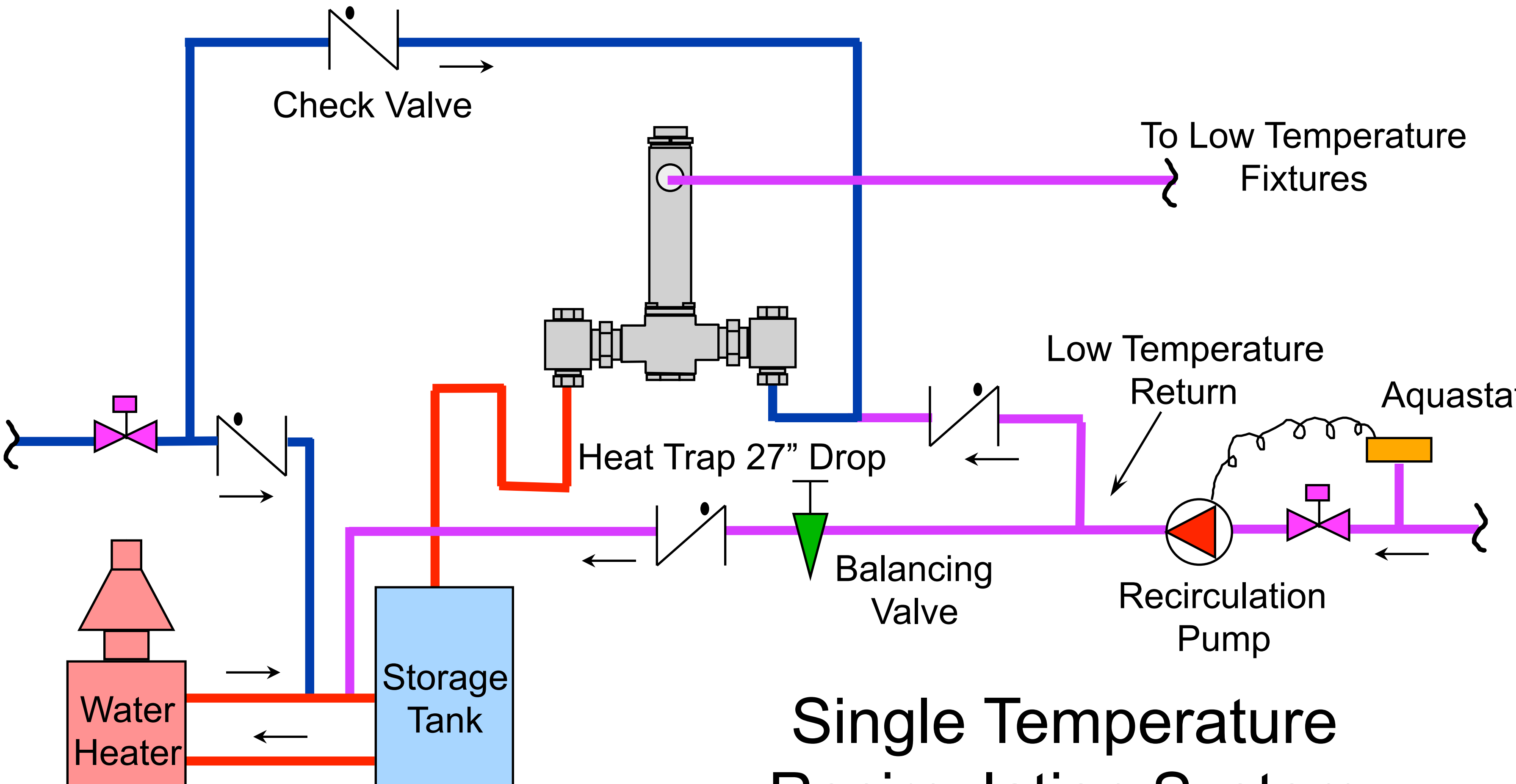

HOFFMAN # 78
AUTO AIR
VENT
B&G
RELIEF
VALVE
PRV STATION
B&G
HEATER
B&G
THERMAL
EXPANSION
TANK
TYPICAL
RISER
B&G
PUMP
B&G
Circuit
Setter
HIGH PRESSURE
DHW RISER
SUPPLY
HIGH PRESSURE
DHW RISER
RETURN
B&G
CIRCUIT
SETTER



SCHEMATIC-COLD WATER RISER SYSTEM

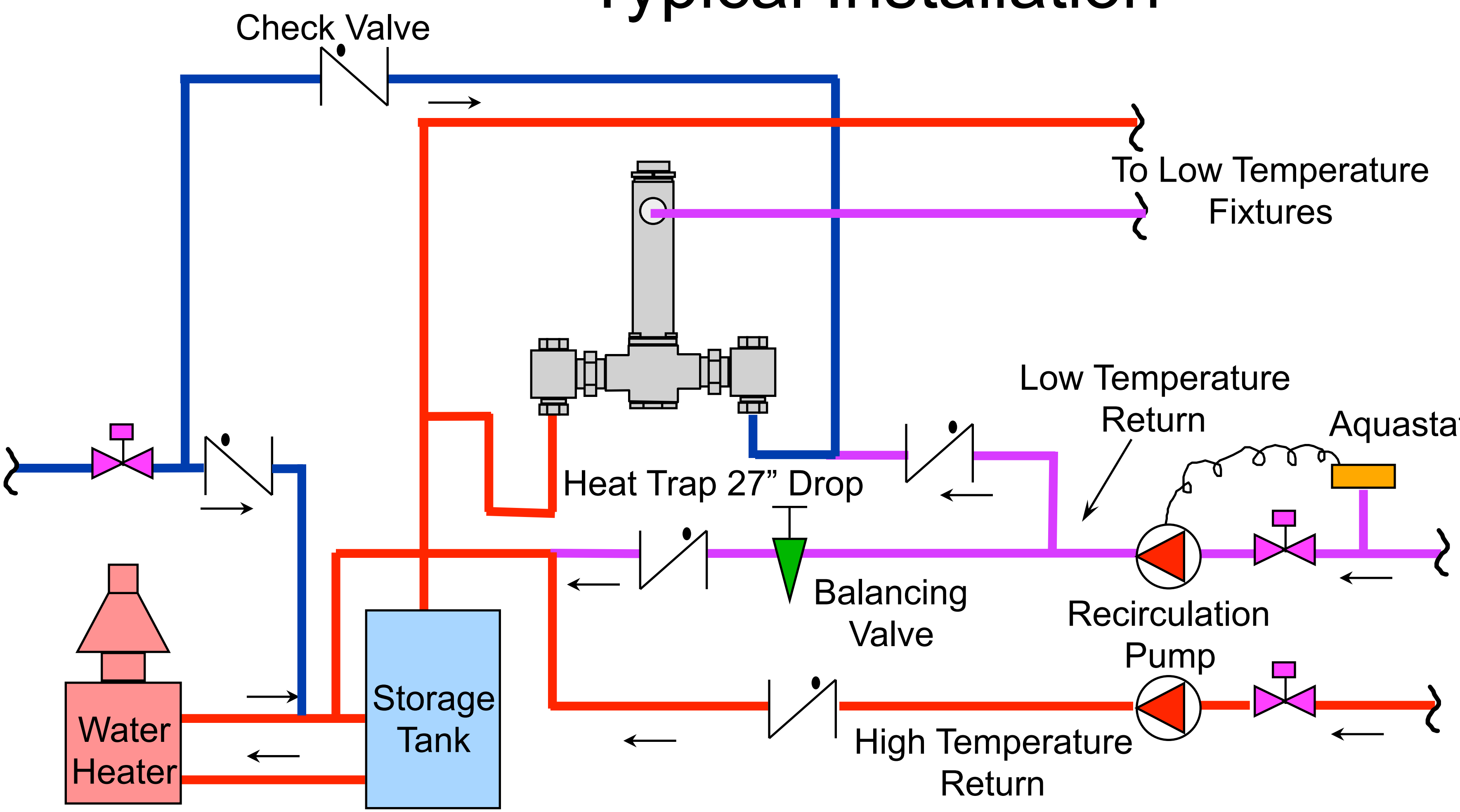
SCHEMATIC-HOT WATER RISER SYSTEM

Typical Installation



Single Temperature Recirculation System

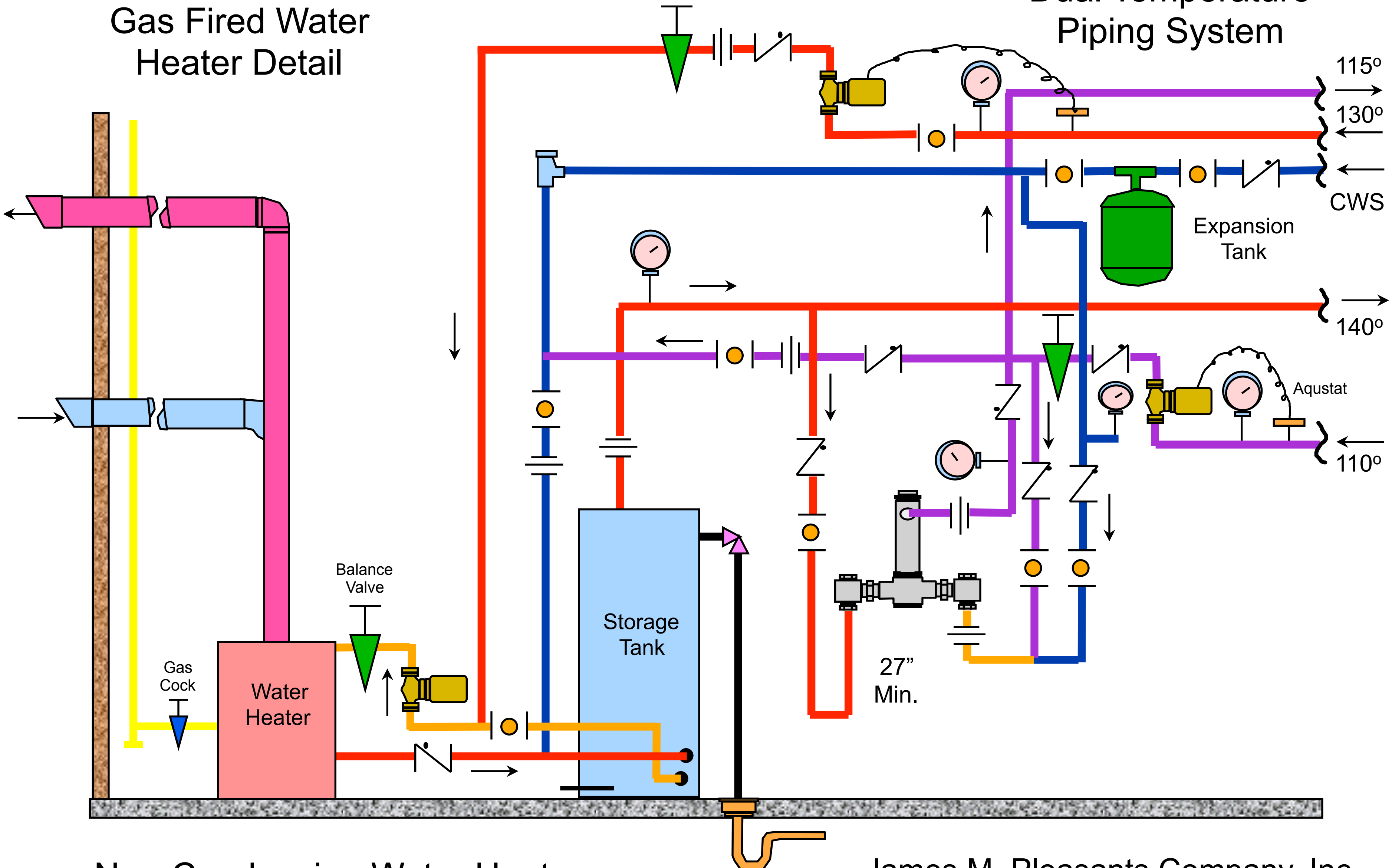
Typical Installation



Dual Temperature Recirculation System

Gas Fired Water Heater Detail

Dual Temperature Piping System



Non-Condensing Water Heater

Approved by GBCI for 1 CE Hour

Course Approval Number is 0090007847

Variable Speed Pressure Boosting

James M. Pleasants Company

www.jmpco.com

Variable Speed Pressure Boosting

Learning Objectives

In this seminar you will learn too:

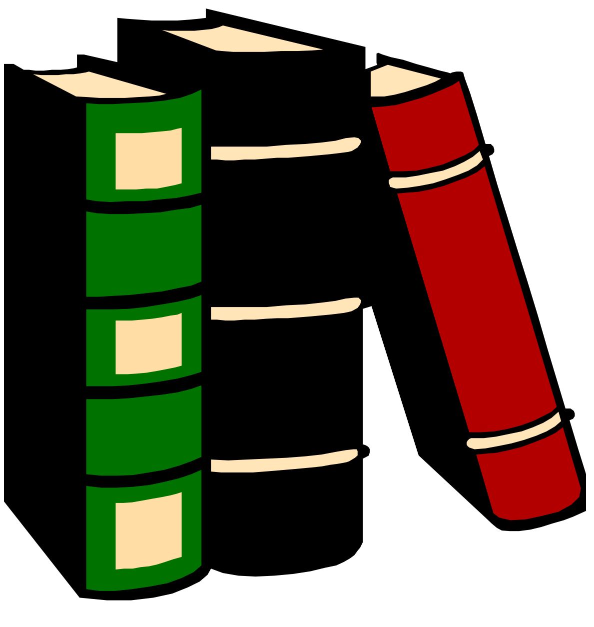
1. Identify different methods buildings were supplied domestic water.
2. Utilize a domestic water pressure booster selection procedure to calculate the required flow and pressure.
3. Properly size and locate a hyrdo-pneumatic tank.
4. To compare the advantages of variable speed versus constant speed pressure boosting.
5. Understand the new pressure booster requirements listed in ASHRAE 90.1 and DOE Building code 2013.

Outline of Presentation

- Historical Review
- System Design Example
- Required System Flow and Pressure
- Pressure Booster Selection Procedure
- Hydro-Pneumatic Tanks
- Variable vs. Constant Speed
- ASHRAE 90.1 and DOE Building Code 2013

Historical

Review



Plumbing Water History Systems

1700 BC - Island of Crete-Minoan Palace had Terra Cotta hot and cold water supply piping and separate sewers constructed of stone.

1491 BC Approx. - Deuteronomy 23:12-14 (New International Version) (The First Latrine)
12 Designate a place outside the camp where you can go to relieve yourself.
13 As part of your equipment have something to dig with,…

700 BC Approx. - “Plumbum” - Latin for “Lead” - which is the origin of the word “Plumbing”.

52 AD - Romans had 220 miles of aqueducts to supply 300 gallons of water for every citizen.

79 AD - The Romans of Pompeii had water closets with a cistern to provide flush water and a separate sewer system. Lead and tile pipe was used for supply water. Public baths had hot water and were heated.

1596 - Sir John Harrington invented a water closet for Queen Elizabeth of England.

1775 - In England Alexander Cummings reinvented Harrington’s water closet.

1836 - In England Thomas Crapper is born. He was a plumber until 1904 and his company operated under the Crapper name until 1966.

