Boilers

Single Pass
O-Type

RENTECH

Proposal To:

RockTenn
3950 Shackleford Rd.
Duluth, GA 30096
Attn: Mr. David Speidel

For:
RockTenn Uncasville, CT Containerboard Mill
Rentech Proposal No. DFB-DTB-4179-PB-13

Boilers for people who know and care

TO: RockTenn Corp
3950 Shackleford Rd
Duluth, GA 30096

December 16, 2013

ATTN: Mr. David Speidel

Proposal No.: DFB-DTB-4179-PB-13

Based upon your Request for quotation, we are pleased to furnish our proposal for:

ONE (1) 120,000 LB/HR O-STYLE, GAS TURBINE EXHAUST READY, PACKAGED, WATERTUBE BOILER 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 me if you have any questions.

Sincerely,

Paul Brown
Senior Sales Engineer
Rentech Boiler Systems

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 RockTenn Uncasville 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. **Rentech specializes in both fired packaged boilers and turbine exhaust steam generators. By combining these two technologizes, we have offered a boiler that will work optimally under both the original fired case and if the gas turbine is ever added. Rentech's experience and knowledge in this application simply can not be matched.**

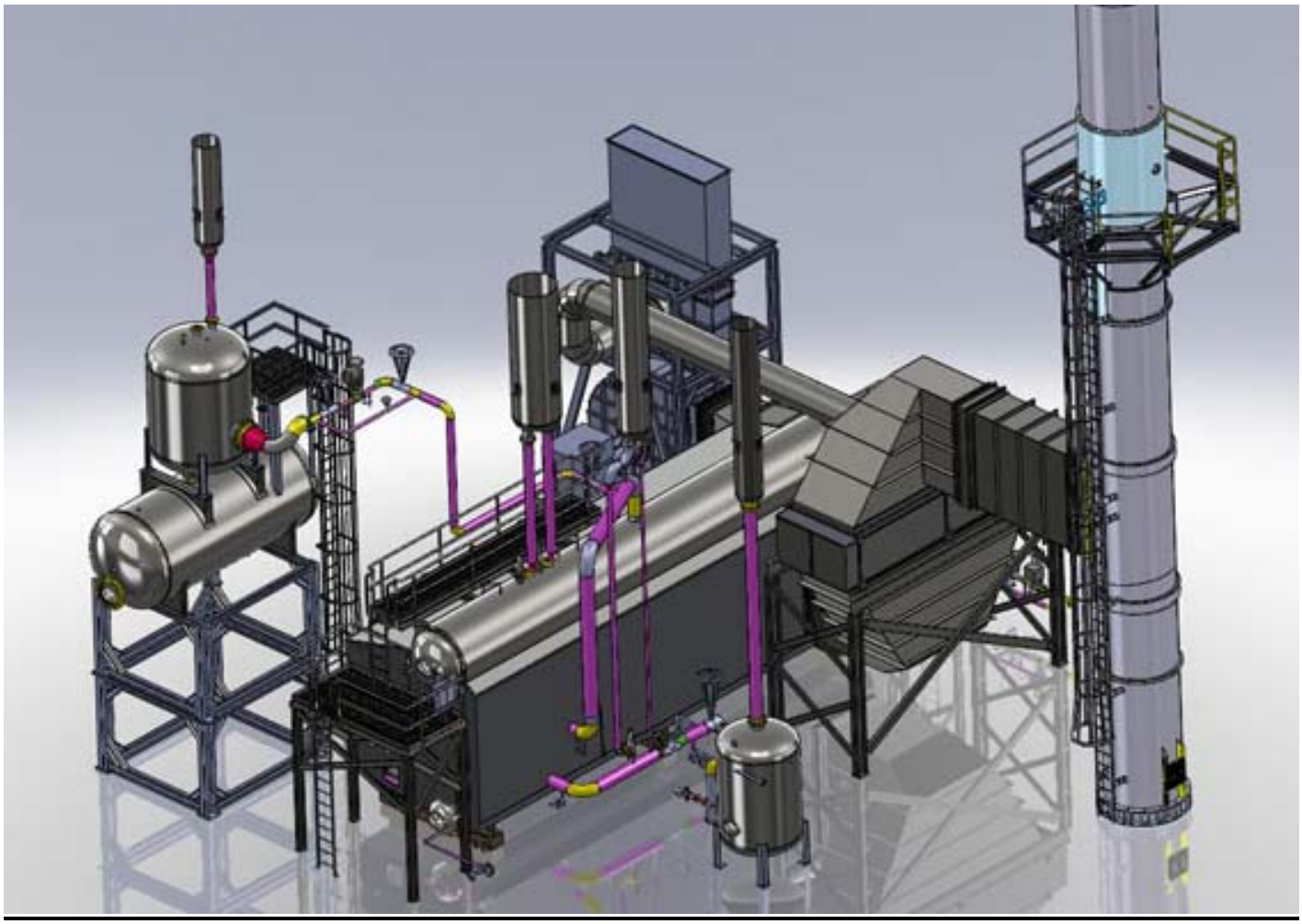
2. We have proposed a boiler with a conservative furnace design as noted in the below discussion regarding furnace heat release rate. This design assures that the equipment will fit your needs, minimize NOx production and provide the longest life expectance possible.

3. 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.

4. 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.

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

5. 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.



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

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			Boiler Pressure parts	X	
			Superheater, single stage with temperature control	X	
X			Boiler Drum internals	X	
	X		Mud Drum heater coil		X
X			Boiler Lagging and insulation	X	
X			Burner windbox	X	
X			Boiler Beam supports	X	
X			Boiler Teflon slide plates		X
X		Economizer	Fully shop assembled unit		X
X			Economizer Pressure parts	X	
X			Economizer Lagging and insulation	X	
X			Economizer Support structure		X
X		Air Ductwork	Inlet silencer up to burner		X
X			Air Inlet silencer		X
N/A			Preheater, coil assembly		N/A
N/A			Preheater, insulation		N/A
X			Fresh air damper		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 (Arrg 7)		X
	N/A		FD Fan casing insulation (acoustical jacket)		N/A
	N/A		Fan VIV with actuator		N/A
X			Fan discharge damper with actuator		X
X			Fan discharge expansion joint		X

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

Package Boiler Scope of Supply and Installation Breakdown					
Supply		**Item**	**Description**	**Installation**	
Rentech	**End User**			**Rentech**	**End User**
X			Fan discharge to windbox duct		X
N/A			Fan discharge duct insulation	N/A	
X			Electric motor for FD fan (200 HP)		X
X			VFD Controller (to be mounted in RockTenn Panel)		X
N/A			Lube oil system		N/A
N/A			Lube oil piping		N/A
X		Flue Gas Ductwork	Boiler outlet expansion joint		X
X			Boiler outlet transition duct		X
X			Boiler outlet transition duct insulation		X
X			Economizer outlet transition duct		X
X			Economizer outlet transition duct insulation		X
X		Stack	60" OD , 50 ft free standing		X
X			Stack personal protection		X
X		FGR ductwork	FGR duct		X
X			FGR damper with actuator		X
X			FGR duct expansion joints		X
	X		FGR duct insulation		X
X		BFW piping	BFW control valve station		X
X			BFW control station - ECO		X
X			BFW ECO - boiler		X
X			DA to control valve station		X
	X		BFW piping insulation		X
X		Steam piping	Boiler outlet to superheater		X

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

Package Boiler Scope of Supply and Installation Breakdown					
Supply		Item	Description	Installation	
Rentech	End User			Rentech	End User
X			Superheater to NRV		X
X			Superheater start up vent		X
X			Superheater startup vent silencer (30% MCR)		X
X			NRV to main steam stop + ASME free blow drain		X
	X		Main steam piping insulation		X
	X		Pegging Steam Piping		X
	X	Mud Drum Heater	Piping from control station to steam coil		X
	X		Mud drum heater 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	X	
X			Burner assembly and throat	X	
X			Fuel skid piping		X
	X		Fuel piping skid to burner		X
	X		Fuel piping insulation (if applicable)		X
N/A		CO Catalyst	CO reduction catalyst		X
N/A			CO Catalyst support	X	
X		Ladders and platforms	Boiler operating platforms		X
N/A			Platform, air preheater		N/A
X			Platform, burner		X
X			Platform, steam drum		X

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

Package Boiler Scope of Supply and Installation Breakdown					
Supply		Item	Description	Installation	
Rentech	End User			Rentech	End User
			length		
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 (if required)		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
	X		Sample line sat steam probe to cooler		X
	X		Sample line CBD line to cooler		X
X		Controls	BMS PLC		X
	X		CCS PLC (Combustion Controls)		X
	X	Deaerator	DA System		X
	X		DA Support Steel		
Per Diem		Installation / Startup	Consultant		
Option		Freight	To site		
	X	Unloading	On site		
X		O&M	English Manuals (3 sets)		
X	X	QA	ASME documentation		

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

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
N/A			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
X			Other fuel conditioning		X

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

Miscellaneous Buyer's Scope of Supply (including but not limited to)					
Supply		**Item**	**Description**	**Installation**	
Buyer				**Rentech**	**End User**
			equipment		
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		Commissionin g	Boiler and piping cleaning/ boilout		X
X			Cleaning/ boilout chemicals		X
X			Chemicals disposal		X
X			Steam blows		X

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

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

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

TECHNICAL DISCUSSION

To meet your process and mechanical requirements, we are pleased to offer One (1) **100% membrane wall construction**, O-Style watertube boiler. Each boiler has been designed for natural gas firing and will have a design pressure of 600 psig. The unit will generate 120,000 lbs/hr of superheated steam at 600 psig and 730ºF, with feedwater supplied at 224°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 ERW** 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 wall. This design avoids the traditional problems that package boilers have had with firebrick and refractory maintenance. Membrane walls will be constructed as 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

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

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 four 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: 9'–0" ; Width: 8'–9"; Length: 26'–0"
Total Heat Input	MMBtu/Hr	169.63
Furnace Volume	Ft^3	1989
Flat Projected Furnace Surface	Ft^2	1042
Volumetric Heat Release Rate	$Btu/Hr\text{-}ft^3$	84,005
Square Foot Heat Release Rate	$Btu/Hr\text{-}ft^2$	160,381
Average Heat Flux	$Btu\text{-}Hr\text{-}ft^2$	38,958
Maximum Heat Flux	$Btu\text{-}Hr\text{-}ft^2$	51,425

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 very depending on unit

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

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 seamless **SA-178A ERW** and 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.

