



The world's new standard in efficiency.

# CBEX

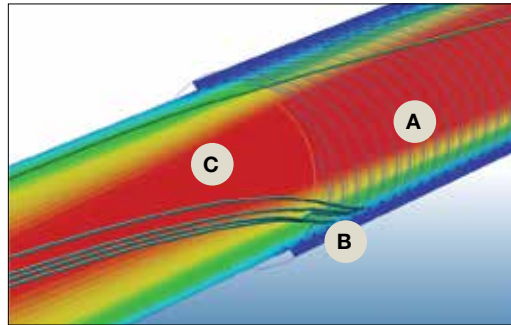
**FIRETUBE**

# CBEX FIRETUBE BOILERS

For decades, engineers have been trying to build a better and more efficient boiler system, but it took Cleaver-Brooks to challenge the status quo and reimagine what is possible. Since Cleaver-Brooks is the only company that manufactures every component of the boiler system, we were able to design a completely new system from the ground up, incorporating our EX technology. It can only be described as a quantum leap in firetube design, with the highest operating efficiency and lowest possible NOx ever achieved.

## DESIGN ADVANCEMENT ONE: Optimizing the tubes for better heat transfer

Computational Fluid Dynamics (CFD) modeling allows us to optimize the extended surfaces of the spiral heat transfer tube, where 30% to 40% of the boiler's heat transfer takes place. This proprietary design increases heat transfer by 85% compared to a traditional bare tube.



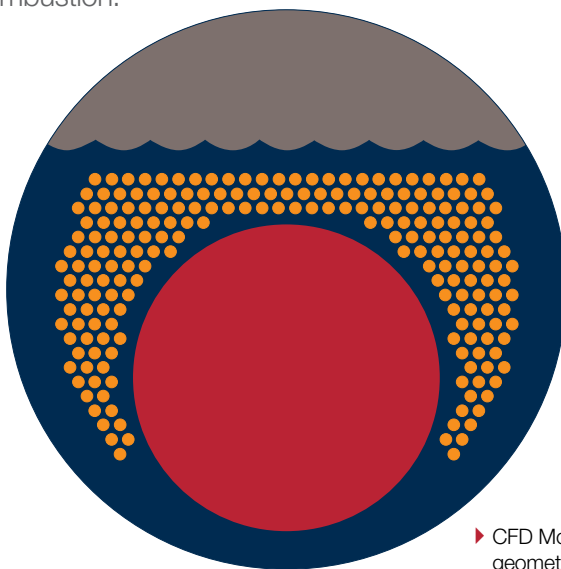
CFD model of an advanced heat transfer tube.

- A. The number of ribs, angle of the ribs, and height and width of the ribs have been optimized for peak tube performance.
- B. Improved tube profile utilizes 100% of the tube diameter for heat transfer.
- C. Increased surface area and a complex boundary layer separation reattachment phenomenon result in better heat transfer.

## DESIGN ADVANCEMENT TWO: Optimizing the geometry of the furnace for near-perfect combustion

With the tubes optimized, they could transfer more heat in less space. We then used this space to optimize the geometry of the furnace, where the remaining 60% to 70% of the boiler's heat transfer occurs for low heat release rates and near-perfect combustion.

▶ Maximum heat transfer in the furnace radiant zone achieves the optimum balance of high heat transfer with the lowest pressure drop.



▶ Low heat release rates result in lower turnaround gas temperature and reduced thermal expansion of the furnace, extending the life of the tube sheet and tube attachments.

▶ Lower and more uniform flame temperature means less thermal stresses on the furnace.

