



Engineered Boiler Systems

Industrial Watertube Boilers, Burners and
HRSG Systems



Manufacturer of Nebraska Boilers,
NATCOM Burners, and ERI
Heat Recovery Steam Generators

Our Commitment

An Extraordinary Commitment to Customers' Needs

Only Cleaver-Brooks offers single source and single responsibility for every aspect of your boiler system projects, from burner to stack, custom built to meet your needs.

Our Nebraska boilers, NATCOM burners and ERI HRSGs have long been the industry benchmarks for innovative design solutions and superior quality. When they're incorporated into a complete system built, managed and commissioned by us, you are getting the best solution, the best efficiency, and the lowest emissions possible. Cleaver-Brooks is the world-renowned provider of boiler room products and systems that outperform and outlast the competition. We spend more time and resources on research, development and innovation than any other manufacturer in the industry.





Total Integration

The Benchmark in Integrated Industrial Boilers



As the only true single source supplier for integrated boiler and burner solutions, we specialize in customer care through our global project management team from the design stage to start-up support.

The Nebraska boiler product line offers the industries widest range of natural circulation watertube steam generators, specializing in packaged D, A and O style boilers.

NATCOM burners offer industrial register and duct burners with capacity ranges from 20 to 600 MMBtu/hr, firing fuels such as natural gas, waste stream gas, hydrogen, digester gas, refinery fuel, crude oil and waste oil. Emissions levels to <9 ppm NO_x.

The ERI natural circulation packaged and modular HRSG product line specializes in systems for gas turbines, process exhaust, incinerator exhaust, hot water generators and more.

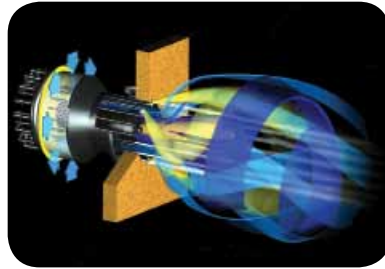
OPTIONS TO MEET EVERY NEED

At Cleaver-Brooks we offer fully integrated systems that can be customized to meet our customers' unique needs, including the following options:

- Burners and burner fuel trains
 - Forced draft fans with motor or turbine drives, control dampers, and silencers
 - Combustion and feedwater controls with instrumentation
 - Deaerators
 - Feedwater pumps
 - Sootblowers
 - Air and flue ducting
 - Expansion joints
 - Stacks
 - Ladders and platforms
- Continuous Emissions Monitoring Systems (CEMS)
 - Air and fluid heaters
 - Fuel oil pumps and heaters
 - Blowdown heat recovery systems
 - Chemical feed equipment
 - SCR, SNCR, & CO Catalysts
 - Economizers
 - Diverters for heat recovery steam generators
 - Duct burners



Deaerators



CFD (Computational Fluid Dynamics)



