1 AIA HSW/LU CE Hour | 1 ASPE CE Hour | 1 RCEP PDH For Engineers

The Devil is in the Details

Common Pitfalls Specifying Commercial Boilers & Water Heaters

Raypak® A Rheem® Company

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About This Course

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  - aspe.org/CPD
  - aspe.org/CPDT
- This course may or may not be accepted for PE renewal
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ASPE American Society of Plumbing Engineers CEU PROVIDER

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AIA Continuing Education Provider

Course Description

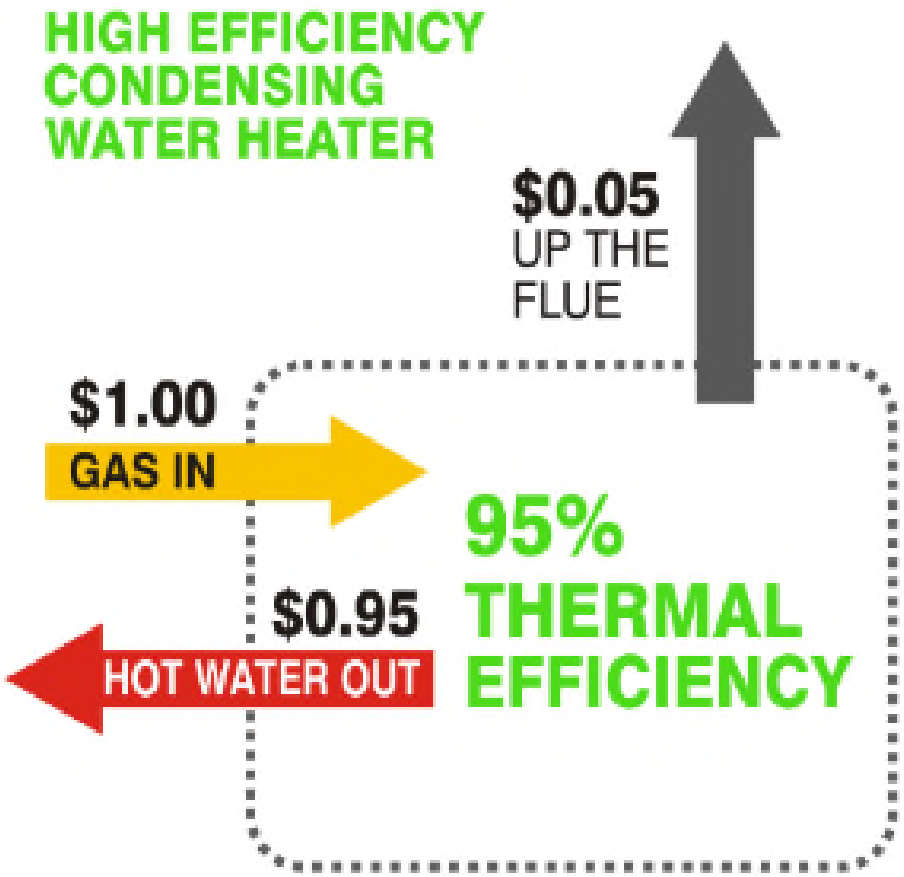
Overlooking the smallest detail in the beginning can cause huge issues later on. Join us in this one-hour course as we cover common pitfalls designers face when specifying commercial boilers and water heaters. We will review different types of installation and application errors that can cause major safety concerns.

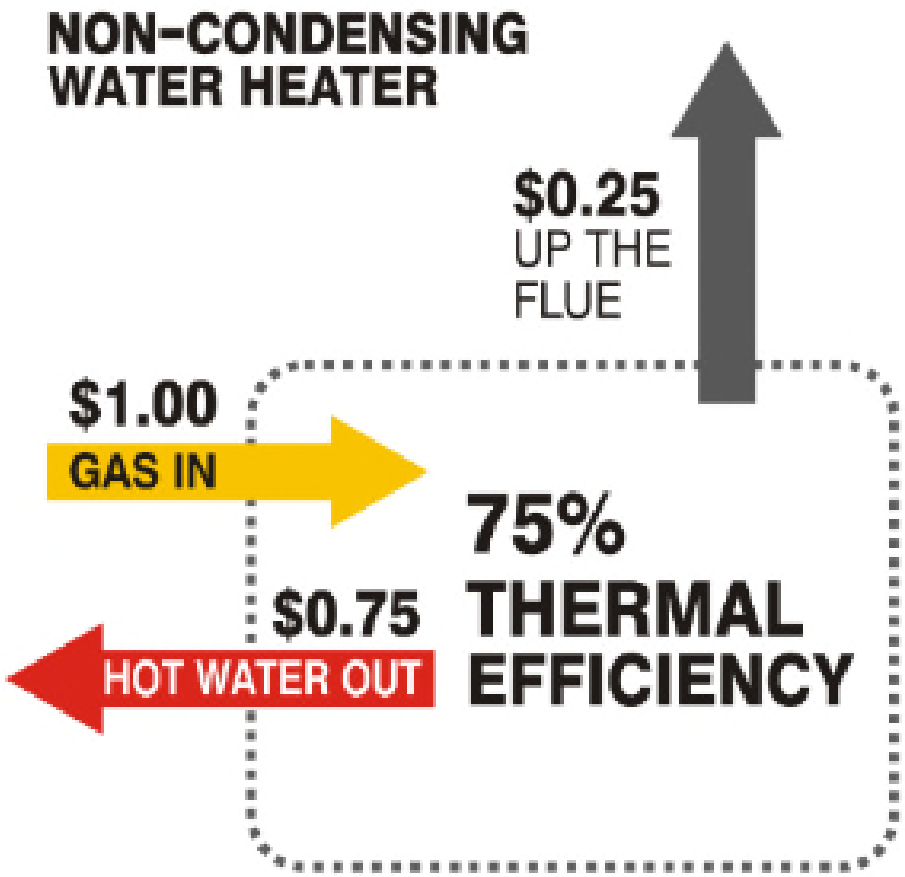
Learning Objectives

- By the end of this course, you will be able to:
  - Review combustion fundamentals and differentiate between condensing and non-condensing water heater systems
  - Discuss how misapplication of water heaters and boilers can cause major concerns and dangerous environments for contractors and occupants
  - Identify the end results of poor venting, including increased liability, destroyed boiler components, and potential risks to occupant safety
  - Recall minimum combustible clearance and minimum service clearance guidelines and articulate the importance of proper service clearance for operation and safety
  - Judge real world applications for proper venting, clearance, piping, and other processes to ensure best practices and guidelines have been followed

Combustion Fundamentals

Messaging in the Marketplace





Burning Natural Gas & Propane

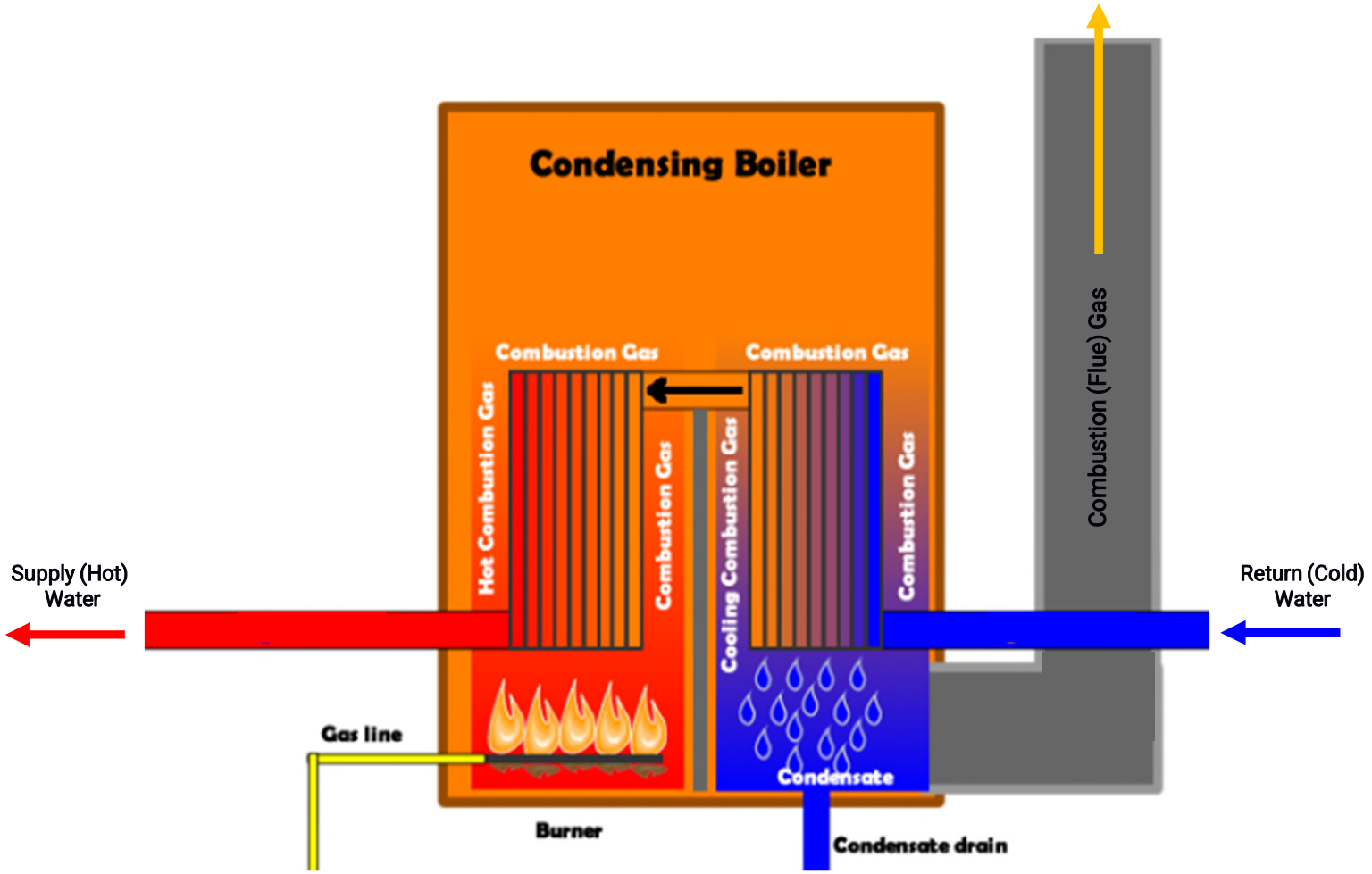
COMBUSTION PROCESS:

Fuel Gas + Air + Ignition Source ➔
Flame

COMBUSTION BYPRODUCTS:

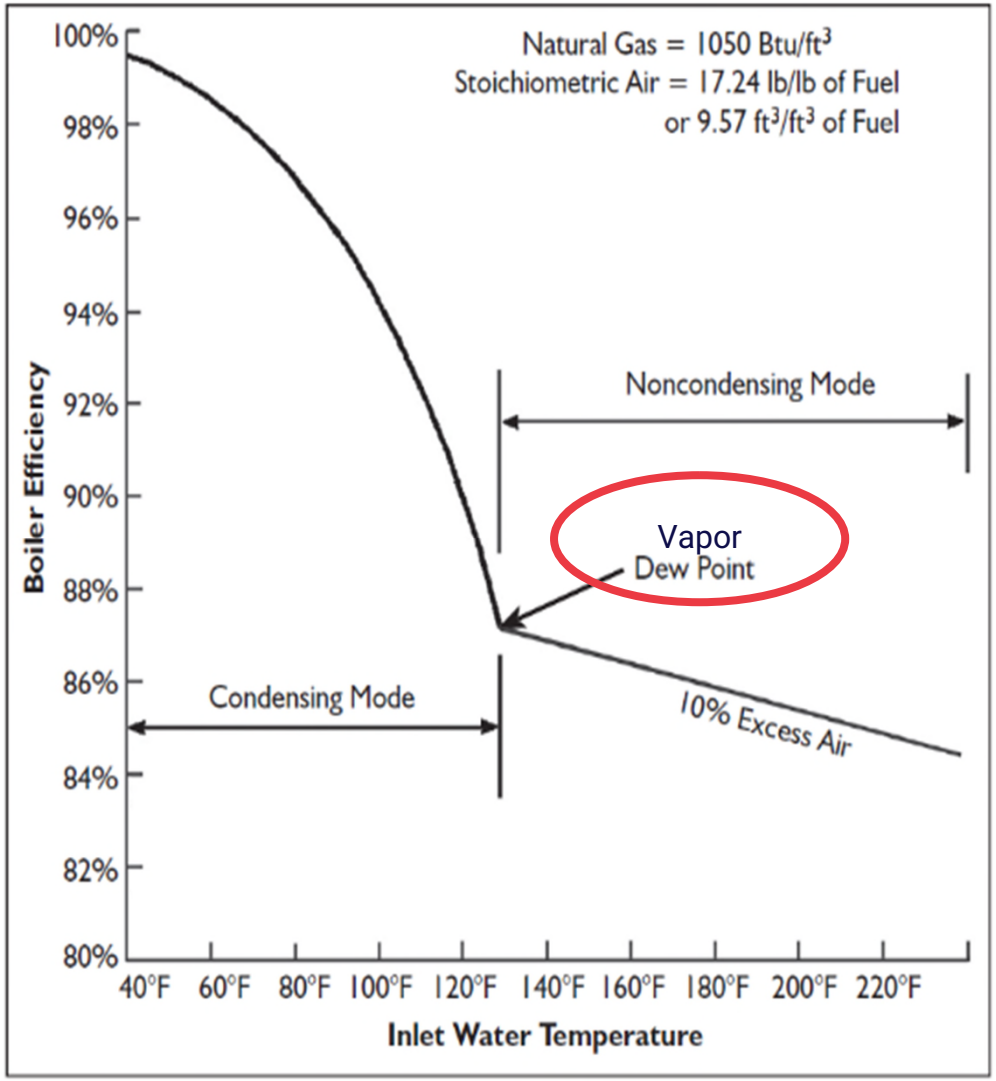
Carbon Dioxide + Water Vapor + Carbon Monoxide + Sulfur Dioxide + Nitrogen Oxide + Sulfuric Acid + Sulfurous Acid + Hydrobromic Acid + Hydrochloric Acid + Nitric Acid

