Boilers

D-Type

RENTECH

Proposal To:
Evergreen Packaging
Attn: Mr. Brian Levering

PR 90403916
PO

For:
RFP-003
Two Package Boilers
Blue Ridge Paper Products, Inc.
Canton Mill, NC
Rentech Proposal DFB-DTB-4301-JB-14R3

Boilers for people who know and care

TO: Evergreen Packaging
175 Main Street, PO Box 4000
Canton, NC, 28716

August 11, 2015

ATT: Mr. Brian Levering

Proposal: DFB-DTB-4301-JB-14R3

Based on your request for quotation, we are pleased to furnish our proposal for:

Two (2) 159,650 LBS/HR D-STYLE PACKAGED WATERTUBE BOILERS AS DESCRIBED IN THE ATTACHED PROPOSAL

Thank you for your interest in doing business with **RENTECH BOILER SYSTEMS, INC.** We look forward to providing a prompt response to all of your questions, attention to all details, and a top quality boiler. Please don't hesitate to contact us if you have any questions.

Sincerely,

Jon Backlund
Senior Sales Engineer
Rentech Boiler Systems

CC: Air Techniques

Rentech Boiler Systems, Inc.
Abilene Office: 5025A E. Business 20 • Abilene, TX 79601 • Phone: 325-672-3400 • Fax: 325-672-9996
Lincoln Office: 145 North 46th Street • Lincoln, NE 68503 • Phone: 325-672-3400 Fax: 402-474-4243

PROPOSAL SUMMARY

Every boiler manufactured by RENTECH Boiler Systems is custom engineered, giving us the flexibility to assure that the equipment fits your needs rather than forcing your needs into a pre-designed boiler model. The boiler proposed has been designed and optimized for the Evergreen Packaging Canton Mill requirements. We have taken into consideration factors such as the intended application, overall economy as well as reliability.

RENTECH Solution:
The following are features that we have included in this proposal to meet specific requirements for this boiler project:

1. We have proposed a boiler with a conservative furnace design as noted in the below discussion regarding furnace heat release rate. This design assures that the equipment will fit your needs, minimize NOx production and provide the longest life expectance possible.

2. We have proposed a **100% convective superheater**. This design assures that the superheater will not be exposed directly to radiant heat.

3. We are proposing a boiler with **conservative steam drum diameters**. This will directly result in a boiler that better handles load swings and that assures that over the life of the equipment, there will be no excessive carryover to the superheater. This will represent a longer life of the boiler.

4. We have offered a 100% membrane wall construction furnace for this boiler. This design is essential in minimizing the need for refractory in the furnace. Rentech's headered wall construction in the furnace assures that furnace gas seals do not fail due to high furnace temperatures and refractory failure. This will significantly reduce downtime and maintenance cost over the life of the equipment.

5. Rentech will pre-fit all structural steel including ladders and platforms in our shop. Once they are assembled, photos will be taken and they will be disassembled for shipment. This added process is unique to Rentech and we have found will significantly save on field fit-up issues which could result in costly delays.

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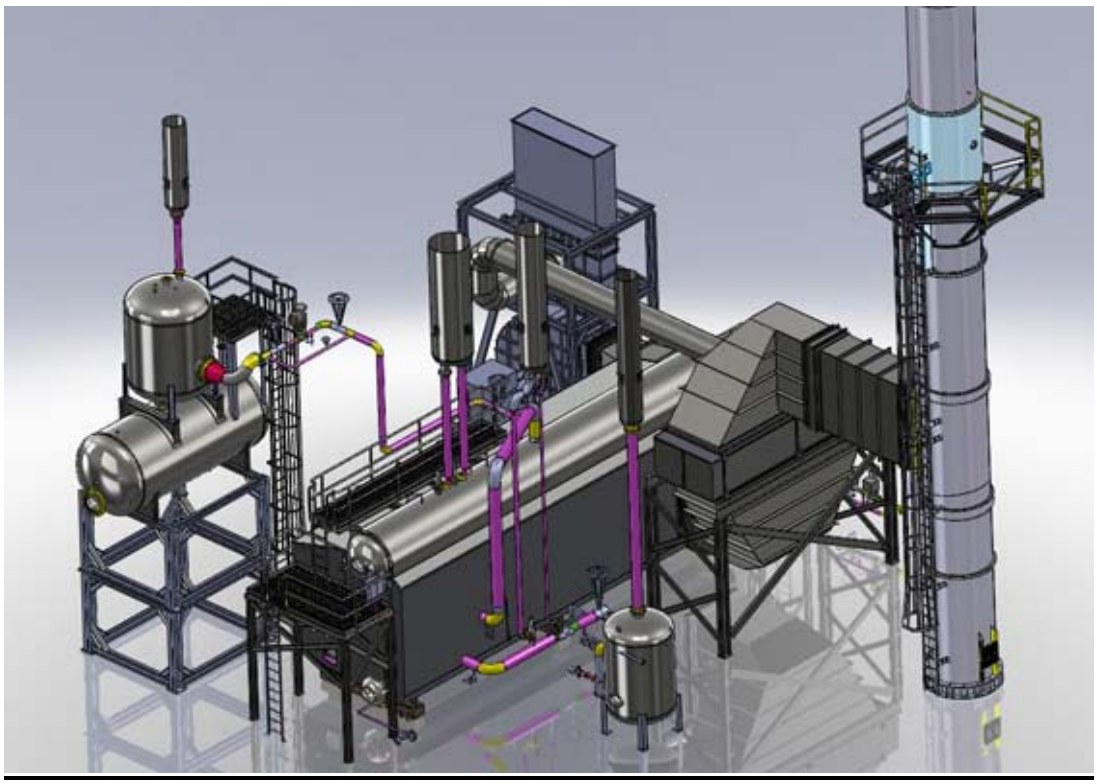
6. Rentech will utilize 3-D modeling in the engineering and design of your system. This will significantly improve fit up accuracy and avoid costly field modifications.
7. ~~We have offered two options for the two NOx levels, resulting in a lower priced system without FGR for the higher NOx level.~~
8. We have not included superheat temperature control. We understand that suitable spray water is not readily available, and that team at slightly higher than the design level can be admitted directly into the plant header. Temperature range will be 730-750F from 50 to 100% load.
9. Stainless steel lagging, heated transmitter enclosures, and a two coat paint system are included in the base pricing.
10. We have designed the boiler to be rail-shippable, and to be no more than 16' tall per spec.
11. All equipment will be raised 4' above grade, with access ladders, stairs, etc to suit
12. We have offered a vertical flow economizer to accommodate a feedwater temperature up to 345 degF without flow stagnation.



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Package Boiler Scope of Supply and Installation Breakdown					
Supply		**Item**	**Description**	**Installation**	
Rentech	**End User**			**Rentech**	**End User**
X		**Package Boiler**	Shop assembled unit		X
X			External / Unheated downcomers	X	
X			Boiler Pressure parts	X	
X			Superheater, single stage	X	
X			Lower Drum Heating Coil	X	
X			Boiler Drum internals (chevron)	X	
X			Boiler SS Lagging and insulation	X	
X			Boiler Teflon slide plates		X
X		**Economizer**	Vertical gas flow unit		X
X		**Steam Coil Air Preheater**	Steam coil air preheater and controls		X
X		**Air Ductwork**	Inlet silencer up to burner		X
X			Air Inlet silencer		X
X			Fresh air damper with Beck actuator		X
X			FGR mixing tee duct		X
	X		FGR mixing tee duct insulation		X
X			Fan inlet expansion joint		X
X			Air inlet duct support structure		X
X			FD Fan (Arrangement 3)		X
	X		FD Fan casing (acoustical jacket)		X
X			Fan damper with Beck actuator		X
X			Fan discharge expansion joint		X
X			Fan discharge to windbox duct		X
	X		Fan discharge duct insulation		X
	X		Electric Motor Drive		X
	X		Motor Starter/VFD		X
X		**Flue Gas Ductwork**	Boiler outlet expansion		X