Controls



Packaged Burner Fuel Trains



Economizer Systems



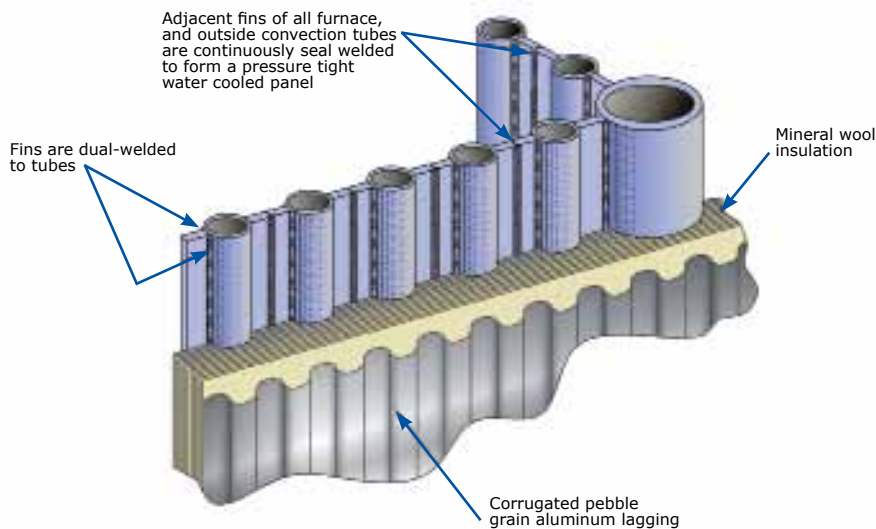
Start-up and Commissioning Support

Innovative Design

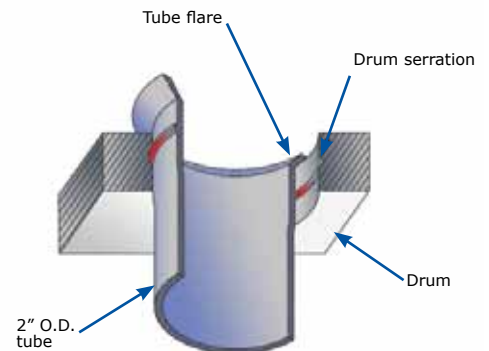
Engineered for Optimum Performance

At Cleaver-Brooks, every aspect of our systems is designed for maximum efficiency, reliability and low emissions. Our integrated Nebraska/NATCOM systems feature:

- Steam capacities from 10,000 to 800,000+ lbs/hr are available shop assembled
- Design pressures to 1,500 psig with steam temperatures to 1,050°F are available
- Conservatively designed tube layouts, coupled with large drums, provide superior natural circulation and operational characteristics
- Large, water-cooled, gas-tight furnace areas are utilized to yield optimum emissions performance, boiler reliability, and longevity with reduced maintenance costs
- Complete access to boiler water side is provided through manways at both ends of every drum



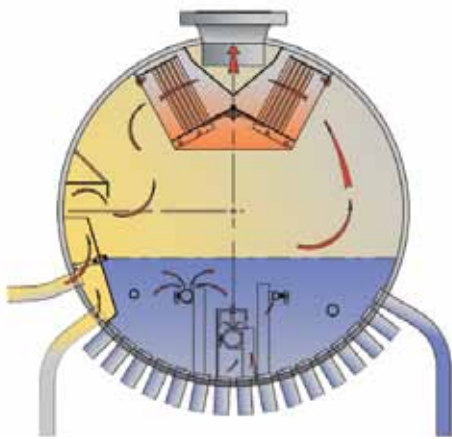
Side, front and rear wall construction featuring welded membrane design



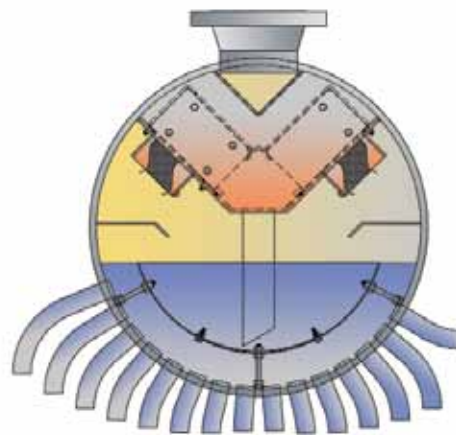
Torque-controlled, roller-expanded, tube-drum connections feature machined serrations for added strength. Welded connections are available for severe-duty service



- Furnace construction utilizes a welded-membrane wall design backed by more than 40 years of experience
- Completely drainable 2 inch OD (minimum) tubes throughout
- Grooved tube seats for improved tube-to-drum attachment are standard
- Convection or radiant superheaters with proven designs are selected for your final required steam temperature and desired operating characteristics
- Fully welded gas seals are used throughout to ensure gas-tight operation
- Boiler wall constructions are 100% water cooled and refractory free
- Integral soot-blowing lanes effectively clean gas side-heating surfaces
- Full fire-side access is provided through furnace doors
- Easy convection pass inspection through removable covers



Baffled impingement primary steam separation and labyrinth steam dryers are utilized to ensure dry steam delivery



