PLUMBING WATER SYSTEMS
DOMESTIC HW RECIRCULATION

ASPE Michigan and Ohio Chapters – 2017

By R L Deppmann Company – Norman Hall

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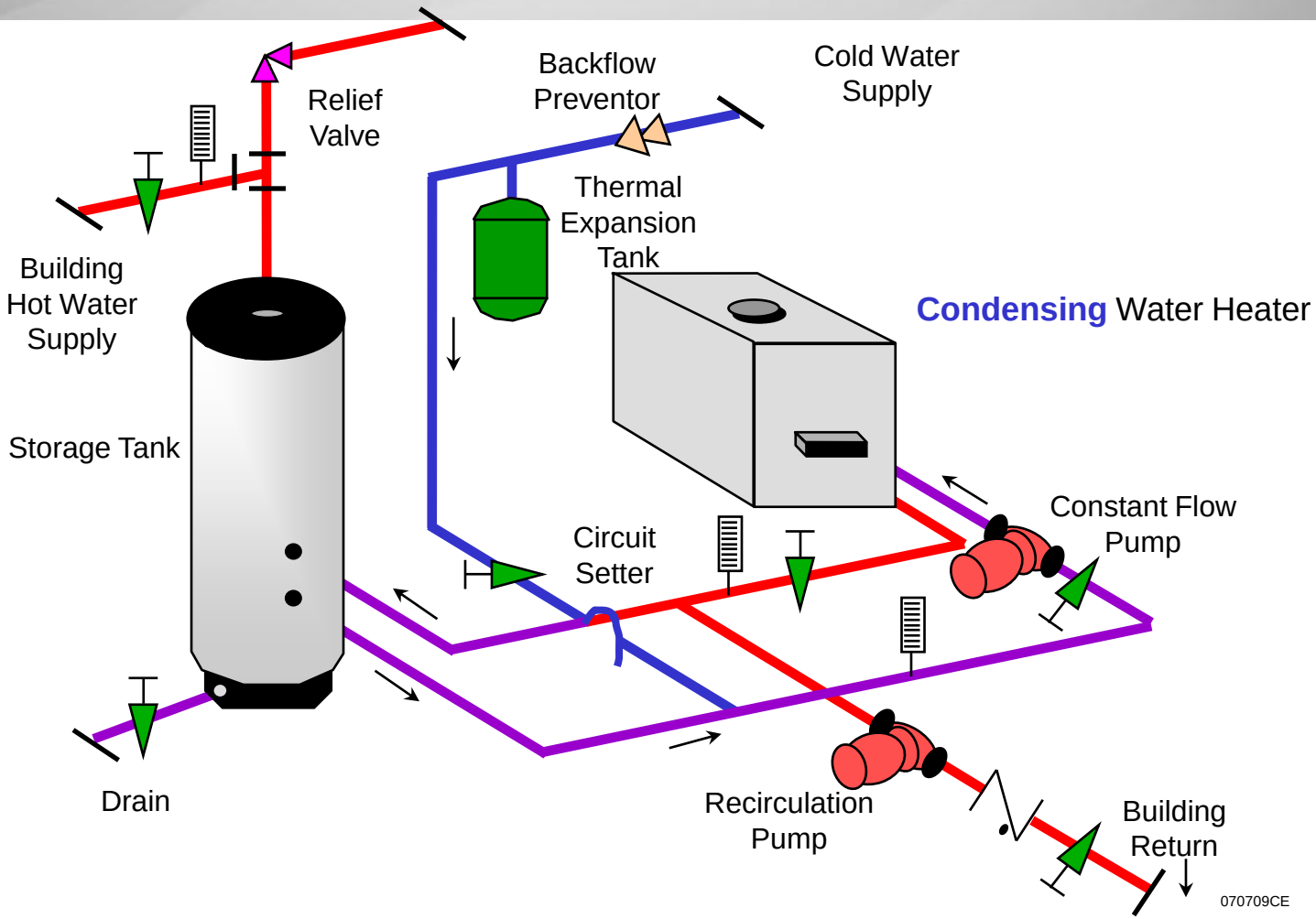
Relief
Valve
Backflow
Preventor
Cold Water
Supply
Thermal
Expansion
Tank
Building
Hot Water
Supply
Condensing Water Heater
Storage Tank
Constant Flow
Pump
Circuit
Setter
Drain
Recirculation
Pump
Building
Return
070709CE

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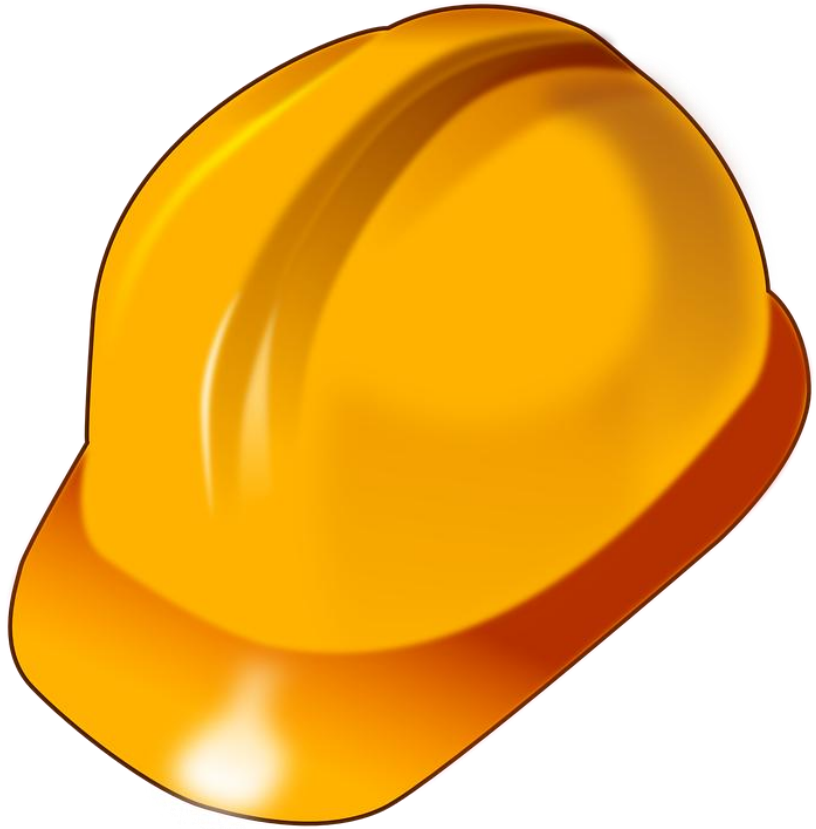
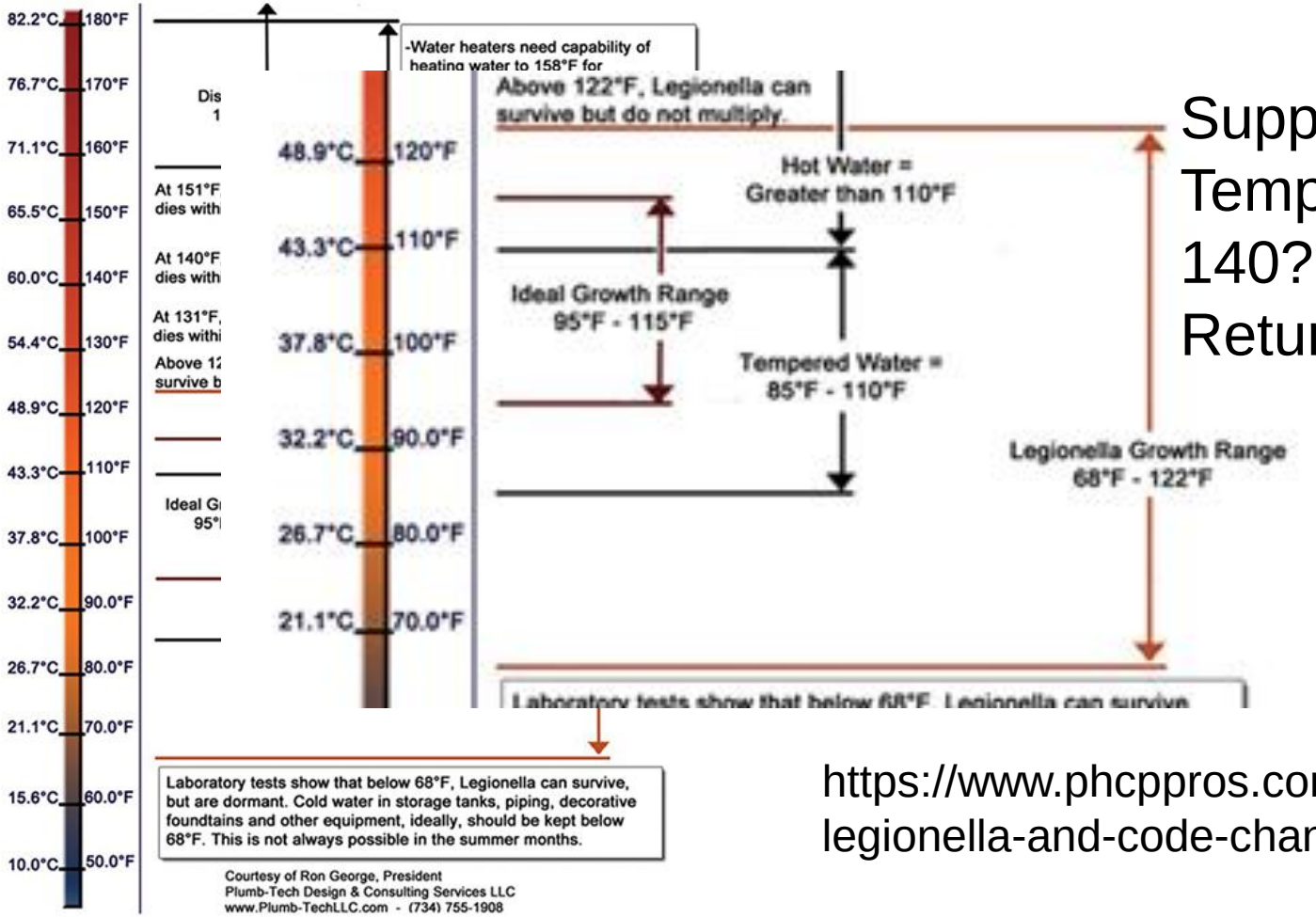
TOPICS DOMESTIC HW RECIRCULATION

