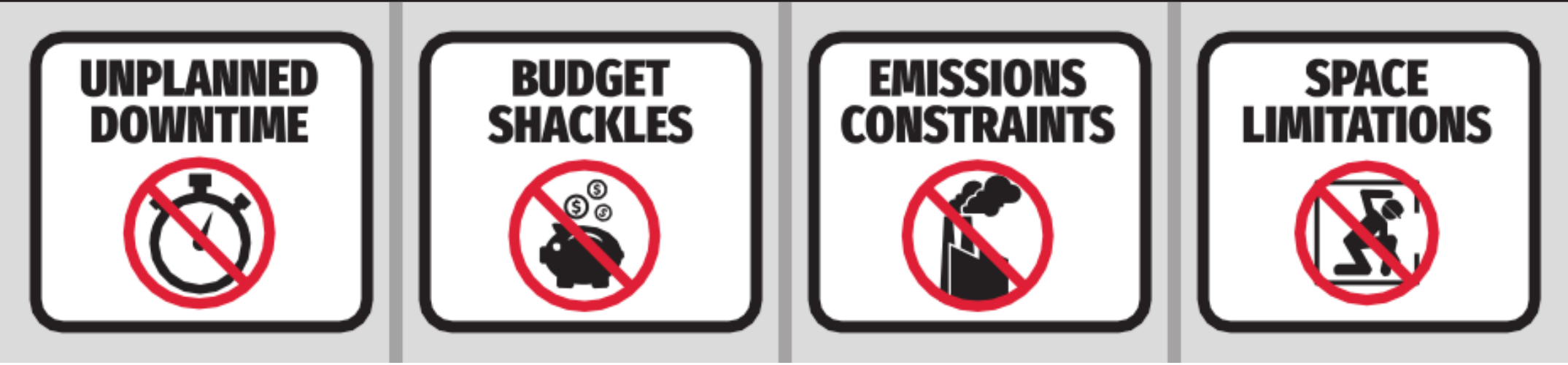

CHEYENNE ENGINEERING UNVEILED
Exploring Superior's Condensing Boiler
SUPERIOR BOILER
Cheyenne Condensing Boiler

Superior Boiler helps you

outwit your challenges



For over 100 years, we've been finding **solutions to the world's greatest boiler challenges.**

BACKGROUND
THE SUPERIOR BOILER STORY

1917

Hugh C. Gass founds Superior Welding Shop in Hutchinson.

WORLD WAR II

Superior Welding Shop transforms into a training facility, preparing around 200 welders for the war effort.

1945

Superior Boiler Works moves into a 5,000 sq. ft. facility with 10 employees.

1960s

Equipment sizes increase, addition of the 3-pass dry back firetube boiler and the new firebox boiler requires more manufacturing space, expanding to 83,000 sq. ft.

1970s

Added 3-pass wetback, horizontal return tube boilers and waste heat recovery boilers. Now producing fire tube boilers up to 600hp and fireboxes up to 350hp.

1984

Superior Boiler produces its first (of many) 1000hp gas and oil-fired boiler.

2002

Superior builds the largest single furnace firetube boiler in the industry, a 2200hp dry back.

2014

Superior Boiler purchases Triad Boiler. Product line expands to include both hot water and steam vertical firetube boilers commonly used in commercial heating applications.

2016

Superior purchases English Boiler, adding watertube boilers to its product offerings.

2021

Added another facility in Hutchinson, bringing the company to 300,000 sq.ft of manufacturing space.

2022

Superior began production on the Cheyenne , a high-efficiency condensing boiler line.

SCOTCH MARINE BOILERS

DRYBACK & WETBACK (10-2,500 BoHP)

- Firebox/Modified Firebox Boilers (7-447 BoHP)
- Waste Heat Boilers - engineered & customized for each project
- Horizontal Return Tubular (HRT) Boilers

WATERTUBE BOILERS

Up to 300,000 LB/HR

- Industrial package watertube boilers
- Heat recovery steam generators (HRSG)
- Forced circulation hot water boilers
- Solid fuel boilers
- Modular boiler systems

BOILER ROOM ACCESSORIES

- Spray & Tray Deaerators; 3,500 LB/HR – 500,000 LB/HR
- Boiler Feed Tanks
- Economizers
- Blow Down & Flash Tank Separators
- Modular water treatment systems

VERTICAL FIRETUBE BOILERS

7-150 BoHP

CONDENSING BOILERS

4,000,000 – 12,000,000 BTU/HR

SUPERIOR BOILER

Superior Boiler Campus

1 Plant 1- Firetube

2 Plant 2- Firetube

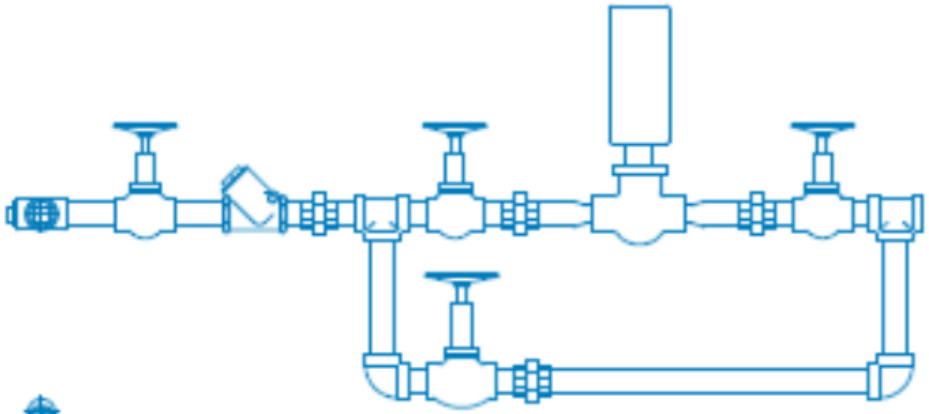
3 Plant 3- Watertube

Hutchinson, KS 67501

Engineered and Built to Order

Customized packages to meet your requirements

- ✓ Fluctuating load demands
- ✓ Emissions compliance
- ✓ Energy efficiency
- ✓ Fuel flexibility
- ✓ Redundancy
- ✓ Footprint challenges



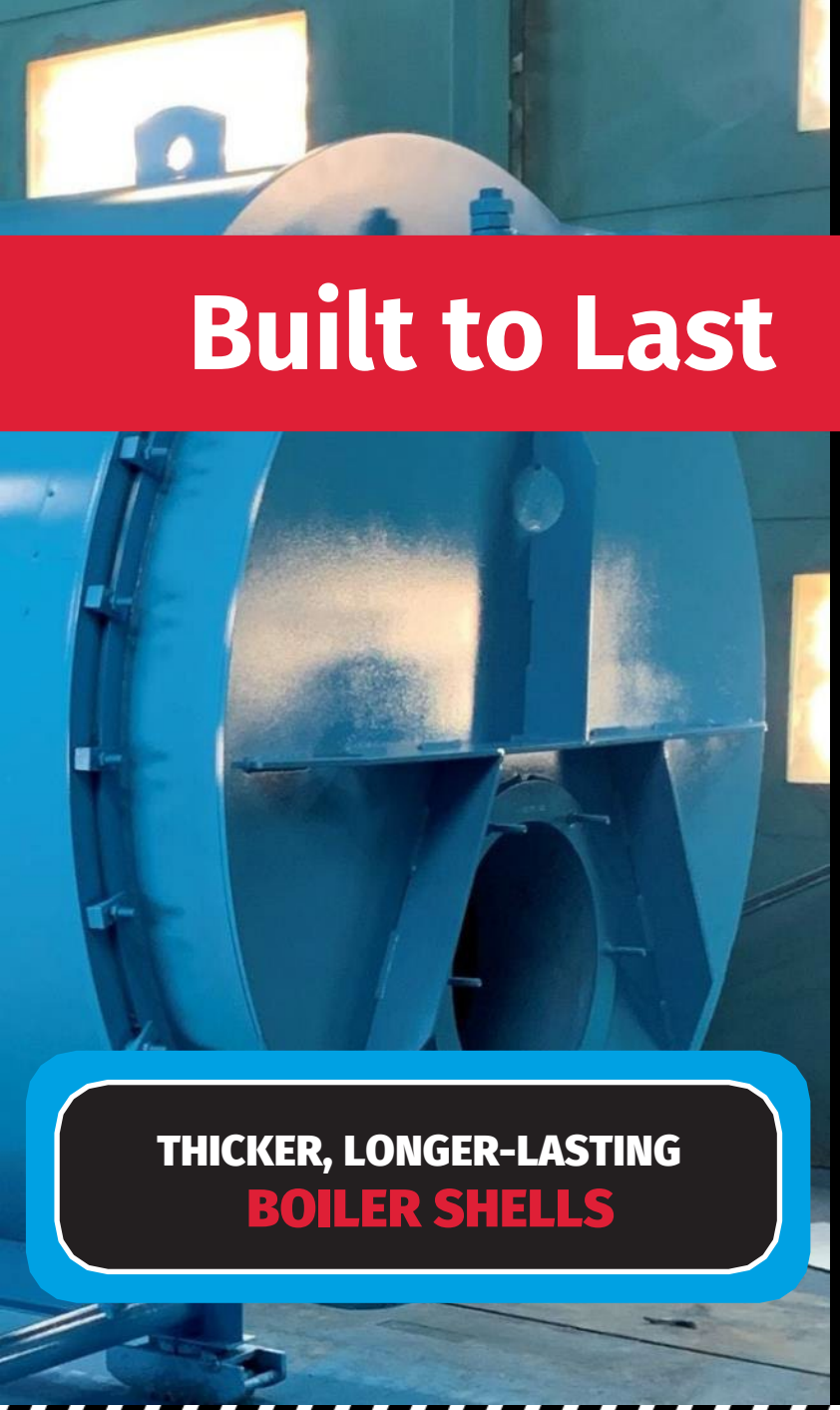
Superior Quality

ISO 9001:2015

ANAB
ANSI National Accreditation Board
ACCREDITED
ISO/IEC 17021-1
MANAGEMENT SYSTEMS
CERTIFICATION BODY

ASR
American Systems
REGISTRAR

Built to Last



THICKER, LONGER-LASTING
BOILER SHELLS

THICKER, STANDARD-SPACED
TUBESHEETS

THICKER, CORROSION-PROTECTIVE
BOILER TUBES

Burner Flexibility

Superior boilers are burner neutral and work with any brand

- ✓ Easier and more cost-effective to maintain
- ✓ Use the qualified boiler technician of your choice for maintenance
- ✓ If burner ever needs to be replaced, use any compatible model

NON-PROPRIETARY PARTS

We use non-proprietary parts, so maintenance and repairs can be completed by the qualified boiler contractor of your choice.

