UNIVERSITY OF WYOMING

West Campus Satellite Energy Plant

Heating and Cooling Analysis

Supplemental Data

February 28, 2017

GLHN

Architects & Engineers Inc.

In Association with

Henneman Engineering Inc

COFFEY ENGINEERING & SURVEYING

Proj No.: 16051.00 | 2939 E. Broadway Blvd. Tucson, Az. 85716

UNIVERSITY OF WYOMING

Supporting Documentation

(Separate Volume)

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(No added information)

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SD-II-2 ID Fan Drawing
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SD-V-10 Specifications TOC

Clarage
A Twin City Fan Company
5959 Trenton Lane N | Minneapolis, MN 55442
Phone: 763.551.7600 | Fax: 763.551.7601

SD-II-1 FAN IDFanQuotation

TO: Henneman
Attn: Paul Boland
DATE: 10/28/2016
REF: CM-2696
QUOTE No.: 21042ML16

We are pleased to offer the attached pricing and construction for the following Clarage equipment.

This proposal is good for 30 days from date above for placement of order.

Pricing is based on equipment being ordered within the above time frame. Shipping terms are. FCA - Point of Manufacture Pulaski TN for fans & supplier's works for buy outs per INCOTERMS 2010. No freight is included unless otherwise stated in this proposal. Export boxing if required is by others unless otherwise stated in this proposal. All products are subject to a weekly storage fee of $0.025/pound starting 5 business days after notification of readiness to ship.

Pricing is in accordance with Clarage Terms and Conditions of Sale & Performance and Equipment Warranty.

Lead Time: 10 to 12 weeks

Delivery dates above are subject to change pending motor and other vendor lead times.

Terms: Net 30 on approved credit

Scope of equipment supply and Pricing is as listed in the following pages.

We trust this information is complete. Should you require additional information, contact under signed at:

Michael Lowe
Clarage – Aftermarket Solutions
Sales / Application Engineer – Clarage Aftermarket Solutions
202 Commerce Way | Pulaski, TN 38449
Direct: 931.424.2510
Web: clarage.com | Email: mlowe@clarage.com

Clarage
A Twin City Fan Company
5959 Trenton Lane N | Minneapolis, MN 55442
Phone: 763.551.7600 | Fax: 763.551.7601

Budgetary Proposal

RE: SN 2696-CM-5
1 Model 132XLR Series 1250, Fan, Replacement for SN 2696CM-5
Per Drawing U-24456-5
And With 150HP 3/60/460Volt, 1200 rpm, TEFC Motor, and Dodge Paraflex coupling
$158,695.00

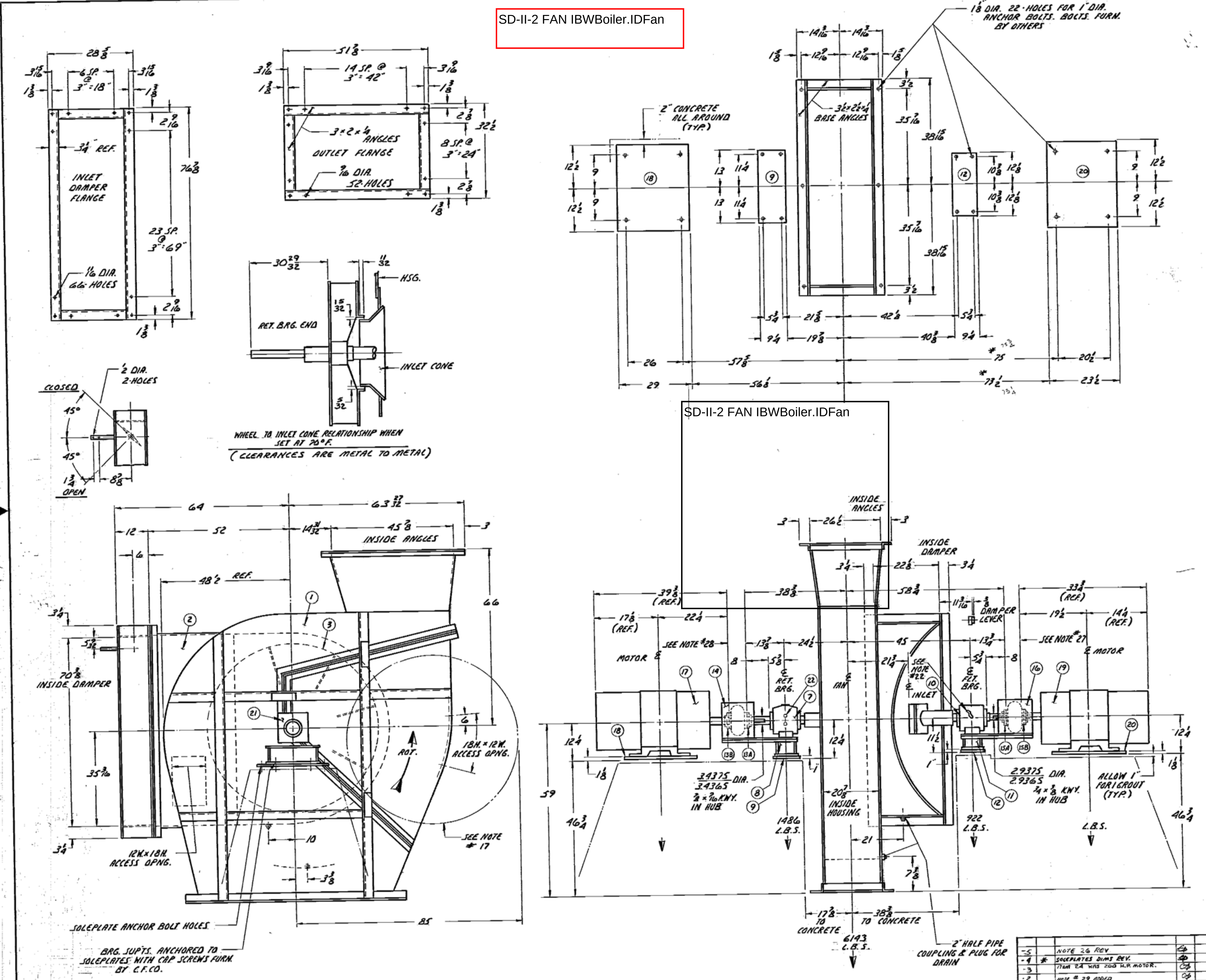
Lead time: 10 to 12 weeks

Michael Lowe

Clarage –Aftermarket Solutions
Sales / Application Engineer
202 Commerce Way | Pulaski, TN 38449
Direct: 931.424.2510
Web: clarage.com | Email: mlowe@clarage.com

SD-II-2 FAN IBWBoiler.IDFan

WHEATON BLUEPRINT & SUPPLY CO.



PERFORMANCE DATA								
CONDITION	#/HR.	CFM	SP	RPM	BHP	TEMP	DENSITY	
	91,733	44,387	16.32	1181	166	375°F.	0.0344	

FAN SOUND POWER LEVEL								
OCTAVE BAND	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-
DB-RE (10-12) WATTS	122	119	112	106	102	99	98	93