Burning Natural Gas & Propane

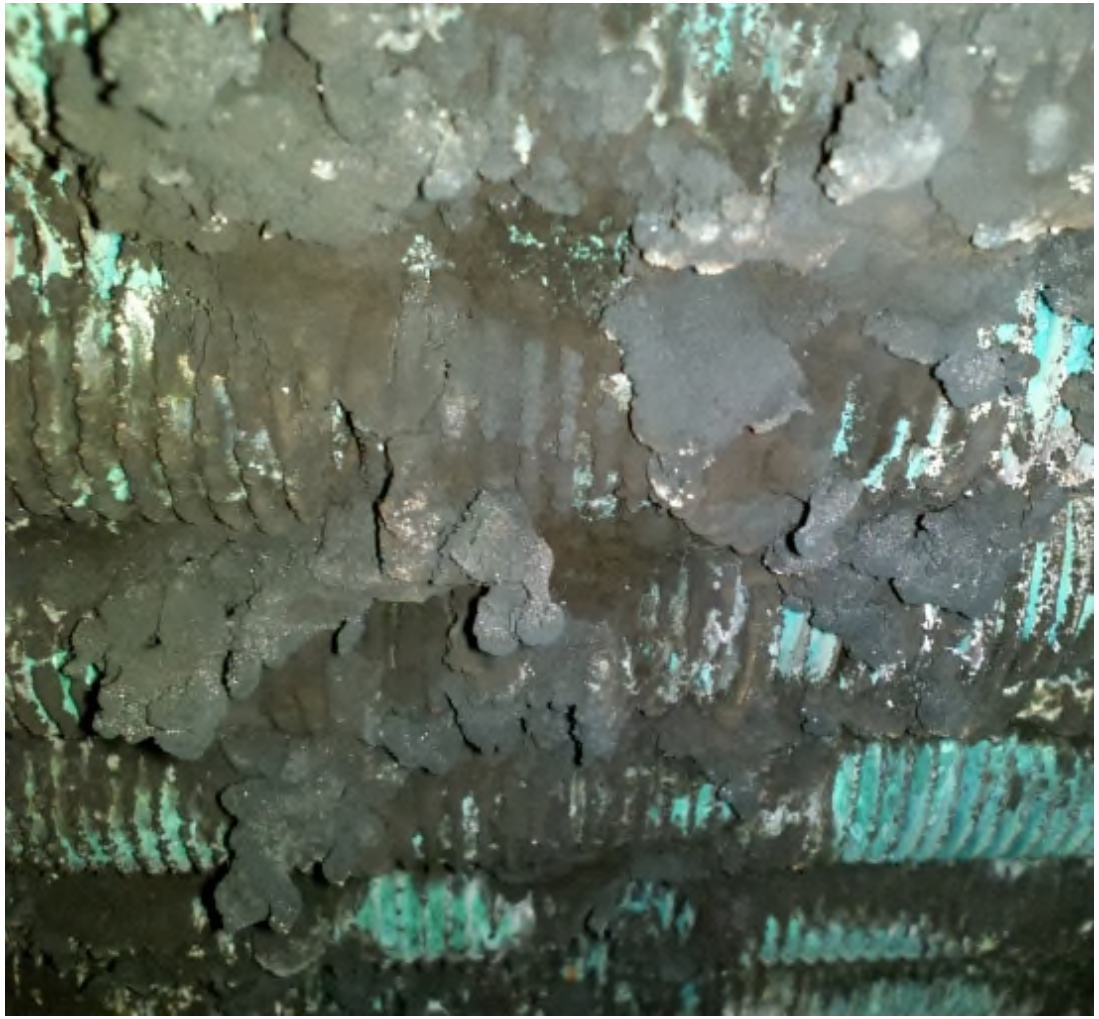


Misapplication of Equipment

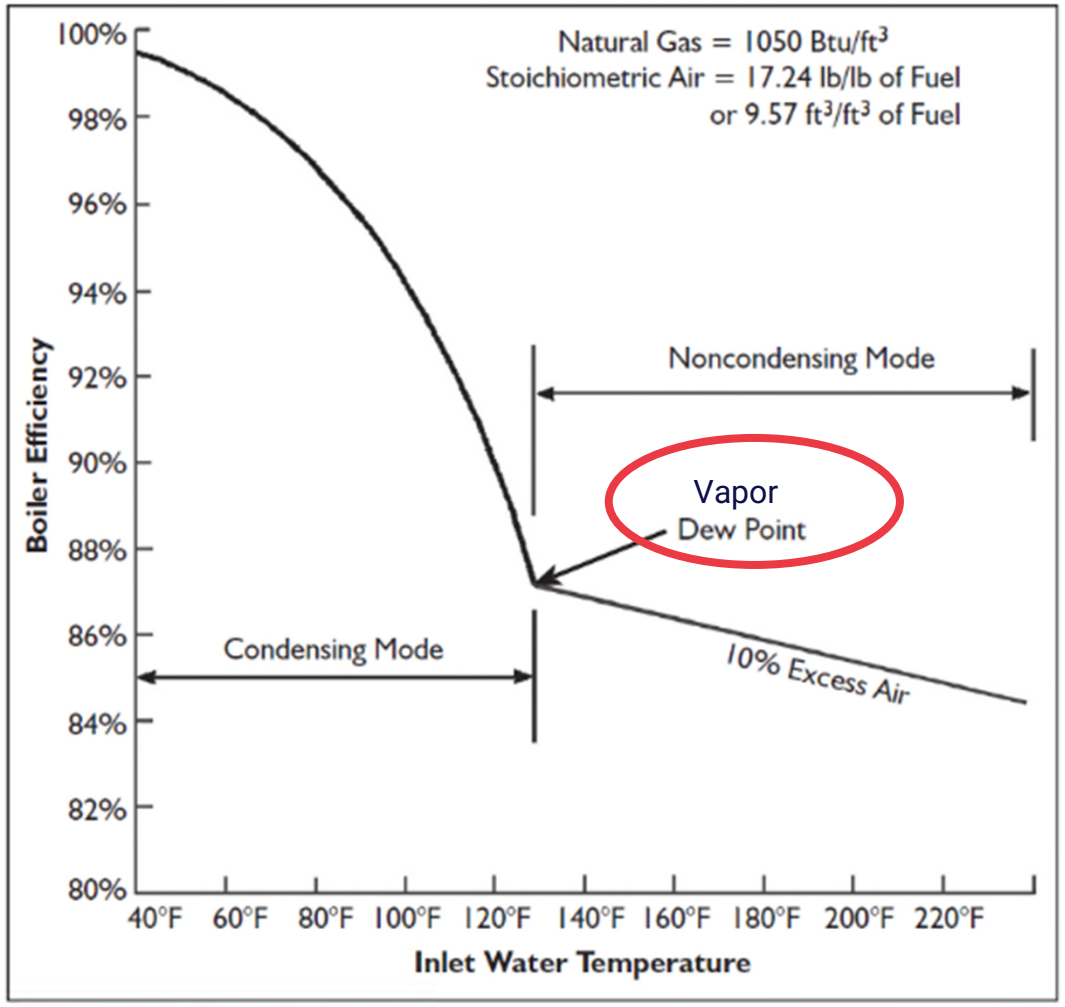
Any boiler can be a condensing boiler



Soot Buildup



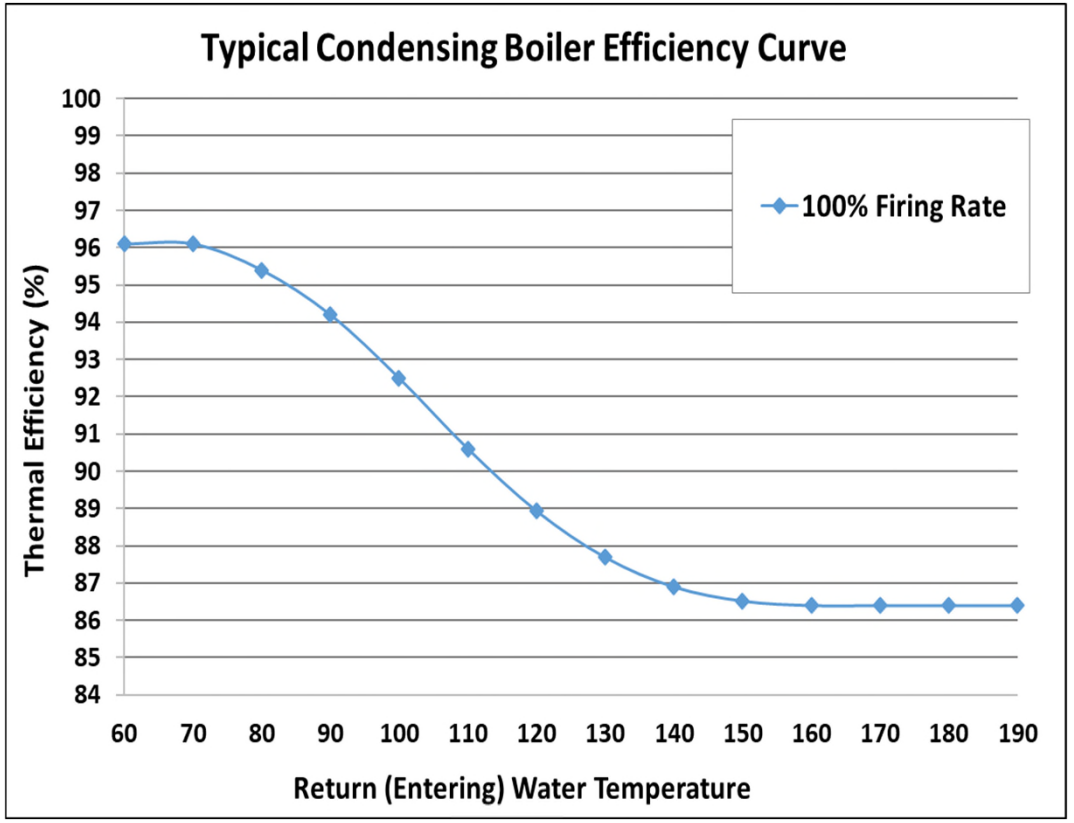
Return Water Temperature



- Dictates:
  - Condensation amount
  - Boiler efficiency

A condensing boiler that doesn't condense

- Example of condensing heater efficiency curve



Venting

Definitions

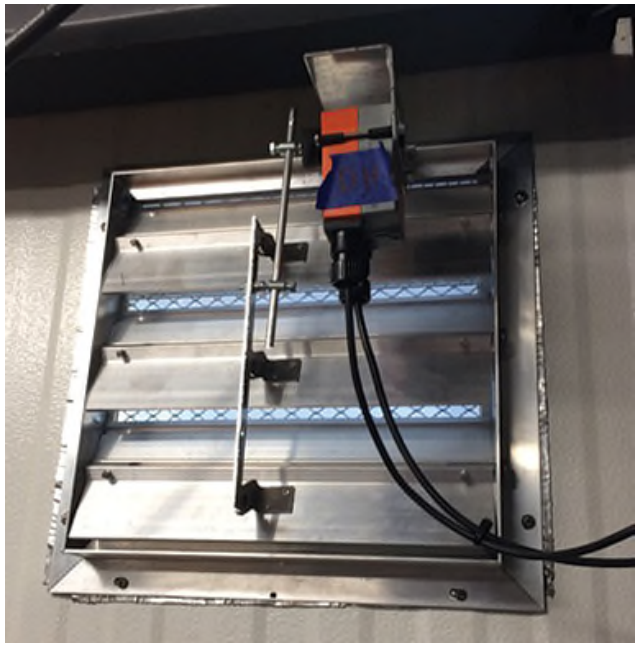
- ANSI/AHRI Standard 1500

- Vent - A passageway used to convey flue gasses from boilers or their vent connectors to the outdoors

- Direct Vent Boiler - An indoor boiler with the means for all air for combustion to be derived directly from the outdoors.

