FCX Oil-Fired Condensing Boiler

Design, Installation, and Startup of Hydronic Systems For the FCX Oil-Fired Condensing Boiler

Geminox – France's Leading Manufacturer of Steel Boilers
Part of Bosch Thermotechnik
http://www.geminox.com/int/instit/instit.asp

Lucky Distributing – Exclusive importer of the Geminox FCX Oil-Fired Condensing Boiler

John Jansen – President & CEO
Bill McConaughy – Sales Alaska / Canada

Quintessence Corporation – Fairbanks Master Dealer and Tech Support

Jim Romersberger – President
Special Technical Representative

Hydronic Considerations

- Science of Condensing
- How the FCX Works
- Hydronic Design/ Heat Emitters
- Controls
- Pumps

Condensing Technology

How Heat is Recovered?

There are **Two Processes** by which heat is recovered from the burning of fuel.

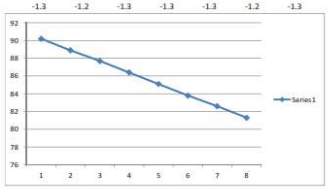
Reduction of the burn temperature (sensible heat). Oil burns at about 4000° F, the stack temperature normally is about 350° F. Further reduction leads to the 2nd Process.

Recovering of the latent heat of vaporization (latent from the Greek root word meaning hidden). This is the condensing part.

How does Lowering Stack Temperature Make for Greater Efficiency

https://www.beckettcorp.com/support/tech-bulletins/a-practical-consideration-of-a-f-u-e-ratings-and-burner-adjustment/

150	200	250	300	350	400	450
90.2	88.9	87.7	86.4	85.1	83.8	82.6
-1.3	-1.2	-1.3	-1.3	-1.3	-1.2	-1.3



NO. 2 FUEL OIL EFFICIENCY CHART

Net Stack Temp. °F

%O2	200	250	300	350	400	450	500	550	600	650	700	750	800	%CO2
1	89.6	88.4	87.3	86.2	85.1	84.0	82.9	81.7	80.6	79.5	78.4	77.3	76.2	14.7
2	89.4	88.2	87.0	85.9	84.7	83.6	82.4	81.2	80.1	78.9	77.7	76.6	75.4	14.0
3	89.2	87.9	86.7	85.5	84.3	83.1	81.9	80.7	79.4	78.2	77.0	75.8	74.6	13.2
4	88.9	87.7	86.4	85.1	83.8	82.6	81.3	80.0	78.7	77.5	76.2	74.9	73.6	12.5
5	88.7	87.3	86.0	84.6	83.3	82.0	80.6	79.3	77.9	76.6	75.3	73.9	72.6	11.7
6	88.4	87.0	85.5	84.1	82.7	81.3	79.9	78.5	77.0	75.6	74.2	72.8	71.4	11.0
7	88.0	86.5	85.0	83.5	82.0	80.5	79.0	77.5	76.0	74.5	73.0	71.5	70.0	10.3

FIGURE 2.

So, a Reduction of Stack temperature from 450F to 150F is…

90.2 - 82.6 = 7.6%

Condensing Technology

What is Condensing?

The products of combustion consist primarily of CO2 and Water Vapor.

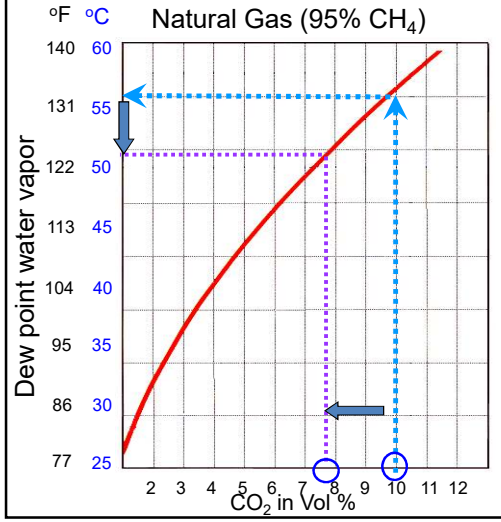
Condensing refers to the cooling of the stack gasses to the point where the water vapor condenses into liquid. It does not refer to the water circulating in the boiler or the heat emitters. Nor are we talking about steam condensing radiators.

Condensing Technology

How does Condensing Make for Greater Efficiency?