– IMPORTANT –

1. CLARAGE FAN CO. FURNISHES ONLY THAT EQUIPMENT SPECIFIED IN THE MATERIAL LIST ON THIS DRAWING.
2. FURNISHING OF PERSONNEL SAFETY EQUIPMENT NOT SHOWN ON THE MATERIAL LIST THAT MAY BE REQUIRED FOR THE INSTALLATION IS THE RESPONSIBILITY OF OTHERS.
3. PERFORMANCE SHOWN IS BASED ON AN OUTLET AREA OF 7.81 SQ. FT. AN EVASE IS BUILT IN REQUIRED.
4. FAN SOUND POWER LEVELS SHOWN MAY RESULT IN UNACCEPTABLE SOUND PRESSURE LEVELS DEPENDING ON INSTALLATION CONDITIONS.
5. FAN ROTOR MUST NOT BE ALLOWED TO SIT IDLE AT TEMPERATURES OVER 200°F.
6. FAN CASING MUST BE ISOLATED FROM DUCT LOADS AT INLET AND OUTLET BY MEANS OF EXPANSION JOINTS, FLEXIBLE CONNECTIONS OR SIMILAR MEANS.
7. THE FOUNDATION MUST BE LEVEL, MUST MAINTAIN ALL FAN AND DRIVE ALIGNMENTS, AND SHOULD BE COMPRISED OF A MONOLITHIC INERTIA BLOCK HAVING A WEIGHT EQUAL TO SIX TIMES FAN ROTOR WEIGHT. THE FOUNDATION MUST BE DESIGNED FOR A DYNAMIC FORCE OF 246 LBS. EACH PLANE, REFERENCED TO THE BEARING CENTERLINE. THE RESULTING SYSTEM RESONANCE MUST BE A MINIMUM OF 20% ABOVE THE MAXIMUM FAN SPEED.
8. FAN ROTOR WEIGHT 1688 LBS. TOTAL FAN WEIGHT 8,551 LBS.
FAN ROTOR WR^2 4394 LB. FT^2. FAN ROTOR CRITICAL SPEED 1562 RPM
9. MAXIMUM SAFE FAN RPM 1200 MAXIMUM SAFE TEMP. 430 °F.
10. BEARING VIBRATION LIMITS (IN MILS); NORMAL 1.8 UNFILT., ALARM 3.5 UNFILT., SHUTDOWN 6.0 UNFILT.
11. PROPER ALIGNMENTS SHOWN ON THIS DRAWING OR IN THE CLARAGE FAN SERVICE MANUAL INCLUDE; WHEEL TO INLET CONE(S), SHAFT SEALS, BEARINGS TO SHAFT, AND FAN SHAFT TO DRIVE SHAFTS.
12. AFTER FINAL ALIGNMENTS ARE MADE, DOWEL BEARINGS AND PEDESTALS TO SUPPORTS. TWO PINS REQUIRED FOR EACH.
13. BEARING LUBRICANT SAE 20 WT. TURBINE GRADE OIL. 56 FL. OZ. RET. BRG. 33 FL. OZ. FLT. BRG.
14. BEARING COOLANT 3½ G.P.M. RET. BRG. / 1½ G.P.M. FLT. BRG. CITY QUALITY WATER, @ 90° MAX. INLET & 80 P.S.I.G. MAX. INLET PRESS.
15. REFER TO CLARAGE FAN SERVICE MANUAL AND ACCESSORY MANUALS FOR ADDITIONAL INFORMATION.
16. GASKETS: PECORA OR FIRETITE ASBESTOS FURNACE CEMENT BETWEEN COMP. ANGLES. ¼" ASBESTOS ROPE AROUND ACCESS DOORS. ASBESTOS SHAFT SEALS AT HSG. DRIVE SIDE AND AT INLET BOX SIDE.
17. 68⅝" DIA. WHEEL OVERALL WITH SPLIT SECTION OF HSG. & INLET BOX REMOVED WHEEL SHAFT & BRG'S. CAN BE MOVED TO THIS POSITION & OUT OF FAN LONGITUDINALLY.
18. BRG'S. ARE NOT DRAINABLE & PROVISIONS MUST BE MADE TO BLOW OUT THE JACKETS WITH COMPRESSED AIR IF FAN IS SHUT DOWN DURING FREEZING WEATHER.
19. 176 FT. LBS. TORQUE REQ'D. TO OPERATE INLET DAMPER
20. DO NOT INSULATE DAMPER BRG'S. ON SHAFTS.
21. RELUBRICATE DAMPER BRG'S. WITH DOW DC-41 GREASE MONTHLY TO CAUSE SOME PURGING AT THE SEALS.
22. ¼" N.P.T. FLEXIBLE PIPE CONNECTION, ONE EACH SIDE.
23. SHIM AS REQ'D. UNDER MOTOR FEET TO ALIGN MOTOR SHAFT WITH FAN SHAFT.
24. MOTOR - ITEM (17) MAKE: LOUIS ALLIS FRAME #447TS, OPEN DRIP PROOF, H.P.-175, R.P.M.-1181, VOLTS-230/460, PHASE-3, CYCLES-60. FURN. BY C.F.CO., MTD. BY OTHERS.
25. MOTOR - ITEM (19) MAKE: LOUIS ALLIS FRAME #444TS, OPEN DRIP PROOF, H.P.-75, R.P.M.-900, VOLTS-230/460, PHASE-3, CYCLE 60. FURN. BY C.F.CO. MTD. BY OTHERS.
26. INSULATION RETAINERS: 10GA. ×4P2P DOUBLE POINTED PINS SPACED ON APPROX. 18" CTR'S.
27. 7" GAP BETWEEN COUPLING HUB FACES. SHAFTS NOT TO PROJECT BEYOND COUPLING HUB FACES.
28. 10" GAP BETWEEN COUPLING HUB FACES. SHAFTS NOT TO PROJECT BEYOND COUPLING HUB FACES.
29. FAN TO BE PAINTED WITH HEAT RESISTANT ALUMINUM PAINT.

NOTE: 3 FANS REQ'D.

ITEM	QTY.	PART NUMBER	DESCRIPTION	DIMENSIONS	MAT'L.	SPEC.	WT.
25.	1	R-96854	SCROLL & SIDELINER	⅜"	STEEL	A-36	
24.	1	F-203543	NAMEPLATE				
23.	2	29R-84473 SH.	SHAFT CLAMP				
22.	1	R-90083	BRG. WATER PIPING				
21.	2	27R-84479 SH.	SHAFT SEAL ASS'Y.				
20.	1	F-203540	MOTOR SOLEPLATE				
19.	1		LOUIS ALLIS MOTOR (SEE NOTE # 25)				
18.	1	F-203539	MOTOR SOLEPLATE				
17.	1		LOUIS ALLIS MOTOR (SEE NOTE # 24)				
16.	1	F-203541	COUPLING GUARD				
15.	1	TYPE: PS SIZE: 120	DODGE COUPLING	FURN. & FAN HALF MTD. BY C.F.CO.			
14.	1	F-203542	COUPLING GUARD				
13.	1	TYPE: PS SIZE: 140	DODGE COUPLING	FURN. & FAN HALF MTD. BY C.F.CO.			
12.	1	1L-1133 SH.	SOLEPLATE (FLT. BRG.)				
11.	1	15R-92232 SH.	BRG. SUPT. (FLT. BRG.)				
10.	1		FLT. BRG. - 3$\frac{7}{16}$ W.C.S.S. WITH AUX. SEALS				
9.	1	1L-1145 SH.	SOLEPLATE (RET. BRG.)				
8.	1	15R-92260 SH.	BRG. SUPT. (RET. BRG.)				
7.	1		RET. BRG. - 3$\frac{7}{16}$ W.C. R.T. WITH AUX. SEALS				
6.	1	U-24666	INLET DAMPER	¼"	STEEL	COMM. QUALITY	
5.	1	R-96818	INLET CONE	10GA.	STEEL		
4.	1	1L-2071	SHAFT DETAIL	4½" DIA. @ WHEEL	STEEL	C-1035/45	
3.	1	U-24665	WHEEL ASS'Y.	'3L' PERF. WITH XAR-15 WEAR PLATES			
2.	1	U-24664	INLET BOX	¼" (INLET POS. 270°)	STEEL	COMM. QUALITY	
1.	1	U-24663	HOUSING DETAIL	¼" (DISCHARG-UBD	STEEL	COMM. QUALITY	

– MATERIAL LIST FOR ONE APPARATUS –

NO.	C.O.	REVISION	BY	CH.	DATE
-5		NOTE 26 REV	CP		5-23-8
-4	*	SOLEPLATES DIMS REV.	CP		3-25-80
-3		ITEM 24 WAS 200 H.P. MOTOR.	CP		3-17-80
-2		NOTE # 29 ADDED	CP		11-19-79
-1		ITEM 19-MOTOR WAS 444T. - NOTE 28 ADDED MOTOR LENGTHS & SOLEPLATE DIMS REV.	"		"

PURCHASER: INTERNATIONAL BOILER WORKS COMPANY, EAST STROUDSBURG, PENN.
P.O. 18031 CONTRACT
ZURN S.O. CM-2696 SERVICE I.D.
USER

CLARAGE FAN COMPANY
A DIVISION OF ZURN INDUSTRIES
Kalamazoo, Michigan U.S.A.

TITLE: ARRANGEMENT DRAWING
SIZE 132 SERIES 1250 TYPE XLR
ARR. 3½ WIDTH 100% SW DESIGN 1200 R.P.M. @ 430°F. ROT. CCW

THIS DRAWING, INCLUDING THE PRINCIPLES OF DESIGN, IS THE PROPERTY OF CLARAGE FAN CO. AND IS SUPPLIED WITH THE UNDERSTANDING THAT IT WILL NOT BE USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS LOANED WITHOUT WRITTEN CONSENT FROM CLARAGE FAN CO., NOR WILL IT BE USED IN ANY WAY HARMFUL TO CLARAGE FAN CO.