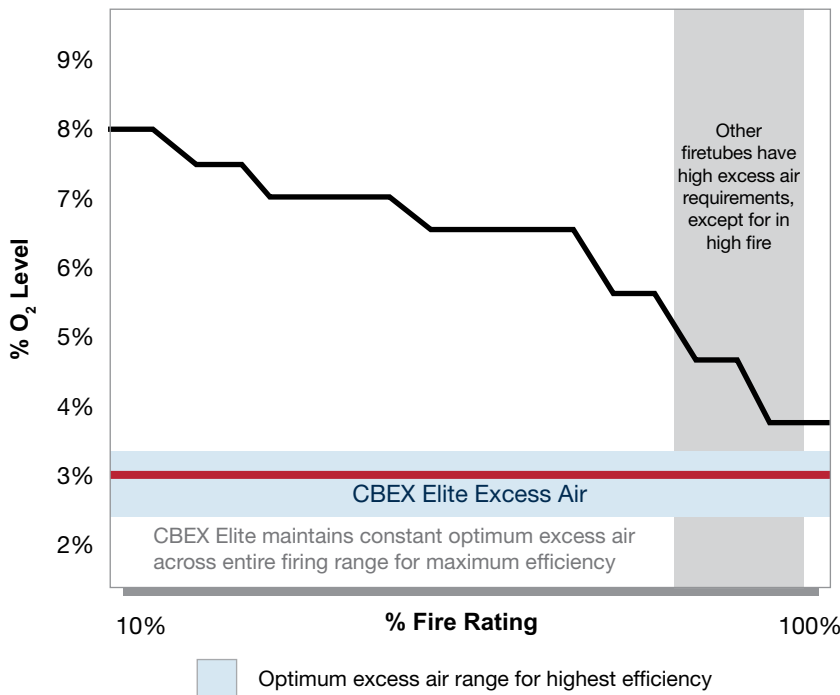
▶ CFD Modeling leads to a geometrically optimized furnace with average heat release rates of 125,000 BTU/hr/cu. ft. This leads to near-perfect combustion and the lowest possible NOx levels.

## DESIGN ADVANCEMENT THREE: Integrating the burner and controls

Ultimately, the performance of a boiler is based on the ability of the burner, boiler, and controls to work together. Controlling the CBEX is the Cleaver-Brooks Hawk, an integrated control system embodying precise boiler/burner management and safety with logic-based ancillary devices and functions. The Hawk keeps your boiler and burner consistently operating at peak efficiency with the lowest possible emissions, regardless of changes in environmental conditions.

# THE BENEFITS OF EX TECHNOLOGY

EX technology provides for a revolutionary boiler system that features the lowest emissions, most robust combustion, and best thermal efficiency across all operating ranges. Compared to existing models, the CBEX attains the highest fuel efficiency in lower firing ranges. It also emits fewer air pollutants than any firetube system on the market today.



## Highest Operating Efficiency of any Firetube: 10:1 turndown while maintaining 3% O<sub>2</sub> across the firing range

To achieve the best operating efficiency, boiler engineers strive to maintain the lowest excess air throughout the firing range. Maintaining low excess air translates into higher efficiency. The CBEX Elite is the only firetube to achieve 3% O<sub>2</sub> across the entire 10:1 turndown range\*, making it the most efficient firetube boiler ever built. The high operating efficiency paired with the high turndown rate means the boiler cycles less, minimizing the purging of energy caused by boiler cycling.



\*At 30 ppm NOx on select models

## Lowest Possible NOx: Sub-5 ppm without SCR†

The optimized furnace in the CBEX provides lower heat release and near-perfect combustion. This, combined with the Hawk integrated control system, reduces emissions to unprecedented levels. Prior to the development of the CBEX, sub-5 ppm NOx without Selective Catalytic Reduction had never been achieved.

†Select Elite models

## Quick Steam Up

With the smaller footprint and lower water volume, the system heats up 20% quicker than traditional firetube models.

## Smaller Footprint and Weight

By optimizing the heat transfer of both the tubes and furnace, the CBEX requires less heating surface to achieve the same BTU output as traditional firetubes, while maintaining the highest possible efficiencies. As a result, the CBEX on average has a 15% smaller footprint and weighs 20% less than traditional boilers.

## Extended Pressure Vessel Life

The temperature is more uniform in an optimized furnace and reduces the turnaround gas temperature. This lowers the stresses on the furnace and second-pass tube attachments, extending the life of the tube sheet and attachments. As a result, Cleaver-Brooks offers an industry-leading, 15-year pressure vessel limited warranty.

# CBEX ELITE

**Delivering the best efficiency and emissions control in the world.**

Our new EX technology, with new heat transfer tubes and superior combustion, is at the heart of a whole new way to experience efficiency, but that's only the beginning. The new CBEX Elite is our flagship system. Every core component has been designed and built by Cleaver-Brooks to work together, resulting in the most efficient and lowest-emissions firetube system ever built.