- **People Safety**



LEGIONELLA GROWTH – PRESENCE, TEMPERATURE, AND STAGNATE



Supply Temperatures
140?
Return 124?

https://www.phcppros.com/articles/2263-legionella-and-code-change-submittals

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SCALDING NEED TO ID AND PROTECT AT FIXTURE (POINT OF USE)

Water Temperature:	Time for a third degree burn to occur:
155° F	1 second
148 ° F	2 seconds
140 ° F	5 seconds
133° F	15 seconds
127 ° F	1 minute
124 ° F	3 minutes
120 ° F	5 minutes
100 ° F	Safe temperature for bathing

http://burnprevention.org/scald-prevention/

DESIGN TEMPERATURES

Your choices in design will determine, for the most part, the return temperature.

http://www.policymed.com/2016/03/cms-proposed-rule-drastically-changes-the-way-medicare-pays-for-part-d-drugs.html

ASHRAE GUIDELINE 12? CHANGES STILL COMING

Not seen the final version with comments ending Sept 11th BUT……

One Comment: Minimum water temperature of 124°F maybe coming?

So If the supply is 140°F and the system insulation allows a 10°F drop. Return insulation can allow 6°F drop.

TOPICS DOMESTIC HW RECIRCULATION

- **Code Compliance**

http://www.thebluediamondgallery.com/wooden-tile/c/compliance.html

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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.

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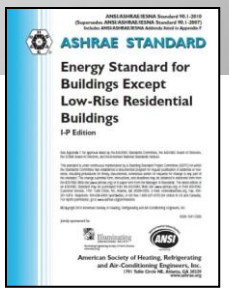
CHAPTER 7

SERVICE WATER HEATING



ASHRAE 90.1
2010 & 2013

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.

NO??

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**.

NO??

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IEC - 2015

C404.6.1 Circulation systems. Heated-water circulation systems shall be provided with a circulation pump. The system return pipe shall be a dedicated return pipe or a cold water supply pipe. Gravity and thermo-syphon circulation systems shall be prohibited. Controls for circulating hot water system pumps shall **start the pump** based on the **identification of a demand** for hot water within the occupancy. The controls shall **automatically turn off the pump** when the water in the circulation loop is at the **desired temperature and** when there is **no demand for hot water**.

NO??

Department of Veterans Affairs VHA Directive 1061
Veterans Health Administration Transmittal Sheet
Washington, DC 20420

VHA Directive 1061
August 13, 2014

Legionella Disease and Scald Injury from Potable Domestic Water Systems
PREVENTION OF HEALTHCARE-ASSOCIATED *LEGIONELLA* DISEASE AND SCALD INJURY FROM POTABLE WATER DISTRIBUTION SYSTEMS

b. Water Temperature. VHA requirements for water temperature limits for *Legionella* control in the building's potable hot and cold water distribution systems are as follows:

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VHA Directive 1061

1) **Hot Water Distribution Systems.** If a building uses **domestic hot water storage tanks**, water temperature of all such storage tanks must be maintained at a **minimum of 140 degrees Fahrenheit (°F)** (60 degrees Celsius (°C)) to prevent *Legionella* growth. The **minimum discharge temperature for instantaneous and semi-instantaneous heat exchangers must be 130°F** (54.4°C). Water in the potable **hot water distribution system piping must be no lower than 124°F** (51.1°C) (prior to any temperature-reducing mixing valve or anti-scald device at the water outlet). ***NOTE:*** *To limit the risk of scald injury, hot water in the distribution system piping should be maintained at the lowest temperature that* ***will ensure the minimum of 124°F*** *(51.1°C) throughout.*

(2) **Cold Water Distribution Systems.** ***Legionella*** **can grow in the building's cold water** distribution system as water temperatures increase **above 67°F (**19.4°C). Cold water temperature throughout the system should be **maintained at or below 67°F** (19.4°C) to the greatest extent practicable to inhibit growth. ***NOTE:*** *Use of piping system insulation, automatic drain devices and* ***recirculation can limit the rate and*** *duration of increased temperatures within the cold water*

(4) **Water Temperature Control at the Outlet.** Buildings subject to this Directive must minimize the risk of scald injury to patients, residents, staff and visitors. The use of mixing valves and anti-scald devices on all outlets where people access water from the potable hot water distribution system is required in order to prevent scald injury. The **water temperature delivered from the outlet must not exceed 110°F (**43.3°C). See Appendix B for specific requirements and guidelines for the prevention of scald injury

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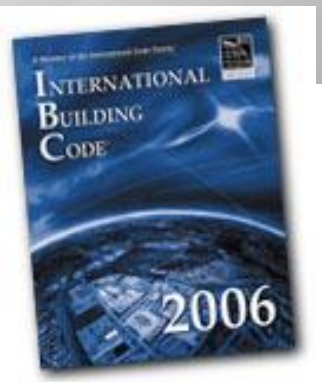
WHAT DO WE RECIRC?

SECTION 607

HOT WATER SUPPLY SYSTEM



IBC 2012 CHANGED TO 50 FEET

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.

INTERNATIONAL PLUMBING CODE

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THE AFFECT OF LOW FLOW FIXTURES

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)

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LOW FLOW FIXTURE – COMMON PROBLEM

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

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

Example: 50 feet at .35 FPS = over 2 minutes
Even at .5 FPS
ARE YOU GOING TO WAIT?

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BSR/ASHRAE/USGBC/ASPE/AWWA Standard 191P (Public Review Draft)

Standard for the Efficient Use of Water in Building, Site, and Mechanical Systems

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.

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International Plumbing Code Update 2015

IPC accept “cross connections” as an acceptable design practice

Local plumbing codes will rule

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IEC - 2015

A water distribution system having recirculation pumps that **pump** water from a **heated-water supply pipe back** to the heated-water source **through a cold-water supply pipe** shall be a ***demand recirculation water system*.**

- Pumps shall start on signal from user, appliance, or flow
- Control shall limit cold water flow to

104°F

UNDER-SINK PUMP OR CIRCULATOR

How [redacted]t Autocirc® works

No Return Line Required!