1850 - privy - a room equipped with toilet (a private place)

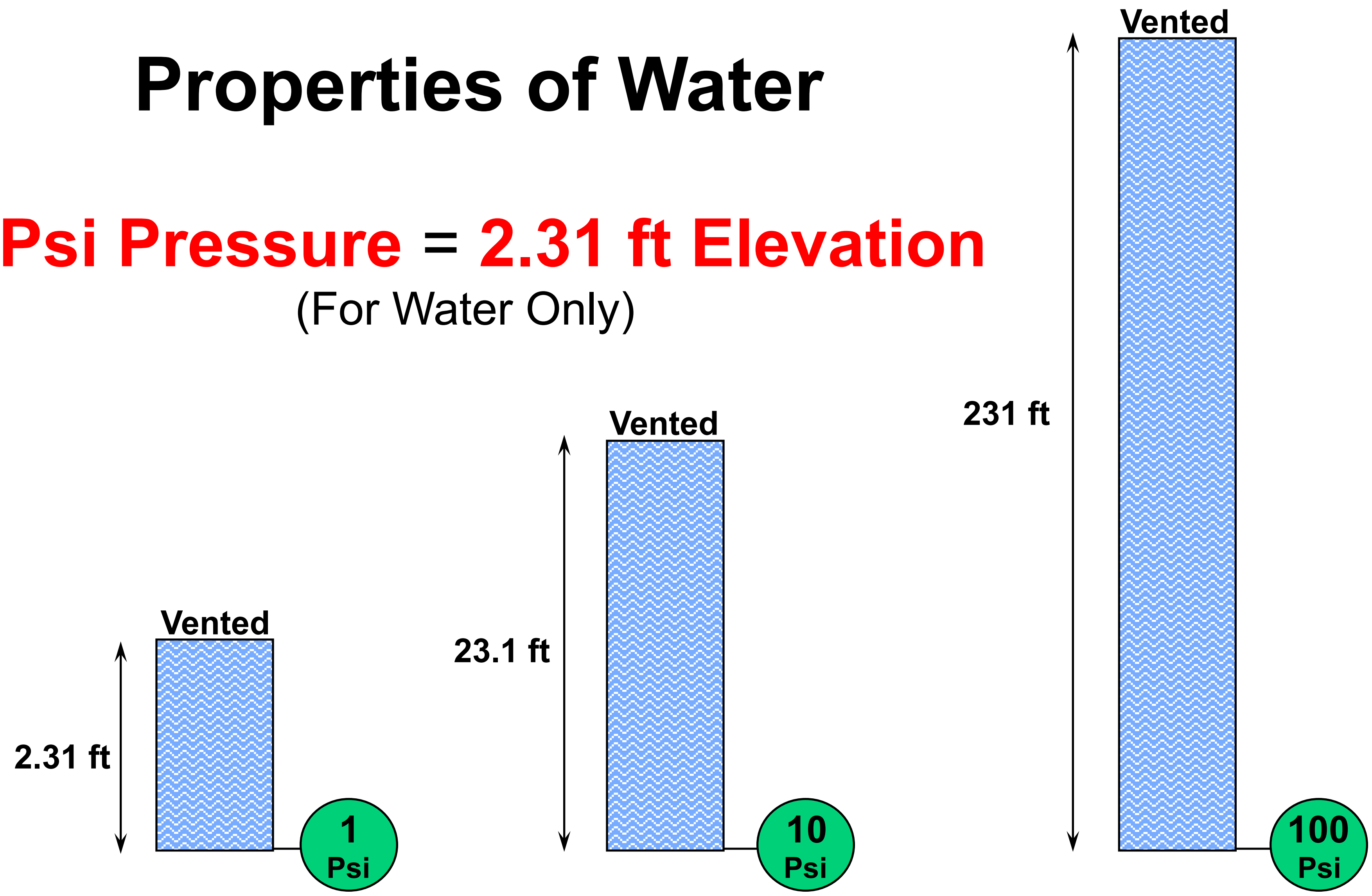
Water covers more than **70%** of the earth's surface.

about
97% is salty water
3% **fresh** water

Properties of Water

1 Psi Pressure = 2.31 ft Elevation

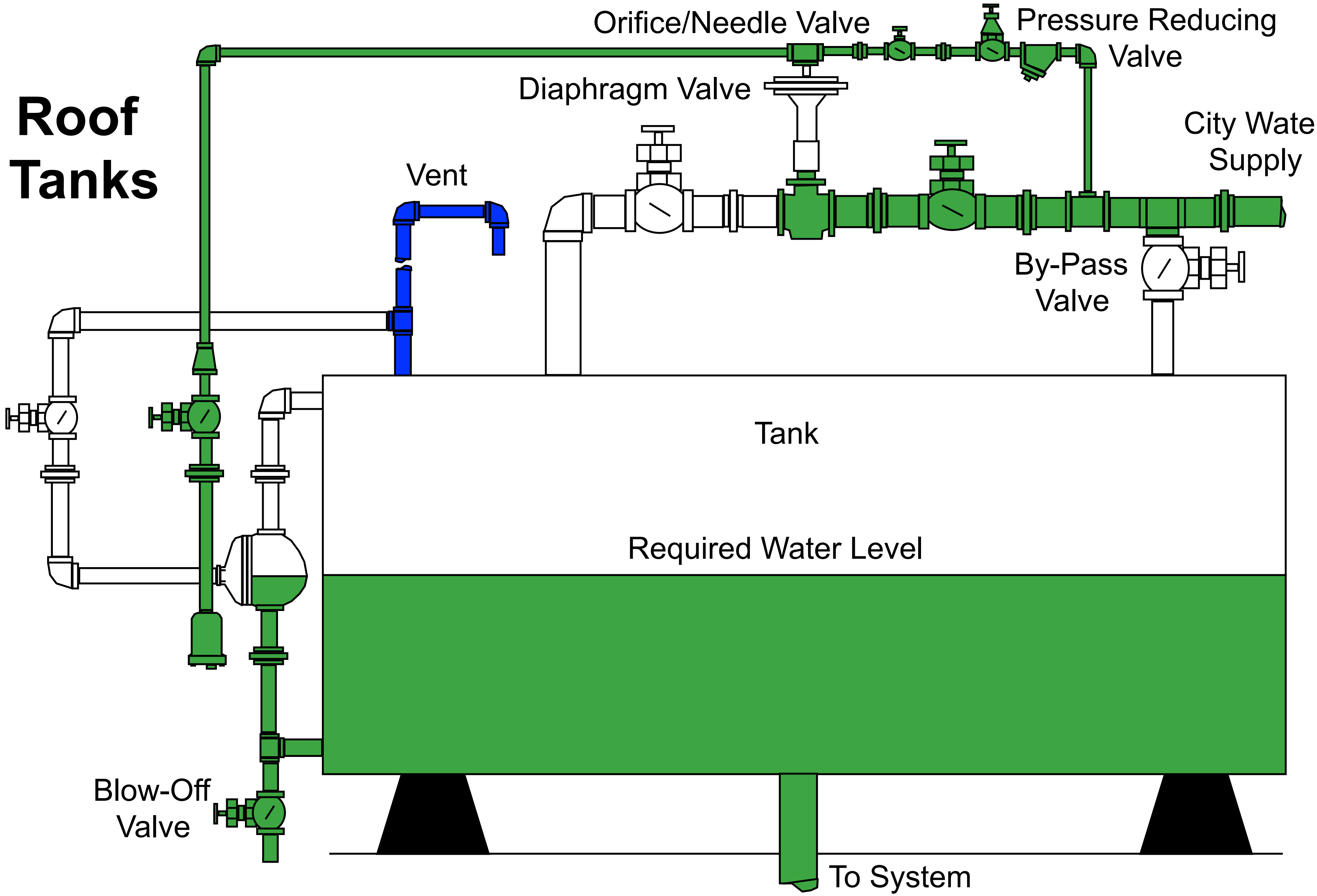
(For Water Only)



Domestic Water Supply **History**

- Roof Tanks (Pre 1945 - Gravity)
- Hydro - Pneumatic Tank (1948-1952)
- Constant Speed Pump PRV System
- Variable Speed Systems

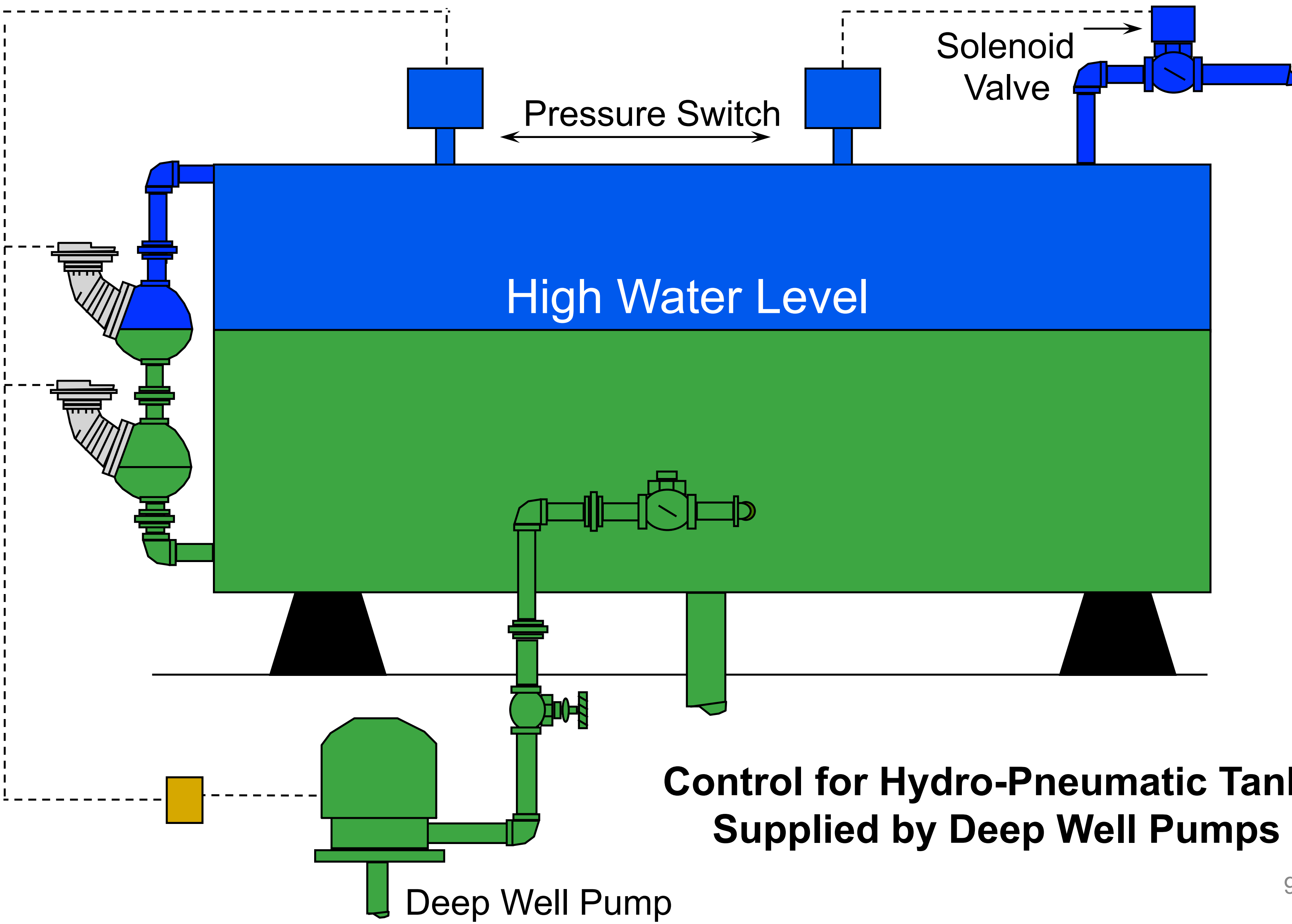
Roof Tanks



1829 Boston Tremont Hotel first with indoor plumbing with steam driven pump and roof tank.

Roof Tanks

- Basic Design Pre-**1948**
- **No Reliable** Mechanical Booster System
- Pumps Could **Fail** - You Still Had **Water**
- **Did Not Use** Basement Space
- **Stable** Building Supply Pressure
- Simple to Design and **Operate**
- **Vented** - Non Code Tanks
- **Run** Pump Off Peak
- **Fire** Protection

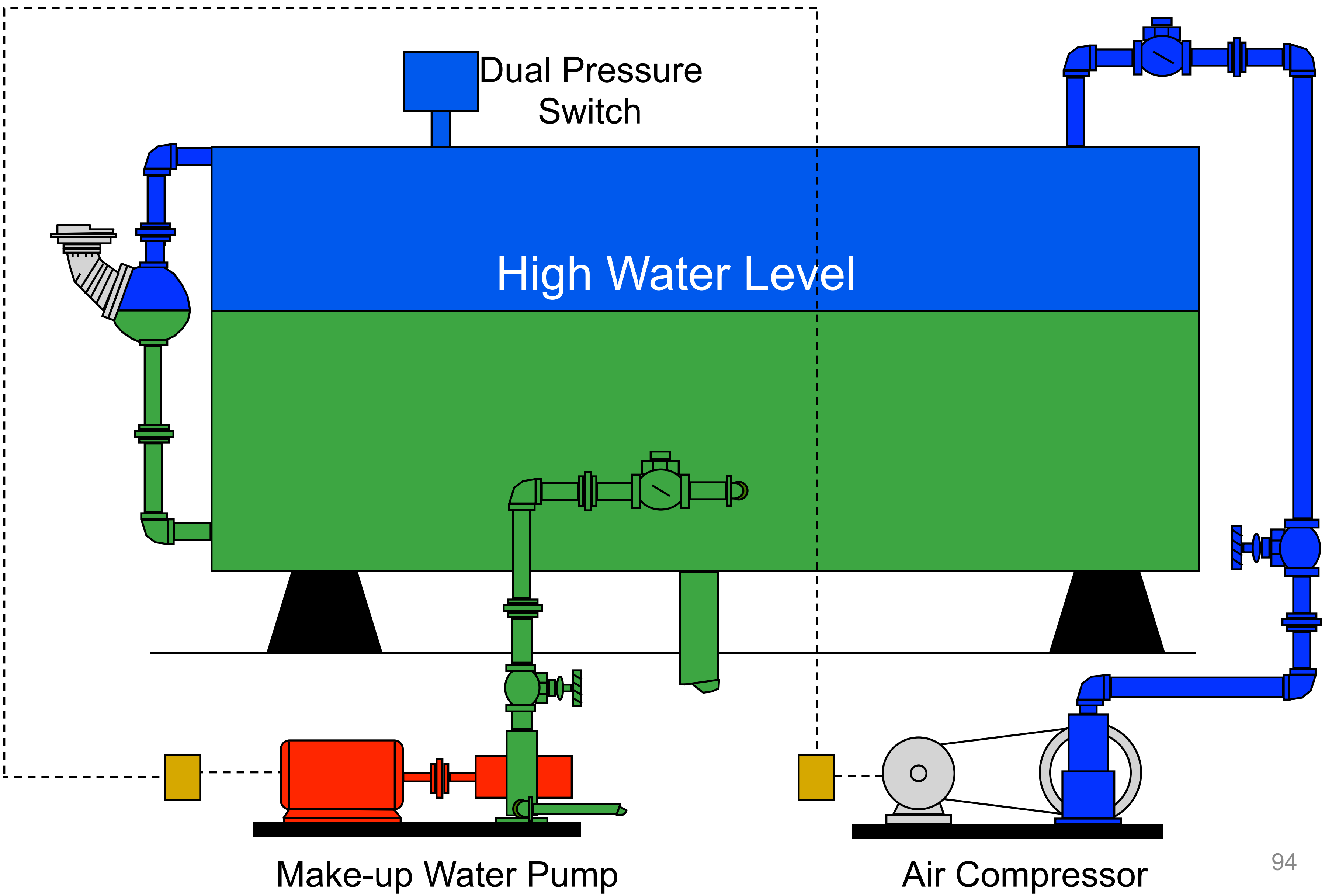


Control for Hydro-Pneumatic Tanks Supplied by Deep Well Pumps

Hydro-Pneumatic Tanks

- Between 1952 and 1957
- Two 100% Pumps with Air Compressor
- Higher System Pressures
- Expensive Large Tanks   Should be Code
- Expensive Floor Space   Rooftop and Basement
- High Pneumatic Tank Maintenance
- Corrosion Problem Due to Oxygen

Control for Hydro-Pneumatic Tanks



Constant Speed Pump and PRV System

- First in 1957 - **Constant** Pressure
- About 1963 Staged Pumps
- Two Pumps   Two at 50%
- Three Pumps   Lead Pump 20%   Two at 40%

Variable Speed Systems

2007

- Now Reliable Adjustable Frequency Drives

First Cost are Dropping (Competitive with Constant Speed)

Introduction

of

System Design Example

100 Room
Apartment Design

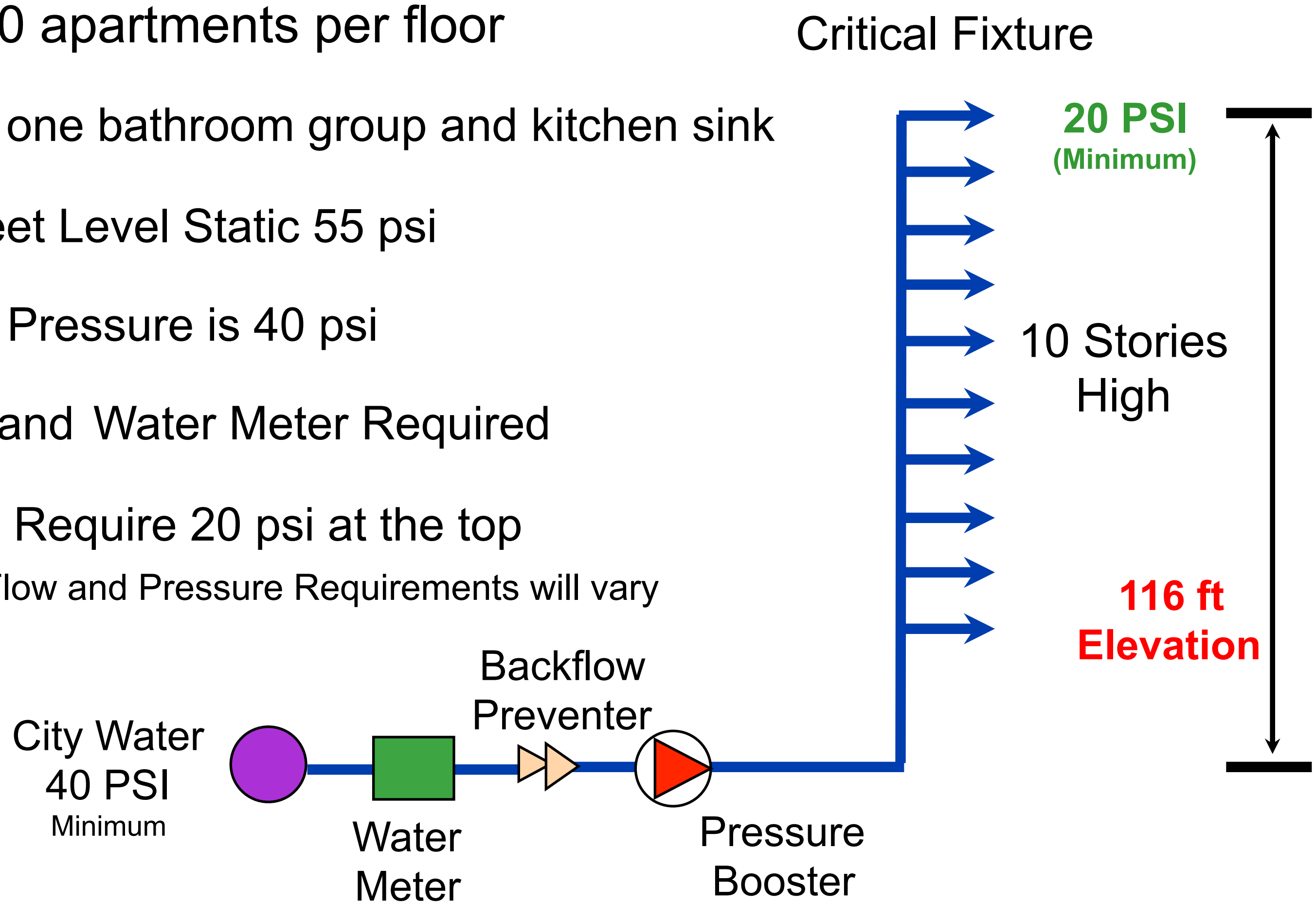
F.ixture U.nit and **GPM**

Example: Fixture unit **counts determine** your **GPM** flow rates.