## 100–1,200 HP

Exclusive Cleaver-Brooks integral burner with optional heat recovery system

Integral burner design now available with 50% more capacity

Air-cooled integral front head

Can meet 5 ppm NO<sub>x</sub> emissions requirements without SCR (select models)

Can meet 10 ppm CO emissions requirements (at 30 ppm NO<sub>x</sub>)

**Best operating efficiency** of any firetube ever built

**Completely integrated** boiler, burner, controls, and heat recovery system

**Minimum excess air** across the operating range

**Ultra-low NOx** emissions without Selective Catalytic Reduction (SCR)

**15% reduction in footprint** versus traditional designs



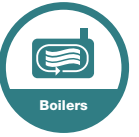
## 1,300–2,200 HP

System-matched Cleaver-Brooks packaged burner

Maintains a small footprint in large capacities

Affordable alternative to industrial watertube boilers

Can meet 9 ppm NOx emissions requirements



# CBEX PREMIUM

## Get EX advantages with a packaged burner.

The CBEX Premium also includes our revolutionary EX technology, along with a completely integrated boiler and burner system. Extraordinarily efficient and capable of meeting very low NOx requirements, the CBEX Premium provides a high-value solution with next-generation engineering.

**EX technology** in a high-value solution

**Completely integrated** boiler and burner system

**High-efficiency,** next-generation firetube

**Can meet 9 ppm NOx** and low emissions requirements

**Smaller footprint** than traditional firetubes



### 100–1,200 HP

High-quality, Cleaver-Brooks packaged burner

Available up to 1,200 HP with a traditional, packaged burner

Add available heat recovery and controls for a completely integrated package

# The integration is the key in a CBEX system.

## Hawk Control



**The brain of the EX system, the Hawk Control allows you to run your boiler at the absolute maximum efficiency.**

- Completely integrated boiler/burner control for maximum reliability and efficiency
- Automatically tunes boiler to changes in environmental conditions
- Easily pays for itself in fuel savings
- Linkageless control with air and fuel load following capabilities
- Reduced fan horsepower load with VSD control - option
- Control emissions with NOx trim
- Advanced communication options provide easy access to information and building automation system integration
- Unlimited options for system customization and optimization
- NPFA and UL® compliant for maximum safety

*Standard on the Elite / Available on the Premium*

## Economizer

**A stack economizer is an option that will reduce fuel use by recovering waste heat from flue gases and using it to preheat boiler feedwater.**

- Versatility of fuel choices and fin-to-tube combinations
- Available for steam and hot water boilers
- Stainless steel access doors for easy maintenance
- Built to last, with stainless steel inner casing and carbon steel exterior
- Condensing designs available