Combustion Air

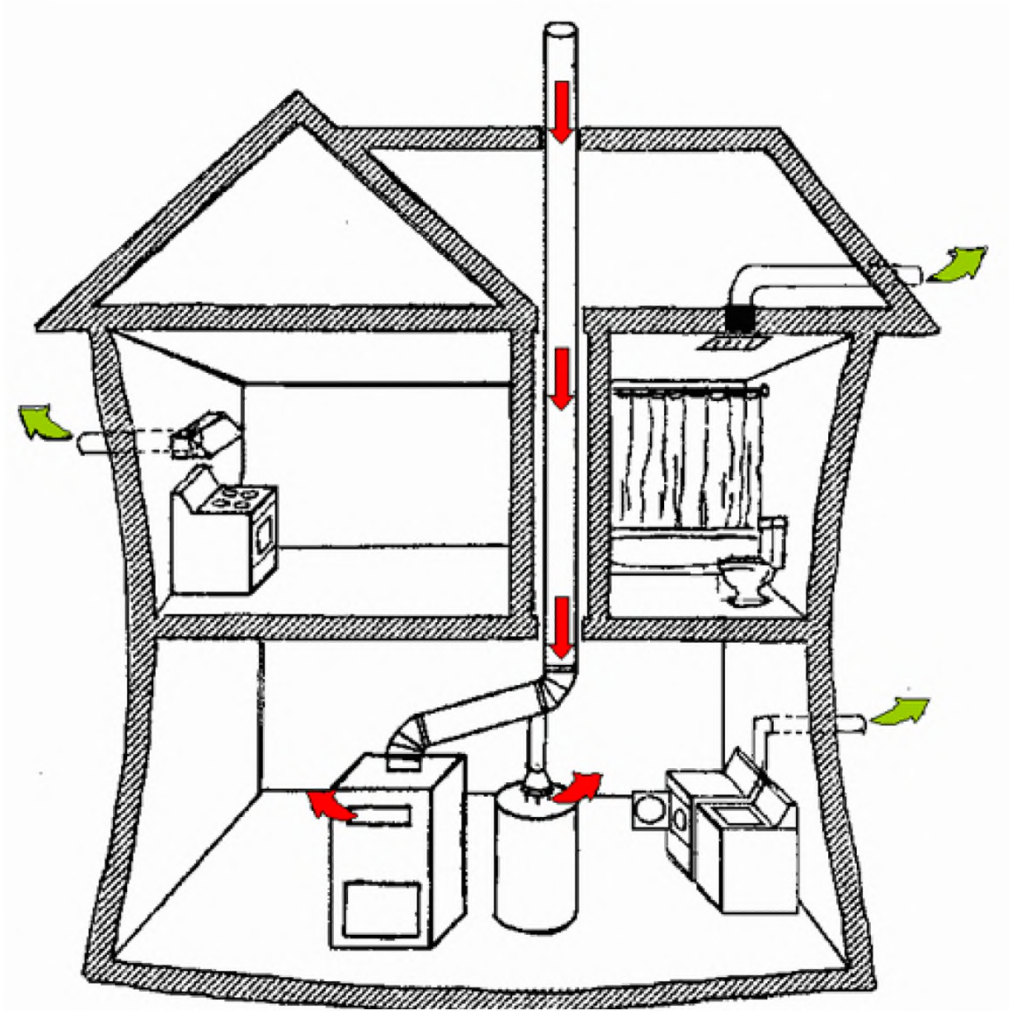
- Using room air through louvered openings



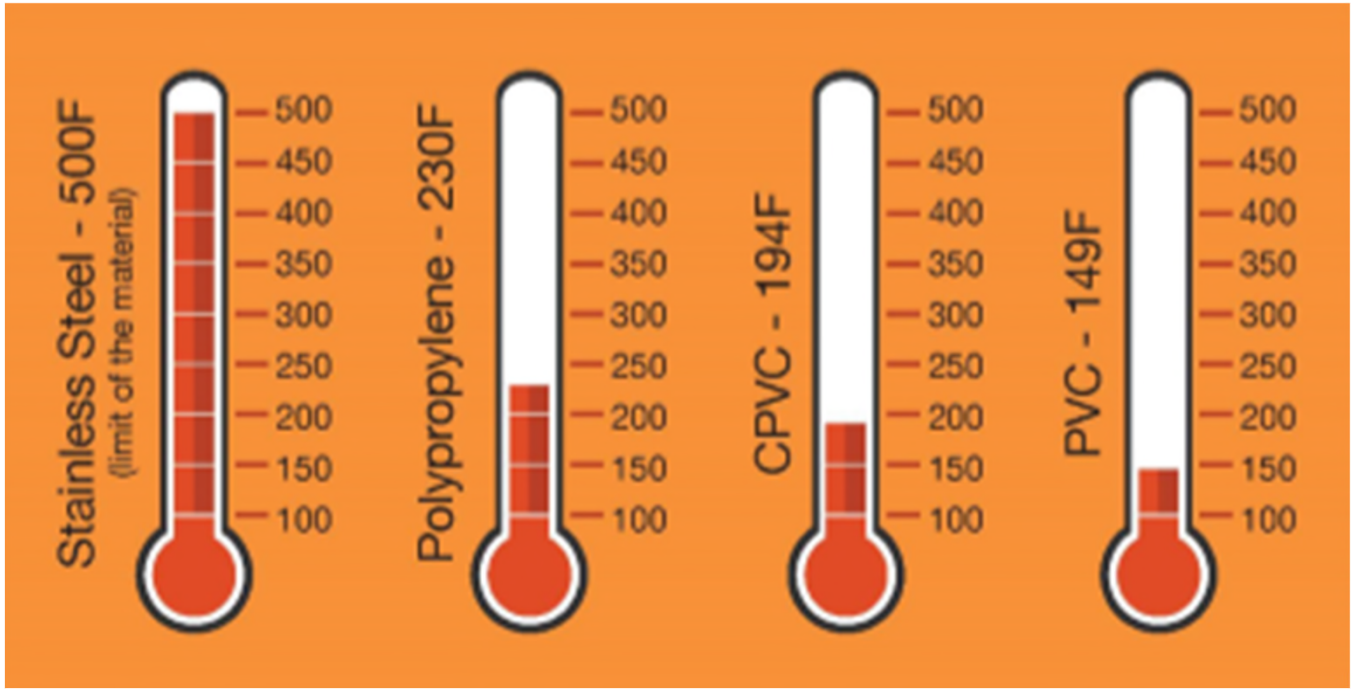
Combustion Air

- Intake (direct vent combustion air)
- Exhaust (Category IV vent for flue gas)

Adequate Combustion Air



Exhaust Venting Materials



- Boiler manufacturer dictates which type of vent material is required, based on model efficiency & application

Improper Venting Materials

- Improper Vent Material, Termination, Length, everything…

Improper Venting Material

- Wrong material

Improper Vent Material

- Wrong vent material

OR

- A non-condensing heater that was condensing

End Result of Poor Venting

Increased Liability

Destroys Boiler Components

Harms Occupant / Life Safety

Wishful Venting

- I wish this residential bathroom exhaust fan will magically pull the flue gas away