Optional steam separation equipment, such as chevron separators, are available

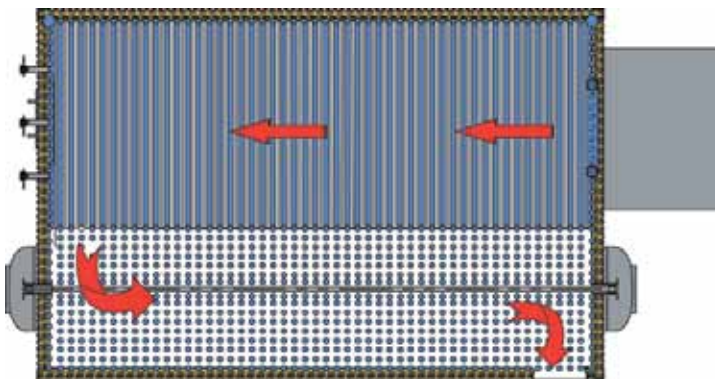
D - Style Boilers

Elevating the Industry Standard

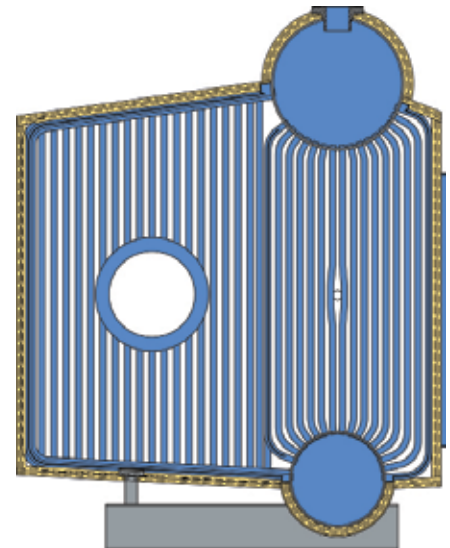
Cleaver-Brooks turns advanced watertube knowledge into Nebraska D-style boilers that provide an ideal solution to almost any steam need.

Our state-of-the-art Nebraska design incorporates a 100% membrane water-cooled furnace. This feature greatly reduces the costly, time-consuming annual maintenance associated with other boiler designs. The front and rear walls (including all of the corner gas seals) are completely welded and refractory-free, as well as the burner throat when integrated with our NATCOM burner.

All units are available with either a corrugated-aluminum or painted steel outer casing, depending on the application and/or customer preference.



Horizontal cross section



Vertical cross section

CAPACITIES
10,000 to 300,000+ lbs/hr

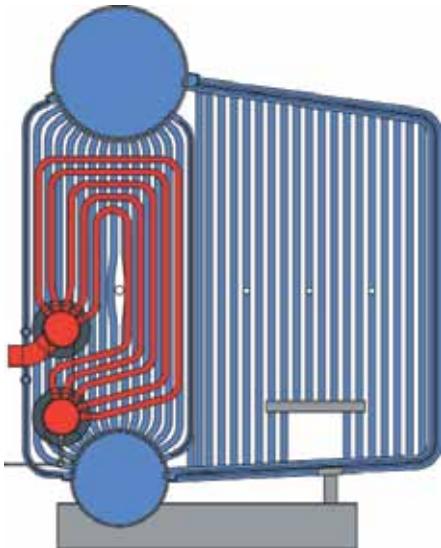
DESIGN PRESSURE
200 to 1,500 psig

STEAM TEMPERATURES
to 1,050°F



Superheated Steam Adaptability

In addition to standard, high-performance features, all our D-style boilers can be customized to provide superheated steam. We offer both single and dual-stage integral superheater systems that are capable of steam temperatures up to 1,050°F with optional temperature control over turndown. All superheaters are constructed of high-temperature alloys and strategically positioned inside the boiler to optimize performance and ensure a long, trouble-free life.



**Vertical cross section
with superheater**

INTEGRATED STANDARD D-STYLE BOILERS

Cleaver-Brooks offers a wide array of proven Nebraska D-style boiler designs, including:

- NB-100D, 10,000-35,000 pph
- NB-200D, 35,000-50,000 pph
- NB-300D, 50,000-90,000 pph
- NB-400D, 70,000-120,000 pph
- NB-500D, 100,000-225,000 pph
- NB-600D, 100,000-250,000 pph
- NB-700D, 250,000-300,000 pph

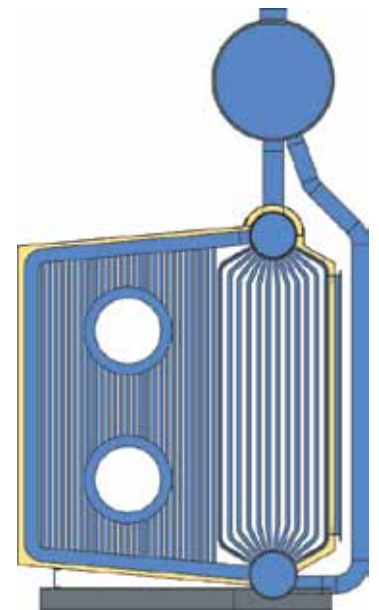
Custom Boilers

Maximum Shop Assembly. Minimum Field Labor.