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Supply		**Item**	**Description**	**Installation**	
Rentech	**End User**			**Rentech**	**End User**
			joint		
X			Boiler outlet transition duct to economizer		X
X			Boiler outlet transition duct insulation		X
X			Economizer outlet transition duct to stack		X
X			Draft control damper with Beck actuator		X
	X	**Stack**	160' free standing		X
	X		Stack personal protection		X
X		**FGR ductwork**	FGR duct		X
X			FGR damper (manual)		X
X			FGR duct expansion joints		X
	X		FGR duct insulation		X
X		**BFW piping**	BFW control valve station		X
X			BFW control station to ECO		X
X			BFW ECO to boiler		X
	X		DA to control valve station		X
	X		BFW piping insulation		X
X		**Steam piping**	Boiler outlet to superheater		X
X			Superheater to NRV		X
X			Superheater start up vent		X
X			Superheater startup vent silencer (33% MCR)		X
X			NRV to main steam stop + ASME free blow drain		X
	X		Main steam piping insulation		X
X		**Mud Drum Heater**	Piping from control station to steam coil		X
	X		Mud drum heater piping insulation		X

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Supply		**Item**	**Description**	**Installation**	
Rentech	**End User**			**Rentech**	**End User**
X		**SCAPH**	Piping from control station to steam coil		X
	X		SCAPH piping insulation		X
X		**Boiler Trim piping**	Drain piping, small bore to terminal point		X
X			Vent piping, small bore to terminal point		X
	X		BD piping, small bore to terminal point		X
X			Level trim piping		X
X			Safety valve stacks		X
	X		Boiler Trim piping insulation		X
X		**Burner**	Windbox (Low NOx)	X	
X			Burner assembly and throat	X	
X			Fuel piping (on windbox)	X	
X			Fuel piping to burner	X	
X		**Ladders and platforms**	Boiler operating platforms		X
X			Platform, FD fan inlet		X
X			Platform, burner		X
X			Platform, steam drum length		X
X			Platform, steam drum head		X
X			Platform, furnace sight ports		X
	X		Platform, stack testing		X
X		**Instrumentation**	See Boiler Trim Section		X
X			Heated boxes for transmitters		X
	X		Instrumentation impulse lines		X
	X		Heat tracing (if required)		X
	X	**Sampling systems**	Saturated steam sample cooler		X
	X		Continuous blowdown sample cooler		X

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Supply		**Item**	**Description**	**Installation**	
Rentech	**End User**			**Rentech**	**End User**
	X		Sample line sat steam probe to cooler		X
	X		Sample line CBD line to cooler		X
X		**Controls**	BMS PLC (A-B ControlLogix)		X
X			Combustion Control PLC (A-B ControlLogix)		X
	X	**Deaerator**	DA System		X
	X		Boiler Feed Pumps		X
	X	**Installation**	Consultant		
	X	**Installation**	Per Diem Option		
	X	**Start Up**	Per Diem Option		
	X	**Start Up**	Per Diem Option		
	Alternate Estimate	**Freight**	Rail to nearest accessible siding (boiler only), Truck		
	X	**Unloading**	On site		
X		**O&M**	Manuals (3 sets)		
X	X	**QA**	ASME documentation		

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Miscellaneous Buyer's Scope of Supply (including but not limited to)					
Supply		**Item**	**Description**	**Installation**	
Buyer				**Rentech**	**End User**
X		**Civil**	Foundations		X
X			Concrete		X
X			Anchor bolts		X
X			Grout		X
X			Building (as applicable)		X
X		**Storage**	All applicable hardware		X
X		**Piping**	Steam piping beyond terminal point		X
X			BFW piping up to terminal point		X
X			Drain piping beyond terminal point		X
X			Vent piping beyond terminal point		X
X			BD piping beyond terminal point		X
X			Fuel gas piping up to terminal point		X
X			Heating media piping up to Air preheater		X
X			Cooling water to lube oil system and/or sample coolers		X
X			Instrument air piping to flame scanners		X
X			Instrument air piping to control valves and actuators		X
X		**Chem Feed System**	Chemical Feed System		
X		**Fuel System**	Filters and coalescers		X

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Miscellaneous Buyer's Scope of Supply (including but not limited to)					
Supply		**Item**	**Description**	**Installation**	
Buyer				**Rentech**	**End User**
X			Other fuel conditioning equipment		X
N/A			Spec gravity analyzer (if required)		X
N/A			Heavy Oil heating and pumping set		X
X		**Electrical**	Distribution panel		X
X			Electrical feed to actuators (if required)		X
X			Electrical feed to boiler level trim		X
X			Electrical feed to control panel		X
X			Electrical feed to analytical instruments		X
X			MCC (fan motor starter) for FD Fan and Core air fan motors (as required)		X
X			Motor Control Center wiring to motors		X
X			Area lighting and contacts		X
X			Field instruments to control panel wiring		X
X			Lightning protection		X
X			Grounding		X
X		**Controls**	SIL evaluation / LOPA		X
X			Controls upgrades after LOPA		X
X		**Commissioning**	Boiler and piping cleaning/ boilout		X
X			Cleaning/ boilout chemicals		X
X			Chemicals disposal		X

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Miscellaneous Buyer's Scope of Supply (including but not limited to)					
Supply		Item	Description	Installation	
Buyer				Rentech	End User
X			Steam blows		X
X			Field balancing and alignment of fan		X
X		**Start up**	(See Rentech service rates)		X
X		**Training**	(See Rentech service rates)		X
X		**Environmental**	Permit		X
X			CEMS system (if applicable)		X

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TECHNICAL DISCUSSION

To meet your process and mechanical requirements, we are pleased to offer two (2) **100% membrane wall construction**, D-Style watertube boilers with integral convective superheater. The boiler has been designed for natural gas firing and will have a design pressure of 500 psig. The unit will generate159,650 lbs/hr of superheated steam at 418 psig and 730°F, with feedwater supplied at 280 to 345°F. Please refer to the attached Data Sheets for performance at the design conditions.

The boiler will be designed with complete membrane wall construction of the furnace, including the front wall. This design minimizes the need for refractory and refractory seals, even in the corners. By minimizing the refractory, faster start-ups are possible because the slow ramp-up time required to sustain the refractory at a constant temperature is not necessary. Of course, the absence of refractory rules out the possibility for cracking and crumbling problems that traditionally are associated with refractory in packaged boilers. The water-cooled front and rear walls also allow the furnace to operate at a lower temperature, which helps to reduce the formation of NO_x.

RADIANT FURNACE

The furnace section of the proposed boilers is of **100% membrane wall design** and is constructed of 2.0"OD x 0.135"MW **SA 178A** tubes on 4" centers. The tubes are connected by 1/4" x 2" carbon steel membranes to form a totally water cooled enclosure, including the front and rear walls. This design avoids the traditional problems that package boilers have had with firebrick and refractory maintenance. Membrane walls will be constructed as

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multiple tube panels maximizing machine welding and eliminating a fin to fin weld between tubes. The membrane wall construction is unique in that it utilizes a headered construction, which eliminates the need for, and traditional problems associated with gas seals in the corners of the furnace. Our competition would utilize steel box seals at the locations where one furnace wall joins another. These gas seals require the use of refractory or ceramic fiber to protect them from the high temperatures in the furnace. Problems with gas seal failures arise over time as the refractory or ceramic fiber fails, exposing the gas seals to 2,000°F temperatures. With RENTECH'S headered wall design, the water cooled header forms the corners. It simply cannot fail by overheating.

The furnace will have two observation ports located on the rear wall to allow for viewing the flame along the sidewalls. The front of the furnace can be viewed through ports located on the burner. The rear wall of the furnace will have a davited 15"x18" access door, with a 9" refractory lining.

FURNACE DATA:

Item	Units	Fuel Gas
Furnace Dimensions	Ft – in	Height: 10'–2" ; Width: 6'–8"; Length: 34'–10"
Total Heat Input	MMBtu/Hr	225
Furnace Volume	Ft^3	2374
Flat Projected Furnace Surface	Ft^2	1291
Volumetric Heat Release Rate	$Btu/Hr\text{-}ft^3$	93,326
Square Foot Heat Release Rate	$Btu/Hr\text{-}ft^2$	171,628
Average Heat Flux	$Btu\text{-}Hr\text{-}ft^2$	42,220
Maximum Heat Flux	$Btu\text{-}Hr\text{-}ft^2$	55,730

Notes:

- Volumetric Heat Release Rate = **Total Heat Input (includes all losses from the boiler)** at MCR / Actual Furnace Volume Available For Combustion (This would exclude any volume occupied by a radiant superheater if such a design were offered). The heat input is a known value and will vary depending on unit

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efficiency and fuel fired. The furnace volume is simply a calculation of the open volume in the furnace. This results in a value in Btu/Hr-ft^3.