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

DRUMS

The steam drum is **50"** ID and approximately **42'** 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 "V" bank **chevron** to assure that steam leaving the drum contains less than 0.05% moisture 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 an 14"x18" manway with hinged cover. The lower drum is 24" ID and is complete with bottom blowdown connections to allow for the proper intermittent blowdown of solids that accumulate in the bottom of the drums. The lower drum will have a 12"x16"" hinged manway.

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

CONVECTIVE SUPERHEATER

We have proposed a single stage, horizontal tube 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 T11 tubes. Headers for the superheater will be completely outsize the membrane wall of the boiler for easy inspection. Steam temperature will be controlled with a desuperheater down stream of the steam outlet.

ECONOMIZER

A horizontal gas flow, horizontal tube economizer has been included. The tubes are fully drainable. They are described further on the attached Mechanical Data Sheet. The economizer will be complete with galvanized structural support steel.

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

The economizer will be externally insulated with 3" mineral fiber block insulation and covered with corrugated lagging.

COIL DATA:

Manifold:	6" x Sch 80 x SA-106-B material
Tubes:	2.5" OD x 0.105" MW x SA-178 A material
Finning:	4 FPI x 0.75" Ht x 0.05" Thk x Coil Serrated
Bends:	Hot forged
Connections:	
Inlet-	6" 600# RFWN x SA-105 material
Outlet-	6" 600# RFWN x SA-105 material
Vent-	1 pc 1" 3000# sock-o-let x SA-105 material
Drain-	1 pc 1" 3000# sock-o-let x SA-105 material
SRV-	1 pc 1 1/2" 600# RFWN x SA-105 material
Other-	N/A

CONSTRUCTION:

ASME Code(s):	YES	Section I
Canadian Register:	N/A	
PED Certification:	N/A	
DOSH Certification:	N/A	
Casing thickness:	7 ga. x Carbon steel material	
Insulation thickness:	3" thick	
Outer Casing:	Aluminum	
Paint:	SP3, Red Primer & Black finish	

DIMENSIONS & WEIGHTS:

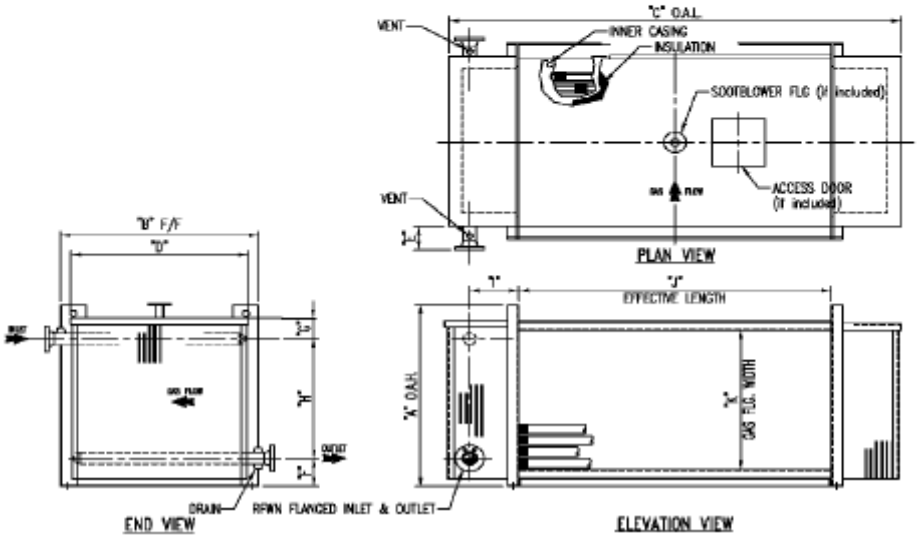
A =	9.47 feet	= Height
B =	5.82 feet	= Width
C =	15.48 feet	= Length
D =	5.49 feet	
E =	1.00	feet
F =	0.8900	feet
G =	0.7200	feet
H =	6.57	ft = C/C Inlet & Outlet connections-Horizontal Headers
I =	1.25	feet
J =	12 feet	= Effective tube length (Duct opening)
K =	6.94 feet	= Casing inside width (Duct opening)
Weight =	26536	pounds Dry
Weight =	31569	pounds Wet

Header orientation (Vertical / Horizontal)= Horizontal Headers Required

IF Horizontal Headers, Same End or Opp End?= Same End Headers Required

0.040" Pebble Grain Corrugated Aluminim Lagging Provided

Headers are Horizontal, but below may not be true in Inlet & Outlet orientation



STACK

A 60" diameter, 50 ft high Corten freestanding stack is offered. Stack will include a galvanized platform and ladder for testing, a set of test and CEMS ports, and personnel protection.

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

Base Stack Is Designed By A Professional Engineer In Accordance With The *ASME STS-1 Steel Stack Standard* And Includes Anchor Chairs, Structural Reinforcement, Test Ports And Instrument Ports As Required, As Well As The Following:		
1.	Stack Height Above Grade	50'-0"
2.	Shell Diameter – TOP	60"
3.	Shell Diameter – BOTTOM	60"
4.	Shell Material	1/4" Min. A-242 / A-588 "Corten" Steel
5.	Breeching Opening(s)	One (±36" Wide x 96" High Each) C.L Elevation. T.B.D.
6.	False Bottom	Yes, With Drain
7.	Access Door	One At Base
8.	Vibration Isolation	Not Required
9.	Ground System	Lugs At Base Per NFPA Requirements
10.	Corrosion Allowance	1/8" *Included* In Calculated Plate Thickness
11.	Inspection And Testing	100% Visual And Spot Radiograph Per ASME STS-1
12.	Windload	120 MPH IBC 2009 / Exposure: C / Importance Factor = 1.00
13.	Seismic Load	Seismic Loads Do Not Control Design
14.	Exterior Surface Coating	A-242 / A-588 "Corten" Self Weathering Steel – No Paint Required
15.	Interior Surface Coating	None

AIR & FLUE GAS DUCTWORK

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

FGR DUCTWORK

FGR ductwork including 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

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

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 drums, excluding the drum heads, and all of the walls of the unit will be insulated with a minimum of 4" mineral fiber insulation and protected with aluminum lagging. The roof of the furnace will be covered with a carbon steel casing to support foot traffic. The steam drum, excluding the heads, will be lagged with corrugated aluminum. The economizer will be insulated with 3" mineral fiber insulation covered with aluminum lagging. Exterior surfaces that will not be insulated will be cleaned in accordance with SSPC-SP6 procedures and painted with one coat of inorganic zinc primer and finish coat. Vendor supplied equipment will receive their standard paint application. Piping components, ductwork interior and surfaces that will be insulated will not be painted.

SPARE PARTS

We have included two sets of Manway gaskets, two water gage glasses, rope gasket material and two observation port lens. 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.

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

BURNER

One (1) 120,000 pounds per hour 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 Coen Division of the John Zink Company, LLC (Coen) is pleased to offer Rentech Boiler Systems, Inc., our pre-engineered, gas only low NOx Variflame burner with windbox, valve trains, and flame scanning equipment.

As options, Coen offers a PLC based burner management system control panel and boiler control system engineering services.

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

In order to meet the NOx requirements, flue gas recirculation, in combination with the low NOx burner, will be required. Flue gas recirculation will be induced into the F. D. fan, premixing with the combustion air upstream of the windbox.

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, 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 Variflame 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

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

heat flux

- Known flame length and diameter, to suit furnace firing lane without impinging on boiler tubes or furnace walls

- Dual air registers provide internal staging of the combustion process to reduce NOx formation

- Combustion air passes through a fixed dual air register design with no moving parts to reduce operator attention

- 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

BURNER DESIGN BASIS & SPECIFICATIONS

A. Burner Design Basis

Boiler Data

Manufacturer	Rentech
Type	O - once through
Design Steam Flow	120,000 lb/hr
Steam Pressure	500 psig (superheated)

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

Steam Temperature	730 deg F
Furnace Dimensions:	
Depth	26 ft
Width	8.5 ft
Height	9 ft
Furnace Operating Pressure including FGR at MCR	10 in wg
Combustion Air Temperature	80 deg F
Flue Gas Temperature	300 deg F

Fuel Data

Fuel Gas	
Type	Natural
High Heat Value	1,000 Btu/scf
Pressure Available	30 – 40 psig
Pressure Required at Coen interface	15 psig (regulated by others)

Burner Management System Design

Insurance Guidelines	NFPA85 for single burner
Type of Operation	Automatic, non-recycling

Miscellaneous Data

Burner Location	Indoors, non-hazardous
Plant Elevation	< 1,000 ft asl
Power Supply Available	120V/1Ph/60Hz
Instrument Air Available	80 psig
Valve Train Construction	NFPA54 (gas)
Surface Preparation and Painting	Manufacturer standard
Quality Control	Manufacturer standard

B. Burner Specifications

Number of Burners per Boiler	One (1)
Gas Firing per Burner	
Heat Input	169.63 mmbtu/hr
Turndown	10 to 1
Pressure at Burner	8 psig
Excess Air at MCR	15%
Recycle Flue Gas Rate at MCR	15%
Draft Loss at MCR	7.5 in wg
Type	Variflame

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

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

COEN'S SCOPE OF SUPPLY

A. Engineering Services

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

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

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 Coen's Instruction Manual.

C. Jobsite Services

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.

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

D. Equipment and Materials

The following is an itemization of all components supplied by 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.