*Option for both the Elite and the Premium*

## LevelMaster

**The LevelMaster low water cutoff and pump control is the safest control available.**

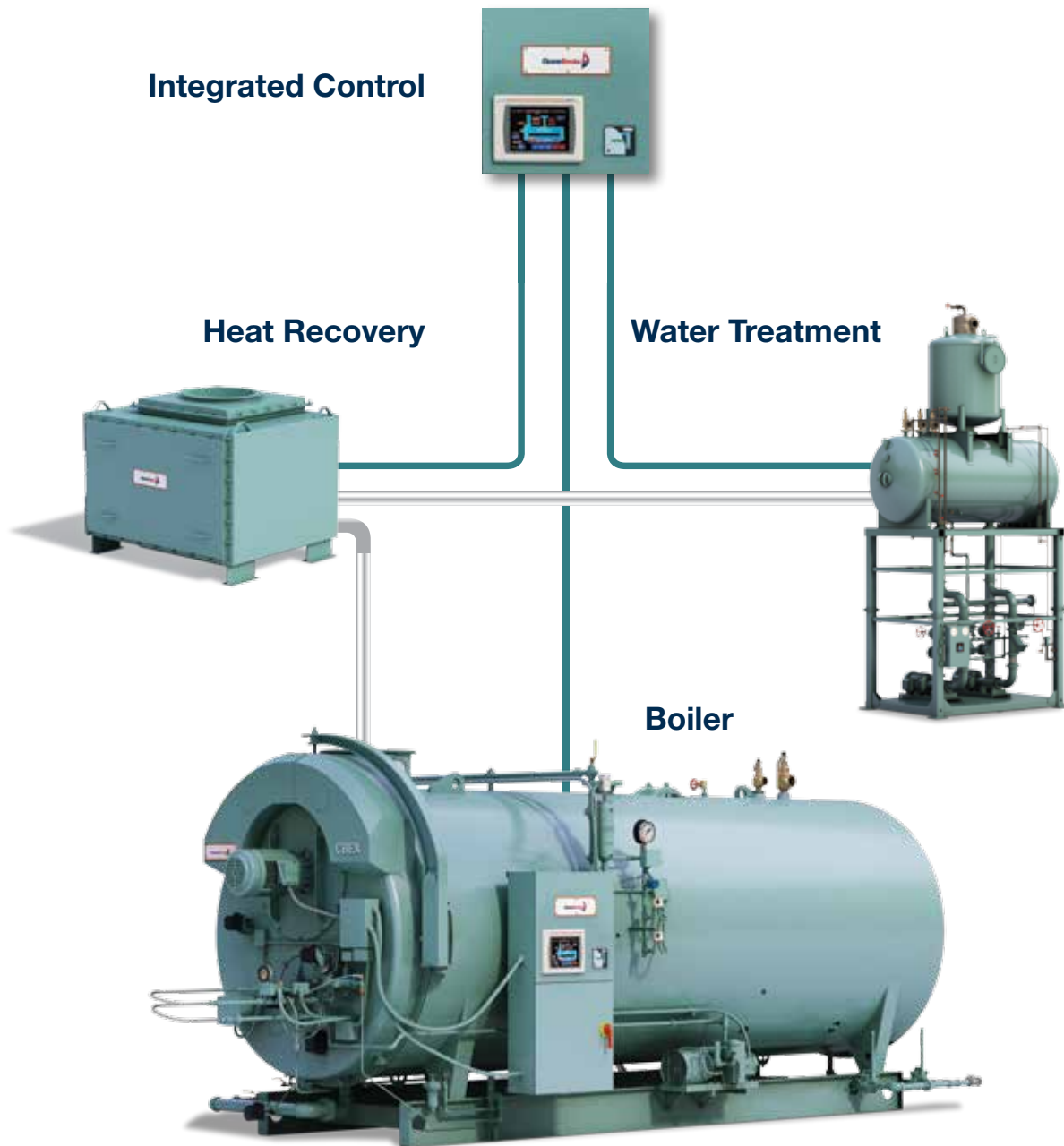
- User-friendly interface
- Magnetorestrictive technology eliminates levers and switches
- Multiple safety backups and redundancies constantly monitor float movement
- Secure and dependable blowdown and alarm log are password-protected
- Adaptable for any steam boiler
- Provides feedwater modulation signal and safety cutoff alarms