- **When water changes state from a gas to a liquid (goes from a gas at 212° to liquid at 212°), it gives off heat that is absorbed by the water in the boiler. Think of it as just the opposite of adding heat to make water boil.**
- **This process recovers the latent (hidden) heat of vaporization, takes place in the condenser, and is added back into the Boiler water.**
- ***The net result is greater efficiency*.**

WATER VAPOR DEW POINT

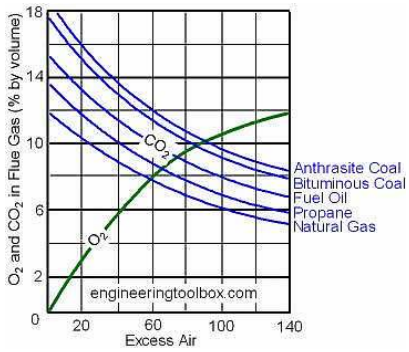


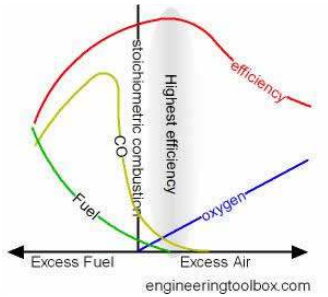
CO_2% of flue gas influences dew point temperature

Higher CO_2
=Higher Dew point
=More Condensation

Lower CO_2
=Lower Dew point
=Less Condensation

Tuning a Condensing Boiler





Heat Transfer and the FCX

How it works

Counter Flow vs. Parallel Flow

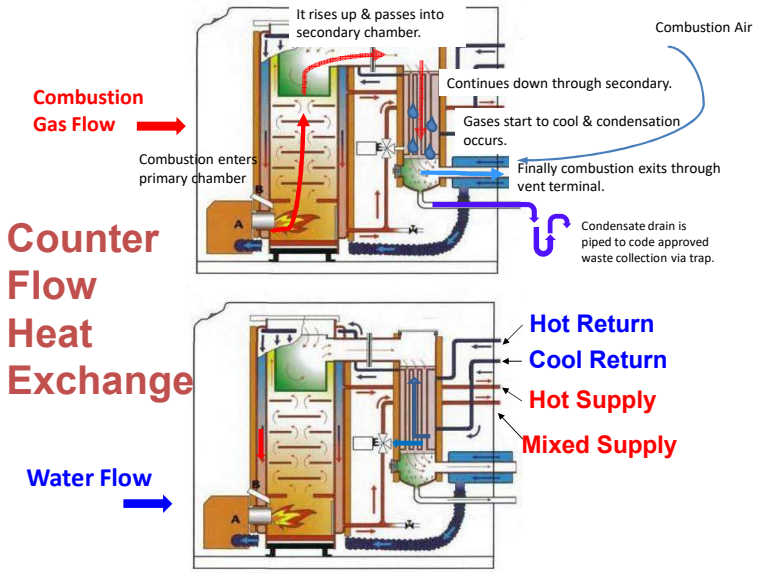
3800 F° Flow of Combustion Gas 150 F°

80 F° Parallel Flow of Water 150 F°

[In Parallel Flow] "…the temperature of the cold fluid exiting the heat exchanger never exceeds the lowest temperature of the hot fluid. This relationship is a distinct disadvantage if the design purpose is to raise the temperature of the cold fluid."

3800 F° Counter Flow of Water 80 F°

http://www.engineersedge.com/heat_transfer/parallel_counter_flow_designs.htm



Heat Emitters

The more you have the lower the water temperature needed, thus the lower the return water Temperature.

Hydronics – Unique to Condensing

Heat Emitters

- High Mass – the best for condensing
  - Lowest temperatures needed
- Staple Up – don't do it, requires water 30°F greater water temperature
- Radiant Panels – pricey, but can use lower water temperatures
- Baseboard and Super Baseboard
- Unit Heaters and other low mass

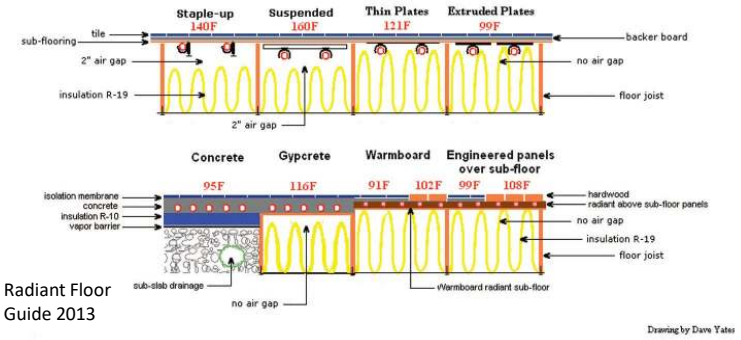
The Key is lower water return temperatures

The most important thing is return water temps so…how do we do it?

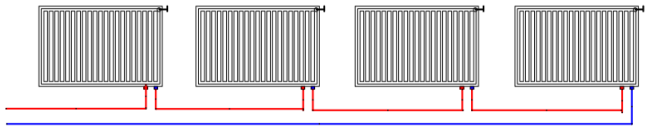
Typical Floor Types

The Major Factor: "The lower the systems temperature requirements, the better the overall system-wide efficiency, which will ensure the lowest possible operating costs for fuel and power." [and the Most Condensing and Lowest Stack Temperatures]

Water temperatures required to meet the required 80F floor surface temperature.