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

   - One (1) dual air register
   - One (1) burner front hub assembly, complete with two (2) observation ports, and two (2) flame scanner swivel mounts
   - One swirling diffuser assembly
   - One (1) gas burner assembly (fixed multiple poker)
   - One (1) ignition assembly complete with gas-electric ignitor, high tension cable and connector and high voltage transformer in a NEMA 4 enclosure
   - 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 4 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 windbox mounted NEMA 4 terminal box. Unless otherwise noted, the interface points with Rentech Boiler Systems, Inc. are at the inlet of the supply manual shut-off

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

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
  2- 3/4" Automatic safety shut-off valves, solenoid type, aluminum body, NPT (Asco)
  1- 3/4" Automatic safety vent valve, solenoid type, aluminum body, NPT (Asco)
  1- High gas pressure switch
  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 (Ashcroft), with isolation valve
  1- Low gas pressure switch
  1- 4" Automatic safety shut-off valve, motor operated, with proof of closure switch, cast iron body, 125# FF (Maxon)
  1- 2" Automatic safety vent valve, solenoid type, aluminum body, NPT (Asco)
  1- 2" Manual vent valve, locked in the open position, brass body, NPT
  1- 4" Automatic safety shut-off valve, motor operated, with proof of closure switch, cast iron body, 125# FF (Maxon)
  1- High gas pressure switch
  2- Leak test connections with isolation valves
  1- Gas flow control valve, vee-ball type, carbon steel body, 150# wafer, with low fire limit switch, pneumatic actuator and I/P positioner (Fisher)

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

1- Burner manual shut-off valve, semi-steel body, 125# FF
1- Burner pressure gauge, 4 in dial, with isolation valve

BMS Control Panel

1. Coen will provide burner management system engineering services consisting of:

   - Detailed sequence of operating description for burner start/shutdown control and operating control, in accordance with NFPA 85, "Boiler and Combustion Systems Hazards Code"

   - Factory acceptance testing

2. One (1) burner management system panel designed to safely fire natural gas.

   - One (1) NEMA 4 enclosure, will house:

     1- Circuit breaker

     1- 24 vdc power supply

     1- Allen Bradley programmable logic system for burner management system relay and timing logic, consisting of the CompactLogix processor, Ethernet communications, EEPROM memory back up, power supply, and input and output modules

     1- External watchdog timer

     1- Alarm horn

     1- Lot of contacts for interfacing with combustion control system: go to purge, go to low fire, released to modulate

   - One (1) Allen Bradley PanelView Plus 1000 Touchscreen Operator Interface with burner management system pushbuttons, status lights, first out annunciation, and flame strength display

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

- One (1) hard-wired control panel display, limited to:

  1-"Emergency Stop" pushbutton

  1-"System Reset" pushbutton

BCS Engineering Services

1. Coen will provide boiler control engineering services, consisting of:

   - Narrative and SAMA diagrams for combustion, FGR, and feedwater control

BURNER PERFORMANCE GUARANTEES

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	30 ppm (0.036 lb/mmbtu)
CO	50 ppm (0.037 lb/mmbtu)
VOC	10 ppm (0.004 lb/mmbtu)
PM/PM10	0.005 lb/mmbtu

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

B. All performance specifications stated throughout this proposal are intended to show probable operating results only which cannot be guaranteed except as expressly stated in the guarantee clause 4.A). Packaged boilers shall be designed and operate with the inboard row of furnace tubes forming a gas tight wall baffle to prevent the short circuiting of furnace gases to the boiler gas outlet, for performance guarantees to be in effect. Emission guarantees exclude background emissions present in the ambient air used for combustion.

C. Testing for performance guarantees shall be run within thirty (30) days

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

after the equipment has been installed and operated. Others shall furnish all operating personnel and equipment for such tests. A Coen trained service engineer shall fine tune the burner as required and observe the operation of auxiliary equipment to assure that performance guarantees will be met, prior to testing. Coen's representative will have access to the records at all times and the tests will be conducted in a manner to ensure that the specified performance conditions are being maintained. Coen will be supplied a complete copy of all test results and data.

D. The equipment shall be considered accepted if tests show that the guarantees have been fulfilled, or if others fail to have the equipment tested within the specified period. In case of the failure to meet the guarantees, Coen reserves the right to change or replace, on a straight time basis, the equipment furnished so that the guaranteed performance will be obtained.

BURNER SCOPE OF SUPPLY BY OTHERS

Others shall be responsible for the receipt, unloading, and installation of the burner and auxiliary equipment furnished by Coen plus the supply and installation of any additional components or materials required for a complete operable installation. Items to be supplied by others shall include but not necessarily be limited to the following:

- Main gas supply pressure regulating valve with strainer and manual supply shut-off valve
- Boiler control panel (for combustion, FGR, and feedwater)
- Purge air piping for flame scanners (approximately 10 scfm of plant air at 8 in wg above windbox pressure)

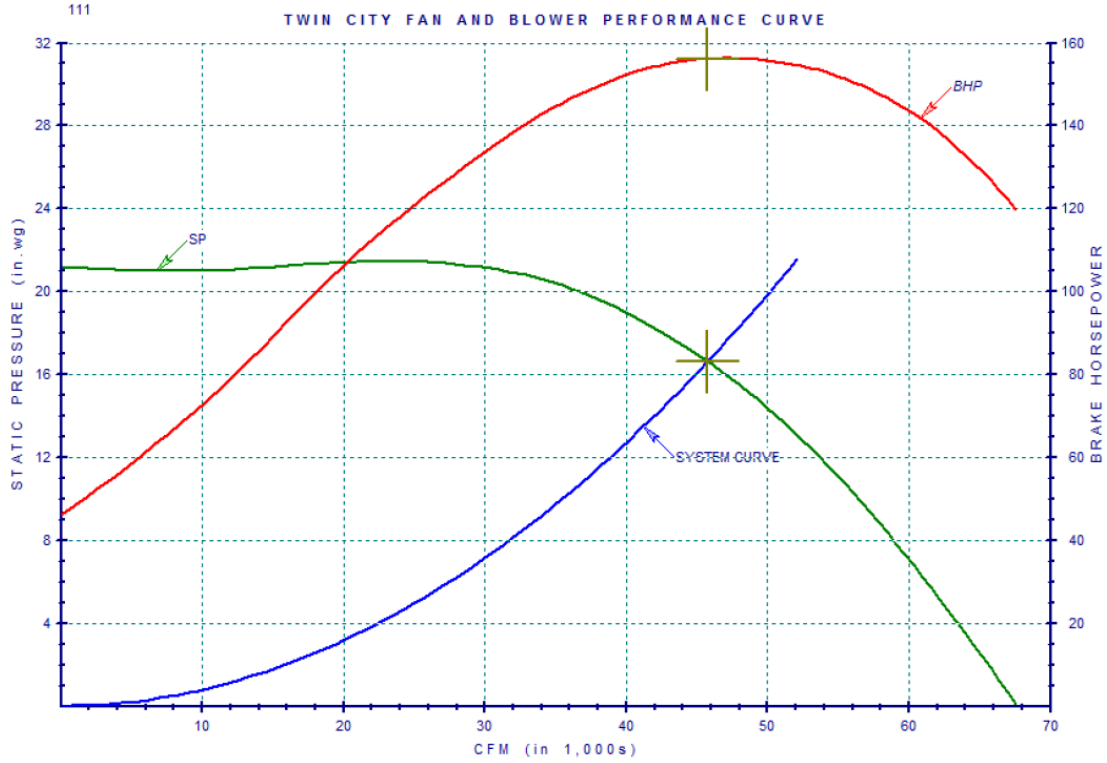
FORCED DRAFT FAN

We have included One (1) Twin City Arrangement 7 FD fan. The FD fan will be complete with outlet damper w/ actuator, inlet silencer with supports, FGR mixing box, and 200 HP inverter duty, GE IEEE 841 motor.

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

Customer: RENTECH	Fan Tag:	CFM: 45,751
Job ID: SQ548-1-13	Model: 445 BCS	SP: 16.6 in.wg
Represented By: Brookside & Lane Associates 816-561-0777		RPM: 1745
		BHP: 156.19
		Outlet Velocity: 4,277
		Density: 0.066

111



Corrected for:
Compressibility
% width: 82%
Inlet Box
Altitude 260
Temperature 132°F

Inlet Sound Power

Octave	Level
1	115
2	109
3	106
4	106
5	106
6	105
7	99
8	92

in db re 10^{-12} watts

12/6/2013
Page: 1 of 1

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

Boiler Trim – Theodore County

Safety Relief Valves

2	Boiler		Drip pan elbows
1	Superheater		Vent stacks
	Economizer		Silencer(s)
	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	
Number of remote indicators	
Number of lights per indicator	
Valves	
Process block	
Drain	
Vent	

Controllers / Analyzers

	Drum level controller		Conductivity analyzer (steam)
	Desuperheater controller	X	Conductivity analyzer (water)
	Desuperheater		PH analyzer (water)
X	O2 Analyzer		

Flow Elements

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

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

Flue gas	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		1			
Burner windbox								
Furnace	1	1						
Convection section								
SH inlet								
SH intermediate								
SH outlet								
Boiler outlet					1			
Economizer inlet								
Economizer outlet	1		1		1			
Water								
Upstream control valve station	1		1					1
Downstream control valve station	1		1		1			
Upstream economizer								
Downstream economizer			1		1			
Steam								
Boiler outlet								
SH Interstage								
SH outlet	1		1		2	1		1
Steam drum	1	4					3	
Continuous blowdown								
SH Tubes					4			

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

PI = Pressure Indicator
PT = Pressure Transmitter
TI = Temperature Indicator
TT = Temperature Transmitter
TC/TW = Thermocouple/Thermowell
PS = Pressure Switch
LT =Level Transmitter
FT = Flow Transmitter

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	2	X	
Economizer block	2		
Economizer by-pass	1		
Steam non-return	1	1	
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	2	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	4	X	
Sootblower steam block	0		
Desuperheater spray water			
Control valve	1		X
Control valve block	2	X	
Control valve by-pass	1	X	
Control valve drain	2	X	
Power operated block	1		X
Stop valve	1	X	
Check valve	1	X	
Boiler drain	0		
Steam sample	2	X	
Water sample	0		

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

PREDICTED PROCESS SUMMARY SHEET
100% MCR, Firing Natural Gas

	FURNACE	SCREEN	SUPERHEATER	CONVECTIVE	ECONOMIZER
GAS SIDE					
Flue Gas Flow Rate, lb/hr	171,221 @ 15% excess air				
Inlet Temperature, °F	Combustion	2219	2037	1648	531
Outlet Temperature, °F	2219	2037	1648	531	275
Pressure Drop, " wc	4.0				
Fouling Factor	0.001				
STEAM SIDE					
Design Pressure, psig	600				700
Operating Pressure, psig	530		500	530	540
Inlet Temperature, °F	321		476	321	224
Outlet Temperature, °F	476		730	476	321
Blowdown, %	3.0				---
Fouling Factor	0.001				0.001
Flow Rate, lb/hr	120,000				123,600
Heating Surface, ft²	1042	398	977	20,612	15,060

Notes:

1. HHV Efficiency: 84.30%
2. Total BTU Input: 169.63 MMBtu/hr

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

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 T11	SA 178A
Rows Deep	78	4	10	24
Rows Wide		18	22	18
Transverse Pitch, (in.)		5.5	4	5.5
Longitudinal Pitch, (in.)	4	4	5	4
Fins, (in)	¼" membrane	Bare	Bare	6 Rows Bare 18 Rows 5 fins/inch 0.75"H x 0.05"T

DRUMS

	STEAM DRUM	HEADERS
Diameter (in.)	50	24
Length, seam-seam, (ft.)	42	42
Thickness, (in.)	2.0	0.75
Material	SA 516 Gr. 70	SA 516 Gr. 70
Manways	14x18	12x16
Corrosion Allowance (in)	1/ 16"	1/16"

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

Performance Guarantees

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

DESCRIPTION	UNITS	
System Performance		
Steam Flow (Gross)	Lb/hr	120,000
Steam Pressure	PSIG	500
Steam Temperature	ºF	730
Fractional Carryover	%	0.05
System Efficiency	%	84.30
Emissions (Natural Gas / No CO Catalyst)		
NOx	Lb/mmbtu	0.036
CO	Lb/mmbtu	0.037

Notes:

1. System performance guarantees are at 100% MCR only.
2. Feedwater temperature to boiler is 224 deg. F
3. Ambient temperature is 80°F.
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.
8. Emission guarantees are from 25% to 100% MCR on a lb/MMBtu bases

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

COMMERCIAL INFORMATION

The price for the supply of equipment, as described above:

Description	Alternate	Quantity	Price
Boiler System	**Base Bid**	**One (1)**	**$1,949,900.00**
To supply rail freight to nearest accessible rail siding	**Alternate #1**	**One (1)**	**$78,800.00**
To supply the proposed boiler with a Coen ultra low NOx burner to achieve a NOx guarantee of 9 PPM	**Alternate #2**	**One (1)**	**Add $137,000.00**

Bid Validity

Pricing is valid for ninety (90) days from the date of this proposal.