*Standard on the Elite / Available on the Premium*



# Engineered integration from the ground up.

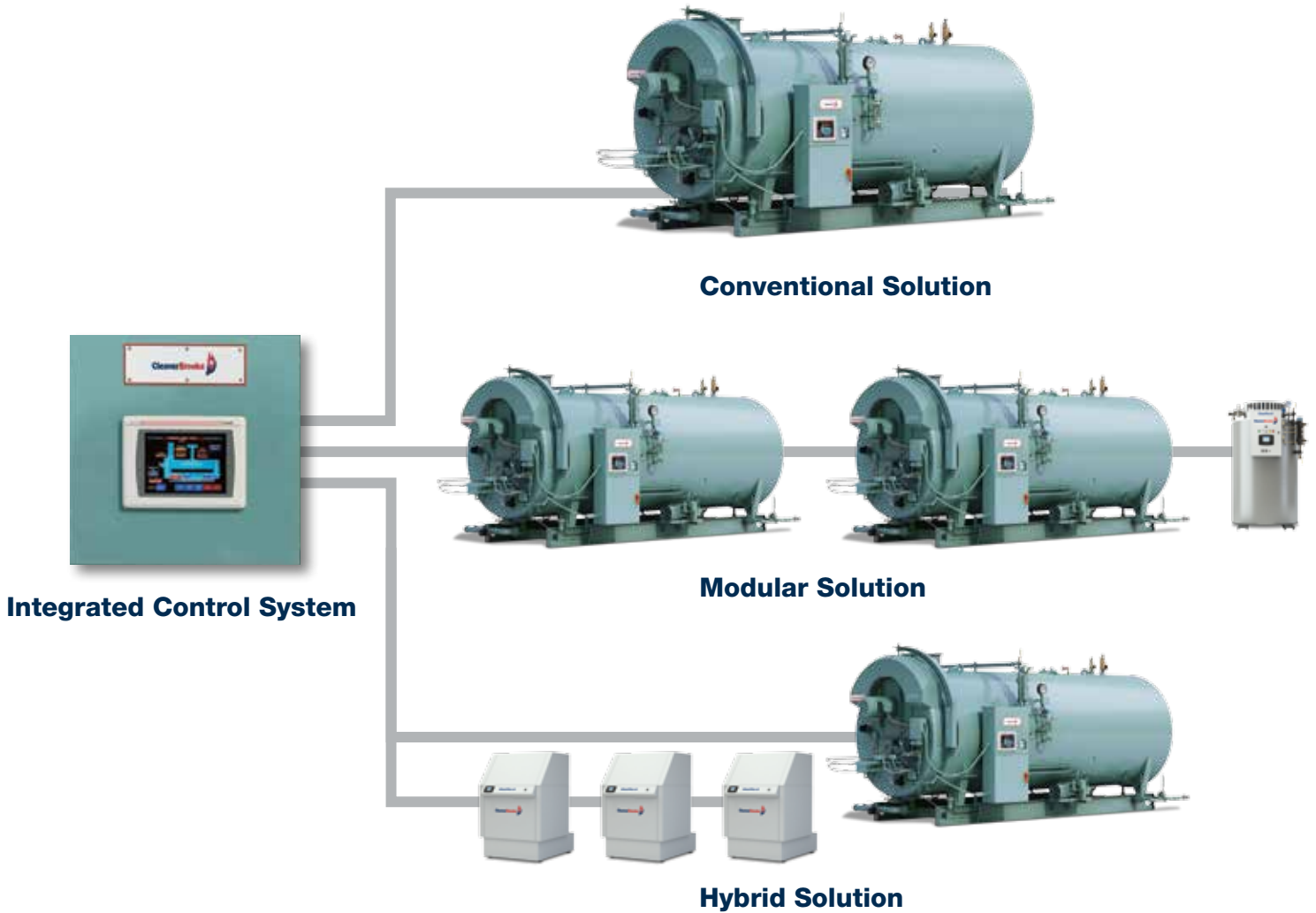
Cleaver-Brooks has once again brought its 90 years of experience and exclusive engineered integration to a series of boiler systems that only Cleaver-Brooks could have built. We can integrate any firetube system from burner to stack, and we are the only manufacturer of fully integrated boiler systems in the world. Add additional Cleaver-Brooks manufactured accessories like water treatment and heat recovery to make your systems work even harder and more efficiently. Our engineered integration ensures that all system components are designed, spec'd, built and guaranteed to work together. We are the only manufacturer in the world who can say that.





# Flexible Solutions

As the demand for more efficient and sustainable steam and hot water systems increases, differing combinations of boilers are required to deliver the best solution. Modular boiler systems that divide system load among boilers of similar size and type allow for more flexibility, because only the boilers you need to meet system demand will be operating at any given time. Not only can we provide you with modular systems, we can combine different types of Cleaver-Brooks boilers in a hybrid system for additional flexibility and ever-increasing efficiency.



**Conventional**  
Traditional, single-boiler solutions.

**Modular**  
Divide the load between different size boilers for more flexibility. Only the boilers you need to meet demand will be operating at any given time.

**Hybrid**  
Combine steam, hot water and condensing boilers in hybrid systems for additional flexibility.



# After-Sale Support

Whether it's our proprietary BOOST<sup>SM</sup> (Boiler Operation Optimization Savings Test) program for evaluating your boiler system, our boiler room training seminar, our service, our global sales network, or simply the most complete resource for boiler room parts, accessories, maintenance, and emergency service, no one provides you better support in more locations than Cleaver-Brooks.



## Training

Cleaver-Brooks is committed to helping you maximize the safety and performance of your boiler room, and is the only boiler manufacturer with a dedicated Training Department. We offer comprehensive, in-depth training that teaches how to operate and maintain boiler systems at maximum safety and performance, both at the Cleaver-Brooks Boiler House and Product Development facility in Milwaukee, Wis., or custom onsite programs at the customer's facility. We also offer Web-based programs and co-sponsored authorized representative regional programs. If you're responsible for the day-to-day operation or maintenance of your company's boiler room, a plant

engineer, maintenance supervisor, operating engineer, facilities manager, plant manager, or boiler room supervisor, we have a boiler room training seminar that can help. Visit [cleaverbrooks.com/training](http://cleaverbrooks.com/training) to register or view available classes.