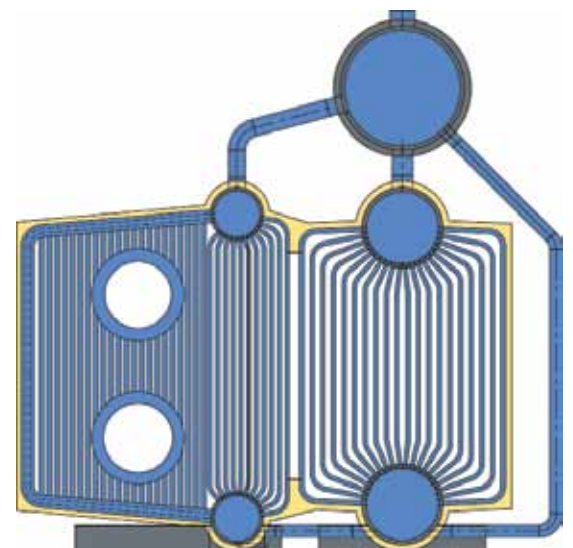
At Cleaver-Brooks, we leverage our specialized engineering expertise to deliver fully customized steam solutions that meet your specific needs.

Our innovative Nebraska D-style elevated-drum and modular elevated-drum boiler designs maximize the amount of shop assembly while minimizing the costly field labor often associated with boilers of such high capacity. The benefits of these customized solutions include:

- Minimal field assembly
- Faster, more cost effective delivery time vs field erected boilers
- Reduced gas side pressure drop and smaller forced draft fans
- Prefabricated risers and downcomers
- Superheater option available
- Dual burners on some applications



Elevated drum boiler design



Modular boiler design

CAPACITIES
300,000 to 800,000+ lbs/hr

DESIGN PRESSURE
200 to 1,500 psig

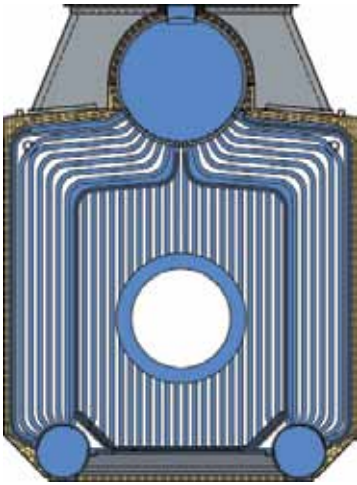
STEAM TEMPERATURES
to 1,050°F

A - Style Boilers

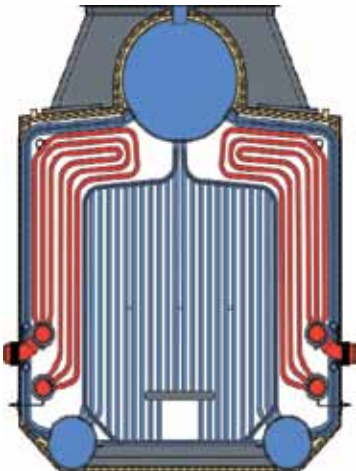
Large Capacity in a Small Footprint

Cleaver-Brooks has the specialized engineering expertise to meet not only your capacity needs, but your space needs as well.

Our proven Nebraska A-style boiler design features a large watercooled furnace and an evaporator section with a low gas-side pressure drop that reduces fan power consumption. The vertical gas outlet minimizes the width of the overall package and allows for large steam capacities in restrictive footprints.



Vertical cross section



Vertical cross section
with superheater

A-STYLE BOILERS

All Nebraska A-style boilers can be equipped with superheaters that produce up to 1,050°F superheated steam. NEBRASKA A-style boiler designs include:

- N2S-7S 60,000-175,000 pph
- N2S-8S 150,000-275,000 pph



CAPACITIES
10,000 to 275,000 lbs/hr

DESIGN PRESSURE
200 to 1,500 psig

STEAM TEMPERATURES
to 1,050°F

O - Style Boilers

High Power in a Slimmer Fit

The Nebraska O-style boiler design is a perfect fit for restrictive footprints. The vertical gas outlet puts the economizer above the boiler, minimizing the width of the overall package.