SUPERIOR BOILER

Our Presenters

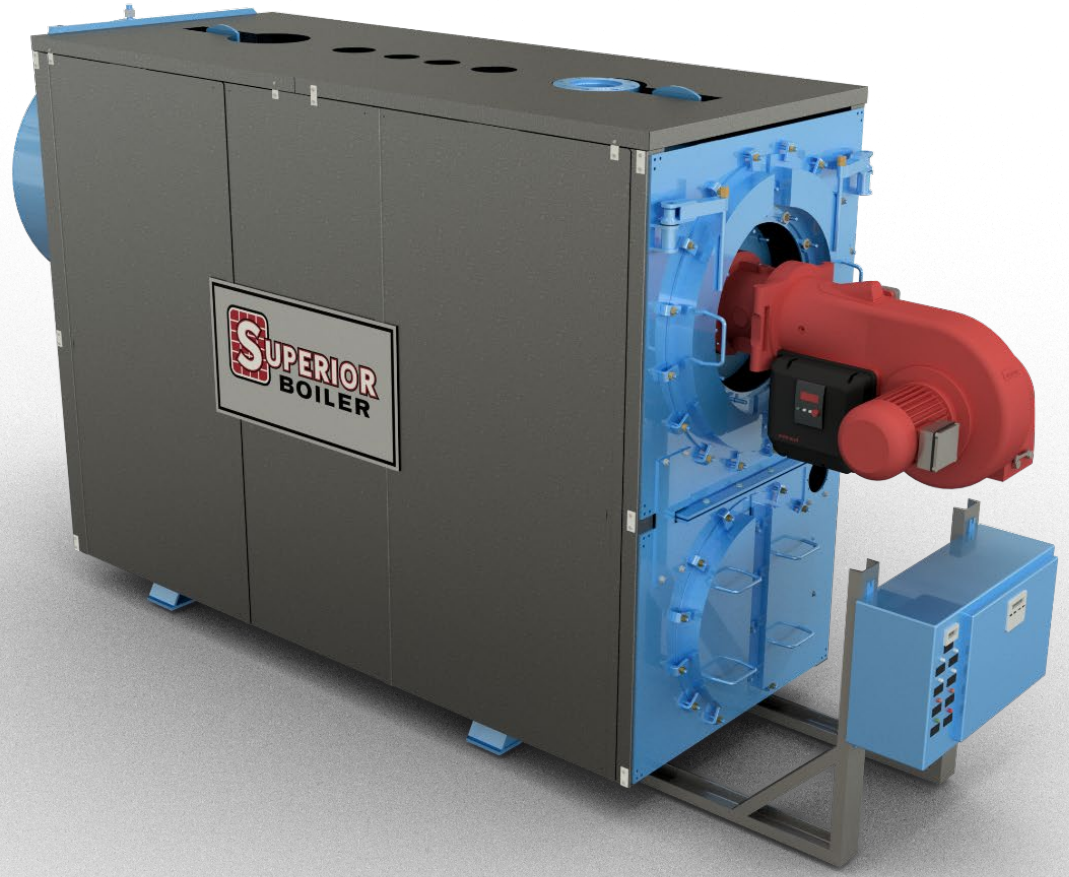
Mike Meininger
Inside Sales Manager – Firetube Division

Mark Yates
Product Manager – Cheyenne and Triad

Trent Thurston
Product Engineering Manager – Condensing Boilers

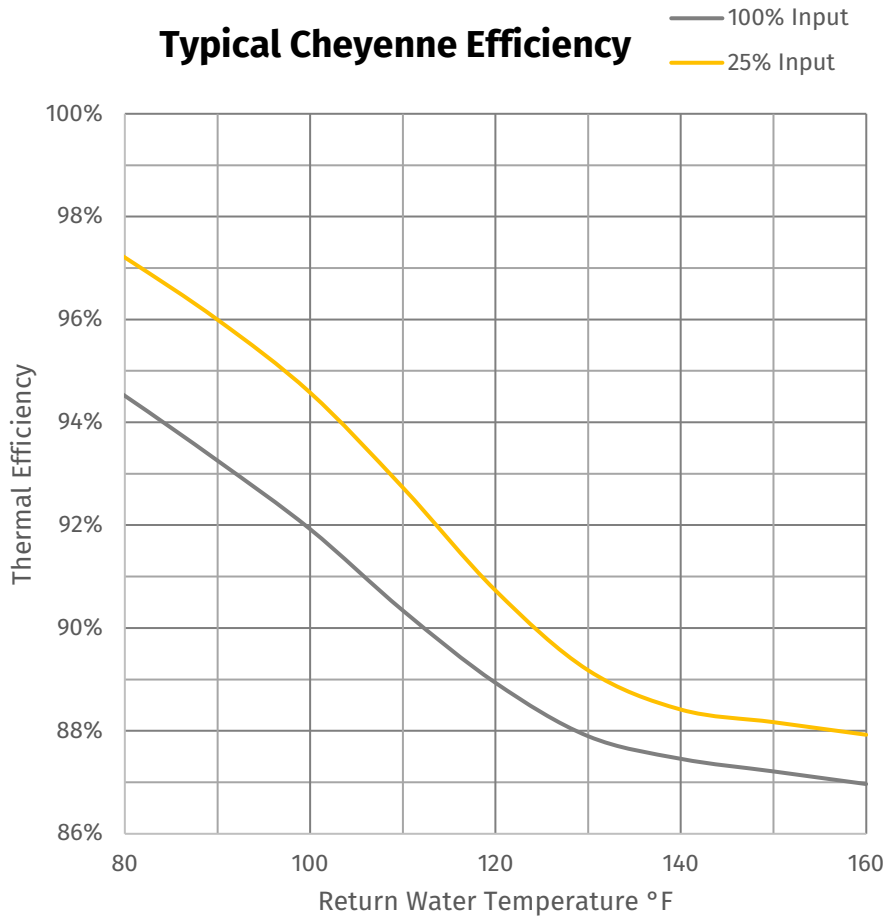
What is the Cheyenne?

- 3-Pass Firetube Condensing Boiler
- Capacity range: 4 to 12 MBTU/HR
- True dual fuel capabilities (gas/oil)
- UL Listed Packages
- 125 psi – Standard Design Pressure
- 160 psi – Max Design Pressure
- 210°F Design Temperature



Condensing Boiler Overview

- Condensing boilers are more efficient than conventional boilers
- Efficiency is gained by condensing the water vapor present in flue gas
- Efficiency and condensation increase with colder return temperature
- Condensing conditions create challenges which quickly damage conventional boilers
- Product is an advantage over conventional hot water boilers where mixing valves/blending pumps may be required due to cool return water (Cost savings/Efficient)



Burning Natural Gas

01 **Oxyfuel Combustion**

$$CH_4 + 2O_2 = CO_2 + 2H_2O + Heat$$

02 **Perfect Combustion with Air**

$$CH_4 + 2(3.76N_2 + O_2) = CO_2 + 2H_2O + 7.52N_2 + Heat$$

03 **Combustion with 15% Excess Dry Air**

$$CH_4 + [1.15] * 2(3.76N_2 + O_2) = CO_2 + 2H_2O + .3O_2 + 8.65N_2 + Heat$$

04 **Combustion with 50% Excess Dry Air**

$$CH_4 + [1.5] * 2(3.76N_2 + O_2) = CO_2 + 2H_2O + O_2 + 11.28N_2 + Heat$$

Products of Combustion

15% EXCESS AIR

Compound	Quantity	% Volume	Dry Volume
CO_2	1	8.37%	10.05%
H_2O	2	16.74%	0%
O_2	0.3	2.51%	3.02%
N_2	8.65	72.38%	86.93%

50% EXCESS AIR

Compound	Quantity	% Volume	Dry Volume
CO_2	1	6.54%	7.53%
H_2O	2	13.09%	0%
O_2	1	6.54%	7.53%
N_2	11.28	73.82%	84.94%

Effects of Humidity

Total condensation is affected by relative humidity.