100 Room Apartment

- Elevation of 116 ft to top
- 10 Stories high - 10 apartments per floor
- Each apartment has one bathroom group and kitchen sink
- City Pressure at Street Level Static 55 psi
- Minimum City Water Pressure is 40 psi
- Backflow Preventer and Water Meter Required
- *Flush Tanks Used - Require 20 psi at the top

  *CAUTION: Specific Flow and Pressure Requirements will vary



Note: First few floors with street pressure?

Domestic Water Supply
GPM and Fixture Units

- Demand is based on Fixture Units

(Check your local code on F.U.)

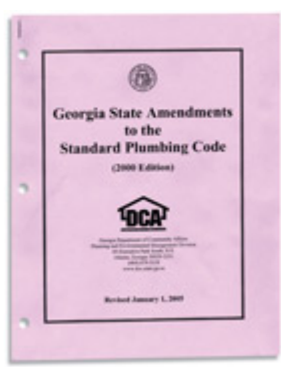
Fixture Type	Fixture Unit/Fixture		CW Fixture Units/Fixture		HW Fixture Units/Fixture	
	Old	New	Old	New	Old	New
WC/Public - Flush Valve	10	-	10	-		-
WC/Public - Flush Tank	5	-	5	-		-
Pedestal Urinal/Public	10	-	10	-		-
Stall - Wall Urinal/Public	5	-	5	-		-
Stall - Wall Urinal/Public	3	-	3	-		-
Lavatory/Public	2	-	1.5	-	1.5	-
Bathtub/Public	4	-	3	-	3	-
Shower Head/Public	4	-	3	-	3	-
Service Sink/Office	3	-	2.25	-	2.25	-
Kitchen Sink/Hotel, etc.	4	-	3	-	3	-
WC/Private Flush Valve	6	-	6	-		-
WC/Private Flush Tank	3	2.2	3	2.2		-
Lavatory/Private	1	.7	0.75	.5	0.75	.5
Bathtub/Private	2	1.4	1.5	1.0	1.5	1.0

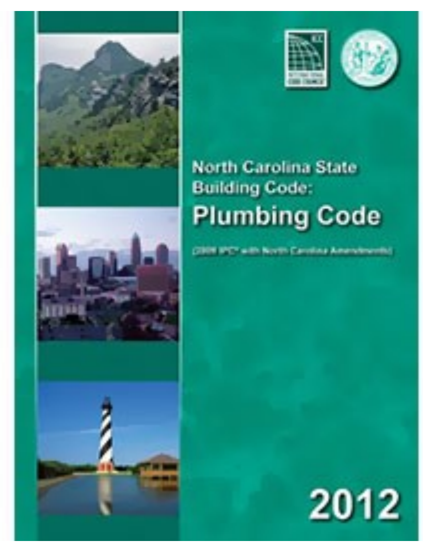
South Carolina Department of Labor, Licensing and Regulation

South Carolina Board of Building Codes Council
Notice of Intention to Adopt Building Codes
2006 Edition of the International Plumbing Code

Tennessee Code
Effective 3/1/07
IBC 2006

State Plumbing Codes





Each Apartment 8 Fixture Units

100 Apartments x 8 F.ixture U.nits = 800 F. U.

Per Hunter Curve Flush Tanks

800 F.U. = Demand of 180 GPM

Kitchen Sink

One Bathroom w/Flush Tank and Separate Shower (Private)

H.W.	C.W.	Combination
3.75 F.U.	6.75 F.U.	8.00 F.U.

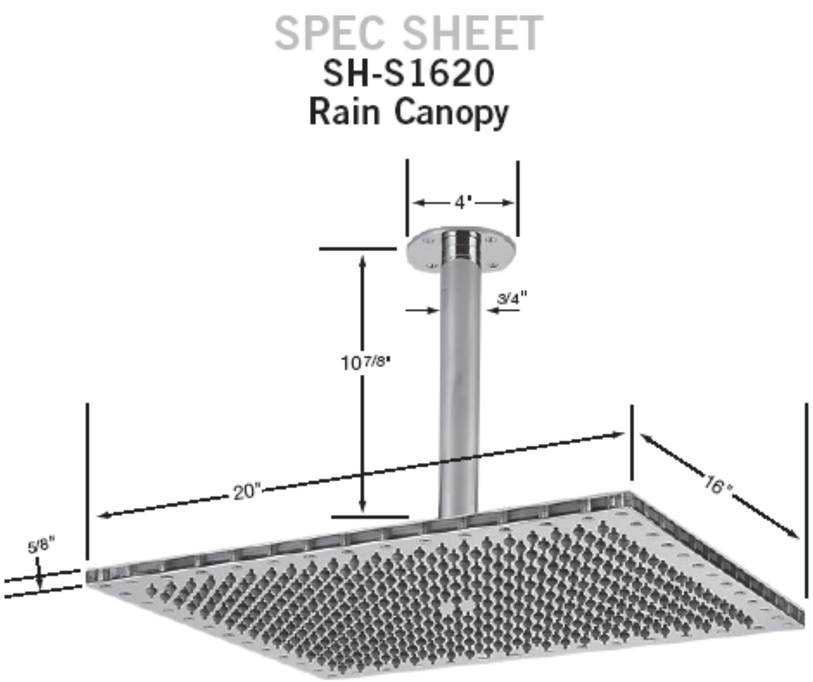
Peak Demand is **180 GPM**

Full Body Showers

Flow, Pressure and Riser Pipe Sizes, and Water Heater Sizing

Critical

Canopy
Showerhead



Critical

Flow, Pressure and Riser Pipe Sizes, and Water Heater Sizing

16 x 20

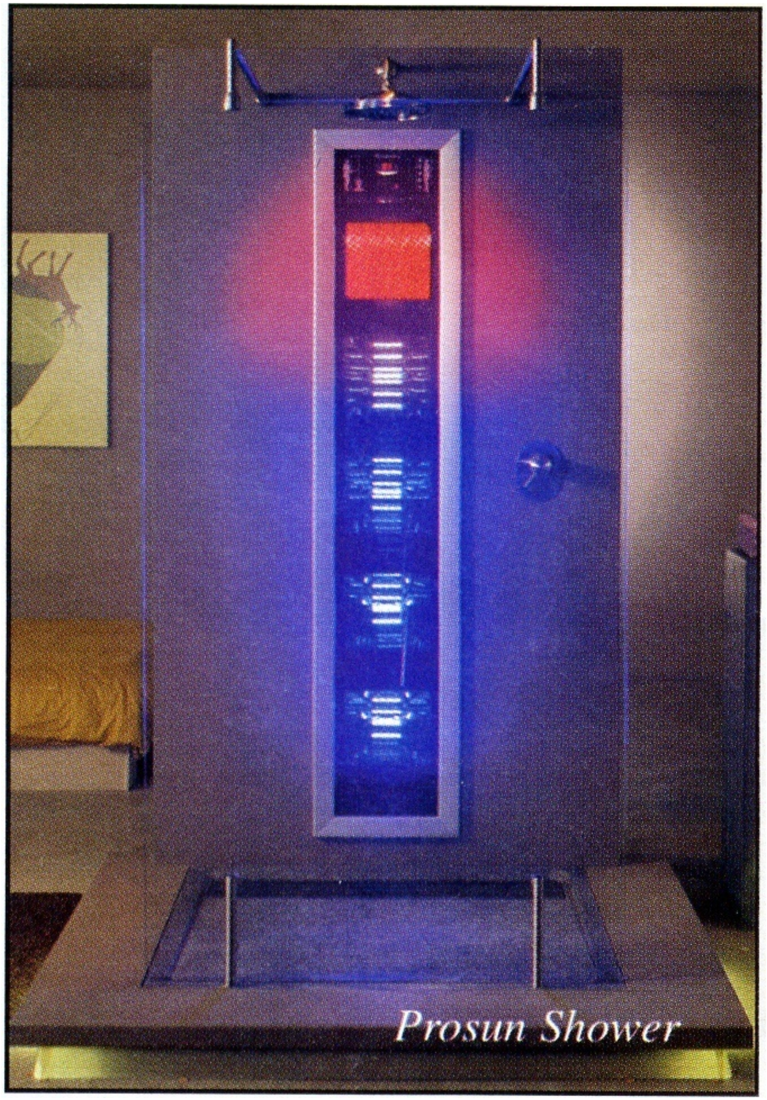
59 psi 27.8 gallons per minute

Prosun

Shower

Critical

Flow, Pressure and Riser Pipe Sizes, and Water Heater Sizing

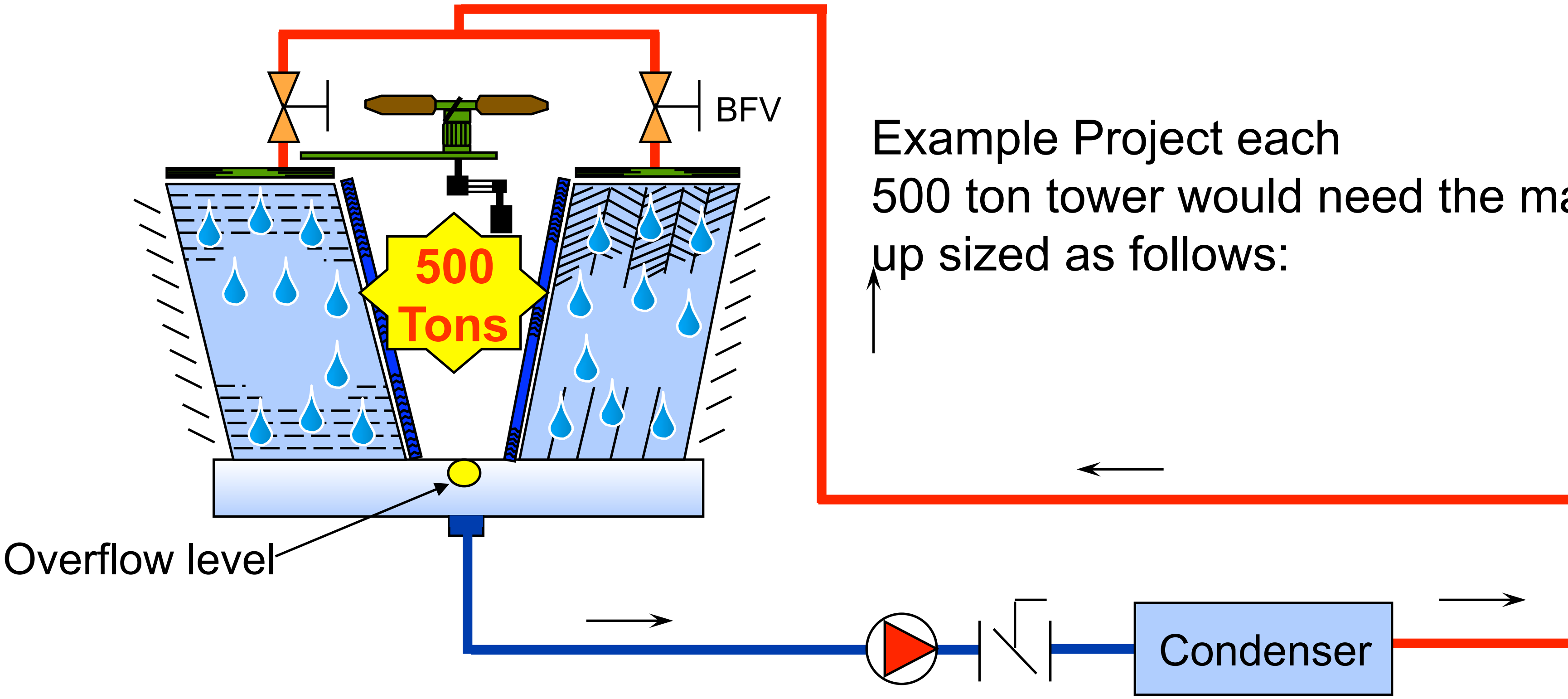


The $100,000
Shower

18 shower heads
6 zones

65 gallons of water per minute
250 gallons of water after 5 minutes

Is your Cooling Tower on the Roof?



Example Project each
500 ton tower would need the make
up sized as follows:

Evaporation = 500 Tons x .03 = 15 GPM **Full load only**

Drift Loss = 1500 GPM x .0002 = .3 GPM

*Estimated Blow down rate = Evaporation Rate = 15 GPM

* Chemical treatment will determine the actual requirements

Total makeup per 500 ton tower = **30.3 GPM** **Full load only**

Based on a minimum pressure of 15 psi and a maximum of 50 psi Pipe size **1½"**

Or size on cooling tower makeup size per cell (2")

CHAPTER 6
WATER USE EFFICIENCY
6.3 Mandatory Provisions
6.3.2.2 Appliances

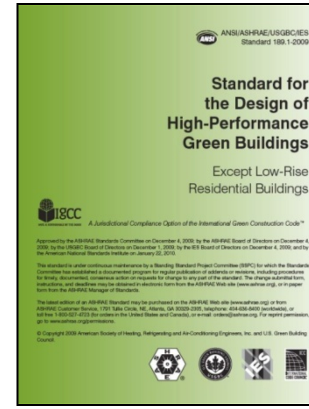


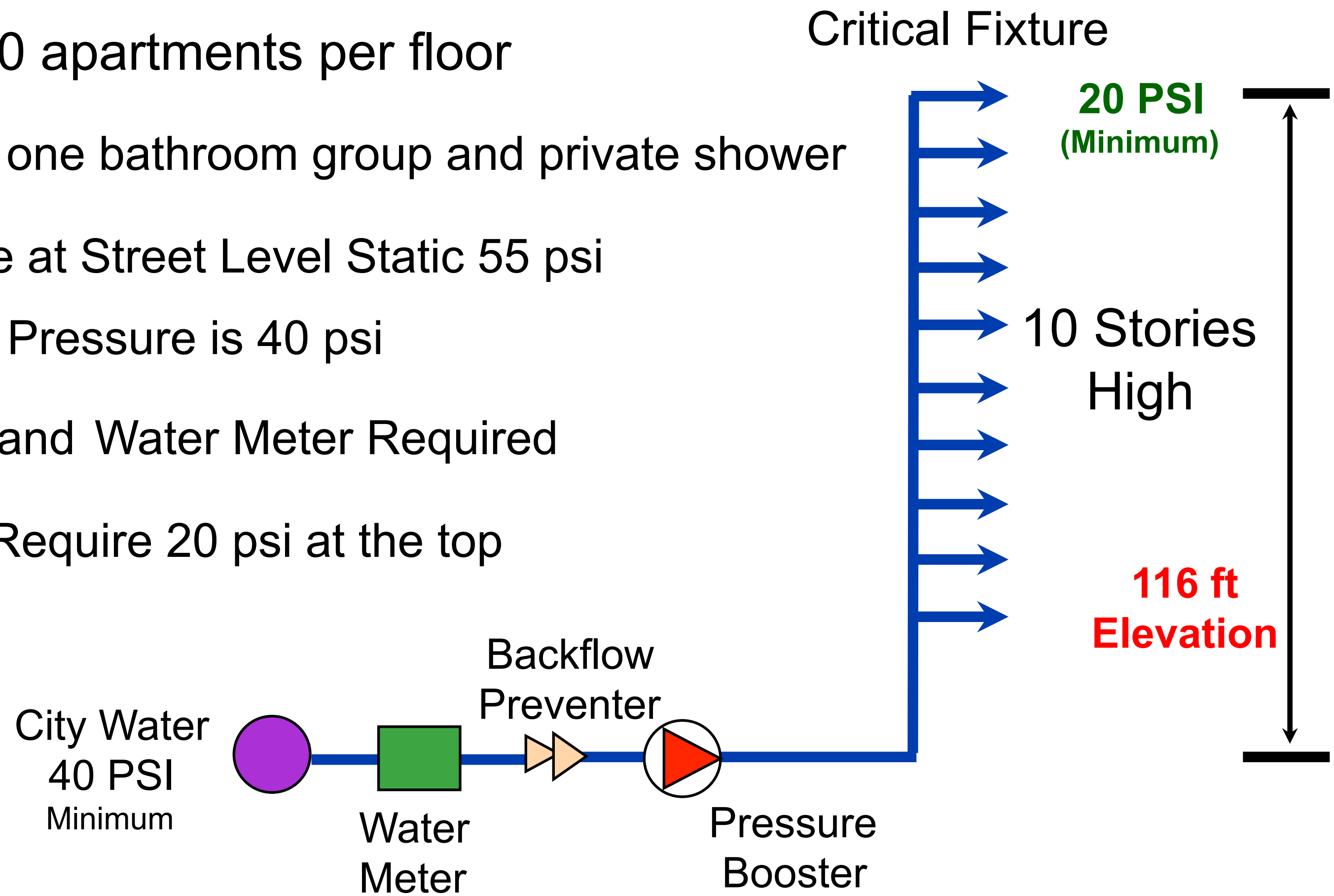
TABLE 6.3.2.1 Plumbing Fixtures and Fittings Requirements