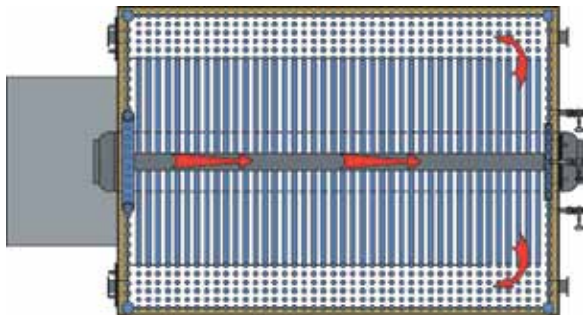
The rugged Nebraska O-Style design has become the true workhorse of the rental boiler industry. Its symmetrical design is ideally suited for mounting on a trailer for over-the-road transport. Our line of rental units continues to provide efficient & reliable service year-after-year while withstanding rapid emergency start-ups.



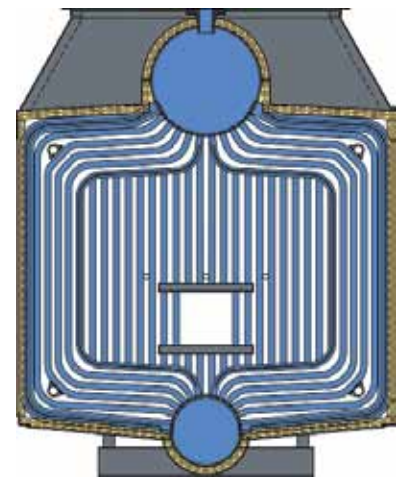
O-STYLE BOILERS

The Nebraska O-style designs include the same features of our standard Nebraska D-style boilers, including a 100% membrane water-cooled furnace design and refractory-free front and rear walls. Our Nebraska O-style models include:

- NOS-1A 10,000-40,000 lbs/hr
- NOS-2A 40,000-80,000 lbs/hr
- NOS-3A 80,000-150,000 lbs/hr



Horizontal cross section



Vertical cross section

CAPACITIES
10,000 to 150,000 lbs/hr

DESIGN PRESSURE
200 to 1,500 psig

STEAM TEMPERATURES
to 1,050°F

Linear Style Boilers

High Efficiency, Ultra-low Emissions with the Smallest Footprint Available



Versatile and Powerful

This design can be configured as a super-efficient, low NO_x, gas fired boiler or as the world's most efficient heat recovery steam generator (HRSG).

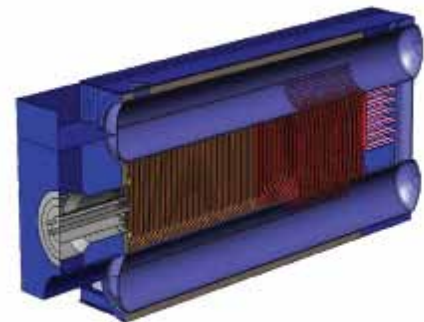
Lowest NO_x, Highest Efficiency

NO_x levels of less than 9 PPM (or less than 2 PPM with integral SCR option), and at up to 90% efficiency, is the most powerful, lowest emission, fully integrated, boiler/burner watertube available.

- Up to 90% boiler operation efficiency
- NO_x < 9 PPM
- World's most compact IWT burner/boiler
- Super-efficient, single-pass design
- Integral economizer (optional)
- Integral, high-efficiency, NATCOM burner
- Optional SCR for NO_x to meet 2 PPM
- Gas only

Smallest Footprint

The small footprint of the linear boiler saves floor space and construction costs while competing IWT boilers can be as much as twice the size.



Vertical cross section

CAPACITIES
70,000 to 150,000 lbs/hr

DESIGN PRESSURE
200 to 1,500 psig

STEAM TEMPERATURES
to 1,050°F

NATCOM Burners

Highest Efficiency, Lowest Emissions

NATCOM burners deliver the world's highest-efficiency, lowest-NOx burners to customers in a wide variety of industries.

NATCOM burners are found worldwide on packaged boilers in single burner sizes ranging from 20 to 600 MMBtu/hr capacities and on multi-burner boiler applications.

Every NATCOM burner is custom-designed for each specific application and furnace configuration, ensuring that the burner and boiler run as a seamlessly integrated package.

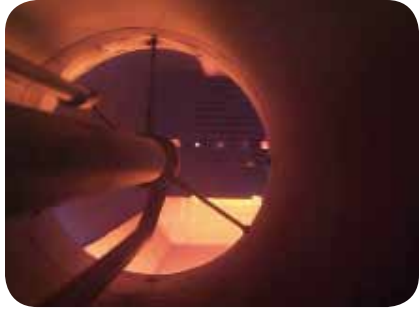
Our Technological Edge

NATCOM burners meet the most stringent NOx, CO, VOC and particulate emission requirements for any furnace configuration.