- Square Foot Heat Release Rate = Total Heat Input at MCR / Flat Projected Furnace Heating Surface. The Flat Projected Furnace Heating Surface is the heating in the furnace not taking into account the curvature of the tubes. If one were to look at the furnace membrane wall, it a square foot of Flat Projected Heating Surface would simple be a 1 foot by 1 foot square.
- Average Heat Flux = Total Heat Absorbed In The Furnace / Flat Projected Furnace Heating Surface.
- Maximum Heat Flux = Average Heat Flux X Furnace Tube Shape Factor (1.2) X Furnace Location Factor (1.1). With this number we applying factors to the average to reflect that we will have a higher heat flux at the point of the furnace tube that projects the furthest into the furnace and thus is closest to the flame. This point is said to have a better view factor of the radiant flame. It also applies a factor to reflect that the location down the length of the furnace will have an effect on the local heat flux. Again, the closer you are to the hottest part of the flame, the higher the Heat Flux.

CONVECTION TUBES

The convection tubes are 2.0"OD x 0.120"MW **SA 178A** and will be attached to drums by rolling. Each tube hole will be serrated and carefully cleaned and polished just prior to tube installation. The ends of each tube will also be polished just prior to installation.

Please refer to the attached Mechanical Data for details of the convection section tube layout. This tube layout was specifically selected to meet your process and space requirements and keep draft loss and the associated FD fan horsepower requirement to a minimum.

Rentech performs an acoustic analysis on all sections of the boiler at various loads to determine if longitudinal, vertical baffles are required to eliminate problems associated with acoustic vibration. Rentech will include these when necessary.

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DRUMS

The steam drum is 54" ID and approximately 38.5' in length seam to seam. This combination of diameter and length has been optimized for the capacity of the boiler. This steam drum will allow the boiler to react to load swings while reducing the likelihood of excess moisture carryover or nuisance trips due to high or low water level.

The drum is provided with primary belly pan and cyclone type separators to assure that steam leaving the drum contains less than 0.5 PPM TDS carryover. Any steam purity guarantee will not include vaporous silica carryover. All other drum internal piping is also included as needed to make the unit operational. Each steam drum head will have a 14"X18" elliptical manway with davited cover, to provide access for inspection.

The lower drum will be 24" ID. The lower drum is complete with bottom blowdown connections to allow for the proper intermittent blowdown of solids that accumulate in the bottom of the drums. Mud drum will have two 12" X 16" elliptical manways.
The boiler is supported from grade on channel saddles. It will be fixed on the burner end and the other end will free to slide and accommodate thermal expansion.

UNHEATED DOWNCOMERS

Unheated downcomers will be located at either end of the drums and will be outside the hot gas path or protected from the flue gas heat. This design is key to assuring that the unit can properly react to rapid load swings.

CONVECTIVE SUPERHEATER

We have proposed a single stage, inverted loop superheater. The superheater will be located fully behind convective screen tubes to protect superheater tubes from direct exposer to radiant heat. The superheater will utilize SA 213 T22 tubes.

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ECONOMIZER

A vertical gas flow economizer has been included. The tubes are horizontal and fully drainable. The economizer will be complete with galvanized structural support steel. The economizer will be externally insulated with 3" mineral fiber block insulation and covered with corrugated SS lagging.

FORCED DRAFT FAN

We have included one (1) arrangement 3 FD fan, supplied by Howden. The fan will require an 1800 RPM XXX HP motor with VFD by owner. Included are fresh air damper (FGR design only), discharge damper, vertical silencer with rain hood and air flow element, expansion joints, and evase. Damper electric actuators are Beck.

Test block for the fan and drives is based on 110% of volumetric flow and 121% of static pressure. The volumetric flow includes the flue gas recirculation. Fan performance is summarized below

	RPM	Flow,PPH	Static Pressure, "WC	Temp. °F	Density, lb/ft^3	BHP
Test Block (FGR)	1,780	226,000	41.0	125	0.061	490
MCR (FGR)	1,577	205,500	33.9	100	0.064	353
Test Block (No FGR)	1,780	209,600	36.8	105	0.064	394
MCR (No FGR)	1,598	190,500	31.4	80	0.066	293

All ductwork from the inlet silencer to the forced draft fan and from the forced draft fan to the windbox, including expansion joints, have been included.

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STEAM COIL AIR PREHEATER

An Aerofin steam coil air preheater system, with piping, controls, structure, and access platforms is included. (Non ASME code design)

STACK

A 160 ft. total elevation, free standing stack complete with emission test ports and access platform with ladder is to be provided by others. We have included insulated ducting to stack connection, expansion joint, and automated draft control damper with Beck actuator.

AIR & FLUE GAS DUCTWORK

A complete set of ductwork is provided. All applicable air and flue gas ducts will be supplied. Ducts will be shop insulated and SS lagged as specified. Ductwork minimum thickness is ¼".

FGR DUCTWORK

FGR ductwork (FGR option only) including manual trim damper has been included. Insulation and lagging of the FGR ductwork will be required in the field by others. Rentech will be responsible for supporting this ductwork.

BOILER TRIM, INSTRUMENTATION AND FINAL CONTROL ELEMENTS

The boiler trim included in the base pricing is itemized on the trim list. Boiler trim appurtenances and instrumentation will be crated and shipped for safe delivery to site where it will be mounted by end user and/or his site contractor.

PIPING

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We have included boiler external piping from boiler feedwater control valve station inlet through steam non return and main steam stop valve.

Small bore piping for drains, vents and blowdowns is included up to the boiler external piping boundary as defined by ASME Section I.

Boiler trim piping has also been included. This includes level trim, pressure gage, level transmitter connections as well as safety valve vent stacks.

All piping supplied under this proposal will be installed by end user and/or his installation contractor (see scope of supply pages).

INSULATION, LAGGING, AND PAINTING

The mud drum, excluding the drum heads, and all of the walls of the unit will be insulated with 4" mineral fiber insulation and protected with SS lagging. The roof of the furnace will be covered with corrugated SS casing. The steam drum, excluding the heads, will be lagged with corrugated SS. The economizer will be insulated with 3" mineral fiber insulation covered with SS lagging. Exterior surfaces that will not be insulated will be cleaned in accordance with SSPC-SP6 procedures and painted with a two coat epoxy system. Breeching from boiler to stack will be shop insulated. Vendor supplied equipment will receive their standard paint application. Piping components, ductwork interior and surfaces that will be insulated will not be painted.

STARTUP SPARE PARTS

We have included two sets of manway gaskets, two water gage glasses, rope gasket material and two observation port lenses. Due to the custom nature of our products, a full operating and spare parts list can only be provided once design has been completed and approved.

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1. INTRODUCTION

Two (2) 160,000 pounds per hour "D" type package boiler is to be supplied with a low NOx packaged burner which will fire natural gas.

Based upon the burner design specification presented in Section 2, the Power Group of the John Zink Company, LLC (JZHC/Coen) is pleased to offer Rentech Boiler Systems, Inc., our pre-engineered, low NOx ECOjet burner with windbox, valve trains, miscellaneous field switches, and flame scanning equipment.

The packaged burner is factory pre-assembled to the maximum extent to minimize field installation and easily mounts onto the boiler frontplate.

Recognizing that combustion air is 94% of the mass flow through the burner, with fuel only being 6%, as part of the "system" solution for supplying a burner for optimum performance, JZHC/Coen will provide air flow distribution studies of the windbox and upstream combustion air duct, using our in-house modeling facilities. These model studies determine the size and location of straightening devices to be provided, in order to assure balanced air flow to the burner, and will result in reduced system draft losses, reduced stack emissions at lower excess oxygen levels, and greater boiler efficiency. A drawing will be provided indicating the size and location of straightening devices in the combustion air duct, if required.