Terms of Payment

For this order, progress payments in accordance with the following schedule will be required.

% of Contract	Milestone
10%	Upon receipt of a Purchase Order
10%	Upon approval of GA drawings by Southern Company
20%	Receipt of boiler tubes and drum cylinders in Rentech shop
20%	Upon 50% completion of the total insertion of tubes into the drum
10%	Successful shop hydro
20%	Upon delivery of boilers to Plant Theodore rail siding
10%	Upon startup and acceptance, not to exceed 180 days from boiler delivery

Payment Terms: Net 30 from receipt of invoice.

Shipment

The following preliminary schedule is provided:

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

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

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

Technical & Commercial Comments and Clarifications

Item	Reference	Technical Notes and Clarifications
	Technical Specification	
1.	PB-5, item 3.3.4	Cyclone type separators will not be required for this application.
2.	PB-6, item 3.3.6	We have proposed a 50" diameter drum to help handle possible load swings in the steam demand.
3.	PB-6, item 3.3.9	Boiler outer lagging will be 0.04" pebble grain aluminum.
4.	PB-16, item 3.10	Turbine exaust duct is not currently included in this proposal scope.
5.	PB-17, item 3.14	A CEMS is not currently included in our scope of supply for this proposal.
6.	PB-9, item 3.5.7	Air for flame scanners is assumed to come from plant air supply.
7.	PB-15, item 3.9	We have included a Allen Bradley PLC based Burner Management System and logic documentation for the combustion / feedwater controls. We have spoken with New England Controls and will be glad to work with them to assure that the best system sis provided for RockTenn.
	Burner Specific Comments	
8.	Purchase Specification High Steam Boiler, pages 1-24, Rev 3 - 3.5.1 – The regulated gas pressure at the Coen interface is assumed to be 15 psig (in lieu of 10 psig), in order to provide a standard burner design and the specified 10 to 1 turndown. Lower available gas pressure at the Coen interface while maintaining 10 to 1 turndown can be provided, however, will require an a custom Variflame burner system which can be quoted upon request. - 3.5.4; 3.5.5 – Burner elements that are exposed to high temperature are stainless steel, otherwise are carbon steel. - 3.5.7 – A scanner blower is not included in the Coen scope of supply. Typically plant air is used for scanner cooling. - 3.5.8 – The burner valve trains as offered by Coen are in accordance with NFPA 54 (the National Fuel Gas Code) and uses cast iron body and aluminum body valves. As an option, Coen will upgrade the burner valve trains to be in accordance with ANSI B31.1 code, using steel body valves and maximizing socket welded fittings in lieu of threaded fittings. The optional firm price adder is: SIXTEEN THOUSAND NINE HUNDRED DOLLARS ($16,900.00) - 3.5.8 – The burner valve trains as offered by Coen are mounted on the windbox. As an option, Coen will provide the burner valve trains on a separate valve rack and	

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

wired to a rack mounted NEMA 4 terminal box. The optional firm price adder is: ELEVEN THOUSAND NINE HUNDRED DOLLARS ($11,900.00)

- 3.5.8 – The pressure gauges in the burner valve trains are line mounted. As an option, Coen will provide a gauge panel for the pressure gauges. The optional firm price adder is: TWO THOUSAND FIVE HUNDRED DOLLARS ($2,500.00)

- 3.5.8 – The BMS field devices offered in the Coen scope (main gas train – high pressure, main gas train – low pressure, pilot gas train – high pressure) are pressure switches.

- 3.10.1 – Windbox and burner frontplate are not insulated. It is anticipated when the unit is converted from a boiler to an HRSG, the burner/windbox will be removed.

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

Domestic Field Service Rate Sheet

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	Domestic Standard Hourly Rate	International Standard Hourly Rate	Description
I	Mechanical Assistance	$145.00 + Expenses	$187.50 + Expenses	Boiler Assembly & Erection Assistance
II	Boiler Start Up	$187.50 + Expenses	$250.00 + Expenses	Boiler Start up, Boiler Maintenance, Boiler Operational Training
III	Controls Start up	Consult Factory	Consult Factory	Controls configuration, tune up, troubleshooting, Controls training
IV	Engineering Consultation	Consult Factory	Consult Factory	

Rates are quoted on a time and material basis, not including parts, travel and living expenses or overheads agreed per contract.

Standard Hourly Rate is defined as time worked during Monday thru Friday up to a maximum of 8 Hr/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 (Such as night shift) will be billed at 1-1/2 times the standard rate. Any work performed on Saturday will be billed at 1-1/2 times the standard rate. Any work performed on Sunday or RENTECH's recognized Holidays will be billed at 2 times the standard hourly rate.

Travel time will be billed at standard hour rates. Travel time billing will not exceed 8 hr/day.

Expenses are billed at cost +10% administration fees.

Service from other companies (i.e. burner, fan, turbine etc.) can be hired thru RENTECH at customer's request. Such service will be billed at their current rate plus 15%.

Minimum invoice will be 1 working day (8 hr.) + travel time.

Standby time is defined as readily available to report to the jobsite (Such as standing by in the hotel). When requested, RENTECH will stand by at ½ the applicable rates.

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

Attachment I

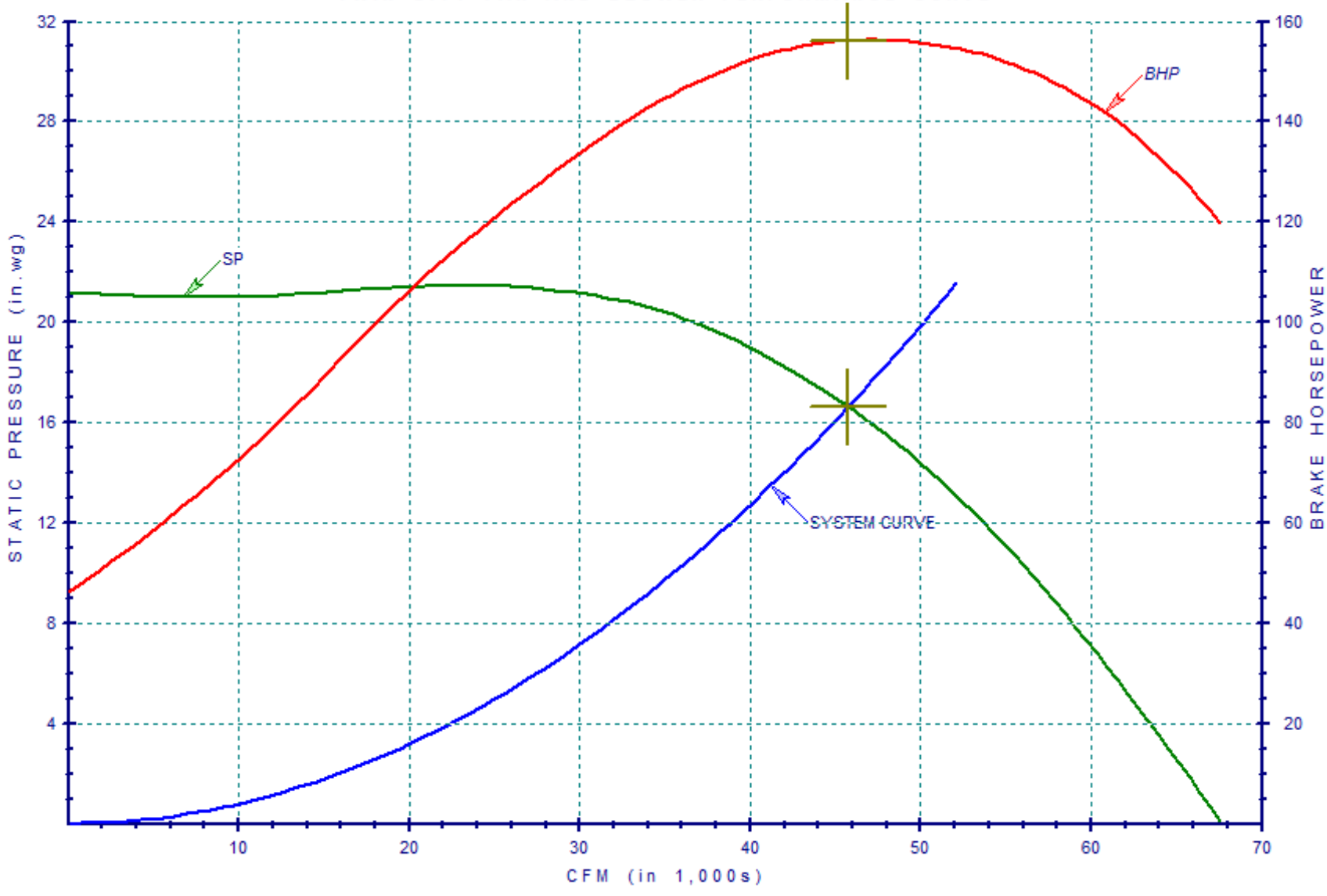
FD Fan Details

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

111

Customer: RENTECH	Fan Tag:	CFM: 45,751
Job ID: SQ548-1-13	Model: 445 BCS	SP: 16.6 in.wg
Represented By: Brookside & Lane Associates 816-561-0777		RPM: 1745
		BHP: 156.19
		Outlet Velocity: 4,277
		Density: 0.066

TWIN CITY FAN AND BLOWER PERFORMANCE CURVE



Corrected for:
Compressibility
% width: 82%
Inlet Box
Altitude 260
Temperature 132°F