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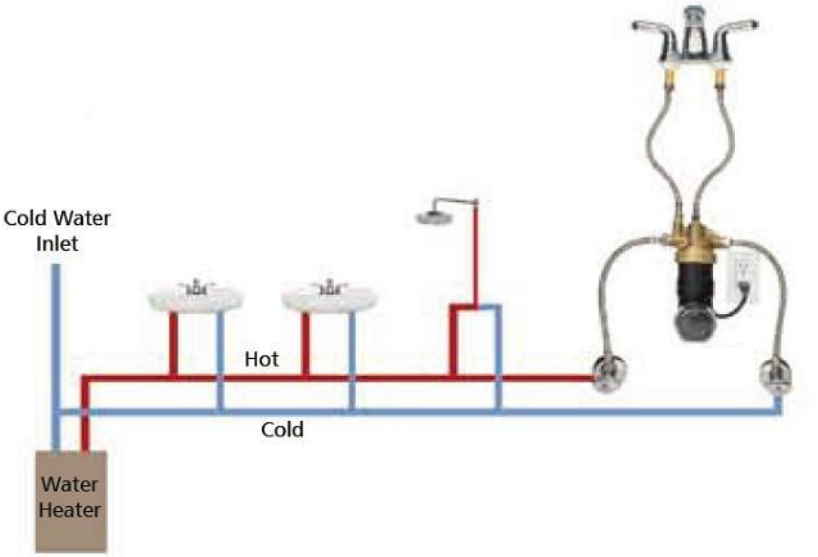
LOW FLOW RATES – AVOIDS RETURN LINE

On Demand Recirculation System

Installation

Pump should be installed under the **farthest fixture** from the water heater



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LOW FLOW RATES – AVOIDS RETURN LINE

wireless….how it works!

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

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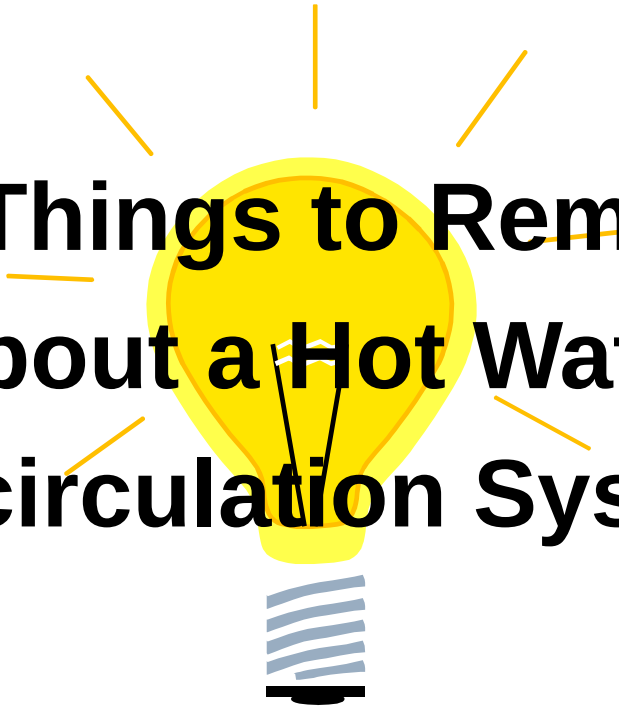
DESIGN THE RECIRCULATION SYSTEM

https://www.army.mil/article/163533/installation_planning_board_to_revitalize_army_laboratory_sites

Four Things to Remember about a Hot Water Recirculation System



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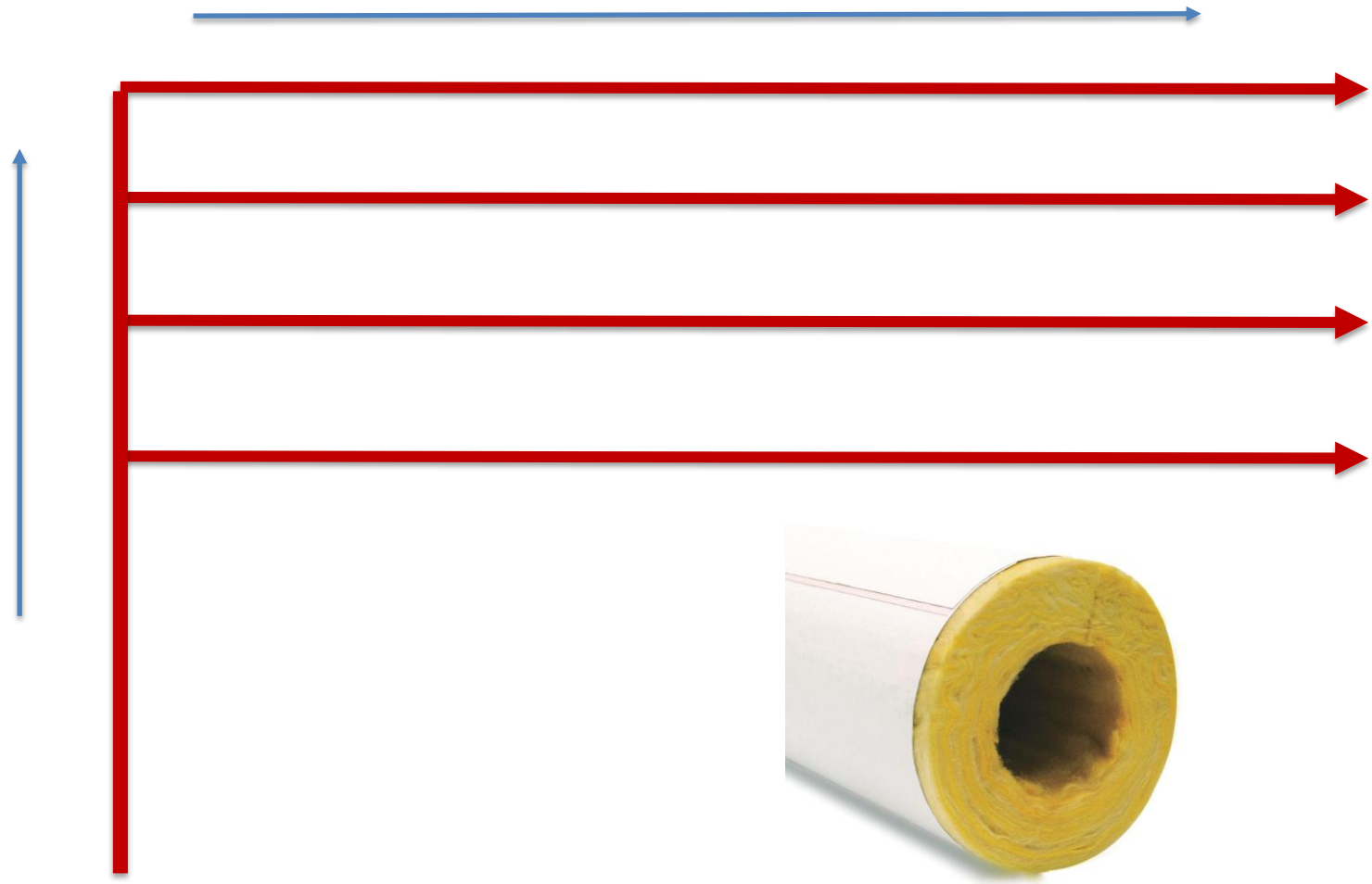
SIMPLE RULE ONE

Flow rate is determined by **supply piping heat loss** to the **farthest faucet or riser** at a **given delta temperature**

Flow Rate is determined by the **total heat loss** of the system supply at the given ΔT

$$\text{TOTAL GPM} = \text{BTUH}/(10 \times 500)$$

COMFORT AND SAFETY



FARTHEST LOOP VS. TOTAL LOSS

Pipe Size	Conductivity	Insulation Thickness	Sq Ft/ft	BTU/Ft	Total Feet	BTU Total
0.75	0.3	1	0.2	4.2	400	1680
1	0.3	1	0.27	5.67	0	0
1.25	0.3	1	0.33	6.93	360	2494.8
1.5	0.3	1.5	0.4	5.6	0	0
2	0.3	1.5	0.53	7.42	60	445.2
3	0.3	1.5	0.79	11.06	0	0
4	0.3	1.5	1.05	14.7	110	1617
6	0.3	1.5	1.57	21.98	0	0
8	0.3	1.5	2.1	29.4	0	0
TOTAL BTUH		ZONE 1				6237
Delta T						10
GPM						1.25

Pipe Size	Conductivity	Insulation Thickness	Sq Ft/ft	BTU/Ft	Total Feet Pipe	BTU Total
0.75	0.3	1	0.2	4.2	400	1680
1	0.3	1	0.27	5.67	0	0
1.25	0.3	1	0.33	6.93	360	2494.8
1.5	0.3	1.5	0.4	5.6	0	0
2	0.3	1.5	0.53	7.42	60	445.2
3	0.3	1.5	0.79	11.06	0	0
4	0.3	1.5	1.05	14.7	15	220.5
6	0.3	1.5	1.57	21.98	0	0
8	0.3	1.5	2.1	29.4	0	0
TOTAL BTUH		ZONE 2				4840.5
Delta T						10
GPM						0.97