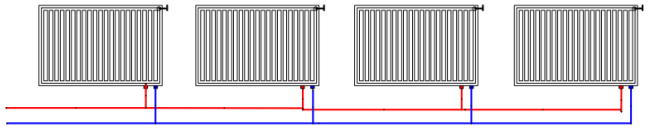
Radiant Floor Guide 2013



Parallel Vs Series

Parallel:

- **More Even Heat Distribution**
- **Better Pumping Characteristics**



Controls

Control Options

The FCX is a plug and play Boiler….but

1. **None / Built-in**
2. **Zone Controllers**
3. **Switching Relays with Digital Temperature Control**
4. **Outside Reset with Indoor Feedback**

Boiler and Pump Control

Minimum recommended for new construction w/radiant or low temp emitters.

Johnson a421 Digital Temperature Controller

The Johnson provides more accurate temperature control of the boiler core and led read out.

Taco SR502-4 Series

The Taco allows for cold starting the boiler and the control of multiple pumps.

Manual Mix Control

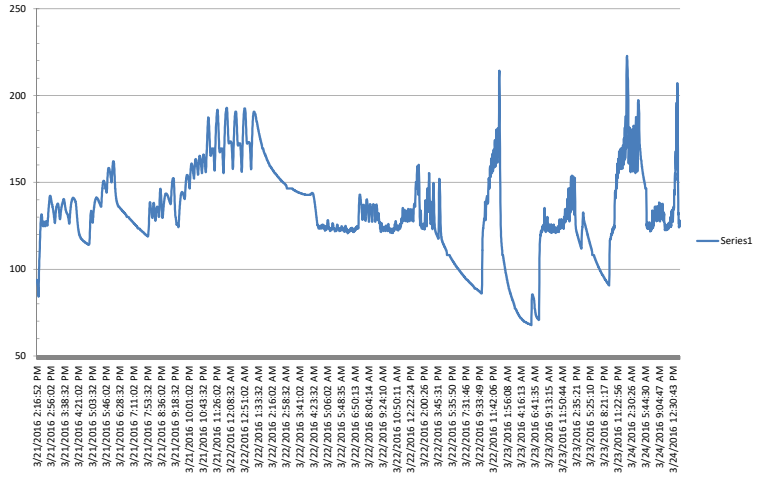
The Cadillac

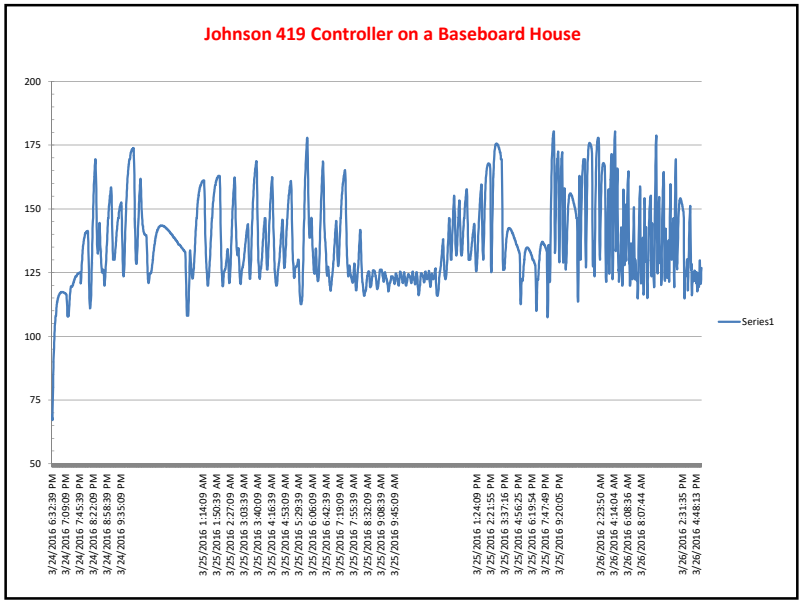
Tekmar Digital Controller
Boiler / Mixing Valve / Pump / Temperature