- HyperMix™ technology for ultra-low NOx and ultra-low CO with compact flame to fit large packaged units
- On-line adjustability and possible removal of each individual gas injector
- Multi-fuels applications
- Burner-integrated air flow meter for strong control signal at high turndown
- No refractory throat required / full metal throat
- Unmatched flame stability with Center-Core technology
- Unbreakable 100% reliable pilot
- NOx levels from 15 to 30 PPM – No FGR
- NOx levels of 5 ppm - HyperMix™ & FGR
- Ultra low excess air / high efficiency
- High turn down ratio: 40 to 1 on gas / 15 to 1 on oil

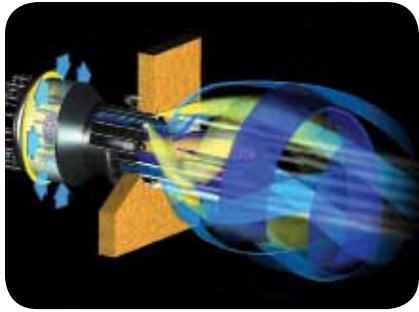


SINGLE BURNER SIZES
20 to 600 MMBtu



True Leaders in Design, Research and Development

Many companies claim leadership in high efficiency and low emissions, but NATCOM burners have the numbers to back it up. Cleaver-Brooks brings together state-of-the-art technology and over 75 years of combustion experience to deliver high efficiency, ultra-low NOx burners. As an organization, Cleaver-Brooks spends more time and resources on research and development than any competitor.



Design guidelines for NATCOM burners are based on aircraft jet engine combustion chambers. Using Computational Fluid Dynamics (CFD), we developed modeling software that simulates fuel and air distribution required to achieve complete combustion using actual furnace geometries. This sophisticated analysis helps us create burners that can be integrated for optimum performance into systems around the world.

NATCOM BURNER APPLICATIONS

- Oil and gas burners for industrial watertube, firetube boilers and package boilers
- Multiple burners for large, field erected and utility boilers
- Duct burner for Co-Gen (HRSG) applications
- Igniters, NFPA class 1, 2 or 3
 - High velocity igniter stable up to 200 ft/sec
 - Heat input up to 20 MMBtu/hr
- Specialty burners
 - For waste fuels, digester gases, bio-gas, refinery gas, low BTU gas
 - High efficiency, high turndown oil atomizer: crude, heavy oils, light grade oils, waste oil
- Burner accessories
 - Fuel trains
 - Windboxes
 - Fans
 - BMS panels
 - Combustion control systems
- Engineering services
 - Total power plant engineering audits
 - System retrofitting

ERI

Committed to Energy Efficiency

Our ERI designs help offset our customer's rapidly increasing fuel costs with a variety of customized, highly efficient systems.

We lead the industry with our packaged heat recovery steam generators, waste heat boilers, and waste heat recovery units in a wide variety of applications including:

- Air heaters
- HRSGs for gas turbine applications up to 50MW electric output
- Economizers
- Reciprocating engines
- Thermal fluid heaters
- Waste heat boilers for:
 - Fluidized catalytic cracker units (FCCU)
 - Gasifiers
 - Incinerators
 - Other solid fuel combustors
 - Process furnaces
 - Thermal oxidizers

Natural circulation designs with design pressures to 1500 psig and steam temperatures to 1050°F are available.

For supplemental and/or fresh-air fired applications, our heat recovery steam generator will be integrated with a NATCOM duct burner for the highest efficiency and lowest emissions.

Custom waste heat boiler designs such as "Open Bottom A and O-Type" are available for handling dust-laden applications. Firetube waste heat designs are also available for high pressure and low volume gas and special applications.