Inlet Sound Power

Octave	Level
1	115
2	109
3	106
4	106
5	106
6	105
7	99
8	92

in db re 10^{-12} watts

12/6/2013

Twin City Fan & Blower
A Twin City Fan Company
5959 Trenton Lane · Minneapolis, MN 55442-3238
Phone (763) 551-7600 · Fax (763) 551-7601 · www.tcf.com
ISO 9001 CERTIFIED

Customer: RENTECH
Job Name: RockTenn CT
Job ID: SQ548-1-13

December 06, 2013

Fan Description

Tag	N/A
Quantity	1
Type	BCS
Size	445
Width	SWSI
Arrangement	7SI
Class	22
Rotation	W/A
Discharge	W/A
Wheel diameter (in.)	44.5
Drive method	60 Hz direct drive
Percentage width	82%
Percentage diameter	100%

Fan Performance

CFM	45,751
Operating SP (in.wg)	16.6
Standard SP (in.wg)	18.9
RPM	1745
Tip Speed (fpm)	20,329
Oper. BHP	156.19
Standard BHP	177.22
Outlet area (sq. ft)	10.7
Outlet Velocity (fpm)	4,277
Temperature (°F)	132
Altitude (ft)	260
Density (lb/ft³)	0.066
Max RPM for Class	1859
Static Efficiency	76.57
Total Efficiency	81.19

Motor Data

HP	200
RPM	1800
Voltage	460V
Phase	3
Hz	60
Enclosure	CHEM
Efficiency	Prm.Eff.
Frame	447T

Modifiers

Compressibility, % width: 82%, Inlet Box

Sound

Sound Power Levels in dB re. 10-12 Watts:

Octave Bands	1	2	3	4	5	6	7	8	LwA
Level at Inlet	115	109	106	106	106	105	99	92	111

Estimated sound pressure level in dBA (re: 0.0002 microbar) based on a single* ducted installation:

Distance in ft	1	3	3.3	5	10
dBA at Inlet	114	104	103	100	94

*To estimate dBA level for ducted inlet and ducted outlet (into and out of the room) type installation, deduct 20 from the LwA value shown.

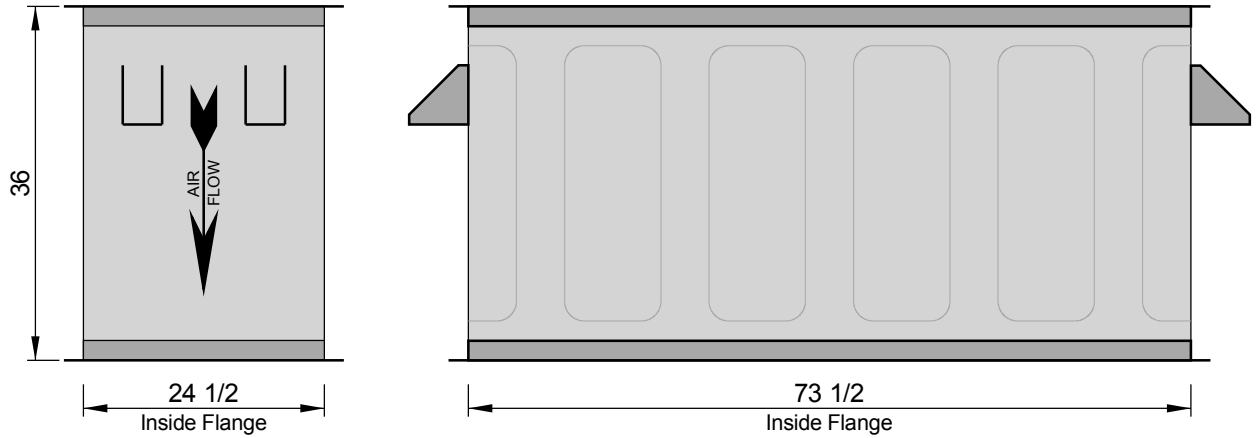
Using a directivity factor of 2.

Estimated Sound Pressure based on free field, hemispherical (Q = 2) radiation at the stated distance.

Definitions:

LwA — The overall (single value) fan sound power level, 'A' weighted.

dBA — The environment for each fan installation influences its measured sound value, therefore dBA levels cannot be guaranteed. Consult AMCA Publication 303 for further details.
A fan's dBA is influenced by nearby reflective surfaces.



Silencer Information

Silencer Tag:	SA-1
Model:	74VRIB-S11
Quantity:	1
Unit Weight:	728 lbs
Pressure Drop:	0.35 in wg

Fan Information

Fan Tag:	FAN-1
Rating:	45751 cfm @ 0.066 lb/ft³
Design Temp:	100 °F
Operating Temp:	132 °F
Width:	Single Width

Noise Criterion

Required:	85 dBA
Position No.:	3 (90° from Silencer Opening)
Distance:	3 ft
Location:	Outdoors

Frequency	63	125	250	500	1k	2k	4k	8k
Fan Lw	118	112	109	109	109	108	102	95
DIL	3	5	8	13	19	16	10	3

Coating System

System:	Standard VAW Primer
Surface Prep:	SP 2
Coat 1:	VAW Standard Primer (1-3 mils)

Silencer Construction

- 11GA Hot Rolled Steel Casing
- Galvanized Internals
- 2in HRS Flange Fan Connection
- 2in HRS Flange Connection
- Acoustic Media with Fiberglass Cloth Media Protection

Accessories

- Vertical Support Brackets

Notes

The silencer selection is based on the input fan sound data provided by the fan manufacturer. It does not take into consideration other factors which may contribute to the over all sound level. This may include noise from the motor, casing, duct, or other equipment. Pressure drop does not take into account system intake or discharge losses. The silencer construction is valid for temperatures equal to or less than 500 °F (260 °C). The coating is valid for temperatures equal to or less than 200 °F (93 °C).

REV	DESCRIPTION	DATE ISSUED	BY	APR. BY
A	FIRST ISSUE	07-Dec-2013	AM	

REVISIONS

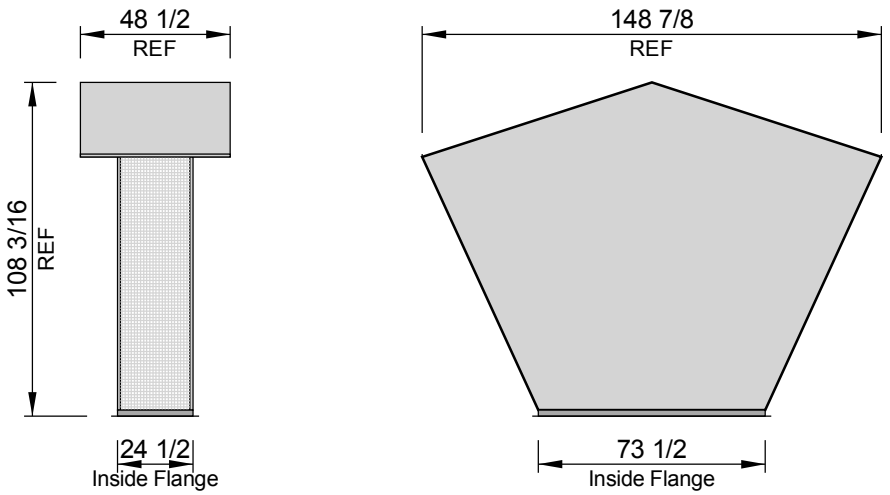
Unless Otherwise Specified:
-Dimensions are in inches.
-Dimensions shown are nominal. For information on manufacturing tolerances contact VAW Systems Ltd.

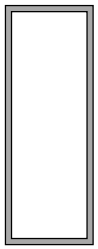
SCALE	NTS
DATE	07-Dec-2013
DWN BY	Andy Muir
MODEL No.	74VRIB-S11

VAW Systems *NOISE CONTROL*
1300 Inkster Boulevard, Winnipeg, Manitoba, Canada www.vawsystems.com

CUSTOMER Brookside and Lane Associates
PROJECT RockTenn CT
DWG TITLE RIB - Rectangular Inlet Silencer

SIZE A | DWG NO. **SQ548-1.13 Silencer** | REV **A** | SHT **1 of 1**





Rain Hood Information

Rain Hood Tag:	RH-1
Model:	VRH1-74x24
Pressure Drop:	0.5 in wg
Quantity:	1
Unit Weight:	1023 lbs

System Information

System Tag:	FAN-1
Connects To:	SA-1 - FAN-1 - 74VRIB-S11
Flow Rate:	45751 cfm

Construction

- HRS 14 Ga
- GALV Perf 18 Ga
- 2in HRS Flange Connection
-

Coating System

System:	Standard VAW Primer
Surface Prep:	SP 2
Coat 1:	VAW Standard Primer (1-3 mils)

Notes

The rain hood construction is valid for temperatures equal to or less than 500 °F (260 °C). The standard coating is valid for temperatures equal to or less than 200 °F (93 °C).

REV	DESCRIPTION	DATE ISSUED	BY	APR. BY
A	FIRST ISSUE	07-Dec-2013	AM	

REVISIONS

Unless Otherwise Specified:
-Dimensions are in inches.
-Dimensions shown are nominal. For information on manufacturing tolerances contact VAW Systems Ltd.

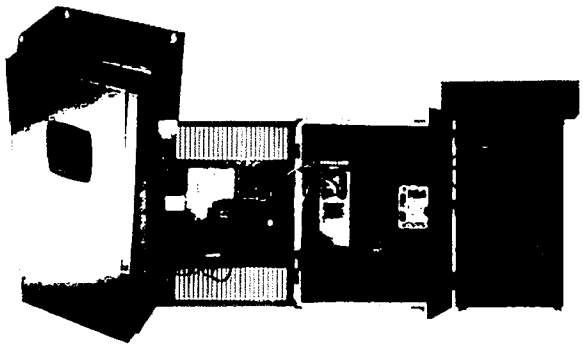
SCALE	NTS
DATE	07-Dec-2013
DWN BY	Andy Muir
MODEL No.	VRH1-74x24

VAW Systems *NOISE CONTROL*
1300 Inkster Boulevard, Winnipeg, Manitoba, Canada www.vawsystems.com

CUSTOMER Brookside and Lane Associates
PROJECT RockTenn CT
DWG TITLE Vertical Acoustic Intake Rain Hood

SIZE A | DWG NO. **SQ548-1.13 Silencer** | REV **A** | SHT **1 of 1**

SVX9000 Drives



Contents

Product Overview

With the SVX9000 Series Sensorless Vector Control, Eaton's expanded Eaton drive offering now covers a complete line of PWM adjustable frequency (speed) drives in ratings from:

- 208V—3/4 to 100 hp I_H; 1 to 100 hp I_L
- 230V—3/4 to 100 hp I_H; 1 to 125 hp I_L
- 480V—1 to 1900 hp I_H; 1-1/2 to 2200 hp I_L
- 575V—2 to 2000 hp I_H; 3 to 2300 hp I_L

The Eaton family of drives includes HVX9000, H-Max, M-Max, SVX9000, SLX9000 and SPX9000. 9000X Series drive ratings are rated for either high overload (I_H) or low overload (I_L). I_L indicates 110% overload capacity for 1 minute out of 10 minutes. I_H indicates 150% overload capacity for 1 minute out of 10 minutes.