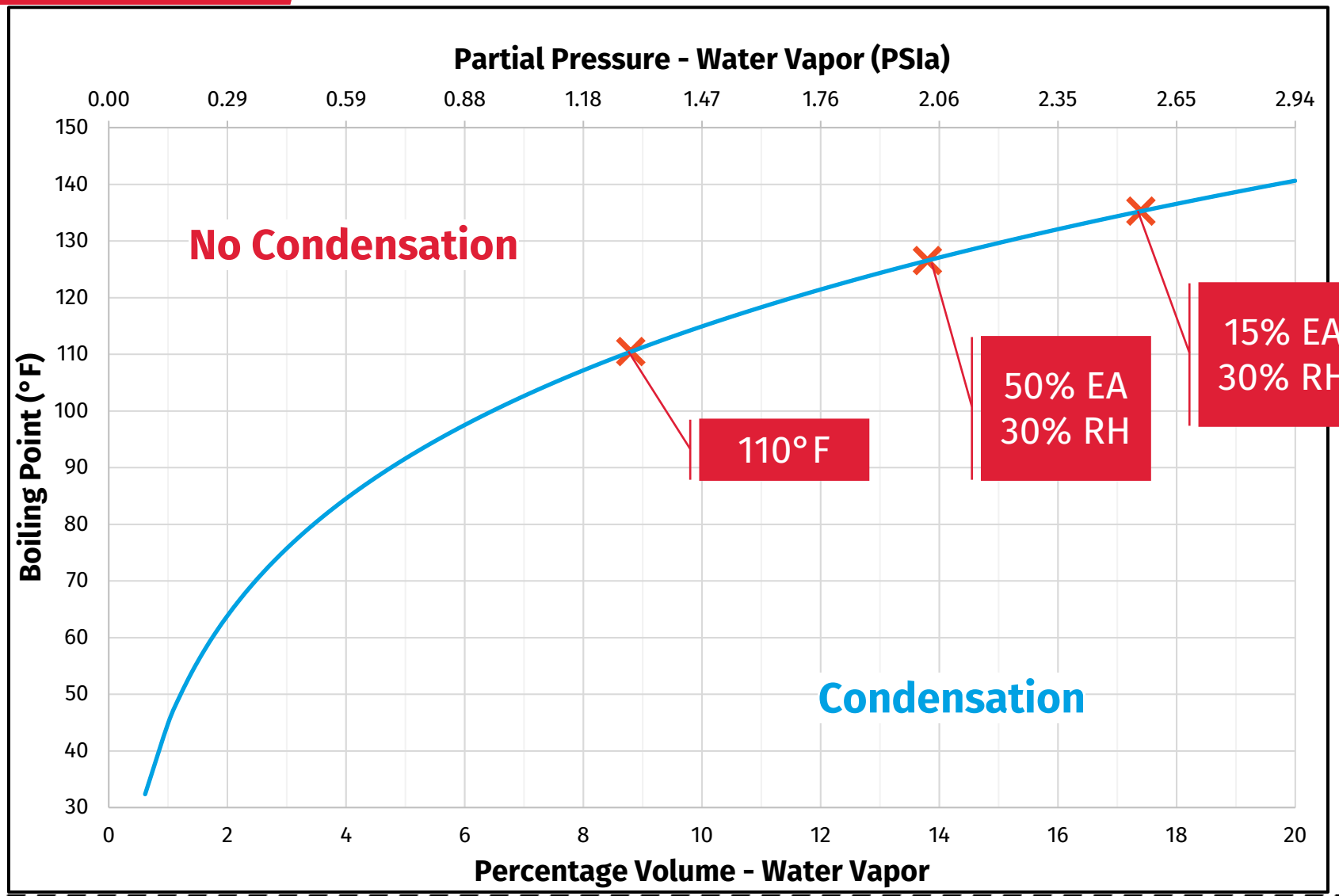
Percentage Water Volume in Flue Gas Based on Relative Humidity											
RH %	0	10	20	30	40	50	60	70	80	90	100
15% EA	16.74	17	17.26	17.52	17.78	18.04	18.29	18.55	18.81	19.06	19.32
50% EA	13.09	13.36	13.64	13.92	14.2	14.47	14.75	15.02	15.29	15.56	15.83

Water Boiling Point

Boiling/Condensing Point

Water boils at different temperatures at different partial pressures.

- $P_W = P_A * \%Vol_W$
- Assumed elevation is 0 ft. above sea level

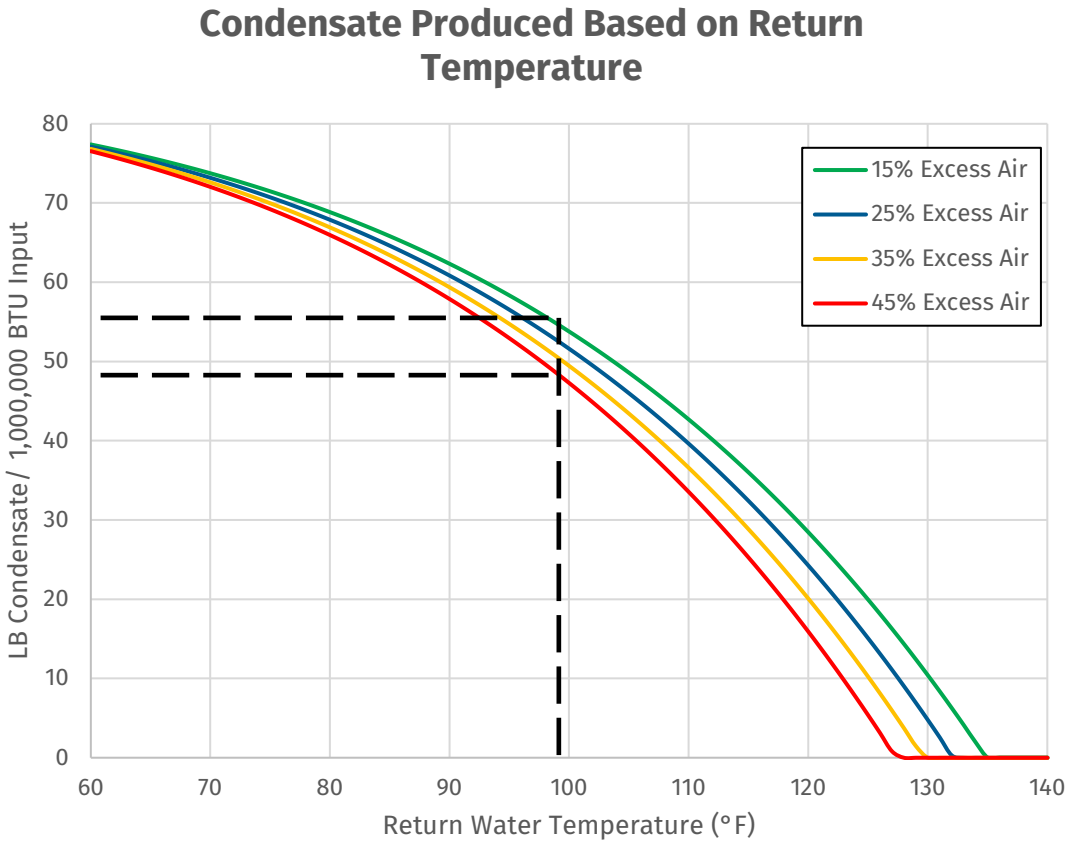


Rate of Condensation

Gas Composition Based on Natural Gas with 30% Relative Humidity

Excess Air	15%	25%	35%	45%
Carbon Dioxide*	10.1%	9.2%	8.5%	7.9%
Oxygen*	3.0%	4.5%	5.9%	7.0%
Water Vapor	17.2%	16.0%	15.0%	14.1%
Condensate @ 100°F (lb condensate per 1,000,000 BTU input)	54 lb	52 lb	49 lb	47 lb

*CO_2 and O_2 based on dry basis



Efficiency maximized, but how?

There are Three Forms of Losses for Boilers

- Dry Flue Gas Losses (Sensible Heat)
  - These are due to the hot flue gas temperature and excess air
- Radiation and Convection Losses (Jacket)
  - Due to heat escaping through the insulation to the room
- Losses due to Moisture in Flue Gas (Latent Heat)
  - Due to water vapor content in fuel remaining as a vapor
  - Varies slightly based on stack temperature, typically 10-11% for conventional boilers

Condensing boilers recover some of these losses

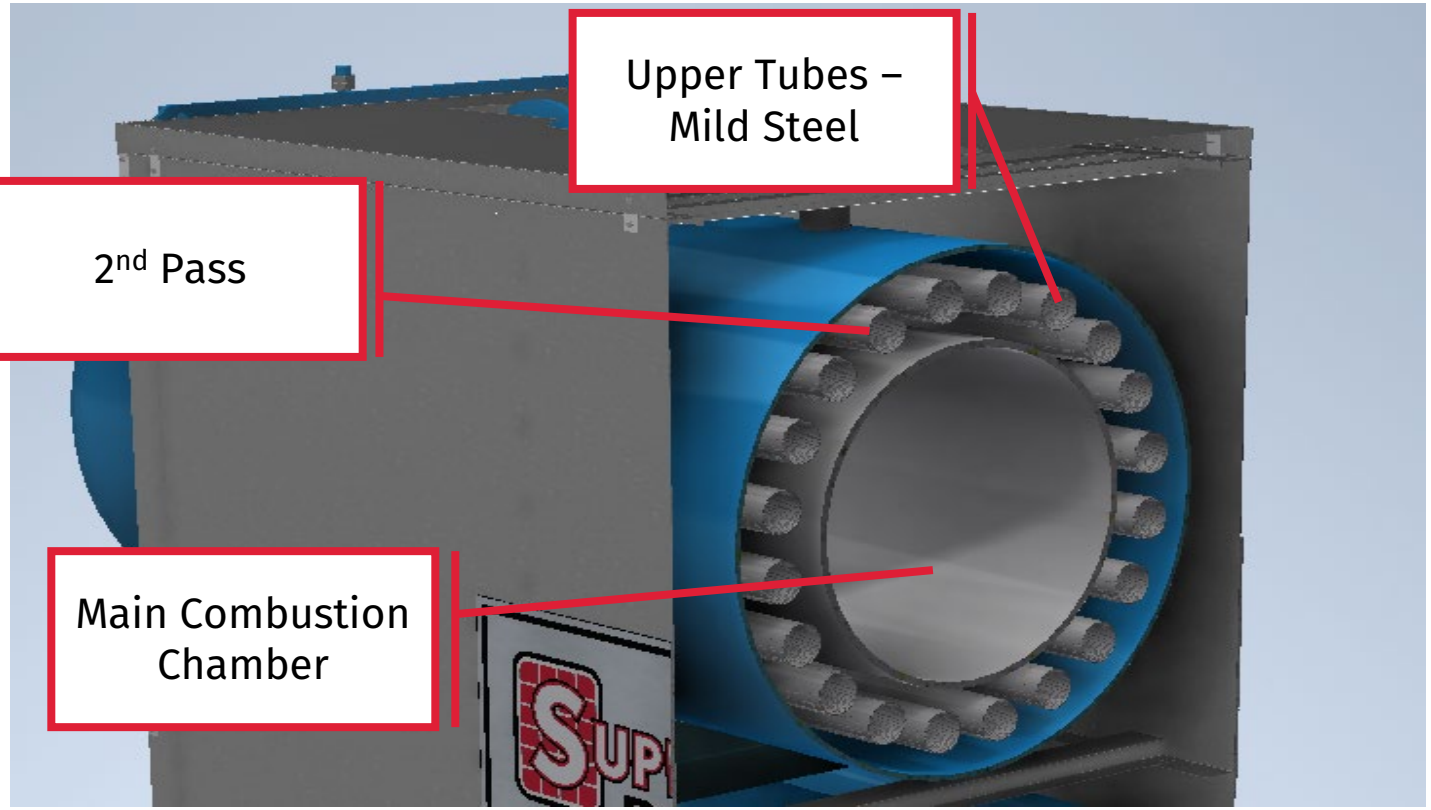
Efficiency Example		
	Dry Flue Gas Losses	Loss Due to Moisture in Flue Gas
Conventional Efficiency	3.2%	10.3%
Condensing Efficiency	0.9%	3.8%

How much more efficient are they?