DR. CP DATE 11-9-79 SCALE N.T.S.
CH. LR DATE 11-14-79 DRG. NO. U-24456 REV. -5
APP'D. DATE 11-16-79

DRG. NO. U-24456 REV. -5

B&W babcock & wilcox power generation group

Plant Service Bulletin

Tube Thickness Evaluation Repair or Replacement Guideline

Purpose

This bulletin was written to assist customers in evaluating existing boiler tube wall thicknesses and defining when repair or replacement is recommended.

Background

Experience has shown that many tubes do not necessarily fail when operating at thicknesses below the minimum wall calculated, according to the ASME Code. However, operation in this manner encroaches on the ASME Code design margin. A tube that is below minimum wall thickness may or may not be tolerant of temperature excursions, thermal cycling, mechanical loading and other stresses.

Cognizant of this, some operators have elected to take a practical approach, based on actual operating experience, to determine when to repair or replace thinned tubes. A practical minimum wall thickness criterion can be established through a record-keeping process, to track the wall thickness of various boiler tubes over time and to relate tube failure history of those tubes to tube thicknesses. This is an effective method for locating troubled areas before they lead to forced outages. With this method, the decision to take action for thinned tubes is based on a percentage of the original wall thickness (t) of the tubes.

Since high-temperature (steam-cooled) tubes usually fail by creep-rupture, and water-cooled tubes usually operate below the creep-rupture regime, a different set of evaluation criteria is required for each of these two types of tubes. Furnace tubes of once-through boilers operate at high temperatures and therefore are classified as steam-cooled tubes when evaluating tube thickness. A guideline for determining what course of action to take is shown in Table I.

Many factors were used and taken into consideration for establishing the usable thickness guideline. One of these factors is the need to avoid material yielding as the tube thins in service.

The decision to repair or replace tubing that is under the original specified minimum wall thickness should be evaluated by the operating company and discussed with the local jurisdiction and/or insurance carrier. This evaluation should consider the following:

1. History of previous failures of similar tubes
2. Wastage rate
3. Susceptibility to temperature excursion
4. Thermal cycling
5. Mechanical loading
6. Scheduling of outages of sufficient length to replace tubes
7. Risk of injury to personnel from primary failure or subsequent reactions

Table 1
Guidelines for Tube Repair/Replacement

Location	Actual Tube Wall Thickness Relative to Percent Specified Wall Thickness, t	Course of Action
1. Furnace Support Tubes and Economizer Stringer Support Tubes	Tubes equal to or greater than 85% t	Monitor thickness
	Tubes less than 85% t	Restore tube wall thickness or replace tube*
2. Economizer, Furnace Wall and other Water-Cooled Tubes	Tubes equal to or greater than 70% t	Monitor thickness
	Tubes less than 70% t	Restore tube wall thickness or replace tube*
3. Superheater, Reheater and Other Steam-Cooled Tubes	Tubes equal to or greater than 85% t	Monitor thickness
	Tubes less than 85% t	Restore tube wall thickness or replace tube*

*It is difficult to restore the wall thickness for tubes below .090 inch due to possible weld burn through and distortion. On Kraft Recovery boilers, Refuse boilers, and boilers operating below 1000 psig the tubes should be replaced when below the ASME minimum wall thickness.

(Continued on reverse side)

Recommendations

Customers should develop a program for their individual boilers using this as a guide to collect the specific information needed for reliable maintenance planning.

When replacing short tube segments, it is recommended that replacement tubing be the same OD, thickness and material specification as the original. When replacing large sections, an engineering review should be made to determine the advisability of upgrading to the latest design criteria or to apply other design changes that may eliminate existing problems. Arbitrarily increasing the tube wall thickness or alloy grade is not recommended, as it may lead to additional problems.

All boiler tubes may be replaced without weld restriction providing a qualified welding procedure is employed, together with a welding filler metal that is appropriate for the alloy content, tensile strength and service temperature of the tubing.

ALL REPAIRS MUST BE ACCEPTABLE TO THE GOVERNING CODE JURISDICTION AND/OR INSURANCE CARRIER.

Support

If you elect to follow the above guidelines, Babcock & Wilcox can assist in developing the specific information needed for an individual unit. Contact Babcock & Wilcox Field Service Engineering if you have any questions or need assistance.

For more information...

In the U.S., call 1-800-BABCOCK (222-2625) or fax (216) 860-1886 (Barberton, Ohio). Outside the U.S., call (519) 621-2130 or fax (519) 621-2142 (Cambridge, Ontario, Canada). In Mexico, call (5) 208-1906 or fax (5) 533-5550. Or contact your nearest B&W sales or service office worldwide.

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Dallas, Texas
Denver (Lakewood), Colorado
Edmonton , Alberta, Canada
Halifax (Dartmouth), Nova Scotia, Canada
Houston, Texas
Jakarta, Indonesia
Kansas City, Missouri
Los Angeles (Los Alamitos), California
Melville, Saskatchewan, Canada
Mexico City, Mexico
Montreal, Quebec, Canada
New York, New York
Portland, Oregon (Vancouver, WA)
Pune, India
Saint John, New Brunswick, Canada
St. Petersburg, Florida
San Francisco (Vacaville), California
Vancouver (Richmond), British Columbia, Canada

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PSB-26 2M H 6/94

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TECHNICAL OVERVIEW
Boiler Evaluation Services

Boiler Evaluation Services

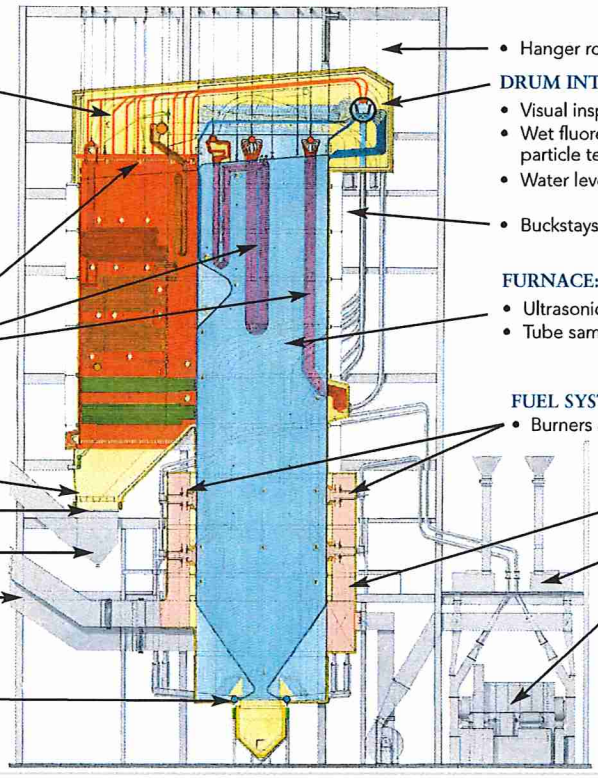
High Energy Piping Hanger Systems:
- Visual inspections (hot & cold conditions)
- Flexibility analysis (stress analysis)

DA Tank:
- Ultrasonic thickness testing
- Wet fluorescent magnetic particle testing

High Energy Piping:
- Visual inspection
- Diametral measurements
- Ultrasonic thickness testing
- Metallographic replications
- Ultrasonic phased array inspection
- Wet fluorescent magnetic particle testing

Coal Piping:
- Ultrasonic thickness testing

Feed Water Piping:
- Flow accelerated corrosion
- Ultrasonic thickness testing



- Penthouse interior
- Roof Seals

OTHER POINTS:
- Refractory / tile
- Baffle integrity
- Tube erosion / corrosion
- FD / ID fans
- Primary fans

- Element supports, clamps, guides, & alignment
- Damper operation / condition
- Expansion joints
- Ash hopper
- Ductwork, supports & stiffeners
- Lower headers and furnace hopper

- Hanger rods

DRUM INTERNALS:
- Visual inspection
- Wet fluorescent magnetic particle testing
- Water level

- Buckstays, casing & seals

FURNACE:
- Ultrasonic thickness testing
- Tube samples analysis

FUEL SYSTEM INSPECTION:
- Burners & refractory
- Windbox interior
- Coal feeders
- Pulverizer & drive train system

HEADERS:
- Hardness testing
- Internal video inspection
- Diametral measurements
- Metallographic replications
- Ultrasonic thickness testing
- Wet fluorescent magnetic particle
- Ultrasonic phased array inspection
- Internal oxide scale thickness testing on terminal tubes

Safety[3]

People. Power. Projects. We're giving safety the third degree. Babcock Power Inc. and its subsidiaries place the safety, health and security of our people at the core of our company values. Our team is our most valuable resource, generating solutions everyday to deliver safe, clean, reliable energy globally. With a keen focus on safety, Babcock Power Inc. conducts business in a manner that protects our people, our customers and the environment. From innovation to generation, we are proud of our award-winning safety record and are committed to operating with integrity and excellence.