Pipe Size	Conductivity	Insulation Thickness	Sq Ft/ft	BTU/Ft	Total Feet	BTU Total
0.75	0.3	1	0.2	4.2	400	1680
1	0.3	1	0.27	5.67	0	0
1.25	0.3	1	0.33	6.93	360	2494.8
1.5	0.3	1.5	0.4	5.6	0	0
2	0.3	1.5	0.53	7.42	60	445.2
3	0.3	1.5	0.79	11.06	0	0
4	0.3	1.5	1.05	14.7	15	220.5
6	0.3	1.5	1.57	21.98	0	0
8	0.3	1.5	2.1	29.4	0	0
TOTAL BTUH		ZONE 3				4840.5
Delta T						10
GPM						0.97
					PUMP TOTAL =	4.16

Pipe Size	Conductivity	Insulation Thickness	Sq Ft/ft	BTU/Ft	Total Feet Pipe	BTU Total
0.75	0.3	1	0.2	4.2	400	1680
1	0.3	1	0.27	5.67	0	0
1.25	0.3	1	0.33	6.93	360	2494.8
1.5	0.3	1.5	0.4	5.6	0	0
2	0.3	1.5	0.53	7.42	60	445.2
3	0.3	1.5	0.79	11.06	0	0
4	0.3	1.5	1.05	14.7	15	220.5
6	0.3	1.5	1.57	21.98	0	0
8	0.3	1.5	2.1	29.4	0	0
TOTAL BTUH		ZONE 4				4840.5
Delta T						10
GPM						0.97

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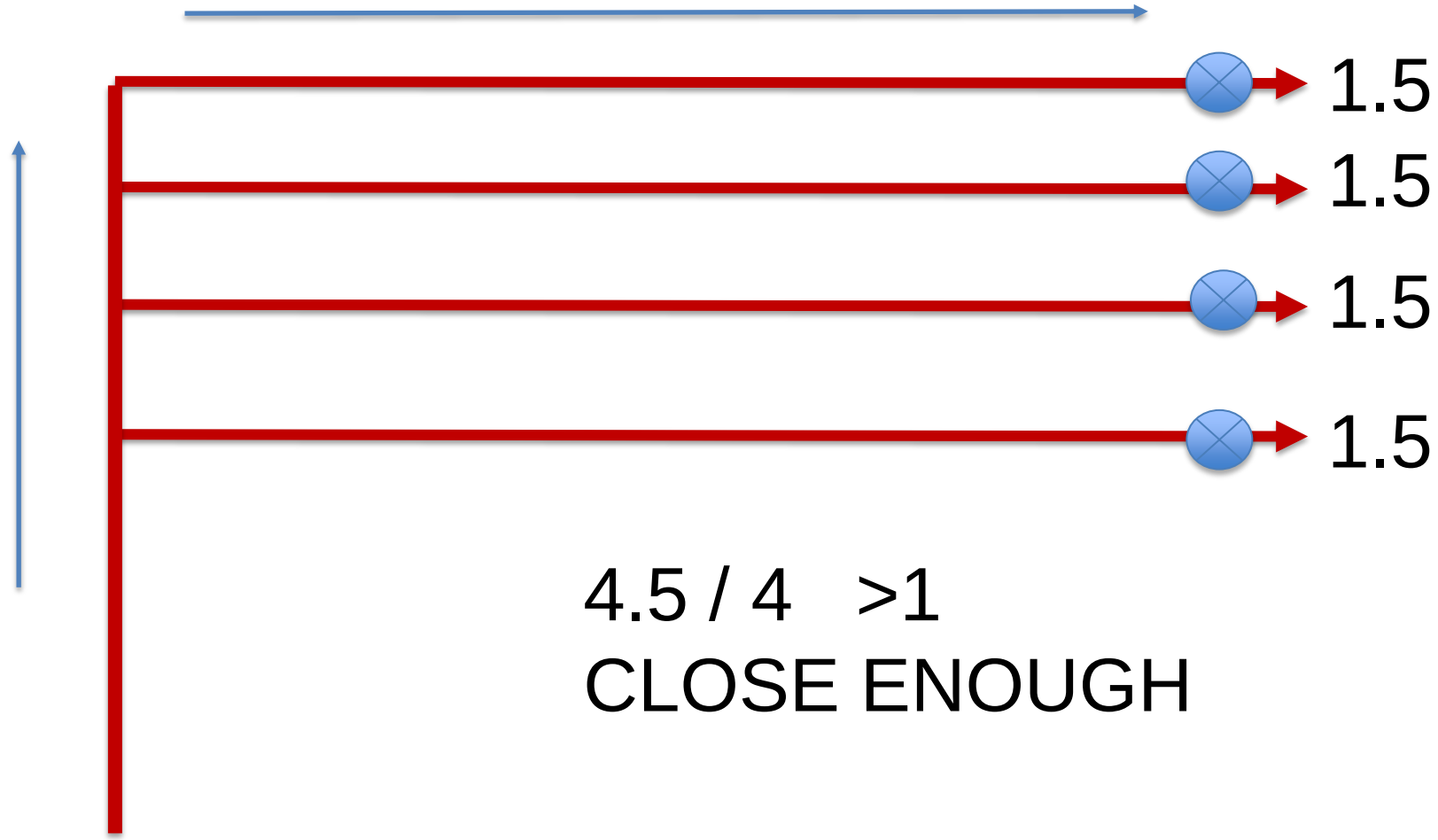
TOTAL BTUH LOSS FOR SUPPLY PIPE

	A	B	C	D	E	F	G
1	Pipe Size	Conductivity	Insulation Thickness	Sq Ft/ft	BTU/Ft	Total Feet Pipe	BTU Total
2	0.75	0.3	1	0.2	5	1600	8000
3	1	0.3	1	0.27	6	0	0
4	1.25	0.3	1	0.33	7	1440	10080
5	1.5	0.3	1.5	0.4	6	0	0
6	2	0.3	1.5	0.53	8	240	1920
7	3	0.3	1.5	0.79	12	0	0
8	4	0.3	1.5	1.05	15	155	2325
9	6	0.3	1.5	1.57	22	0	0
10	8	0.3	1.5	2.1	30	0	0
11							
12	**TOTAL BTUH**						**22325**
13	**Delta T**						**10**
14	**GPM**						**4.5**
15							

COMFORT AND SAFETY



4.5 / 4 >1

CLOSE ENOUGH

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SIMPLE RULES

Flow Rate is determined by the **total heat loss** of the system supply at the given ΔT

Heat loss in the **return line is only considered for minimum overall temperature limits and for minimum cycling load decisions**

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

The **recirculation return line** is usually **equal** in length to **supply main** length

BASIC RECIRCULATION DESIGN PROCEDURES (NORM HALL)

- Determine **Required** Recirculation Flow Rate (based on **heat loss** of supply pipe)
- Determine Type of **Balance** to specify
- Size return lines
- Determine **Flow-Friction Head Loss** in Recirculation
- Make the Energy decision. Slow the pump down but not stop it.
- Select Pump Based on **Flow Requirement** and **Head Loss**.