A full range of enclosure types and options are available to meet a wide array of applications—from simple variable torque to more complex industrial applications such as conveyors, mixers and machine controls.

Application Description

Application Engineering

Proper selection and application of all drive system components is essential to assure that an adjustable frequency drive system will safely and reliably provide the performance required for any given application. The party responsible for the overall design and operation of the facility must make sure that qualified personnel are employed to select all components of the drive system, including appropriate safety devices. Eaton's AF Drives Application Engineering Department is prepared to provide assistance to answer any questions about the technical capabilities of Eaton drives.

Motor Selection

The basic requirement of motor selection is to match the torque vs. speed capability of the motor to the torque vs. speed requirement of the driven load.

Motor Torque vs. Speed Capability

As the speed of a motor is reduced below its 60 Hz base speed, motor cooling becomes less effective because of the reduced speed of the self-cooling fan. This limitation determines the maximum torque for continuous operation at any operating speed. The maximum intermittent operating torque is determined by the motor's torque vs. current characteristics and the output current capability of the adjustable frequency controller.

Multiple Motor Operation

A number of motors can be connected in parallel to a single controller. Since the frequency of the power supplied by the controller is the same for each motor, the motors will always operate at the same speed. Application Engineering assistance must be requested for all multiple motor applications to assure compliance with all controller design limitations.

Special Types of Motors

Standard NEMA Designs A and B three-phase motors are the only motors recommended for use in the majority of applications, but other types of motors are occasionally used. If the existing motor used in the application or the motor proposed for use with the drive system is a type other than NEMA Design A or B, Application Engineering assistance must be requested to make certain that the drive is properly applied.

Product Selection Guide

Controller Selection

The basic requirement of controller selection is to match the output current, voltage and frequency capabilities of the controller with the requirements of the connected motor.

Output Current

The controller must be selected and applied such that the average operating motor current and horsepower do not exceed the continuous current and horsepower ratings of the controller. The intermittent operating current must not exceed the intermittent current rating of the controller.

Motor Protection

Eaton adjustable frequency drives include electronic motor overload protection circuits that are designed to meet the requirements of NEC article 430-2 provided that only one motor is connected to the output of the controller.

Output Voltage and Frequency

When they are shipped, AF controllers are adjusted to provide a maximum output voltage and frequency equivalent to the input line voltage and frequency. The controllers can be adjusted to operate above line frequency, but a hazard of personal injury or equipment damage may exist when the motor is operated above base speed. Before adjusting the drive to operate above line frequency, make sure that the motor and the driven machinery can safely be operated at the resulting speed.

Features

Controller Features

Operator Control and Interface Requirements

Since there are many possible configurations and many ways of achieving a specific end result, it pays to consider the operator control and interface requirements carefully. A simplified and more economical drive package can often be achieved by selecting from standard product offerings rather than specifying a custom designed configuration.

Installation Compatibility

The successful application of an AC drive requires the assurance that the drive will be compatible with the environment in which it will be installed. In planning the installation, be sure to carefully consider the heat produced by the drive, the altitude and temperature limits and the need for clean cooling air. Other important considerations include acoustical noise, vibration, electromagnetic compatibility, power quality, controller input harmonic current and power distribution equipment requirements.

Auxiliary Equipment and Accessories

Adjustable drives are generally designed to have a motor directly connected to the controller output terminals with no other equipment connected in series or parallel. Motor starters, disconnect switches, surge absorbers, DV/DT suppression circuits, output chokes, output transformers and any other equipment under consideration for installation on the output of the controller should not be installed without first requesting Application Engineering assistance. Power factor correction capacitors must never, under any circumstances, be connected at the output of the controller. They would serve no useful purpose, and they may damage the controller.

Enclosure Definitions

- **NEMA Type 1/IP21**—Enclosures are intended for indoor use primarily to provide a degree of protection against contact with enclosed equipment and provide a degree of protection against a limited amount of falling dirt in locations where unusual service conditions do not exist. Top or side openings in the NEMA Type 1/IP21 enclosure allow for the free exchange of inside and outside air while meeting the UL rod entry and rust resistance design tests.
- **NEMA Type 12/IP54**—Enclosures are intended for indoor use primarily to provide a degree of protection against circulating dust, falling dirt and dripping noncorrosive liquids. To meet UL drip, dust and rust resistance tests, NEMA Type 12/IP54 enclosures have no openings to allow for the exchange of inside and outside air.
- **Chassis IP00**—Similar to Protected Chassis IP20 except power terminals are protected by plastic shielding only. Primarily intended to be mounted inside a surrounding protective enclosure.
- **NEMA Type 3R**—Similar in design to NEMA Type 12/IP54 except with more stringent design and test requirements.

Motor Protection

DV/DT and Peak Motor Voltage Solutions

Today's AFD products offer significantly improved performance, but at the potential cost of motor insulation stress. The fast switching time of the IGBT devices used in newer AFDs can cause a transmission line effect in the output power leads to the motor, leading to possibly damaging voltage levels. To meet this need, NEMA has introduced a motor in MG1, Part 31, which provides an insulation system designed to maintain normal motor life in AFD applications. For existing motors, a motor protection scheme is required for longer cable runs. Eaton offers three standard solutions for existing systems.

- **MotoRx** This solution provides an energy recovery system which clamps the peak motor voltage to a safe level for standard motors. This option is used when the distance between a single motor and the drive is 600 ft or less.
- **Output Line Reactor** This option provides an output line reactor, reducing the DV/DT of the AFD output voltage and lessening the transmission line effect, to lower the peak voltage at the motor terminals.

Product Availability Codes

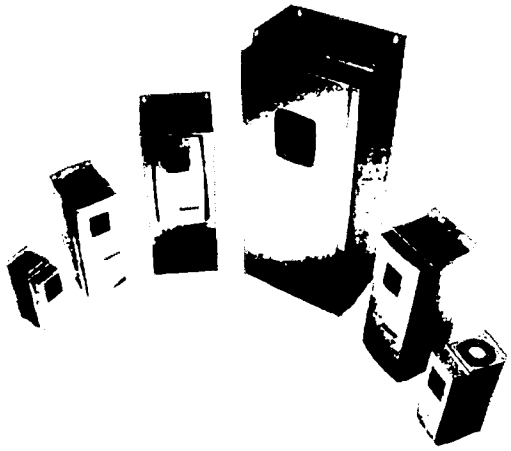
The product availability codes indicate the type of facility (warehouse, Mod Center or factory) that the product will ship from and, if it is not in stock, the number of working days needed to assemble the product from receipt of the order to shipment from the designated facility. Please note that this lead-time does not include any in-transit time from our facility to your facility.

Product Availability Codes

Code	Description
W	Warehouse stocked item. Shipped on customer request date. If item is backordered, please check Vista/VISTALINE or contact your Customer Support Center for product availability.
F1	Factory assemble-to-order. Shipped from factory within 1 working day after receipt of order on Vista.
FA	Factory assemble-to-order. Shipped from factory within 2–3 working days after receipt of order on Vista.
FB	Factory assemble-to-order. Shipped from factory within 4–10 working days after receipt of order on Vista.
FC	Factory assemble-to-order. Shipped from factory within 11–15 working days after receipt of order on Vista.
FD	Factory assemble-to-order. Shipped from factory within 16–20 working days after receipt of order on Vista.
FP	Factory assemble-to-order. Shipped from factory on negotiated promise date.
MA	Mod Center assemble-to-order. Shipped from Mod Center within 1–3 working days after receipt of order on Vista.
MB	Mod Center assemble-to-order. Shipped from Mod Center within 4–10 working days after receipt of order on Vista.
MP	Mod Center assemble-to-order. Shipped from Mod Center on negotiated promise date.

Product availability codes contained herein for a given product may be quantity sensitive and are subject to change without notice. For the most current information, refer to the Product Identification Inquiry (PIN) screen on Vista.

SVX9000 Open Drives



Contents

SVX9000 Open Drives

Product Description

SVX9000 Series Adjustable Frequency Drives from Eaton's Electrical Sector are the next generation of drives specifically engineered for today's commercial and industrial applications. The power unit makes use of the most sophisticated semiconductor technology and a highly modular construction that can be flexibly adapted to the customer's needs.

The input and output configuration (I/O) is designed with modularity in mind. The I/O is compromised of option cards, each with its own input and output configuration. The control module is designed to accept a total of five of these cards. The cards contain not only normal analog and digital inputs but also fieldbus cards.

These drives continue the tradition of robust performance, and raise the bar on features and functionality, ensuring the best solution at the right price.