Plumbing Fixture	Maximum
Water closets (toilets) - flushometer valve type	Single flush volume of 1.28 gal (4.8 L)
Water closets (toilets) - flushometer valve type	Effective dual flush volume of 1.28 gal (4.8 L)
Water closets (toilets) - tank-type	Single flush volume of 1.28 gal (4.8 L)
Water closets (toilets) - tank-type	Effective dual flush volume of 1.28 gal (4.8 L)
Urinals	Flush volume of 0.5 gal (1.9 L)
Public lavatory faucets	Flow rate - 0.5 gpm (1.9 L/min)
Public metering self-closing faucet	0.25 gal (1.0 L) per metering cycle
Residential bathroom lavatory sink faucets	Flow rate - 1.5 gpm (5.7 L/min)
Residential kitchen faucets	Flow rate - 2.2 gpm (8.3 L/min)
Residential showerheads	Flow rate - 2.0 gpm (7.6 L/min)
Residential shower compartment (stall) in dwelling units and guest rooms	Flow rate from all shower outlets total of - 2.0 gpm (7.6 L/min)

Required System Pressure

100 Room Apartment

- Elevation of 116 ft to top
- 10 Stories high - 10 apartments per floor
- Each apartment has one bathroom group and private shower
- Typical City Pressure at Street Level Static 55 psi
- Minimum City Water Pressure is 40 psi
- Backflow Preventer and Water Meter Required
- Flush Tanks Used - Require 20 psi at the top



Note: First few floors with street pressure?

Pressure Booster Selection Procedure

A - Ask for a **flow** and **pressure test** at the supply connection to your building. Have the test results confirmed to you in **writing** and **certified** by the **Domestic Water supplier**.

B - Refer to **state** and **local plumbing codes** where applicable to determine gpm demand. Most codes, ASPE, ASHRAE and Bell & Gossett use the same fixture unit counts from a National Bureau of standard report: BMS79 by R.B. Hunter; a flow probability curve (Hunter's Curve) is then applied to get the net gpm demand. Refer to pages 1 - 5 of bulletin TEH-1175 or pages 3 - 6 of bulletin TEH-1096.

C - **Hot** or **cold water demand** will be **75%** of the total demand. Calculate total fixture units and separate into hot and cold water demand.

D - Make a **simple system sketch** showing pipe mains, main pipe branches, water meter, backflow preventer, water heaters, reducing valves, recirculation lines and pumps, system elevation, required minimum fixture pressure at the high point, system elevation in feet or psi and location of the pressure booster.

E - Size all pipe based on local codes, your firms limitation, **a suggestion is a maximum pressure drop of 5psi/100' and a maximum velocity of 8 ft/sec,** most local engineering offices use the same with a limit of 10 ft/sec velocity. **ASPE chapter 3 "Cold Water Systems" suggest 6 or 7 ft/sec maximum. ASHRAE chapter 36 page 36.11 2005 fundamentals states a maximum of 10 ft/sec.** Try using figure 3.3 thru figure 3.6 pages 17 - 21 TEH-1096. Also, table 3.7 and 3.8 based on a maximum of 5 psi/100' of drop, on page 23. **Please note that fixture units are included on both.**

F - Calculate the required pressure boost using attached form.

G - Determine the number of pumps for system. Run ESP-Plus to determine energy cost for constant speed booster system vs. variable speed system. Select type of system. Refer to **section #4 for Bell & Gossett Package Constant Speed Pressure Booster** selection. Size and specification. Refer to **section #6 for a Bell & Gossett Package Variable Speed Pressure Booster** selection with dimensions and weights.

H - Write pressure booster specification.

COPPER TUBING: SIZE, PRESSURE DROP & VEL. VS. FIXTURE UNITS*

1-800-365-9010
www.jmpco.com

* BASED ON HUNTERS' EVALUATION REPORT BMS79, NATIONAL BUREAU OF STANDARDS

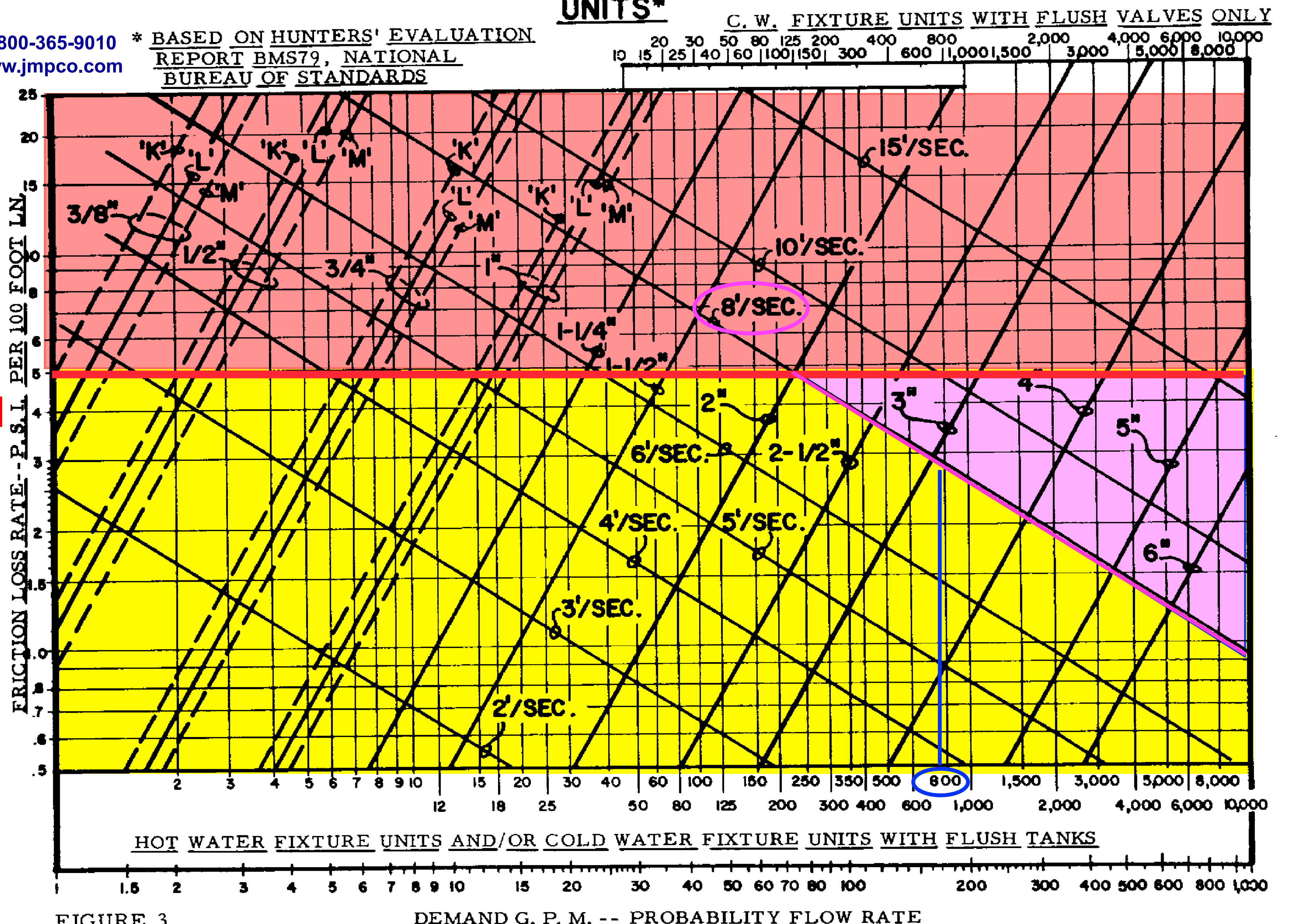
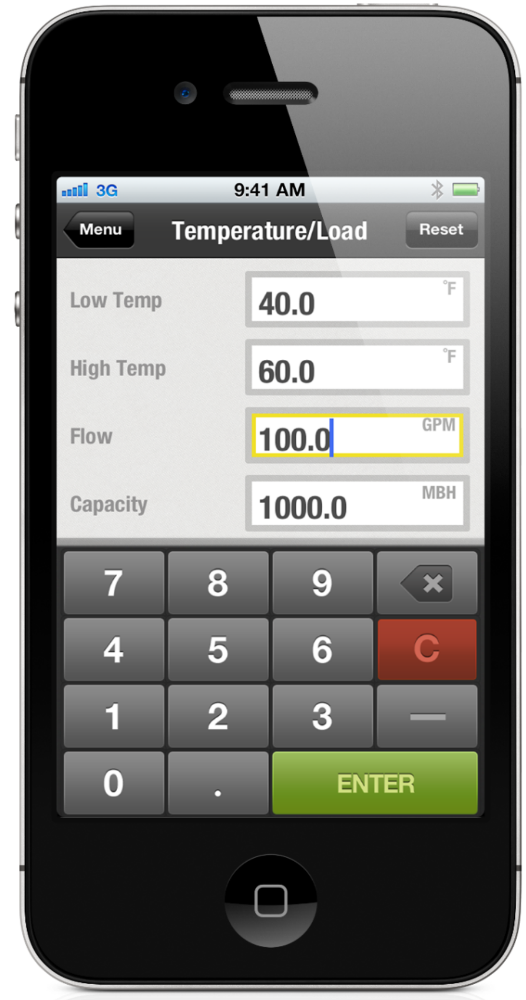


FIGURE 3

PVC Pipe Sizing Applications are Available

iPad & iPhone Versions

- Available free from iTunes App Store
  - Greater range of pipe sizes
  - Addition of PVC Pipe
  - Includes English & Metric Units
  - Handles fluids other than water



Minimum **Pressure** at Critical Fixture = 20 PSI

Pipe Friction @ 5 PSI/100 ft. = 6 PSI

Elevation 115 ft. = 50 PSI

Backflow Preventer = 12 PSI

Water Meter = 8 PSI

Total Required Pressure = 96 PSI

Minimum City Pressure = 40 PSI

Required System Pressure Boost = 56 PSI

Pressure Booster Selection Procedure

Job Name:__________________________
Date:__________________________

Total Fixture Units ________F.U. Hunter Curve Demand ________GPM

Minimum Pressure at the System Top (Pressure Drop of Greatest Pressure Drop Fixture) (Typically 20 to 25 PSI Flush Tanks and Dishwashers) (Typically 30 to 35 PSI Flush Valves) (Low Flush Valves 35 psi)	________	PSI
Pipe Friction at 5 PSI/100 ft Longest Run (Add 20% for Tees, Elbows, and Fittings)	________	PSI
Elevation Above Water Supply Conn. Divide Feet by **2.31 ft/PSI** to get PSI	________	PSI
Water Heater if Used **(2.31 ft/PSI)**	________	PSI
System Pressure Reducing Valve or Check Valve	________	PSI
Back Flow Preventer (Typically 10 to 12 PSI)	________	PSI
Water Meter (Typically 5 to 6 PSI)	________	PSI
Thermostatic Mixing Valve (Typically 5 to 20 psi)	________	PSI
Miscellaneous (Pump Suction Valves, Filters, Strainers, Water Softner, etc.)	________	PSI
Total Required System Pressure	________	PSI
***Minimum City Suction Pressure**	(-) ________	PSI
***Required System Pressure Boost**	________	PSI
PSI * 2.31 ft/PSI Equals Head in Feet	________	ft

Note: *Pressure Booster Selections Include The Pressure Reducing Valve Drop.
***Confirm Minimum City Pressure in Writing for the Project Data File.**

Pressure Booster Selection Procedure

Job Name: 100 Room Apartment Example

Date: ____________

Total Fixture Units 800 F.U. Hunter Curve Demand 180 GPM

Minimum Pressure at the System Top (Pressure Drop of Greatest Pressure Drop Fixture) (Typically 20 to 25 PSI Flush Tanks and Dishwashers) (Typically 30 to 35 PSI Flush Valves) (Low Flush Valves 35 psi)	20	PSI
Pipe Friction at 5 PSI/100 ft Longest Run (Add 20% for Tees, Elbows, and Fittings)	6	PSI
Elevation Above Water Supply Conn. Divide Feet by **2.31 ft/PSI** to get PSI	50	PSI
Water Heater if Used **(2.31 ft/PSI)**		PSI
System Pressure Reducing Valve or Check Valve		PSI
Back Flow Preventer (Typically 10 to 12 PSI)	12	PSI
Water Meter (Typically 5 to 6 PSI)	8	PSI
Thermostatic Mixing Valve (Typically 5 to 20 psi)		PSI
Miscellaneous (Pump Suction Valves, Filters, Strainers, Water Softner, etc.)		PSI
Total Required System Pressure	96	PSI
***Minimum City Suction Pressure**	(-) 40	PSI
***Required System Pressure Boost**	56	PSI
PSI * 2.31 ft/PSI Equals Head in Feet		ft

Note: *Pressure Booster Selections Include The Pressure Reducing Valve Drop.
***Confirm Minimum City Pressure in Writing for the Project Data File.**

21507CE

Hydro-Pneumatic Tanks

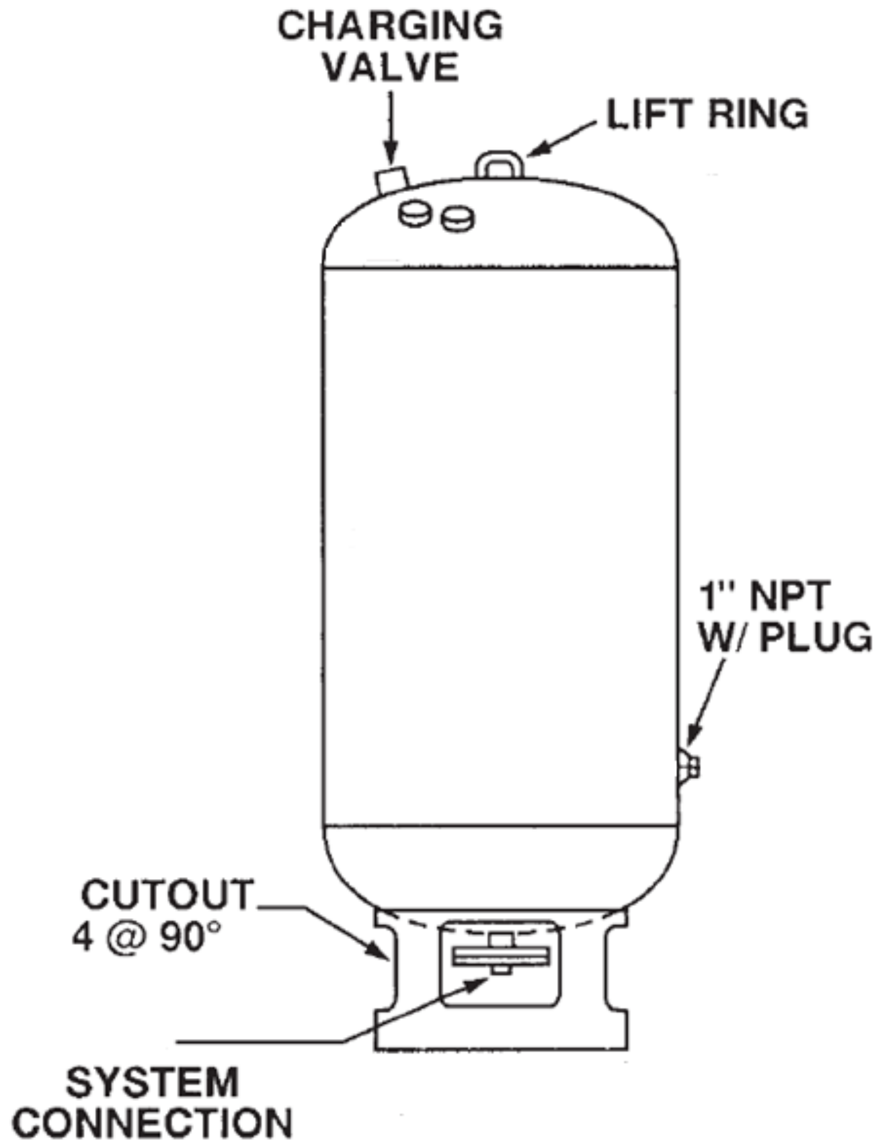
- Hydro-pneumatic tanks are primarily used in a domestic water system for **draw down purposes** when the pressure booster system is off on no-flow shutdown.