Boiler Model	Conventional Firetube Boiler	Cheyenne Modeled Data (Full Fire)	Cheyenne Modeled Data (Full Fire, Typical Operation)	Cheyenne Modeled Data (Low Fire)
Boiler Input (% Max Input)	100%	100%	100%	20%
Supply Water Temperature (°F)	180	100	140	70
Return Water Temperature (°F)	160	80	110	60
Efficiency (%)	84-87	95	91.5	99
Flue Gas Temperature (°F)	230-280	127	150	63

Full-Size Furnace

- Can burn multiple fuels including #2 fuel oil, and even A1 Jet fuel
- No restrictions on burner style
- Capable of low excess air operation
- Low excess air gives more condensation and better efficiency

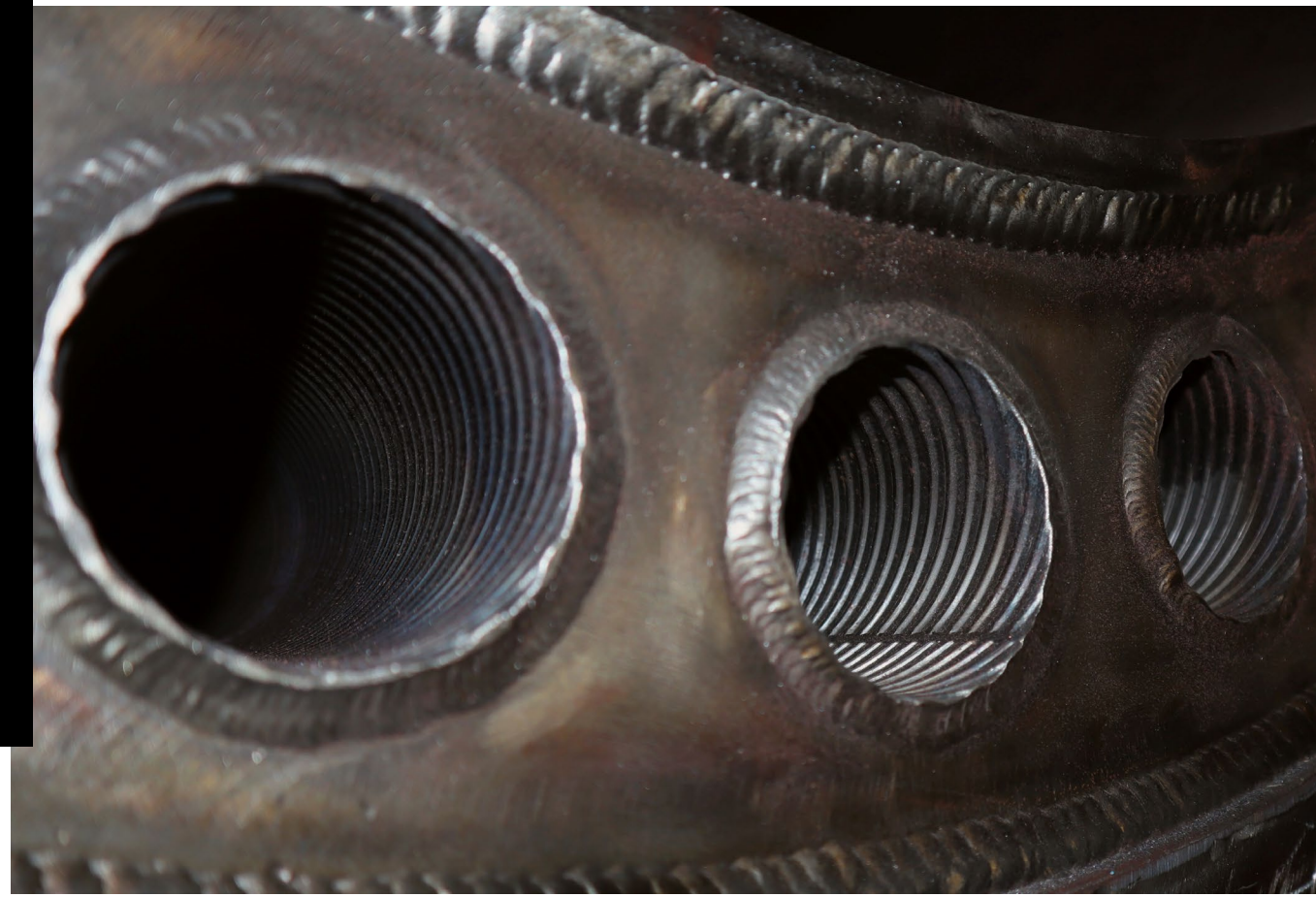


Challenges Inherent to Condensing Boilers

- **Flue gas condensate is acidic**
  - Carbonic acid forms when carbon dioxide is dissolved in water
  - Carbonic acid has a pH of about 4.2 (similar to tomato juice)
  - Condensate requires a neutralizer before discharge to sewer
- Materials in contact with condensate need to be **corrosion resistant**
- Boilers must be designed to resist **thermal shock**

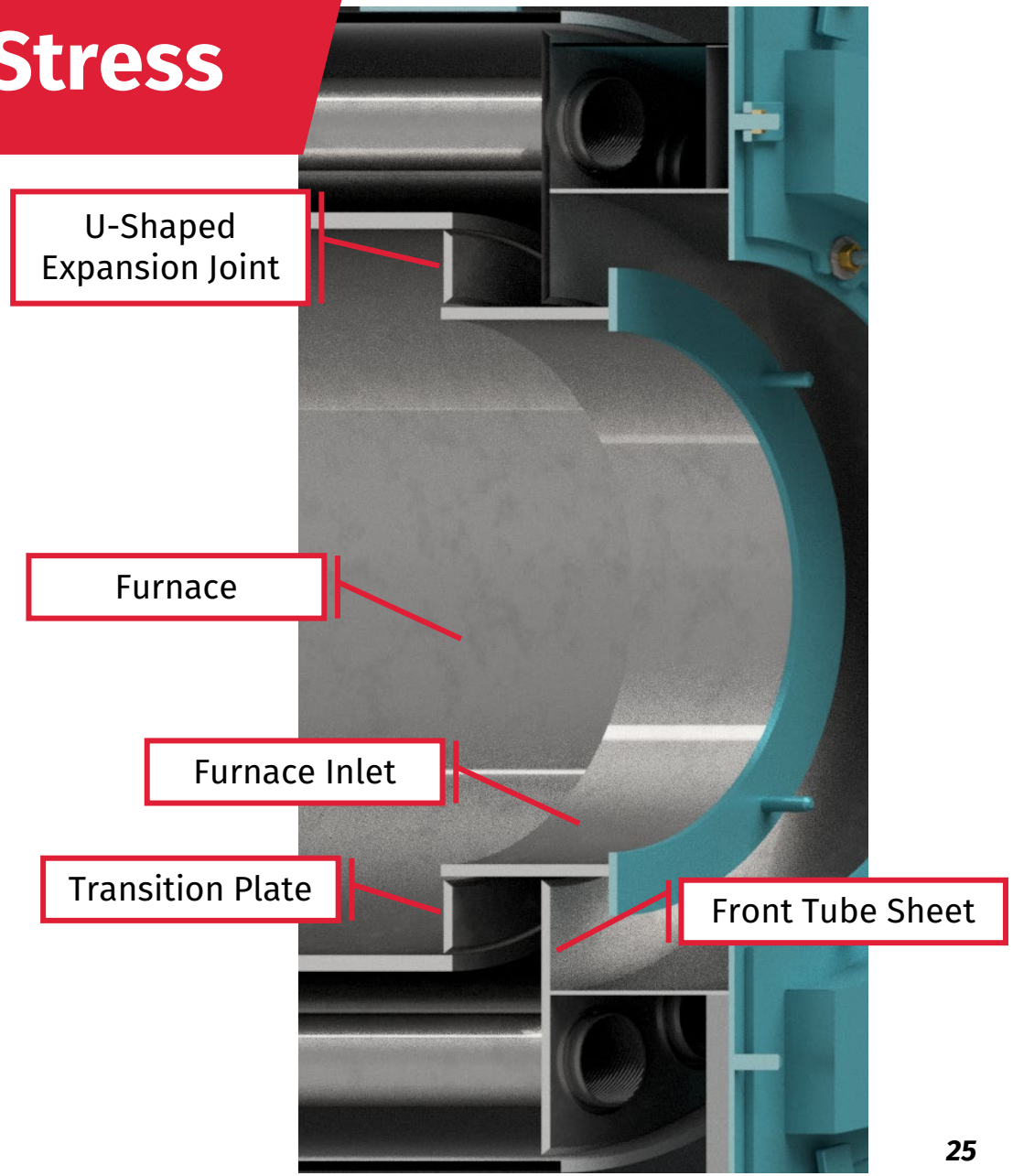
Cheyenne Construction

- Condensing section is grade 316 stainless steel
  - Excellent weldability
  - Highly resistant to corrosion
  - Capable of high temperature operation
- Tubes are 12-gauge material – SS tubes >500 psi MAWP
- Tube sheets are 3/8” material
- Corner joints and tube/tube sheet joints attached by penetration welds



Condensing Challenge: Thermal Stress

- Thermal stress is caused by temperature changes causing expansion and contraction
- Corner joints/tube connections are attached by full penetration welds
- These welds can flex and better handle thermal expansion
- Our furnace has an expansion joint in inlet, further reducing stress



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High Mass Boiler

- Large water volume helps reduce cycling
  - Increases efficiency
  - Reduces Thermal Stresses
- Safely operates with low flow or no flow conditions
- Boiler safeties have time to shut down the boiler

Boiler Model	20% Input	Water Capacity	Time to Rise 10° F
CH-4000	800 MBH	3,516 lb	2.64 min
CH-6000	1,200 MBH	3,944 lb	1.97 min
CH-8000	1,600 MBH	5,053 lb	1.89 min
CH-10000	2,000 MBH	6,312 lb	1.89 min
CH-12000	2,400 MBH	7,289 lb	1.82 min