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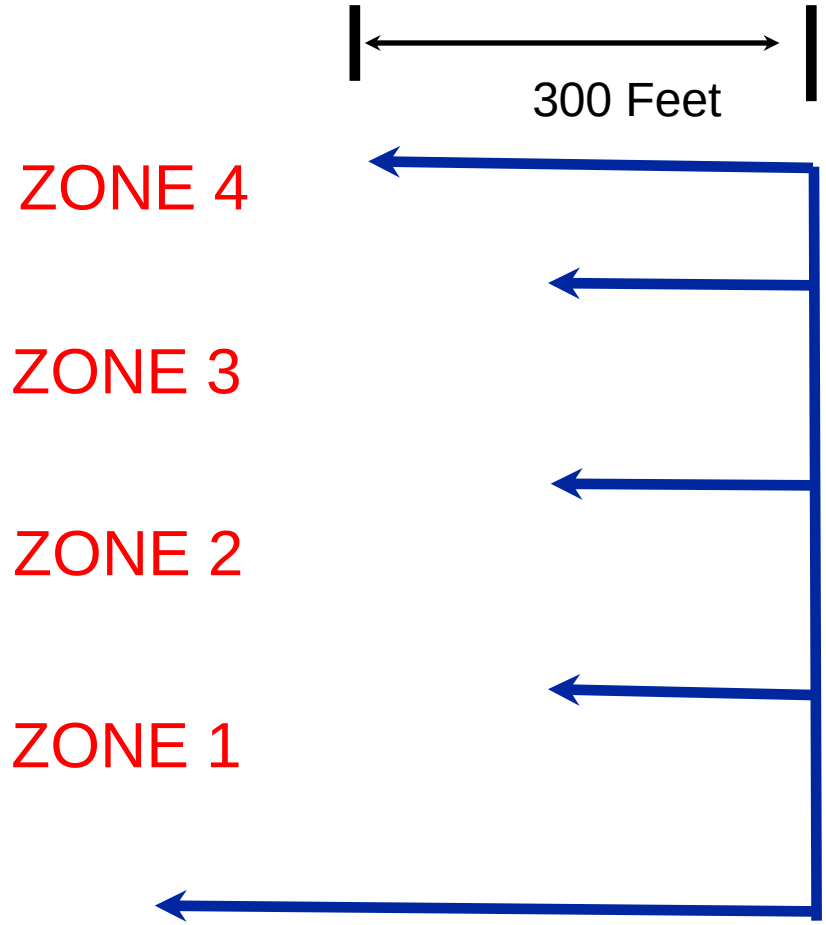
RECIRCULATION

Standard is to select a 10°F ΔT But your choice

I normally do not drop below ½ GPM per zone. Balance issues.

RECIRCULATION LOAD



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RECIRCULATION

Standard is to select a 10°F ΔT

Stay with ¾” minimum as a “Rule of Thumb”

I normally do not drop below ½ GPM per zone. Note that equal length runs in the same floor are somewhat self balancing

BASIC RECIRCULATION DESIGN PROCEDURES (NORM HALL)

- Determine **Required** Recirculation Flow Rate (based on **heat loss** of supply pipe)
- Determine Type of **Balance** to specify
- Size return lines
- Determine **Flow-Friction Head Loss** in Recirculation Lines
- Make the Energy decision. Slow the pump down but not stop it.
- Select Pump Based on **Flow Requirement** and **Head Loss**.

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ASHRAE Standard Project Committee 188 (SPC 188)

Prevention of Legionellosis Associated with Building Water Systems

ASHRAE Standard 188-2015

Legionellosis: Risk Management for Building Water Systems

ASHRAE BOD Approved 6-4-15

8.3 Balancing. All water systems shall be balanced, and a balance report for all water systems shall be provided to the building owner or designer

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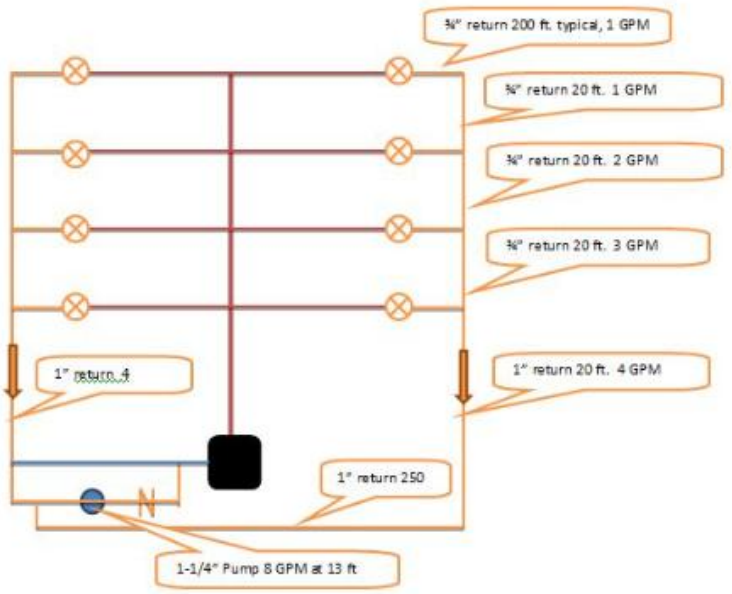
DETERMINE BALANCE TYPE

Manual Flow

Automatic Flow

Automatic Temperature



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MANUAL BALANCE & FLOW METER VALVES

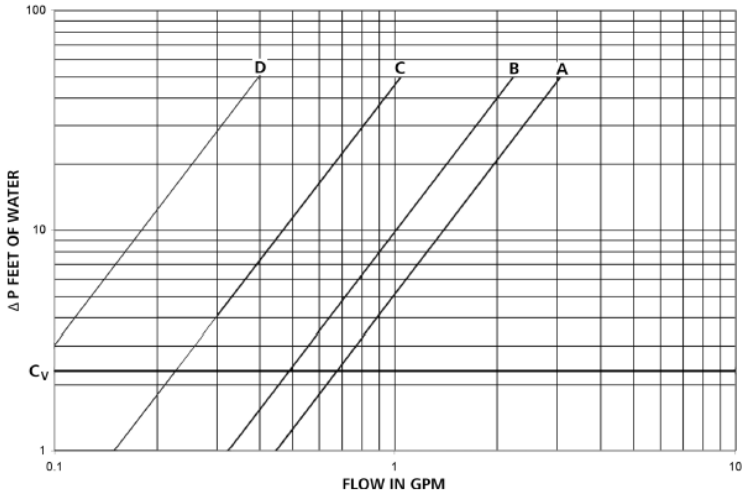
Low lead Design [redacted] ircuit Setter manual balance and flow measurement valve

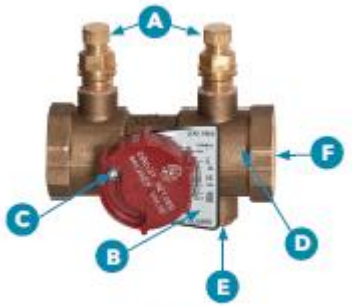
[redacted] Plus Calibrated Balance Valve

Performance Characteristics

Part No. 117410 and 117410LF Model No. RF-1/2 and RF-1/2LF

FOR SYSTEM BALANCING AND SYSTEM PRESSURE DROP





Circuit Setter Plus Lead-Free Brass

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AUTOMATIC FLOW BALANCE VALVES

Low lead
Design

Model “K” is a compact inline automatic flow controller that is factory set to automatically limit the flow to **within ±5%** The flow cartridge is removable from the valve body to provide ease of access for changeout, inspection and cleaning.

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TEMPERATURE CONTROLLED BALANCING VALVES

Should be available with or without high temperature bypass if you are using it.

- Manual or actuated bypass options.

Low Lead wetted surfaces. And NSF 61 certification if specified

Field adjustable temperature settings between 98°F – 150°F. (Who sets the device? Balance Contractor)

Accurate to ±3.6°F of set temperature.

Valve will never have 0 GPM flow to prevent stagnant water and pump deadheading.