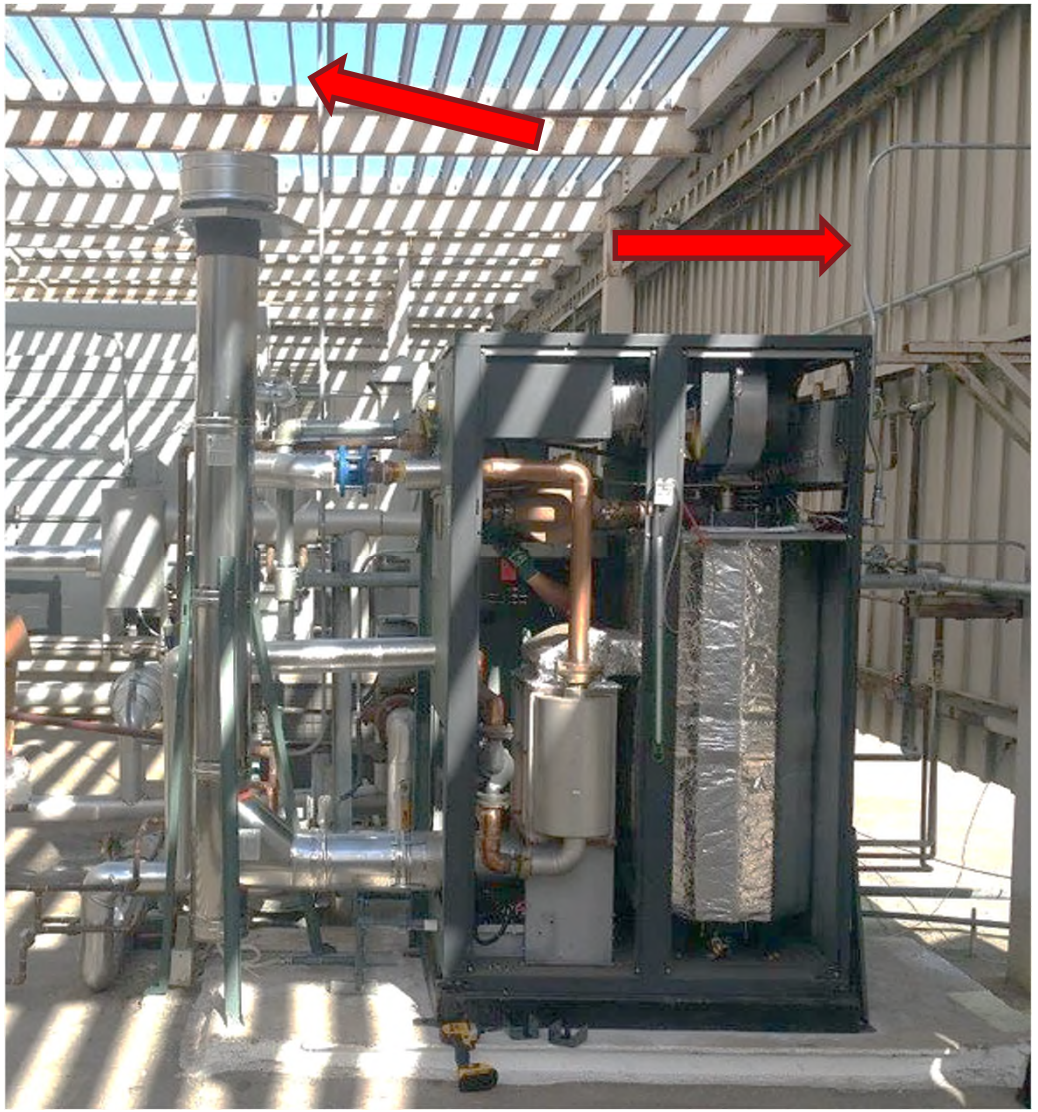
Wishful Venting

- I wish that two 6-inch vents will work

  like one 10-inch vent

Intake and Exhaust Clearances

- High walls and slatted roof prevent flue gases from rising

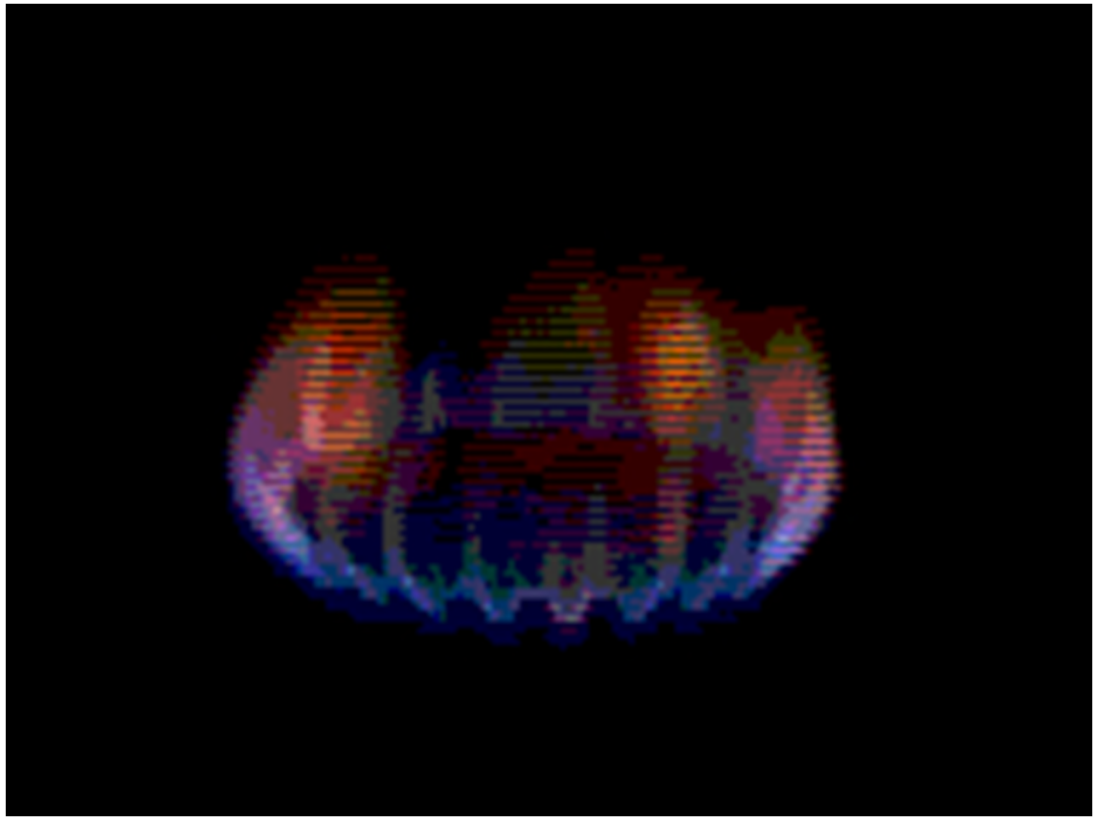


Exhaust Clearances

Intake and Exhaust Clearances

- How many things are wrong here?
  - Two
  - Three
  - Four
  - More than four

Excessive Draft



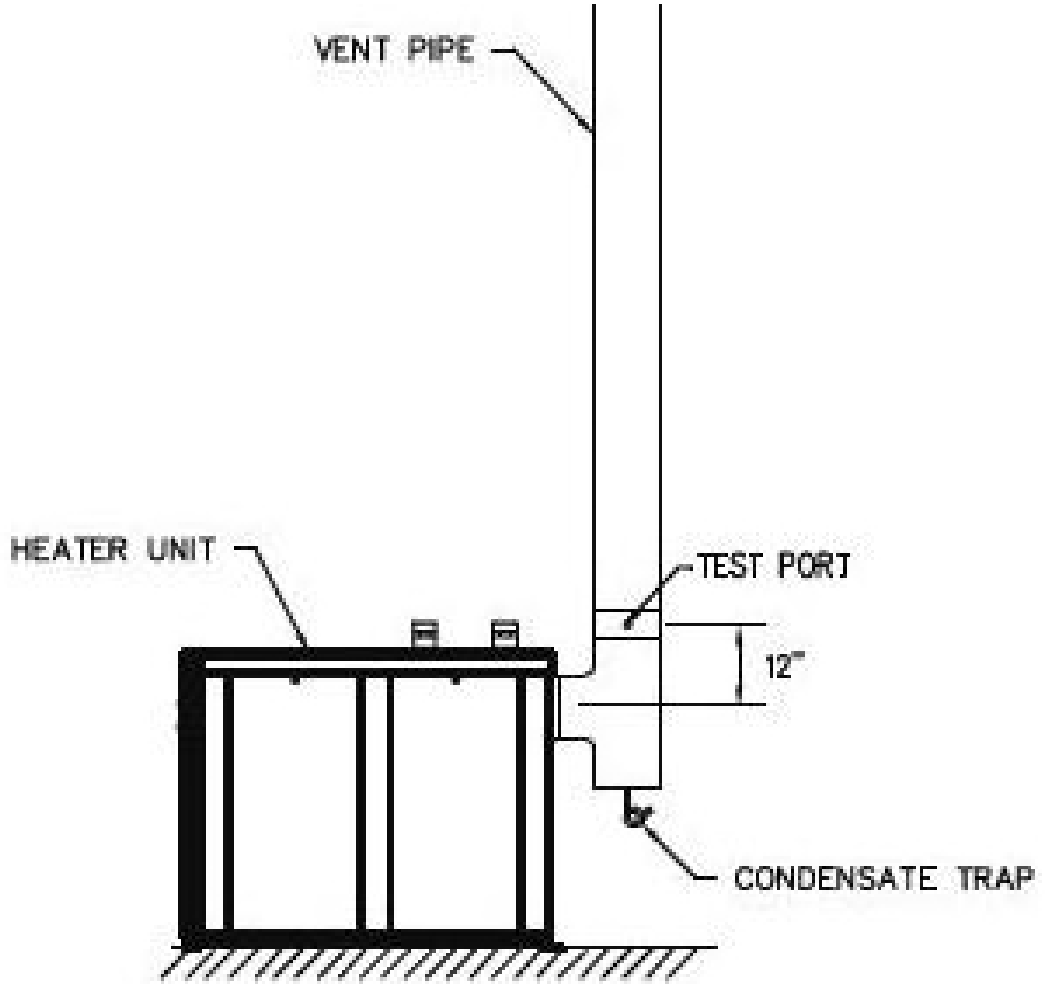
Results of Restricted Airflow / Improper Draft

Combustion Analysis

Combustion Analyzer Test Port

- Is this OK? No!

Combustion Analyzer Test Port



Dealing with Flue Gas Condensate

- Condensate drain ports on both the boiler and vent

(*near condensing and condensing only*)

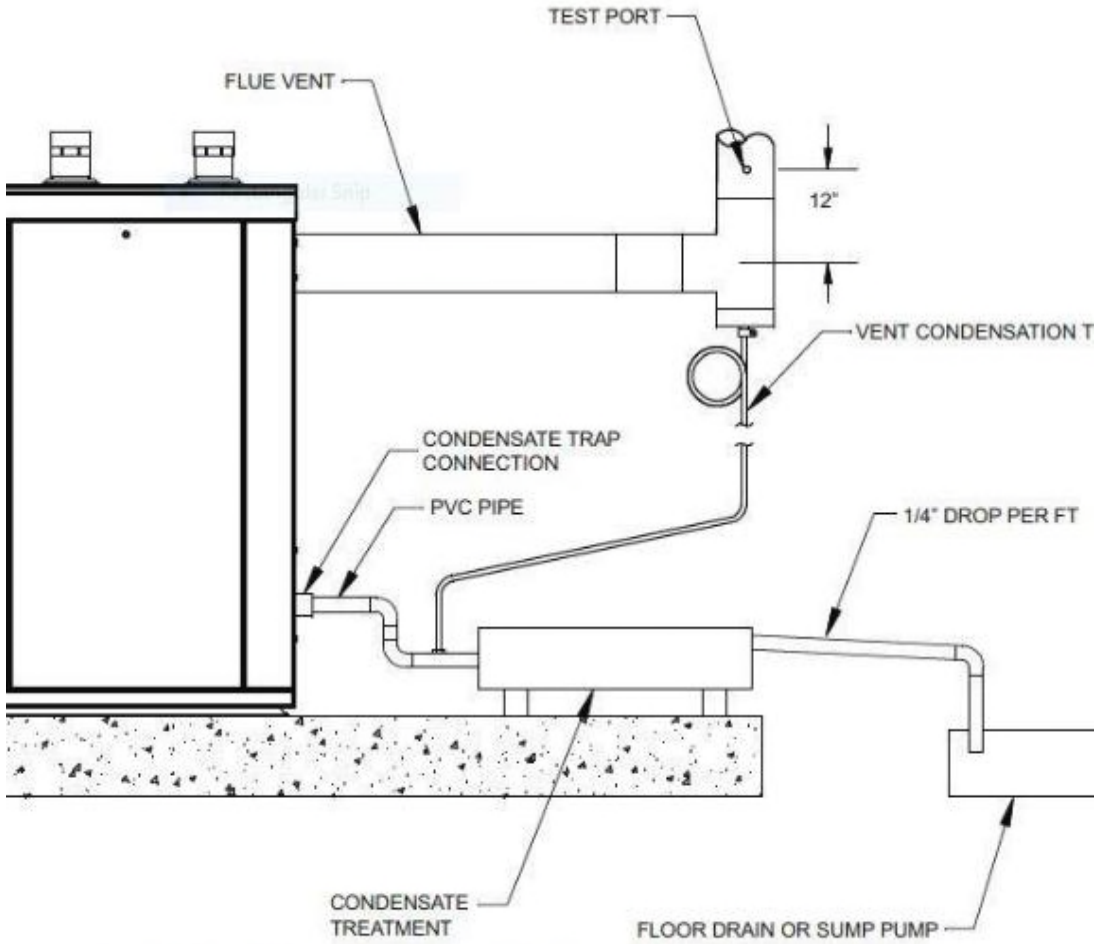


Fig. 30: Guide for Condensate Piping

Wrong Condensate Piping Material

Dealing with Condensate

- No neutralizer (or not maintained) + piping susceptible to impact
- Is this condensate treated?

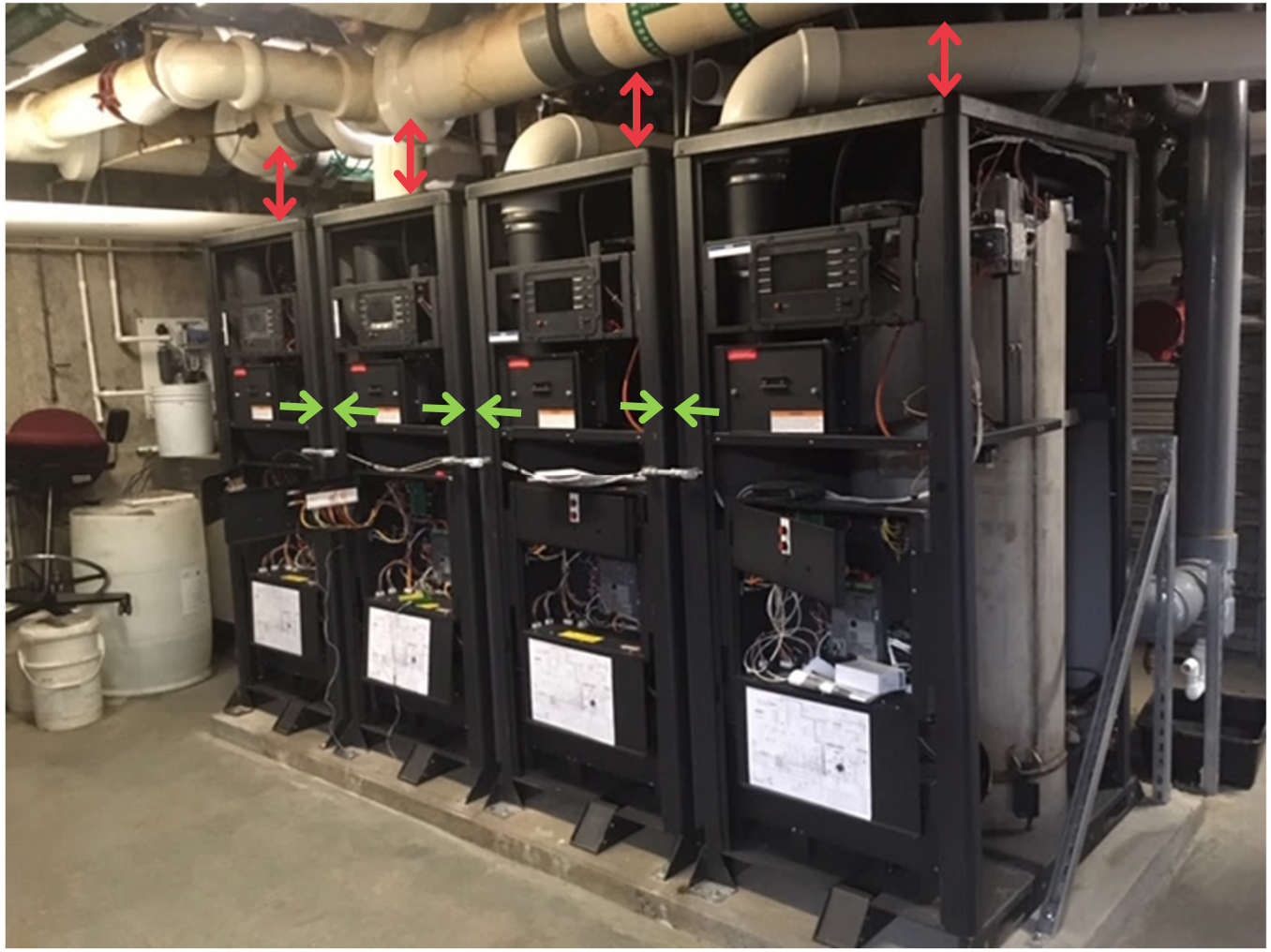
Service Clearances

Minimum Combustible Clearance vs. Service Clearance

Heater Side	Minimum Clearances from Combustible Surfaces in. (mm)	Minimum Service Clearance in. (mm)
Rear	12 (305)	36 (914)
Right Side	1 (25)	24 (610)
Left Side	1 (25)	1 (25)
Top	Unobstructed	Unobstructed
Vent Termination	12 (305)	12 (305)