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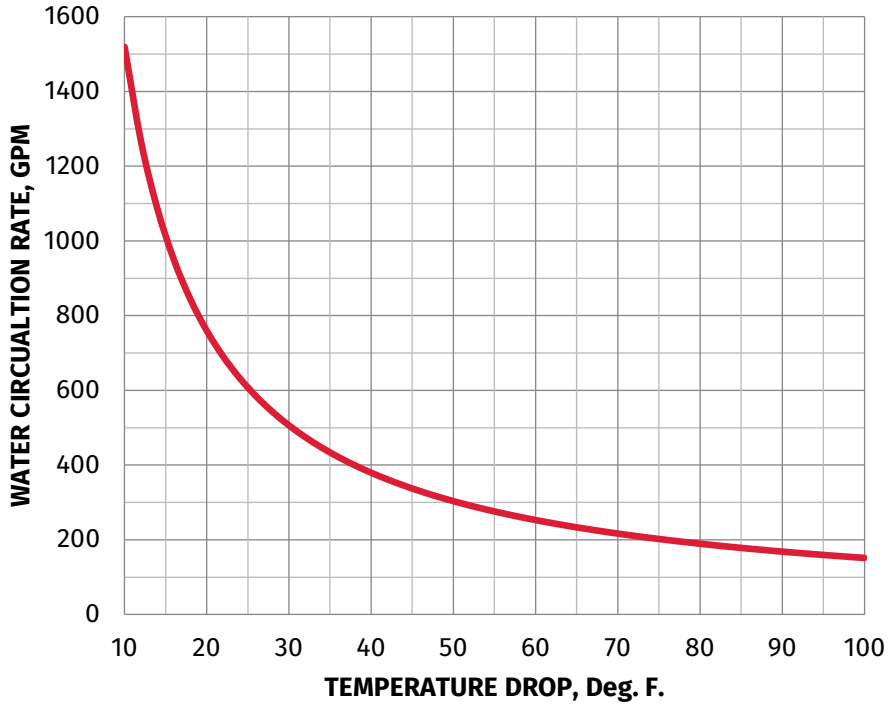
Flow Rate and Pressure Drop - 8M Example

Heat Output MBH	Temperature Drop (DT) °F							
	10	20	30	40	50	60	80	100
	Water Circulation Rate, GPM							
7600	1520	760	507	380	304	253	190	152

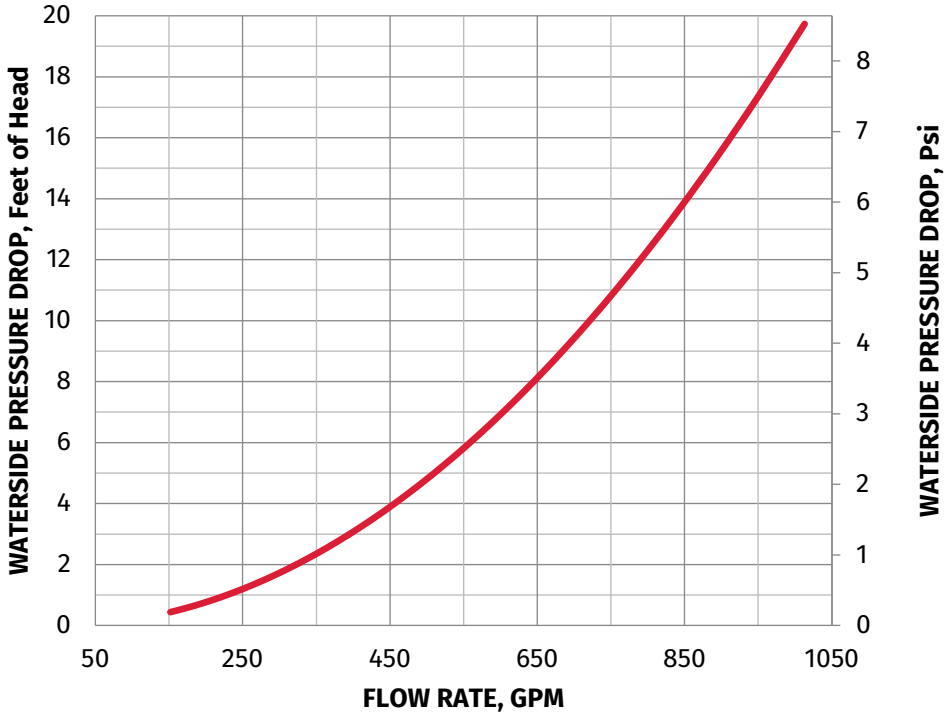
System ΔT, °F									
100	90	80	70	60	50	40	30	20	15
Water Circulation Rate, GPM									
152	169	190	217	253	304	380	507	760	1013
Pressure Drop, Feet of Head									
0.4	0.5	0.7	0.9	1.2	1.8	2.8	4.9	11.1	19.7

GPM vs. Delta T.