Some of the standard design features of the ECOjet burner are:

- Flame stability at low excess air rates for reliable, energy efficient boiler operation
- High turndown ratios for wide range of boiler operation
- Axial parallel air flow to control the flame envelope and provide even heat flux
- Known flame length and diameter, to suit furnace firing lane without impinging on boiler tubes or furnace walls
- Dual gas burner sub-assemblies to provide staging of the combustion process to reduce NOx formation
- Combustion air passes through a fixed air register design with no moving parts to reduce operator attention

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- A strong flame front established approximately eight (8) inches off the face of the diffuser, which maintains the burner refractory throat cool, thus avoiding the replacement of the throat or tile often found on other burners that requires hot refractory to assure a stable burner flame

- A strong flame front established approximately eight (8) inches off the face of the diffuser, which does not move during changes in the firing rate, thus providing a stable flame for scanning, resulting in reliable operation

- Flame scanner swivel mount for ease of "sighting" of flames, mounted on the burner frontplate

- Gas-electric ignitor, operates only through the cycle to light-off the main fuel, is fixed in the burner and terminates behind the diffuser; retraction mechanisms and associated limit switches are not required, thus minimizing boiler front components and reducing maintenance costs

- Heavy gauge construction of all components for ruggedness and durability during installation and servicing

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2. BURNER DESIGN BASIS & SPECIFICATIONS

A. Burner Design Basis

Boiler Data	
Manufacturer	RBS
Type	D
Design Steam Flow	160,000 lb/hr
Steam Pressure	418 psig (superheated)
Steam Temperature	730 deg F
Furnace Dimensions:	
Depth	35.0 ft
Width	6.75 ft
Height	10.0 ft
Furnace Operating Pressure including FGR at MCR	15.0 in wg (assumed)
Combustion Air Temperature	16 - 85 deg F
Flue Gas Temperature	300 deg F

Fuel Data

Fuel Gas	
Type	Natural
High Heat Value	1,022 Btu/scf
Pressure Available	75 psig
Pressure Required at JZHC/Coen interface	25 psig (regulated by others)
Analysis	CH_4 @ 90%; C_2H_6 @ 5%; N_2 @ 5%

Burner Management System Design	
Insurance Guidelines	NFPA85 for single burner
Type of Operation	Automatic, non-recycling

Miscellaneous Data	
Burner Location	Outdoors, non-hazardous
Plant Elevation	2,586 ft asl
Power Supply Available	120V/1Ph/60Hz
Instrument Air Available	70 psig
Valve Train Construction	NFPA54 (gas)
Surface Preparation and Painting	Manufacturer standard
Quality Control	Manufacturer standard

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B. Burner Specifications

Number of Burners per Boiler	One (1)

Option 1 – 0.050 lb/mmbtu

Gas Firing per Burner	
Heat Input	225 mmbtu/hr
Turndown	20 to 1
Excess Air at MCR	15%
Recycle Flue Gas Rate at MCR	7%
Draft Loss at MCR	9.25 in wg
Type	ECOjet

C. Gas Electric Ignitor Specifications

Number of Ignitors per Boiler	One (1)
Gas Firing	
Heat Input	1 mmbtu/hr
Pressure at Burner	1 psig (approx)
Type	Class 3

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3. JZHC/COEN'S SCOPE OF SUPPLY

A. Engineering Services

JZHC/Coen will provide complete engineering and design for all JZHC/Coen furnished equipment and materials specified in Section 3.D., including a comprehensive Instruction Manual complete with data sheets, JZHC/Coen drawings, vendor drawings, parts list and operating instructions.

JZHC/Coen will provide air flow distribution studies of the windbox and upstream combustion air duct, using our in-house modeling facilities. These model studies determine the size and location of straightening devices to be provided, in order to assure balanced air flow to the burner, and will result in reduced system draft losses, reduced stack emissions at lower excess oxygen levels, and greater boiler efficiency. A drawing will be provided indicating the size and location of straightening devices in the combustion air duct, if required.

B. Project Services

JZHC/Coen will provide a submittal consisting of full size blue prints of packaged burner general arrangement drawing, valve train schematics, electrical schematics, and bill of materials, to be sent to Rentech Boiler Systems, Inc. for approval and six (6) copies of JZHC/Coen's Instruction Manual.

C. Jobsite Services

JZHC/Coen can provide field advisory services during installation, and technical assistance services during initial start-up including operator training, at the per diem rate in effect at time of request, in accordance with our Service Terms. **No jobsite services are included in our base bid.**

D. Equipment and Materials

The following is an itemization of all components supplied by JZHC/Coen.

1. One (1) windbox, non-insulated, will be fabricated of ASTM A-36 carbon steel plate, and complete with required structural framing, support legs, access door, lifting lugs, and straightening devices for balancing air flow distribution to the burner. The windbox will be provided with an inlet opening for connection to the combustion air duct. The windbox will be painted with manufacturer standard. The windbox will be seal welded to the boiler front plate.

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2. One (1) ECOjet burner, fabricated using standard stainless and mild steel components, complete with the following sub-assemblies, mounted in the windbox:

- One (1) fixed air register
- One (1) burner front plate assembly, non-insulated, complete with observation port and flame scanner swivel mounts
- One swirling diffuser assembly
- One (1) dual gas burner assembly (combination center-fired gas gun and outer injectors)
- Two (2) burner pressure gauges, 4 in dial, with isolation valve, one for each gas burner sub-assembly
- One (1) ignition assembly complete with gas-electric ignitor
- One (1) burner guide ring to be welded on the boiler front plate to align the burner to the burner opening (shipped loose)
- One (1) throat former for installation of boiler front wall refractory at the burner opening (shipped loose)

3. One (1) lot of flame scanning equipment:

- Two (2) Coen iSCAN2 flame scanners, each with integral flame relay wired to a windbox mounted NEMA 4X terminal box

4. The following valve trains will be shop mounted on the windbox to the maximum extent feasible, and will include valves, piping specialties and instrumentation as specified below. All electrical components will be wired to a NEMA 4X terminal box. Unless otherwise noted, the interface points with Rentech Boiler Systems, Inc. are at the inlet of the supply manual shut-off valves and the discharge of vent, and drain valves.

   Gas trains will be fabricated using Schedule 40 ASTM A-106 Grade B seamless steel pipe, with standard butt-weld fittings and 150 lb. flanges for nominal 3 inch diameter and greater lines, and Schedule 80 ASTM A-106 Grade B seamless steel pipe and 3,000 lb. threaded fittings for nominal 2-1/2 inch diameter and smaller lines. Gas trains will be painted with manufacturer standard.

   - One (1) ignitor gas pilot train, consisting of:

     1- Supply manual shut-off valve, brass body, NPT
     1- Gas strainer with basket "Y" type, cast iron body, NPT
     1- Gas pressure regulating valve, cast iron body, NPT

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2- Automatic safety shut-off valves, solenoid type, aluminum body, NPT (Asco)
1- Automatic safety vent valve, solenoid type, aluminum body, NPT (Asco)
1- Ignitor manual shut-off valve, brass body, NPT
1- Ignitor pressure gauge, 2.5 in dial, with isolation valve
1- Ignitor flexible hose, stainless steel body, NPT

- One (1) main fuel gas train, consisting of:

1- Supply pressure gauge, 4 in dial, with isolation valve
1- Low gas pressure switch (Ashcroft)
1- Automatic safety shut-off valve, motor operated, with proof of closure switch, cast iron body, 125# FF (Maxon)
1- Automatic safety vent valve, solenoid type, aluminum body, NPT (Asco)
1- Manual vent valve, locked in the open position, brass body, NPT
1- Automatic safety shut-off valve, motor operated, with proof of closure switch, cast iron body, 125# FF (Maxon)
1- High gas pressure switch (Ashcroft)
2- Leak test connections with isolation valves
1- Gas flow control valve, vee-ball type, carbon steel body, 150# RF, with low fire limit switch, pneumatic actuator and I/P positioner (Fisher)
1- Burner manual shut-off valve, semi-steel body, 125# FF
1- Bias gas flow control valve, butterfly type, carbon steel body, 150# RF, with low fire limit switch, pneumatic actuator, I/P positioner and position feedback transmitter (Fisher)

5. The following miscellaneous field switches will be mounted on the windbox and wired to a NEMA 4X terminal box:

- One (1) combustion low air flow switch (Dwyer)
- One (1) purge low air flow switch (Dwyer)
- Two (2) boiler drum steam high pressure switches (Ashcroft)
- One (1) furnace high pressure switch (Dwyer)
- One (1) low instrument air pressure switch (Ashcroft)