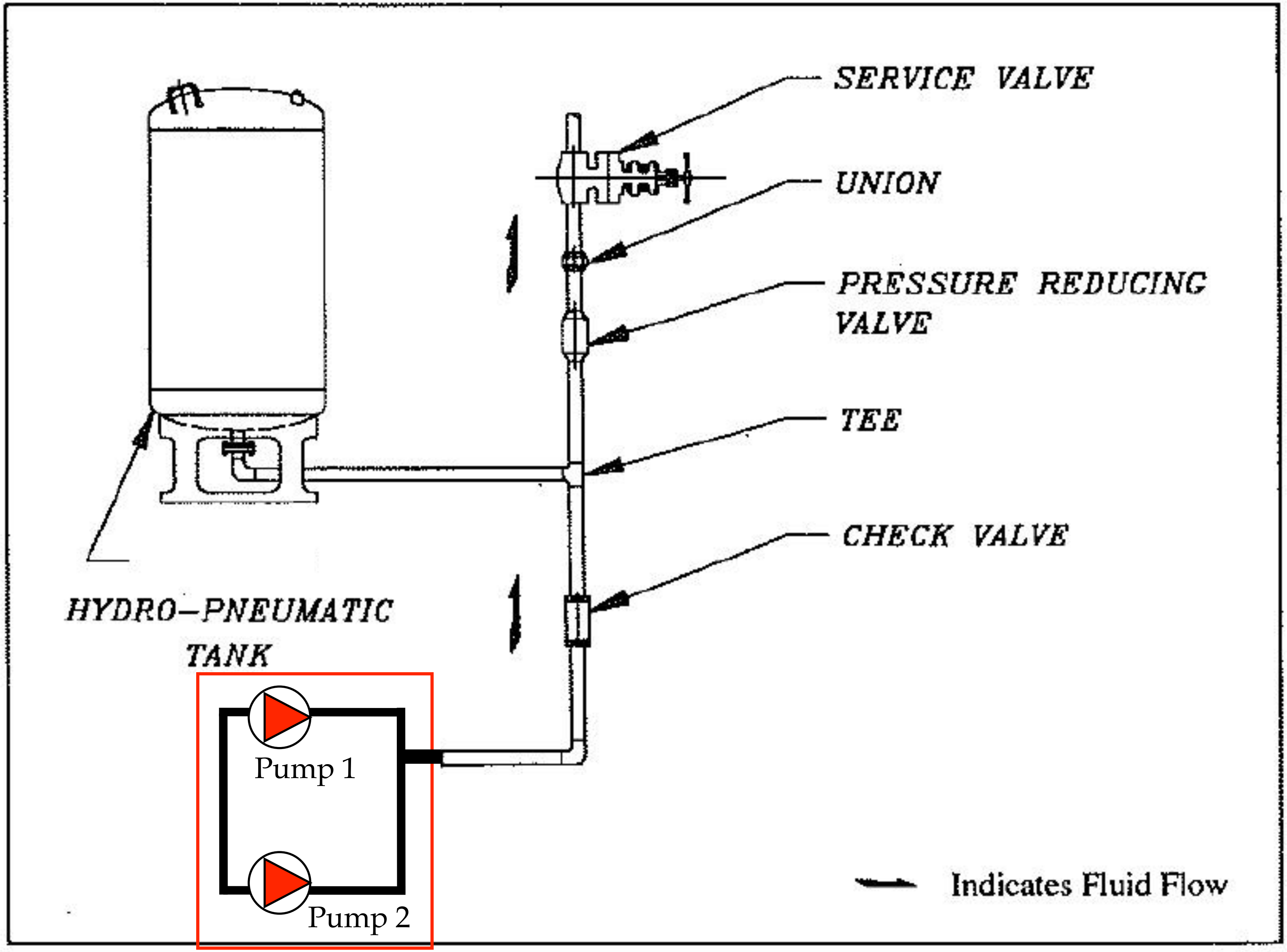
- Without the tank, the booster **would restart upon the slightest call for flow** such as a single toilet being flushed

- These factors **prevent booster pump short cycling**

Constant & **Variable Boosters**

Hydro-Pneumatic Tank





Booster Pump System

Hydro-Pneumatic Tanks

Hydro-pneumatic tanks are primarily used in a domestic water system for draw down purposes when the pressure booster system is off on no-flow shutdown (NFSD). To prevent pump short cycling and to save energy.

Constant & **Variable**

Hydropneumatic Tank Sizing
is Dependent on Two Factors

1. How long you wish to keep the pumps off in a no-flow condition.
2. The tank location in relation to the pressure booster pumps.

- **Discharge Header** Pressure Booster **(most common)**
- **Top of the System** **(smallest tank lower working pressure)** **(best location)**

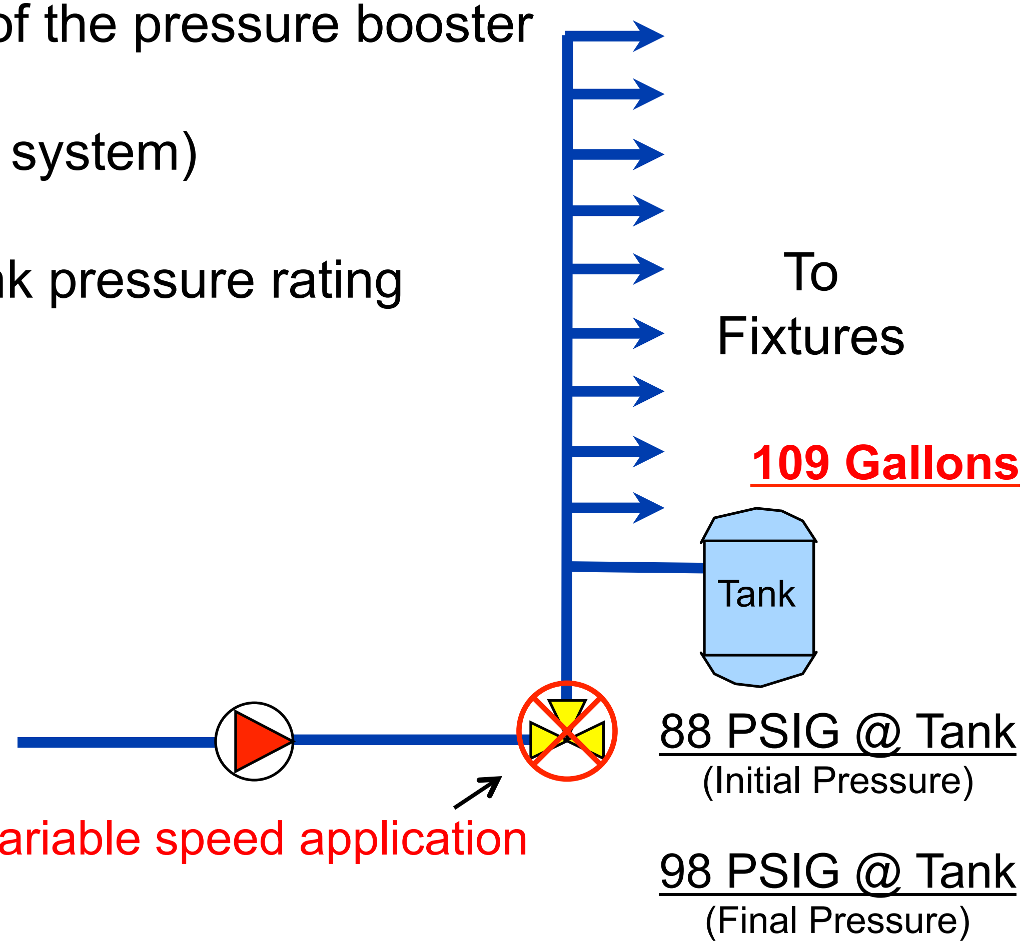
Discharge Header Pressure Booster

Booster size 124 GPM @ 58 PSIG

Located at the discharge of the pressure booster

Easier to install (vs. top of system)

Insure bldg pressure < tank pressure rating
Typically 150 or 200 psi



Acceptance Volume for Various Types of Buildings
(Gallons)

Based on a 30 minute Shut Down

Total System Demand (GPM)	Apartment Building	Hospital	School	University Class Rooms	University Dormitories	Commercial	Hotel	Prison
50	8	60	15	15	23	11	15	38
100	15	120	30	30	45	22	30	75
150	23	180	45	45	68	33	45	113
200	30	240	60	60	90	44	60	150
250	38	300	75	75	113	55	75	188
300	45	360	90	90	135	66	90	225
350	53	420	105	105	158	77	105	263
400	60	480	120	120	180	88	120	300
450	68	540	135	135	203	99	135	338
500	75	600	150	150	225	110	150	375

Based on B&G TEH-1096 page 34

Fill Pressure equals Initial Pressure

Tank at Discharge of Booster

(Page 35)

Booster size 124 GPM @ 58 PSIG
40 PSIG Minimum Suction
15 Minute Booster Shutdown

Required Acceptance Volume = 19 gallons (page 34) x $\frac{15 \text{ minutes}}{30 \text{ minutes}}$ = 9.5 gallons Acc. Volume

88 PSIG Pump Cut In (10 PSI change)
Tank @ Header Location (No Friction + No Elevation Change)

88 PSIG (Pump Cut In) - 0 PSIG = 88 PSIG @ Tank (Initial Pressure)

98 PSIG (Pump Cut Out) - 0 PSIG = 98 PSIG @ Tank (Final Pressure)

From Page 40: Draw down coefficient = .087

Minimum Tank Volume $= \frac{9.5 \text{ Gallons}}{.087}$ = **109 Gallons**

TABLE 1 – DRAWDOWN FACTORS

(Use Gauge Pressure)

P_0 MAXIMUM OPERATING PRESSURE PSIG	P_f – MINIMUM OPERATING PRESSURE AT TANK (PSIG)											
	5	10	12	15	20	25	30	35	40	45	50	55
10	0.202	-										
12	0.262	0.075	-									
15	0.337	0.168	0.101	-								
20	0.432	0.288	0.231	0.144	-							
25	0.504	0.378	0.328	0.252	0.126							
27	0.527	0.408	0.360	0.288	0.168	-						
30	0.560	0.447	0.403	0.336	0.224	0.112	-					
35	0.604	0.503	0.463	0.403	0.302	0.202	0.101					
40	0.640	0.548	0.512	0.457	0.366	0.274	0.183	0.091	-			
45	0.670	0.586	0.553	0.503	0.419	0.335	0.251	0.168	0.084			
50	0.696	0.618	0.587	0.541	0.464	0.386	0.309	0.232	0.155	0.078	-	
55	0.717	0.646	0.617	0.574	0.502	0.430	0.359	0.287	0.215	0.144	0.072	-
60	0.736	0.669	0.643	0.602	0.536	0.469	0.402	0.335	0.268	0.201	0.134	0.067
65	0.753	0.690	0.665	0.627	0.565	0.502	0.439	0.376	0.314	0.251	0.188	0.125
70	0.767	0.708	0.685	0.649	0.590	0.531	0.472	0.413	0.354	0.295	0.236	0.177
75	0.780	0.725	0.702	0.669	0.613	0.558	0.502	0.446	0.390	0.333	0.279	0.223
80	0.792	0.739	0.718	0.686	0.634	0.581	0.528	0.475	0.422	0.370	0.317	0.264
85	0.802	0.752	0.732	0.702	0.652	0.602	0.552	0.502	0.451	0.401	0.351	0.301
90	0.812	0.764	0.745	0.716	0.669	0.621	0.573	0.525	0.478	0.430	0.382	0.335
95	0.820	0.775	0.757	0.729	0.684	0.638	0.593	0.547	0.501	0.456	0.410	0.365
100	0.828	0.785	0.767	0.741	0.698	0.654	0.610	0.567	0.523	0.479	0.436	0.392
105	0.835	0.794	0.777	0.752	0.710	0.668	0.626	0.585	0.543	0.501	0.459	0.418
110	0.842	0.802	0.786	0.762	0.723	0.682	0.642	0.601	0.561	0.521	0.481	0.441
115	0.848	0.810	0.794	0.771	0.734	0.694	0.655	0.617	0.578	0.540	0.501	0.463
120	0.854	0.817	0.802	0.780	0.742	0.705	0.668	0.631	0.594	0.557	0.520	0.483

Tank at High Point

TABLE 1 – DRAWDOWN FACTORS

(Use Gauge Pressure)

P_o MAXIMUM OPERATING PRESSURE PSIG	P_f – MINIMUM OPERATING PRESSURE AT TANK (PSIG)											
	60	65	70	75	80	85	90	95	100	105	110	115
60	-											
65	0.062	-										
70	0.118	0.059	-									
75	0.167	0.111	0.056	-								
80	0.211	0.158	0.106	0.053	-							
85	0.251	0.201	0.151	0.101	0.050	-						
90	0.287	0.239	0.191	0.143	0.096	0.048	-					
95	0.319	0.273	0.228	0.182	0.137	0.091	0.045					
100	0.347	0.305	0.261	0.218	0.174	0.131	0.087	0.043	-			
105	0.376	0.334	0.292	0.250	0.208	0.167	0.125	0.083	0.041	-		
110	0.401	0.361	0.321	0.281	0.241	0.200	0.160	0.120	0.080	0.040	-	
115	0.424	0.386	0.347	0.309	0.270	0.232	0.193	0.155	0.116	0.007	0.039	-
120	0.446	0.408	0.371	0.334	0.297	0.260	0.223	0.186	0.149	0.111	0.074	0.037

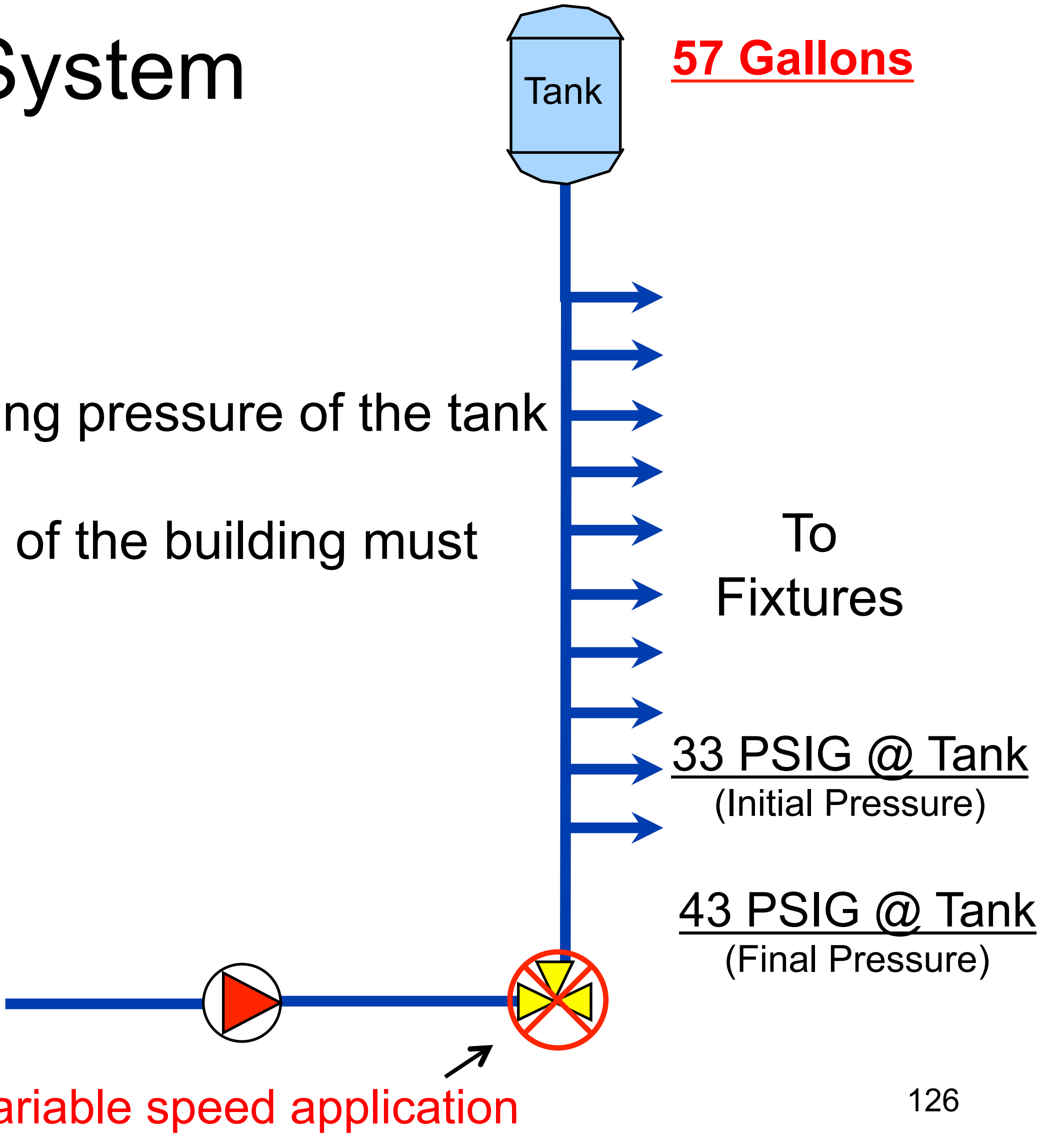
Tank at Discharge of Booster

Top of the System

Reduces the size of the tank

Alleviates exceeding max working pressure of the tank

Transporting the tank to the top of the building must
Be considered



Tank at High Point

Booster size 124 GPM @ 58 PSIG
40 PSIG Minimum Suction
15 Minute Booster Shutdown