This control is a must when retrofitting a Base Board House

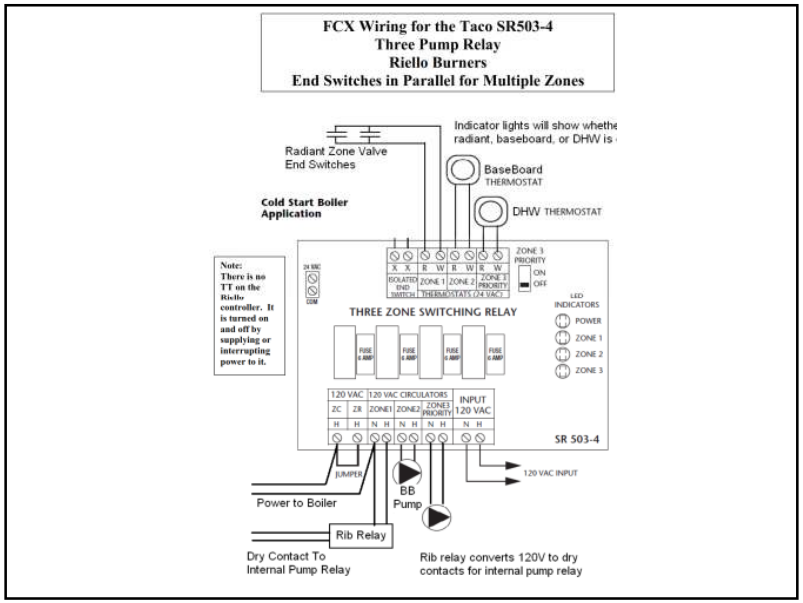
Why Digital Controls

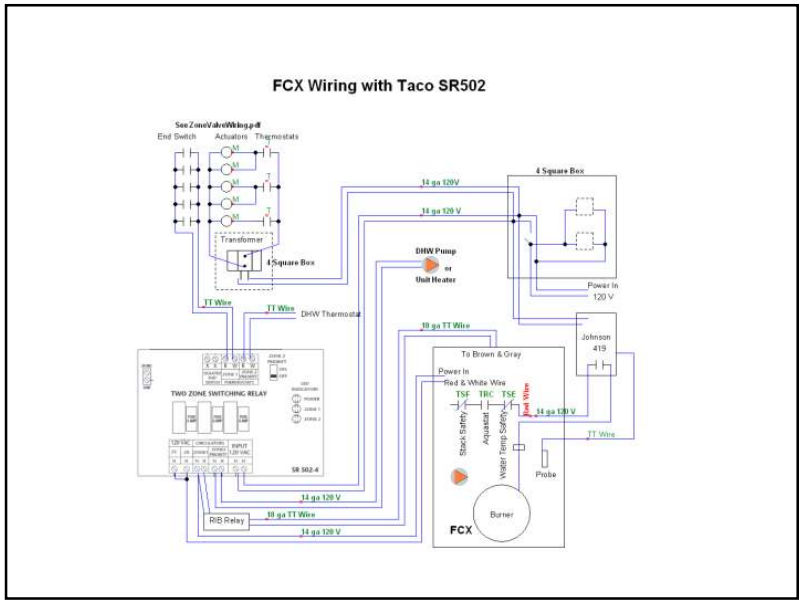
Data Logger every 3 minutes for about 3 days
Capillary Type Aquastat Gone Wild



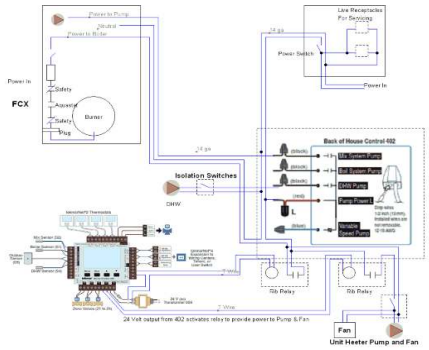

Johnson 419 Controller on a Baseboard House
200
175
150
125
100
75
50
Series1
3/24/2016 6:32:39 PM
3/24/2016 7:09:09 PM
3/24/2016 7:45:39 PM
3/24/2016 8:22:09 PM
3/24/2016 8:58:39 PM
3/24/2016 9:35:09 PM
3/25/2016 1:14:09 AM
3/25/2016 1:50:39 AM
3/25/2016 2:27:09 AM
3/25/2016 3:03:39 AM
3/25/2016 3:40:09 AM
3/25/2016 4:16:39 AM
3/25/2016 4:53:09 AM
3/25/2016 5:29:39 AM
3/25/2016 6:06:09 AM
3/25/2016 6:42:39 AM
3/25/2016 7:19:09 AM
3/25/2016 7:55:39 AM
3/25/2016 8:32:09 AM
3/25/2016 9:08:39 AM
3/25/2016 9:45:09 AM
3/25/2016 12:24:09 PM
3/25/2016 2:21:55 PM
3/25/2016 3:37:16 PM
3/25/2016 4:56:25 PM
3/25/2016 6:19:54 PM
3/25/2016 7:47:49 PM
3/25/2016 9:20:05 PM
3/26/2016 2:23:50 AM
3/26/2016 4:14:04 AM
3/26/2016 6:08:36 AM
3/26/2016 8:07:44 AM
3/26/2016 2:31:35 PM
3/26/2016 4:48:13 PM