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BabcockPower

Riley Power Inc. • 5 Neponset Street, PO Box 15404, Worcester, MA 01615-0040 tel: 508-852-7100 • www.babcockpower.com

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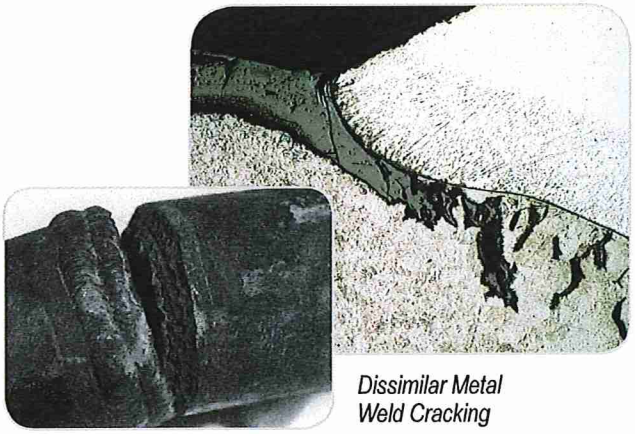
TECHNICAL OVERVIEW
Metallurgical Laboratory Services

Riley Power Inc., a Babcock Power Inc. company, designs, manufactures and provides aftermarket services for steam generators and fuel firing equipment for fossil fired and waste fuel fired plants. For more than six decades, Riley Power Inc. (RPI) has provided expert boiler metallurgical analyses and comprehensive condition assessments in conjunction with RPI's Boiler Evaluation, Engineering and Field Services departments. Our metallurgical laboratory is capable of conducting extensive analyses services, including destructive and nondestructive condition assessments, failure analysis, finite element analysis, quality control and any other materials related concerns.



Dissimilar Metal Weld Cracking

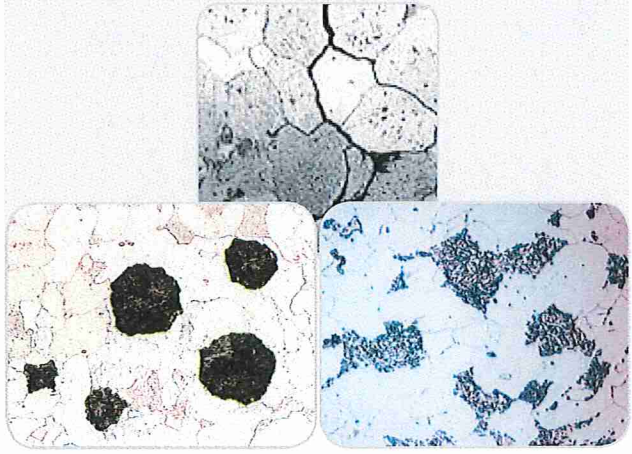
Boiler tube failures continue to be the leading cause of forced outages in the power industry. Diagnosis of the root cause is essential to mitigating failures and reducing time spent off line. Additionally, RPI recognizes that it is increasingly important to accomplish this, while operating with mounting regulation and budgetary constraints. A detailed metallurgical assessment can provide justification for future outage planning, budget management, and capital prioritization.

Rely on Riley Power Inc.'s metallurgical analyses to decrease operating, repair and maintenance costs and improve your plant's reliability. Ask for Boiler Evaluation or Technical Services.

Capabilities

- Microstructural assessment
- Hardness testing
- Mechanical properties
- Scanning electron microscopy
- Material verification and selection
- Quality control
- Chemical analysis (internal and external deposits)
- Weld assessment
- Deposit loading analysis (water carrying tubes)
- Failure analysis, including:
  - Root cause determination
  - Corrosion (internal and external, including hydrogen damage, phosphate hideout, pitting, etc.)
  - Erosion and wall thinning
  - Over temperature conditions
  - Cracking (including fatigue, stress corrosion, and dissimilar metal welds)
  - Creep damage
- Remaining creep life analysis
- Remaining life analysis

Material Degradation



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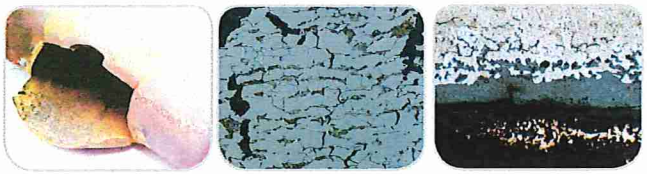
TECHNICAL OVERVIEW
Metallurgical Laboratory Services

Analysis

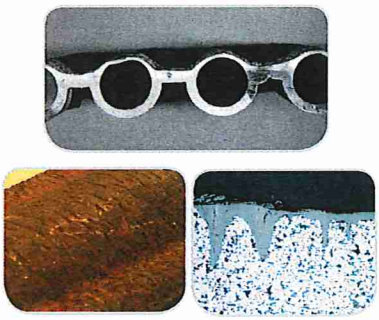
Often, an initial diagnosis can be provided within hours of receipt of the sample. A final report follows, including comprehensive analysis, color photographs, test results and recommendations for continued service, repair or replacement. RPI is dedicated to providing a complete metallurgical assessment, from initial diagnosis in the field to analysis in our laboratory facilities.

Non-destructive metallurgical analysis, in the form of microstructural replication ("replicas"), can also be performed. This technique occurs at the plant, on components where destructive testing is not practical. An on-site RPI engineer "replicates" the exact surface microstructure of the material. The replica is then sent back to RPI's metallurgical laboratory for final analysis. This is often the best method for assessment of headers, high energy piping, and other large components.



Hydrogen Damage

Fireside Corrosion



Replication Metallography of Header

Benefits

- A full metallurgical assessment provides confidence in the current and future condition of critical boiler components
- Complete information about a failure mechanism allows for comprehensive preventative measures, repairs, and replacements before failures occur
- The ability to foresee problems allows better planning of costs, manpower, outages and other resources
- Component analyses can help identify other areas at risk for various damage mechanisms and degradation

Safety[3]

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METALLURGICAL ANALYSIS RATES

FISCAL YEAR 2017

Effective October 1, 2016 through September 30, 2017[1]

TUBE SAMPLE ANALYSIS[2]	
One Tube	$2,720.00
Two Tubes	$2,150.00/each
Three to Four Tubes	$2,000.00/each
Five Tubes or more	$1,800.00/each
Rush service	Call for pricing
TUBE FAILURE ANALYSIS[3]	
Each Tube	$3,230.00
Rush service	Call for pricing
OTHER ANALYSIS	
Each Sample	Call for pricing

For each tube sample[4], the current condition is established and for failed tubes the root causes are determined. The evaluation consists of:

- Visual and dimensional inspection
- Detailed microstructural analysis of I.D./O.D. and mid wall regions by use of an optical microscope
- Quantitative chemical analysis of scale and deposits using energy dispersive spectroscopy and x-ray diffraction to understand corrosion/erosion effects on the I.D./O.D. tube surfaces
- Atwood-Hale deposit weight density analysis to determine if unit cleaning is needed
- Alloy confirmation using x-ray fluorescence
- Precise alloy chemical composition analysis via optical emission spectroscopy
- Hardness readings to determine the estimated tensile strength of the tube material
- Micro-indentation hardness readings to determine localized variations in the strength of the material

The I.D. scale is measured and remaining life calculations performed for superheater and reheater tubes. The remaining life methodology utilizes the Larson-Miller parameter, the Rehn-Apblett relation of oxide scale considerations, and the life fraction rule for cumulative creep damage.

---

[1] Prices are subject to change.

[2] Tube samples having two or more material types and/or bi-metallic welds shall be noted. Only one material will be analyzed, not both. If both materials are analyzed it shall be considered as two tube samples. If there is a concern in regard to a dissimilar or bi-metallic weld, it will be treated as a failed tube and charged accordingly.

[3] Tube samples that contain evidence of pressure boundary breaching are considered "failed".

[4] Tube samples and mounted specimens will be kept for a period of 180 days.