## Maximize efficiency and minimize costs with BOOST.

**Total Annual Savings: \$88,447**

**Payback: 28.0 Months**  
**NPV: \$216,838**  
**IRR: 40.7%**

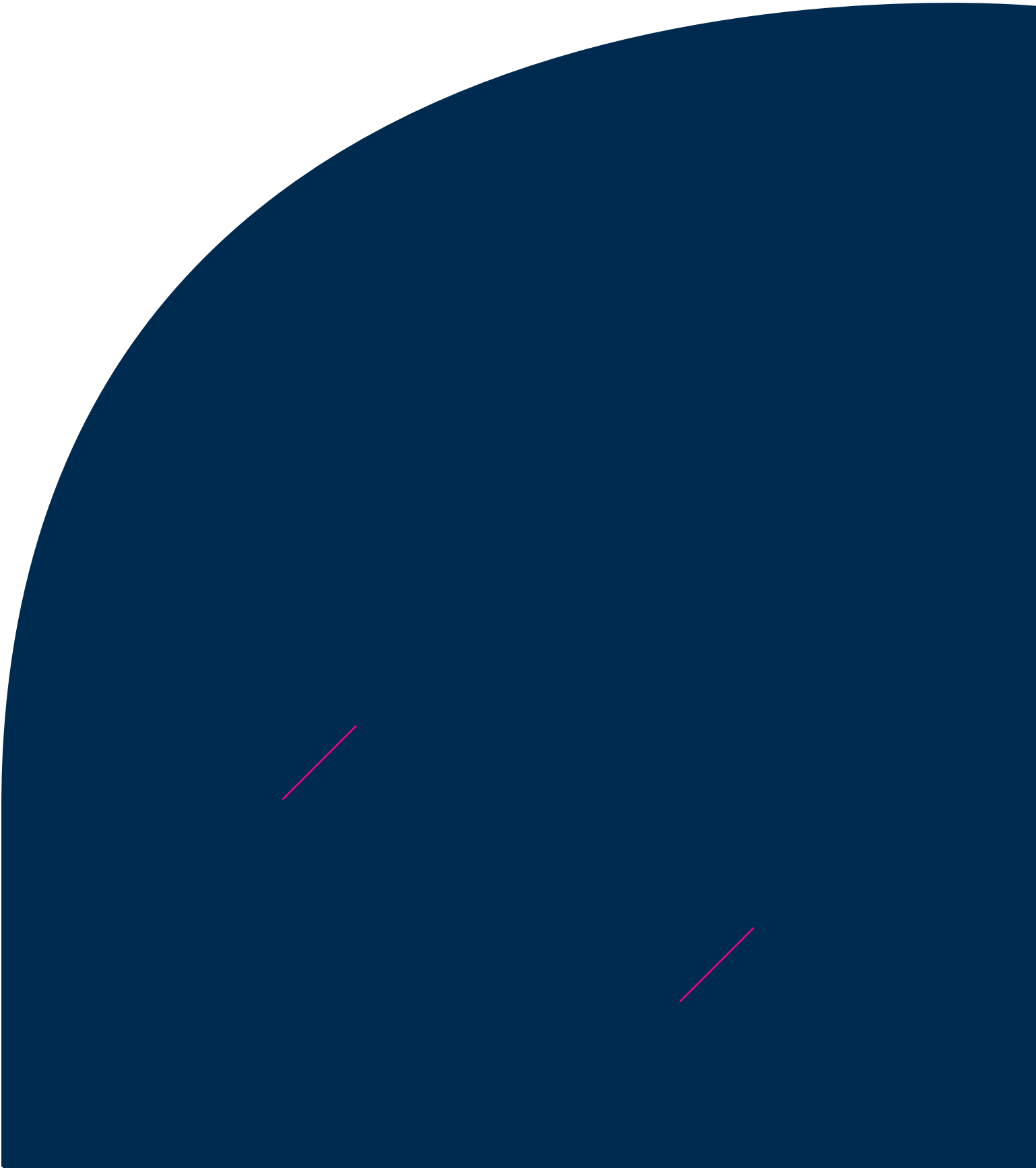
PROJECT SUMMARY CASH FLOW												
Year	0	1	2	3	4	5	6	7	8	9	10	11
Total Implementation Cost	(\$143,780)											
Annual Incremental Pre-Tax Savings		\$88,447	\$88,447	\$88,447	\$88,447	\$88,447	\$88,447	\$88,447	\$88,447	\$88,447	\$88,447	\$88,447
Less Depreciation from Boiler 1		(\$14,378)	(\$25,880)	(\$20,704)	(\$16,563)	(\$13,257)	(\$10,597)	(\$9,418)	(\$9,418)	(\$9,432)	(\$9,418)	(\$4,716)
Before Tax Savings		\$74,069	\$62,567	\$67,743	\$71,884	\$75,191	\$77,851	\$79,030	\$79,030	\$79,015	\$79,030	\$83,731
Less Tax		(\$29,628)	(\$25,027)	(\$27,097)	(\$28,753)	(\$30,076)	(\$31,140)	(\$31,612)	(\$31,612)	(\$31,606)	(\$31,612)	(\$33,492)
After Tax Savings		\$44,441	\$37,540	\$40,646	\$43,130	\$45,114	\$46,710	\$47,418	\$47,418	\$47,409	\$47,418	\$50,239
Add Back Depreciations		\$14,378	\$25,880	\$20,704	\$16,563	\$13,257	\$10,597	\$9,418	\$9,418	\$9,432	\$9,418	\$4,716
Net After Tax Cash Flow	(\$143,780)	\$58,819	\$63,420	\$61,350	\$59,694	\$58,371	\$57,307	\$56,835	\$56,835	\$56,841	\$56,835	\$54,955
Cumulative Net After Tax Cash Flow		\$58,819	\$122,240	\$183,590	\$243,284	\$301,654	\$358,961	\$415,797	\$472,632	\$529,473	\$586,308	\$641,263