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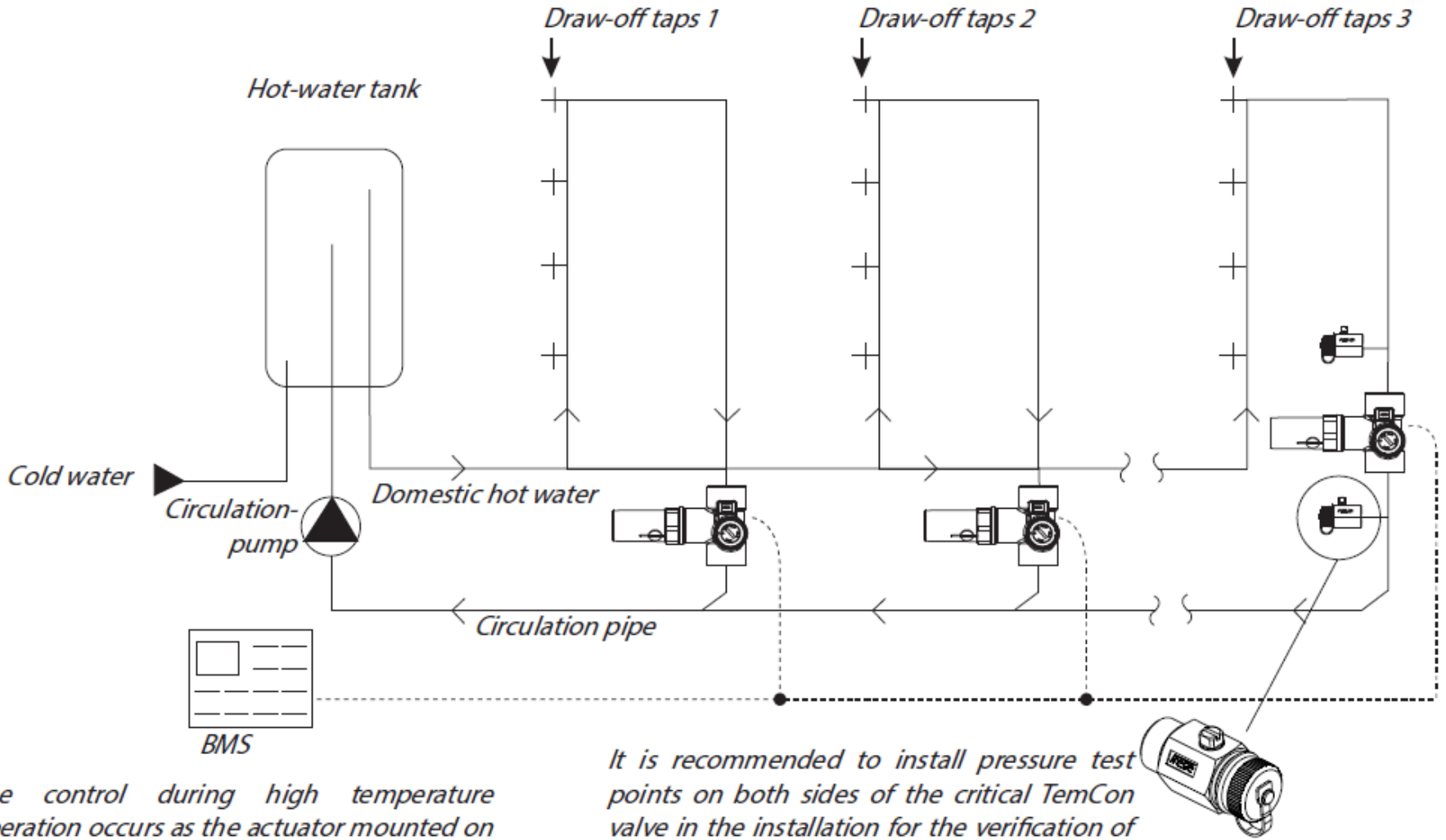

The control during high temperature operation occurs as the actuator mounted on the by-pass opens to a fixed Kv-value of 0.3.

It is recommended to install pressure test points on both sides of the critical TemCon valve in the installation for the verification of differential pressure.

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BASIC RECIRCULATION DESIGN PROCEDURES (NORM HALL)

- Determine **Required** Recirculation Flow Rate (based on **heat loss** of supply pipe)
- Determine Type of **Balance** to specify
- Size return lines
- Determine **Flow-Friction Head Loss** in Recirculation Lines
  - (Watch for large pressure drop items like PRVs)
- Make the Energy decision. Slow the pump down but not stop it.
- Select Pump Based on **Flow Requirement** and **Head Loss**.

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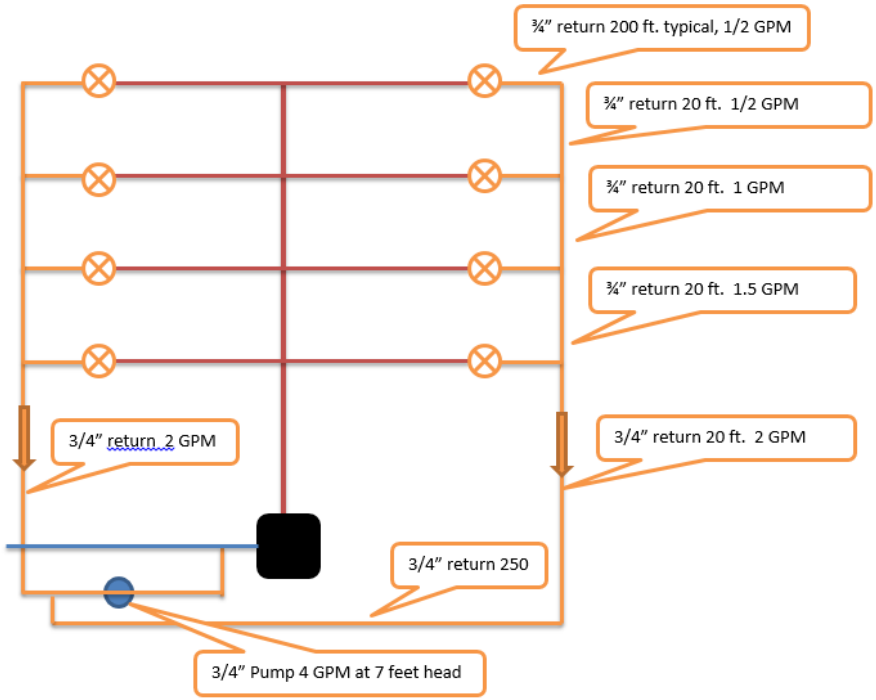
CALCULATING THE PUMP PRESSURE DROP

Pipe Size	Length	Flow	P. Drop/100	P. Drop ft.
3/4"	220	.5	0.1	0.2
3/4"	20	1	0.3	0.1
3/4"	20	1.5	0.62	0.1
3/4"	270	2	1.02	2.8
Check	Valve			0.5
Water	Heater			0.0
Sum				3.7
Fittings	25%			2.5
Final	Head			6.2



4 GPM @ 7 FEET

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THE ISSUE OF DIVERSITY

Why 1/2 GPM if 1/4 GPM will work?

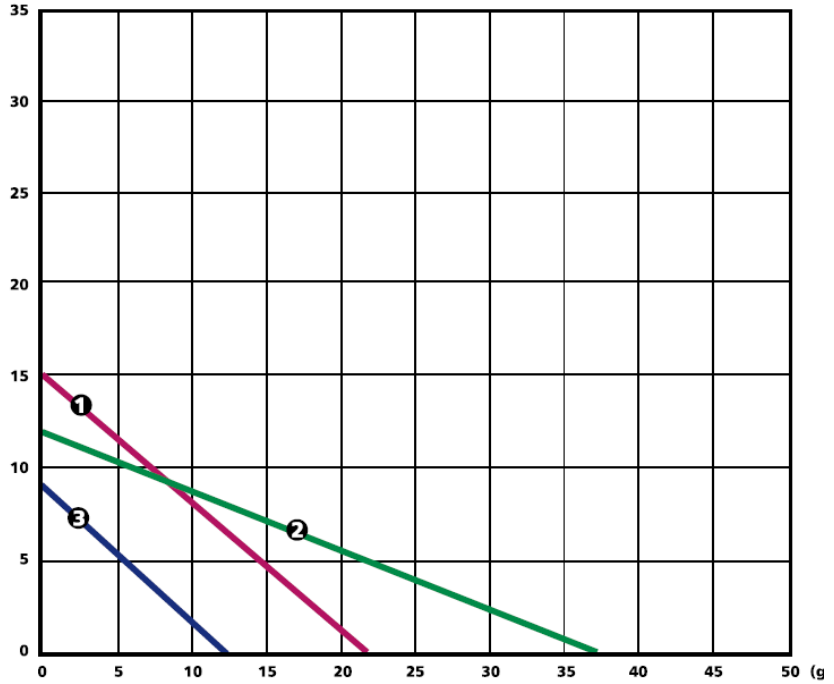
Balance setting issues

What happens if there is a laundry or kitchen at the beginning of the system?

THE ISSUE OF DIVERSITY

What happens if there is a laundry or kitchen at the beginning of the system? Might look at two pumps or STEEPER CURVE

But….if you select to get a Steeper curve, let the world in On the Secret in the schedule



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BASIC RECIRCULATION DESIGN PROCEDURES (NORM HALL)

- Determine **Required** Recirculation Flow Rate (based on **heat loss** of supply pipe)
- Determine Type of **Balance** to specify
- Size return lines
- Determine **Flow-Friction Head Loss** in Recirculation Lines
    - (Watch for large pressure drop items like PRVs)
- Make the Energy decision. Slow the pump down but not stop it.
- Select Pump Based on **Flow Requirement** and **Head Loss**.