Features

- Robust design—proven 500,000 hours MTBF
- Integrated 3% line reactors standard on drives from FR4 through FR9
- EMI/RFI Filters H standard up to 200 hp I_H 480V, 100 hp I_H 230V
- Simplified operating menu allows for typical programming changes, while programming mode provides control of everything
- Quick Start Wizard built into the programming of the drive ensures a smooth start-up
- Keypad can display up to three monitored parameters simultaneously
- LOCAL/REMOTE operation from keypad
- Copy/paste function allows transfer of parameter settings from one drive to the next
- Standard NEMA Type 12/ IP54 keypad on all drives
- The SVX can be flexibly adapted to a variety of needs using our pre-installed "Seven in One" precision application programs consisting of:
  - Basic
  - Standard
  - Local/remote
  - Multi step speed control
  - PID control
  - Multi-purpose control
  - Pump and fan control with auto change
- Additional I/O and communication cards provide plug and play functionality
- I/O connections with simple quick connection terminals
- Hand-held auxiliary 24V power supply allows programming/monitoring of control module without applying full power to the drive
- Control logic can be powered from an external auxiliary control panel, internal drive functions and fieldbus if necessary
- Brake chopper standard from: 1–30 hp/380–500V 3/4–15 hp/208–230V
- NEMA Type 1/IP21 and NEMA Type 12/IP54 enclosures available, Frame Sizes FR4–FR9
- Open chassis FR10 and greater
- Standard option board configuration includes an A9 I/O board and an A2 relay output board installed in slots A and B

Standards and Certifications

2

Product
- IEC 61800-2

EMC (At Default Settings)
- Immunity: Fulfills all EMC immunity requirements; Emissions: EN 61800-3, LEVEL H

Safety
- UL 508C
- CE

Catalog Number Selection

SVX9000 Adjustable Frequency Drives

SVX 010 A 1 – 4 A 1 B 1 _ _ _ _ _ _ _

Product Family
SVX = Open drives
SVX = Open drives FR10 and greater

Horsepower Rating

F07 = 3/4 hp	**800** = 800 hp
F15 = 1-1/2 hp	**900** = 900 hp
007 = 7-1/2 hp	**H10** = 1000 hp
010 = 10 hp	**H12** = 1200 hp
050 = 50 hp	**H13** = 1350 hp
125 = 125 hp	**H15** = 1500 hp
350 = 350 hp	**H16** = 1600 hp
700 = 700 hp	**H20** = 2000 hp

AFD Software Series
A = Standard software

Enclosure ③
0 = Chassis
1 = NEMA Type 1/IP21
2 = NEMA Type 12/IP54

Voltage Rating
2 = 230V (208–240)
4 = 480V (380–500)
5 = 575V (525–690)

Keypad
A = Alphanumeric

Input Options ①
1 = Three-phase, EMC H
2 = Three-phase, EMC N
4 = Three-phase, EMC L

Brake Chopper Options ②
N = No brake chopper circuit
B = Internal brake chopper circuit

Board Modifications
1 = Standard boards
2 = Conformal (varnished) coating ④

Options
Options appear in alphabetical order.

Extended I/O Card Options
B1 = 6 DI, 1 ext +24 Vdc/EXT +24 Vdc
B2 = 1 RO (NC-NO), 1 RO (NO), 1 therm
B4 = 1 AI (mA isolated), 2 AO (mA isolated), 1 ext +24 Vdc/EXT + 24 Vdc
B5 = 3 RO (NO)
B8 = 1 ext +24 Vdc/EXT +24 Vdc, 3 Pt100
B9 = 1 RO (NO), 5 DI 42–240 Vac input

Communication Cards
CA = Johnson Controls N2
CI = Modbus TCP
CJ = BACnet
CQ = EtherNet/IP
C2 = Modbus
C3 = PROFIBUS DP
C4 = LonWorks
C5 = PROFIBUS DP (D9 connector)
C6 = CANopen (slave)
C7 = DeviceNet
C8 = Modbus (D9 Type connector)
D3 = RS-232 with D9 connection

Power Module

FR10 – 0000 – 4 – A N V

Frame Code

Amperage
0170 = 170A

Voltage
4 = 380–500V
5 = 525–690V

Cooling Type
A = Air

Brake Option
N = No brake chopper
B = Brake chopper

Varnishing
V = Varnished

Notes

① All 230V drives and 480V drives up to 200 hp (IH) are only available with input option **1** (EMC Level H). 480V drives 250 hp (IH) or larger are available with input option **2** (EMC Level N). 480V drives are available with input option **4** (EMC Level L). 575V drives 200 hp (IH) or larger are only available with input option **2**. 575V drives up to 150 hp (IH) are only available with input option **4** (EMC Level L).

② 480V drives up to 30 hp (IH) are only available with brake chopper option **B**. 480V drives 40 hp (IH) or larger come standard with brake chopper option **N**. 230V drives up to 15 hp (IH) are only available with brake chopper option **B**. 230V drives 20 hp or larger come standard with brake chopper option **N**. All 575V drives come standard without brake chopper option (N). **N** = **No** brake chopper.

③ 480V drives 250 hp (I_H) and larger are available with enclosure style **0** (chassis); 690V drives 200 hp (I_H) and larger are available with enclosure style **0** (chassis).

④ Factory promise delivery. Consult sales office for availability.

SVX9000 Open Drives

380–500V, Open Chassis Drives

Frame Size	Delivery Code	hp (I_H)	Current (I_H)	hp (I_L)	Current (I_L)	Catalog Number
FR10 ①	W	250	330	300	385	**SPX250A0-4A2N1**
		300	385	350	460	**SPX300A0-4A2N1**
		350	460	400	520	**SPX350A0-4A2N1**
FR11	W	400	520	500	590	**SPX400A0-4A2N1**
		500	590	—	650	**SPX500A0-4A2N1**
		—	650	600	730	**SPX550A0-4A2N1**
FR12	FP	600	730	—	820	**SPX600A0-4A2N1**
	W	—	820	700	920	**SPX650A0-4A2N1**
	FP	700	920	800	1030	**SPX700A0-4A2N1**
FR13	FP	800	1030	900	1150	**SPX800A0-4A2N1**
		900	1150	1000	1300	**SPX900A0-4A2N1**
		1000	1300	1200	1450	**SPXH10A0-4A2N1**
FR14	FP	1200	1600	1500	1770	**SPXH12A0-4A2N1**
		1600	1940	1800	2150	**SPXH16A0-4A2N1**
		1900	2300	2200	2700	**SPXH19A0-4A2N1**

575V SVX9000 Drives

525–690V, NEMA Type 1/IP21 Drives

Frame Size	Delivery Code	hp (I_H)	Current (I_H)	hp (I_L)	Current (I_L)	Catalog Number
FR6	W	2	3.3	3	4.5	**SVX002A1-5A4N1**
		3	4.5	—	5.5	**SVX003A1-5A4N1**
		—	5.5	5	7.5	**SVX004A1-5A4N1**
		5	7.5	7-1/2	10	**SVX005A1-5A4N1**
		7-1/2	10	10	13.5	**SVX007A1-5A4N1**
		10	13.5	15	18	**SVX010A1-5A4N1**
		15	18	20	22	**SVX015A1-5A4N1**
		20	22	25	27	**SVX020A1-5A4N1**
		25	27	30	34	**SVX025A1-5A4N1**
FR7	W	30	34	40	41	**SVX030A1-5A4N1**
		40	41	50	52	**SVX040A1-5A4N1**
FR8	W	50	52	60	62	**SVX050A1-5A4N1**
		60	62	75	80	**SVX060A1-5A4N1**
		75	80	100	100	**SVX075A1-5A4N1**
FR9	W	100	100	125	125	**SVX100A1-5A4N1**
		125	125	150	144	**SVX125A1-5A4N1**
		150	144	—	170	**SVX150A1-5A4N1**
		—	170	200	208	**SVX175A1-5A4N1**

Note

① FR10–FR14 includes 3% line reactor, but it is not integral to chassis.

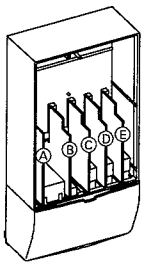
Options

9000X Series Option Board Kits

The 9000X Series drives can accommodate a wide selection of expander and adapter option boards to customize the drive for your application needs. The drive's control unit is designed to accept a total of five option boards.

The 9000X Series factory installed standard board configuration includes an A9 I/O board and an A2 relay output board, which are installed in slots A and B.

Option Boards



Option Board Kits

Option Kit Description ①	Allowed Slot Locations ②	Field Installed Catalog Number	Factory Installed Option Designator	SVX Ready Programs Basic	Local/ Remote	Standard	MSS	PID	Multi-P.	PFC
Standard I/O Cards										
2 RO (NC-NO)	B	**OPTA2**	—	■	■	■	■	■	■	■
6 DI, 1 DO, 2 AI, 1AO, 1 +10 Vdc ref, 2 ext +24 Vdc/EXT +24 Vdc	A	**OPTA9**	—	■	■	■	■	■	■	■
Extended I/O Cards										
2 RO, therm—SPX only	B	**OPTA3**	**A3**	—	■	■	■	■	■	■
Encoder low volt +5V/15V/24V—SPX only	C	**OPTA4**	**A4**	—	■	■	■	■	■	■
Encoder high volt +15V/24V—SPX only	C	**OPTA5**	**A5**	—	■	■	■	■	■	■
Double encoder—SPX only	C	**OPTA7**	**A7**	■	■	■	■	■	■	■
6 DI, 1 DO, 2 AI, 1 AO—SPX only	A	**OPTA8**	**A8**	—	■	■	■	■	■	■
3 DI (encoder 10–24V), out +15V/+24V, 2 DO (pulse+direction)—SPX only	C	**OPTAE**	**AE**	■	■	■	■	■	■	■
6 DI, 1 ext +24 Vdc/EXT +24 Vdc	B, C, **D**, E	**OPTB1**	**B1**	—	—	—	—	—	■	■
1 RO (NC-NO), 1 RO (NO), 1 therm	B, C, **D**, E	**OPTB2**	**B2**	—	—	—	—	—	■	■
1 AI (mA isolated), 2 AO (mA isolated), 1 ext +24 Vdc/EXT +24 Vdc	B, C, **D**, E	**OPTB4**	**B4**	■	■	■	■	■	■	■
3 RO (NO)	B, C, **D**, E	**OPTB5**	**B5**	—	—	—	—	—	■	■
1 ext +24 Vdc/EXT +24 Vdc, 3 Pt100	B, C, **D**, E	**OPTB8**	**B8**	—	—	—	—	—	—	—
1 RO (NO), 5 DI 42–240 Vac input	B, C, **D**, E	**OPTB9**	**B9**	—	—	—	—	—	■	■
Communication Cards										
Modbus ③	D, **E**	**OPTC2**	**C2**	■	■	■	■	■	■	■
Johnson Controls N2 ③	D, **E**	**OPTC2**	**CA**	—	—	—	—	—	—	—
Modbus TCP	D, **E**	**OPTCI**	**CI**	■	■	■	■	■	■	■
BACnet	D, **E**	**OPTCJ**	**CJ**	■	■	■	■	■	■	■
EtherNet/IP	D, **E**	**OPTCQ**	**CQ**	■	■	■	■	■	■	■
PROFIBUS DP	D, **E**	**OPTC3**	**C3**	■	■	■	■	■	■	■
LonWorks	D, **E**	**OPTC4**	**C4**	■	■	■	■	■	■	■
PROFIBUS DP (D9 connector)	D, **E**	**OPTC5**	**C5**	■	■	■	■	■	■	■
CANopen (slave) ④	D, **E**	**OPTC6**	**C6**	■	■	■	■	■	■	■
DeviceNet	D, **E**	**OPTC7**	**C7**	■	■	■	■	■	■	■
Modbus (D9 type connector)	D, **E**	**OPTC8**	**C8**	■	■	■	■	■	■	■
Adapter—SPX only	D, **E**	**OPTD1**	**D1**	■	■	■	■	■	■	■
Adapter—SPX only	D, **E**	**OPTD2**	**D2**	■	■	■	■	■	■	■
RS-232 with D9 connection	D, **E**	**OPTD3**	**D3**	■	■	■	■	■	■	■
Keypad										
9000X Series local/remote keypad (replacement keypad)	—	**KEYPAD-LOC/REM**	—	—	—	—	—	—	—	—
9000X Series remote mount keypad unit (keypad not included, includes 10 ft cable, keypad holder, mounting hardware)	—	**OPTRMT-KIT-9000X**	—	—	—	—	—	—	—	—
9000X Series RS-232 cable, 13 ft	—	**PP00104**	—	—	—	—	—	—	—	—

Notes

① AI = Analog Input; AO = Analog Output, DI = Digital Input, DO = Digital Output, RO = Relay Output

② Option card must be installed in one of the slots listed for that card. Slot indicated in bold is the preferred location.