How to Wire


FCX Wiring for the Taco SR503-4
Three Pump Relay
Riello Burners
End Switches in Parallel for Multiple Zones
Radiant Zone Valve
End Switches
Indicator lights will show whethe
radiant, baseboard, or DHW is
BaseBoard
THERMOSTAT
DHW THERMOSTAT
Cold Start Boiler
Application
Note:
There is no
TT on the
Riello
controller. It
is turned on
and off by
supplying or
interrupting
power to it.
THREE ZONE SWITCHING RELAY
SR 503-4
Power to Boiler
BB
Pump
Rib Relay
Dry Contact To
Internal Pump Relay
Rib relay converts 120V to dry
contacts for internal pump relay


FCX Wiring with Taco SR502
Transformer
4 Square Box
DHW Pump
or
Unit Heater
TT Wire
DHW Thermostat
TWO ZONE SWITCHING RELAY
SR 502-4
To Brown & Gray
Power In
Red & White Wire
Johnson
419
Probe
Burner
FCX
RIB Relay

FCX withTekmar 402, 3 Heating Zones
DHW and a Unit Heater
Controlling 3 pumps



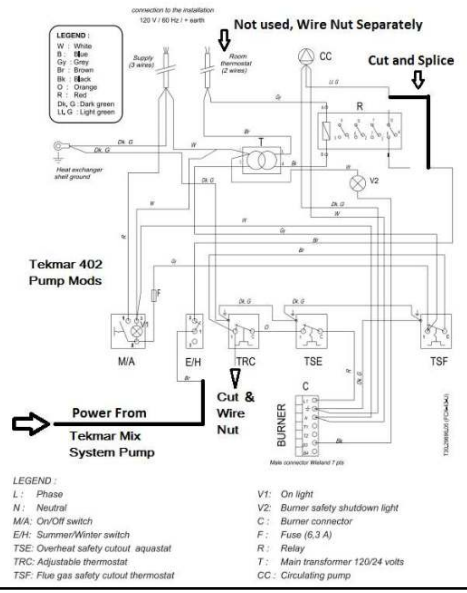
Notes:

The FCX has no TT on its controller, it is turned off and on by interrupting power to the boiler using a RIBU1C relay. These changes are necessary because the pump is powered separately from the boiler with the Tekmar 402.

It is adequate to use 14 gage, 3 conductor cable with ground as only one neutral is required.

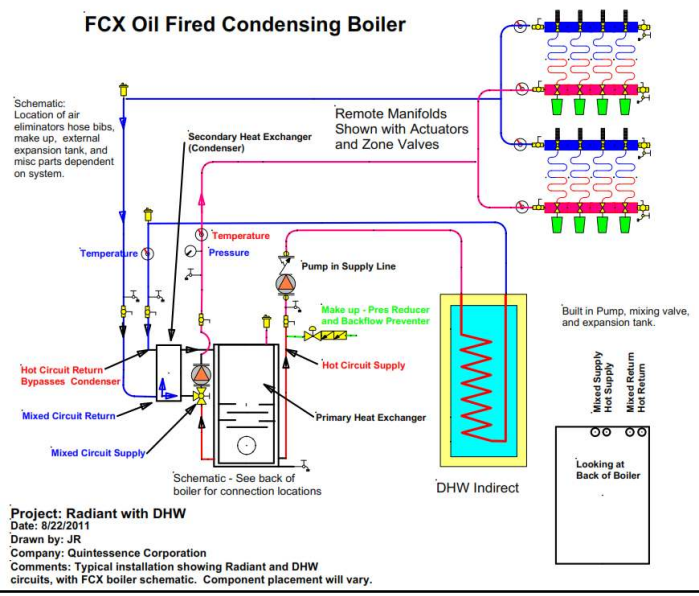
The internal aquastat now functionally becomes a secondary high limit. It must be left in the circuit as the Tekmar is not rated as a primary controller.

Tekmar 402



Pumping And Piping

FCX Oil Fired Condensing Boiler

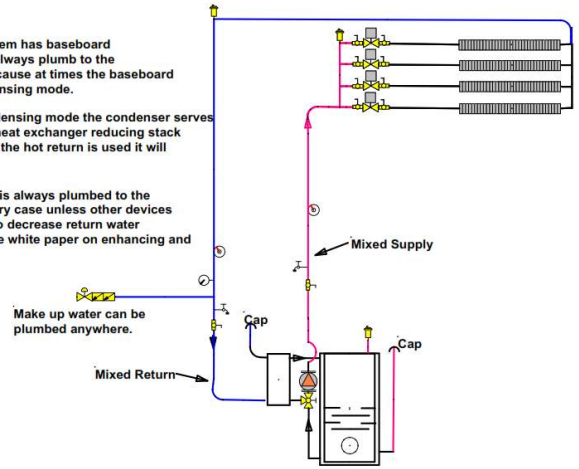


Project: Baseboard Alone
Date: 10/23/2012
Drawn by: JR
Company: Quintessence Corporation www.FCXalaska.com
Comments: Why to use the mixed circuit when baseboard is the only heat emitter.