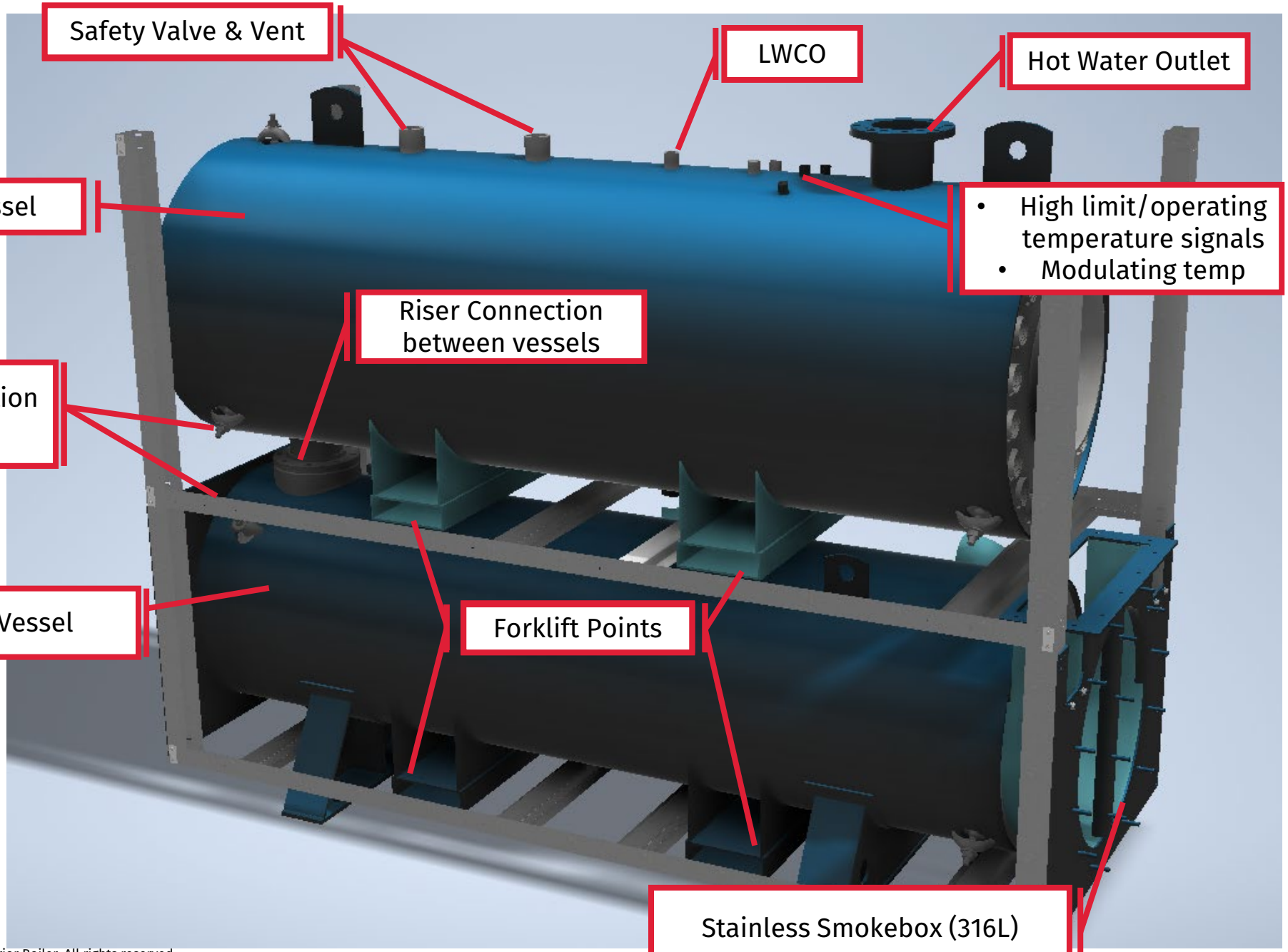


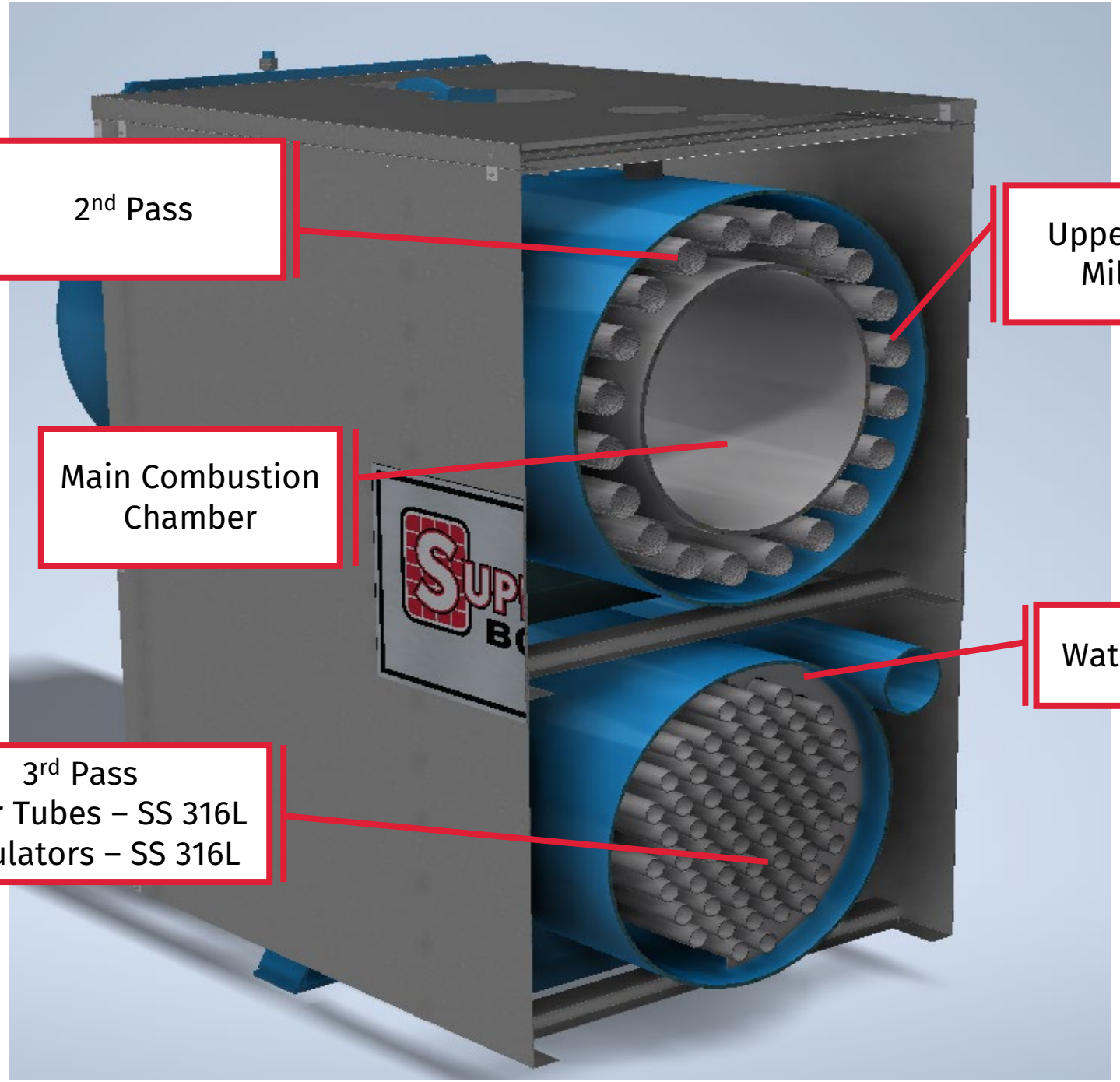
NOTES
1. Water specific heat and specific gravity = 1
2. Operation at ΔT's less than 10°F is not recommended
3. No minimum flow is required for safe boiler operation
4. Flow rates shown are for boiler at 100% firing, 95% efficiency