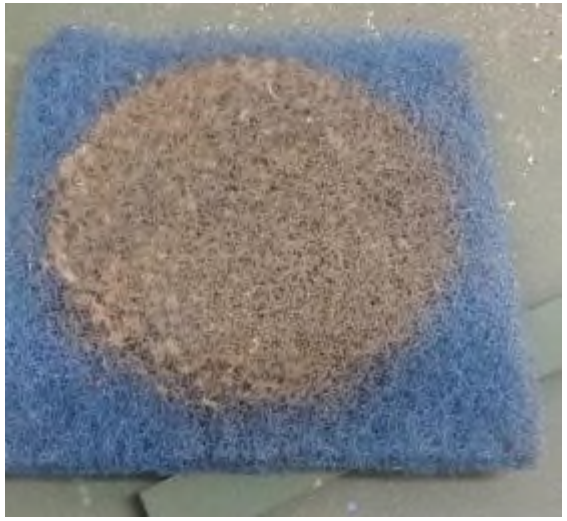
Proper Service Clearance

Proper Service Clearances



Improper Service Clearances

- Poor service clearance leads to poor maintenance
- Poor maintenance leads to dirty filters
- Dirty filters lead to poor combustion
- Poor combustion leads to…



Improper Service Clearances

Gas Piping

Gas Supply Line

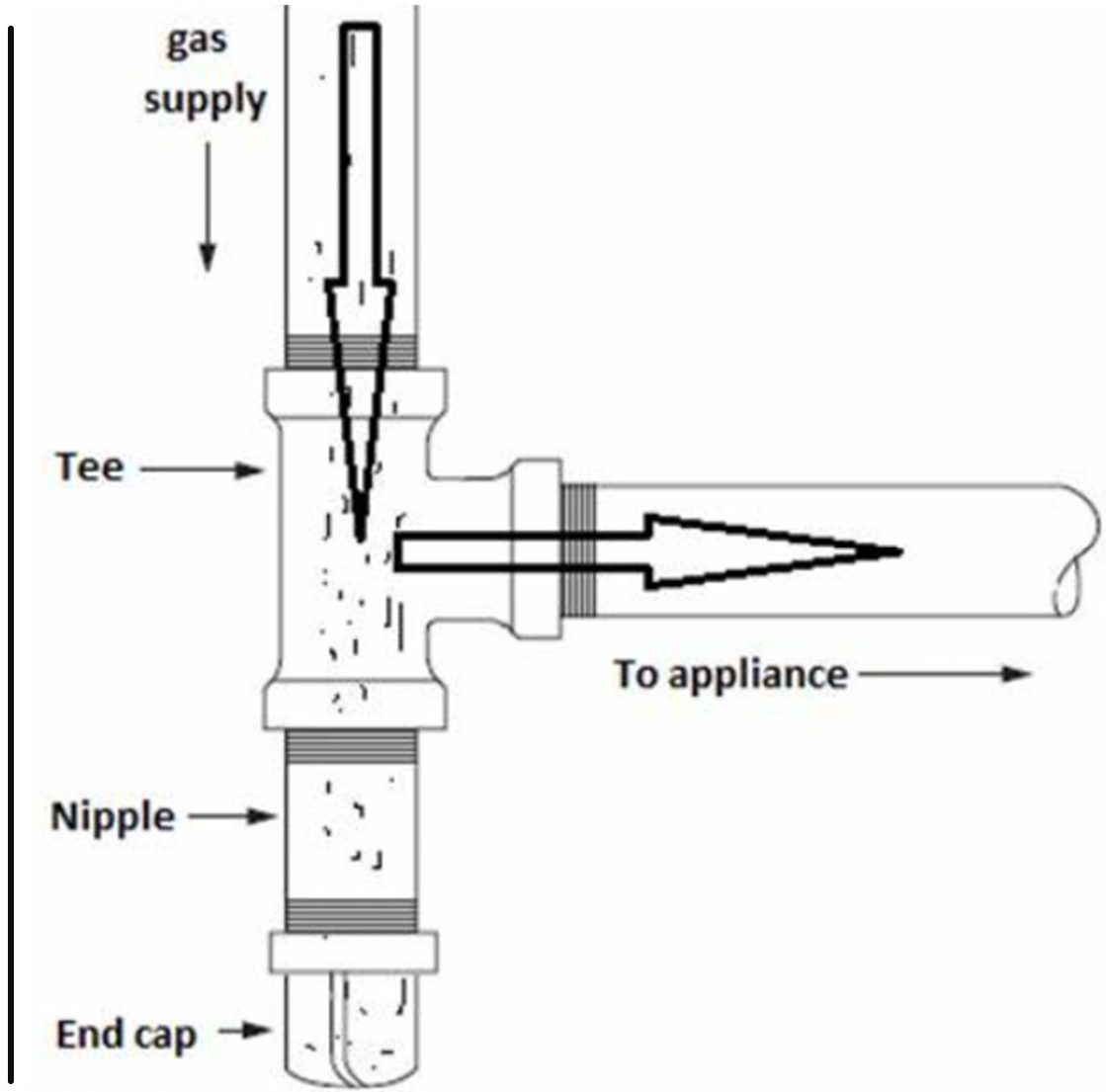
- Sediment Trap Issues, aka drip leg
- Is this acceptable by code?
  - Yes
  - No
  - Depends on manufacturer
  - Depends on your relationship with the inspector

Sediment Trap Issues

- Is this acceptable by code?
  - Yes
  - No
  - Depends on manufacturer
  - Depends on your relationship with the inspector

Code Compliant Sediment Traps

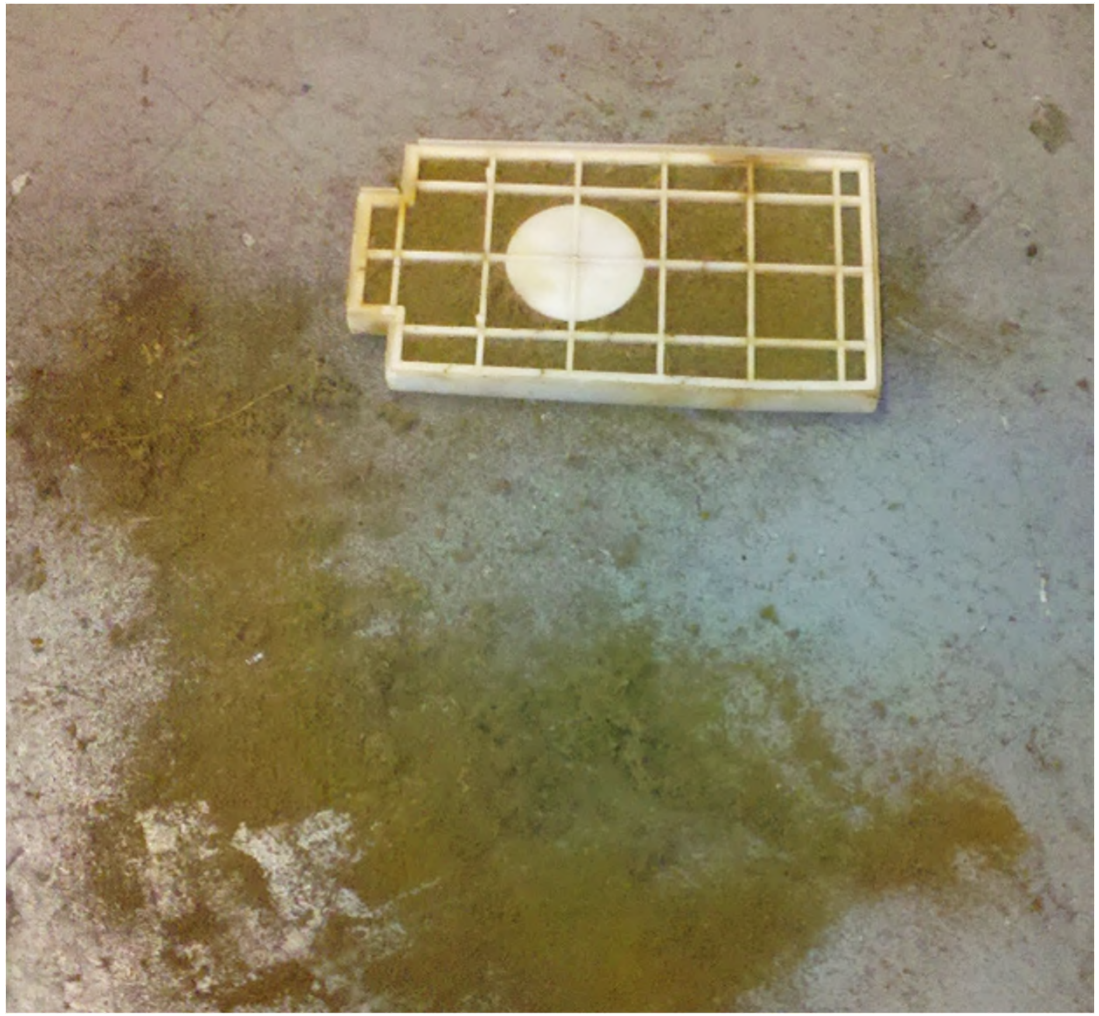
- Both the IFGC and NFGC allow galvanized steel pipe where the gas contains less than 0.3 grains of hydrogen sulphide per 100 SCF
- Sediment trap layout per NFGC 9.6.7



Sediment Trap Issues

- Is this acceptable by code?
  - Yes
  - No
  - Depends on manufacturer
  - Depends on your relationship with the inspector