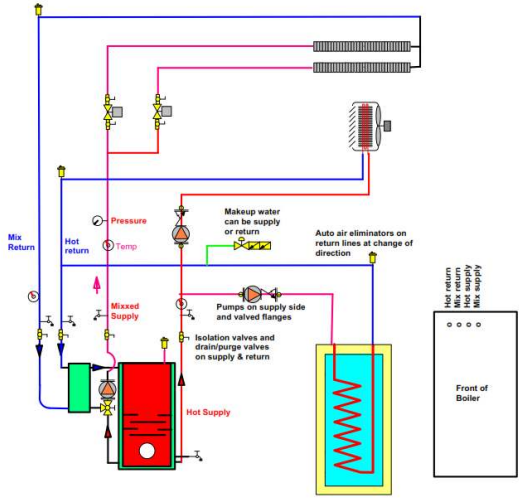
Notes:
Whenever a system has baseboard without radiant always plumb to the mixed circuit because at times the baseboard will run in condensing mode.

Even in noncondensing mode the condenser serves as a secondary heat exchanger reducing stack temperatures. If the hot return is used it will negate this

The DHW heater is always plumbed to the hot circuit in every case unless other devices are added post to decrease return water temperature. See white paper on enhancing and optimising.

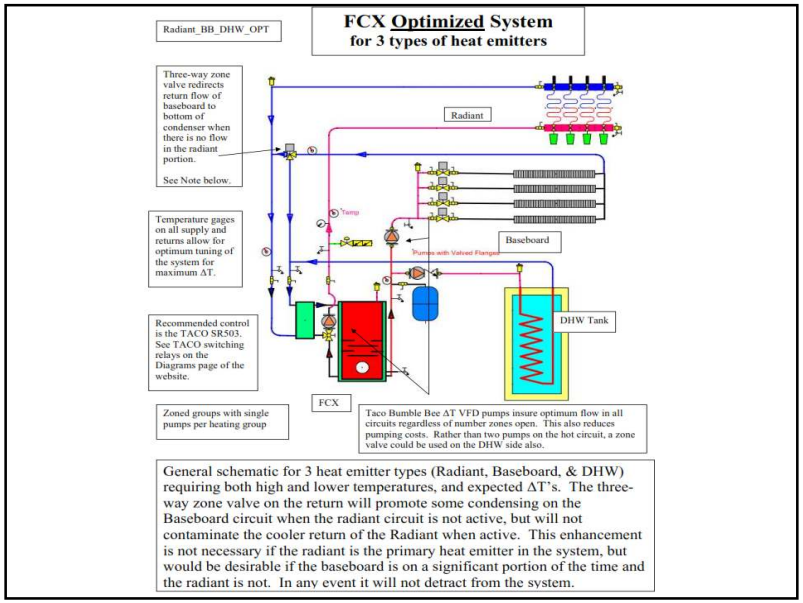


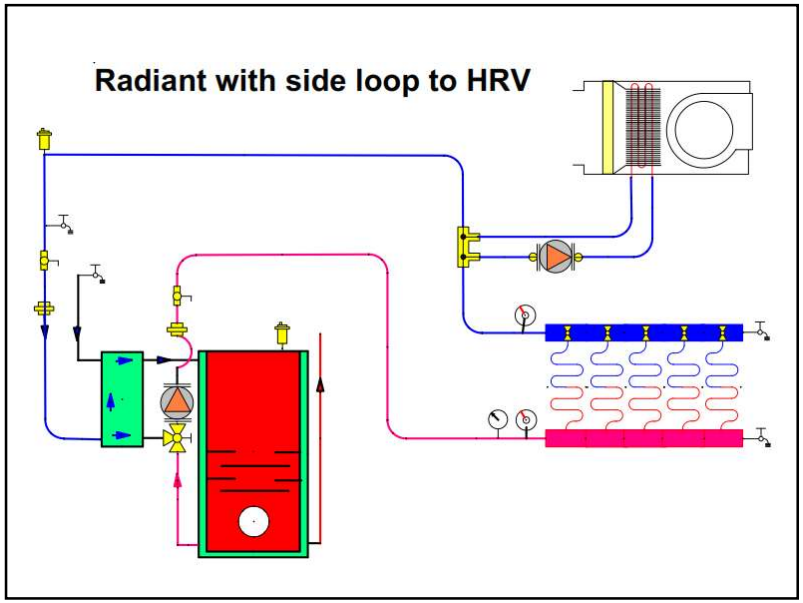
Baseboard - Unit Heater - DHW



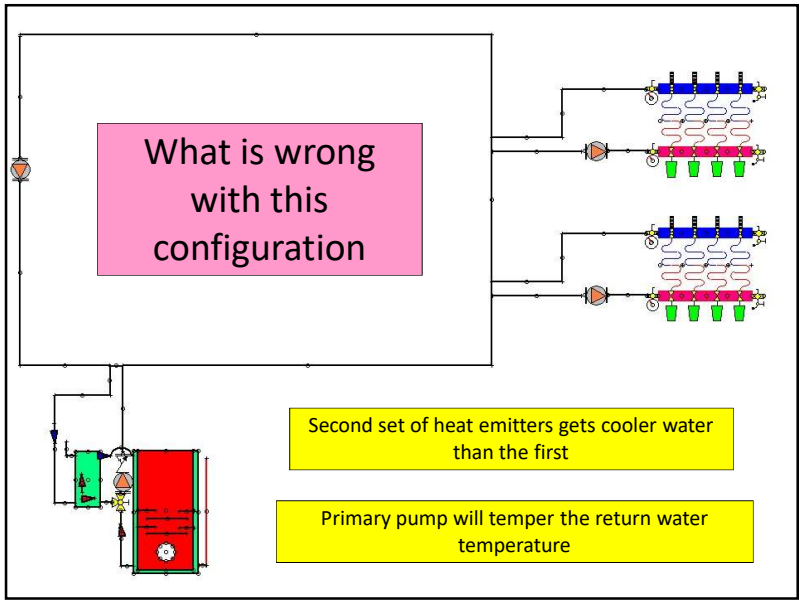
Habit for Humanity - Baseboard

Habit for Humanity - Baseboard

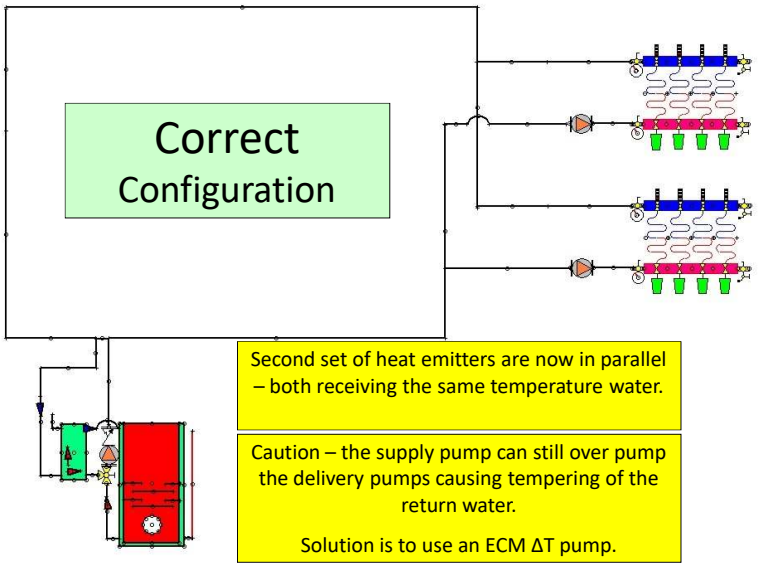




Common Mistakes



Correct Configuration

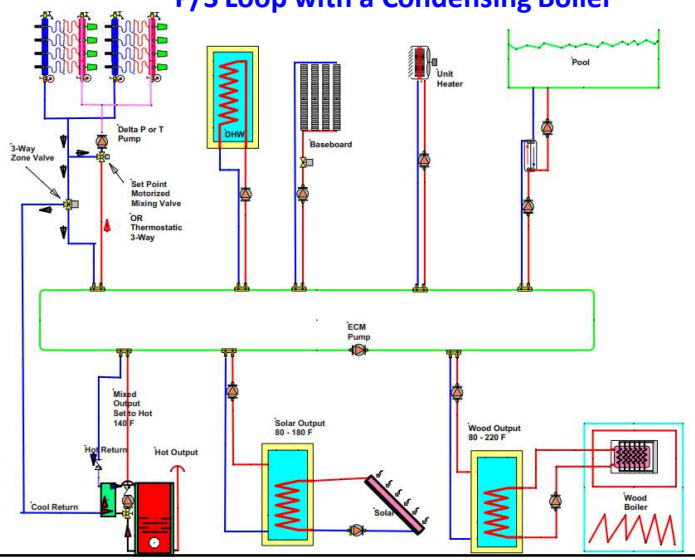


Second set of heat emitters are now in parallel – both receiving the same temperature water.

Caution – the supply pump can still over pump the delivery pumps causing tempering of the return water.