Required Acceptance Volume = 19 gallons (page 34) x $\frac{15 \text{ minutes}}{30 \text{ minutes}}$ = $\frac{9.5 \text{ gallons}}{\text{Acc. Volume}}$

88 PSIG Pump Cut In (10 PSI change)
4.7 PSI Friction + 50.2 PSI Elevation = (55 PSIG)

88 PSIG (Pump Cut In) - 55 PSIG (Friction + Elevation) = 33 PSIG @ Tank (Initial Pressure)

98 PSIG (Pump Cut Out) - 55 PSIG (Friction + Elevation) = 43 PSIG @ Tank (Final Pressure)

From Page 40: Draw down coefficient = .168

Minimum Tank Volume = $\frac{9.5 \text{ Gallons}}{.168}$ = **57 Gallons**

Pre-Charge Pressure for Hydro Pneumatic Tanks

Please pre-charge with air the Hydro-Pneumatic tank at initial pressure less 10 psi to prevent sudden pressure drops before the system cycles back on.

88 psig initial pressure (**pre-charge to 78 psig**)

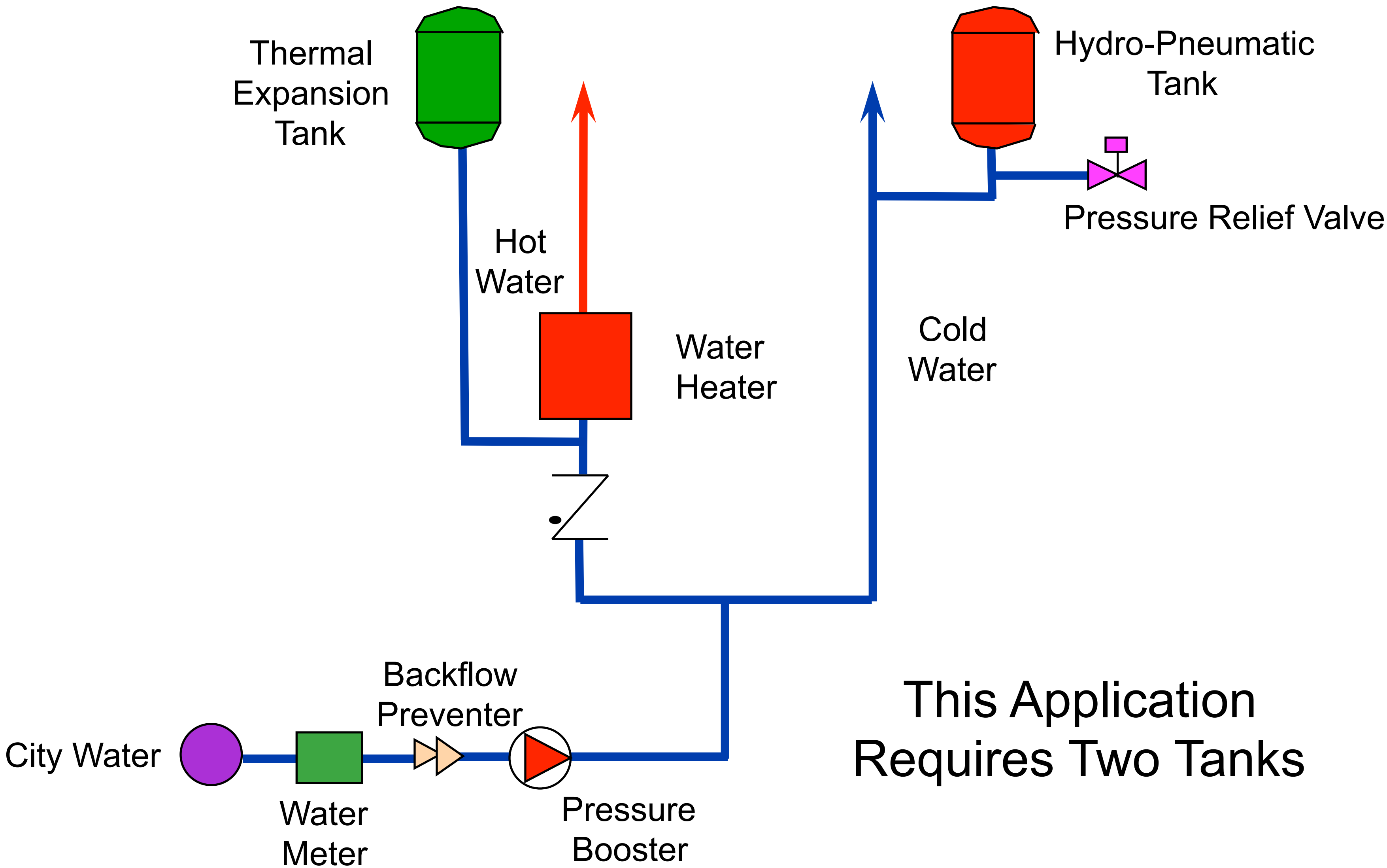
33 psig initial pressure (**pre-charge to 23 psig**)

*** Please specify on your drawing**

Hydro Pneumatic Pressure Tank Relief

(ICC - International Plumbing Code)

606.5.10 Pressure relief for tanks. Every pressure tank in a hydropneumatic pressure booster system shall be protected with a pressure relief valve. The pressure relief valve shall be set at a maximum pressure equal to the rating of the tank. The relief valve shall be installed on the supply pipe to the tank or on the tank. **The relief valve shall discharge by gravity to a safe place of disposal.**



This Application Requires Two Tanks

Pressure Booster
Pumping Applications

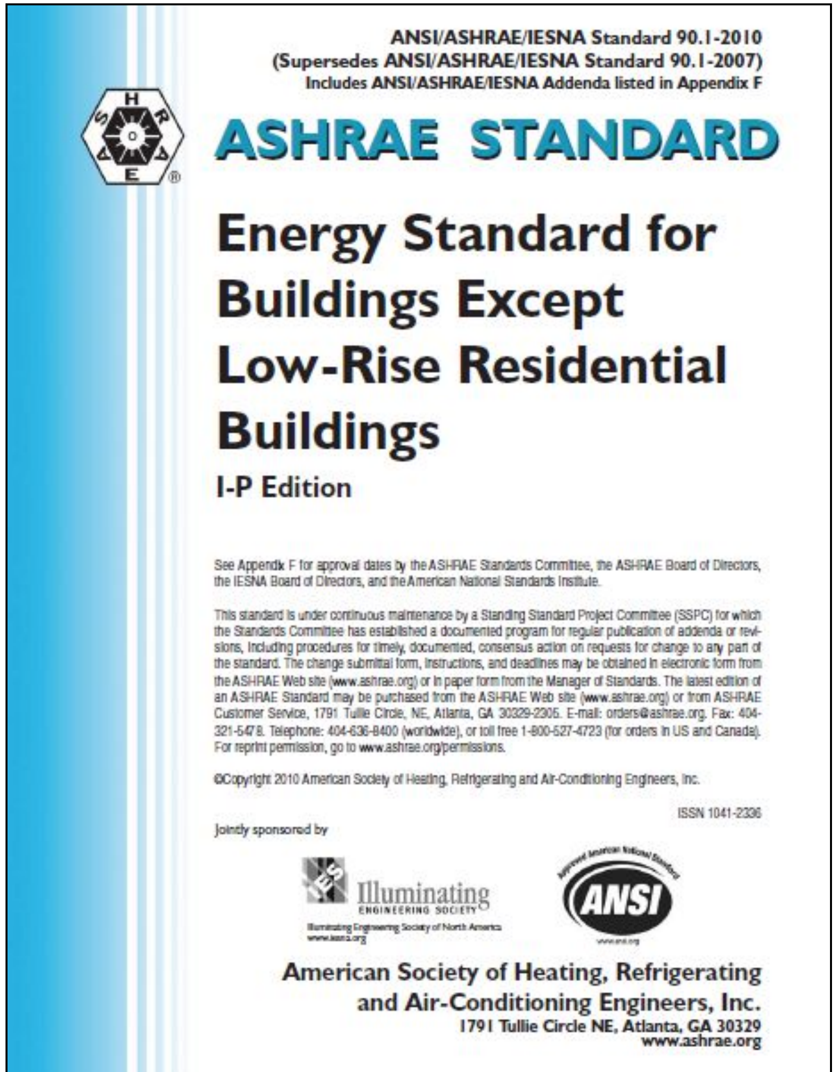
Constant Speed

vs.

Variable Speed

Considerations

ASHRAE STANDARD



ANSI/ASHRAE/IESNA Standard 90.1-2010
(Supersedes ANSI/ASHRAE/IESNA Standard 90.1-2007)
Includes ANSI/ASHRAE/IESNA Addenda listed in Appendix F

ASHRAE STANDARD

Energy Standard for Buildings Except Low-Rise Residential Buildings

I-P Edition

See Appendix F for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IESNA Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site (www.ashrae.org) or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE Web site (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

ISSN 1041-2336

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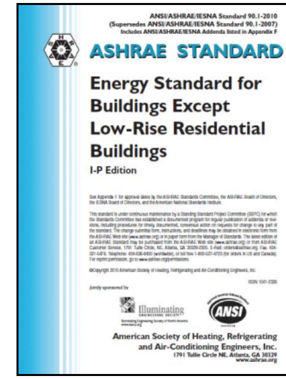
CHAPTER 10

OTHER EQUIPMENT

SECTION 10.4
Mandatory Provisions



10.4.2 Service Water Pressure Booster Systems. Service water pressure booster systems shall be designed such that:

a. One or more pressure sensors shall be used to vary pump speed and/or start and stop pumps. The sensor(s) shall either be located near the **critical fixture(s)** that determine the pressure required, **or logic** shall be employed that adjusts the setpoint to simulate operation of remote sensor(s).

b. **No device(s)** shall be installed for the purpose of reducing the pressure of all of the water supplied by any booster system pump or booster system, **except for safety devices**.

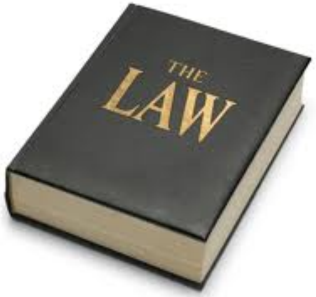
c. **No booster** system pumps shall operate when there is **no service water flow**.

Constant Speed Pressure Boosters using Pressure Reducing Valves are obsolete October 18th, 2013

(Constant Speed Dead)

All pressure boosters will become variable speed with no across the line constant speed bypass. A constant speed bypass may lead to discharge pressure being to high.

“It’s The Law”

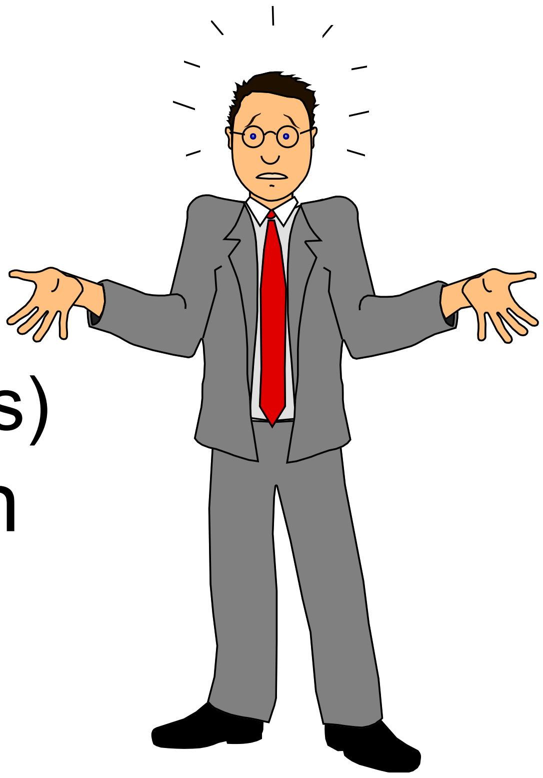


Why

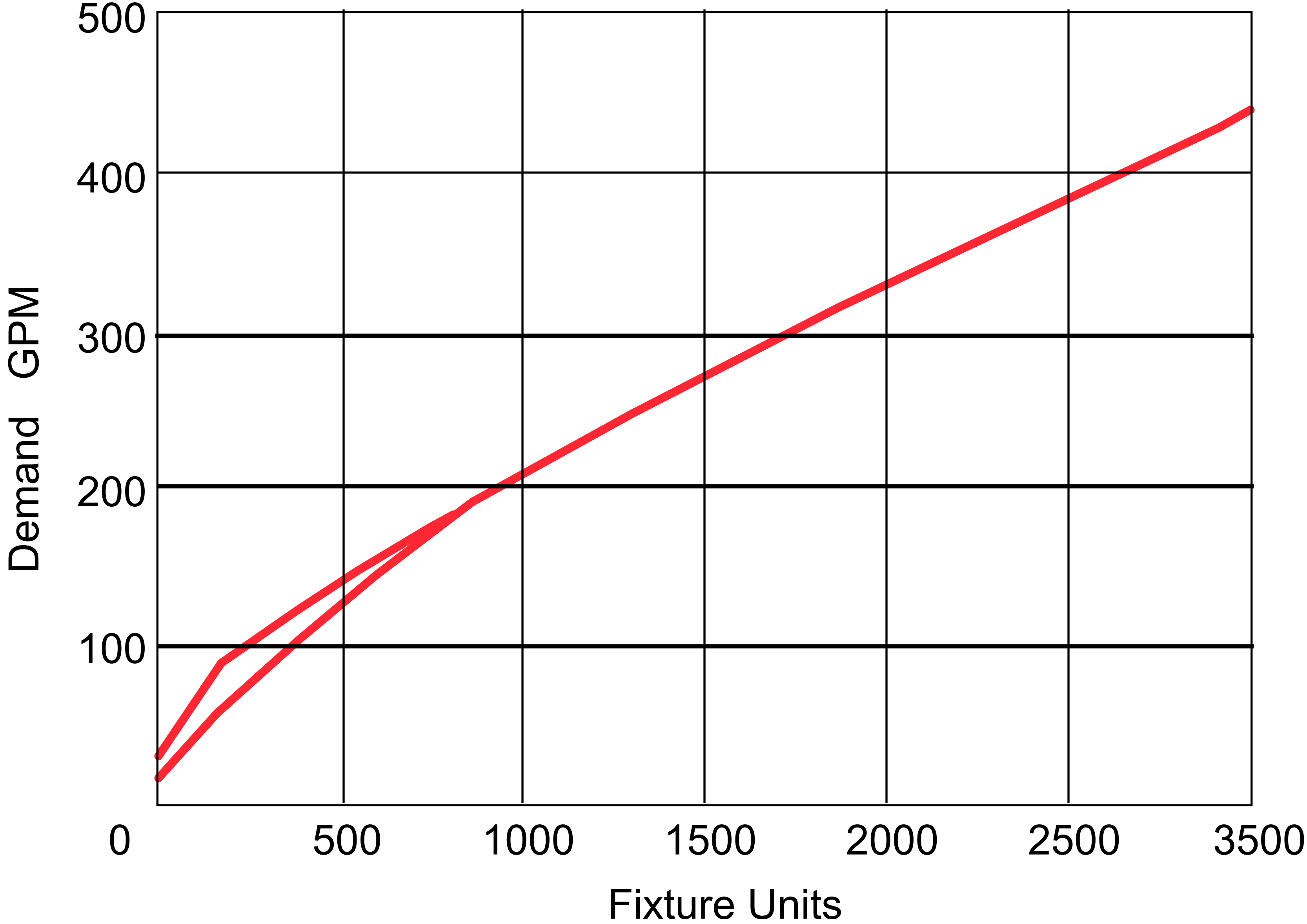
Five Factors to Consider

- Pump **Over Sizing**
- **Variable** System **Head** Loss
- Pressure Reducing **Valve Losses**
- **Changing** System **Loads**
- **Changing** Suction **Pressure**