E. <u>BMS & BCS Control Panel</u>

(Supplied by Rentech)

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4. PERFORMANCE GUARANTEES (BURNER)

A. The following performance guarantees will be extended from twenty-five (25) to one hundred (100) percent of boiler load, provided that the system is operated at steady state conditions, in accordance with the Burner Design Basis and Specifications in Section 2:

- Maximum emission levels on natural gas, with all concentrations corrected to 3% oxygen, on a dry basis:

NOx – 7% FGR	0.050 lb/mmbtu
NOx – 0% FGR	0.075 lb/mmbtu
CO	65 ppm

- The burners will maintain a stable flame with no deleterious impingement over the entire boiler load range

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Boiler Trim

Safety Relief Valves

2	Boiler		Drip pan elbows
1	Superheater		Vent stacks
	Economizer	X	Silencer(s)
1	SCAPH		
	Gags		Silencer supports
X	Spring covers		

Water Columns

1	**Qty.**			**Level Switches**		
X	Probe Type		Float Type	Column 1		Column 2
	Valves			X	HI-HI	HI-HI
	Process block			X	HI	HI
X	Drain			X	LO	LO
	Vent			X	LO-LO	LO-LO

Aux. LWCO

1	Qty.		Valves
X	Probe type		Process block
	Float type	X	Drain
			Vent

Water Level Gage Glass

	Glass 1	Glass 2
Prismatic		
Flat glass	X	X
Bi-Color		
Illuminator	X	X
Direct vision hood		
Remote viewing hood with mirrors		
Fiber optic remote		
Valves		
Water gage	X	X
Drain	X	X
Vent		

Remote Level Indicator

Probe Type	EyeHye
Number of remote indicators	1
Number of lights per indicator	10
Valves	
Process block	1
Drain	1
Vent	

Controllers / Analyzers

	Drum level controller		Conductivity analyzer (steam)
	Desuperheater controller		Conductivity analyzer (water)
	Desuperheater		PH analyzer (water)
1	O2 Analyzer (w/ spare element)		COe (Combustibles)

Flow Elements

Service	Orifice Plate	Flow Nozzle	Venturi	Piezometer
Steam	1	0	0	0
Water	1	0	0	0
Combustion air	0	0	0	1

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Flue gas	0	0	0	0
Fuel gas	1	0	0	0
Fuel oil	0	0	0	0

Boiler Trim

Sootblowers – Qty.

Service	Retractable	Manual Rotary	Electric Rotary		Controls
Boiler	0	0	0		Motor starters
Superheater	0	0	0		Piping
Economizer	0	0	0		

Description	PI	PT	TI	TT	TC/TW	PS	LT	FT
Flue Gas								
Fresh air inlet					1			1
FGR								
Air preheater outlet								
Mix – Fan inlet								
Fan discharge		1	1		1			
Burner windbox	1							
Furnace	1	1						
Convection section								
SH inlet								
SH intermediate								
SH outlet								
Boiler outlet								
Economizer inlet	1		1		1			
Economizer outlet	1		1		1			
Water								
Upstream control valve station	1		1					1
Downstream control valve station	1							
Upstream economizer			1		1			
Downstream economizer	1		1		1			
Steam								
Boiler outlet								
SH Interstage								
SH outlet	1		1	1	1			1
Steam drum	1	1					1	
Continuous blowdown								
SH Tubes					4			
Fuel								
Gas		1						1
Oil								

PI = Pressure Indicator TC/TW = Thermocouple/Thermowell

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PT = Pressure Transmitter	PS = Pressure Switch
TI = Temperature Indicator	LT =Level Transmitter
TT = Temperature Transmitter	FT = Flow Transmitter

All transmitters are mounted in heated enclosures

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Boiler Trim

Valves	Qty.	Manual	Actuated
Feedwater			
Stop	1	X	
Check	1	X	
Level control	1		X
Control valve block	2	X	
Control valve by-pass	1	X	
Control valve drain	4	X	
Economizer block	0		
Economizer by-pass	0		
Steam non-return	1	X	
Steam stop	1	X	
Free blow drain	1	X	
Continuous blowdown control	1	X	
Continuous blowdown block	1	X	
Intermittent blowdown	4	X	
Boiler vent	1	X	
Chemical feed block	1	X	
Chemical feed check	1	X	
Superheater start-up	1	X	
Start-up block	1	X	
Superheater vent	1	X	
Superheater drain	2	X	
Economizer vent	1	X	
Economizer drain	2	X	
Sootblower steam block	0		
Desuperheater spray water			
Control valve	0		
Control valve block	0		
Control valve by-pass	0		
Control valve drain	0		
Power operated block	0		
Stop valve	0		
Check valve	0		
Boiler drain	0		
Steam sample	2	X	
Water sample	2	X	
Acid clean	0		
Fuel gas pressure regulator	1		X
Mud Drum Coil Block	2	X	
Mud Drum Coil Drain	2	X	
SCAPH Block	3	X	
SCAPH Drain	1	X	
SCAPH Control	1		X

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Burner Sentry Burner Management and Boiler Sentry Boiler Controls

Two (2) Thermal Economy Burner Sentry Burner Management and Boiler/Burner Control Systems. The system will include two (2) Allen Bradley Control Logix series programmable controllers for Burner Management and Boiler Controls. The system includes a 12" color human machine interface (HMI) for all operator control and, alarm status. The system includes a NEMA 4X rated enclosure.

The system will be designed to interface with the customer's DCS so that control of the burner management can be performed remotely via the DCS.

The following boiler/burner control strategies will be included.

Combustion Controls
Feed Water Controls
Oxygen Trim Control
Draft Controls
Superheater Controls (if needed)

EQUIPMENT

The following equipment is listed on a per boiler basis.

No.	Qty.	Description Burner Management/Boiler Control Hardware
1	1	NEMA 4X Electrical Enclosure, Saginaw or Rittal, 48"" W x 36" h One Allen Bradley Control Logix series PLC programmed for burner management One Allen Bradley Control Logix PLC programmed for combustion controls and boiler controls Lot of Digital Input and Output Modules Lot of Analog Input and Output Modules 12" Allen Bradley Versa View or Phoenix Contact, flat panel computer RS View SE Human Machine Interface (HMI) software Ethernet Switch, N Tron Surge Suppressor/Filter Emergency stop push-button Warrick electromechanical relays for high water alarm, low water alarm,

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and low water level cutoff
Alarm lamp, fuel valves energized lamp, alarm lamp, push to test, LED
Alarm horn
Enclosure light
External Watchdog Timer
Lot Phoenix Contact Terminal Blocks
Lot Interposing relays per spec
Lot of circuit breakers, Phoenix Contact
Lot 16 ga MTW, wire duct, wire markers, lamacoid nameplates
Enclosure Heater

2 **Flame Scanners**

By Burner Manufacturer

3 **Customer Specified Equipment and Options**

Weidmuller Terminal Blocks
Special Indicating Light Colors
Customer Specific Relays
XHHW-2 Wire
Operation of the burner management from the DCS.
Enclosure Heater and Air Conditioner
Crouse Hind Breather/Drain
NEMA 4X enclosure
-20 deg F outdoor temperature: A heater has been included, however the heater will not keep the HMI warm. The HMI has a 32 deg F temperature limitation.
SIL Analysis Not included
Arc Flash Label Not Included (an arc flash study is required)
Continuous hinge door not included
Allen Bradley Terminal Blocks
Fused Terminal Blocks
Safety Relays (SIL 3 relays) not included
Isolated Contacts to Interface to DCS

PAINTING AND FINISHES

Electrical Enclosure	Painted manufacturer standard or SS for Nema 4X

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DOCUMENTATION

Control System Documentation

1. Enclosure Drawing
2. Electrical Schematic Wiring Diagrams. Includes communication wiring.
3. Bill of Material
4. "PLC" program printout.
5. SAMA diagrams and control narrative.
6. Two hardcopy instruction manuals, 4 CD ROM manuals. All documentation above is included, and vendor cut sheets

MEETINGS

One meeting at the customer's location to discuss the boiler controls for the DCS has been included. Up to two days on site and travel costs are included.