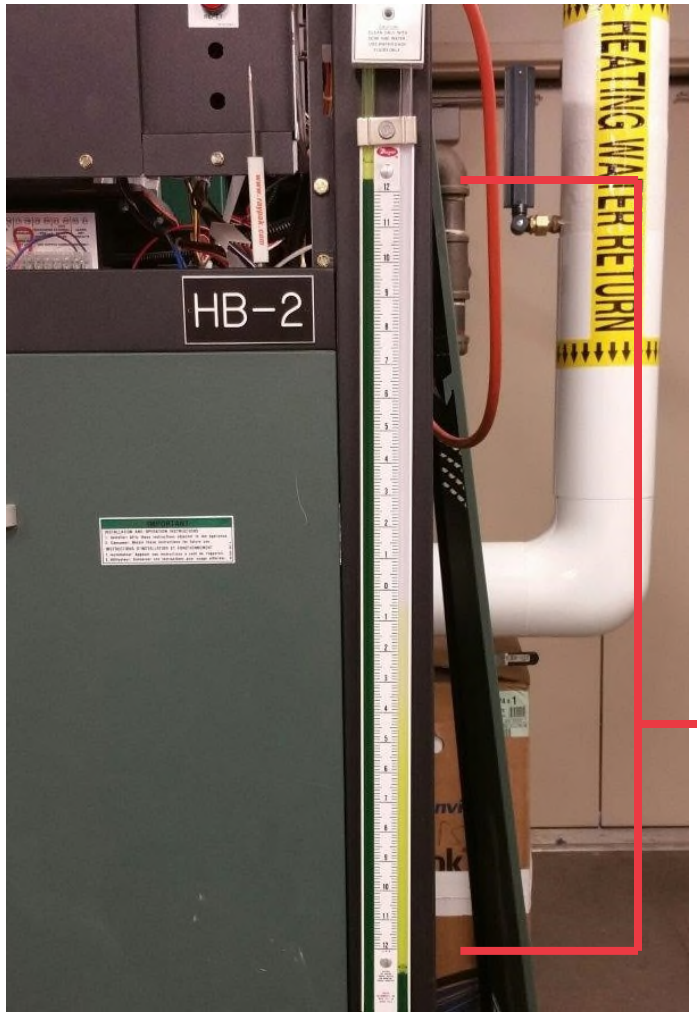
Results of Improper Sediment Trap



Gas Regulator Selection

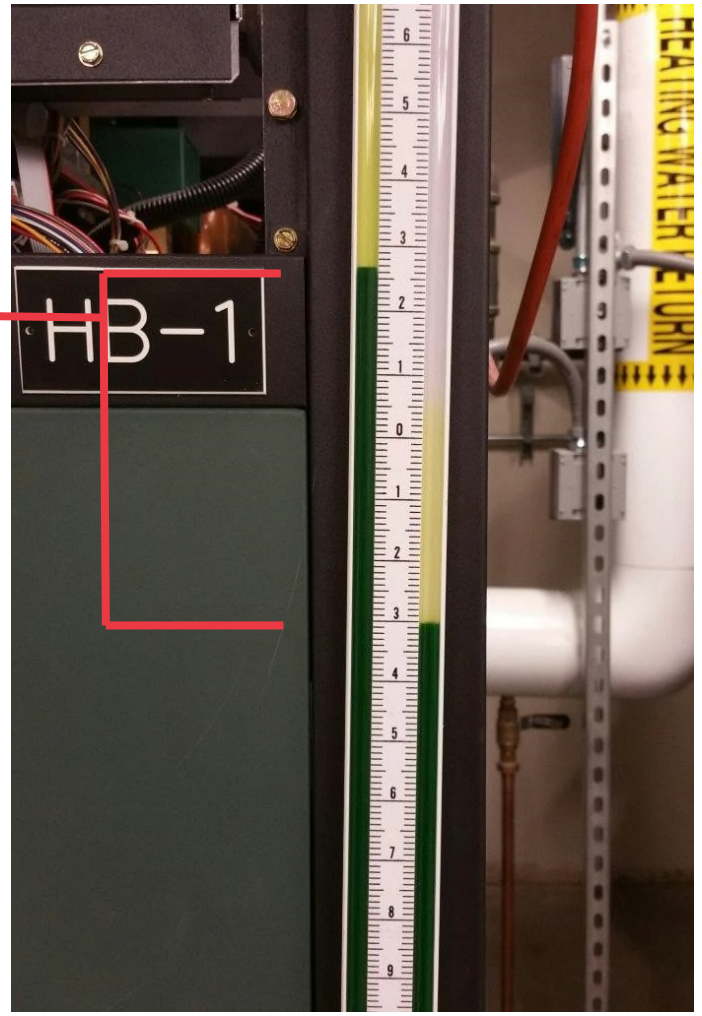
- Per boiler manufacturer
  - “A pounds-to-inches regulator of the lock-up type must be installed to reduce the gas supply pressure if it is higher than 10.5" WC for natural gas or 13" WC for propane gas. This regulator should be installed following the regulator manufacturers instructions.”
- Example from a regulator manufacturer
  - “Make sure on all installations you don't install the regulator directly at the equipment. Install the regulator 3 to 10 feet away depending on the application.”