Pump Over Sizing



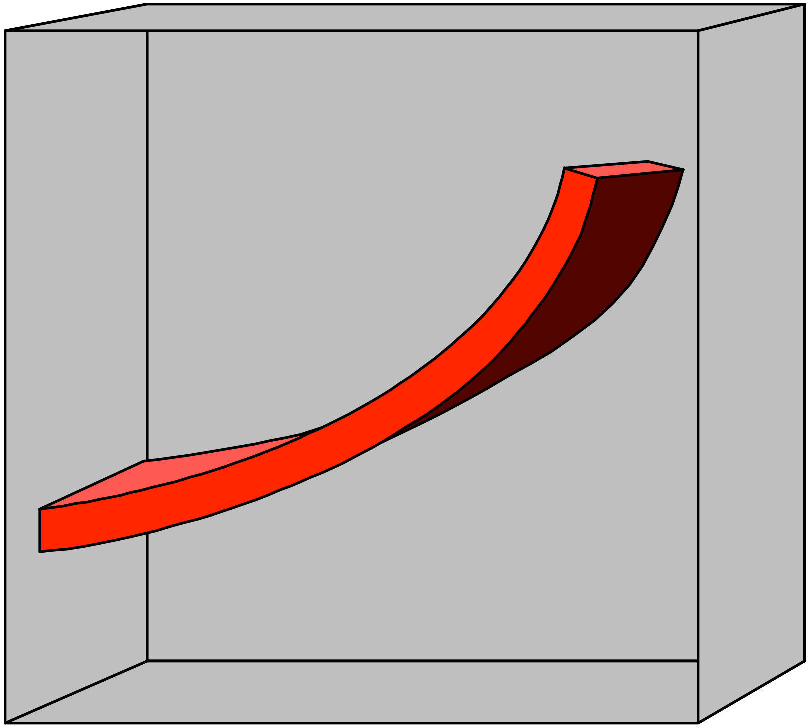
A conservative estimate (or guess) for system flow diversity is often used which results in an oversized pump



“Hunter” Estimate Curves for Demand Load

Variable Head Loss

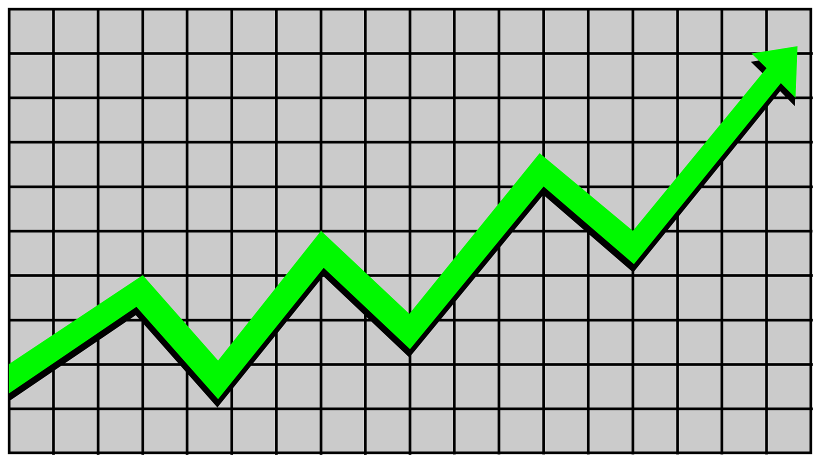
As flow decreases,
friction loss also decreases.
Constant speed boosters
don't take this into account.



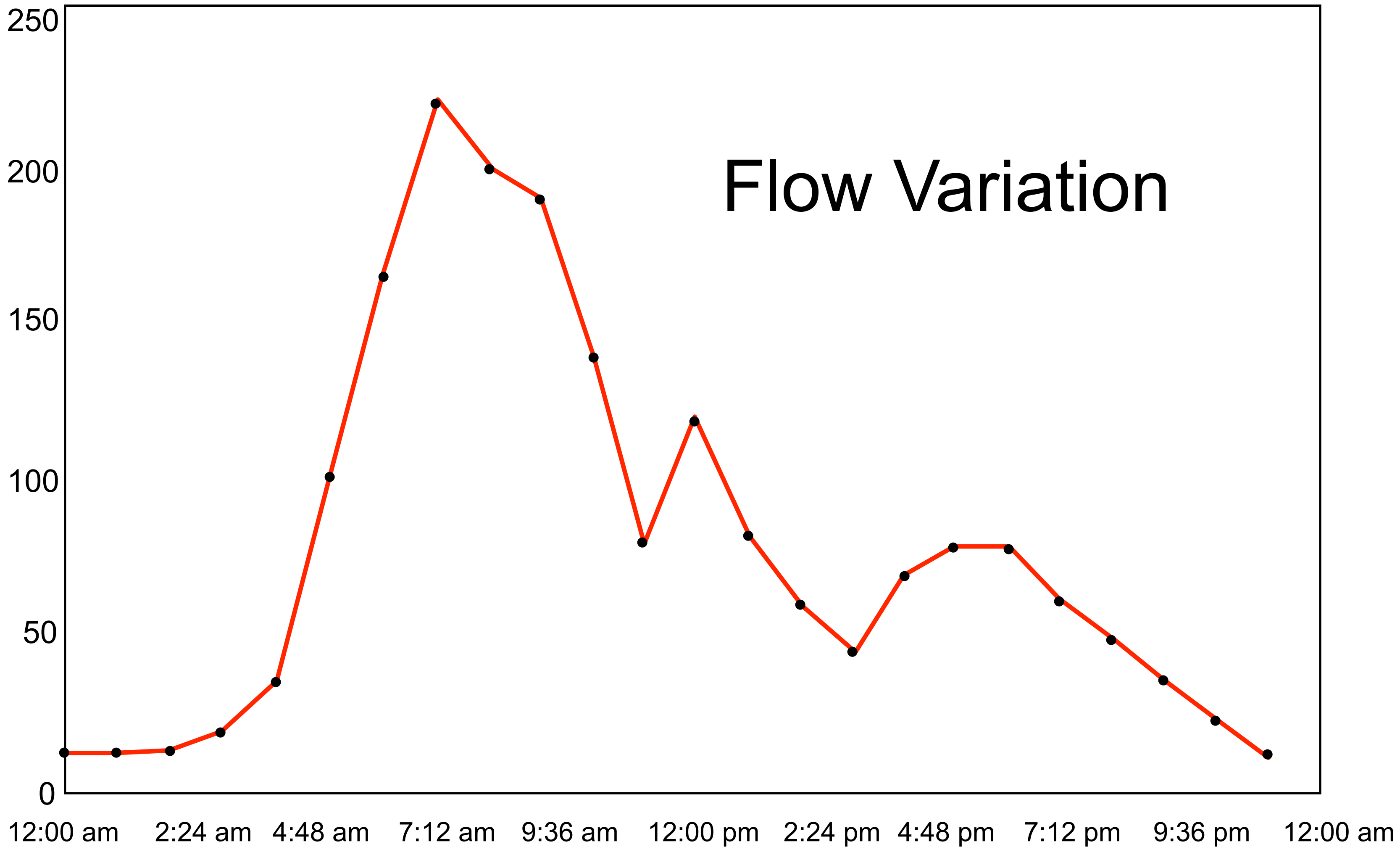
PRV Pressure Drop

Pressure reducing valves typically have a pressure drop of up to **5-8 psi** which must be taken into account when sizing the pump/motor.

Varying System Loads



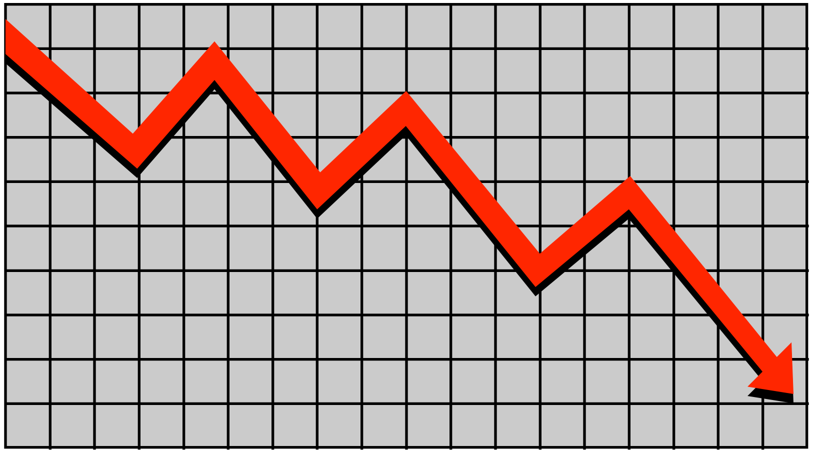
Booster systems experience widely varying system loads during the course of a day



Large Apartment Complex

Varying Suction Pressure

When not drawing from a tank, booster systems can experience a widely varying suction pressure.