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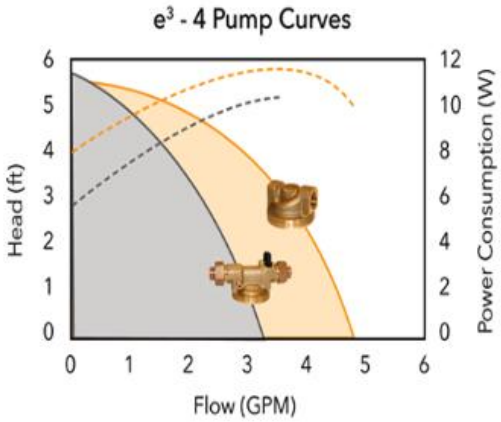
HOT TOPICS DOMESTIC HW RECIRCULATION

- **Energy Usage**

https://pixabay.com/en/earth-world-globe-eco-ecology-159132/

SMALL PUMPS – ECM WITH SMART CIRCUITS

3-4 GPM RANGE



10-12 GPM RANGE

- Small Smart Pump
  - ECM Motor
  - Variable speed

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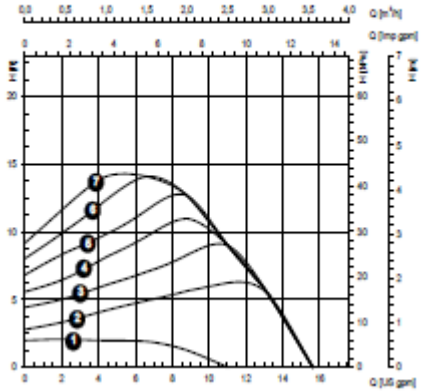
SMALL SMART PUMP – 10 TO 12 GPM

Proportional pressure (PP)	Turn the knob to any position between 1 and 7, with 7 being the highest, to set the speed of the pump. The pump automatically decreases its speed at low flow, thus providing energy savings. This mode is the default setting.
Constant pressure (CP)	Turn the knob to any position between 1 and 7, with 7 being the highest, to set the speed of the pump. The preset pressure remains constant, independent of the flow.
Constant speed (CS)	Turn the knob to any position between 1 and 7, with 7 being the fastest, to set the speed of the pump. The preset speed remains constant, independent of the flow rate.

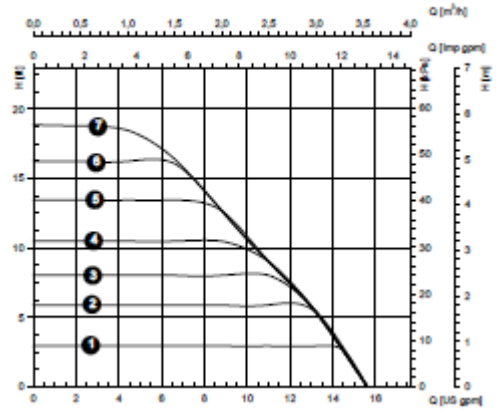
Temperature Balance

Flow Balance

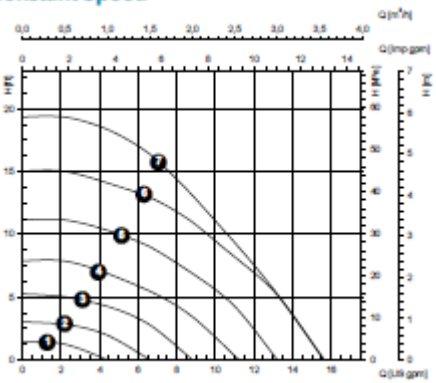
Proportional Pressure (default mode)



Constant Pressure



Constant Speed



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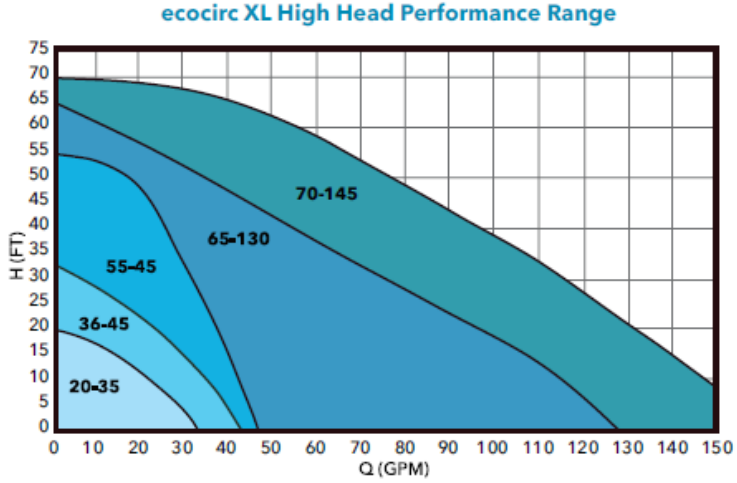
LARGER SMART PUMPS - INTELLEGENCE



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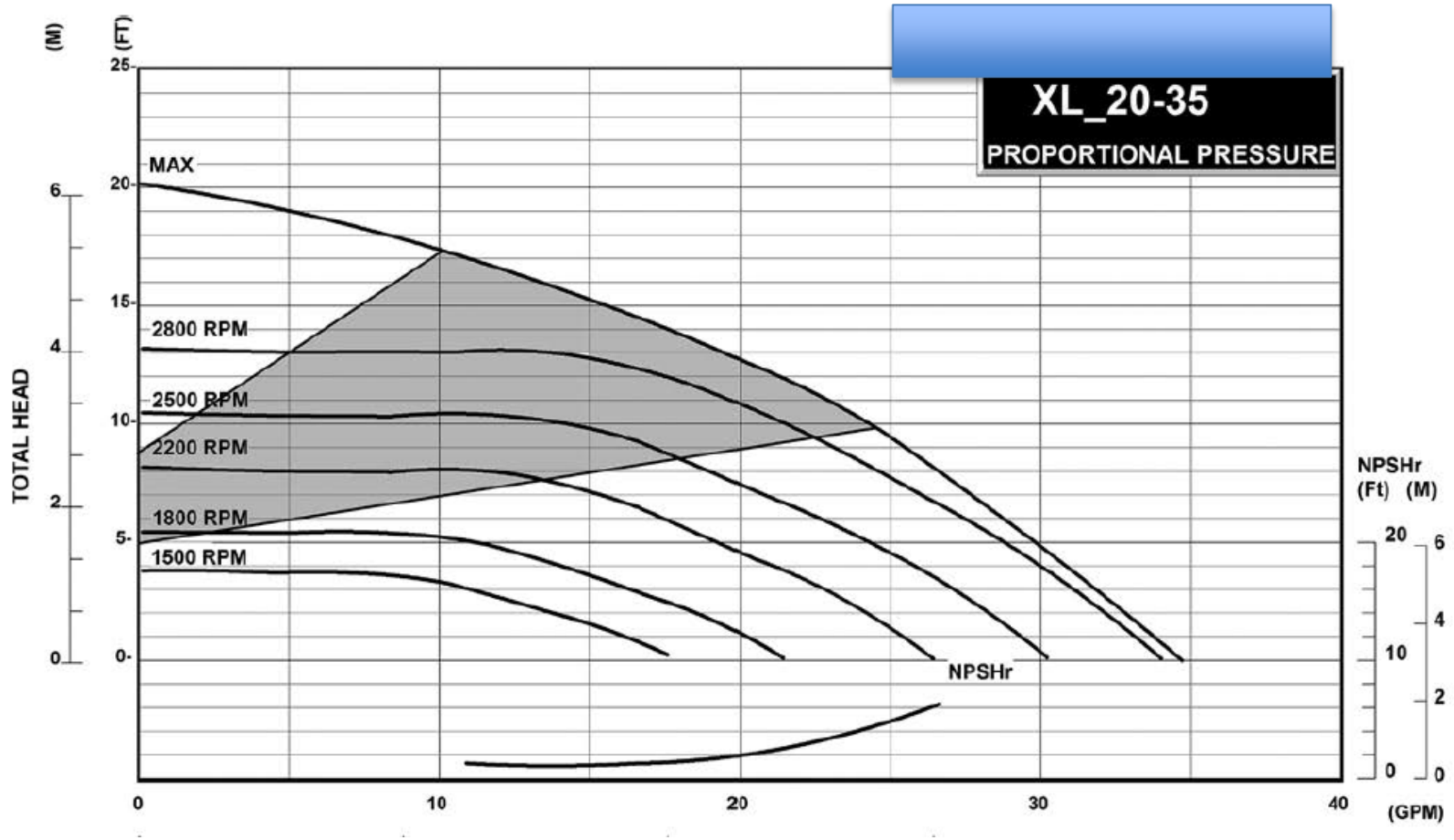
LARGER SMART PUMPS – INTERNAL TEMPERATURE OR FLOW



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TOPICS DOMESTIC HW RECIRCULATION

- **YOUR TIME**

QUICK SELECTION

- ½ GPM for 2500 BTUH – 1 GPM for 5000 BTUH
- Subject to your specification……
  - BTUH per foot = Pipe size X 5
  - Example: 4” pipe 100 feet long (4X5)=20 X 100 = 2000 BTUH
- Kyle can get you the spreadsheet I mentioned
- Temperature balance – No need to show flow rate
  - Select the pump and show the temperature balance valves.
  - If coupled with an ECM smart pump, you can overhead.