Unstable Gas Supply Pressure

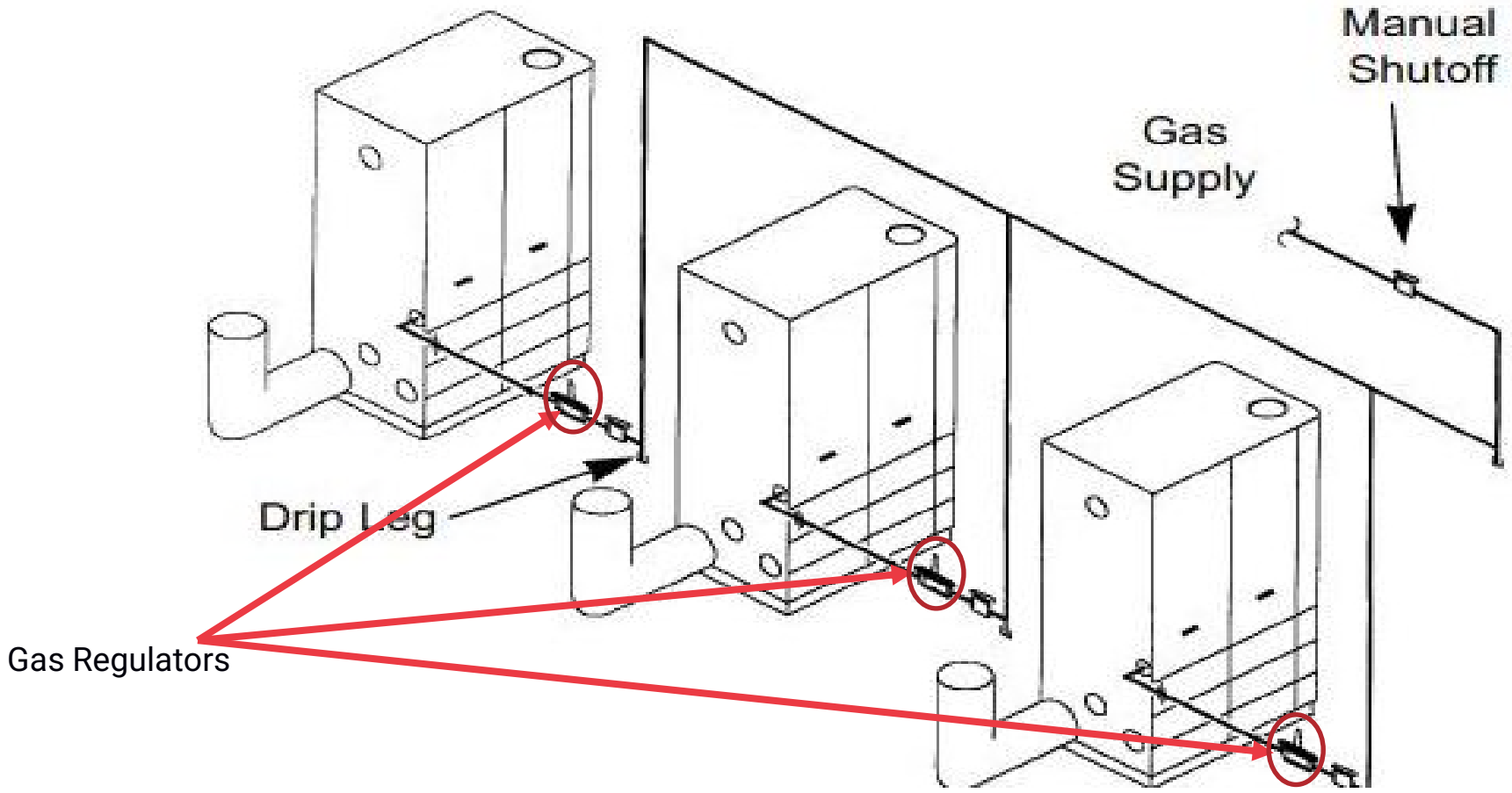


25.4 inch WC

5.7 inch WC

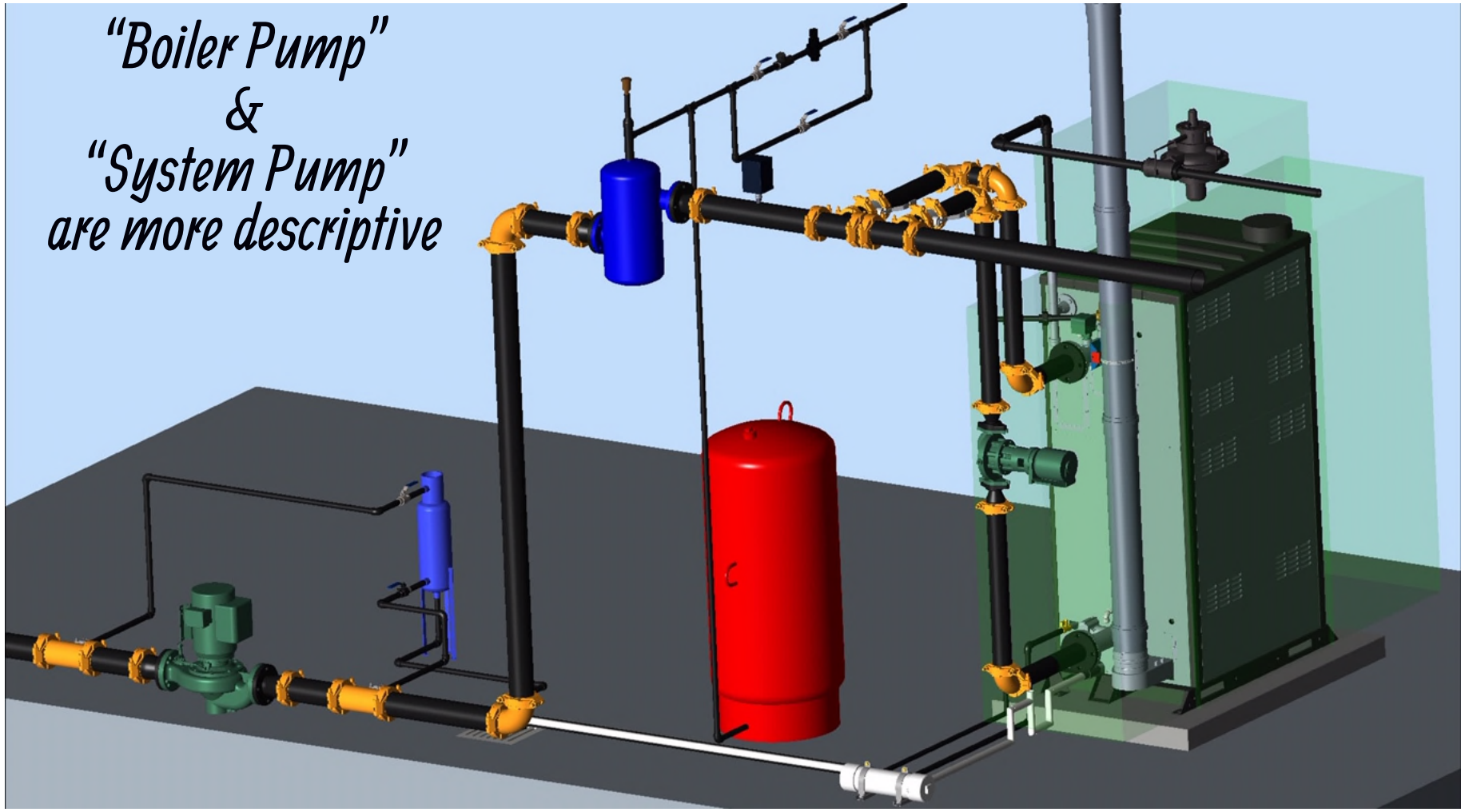


Unstable Gas Supply Pressure

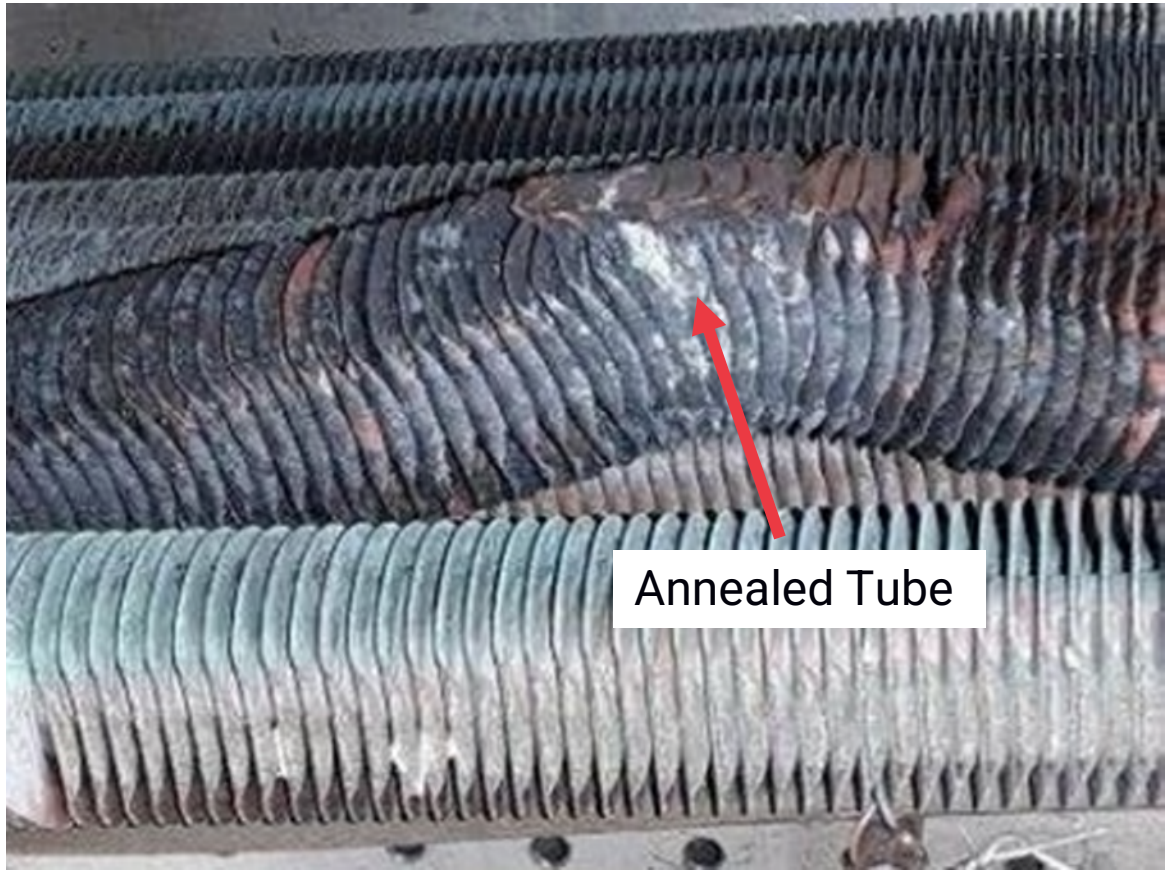


Pump Considerations

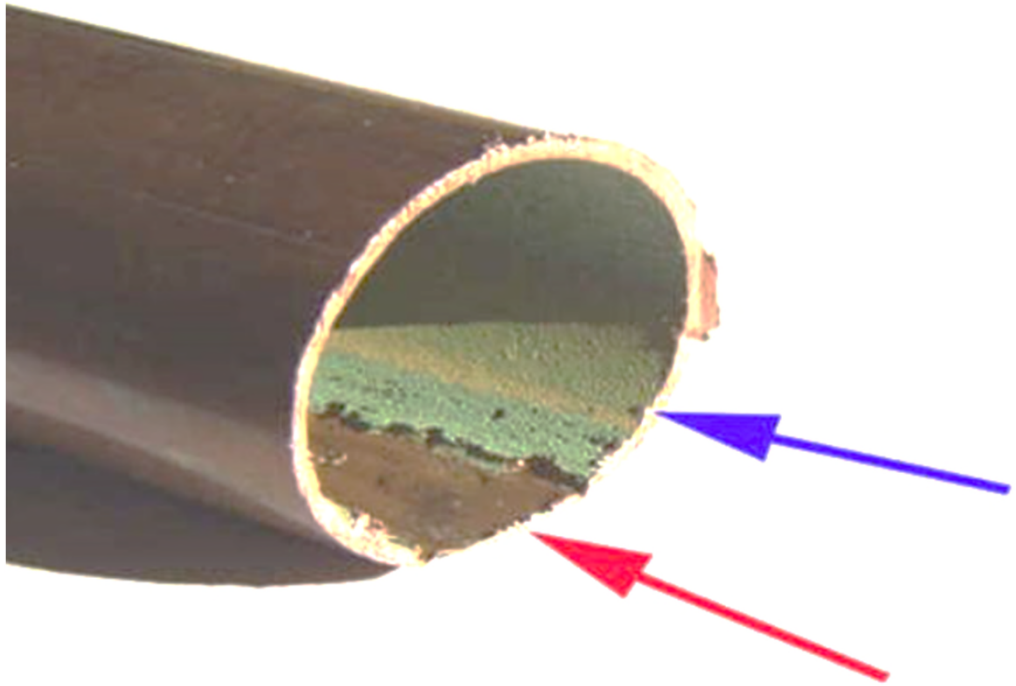
Which Pump is Primary, Which is Secondary?

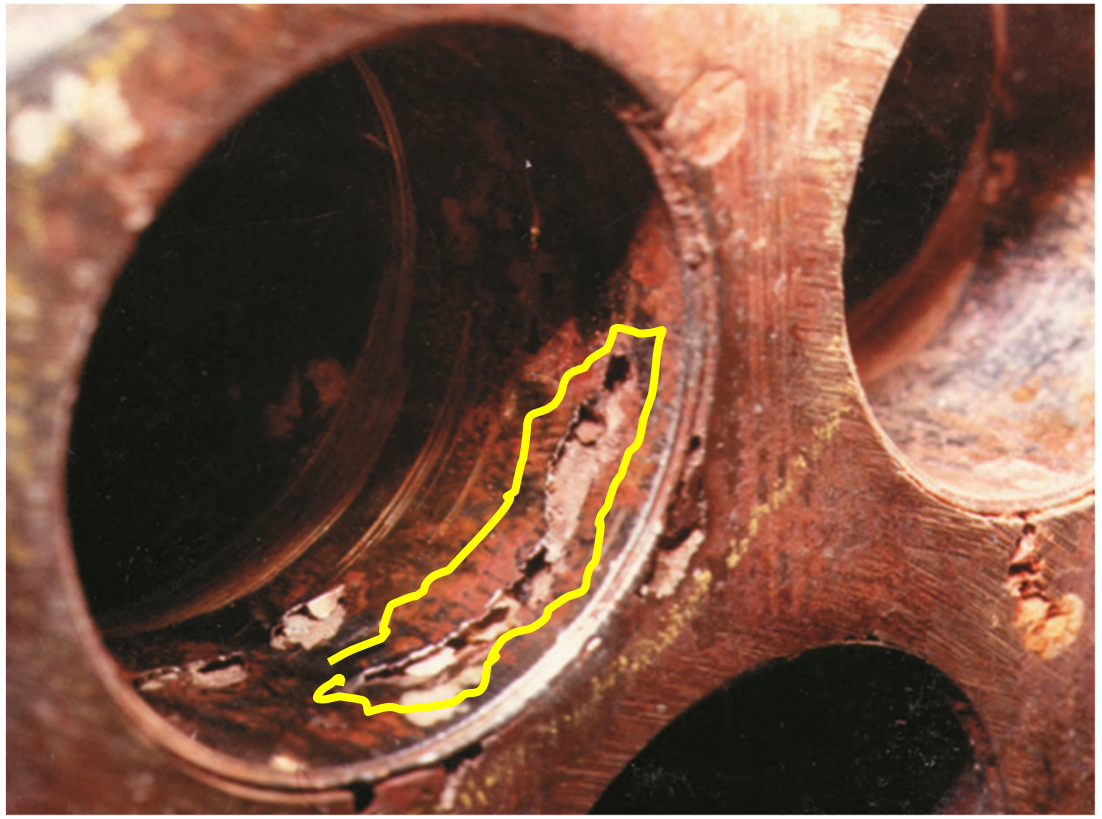


Low Flow



Too Much Flow?



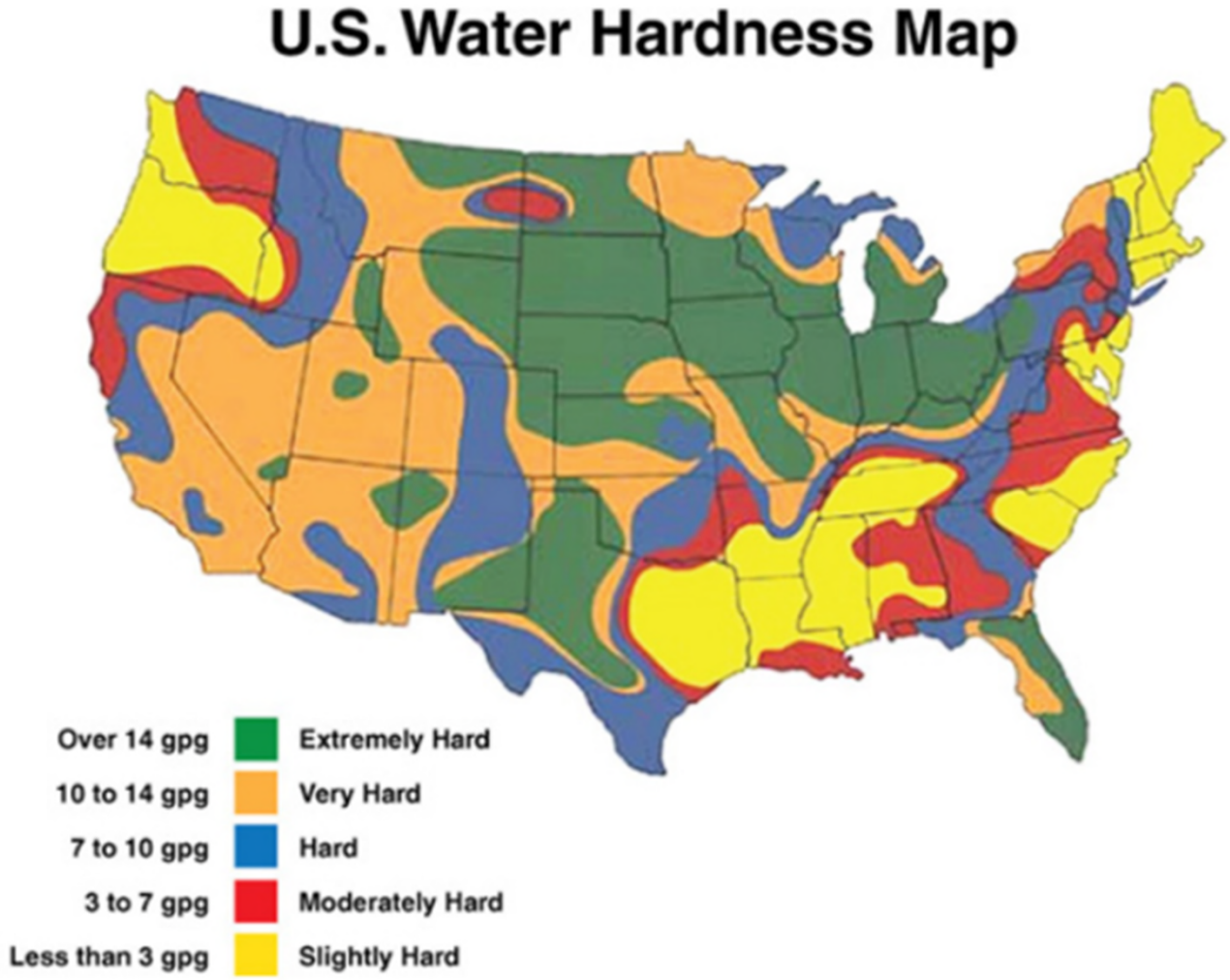


Water Quality

Glycol

	Ethylene Glycol	Propylene Glycol
Heat transfer @180F with no increase in flow rate		
20% Solution	0.96	0.97
50% Solution	0.87	0.9
Flow Rate Correction Required (with no change in pump curve)		
100F	116%	
140F	115%	
180F	114%	110%
Pump Head Correction Required (with increase in flow)		
100F	149%	
140F	132%	
180F	123%	123%
Specific Gravity @ STP	1.25 - 1.135	1.045 - 1.055
Pounds/Gallon @ 60	9.42	8.77
pH (of glycol concentrate)	9.3	9.5
Note: Except as indicated, comparisons are of 50% glycolution to water		

Open Loop / Domestic Hot Water – Water Quality



Open Loop / Domestic Hot Water – Water Quality

Design Parameters for Pump Selection Based on Water Hardness

MODEL	SOFT WATER (3-4 Grains Per Gallon)					MEDIUM WATER (5-15 Grains Per Gallon)					HARD WATER* (16-25 Grains Per Gallon)				
	ΔT	GPM	ΔP	MTS	SHL	ΔT	GPM	ΔP	MTS	SHL	ΔT	GPM	ΔP	MTS	SHL
HD101	9	20	1.8	1 1/2	**3.8**	7	26	3.0	1 1/2	**6.3**	4	45	9.2	1 1/2	**18**
HD151	13	20	1.8	1 1/2	**3.8**	10	26	3.1	1 1/2	**6.3**	6	45	9.2	1 1/2	**18.1**
HD201	17	20	1.9	1 1/2	**3.9**	13	26	3.2	1 1/2	**6.4**	8	45	9.4	1 1/2	**18.2**
HD251	21	20	1.9	1 1/2	**3.9**	16	26	3.2	1 1/2	**6.5**	9	45	9.6	1 1/2	**18.5**
HD301	25	20	1.9	1 1/2	**3.9**	20	26	3.2	1 1/2	**6.5**	11	45	9.8	1 1/2	**18.7**
HD401	34	20	2.0	1 1/2	**4**	26	26	3.3	1 1/2	**6.6**	15	45	10.3	1 1/2	**19.1**