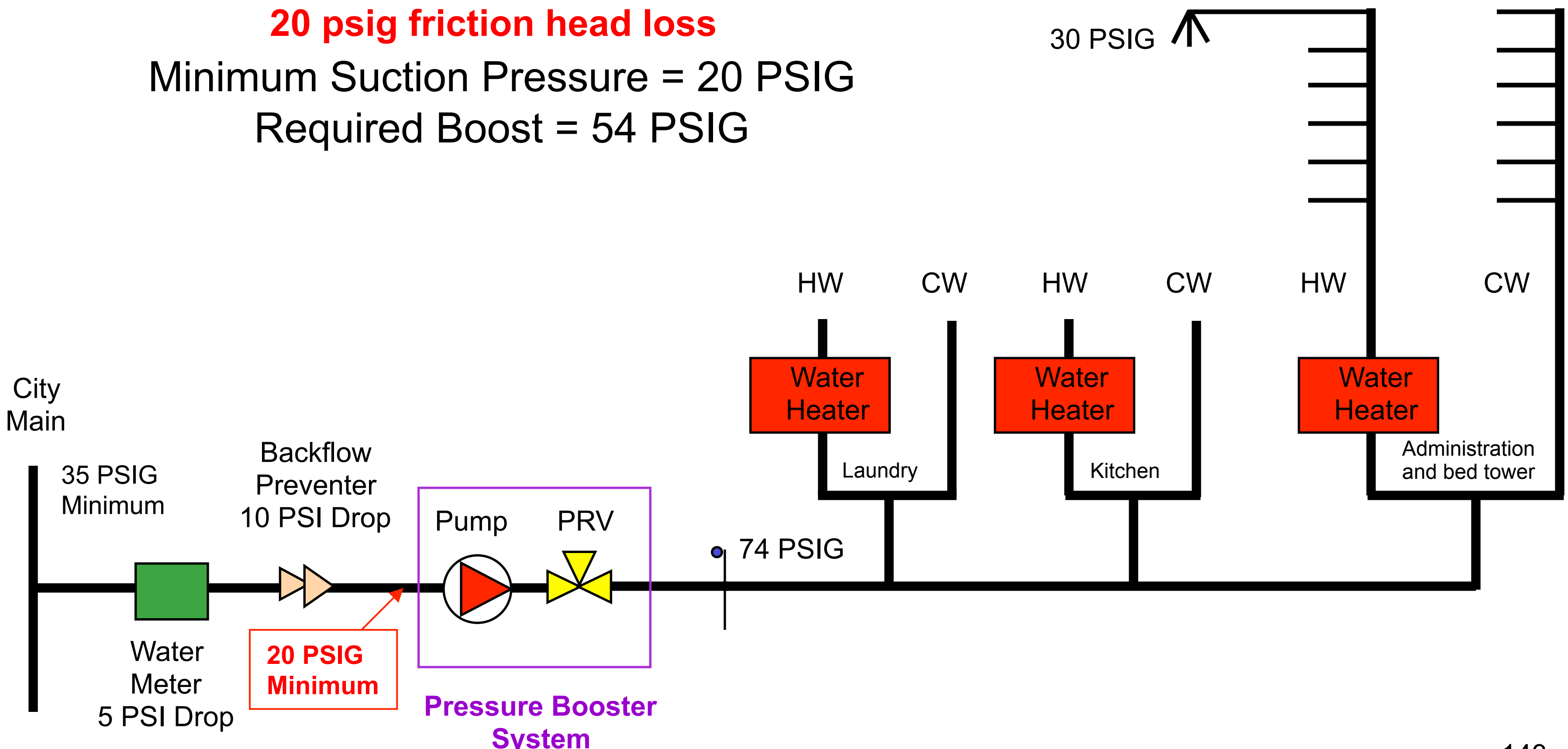


System Efficiency

Maximum Design System Flow = 400 GPM
Required Discharge Pressure = 74 PSIG

30 psig residual pressure
24 psig static pressure
20 psig friction head loss

Minimum Suction Pressure = 20 PSIG
Required Boost = 54 PSIG

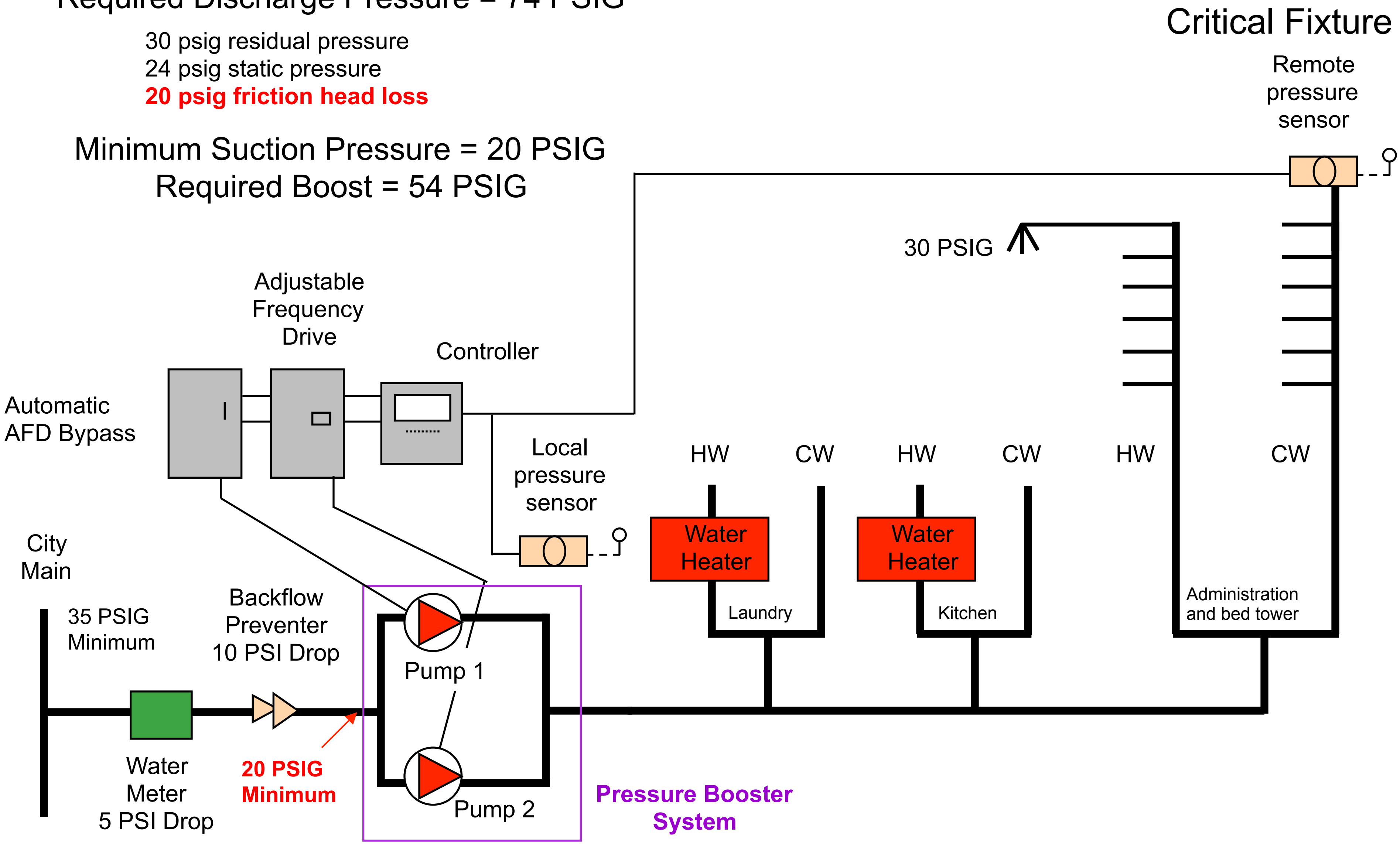


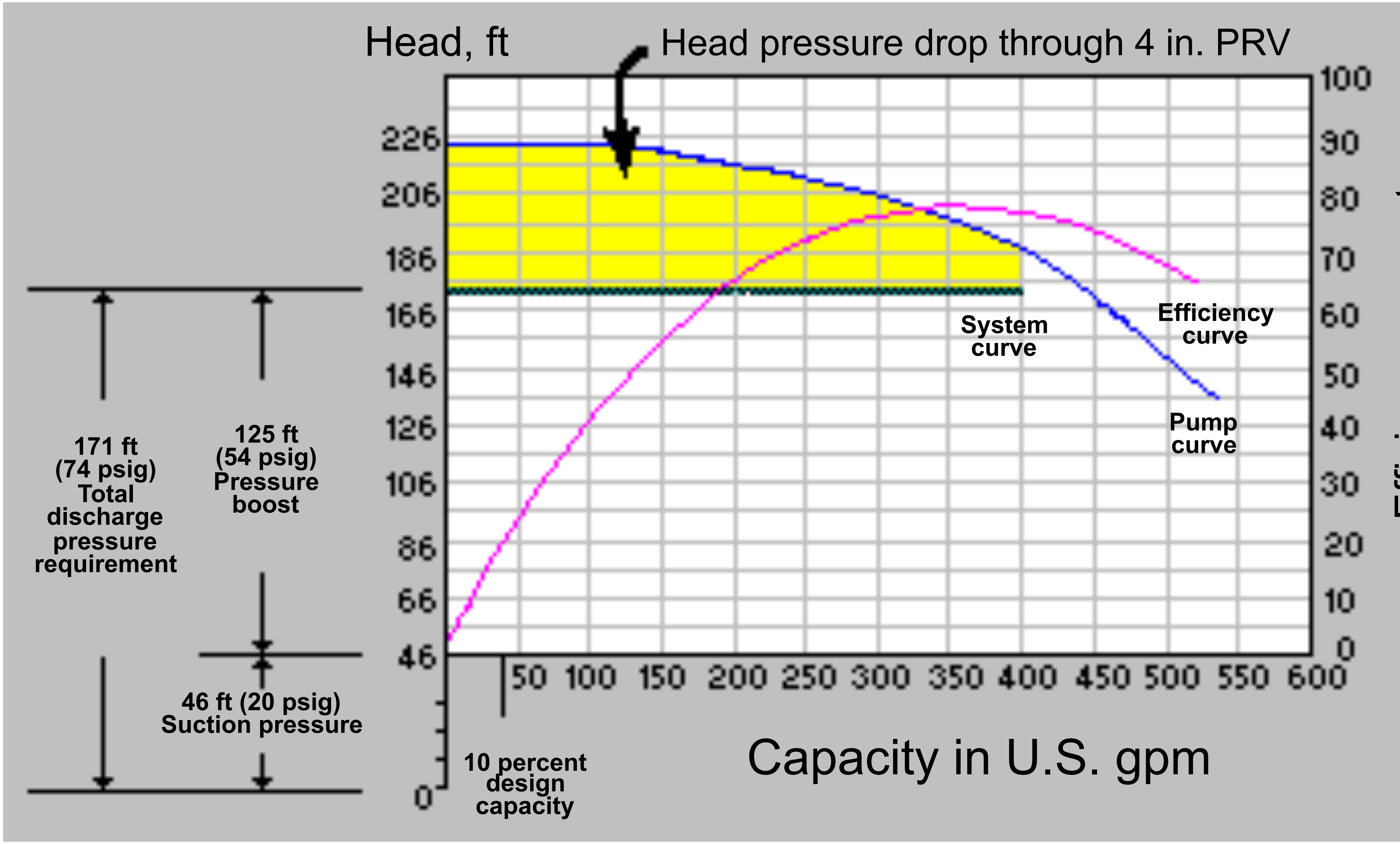
Domestic water pressure boosting system with adjustable frequency pump drives.

Maximum Design System Flow = 400 GPM
Required Discharge Pressure = 74 PSIG

30 psig residual pressure
24 psig static pressure
20 psig friction head loss

Minimum Suction Pressure = 20 PSIG
Required Boost = 54 PSIG





Constant-speed domestic water pressure boosting system with a single 20 hp, 3500 rpm pump and a 4 in. pressure reducing valve. Design conditions are 400 gpm at 125 ft boost.

Relationships for Remote Sensor

(Mounted at Critical Fixture)

Setpoint = Residual Pressure

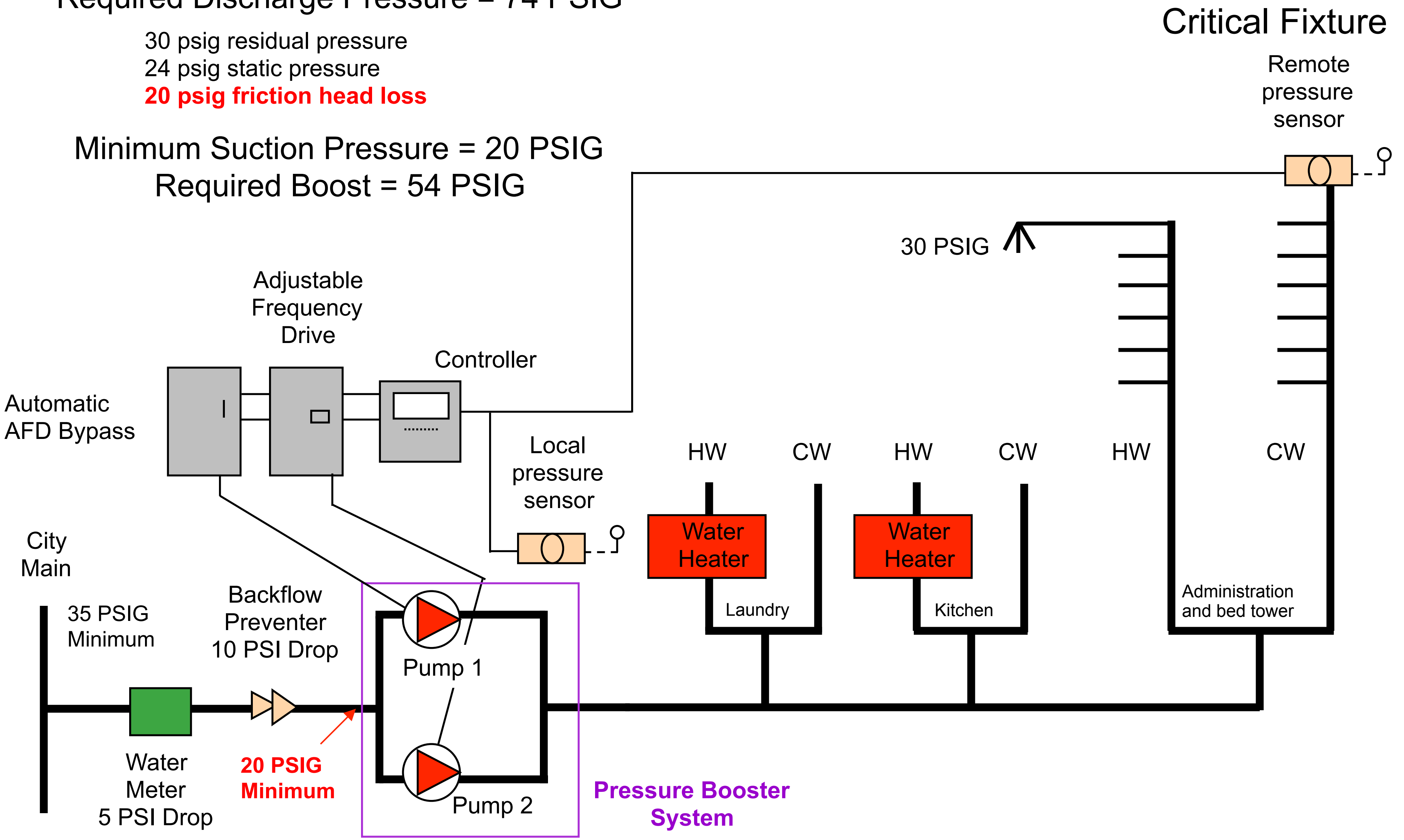
30 PSIG

Domestic water pressure boosting system with adjustable frequency pump drives.

Maximum Design System Flow = 400 GPM
Required Discharge Pressure = 74 PSIG

30 psig residual pressure
24 psig static pressure
20 psig friction head loss

Minimum Suction Pressure = 20 PSIG
Required Boost = 54 PSIG



Effects of Sensor Location on Example System

	Local Sensor	**Remote Sensor**
Set Point	74 psig	30 psig
Control curve	Little change with flow	Significant head reduction at lower flows
Speed reduction achievable	**10 percent**	**26 percent**

AOC Review

Two constant speed pumps, 50/50 percent split	$6,792/yr.
Two variable speed pumps, local sensor, 50/50 percent split	$3,566/yr.
Two variable speed pumps. remote sensor, 50/50 percent split	$2,537/yr.

The Smart $aver™ Incentives Program Carolinas

Using high-efficiency pumps and variable-frequency drive systems with high-efficiency motors can significantly increase savings. Pump curves are required along with the application to receive a rebate.

Motor Incentives

For all motor operations > 2000 hours per year

HP	Incentives
From 1 hp to 5 hp	$10.00/hp
From 25 hp to 100hp	$5.00/hp

Note: Efficiency ratings are based on NEMA Premium™ standards.
Visit www.duke-energy.com for required efficiency levels.

Pump Incentives

For all pump operations > 2000 hours per year

HP	Incentive
From 5 hp to 20 hp	From $170.00 to $400.00/pump

Note: Based on the pump curve, efficiencies must meet the standards outlined.
Visit www.duke-energy.com for required efficiency levels.

Variable Frequency Drives

For VFD operations applied to Chilled Water Pumps > 2000 hours per year

HP	Incentive
From 1.5 hp to 50 hp	Up to $110.00/hp

Visit www.duke-energy.com for required efficiency levels.

A **cool** way to lower your operating costs

Cooling commercial or industrial facilities can be costly. High-efficiency cooling equipment can cut summer energy costs significantly. Whether building, remodeling, or replacing existing equipment, high-efficiency cooling equipment saves energy and money.

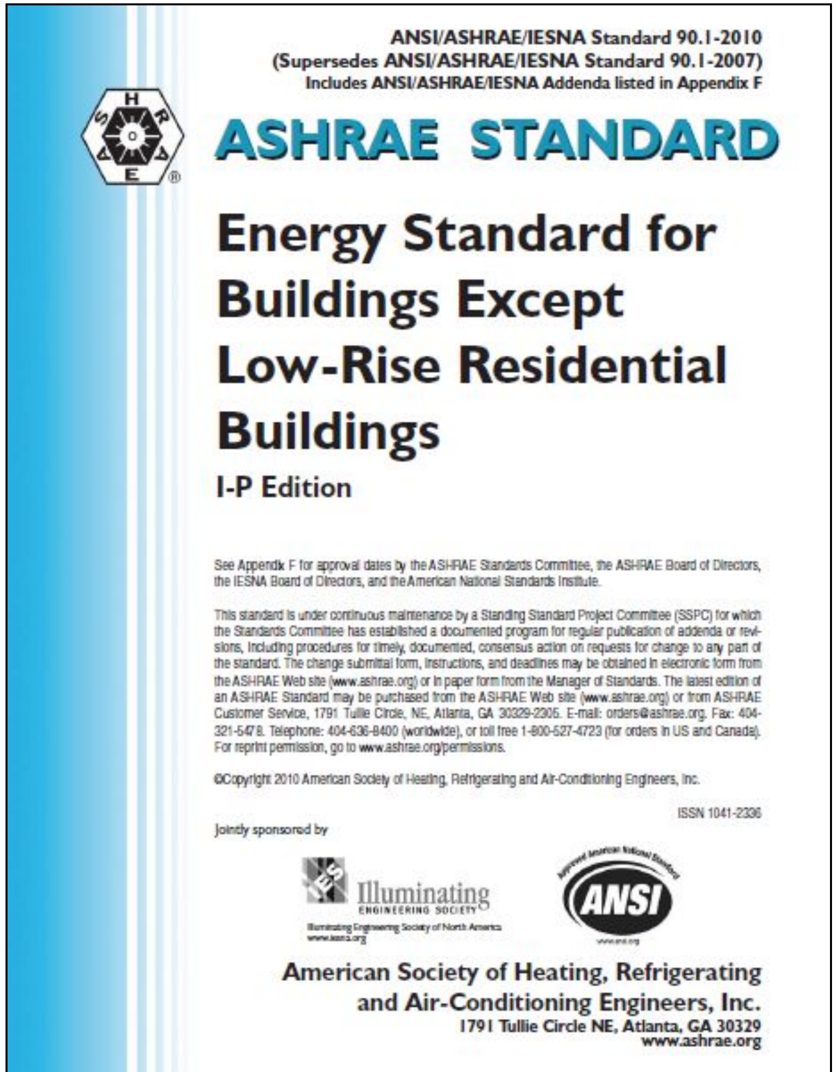
Cooling Equipment and Water Heating Incentives

For cooling operations > 1500 hours per year

Units	Incentives
Unitary & Rooftop A/C or Heat Pumps	Up to $40.00/ton
Air/Water-Cooled Chillers	Up to $25.00/ton
Heat Pump Water Heaters	Up to $9,000.00/unit
Setback Programmable Thermostats	$50.00/thermostat

Note: Incentive amounts vary depending on Efficiency Ratings and BTUH ranges.
For specific details, visit **www.duke-energy.com**.

ASHRAE STANDARD



ANSI/ASHRAE/IESNA Standard 90.1-2010
(Supersedes ANSI/ASHRAE/IESNA Standard 90.1-2007)
Includes ANSI/ASHRAE/IESNA Addenda listed in Appendix F

ASHRAE STANDARD

Energy Standard for Buildings Except Low-Rise Residential Buildings

I-P Edition

See Appendix F for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IESNA Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site (www.ashrae.org) or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE Web site (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

ISSN 1041-2336

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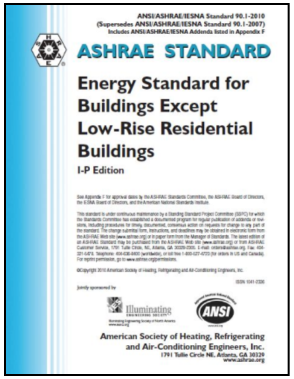
ANSI/ASHRAE/IESNA/Standard 90.1-2010 (I-P Edition)

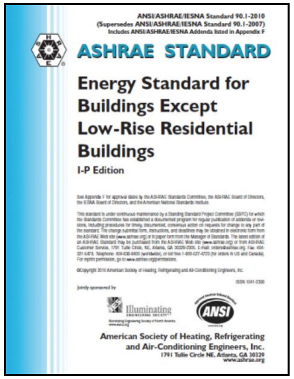
States to Use 90.1-2010 by Oct. 18, 2013



WASHINGTON—ASHRAE's Washington office is reporting that the U.S. Department of Energy (DOE) has determined that ANSI/ ASHRAE/IES Standard 90.1-2010, *Energy Standard for Buildings Except Low-Rise Residential Buildings,* saves more energy than Standard 90.1-2007. Specifically, DOE found national source energy savings of approximately 18.2%, and site energy savings of approximately 18.5%, when comparing the 2010 and 2007 versions of Standard 90.1. As a result of this week's **DOE final determination, states are required to certify by Oct. 18, 2013 that that have reviewed the provisions of their commercial building code regarding energy efficiency and updated their code to meet or exceed Standard 90.1-2010.**

CHAPTER 10

OTHER EQUIPMENT



SECTION 10.4
Mandatory Provisions

10.4.2 Service Water Pressure Booster Systems. Service water pressure booster systems shall be designed such that:

a. One or more pressure sensors shall be used to vary pump speed and/or start and stop pumps. The sensor(s) shall either be located near the **critical fixture(s)** that determine the pressure required, **or logic** shall be employed that adjusts the setpoint to simulate operation of remote sensor(s).

b. **No device(s)** shall be installed for the purpose of reducing the pressure of all of the water supplied by any booster system pump or booster system, **except for safety devices**.

c. **No booster** system pumps shall operate when there is **no service water flow**.

Required Addition to all Pressure Booster Master Specifications

To meet ASHRAE 90.1-2010 standard and DOE building code requirement by October 18th, 2013 the variable speed pressure booster shall control to a **remote sensor at the critical fixture or logic to vary the local discharge pressure setpoint based on demand** to simulate the operation of a remote sensor.

"It's The Law"


The End!
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