Solution is to use an ECM ΔT pump.

P/S Loop with a Condensing Boiler



Stacks Venting Condensate

3 Types of Venting are Available

Singlewall – Inside Combustion Air

Combo

Concentric – Sealed combustion

Applicability

Single Wall (SW)
- Only where house is isolated from the location of the boiler. Never use a sidewall exit. SW on long vertical stacks extending above the highest point in the house have been used successfully with cols air intakes.

Concentric
- This type can be used anywhere but can be very expensive with long lengths. We have gone over 40 feet.
- Always use this type with side exit with a boiler room on a bottom floor.

Combo
- Use this technique when sealed combustion is essential but long lengths are needed.

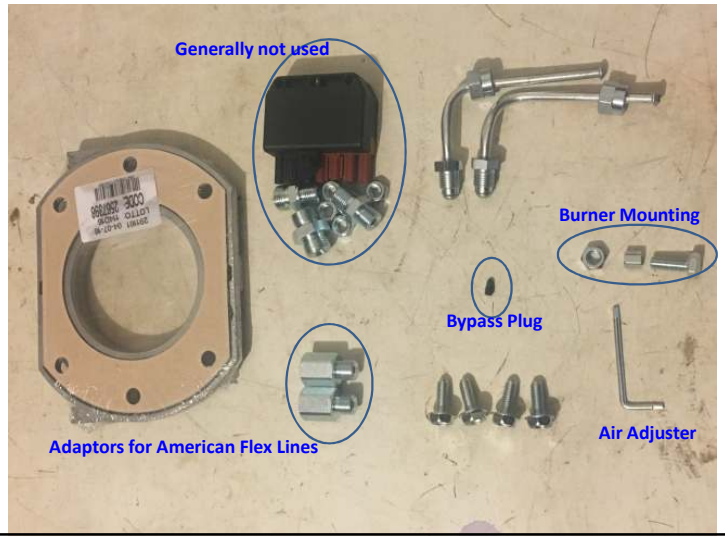
Condensate
Traps, Drains, Vacuum Breaks, Pumps

http://www.fcxalaska.com/PDFs/HandlingCondensate.pdf

Riello Burner Setup

Riello RDB Burner

Riello Burner Parts



Mounting Instructions

You Also Need

Tiger Loop and 36” Flex Lines

Tigerloop Ultra
Recommended

Startup

Commissioning the boiler

Disassembly

- 4 Bolts on Primary
- 1 Wingnut on Condenser
- 1 Nut Holding Burner
- 4 Screws on Control Panel

Disassembly and Assembly




Appling Anti-Sieze

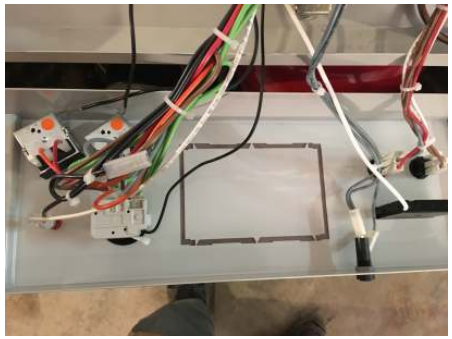
Using a Teflon Paste as an anti-seize

- View port
- Condenser gasket or lid
- 4 – Fastening bolts on primary

Don't lose spring

Inspecting Electrical Connections

Check all Spade Connectors




Check Gasketed Connections

Check Electrodes for blocking Light

Tuning

**** This boiler cannot be tuned by eye ****

- **CO / O2 / Temp / Pres - Measured**
  - CO higher after cleaning – about 30 ppm
  - O2 +- 4.0
  - Pressure 185 psi
- **CO2 / Excess Air - Calculated**
  - CO2 – 12.5
  - Excess air +- 20
- **Efficiency / Stack Temperature**
  - Also Calculated
  - On system startup – 96-97% / Stack 80F
  - Stabilized (Warm Return) – 92+% / 125-175F

CO2 / Excess Air / Pressure

Set: CO2 = 12.5 Pressure = 185

Last and Most Important
Smoke Spot Check

Trouble Shooting

- **Power Route** – see wiring diagram
  - M/A - Switch (green light)
  - Fuse
  - TSF - Flue Gas Safety
  - TRC - Aquastat
  - TSE – Water Temperature Safety
  - Boiler Plug to Riello Burner
- **Riello Control Box**
  - Jumpering the Thermostat
  - Check for loose connections
- **Fires Erratically – Wont Stay Lit**
  - Fires manually removing cad cell, blocking, and then opening
  - High voltage wire blocking cad cell
  - Blast tube on backwards
  - Bad puffer switch
  - Dirty cad cell

- Check safeties first
- Safeties do not stick out when tripped, listen for click when reset
- Check for loose spade connectors