Pump Electrical Load

- Not accounted for in the EE Design

Buffer Tanks

High Mass vs. Low Mass

Low Mass HX

Low Mass Emitter

High Mass HX

High Mass Emitter

Retrofitting from High Mass to Low Mass

Before

After

Where a Buffer Tank may be Needed

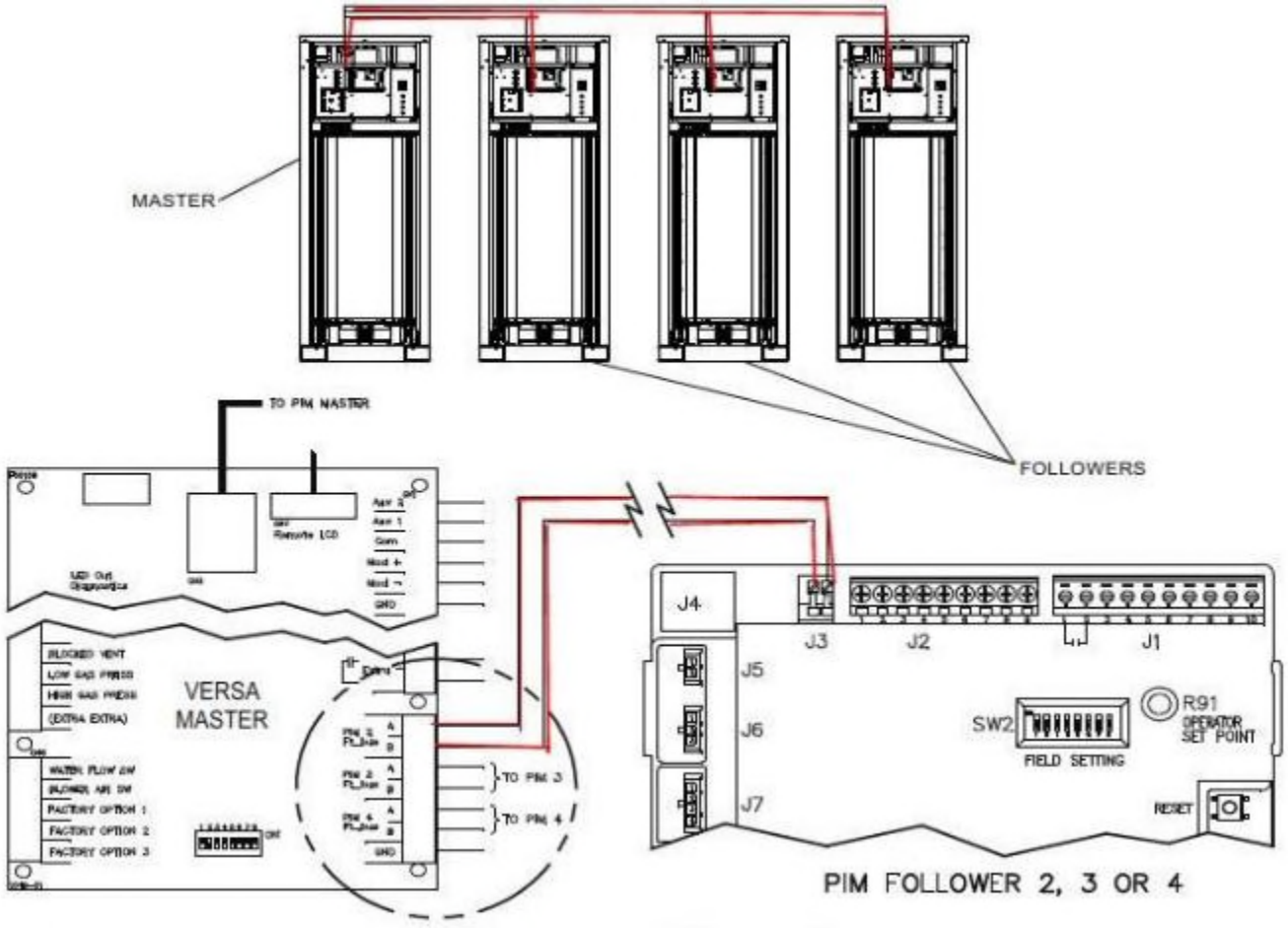
- Boiler short cycling
- Hi-Limit safety switches tripping
- Building loop temperature swings
- Premature failure of system components

Controls

BMS Considerations

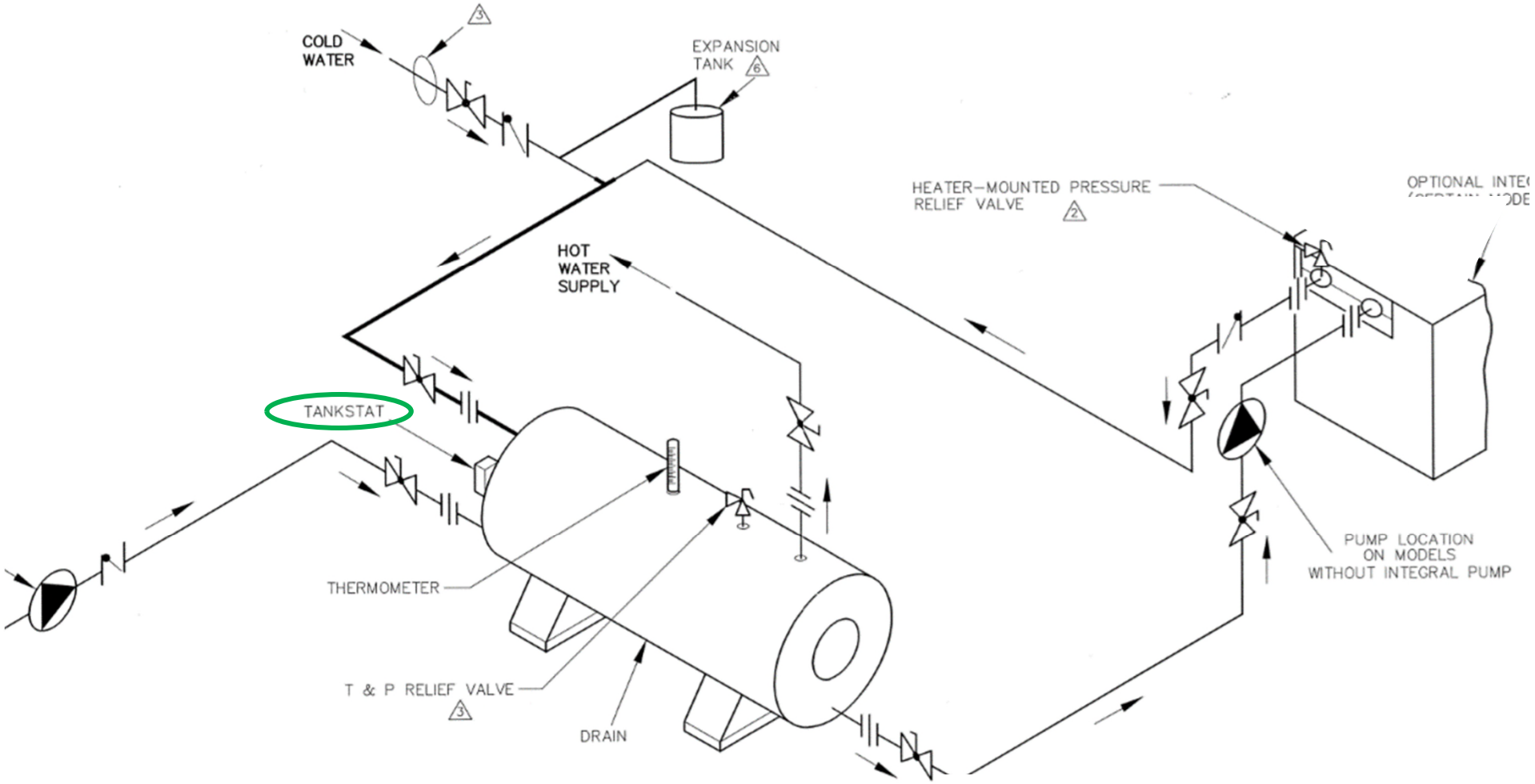
- Which BMS protocol?
  - BACnet
  - Modbus
  - Lonworks
  - Metasys N2
  - Boiler integrated remote connectivity (IOT)
  - None
- Who is controlling the boiler
  - Boiler self-controlled
  - BMS full-controlled
  - BMS temperature setpoint only controlled
  - BMS monitor only
- Multi-Boiler Setup
  - Cascade sequence
  - Redundancy
- **Is it detailed on the plans???**

Low Voltage Wiring



Sample Diagram of a Manufacture's Cascade Wiring

Temperature Sensor Placement



Results of No Coordination of Wiring

- Sloppy wiring
- Poor sensor placement
- Thermocouples hanging in the breeze

=

- **Erratic and unsafe heater performance**

Conclusion

Review

- Now, you will be able to:
  - Review combustion fundamentals and differentiate between condensing and non-condensing water heater systems
  - Discuss how misapplication of water heaters and boilers can cause major concerns such as product performance, product longevity and most importantly, dangerous environments for contractors and occupants
  - Identify the end results of poor venting, including increased liability, destroyed boiler components, and potential risks to occupant safety
  - Recall minimum combustible clearance and minimum service clearance guidelines and articulate the importance of proper service clearance for operation and safety
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Thank You!

Presenter: Dan Goellner with Raypak

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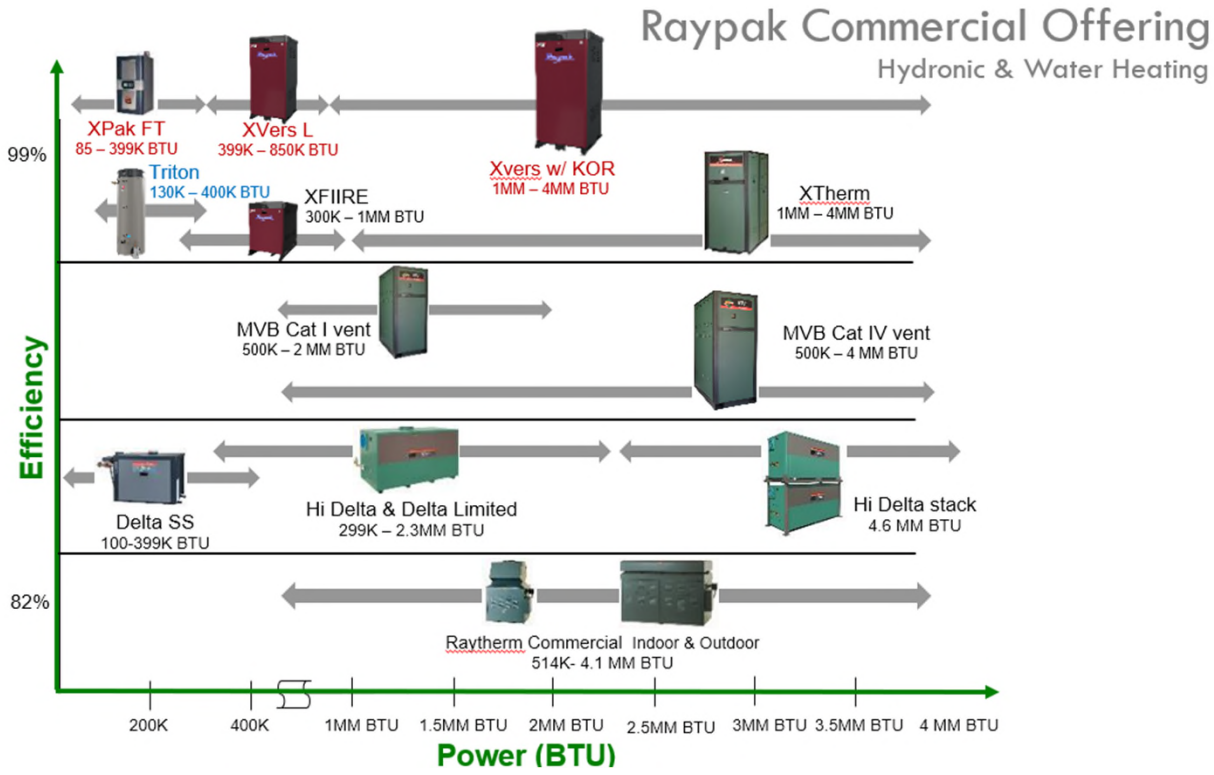

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