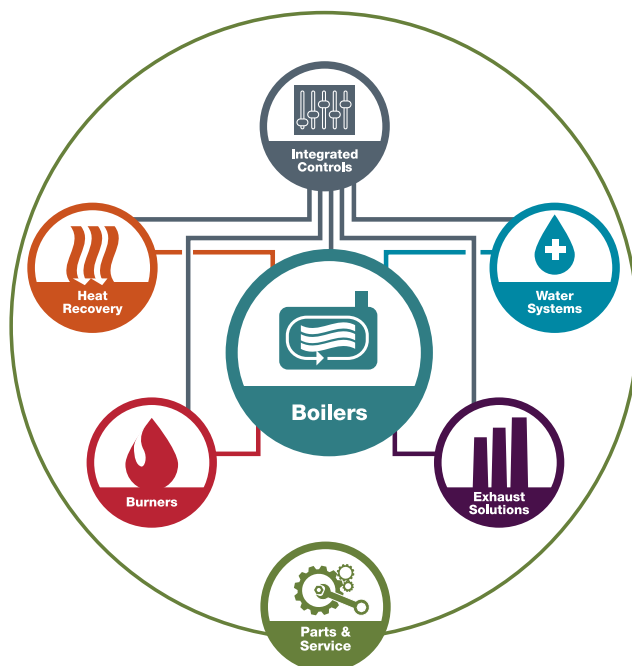
With our proprietary BOOST report, you can determine the exact upgrades and accessories your existing boiler system needs to increase its efficiency to its absolute maximum and decrease emissions. By installing the correct burners, controls, heat recovery, or a brand new CBEX, you can realize substantial savings immediately. And our customized financial report details the cost savings in real numbers, so you can prove it's the right thing to do. No one else has BOOST, and no one else makes the accessories and components engineered specifically to operate together at peak efficiency for your specific operation and applications. We know you want to make the most of every dollar, and we can help.

## Worldwide Industry-Leading Network



The Cleaver-Brooks Representatives Association (CBRA) is the first and only dedicated alliance of boiler room sales and service representatives in the industry. More than 1,500 CBRA representatives across the globe provide unparalleled, ongoing support—from commissioning your system, to providing parts and turnkey after-sale solutions, to extensive product training and knowledge sharing.





# Total Integration goes far beyond boilers.

Efficiency and quality don't end with our boilers. Cleaver-Brooks complete integration produces the most efficient boiler solutions in the world. Completely designed, engineered, manufactured, integrated, and serviced by one company, our systems don't have a single outsourced component to jeopardize compatibility or performance. If you're looking for the best-quality boiler systems with the lowest emissions and highest efficiencies, you're looking for Cleaver-Brooks.



221 Law Street • Thomasville, GA 31792 USA  
1-229-226-3024 • 1-800-250-5883  
info@cleaverbrooks.com • cleaverbrooks.com/EX