FACTORY ACCEPTANCE TEST

The system will be completely tested to ensure correct operation and functional operation prior to shipment. All wiring is checked and tested. All systems will be tested and operated with
simulated field device inputs and outputs. A complete functional test will be performed to ensure correct operation of the burner management system. A point to point wiring test will be performed to ensure correct wiring.

The customer is invited to a factory acceptance test for the system. The system will be fully operational for this test.

One day has been allotted to perform the factory acceptance test at our facility.

NOTES AND COMMENTS

1. Mechanical and electrical installation and startup has not been included.

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2. UL 508 A inspection and sticker, if required is additional cost.
3. Communications to DCS has been included as an adder Ethernet TCP/IP. The DCS will need a communication driver/server to communicate with the Allen Bradley PLC. Other communication protocols such as Modbus can be included for an additional cost. 4. Electrical Spec for Packaged Systems 4.10.2. 14 gauge wires will not fit on the PLC terminals, our internal panel wiring to be 16 gauge.

.

PRICING

Optional Adders

NEMA 4X Enclosure (48" h x 36" w)	$	Included
Data File for Remote DCS Monitoring and Control via Ethernet (customer has compatible Allen Bradley Communications Server Software)	$	Included
Enclosure Air Conditioner	$	Included
Weidmuller or Allen Bradley Fused Terminal Blocks	$	Included
Allen Bradley Relays	$	Included
SIL Rate Relays	$	Not Included
Arc Flash Label and Study	$	Price Pending
Isolated Contacts for DCS Monitoring	$	Included
XHHW-2 Wire for Internal Wiring	$	Included

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PREDICTED PROCESS SUMMARY SHEET
100% MCR, Firing Natural Gas (FGR Case)

	FURNACE	SCREEN	SUPERHEATER	CONVECTIVE	ECONOMIZER
GAS SIDE					
Flue Gas Flow Rate, lb/hr	199,187 @ 15% excess air				
Inlet Temperature, °F	Combustion	2318	2150	1753	742
Outlet Temperature, °F	2318	2150	1743	742	325
Pressure Drop, " wc	20.6				
Fouling Factor	0.001				
STEAM SIDE					
Design Pressure, psig	500				600
Operating Pressure, psig	437 (drum)		430	437	450
Inlet Temperature, °F	409		457	409	280
Outlet Temperature, °F	457		745	457	409
Blowdown, %	14.0				---
Fouling Factor	0.001				
Flow Rate, lb/hr	159,653				185,643
Heating Surface, ft²	1291	275	792	6579	30,494

Notes:

1. HHV Efficiency: 83.12%
2. Total BTU Input: 225 MMBtu/hr
3. Performance for the No FGR case is almost identical. Efficiency is 83.12%, steam production 159,033 PPH

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MECHANICAL DATA SHEET

TUBES

	FURNACE	SCREEN	SUPERHEATER	BOILER BANK
Diameter (in.)	2	2	2	2
Thickness (in.)	0.135	0.120	0.135	0.120
Material	SA 178A	SA 178A	SA 213 T22	SA 178A
Rows Deep	115	5	18	64
Rows Wide		11	12	11
Transverse Pitch, (in.)		5	4	5
Longitudinal Pitch, (in.)	4	4	5	4
Fins, (in)	¼" membrane	Bare	Bare	50 Rows Bare 14 Rows Finned

DRUMS

	STEAM DRUM	LOWER DRUM
Diameter (in.)	54	24
Length, seam-seam, (ft.)	38.5	38.5
Thickness, (in.)	1.75	1.00
Material	SA 516 Gr. 70	SA 516 Gr. 70
Manways	Two 14" x 18"	Two 12" x 16"
Corrosion Allowance (in)	1/ 16"	1/816

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Performance Guarantees

The performance of the packaged boiler is guaranteed as detailed below:

Fuel Fired		**Design Gas**
DESCRIPTION	**UNITS**	
System Performance		
Steam Flow	Lb/hr	159,650
Steam Pressure	PSIG	418
Steam Temperature (50-100)	ºF	730-750
Steam Purity	PPM TDS	1.0
HHV System Efficiency	%	83.1
Emissions		
NOx (FGR/NoFGR)	PPMVD 3% O2	40/60
CO	PPMVD 3% O2	65

Notes:

1. System performance guarantees are at 100% MCR only.
2. Emission guarantees are from 25% to 100% MCR.
3. Ambient temperature is 80°F for efficiency calculation.
4. The blowdown rate is as defined in the attached Predicted Operating Performance Tables.
5. Feedwater analysis must meet suggested Water Quality Limits per latest edition of ASME.
6. Boiler performance will be measured by a performance test based upon the principles of ASME PTC 4.1. Testing is to be by others.
7. The steam conditions are at the Rentech terminal points.

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COMMERCIAL INFORMATION

The below pricing is firm:

Description	Alternative	Quantity	Price
Boiler System w/FGR	**Base**	**Two (2)**	**$4,200,000.00**
Mud Drum Heating Coil	**Base**	**Two (2)**	**Included**
Beck Actuators (3 per boiler system)	**Base**	**Two (2)**	**Included**
EyeHye Remote Level Indicator	**Base**	**Two (2)**	**Included**
Steam Coil Air Preheater System (Non-Code, Automatic Controls)	**Base**	**Two (2)**	**Included**
Truck Freight to Mill (all equipment except boiler)	**Option Add**	**Two (2)**	**$ 100,000.00**
Rail Freight of Boiler to Siding in Mill	**Option Add**	**Two (2)**	**$160,000.00**

Terms of Payment

For this order, progress payments in accordance with the following schedule are requested.

% of Contract	Milestone
10%	After Receipt of Purchase Order
10%	Upon submittal of General Arrangement Drawings
10%	Upon receipt of boiler tubes
20%	Upon receipt of drum cylinders
15%	Upon successful shop hydro test
25%	Shipment
10%	Upon startup and acceptance, not to exceed 120 days from delivery of the boiler

Payment Terms: Net 45 from receipt of invoice.

Shipment

The following preliminary schedule is provided. Subject to discussion and possible improvement

Weeks ARO	Milestone
6	Overall General Arrangement
6	Trim and Piping Drawing
6	Foundation Plan with Loads
8	Process and Instrument Drawings
8	Valve and Instrument List
10	Electrical/Controls Drawings
2 ASD	Return of approved drawings

42	Shipment of Equipment (Based on release to purchase long lead materials (drums and tubes) at the time of order placement.

ARO-After Receipt of Order
ASD-After Submittal of Drawings

Terms and Conditions of Sale:

To be finalized. Generally in accordance with the attached "iv. Business Proposal – Terms and Conditions Form"

Technical & Commercial Comments and Clarifications

Item	Reference	Technical Notes and Clarifications

V3EPI DOC Package Boiler Specification Document, dated 04/23/15

Burner & Control Clarifications

- Section B, 3.4.1 – Instruments and valves are rated for -20 deg F. PLC to be provided with panel heater but lowest temperature rating available for the Allen Bradley Panelview HMI is rated for 32 deg F. Rentech recommends installing the control panel in a heated environment. If required, an alternate HMI manufacturer can be provided, suitable for -20 deg F, as a priced adder.

- Section B, 3.4.2 – The specification, including the Unit Specification Sheet, does not list an area classification requirement. The system is suitable for non-hazardous area classification.

- Section v, 4.3 – Control valve sizing to be per manufacturer's recommendation.

- Section v, 4.37 – SIL compliance is unique for each job location and Rentech recommends that others perform a study to establish the SIL requirements and then provide the supporting calculations for the hardware assumed to assure SIL compliance. SIL 3 rated safety relays are not included.

- Panel shock mounts and continuous hinge not included.

- Arc flash study and label is not included. Cost to be advised.

- Note: engineering services associated with the detailed programming of the DCS (if required), factory simulation testing and field start-up are not included in this offering and can be provided on a per diem basis.

- Section v, 7.2 – Rentech will be glad to discuss the security requirements for the control logic, during the contract stage of the project.

Fan Clarifications:

- The reference to oil mist refers to the motors. There was no reference to oil mist lubrication elsewhere. Howden standard offering is grease lubricated bearings. Preparation for oil mist lubrication can be added if required.