EXHAUST HEAT RECOVERY

SD-II-5 ECON Boiler Economizer Brochure

Boiler Economizer Systems

Rectangular Tube Recovery Series – RTR

Condensing Economizer Series – CXL/DXL

Fin Coil Recovery Series – B/FCR

Energy Manager Series – EM

cain industries
heat recovery systems

"Manufacturing Waste Heat Transfer Products To Save Energy"

Since 1978, Cain Industries has dedicated itself to producing exclusively, combustion exhaust heat transfer products. Our successful experience with lowering fuel costs and reducing pollution makes us the first choice for both the retrofit and OEM client.

We set ourselves apart from the competition by producing products to serve the broad spectrum of the combustion retrofit markets: Diesel and Gas Cogeneration, Boiler Exhaust, and Fume Incineration. The knowledge we gain from each market helps the continuing improvement of the others. As the only manufacturer capturing these three markets, we have developed the greatest selection of products to precisely fit within their particular system applications. Coupled with our heat transfer programs and CAD engineered designs, we have developed fifteen product lines with over 2,350 pre-designed industrial heat transfer models.

We are also especially dedicated to a primary investment in our associates with their manufacturing technology, quality improvements, and innovative cost reductions. As a result, our customers can expect competitively priced products aimed at having the greatest return on their investment along with the longest lasting equipment.

The basic philosophy which Cain Industries has built its success and reputation upon is: "Produce the highest quality products and provide unmatched customer satisfaction".

John Cain
President & CEO

Cain Industries is 10 miles northwest of Milwaukee, Wisconsin and 30 minutes from General Mitchell International Airport.

Image courtesy of NASA | http://visibleearth.nasa.gov/

THE HEAT TRANSFER PRODUCT FAMILY FOR BOILER EXHAUST RECOVERY

INTRODUCTION

Cain Industries offers an extensive selection of boiler economizers specifically designed to recover the lost heat exiting from exhaust stacks and preheat water. Our broad line of economizers covers the spectrum of boiler sizes, ranging from very small hot water boilers with burner inputs of 200,000 Btu/hr to large boilers delivering steam at 250,000 lb/hr. In addition, Cain produces boiler feedwater systems, condensate tank and pump systems, exclusive sootblower assemblies, and unique modulating internal exhaust gas bypass systems.

EXHAUST APPLICATIONS

- Steam Boilers
- Hot Water Boilers
- Hot Oil Heaters
- Ovens and Dryers
- Specific Combustion Sources

EQUIPMENT VARIETY

- Boiler Economizers
- Sootblowers
- Circulating System Components
- Storage Tanks
- Modulating Internal Exhaust Gas Bypass Assembly

SYSTEM FUNCTION

Exhaust heat from combustion typically leaving the stack and into the atmosphere is instead transferred from the exhaust stream by means of a Cain economizer. This lost Btu is now captured and saved to various heat sinks such as boiler feedwater, cold makeup water, process water, swimming pool water, glycol, and thermal fluids. Combustion source fuel types including natural gas, propane, digester gas, diesel fuel, and No.2-6 fuel oil are all heat sources which can be retrofitted with Cain heat exchangers.

PROPOSAL CONSIDERATIONS

Consider Cain for cylindrical or rectangular stack connections, large or small boilers, a particular pinch point requirement, stack or liquid temperature control, special heat sink requirements, special heat transfer metallurgy requirements, specific maintenance concerns, optional equipment requirements, installation space and weight concerns, and package system requirements.

ANTICIPATED RESULTS

- Tremendous fuel savings typically pay for equipment and installation within 1 to 2 years of average use
- Pollution reduction equivalent to lowered annual fuel usage
- Longest heat exchanger life expectancy

RECTANGULAR TUBE RECOVERY SERIES

The RTR is ideal for large steam boilers and hot water boilers. The RTR is typically used to preheat boiler feedwater, process water, hot oil, or cold water condensing applications. A variety of heat transfer surfaces are available, including: 316L stainless steel, carbon steel, duplex stainless steel, and stainless steel tube with aluminum bonded AL-FUSE™ product (see the example RTR product specification for materials). The exclusive, standard feature, internal stainless steel exhaust gas bypass can be used to temper the exiting gas for stack corrosion control or to maintain water temperatures when too much heat is available.

COMBUSTION SOURCES

Steam boilers, hot water boilers, and hot oil heaters with inputs up to 250,000,000 Btu/hr.

Btu/hr input to 250,000,000 - Entering exhaust temps to 800°F

FEATURES

- Internal expansion design
- Most models have no pressure welds in the gas stream
- Mounting flanges for bolting to mating flanges/adapters
- Condensate drain catch ring assembly
- 10 ga. structural exterior
- Stainless steel interior
- 2" factory insulation
- Removable access doors
- Stainless steel bypass
- Header manifold for high liquid flow
- Exclusive Cain compression fittings between finned tubes and the liquid manifolds for easy tube removal that requires no welding

Installation: structural support stand

Ethanol Plant, Oshkosh, Wisconsin
RTR-166K25.7ALS recovering Btu from a 2,200 BHP, steam boiler; Reducing 367°F @ 18,473 SCFM to 299°F; Raising the temperature of 152 gpm of boiler feedwater from 227°F to 245°F.

OPTIONAL EQUIPMENT

- Modulating bypass actuator assembly for automatic operation
- Hinged inspection doors for immediate access
- Timed automatic sootblower assembly provides blowdown without scheduling personnel
- Stack corrosion control assembly
- Liquid temperature control assembly
- Structural support stand

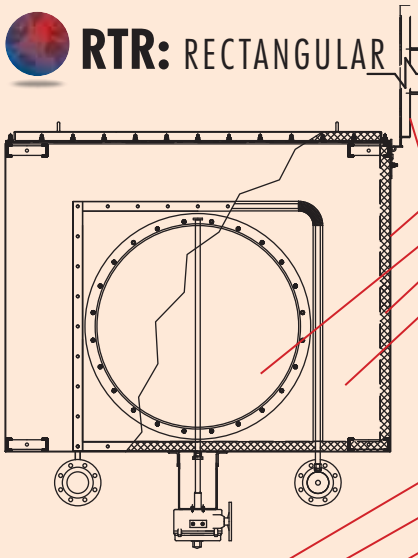
Installation: ceiling suspension

Ice Cream Plant, Bakersfield, California
RTR-148F26ALS recovering Btu from a 500 BHP, steam boiler; Reducing 430°F @ 4,198 SCFM to 305°F; Raising the temperature of 35 gpm of boiler feedwater from 210°F to 247°F.

BOILER EXHAUST APPLICATION

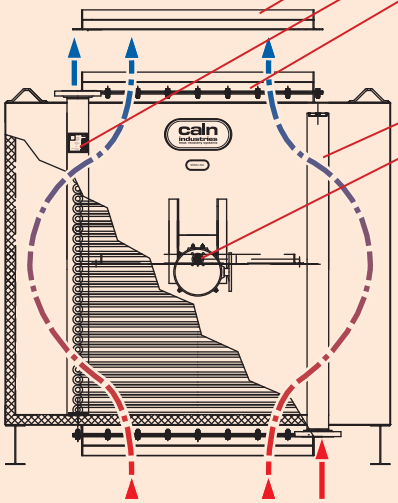
- Capacity: to 250,000 lb/hr steam
- Entering gas temps: 300°F – 800°F
- Heat sink types: Boiler feedwater, makeup water, hot water return, hot water storage tank, condensate tank, process water

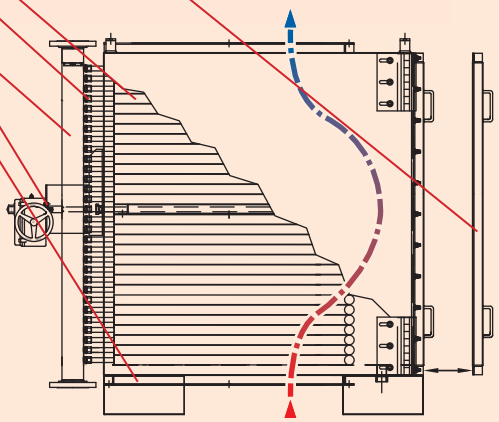
RTR: RECTANGULAR TUBE RECOVERY SERIES



Optional hinged door
10 ga. carbon steel exterior
Stainless steel exhaust gas bypass
2" thks. insulation
Stainless steel interior

Inspection door for tube cleaning
Optional RTR-to-stack adapter
Optional ASME stamp
2" x 2" gas flange connection
Removable finned tube rows
Compression fittings for easy tube removal
Header manifold
Optional modulating actuator
Optional condensate drain catch assembly





INSTALLATION FOR EXACT FIT

In many cases, the RTR is designed to replace a competitor's unit. The RTR will meet or exceed the old performance and at the same time fit within the original stack connections.