GAS TURBINE CAPACITY
1 to 50 MW

STEAM CAPACITY
10,000 to 300,000 lbs/hr

STEAM PRESSURE
up to 1,500 psig



Depending on specific flue gas characteristics of the application such as the flow, quality (clean, particulate laden, corrosive, etc.), and temperature; one of the following products will be offered:

Modular Heat Recovery Steam Generators (HRSG)

- Flue gas flows $\geq 500,000$ lbs/hr
- Supplementary fired up to 1700°F
- Multiple pressures with integral deaerator
- Natural circulation with vertical tubes
- Maximum shop assembly minimizes field erection costs
- Accommodates CO/SCR to meet stack emissions



Slant Boilers

- Gas side
 - Flow rates $\leq 500,000$ lbs/hr
 - Flue gas temperatures up to 1,700°F
- Single pressure design with integral steam drum
- Single pass design for lower gas side pressure drop and no gas baffles in tube bank
- Multiple gas flow options to fit the plant layout
- Compact design results in low installation costs
- External superheater(s), economizers and feedwater heaters
- Accommodates CO/SCR to meet stack emissions



MAX-FIRE® Boilers

- Gas side
 - Flow rates $\leq 500,000$ lbs/hr
 - Gas temperatures up to 2,800°F
- Water wall firing chamber with a heat recovery section in one shop assembled package
- Welded membrane wall construction eliminates inner casing problems
- Accommodates CO/SCR to meet stack emissions
- Integral or external superheater(s), economizers and feedwater heaters

Hot Water Generators

The exclusive MAX-FLOW® design incorporates a water cooled membrane furnace wall construction with a balanced circulation and an integral finned-tube economizer section. This creates a highly efficient, shop assembled package in the capacity range of 20 to 150 MMBtu/hr. Hot water generators can be designed to fire gas or oil.

Controls

Seamlessly Integrated Components

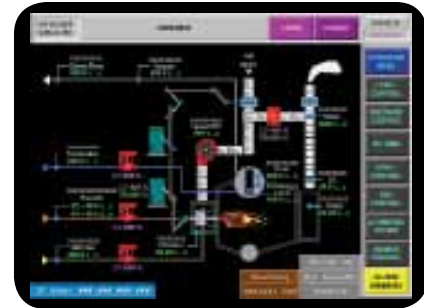
Cleaver-Brooks utilizes an in-house instrumentation and controls department to provide boiler control and burner management systems. Our approach delivers seamless, single-source engineered boiler/burner package systems.

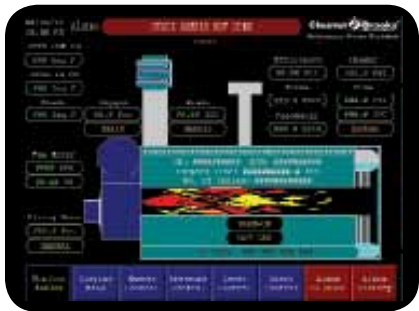
Our controls range from a cost-efficient, standard boiler-control logic and flame safeguard system to a custom-engineered package to meet specific customer requirements. The standard control platform is called the C-B Hawk ICS Ultra IWT.

Powerful Control Platforms

C-B Hawk ICS ULTRA IWT

- PLC based with modular I/O
- Allen Bradley Panelview Plus 10" color touch screen HMI for setup, monitoring and data acquisition
- Allen Bradley CompactLogix PLC for boiler control
- Choice of Fireye (CB110) or Honeywell (CB-780) based integrated burner management system
- Optional integration with Allen Bradley PLC-based burner management system
- Trending and data logging of up to 300,000 points
- High stack temperature annunciation with auto cutoff
- Hot Standby & Auto-Recycle modes of operation
- Automatic "boiler warming" feature limiting thermal shock
- Boiler efficiency and O₂ corrected efficiency readings available
- External communications to virtually any protocol
- Plant Master Panel available for multiple boiler installations
- Free-standing, wall-mount or windbox-mount control enclosures
- NEMA 12, NEMA 4, NEMA 4X enclosure options





- Fully integrated PLC programming for:
 - Pressure control options for unison modulation, local stand-alone pressure control, or remote firing rate input
 - Single point (jackshaft), parallel positioning or fully-metered combustion control strategy
 - 1, 2, or 3 element feedwater control
 - O₂ trim and monitoring -- trims combustion on all fuels to maintain most efficient fuel/air ratio
 - Flue gas recirculation control
 - Variable speed drive (VSD) control
 - Draft control
 - Flow totalization with display of previous total before reset

Custom Engineered Systems -- The Ultimate in Boiler and Combustion Control

- Alternate controller hardware available, including:
 - Siemens, Toshiba, GE Fanuc, ABB, and others.
 - Safety applications -- redundant PLCs, SIL 1 to SIL 3 applications
 - Simultaneous firing
 - Multi-burner, multi-fuel applications
 - SCADA Systems for data collection and/or remote faceplate control



Engineered Boiler Systems

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