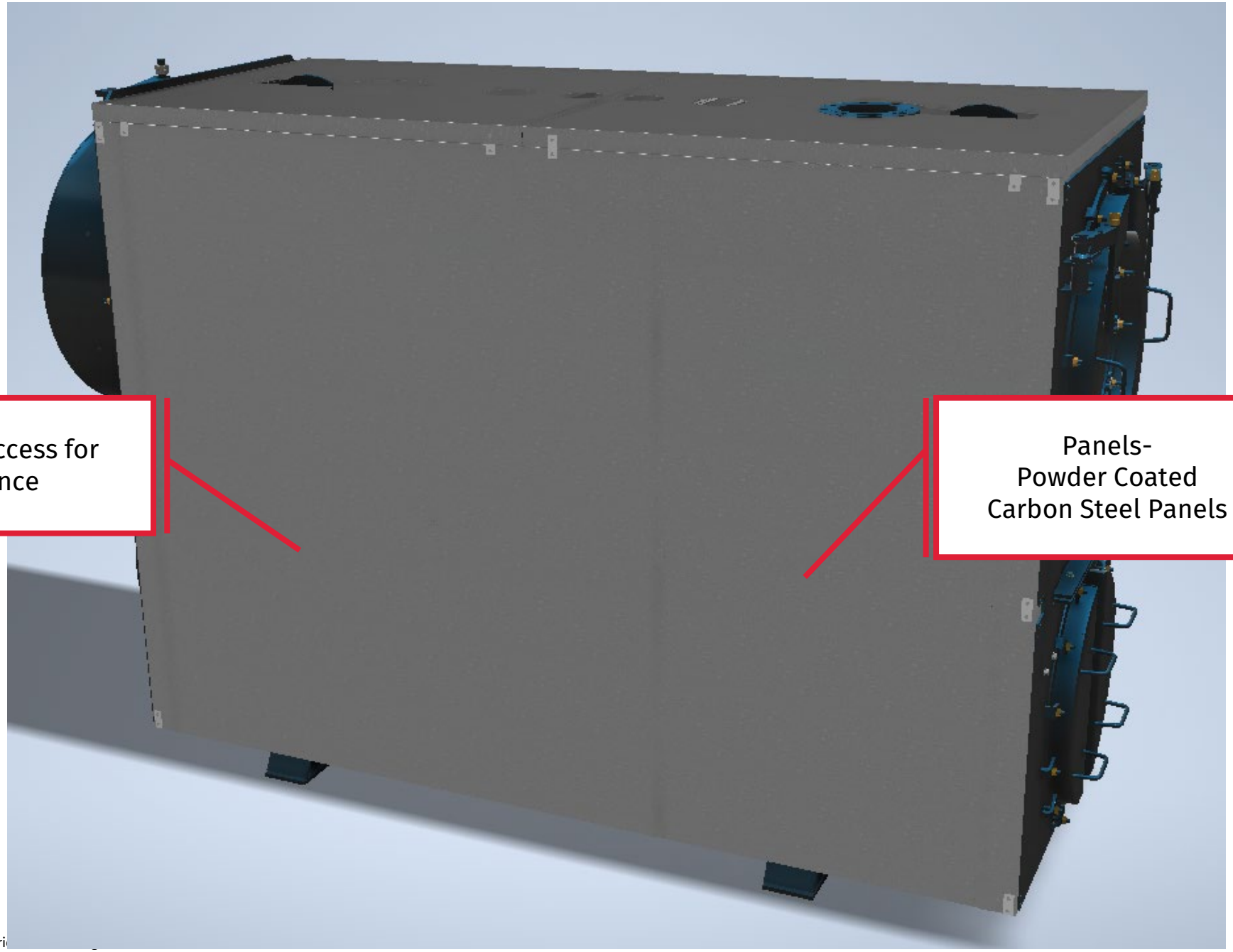
Pressure Drop vs. GPM

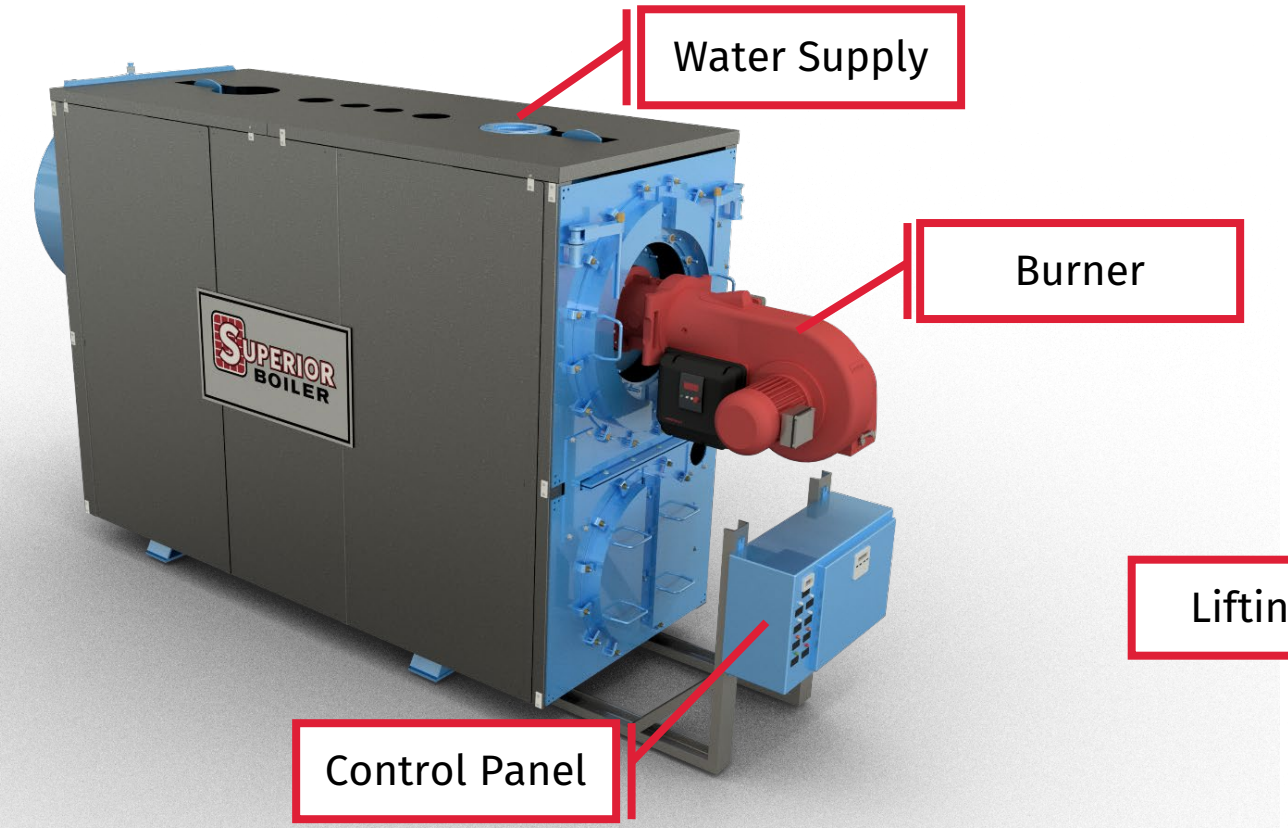


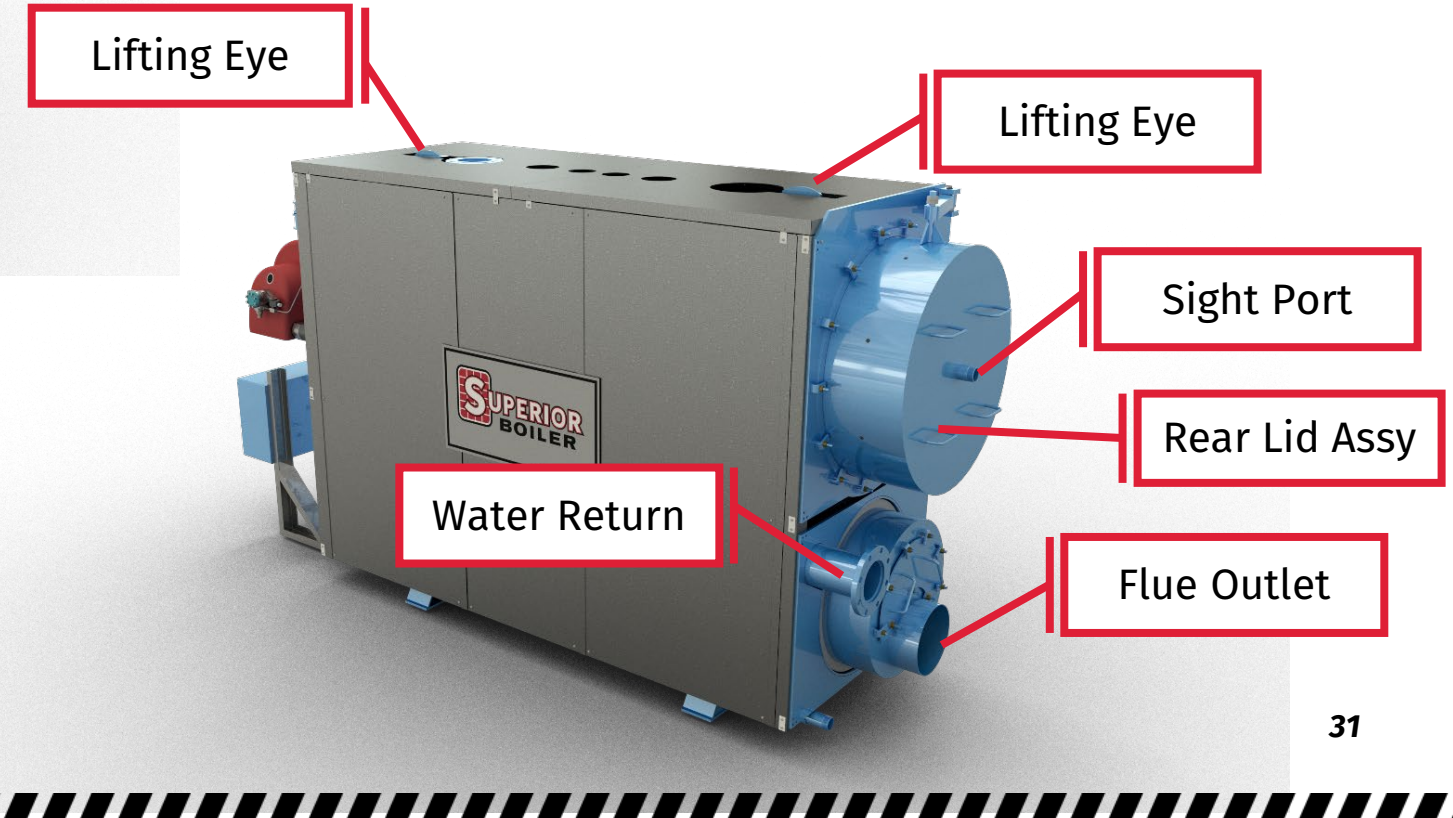
NOTES
1. Water Specific gravity assumed to be 1
2. Pressure drop is for clean boiler
3. Flow Rate is at 100% firing, 95% Efficiency