- Provision for any overspeed design is not included in base price. Fab test block (margins of 10% & 21%) is at 1780 RPM.
- Foxboro RTDs are not included; RTDs of our standard suppliers included.
- The coupling is a Falk T10 type. The max bore is shown on the data sheet (4"). The specification states that a gear coupling should be used for bores greater than 3 1/2", however gear couplings are not recommended for variable speed operation. If the motor shaft is greater than 3 1/2" then a clarification should be added.

Economizer Clarifications

Provision for sootblower is not included. Unnecessary for clean gas fuel.

Domestic Field Service Rate Sheet - 2015

RENTECH Boiler Systems can provide services of an authorized service representative to inspect, startup, test and provide general instruction of plant personnel. The following rates will apply:

Category	Service Type	Standard Hourly Rate	Description
I	Mechanical Assistance	$155.00 + Expenses	Boiler Assembly & Erection Assistance
II	Boiler Start Up	$205.00 + Expenses	Boiler Start up, Boiler Maintenance, Boiler Operational Training
III	Controls Start up	Consult Factory	Controls configuration, tune up, troubleshooting, Controls training
IV	Engineering Consultation	Consult Factory	
Other	Auxiliary Equipment Vendors	Varies	See note 5, below. Rates and terms for each vendor can be provided on request.

1. Rates are quoted on a time and material basis, and do not include travel or living expenses. The rates above are good thru December 31st, 2015 only.
2. Standard Hourly Rate is defined as time worked from Monday to Friday up to a maximum of 8 hours per day. Time beyond this is considered overtime and will be billed at 1-1/2 times the standard rate. Work performed during the hours of 6:00P.M through 6:00A.M will be billed at 1-1/2 times the standard rate. Any work performed on Saturdays will be billed at 1-1/2 times the standard rate. Any work performed on Sundays or Holidays will be billed at 2 times the standard hourly rate.
3. Travel time will be billed at standard hourly rates. Weekend rates still apply to weekend travel time. Travel time billing will not exceed 8 hrs/day. Days that include both Travel time and Work will be billed up to 8 hours at the regular rate, and OT rates will apply for anything beyond 8 hours.
4. All expenses are billed at cost +15% administration fee.
5. Service from auxiliary equipment vendors (burner, fan, turbine etc.) can be hired thru Rentech upon request. Such service will be billed at the vendor's current rate plus 20%, and will be according to the terms stipulated by that vendor.
6. Rentech may elect to use subcontractors for Boiler mechanical (Category I) or Boiler Startup and Controls (Category II, III). The rates listed above will still apply.
7. Minimum invoice will be 1 working day (8 hr.) + travel time.
8. Standby time is defined as readily available to report to the jobsite. (Such as standing by in the hotel).
9. Daily Timesheets will be provided by all Rentech Field Service Representatives, Subcontractors, and Sub-Vendors. Timesheets will be signed by a designated representative.

10. "Rentech Technical Assistance Terms and Conditions" apply to all Field Service work contracted through Rentech Boiler Systems, Inc.

RENTECH BOILER SYSTEMS, INC. STANDARD TECHNICAL ASSISTANCE TERMS AND CONDITIONS

All Technical Assistance provided by RENTECH Boiler Systems, Inc. (the "Seller") are based upon and conditioned upon the following terms and conditions. No provision, printed or otherwise, contained in any order, acceptance, confirmation or acknowledgment which is inconsistent with, different from or in addition to these Standard Terms and Conditions of Sale is accepted by Seller, unless specifically agreed to in writing by Seller. No order for or changes to any terms or scope of an order for the Seller's Technical Assistance ("Service") shall be binding until accepted in writing by the Seller at its home office at Abilene, Texas.

1. **QUOTATIONS.** Seller's quotations are valid for thirty (30) days from the date of the quotation unless otherwise stated. The latest quotation supersedes all previous quotations or correspondence concerning the transaction. If Service is performed on an hourly basis then the most current Rate Sheet will apply.

2. PRICE. Rates are valid for thirty days from date of initial dispatch of the Service technician. Thereafter rates may be changed by Seller with one week advance written notice.

3. PAYMENT. Unless otherwise stated in writing by Seller, payment of all invoices shall be net 30 days. To the extent permitted by applicable laws, Buyer shall pay on demand, as a late charge, an amount equal to 1.5% per month of each payment which remains overdue or the maximum rate allowed by applicable law. Buyer's failure to make payment when due shall be a material breach of the order and these terms and conditions. The Seller, at its sole option, and without incurring any liability, may suspend its performance until such time as the overdue payment is made or Seller is provided assurances, adequate in Seller's opinion, that the payment shall be promptly made. Payments due hereunder shall in no event be subject to set-off with any other order or business arrangement. Waivers of lien by Seller shall be contingent upon Seller receiving in full all payments due hereunder.

4. **WARRANTY** All Service shall be performed by seller in a workman like manner, consistent typical industry practices. If within 90 days of the performance of service, any service that is found to be deficient, the Seller will correct the deficiency. There are no other warranties, express or implied, except as expressly stated herein. Seller extends no implied warranty of merchantability or fitness for a particular purpose. The seller shall not be responsible for Goods and Services furnished by the Buyer or other third parties, or the costs thereof. Buyer's remedies under this warranty are specifically limited to the correction of any deficient Services performed by Seller and are exclusive of all other remedies.

5. **OBLIGATIONS OF BUYER**. Services rendered by Seller, whether with or without charge, are only technical or advisory in nature and are merely incidental to the sale of any Equipment. When any such services are rendered, Buyer will retain full responsibility for and full control, custody and supervision of the Equipment and the installation, selection of material therefore, use or operation there of, and a representative of Buyer shall be present with full authority to direct operations. If Seller furnishes technical or other advice to Buyer, whether or not at Buyer's request, with respect to Buyer's process or equipment, such advice shall be made in good faith, and Buyer assumes all risk of such advice and the results thereof. Buyer shall provide for free and safe access to the worksite and equipment.

6. **LIMITATION OF LIABILITY**. SELLER'S LIABILITY IS LIMITED TO THE PRICE ALLOCABLE TO THE SERVICE DETERMINED DEFECTIVE, AND IN NO EVENT WILL SELLER'S CUMULATIVE LIABILITY BE IN EXCESS OF THE TOTAL PRICE OF SERVICE, WHETHER ARISING UNDER WARRANTY, CONTRACT, NEGLIGENCE, STRICT LIABILITY, INDEMNIFICATION, OR ANY OTHER CAUSE OR COMBINATION OF CAUSES WHATSOEVER. SELLER AND BUYER WILL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOST PROFIT WHETHER ARISING UNDER WARRANTY, CONTRACT, NEGLIGENCE, STRICT LIABILITY, INDEMNIFICATION, OR ANY OTHER CAUSE OR COMBINATION OF CAUSES WHATSOEVER. THIS LIMITATION SHALL APPLY NOTWITHSTANDING ANY FAILURE OF ESSENTIAL PURPOSE OF ANY LIMITED REMEDY. BUYER'S REMEDIES ARE SPECIFICALLY LIMITED TO THE REPAIR OR REPLACEMENT OF THE DEFECTIVE SERVICE AND ARE EXCLUSIVE OF ALL OTHER REMEDIES. SHOULD THESE REMEDIES BE FOUND INADEQUATE OR TO HAVE FAILED THEIR ESSENTIAL PURPOSE FOR ANY REASON WHATSOEVER, BUYER AGREES THAT RETURN OF THE FULL SALES ORDER PRICE TO IT BY SELLER SHALL PREVENT THE REMEDIES FROM FAILING THEIR ESSENTIAL PURPOSE AND SHALL BE CONSIDERED BY BUYER AS A FAIR AND ADEQUATE REMEDY.

7. **EQUIPMENT SALE**. It is expressly understood that any Equipment furnished by Seller will be addressed in a separate written agreement between the parties. In no event will any such Equipment provided by Seller constitute a waiver by Seller of any of these terms and conditions or affect or expand Seller's obligations under these terms and conditions, this order or any other contractual arrangement.

8. **DURATION**. If, at the request of the Buyer, the service personnel are required to remain on site in excess of five days beyond the original schedule, Seller, at its option, may replace the service personnel with a service personnel of like qualifications and all cost associated with such a replacement will be to the Buyer's account.