TOPICS DOMESTIC HW RECIRCULATION

- **Cost and Operation Recirc pumps**
  - **Good $400 Standard**
  - **Better $800 ECM not smart (2 times)**
  - **Best $1,200 ECM SMART (3 times)**

TOPICS DOMESTIC HW RECIRCULATION

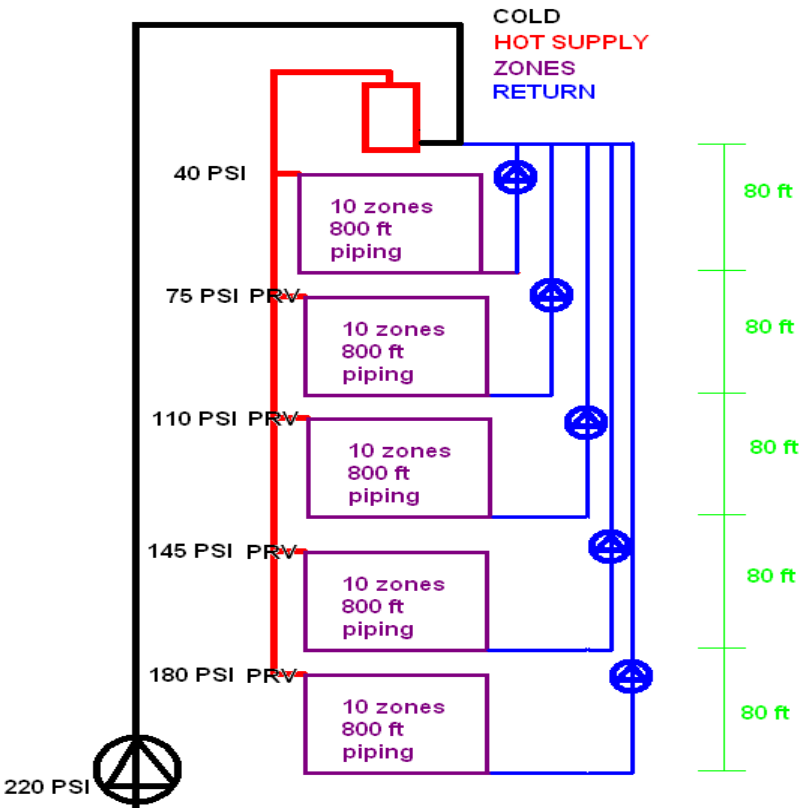
- **High rise issues**

HIGH RISE CIRCULATION PUMP SIZING

Multi-zone Systems

- Flowrate
  - Same as single zone systems
  - Just add them together
- Head
  - Friction Loss
    +
  - Loss through additional balancing (if applicable)
    +
  - Loss through PRVs (if applicable)
    +
  - 5 PSI extra for blending valve

HIGH RISE WITH PRVS



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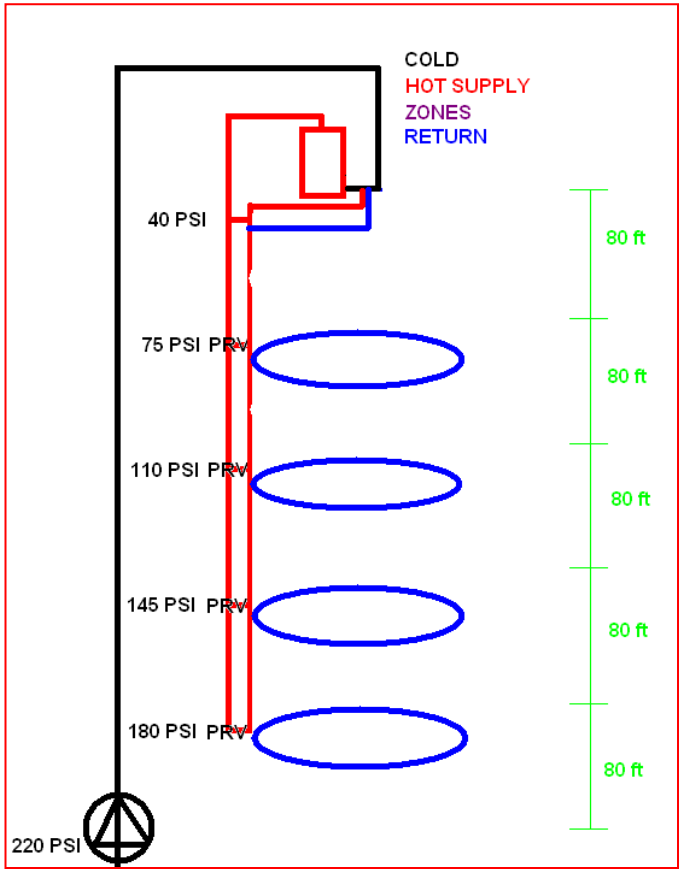
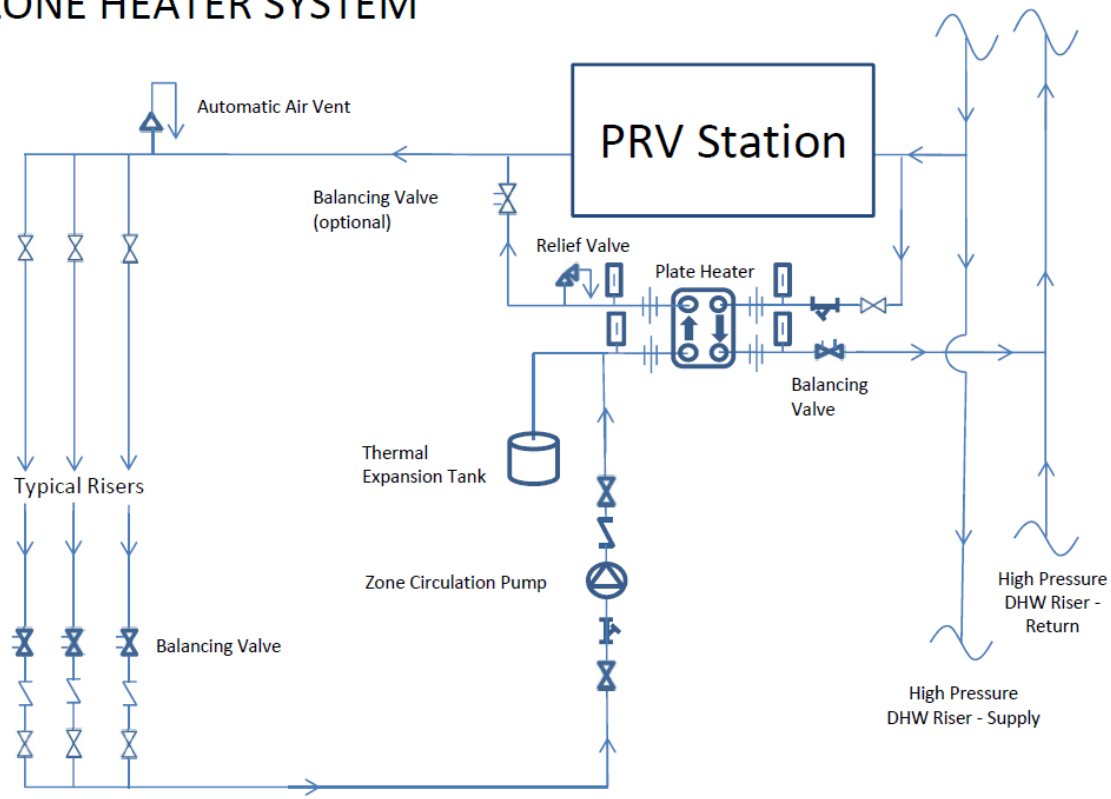


What if we could just circulate the zones and not have to worry about making up the pressure the PRV stole?

HIGH RISE ZONE SYSTEMS

ZONE HEATER SYSTEM



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TOPICS DOMESTIC HW RECIRCULATION

- People Safety
- Code Compliance
- Design
- Energy Usage
- People time
- Cost and Operation
- High Rise Issues

THANK YOU AND QUESTIONS?

From R. L. DEPPMANN and NORMAN HALL