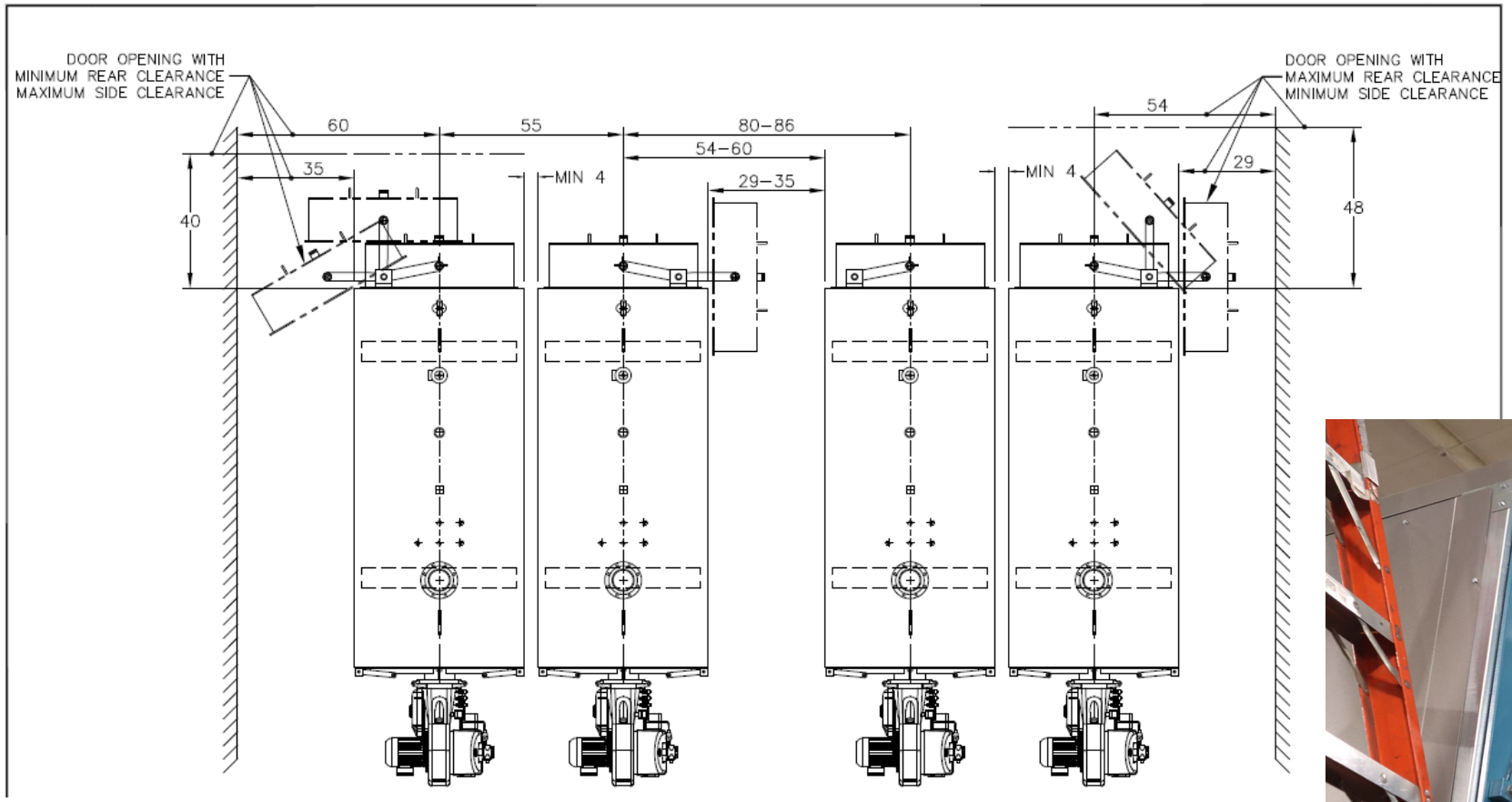


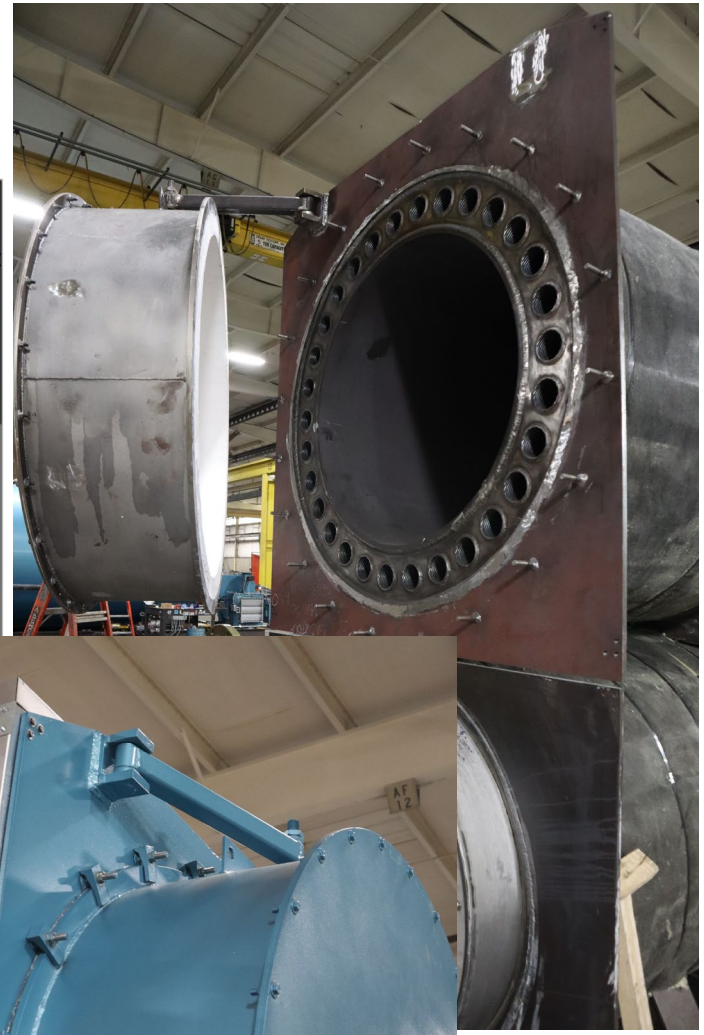

Ease of Use/Access for Maintenance
Panels-
Powder Coated
Carbon Steel Panels





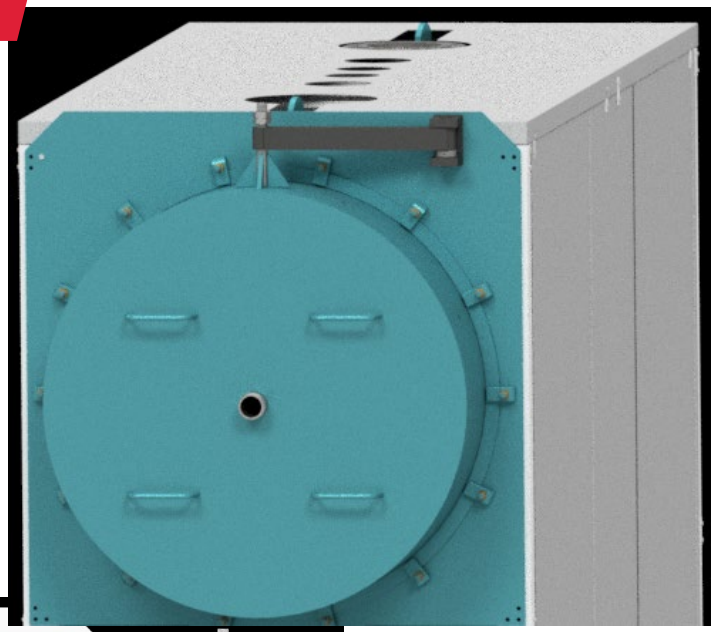
Clearance of Side/Side Installations

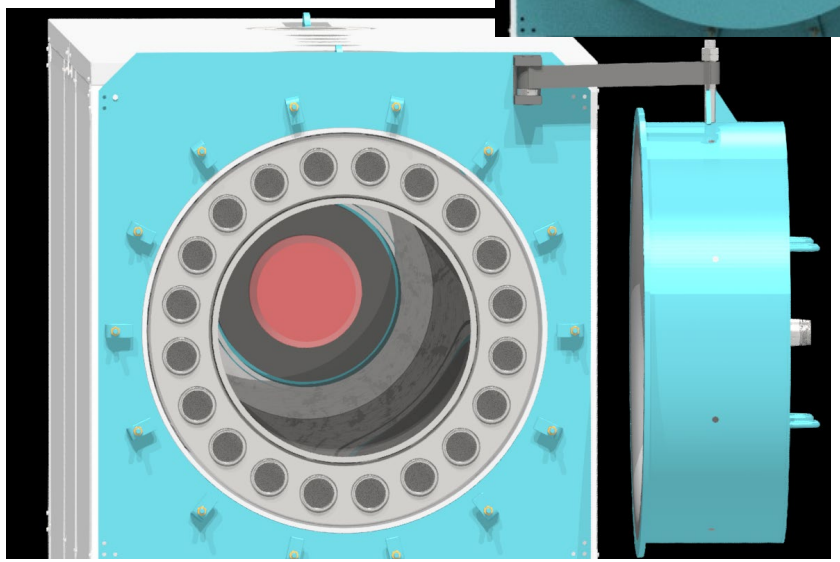




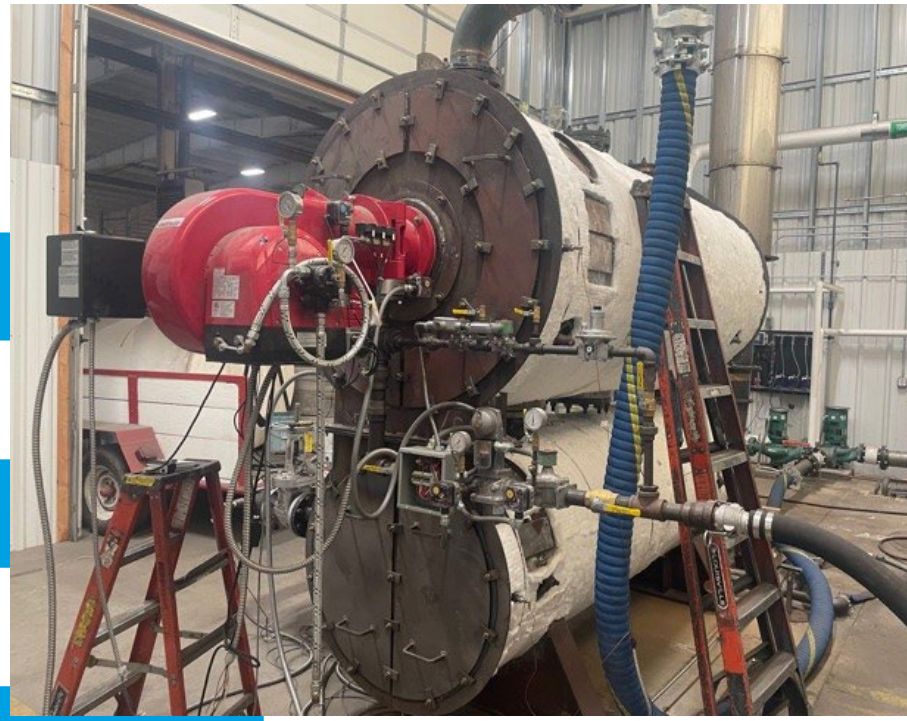
Cheyenne Features: Inspection & Access

- Rear sight port gives an additional view of the flame aiding commissioning
- Davited rear lid gives access to the furnace and burner head without disturbing the burner
- Additional doors allow full fireside access
- Waterside handholes easily accessed after removing the side jacket panels
- Full waterside inspection possible from only one side





Cheyenne R&D Testing



Proof of Design Testing

- Tested prototypes to confirm condensing boiler efficiency
- In addition to run time, purposefully rapidly cycled the boiler

UL Safety Testing

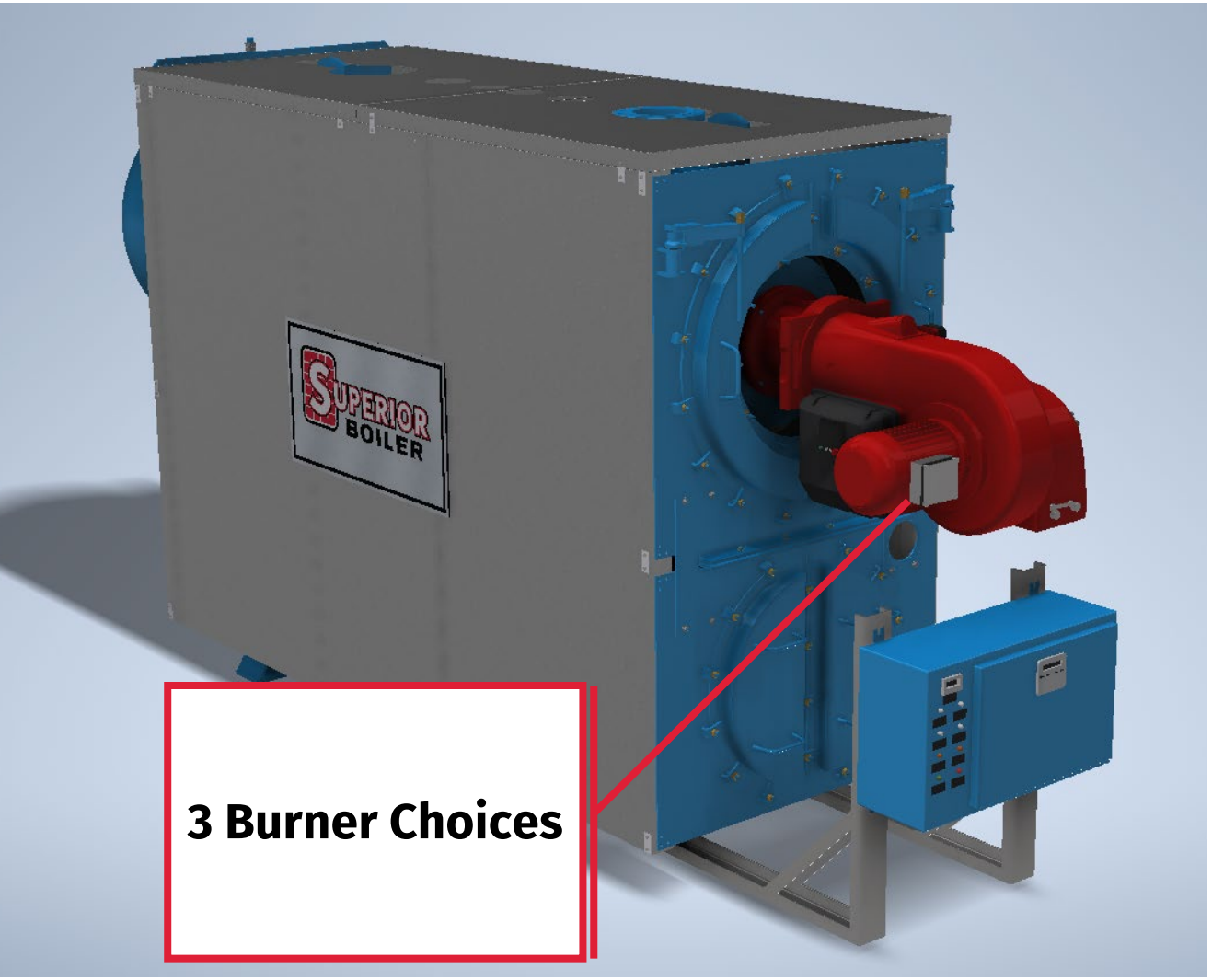
- Proof of safe operation with the boiler/burner package
- All selections are UL certified

DOE Efficiency Testing

- Proved ratings under standard conditions (80°F return, 180°F supply)

Boiler Performance – Real Life Conditions

- Tested the boiler under varied inlet/outlet water temperature
- Tested at part load performance



Burner Manufacturers Available:

- **Weishaupt**
- **Webster**
- **Power Flame**

Single or Dual Fuel

<60 PPM - NOx Dual Fuel - Natural Gas/Oil
<60 PPM - NOx Single Fuel - Natural Gas/Propane

<30 PPM - NOx Dual Fuel - Natural Gas/Oil
<30 PPM - NOx Single Fuel - Natural Gas/Propane

9PPM - Low NOx Single Fuel - Natural Gas

- High Turn Down capabilities
  - Minimum 5:1 on Gas / 3:1 on Oil
- UL Certification of Cheyenne Lineup
- ~75-85 dB on noise ratings
- Voltage: 460 standard
- 208 & 230 available
- Single point power connection
- Ducted combustion air configurations available
- Lead Lag up to 8 boilers

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Cheyenne Quality Assurance

- Industry-Leading Warranty
  - 10-year pressure vessel warranty
  - Lifetime thermal shock warranty
- 4 MBTU stock units available
- 56 units sold across North America
  - 24 currently in the field

Q&A

Hit us with your challenges

SUPERIOR BOILER

THANK YOU

SUPERIOR BOILER