Brewery, Ontario, Canada
(1) RTR-1V2Q28CSS recovering Btu from (1) 95,000 pph steam boiler; Re educing 505°F @ 24278 SCFM to 333°F; Raising 196 gpm boiler feedwater entering at 225°F to 278°F.

VARIETY

One feature of the RTR product line is the large variety of sizes and configurations that are available. Cain Industries routinely produces RTR models that range in application size from small 50 hp boilers to massive 250,000 pph boilers. In addition, RTR units can be engineered to function in a horizontal or vertical stack and can be outfitted with optional automatic sootblowers.

DELIVERY

Cain Industries keeps strict control over production and delivery scheduling so our customers receive their heat recovery equipment on time and on budget. We routinely ship regionally, nationally, and internationally and keep you informed every step of the way.

(5) RTR model economizers are loaded on a flatbed and are ready for delivery to our customer.

RTR: SPECIFICATION

A general specification, shown as a guide for design & construction. (see Engineering Sales Manual for detailed specification data sheets)

1.0 General Design:

1.1 Furnish and install a rectangular tube recovery (RTR) in the exhaust duct of the boiler in accordance with the following specifications as designed and manufactured by Cain Industries, Inc.

1.2 The RTR shall be a light weight design for easy installation, rectangular with crossflow heat transfer design manufactured and tested in accordance with the requirements of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code, and stamped to a minimum 250 PSIG design pressure to the appropriate section.

1.3 Each RTR shall be designed to include as standard, a stainless steel, internal, Flue Gas Bypass Diverter to provide for full emergency by-pass, requiring no additional ductwork for controlling: 1. Stack corrosion, 2. Turn down performance, 3. Back pressure.

1.4 The RTR shall have removable, gas-tight inspection doors providing complete access to the entire heating surface for inspection, tube removal, and/or cleaning (optional hinged doors available).

1.6 The RTR must be capable of being drained completely when mounted in the vertical or horizontal position.

1.7 Header manifolds for low liquid flow pressure drop shall be provided and shall have connections, threaded or flanged as specified. Liquid inlet and outlet pipe connections greater than 2" NPT shall be flanged. The liquid header manifolds shall also contain ¾" NPT connections for venting, draining, and/or safety relief valves as required.

1.8 The design of the vessel itself shall be such that no tube to tube, or tube to header joint welds shall be in contact with the exhaust stream so as to minimize potential vessel failure.

1.9 The finned tubing shall be a single row design (maximum 2 row depth in the direction of the exhaust flow) for ease of cleaning and inspection. Tube to header joint shall be compression tube fittings requiring no welding for fast/easy tube replacement.

2.0 Construction:

2.1 Design Pressure (water side): 250 PSIG @650°F.; Test Pressure: 375 PSIG; Max. Flue Gas Inlet Temperature: (see below); Design Pressure (exhaust side): 3" water column

2.2 Tube & Fin Designs:

- SA178GrA ERW x 1.0" OD x .083" wall thks. with carbon steel .030 Fin thks x .50 Hgt Nickel Brazed/welded to the tube.
- TP316L x 1.0" OD x .065" wall thks. with aluminum .020 fin thks x .50 hgt AL-FUSE™ bonded to the tube.
- TP316L x 1.0" OD x .065" wall thks. with 304 stainless steel .020 Fin thks x .50 Hgt Nickel Brazed/welded to the tube.

2.3 Compression fitting design: 1000 PSI @ 400°F.

2.4 Headers: thickness: Sch 80; material: SA106 GrB

2.5 2" thickness factory installed, high temperature insulation shall be contained within the exterior less the liquid headers.

2.6 Exterior surfaces shall be 10ga. carbon steel seam welded and the inner casing shall be 304 stainless steel.

2.7 Special codes (optional): design specifications of ASME Code Section VIII Division I; `UM', `U', or `S' symbol; National Board registered; CRN.

3.0 Optional System Component Equipment:
(see Engineering Sales Manual for optional equipment specifications or contact Cain Industries)

Vertical flow RTR shown with optional timed automatic sootblower assemblies. This unit uses three sets of traveling carriages with high velocity cleaning nozzles.

EXHAUST STACK ADAPTERS
allow the RTR to provide maximum heat recovery while mating perfectly with an existing exhaust stack. Adapters also allow the rectangular RTR to work with a round exhaust stack

REMOVABLE ACCESS DOORS
provide a complete view of the finned tube heating surface for inspection, repair, or maintenance. This reduces down time and labor expenses.

MOUNTING FLANGES & ADAPTERS
are integral to Cain Industries economizers, reducing installation time and providing a superior connection between the existing stack and the Cain unit.

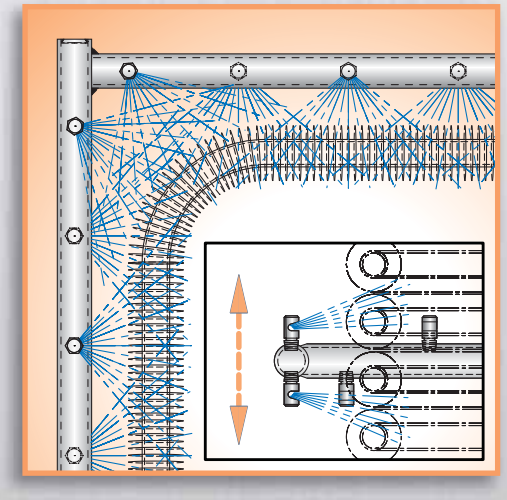
EXTERIOR LIQUID MANIFOLDS
maintain very low liquid pressure drop, eliminating the need for extra pumps/HP. This manifold is connected to the finned tubes with compression fittings which allow a finned tube to be removed for inspection or replacement without requiring any welding.

SINGLE ROW FINNED TUBING
design (maximum of 2 rows in the path of the exhaust flow) allows full access to the entire heating surface and provides ease of cleaning and maintenance. Each finned tube row has no welds in the exhaust gas stream which greatly minimizes the chance of tube failure.

BYPASS DIVERTER
allows the amount of exhaust gas diverted through the economizer to be modulated to achieve desired heat recovery. This becomes an important safety feature when you recover more heat than required by the existing system.

TIMED AUTOMATIC SOOTBLOWER

The exclusive Cain Industries Timed Automatic Sootblower design is applied where sulphur content is high or combustion is poor. The special flood-jet type nozzles achieve maximum cleaning velocity using steam or air discharged through an electric control valve. Together they form a 'continuous knife edge concentrated spray pattern' surrounding the heating surface. This 'ring nozzle assembly' is attached to a manifolded flexible steel hose assembly and is powered back and forth by a pneumatic drive cylinder. Dual timing relays allow full control of cycle duration and interval. Cleaning the finned tubing ensures maximum Btu recovery and maximum cost savings. Fouled finned tubing can reduce heat recovery by up to 50%.



Proper sootblowing is necessary when fuel has a high sulphur content or combustion is poor (such as No. 6 fuel oil). Without sootblowing, the finned tubing will become fouled and the maximum heat recovery cannot be achieved.

The traveling Ring Assembly with Flood-Jet Nozzles, form a unique high velocity knifing action to allow full penetration of the complete heating surface. The Cain Industries sootblowing system is unsurpassed in the marketplace for effectiveness and efficiency.

Built-in timing relays allow you to customize the interval and duration to suit your application.

FIN COIL RECOVERY SERIES

The FCR is a custom-designed heat exchanger which can be applied in confined areas and is offered in stainless steel, carbon steel, or AL-FUSE™ finned tubing. Design flexibility allows specific engineering requirements to be met such as fin spacing for fouling conditions and low gas pressure drops.

COMBUSTION SOURCES

Steam boilers, hot water boilers, hot oil heaters, combustion sources with round stack diameters 4"-36" and a maximum liquid flow rate of 50 gpm.