③ OPTC2 is a multi-protocol option card.

④ SPX9000 drives only (FR10 and larger).

Modbus RTU Network Communications

The Modbus Network Card OPTC2 is used for connecting the 9000X Drive as a slave on a Modbus network. The interface is connected by a 9-pin DSUB connector (female) and the baud rate ranges from 300 to 19200 baud. Other communication parameters include an address range from 1 to 247; a parity of None, Odd or Even; and the stop bit is 1.

PROFIBUS Network Communications

The PROFIBUS Network Card OPTC3 is used for connecting the 9000X Drive as a slave on a PROFIBUS-DP network. The interface is connected by a 9-pin DSUB connector (female). The baud rates range from 9.6K baud to 12M baud, and the addresses range from 1 to 127.

LonWorks Network Communications

The LonWorks Network Card OPTC4 is used for connecting the 9000X Drive on a LonWorks network. This interface uses Standard Network Variable Types (SNVT) as data types. The channel connection is achieved using a FTT-10A Free Topology transceiver via a single twisted transfer cable. The communication speed with LonWorks is 78 kBits/s.

CANopen (Slave) Communications

The CANopen (Slave) Network Card OPTC6 is used for connecting the 9000X Drive to a host system. According to ISO11898 standard cables to be chosen for CAN bus should have a nominal impedance of 120 ohms, and specific line delay of nominal 5 nS/m. 120 ohms line termination resistors required for installation.

DeviceNet Network Communications

The DeviceNet Network Card OPTC7 is used for connecting the 9000X Drive on a DeviceNet Network. It includes a 5.08 mm pluggable connector. Transfer method is via CAN using a two-wire twisted shielded cable with two-wire bus power cable and drain. The baud rates used for communication include 125K baud, 250K baud and 500K baud.

Johnson Controls Metasys N2 Network Communications

The OPTC2 fieldbus board provides communication between the 9000X Drive and a Johnson Controls Metasys™ N2 network. With this connection, the drive can be controlled, monitored and programmed from the Metasys system. The N2 fieldbus is available as a factory installed option and as a field installable kit.

Modbus/TCP Network Communications

The Modbus/TCP Network Card OPTCI is used for connecting the 9000X Drive to Ethernet networks utilizing Modbus protocol. It includes an RJ-45 pluggable connector. This interface provides a selection of standard and custom register values to communicate drive parameters. The board supports 10 Mbps and 100 Mbps communication speeds. The IP address of the board is configurable over Ethernet using a supplied software tool.

BACnet Network Communications

The BACnet Network Card OPTCJ is used for connecting the 9000X Drive to BACnet networks. It includes a 5.08 mm pluggable connector. Data transfer is Master-Slave/ Token Passing (MS/TP) RS-485. This interface uses a collection of 30 Binary Value Objects (BVOs) and 35 Analog Value Objects (AVOs) to communicate drive parameters. The card supports 9.6, 19.2 and 38.4 Kbaud communication speeds and supports network addresses 1–127.

EtherNet/IP Network Communications

The EtherNet/IP Network Card OPTCK is used for connecting the 9000X Drive to Ethernet/Industrial Protocol networks. It includes an RJ-45 pluggable connector. The interface uses CIP objects to communicate drive parameters (CIP is "Common Industrial Protocol", the same protocol used by DeviceNet). The board supports 10 Mbps and 100 Mbps communication speeds. The IP address of the board is configurable by Static, BOOTP and DHCP methods.

Control Panel Options

2

Factory Options

Description	Factory Installed Option Code	Field Installed NEMA Type 1/IP21 Catalog Number
Local/Remote Keypad SVX9000 Control Panel—This option is standard on all drives and consists of an RS-232 connection, backlit alphanumeric LCD display with nine indicators for the RUN status and two indicators for the control source. The nine pushbuttons on the panel are used for panel programming and monitoring of all SVX9000 parameters. The panel is detachable and isolated from the input line potential. Include LOC/REM key to choose control location.	**A**	**KEYPAD-LOC/REM**
Keypad Remote Mounting Kit—This option is used to remote mount the SVX9000 keypad. The footprint is compatible to the SV9000 remote mount kit. Includes 10 ft cable, keypad holder and mounting hardware.	—	**OPTRMT-KIT-9000X**

Miscellaneous Options

Description	Catalog Number
9000XDrive—A PC-based tool for controlling and monitoring of the SVX9000. Features include: loading parameters that can be saved to a file or printed, setting references, starting and stopping the motor, monitoring signals in graphical or text form, and real-time display. To avoid damage to the drive or computer, SVDrivecable must be used.	**9000XDRIVE**
SVDrivecable—6 ft (1.8m) RS-232 cable (22 gauge) with a 7-pin connector on each end. Should be used in conjunction with the 9000XDrive option to avoid damage to the SVX9000 or computer. The same cable can be used for downloading specialized applications to the drive.	**SVDRIVECABLE**
External Dynamic Braking Resistors—Used with the dynamic braking chopper circuit to absorb motor regenerative energy for stopping the load and to dissipate the energy flowing back into the drive. Resistors are separated into standard duty and heavy-duty. Standard duty is defined as 20% duty or less with 100% braking torque, while heavy-duty is defined as 50% duty or less with 150% braking torque.	①

Open Drive Options

Brake Chopper Options

The brake chopper circuit option is used for applications that require dynamic braking. Dynamic braking resistors are not included with drive purchase. Consult the factory for dynamic braking resistors which are supplied separately. Resistors are not UL Listed.

For brake chopper circuit selection and adder—NEMA Type 1/IP21, NEMA Type 12/IP54, Chassis, consult the factory. Delivery code is FP.

Conformal (Varnished) Coating ②

Chassis Frame	Delivery Code
FR4	FP
FR5	FP
FR6	FP
FR7	FP
FR8	FP
FR9	FP
FR10	FP
FR11	FP
FR12	FP
FR13	FP
FR14	FP

Conformal Coated Board Kits ③

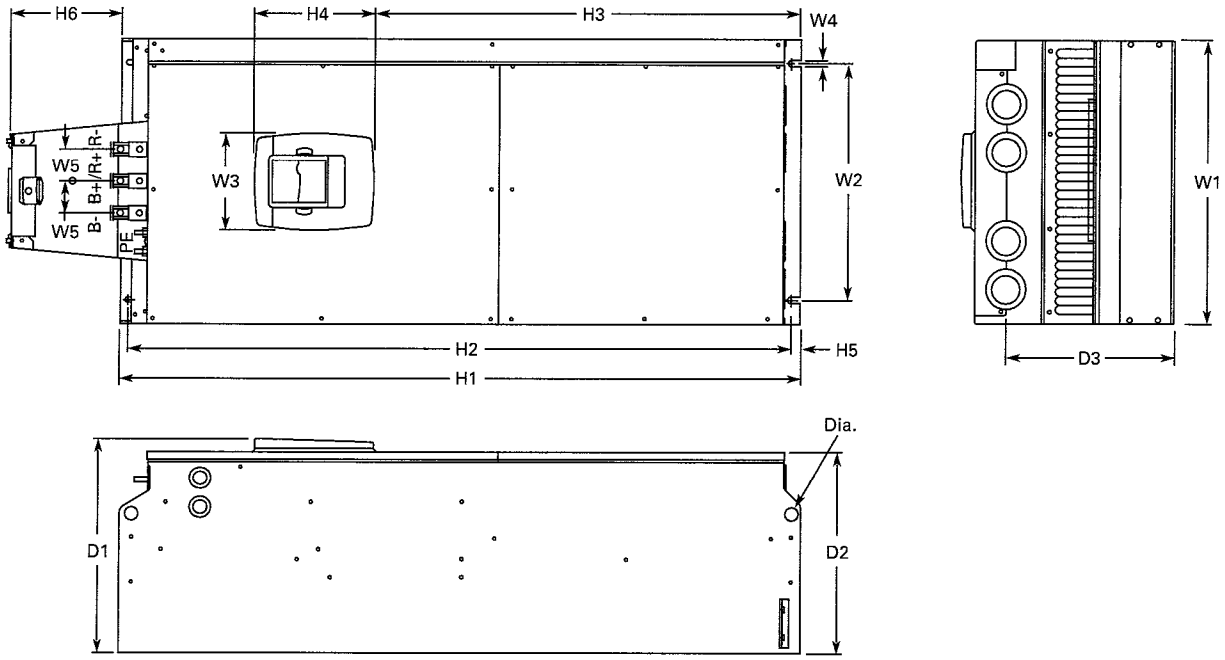
Field Installed Catalog Number	Factory Installed Option Designator
OPT_V ④	⑤

Notes

① Consult factory.
② See Product Selection on **Pages V6-T2-33** to **V6-T2-36**, 208–240V, 380–500V, 525–690V. Consult the factory for adder.
③ See option catalog numbers on **Page V6-T2-38**.
④ Replace "__" with the correct catalog number from **Page V6-T2-38**. Example: OPT**C2**V.
⑤ Construct catalog numbers for factory installed per Catalog Number Selection on **Page V6-T2-32**.

Approximate Dimensions in Inches (mm)

NEMA Type 1/IP21 and NEMA Type 12/IP54 FR9



W1	W2	W3	W4	W5	H1	H2	H3	H4	H5	H6 ①	D1	D2	D3	Dia.	Weight Lbs (kg)
18.9 (480)	15.7 (400)	6.5 (165)	0.4 (9)	2.1 (54)	45.3 (1150)	44.1 (1120)	28.3 (721)	8.0 (205)	0.6 (16)	7.4 (188)	14.2 (361.5)	13.4 (340)	11.2 (285)	0.8 (21)	321.9 (146)

Note

① Brake resistor terminal box (H6) included when brake chopper ordered.