9. **INDEMNITY** Seller shall, at its own cost and expense and to the fullest extent allowed by applicable laws, subject to the limit on Seller's liability, defend, indemnify and hold harmless Purchaser, its parent, affiliates, subsidiaries, officers, directors, employees and agents, and their successors and assigns against all damages, losses, costs, claims, strict liability claims, liens, encumbrances, liabilities, and expenses (including attorneys' fees), as and to the extent arising out of or resulting from the negligent acts or omissions of Seller. Purchaser shall, at its own cost and expense and to the fullest extent allowed by applicable laws, subject to the

limits on Purchaser's liability, defend, indemnify and hold harmless Seller, its parent, affiliates, subsidiaries, officers, directors, employees and agents, and their successors and assigns, against all damages, losses, costs, claims, strict liability claims, liens, encumbrances, liabilities, and expenses (including attorneys' fees), as and to the extent arising out of or resulting from the negligent acts or omissions of Purchaser. All liability, losses, damages, costs or expenses resulting from personal injury, including death, loss of or physical damage to property, caused by the joint or concurring acts of Purchaser and Seller, and their respective officers, directors, employees or agents, shall be borne by Purchaser and Seller to the extent each is determined negligent either by agreement of the parties or by a court of competent jurisdiction. The obligations of the parties under this paragraph shall survive the expiration or other termination of this agreement.

10. **SEVERABILITY**. Invalidity of any of these terms and conditions will not affect the validity of any other provision and the remaining provisions will remain in full force and effect.

11. **WAIVER**. Failure to enforce any of these terms and conditions in a particular instance will not constitute a waiver of, or preclude subsequent enforcement of, any of these provisions.

12. **APPLICABLE LAW**. These terms and conditions, this order and the legal relations of the parties shall be determined in accordance with the laws of the State of Texas. The parties consent and will submit to the jurisdiction of the courts of, and of the federal courts seated in, the State of Texas with respect to disputes relating to the order.

Suggested Water Chemistry Limits
Industrial Watertube, High Duty,
Primary Fuel Fired, Drum Type

Makeup water percentage: Up to 100% of feedwater
Conditions: Includes superheater, turbine drives, or process restriction on steam purity
Saturated steam purity target: See tabulated values below.

Drum Operating Pressure (1) (11)	Psig 0-300 (MPa) (0-2.07)	301-450 (2.08-3.10)	451-600 (3.11-4.14)	601-750 (4.15-5.17)	751-900 (5.18-6.21)	901-1000 (6.22-6.89)	1001-1500 (6.90-10.34)	1501-2000 (10.35-13.79)
Feedwater (7)								
Dissolved oxygen ppm (mg/l)O2 - measured before chemical oxygen scavenger addition (8)	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007
Total iron ppm (mg/l) Fe	< 0.1	< 0.05	< 0.03	< 0.025	< 0.02	< 0.02	< 0.01	< 0.01
Total copper ppm (mg/l) Cu	< 0.05	< 0.025	< 0.02	< 0.02	< 0.015	< 0.01	< 0.01	< 0.01
Total hardness ppm (mg/l)*	< 0.3	< 0.3	< 0.2	< 0.2	< 0.1	< 0.05	ND	ND
pH @ 250C	8.3-10.0	8.3-10.0	8.3-10.0	8.3-10.0	8.3-10.0	8.8-9.6	8.8-9.6	8.8-9.6
Chemicals for preboiler system protection	NS	NS	NS	NS	NS	VAM	VAM	VAM
Nonvolatile TOC ppm (mg/l) C (6)	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.2	< 0.2	< 0.2
Oily matter ppm (mg/l)	< 1	< 1	< 0.5	< 0.5	< 0.5	< 0.2	< 0.2	< 0.2
Boiler Water								
Silica ppm (mg/l)	< 150	< 90	< 40	< 30	< 20	< 8	< 2	< 1
Total alkalinity ppm (mg/l)*	< 700(3)	< 600(3)	< 500(3)	< 200(3)	< 150(3)	< 100(3)	< NS(4)	< NS(4)
Free OH alkalinity ppm (mg/l)* (2)	NS	NS	NS	NS	NS	NS	ND(4)	ND(4)
Specific conductance (12) µmhos/cm (µS/cm) 250C without neutralization	5400-1100(5)	4600-900(5)	3800-800(5)	1500-300(5)	1200-200(5)	100-200(5)	< 150	< 80
Total Dissolved Solids in Steam (9)								
TDS (maximum) ppm (mg/l)	1.0-0.2	1.0-0.2	1.0	0.2	0.5-0.1	0.5-0.1	0.1	0.1

* as $CaCO_3$
NS = not specified
ND = not detectable
VAM = Use only volatile alkaline materials upstream of attemperation water source. (10)
Notes to Table:
(1) With local heat fluxes >1.5 x 105 Btu/hr/ft2 (>473.2 kW/m2), use values for at least the next higher pressure range.
(2) Minimum hydroxide alkalinity concentrations in boilers below 900 psig (6.21 MPa) must be individually specified by a qualified water treatment consultant with regard to silica solubility and other components of internal treatment. See section 6.6 of ASME code.
(3) Maximum total alkalinity consistent with acceptable steam purity. If necessary, should override conductance as blowdown control parameter. If makeup is demineralized quality water and boiler operates at less that 1000 psig (6.89 MPa) drum pressure, the boiler water conductance should be that in table for 100-1500 psig (6.9-10.34 MPa) range. In this case, the necessary continuous blowdown will usually keep these parameters below the tabulated maximum values. Alkalinity values in excess of 10% of specific conductance values may cause foaming.
(4) Not detectable in these cases refers to free sodium or potassium hydroxide alkalinity. Some small variable amount of total alkalinity will be present and measurable with the assumed congruent or coordinated phosphate-pH control or volatile treatment employed at these high pressure ranges.
(5) Maximum values are often not achievable without exceeding maximum total alkalinity values, especially in boilers below 900 psig (6.21 MPa) with >20% makeup of water whose total alkalinity is >20% of TDS naturally or after

pretreatment by lime-soda, or sodium cycle ion exchange softening. Actual permissible conductance values to achieve any desired steam purity must be established for each case by careful steam purity measurements. Relationship between conductance and steam purity is affected by too many variables to allow its reduction to a simple list of tabulated values.

(6) Nonvolatile TOC is that organic carbon not intentionally added as part of the water treatment regime. See Section 6.4 of ASME code.

(7) Boilers below 900 psig (6.21 MPa) with large furnaces, large steam release space, and internal chelant, polymer, and/or antifoam treatment can sometimes tolerate higher levels of feed water impurities than those in the table and still achieve adequate deposition control and steam purity. Removal of these impurities by external pretreatment is always a more positive solution. Alternatives must be evaluated as to practicality and economics in each individual case.

(8) Values in the table assume existence of a deaerator.

(9) Achievable steam purity depends on many variables, including boiler water total alkalinity and specific and specific conductance as well as design of boiler steam drum internals and operating conditions [(Note 5)]. Since boilers in this category require a relatively high degree of steam purity for protection of the superheaters and turbines, more stringent steam purity requirements such as process steam restrictions on individual chemical species or restrictions more stringent than 0.1 ppm (mg/l) TDS turbine steam purity must be addressed specifically.

(10) As a general rule, the requirements for attemperation spray water quality are the same as those for steam purity. In some cases boiler feed water is suitable; however, frequently additional purification is required. In all cases the spray water should be obtained from a source that is free of deposit forming and corrosive chemicals such as sodium hydroxide, sodium sulfite, sodium phosphate, iron, and copper. The suggested limits for spray water quality are < 30 ppb (µg/l) TDS maximum, < 10 ppb (µg/l) Na maximum, < 20 ppb (µg/l) SiO_2 maximum, and it should be essentially oxygen free.

(11) Low pressure boilers frequently use feed water that is suitable for use in higher pressure boilers. In these cases the boiler water chemistry limits should be based on the pressure range that is mose consistent with the feed water quality. See Sections 1 and 6.2 of ASME code regarding blowdown.

(12) Conversion from ppm (mg/l) TDS values in the ABMA standards [12] used a factor of 0.65. See Section 6.7 of ASME code.