FEATURES

- Internal thermal expansion design
- Cylindrical heat transfer coil(s) design
- Mounting flanges for bolting to mating flanges
- Quick release tension latches
- Stainless steel internal bypass
- Condensate drain catch ring assembly
- Hinged stainless steel access door panels

Custom designed to meet space and performance demands

FCR shown with optional sootblower assembly

OPTIONAL EQUIPMENT

- Exclusive manual or timed automatic ring-type sootblower assembly
- Stack corrosion control assembly including temperature-regulated modulating exhaust gas bypass and remote indicators
- Circulating pump kit to maintain desired liquid flow rate
- Vertical pressurized storage tank, to create a "bulge" or temporary heat sink in the event of no-water-flow conditions
- Liquid temperature control assembly including temperature-regulated modulating exhaust gas bypass and remote indicators

Waste Water Treatment Plant, Fond du Lac, Wisconsin
(2) FCR-1J2D25ALS each recovering Btu from (2) 150 BHP steam boilers; Reducing 700°F @ 1603 SCFM to 246°F; Raising 18 gpm boiler feedwater entering at 100°F to 201°F.

BOILER EXHAUST APPLICATION

- Capacity: 40 – 500 BHP (50 –10,000 SCFM)
- Entering gas temps: to 800°F
- Heat sink types: Boiler feedwater, process water, thermal fluids, run-around systems

FCR: SPECIFICATION

A general specification, shown as a guide for design & construction. (see Engineering Sales Manual for detailed specification data sheets)

1.0 General Design:

1.1 Furnish and install economizers on each of the combustion sources (boilers, hot water heaters, hot oil heater, etc.) as designed and manufactured by Cain Industries, Inc.

1.2 The Economizer shall be a light weight design for easy installation, cylindrical with counterflow heat transfer design manufactured and tested in accordance with the requirements of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code, and is stamped to a minimum 250 PSIG design pressure.

1.3 Each Economizer shall be designed to include as standard, a stainless steel, internal, Flue Gas Bypass Diverter to provide for full emergency by-pass, requiring no additional ductwork for controlling: 1. Stack corrosion, 2. Turn down performance, 3. Back pressure.

1.4 Each Economizer shall have continuous hinged, gas-tight, stainless steel inspection panels, which provide for complete access to the entire heating surface for inspection and/or cleaning. The inspection panels shall be secured by adjustable, quick release tension latches and no tools shall be required for the opening of the inspection panels.

1.5 Heat Recovery unit shall be either a single, multiple, or parallel coil design and must be completely drainable when mounted vertically.

1.6 Header manifolds, where used, shall be SA53 GrB schedule 80 or SA105, connections shall be threaded or flanged as specified.

1.7 Exterior surfaces other than stainless steel shall be primed and painted with a high temperature metallic paint rated for 1000°F.

2.0 Construction:

2.1 Design Pressure (water side): 250 PSIG @650°F.; Test Pressure: 375 PSIG; Max. Flue Gas Inlet Temperature: (see below); Design Pressure (exhaust side): 3" water column

2.2 Tube & Fin Designs:

- SA178GrA ERW x 1.0" OD x .083" wall thks with carbon steel .030 Fin thks x .50 Hgt Nickel Brazed/welded to the tube. (Max. Flue Gas Inlet Temperature: 800°F)
- TP316L x 1.0" OD x .065" wall thks. with aluminum .020 fin thks x .50 hgt AL-FUSE™ bonded to the tube. (Max. Flue Gas Inlet Temperature: 750°F)
- TP316L x 1.0" OD x .065" wall thks. with 304 stainless steel .020 Fin thks x .50 Hgt Nickel Brazed/welded to the tube. (Max. Flue Gas Inlet Temperature: 800°F)

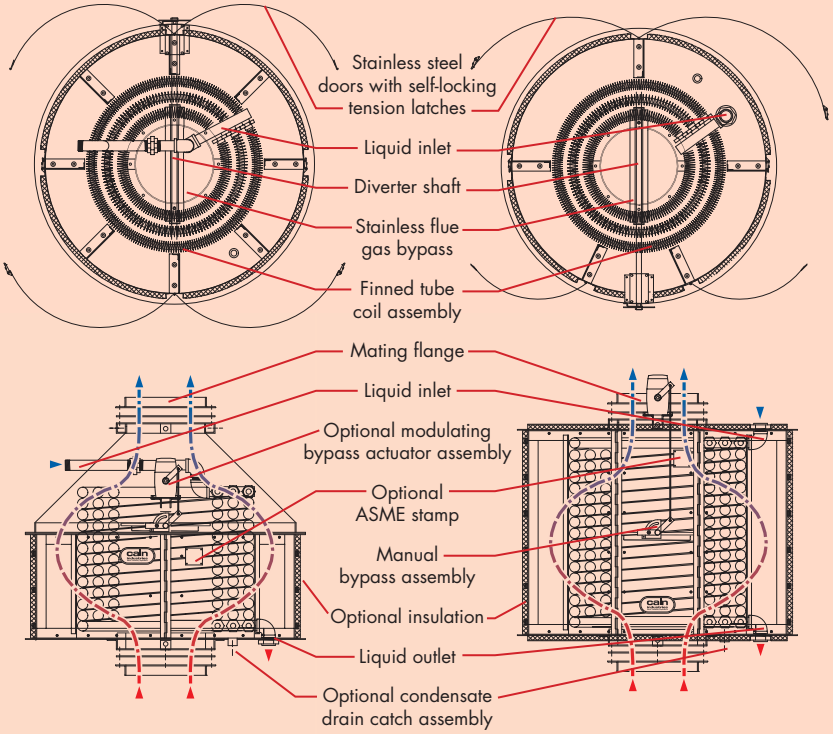
2.3 Headers: thickness: Sch 80; material: SA53 GrA and/or 2000# Forged Steel

3.0 Optional System Component Equipment:
(see Engineering Sales Manual for optional equipment specifications or contact Cain Industries)

FCR: FIN COIL RECOVERY SERIES

SINGLE PASS

DOUBLE PASS



Printing Facility, Lomira, Wisconsin
(2) Model: FCR-1L2C16ALS each Recovering Btu from a 500 BHP steam boiler; Reducing 400°F @ 4205 SCFM to 252; Raising 34.5 gpm boiler feedwater entering at 120°F to 164°F.

BEFORE AND AFTER

A Cain Industries FCR boiler economizer can often be installed in-line with your existing stack, resulting in a relatively quick and cost-efficient installation process with minimal retrofitting, labor, materials, and down time. Generally, because of their lighter weight and smaller size, the FCR requires little, if any, additional support (usually suspended from the ceiling). In applications where additional support is required, Cain Industries can offer a structural support stand. Economical in-line installation - another Cain Advantage.

B SERIES

The B Series boiler economizer is comprised of 14 standard models. An "off the shelf" unit, it is designed primarily for boilers with round stacks and a combustion capacity of 40 to 800 BHP with entering gas temperatures between 300° and 700°F. The standard stack connections can be easily modified to fit specific boiler stacks with 10" to 34" diameters, alleviating the cost of stack adapters. The units come standard either with 4 or 6 fins per inch (fpi) spacings for operation with No. 2 fuel oil and/or natural gas and depending on the efficiency of the combustion. With its lightweight design and exclusive AL-FUSE™ heat transfer surface, installation is fast and costs are kept to a minimum. Use the chart on the next page to select the B Series unit that is best suited to your application.

B Series single-pass unit with stack adapter cone

COMBUSTION SOURCES

Steam boilers and hot water boilers

- **Minimum cost**
- **Easy Installation**
- **Maximum savings**

FEATURES

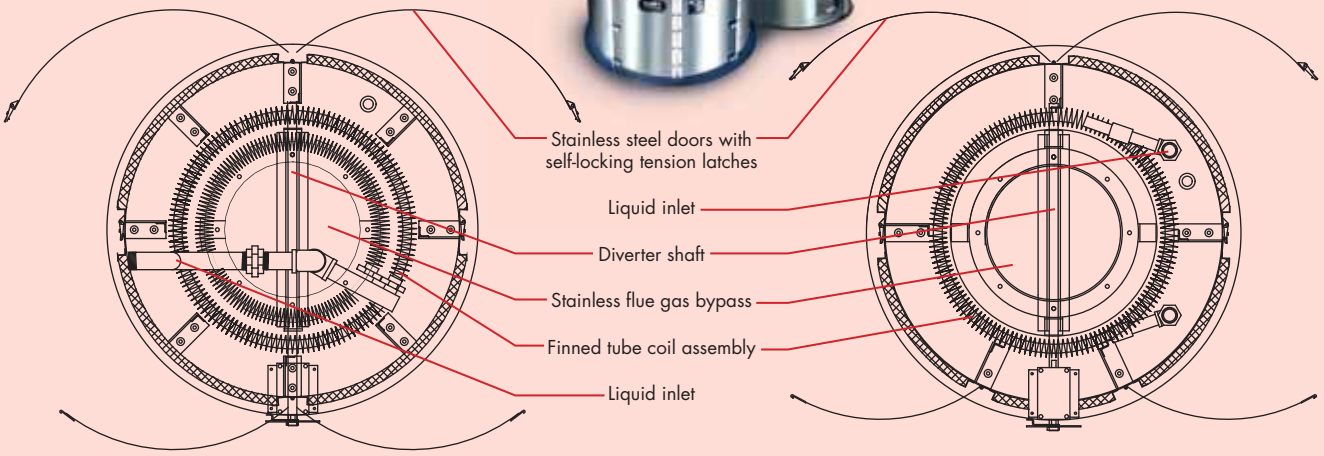
- Hinged stainless steel access door panels
- Internal thermal expansion design
- Mounting flanges for bolting to mating flanges or adapters
- Stainless steel internal exhaust bypass assembly
- Quick release tension latches for doors
- Optional sootblower assembly

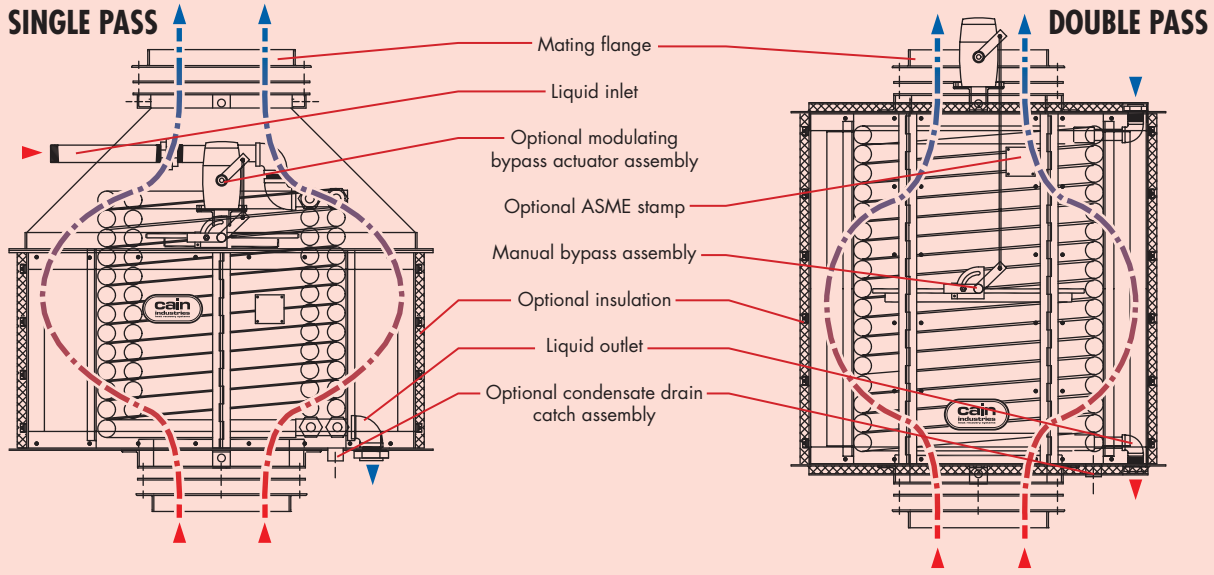
With the variety of boiler room sizes, coupled with limited space, horizontal or vertical installations, can be accommodated with the cylindrical B Series or FCR economizer product lines.

BOILER EXHAUST APPLICATION

- Capacity: 40 – 800 BHP
- Entering gas temps: 300°F – 700°F
- Heat sink types: Boiler feedwater, hot water return, hot water storage tank, condensate tank, process water

B: BOILER ECONOMIZER SERIES





B SERIES MODEL SELECTION

Model	BHP	H.S.	Ft²	Dia.	Height	Weight in LBS	Stack Flange Conn.			Water Conn. NPT	Sootblower Conn.	Drain Catch Ring Conn.	Total Weight w/Insulation & Stblr.
		6FPI	4FPI				ID	B.C.	Qty. Holes				
B04	40	91	N/A	30	15.5	175	12	14	8	1	N/A	1/2	210
B07	70	126	N/A	30	19.5	190	12	14	8	1	N/A	1/2	250
B10	100	72	119	36	23.5	220	12	14	8	1	N/A	1/2	300
B12	125	218	151	36	27.5	260	16	18	8	1	N/A	1/2	345
B15	150	263	182	36	31.5	300	16	18	8	1	N/A	1/2	390
B20	200	384	265	42	24.5	350	20	213/4	12	11/4	1	N/A	450
B25	250	486	336	42	28.5	390	20	213/4	12	11/4	1	N/A	490
B30	300	635	440	48	30.0	440	24	257/8	12	11/2	11/4	N/A	550
B35	350	720	498	48	32.0	485	24	257/8	12	11/2	11/4	N/A	600
B40	400	805	557	48	34.0	550	24	257/8	12	11/2	11/4	N/A	645
B50	500	932	645	48	38.0	590	24	257/8	12	11/2	11/4	N/A	700
B60	600	1059	733	48	42.9	650	30	323/8	16	11/2	11/4	N/A	760
B70	700	1186	821	48	46.0	690	30	323/8	16	11/2	11/4	N/A	830
B80	800	1313	909	48	50.0	750	30	323/8	16	11/2	11/4	N/A	890

ENERGY MANAGER SERIES

The EM is designed to recover heat from combustion sources with atmospheric burners from 200 to 6400 MBH. Ten standard models are designed to operate with low static gas pressure drop for safe, automatic operation on atmospheric, or power burners.

COMBUSTION SOURCES

Steam boilers, hot water boilers, dryers, and ovens

Built to rigid ASME quality control standards

FEATURES

- Built to rigid ASME quality control standards
- Highest heat transfer efficiency with AL-FUSE™ finned tubing
- Quick release access door latches for ease of maintenance/inspection
- Packaged design includes all basic control hardware to properly operate unit in the field
- Adjustable internal stainless steel exhaust gas bypass
- Guaranteed heat recovery performance

EM Series package includes all basic control hardware for simplified installation.

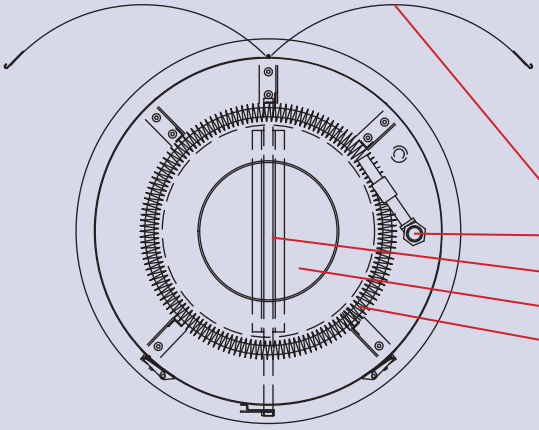
College Campus, Long Beach, California
(10) EM Series boiler economizers preheating hot water return loops.

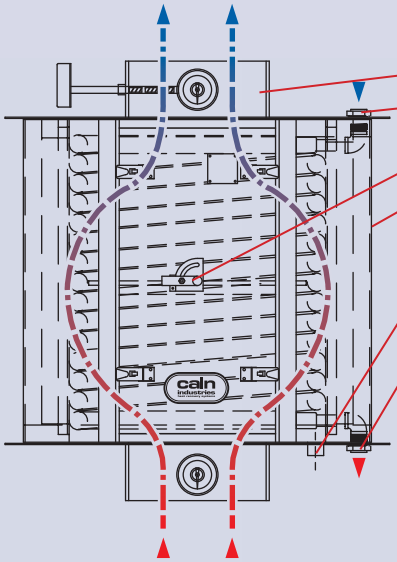
- Slip-fit gas connections
- Temperature Controlled Pump controller
- Internal stainless steel bypass to modulate heat recovery as needed
- Single row finned tubing for maximum efficiency and ease of cleaning
- Quick-release tension latches do not require tools
- Stainless Steel hinged access panels minimize labor and downtime during inspection, cleaning, or repair
- Includes circulating pump package: In-line circulating pump, inlet and outlet temperature gauges, check valve, relief valve, flow control valve, differential pump control

BOILER EXHAUST APPLICATION

- Capacity: 200,000 – 6,400,000 Btu/hr input
- Entering gas temps: 300°F – 700°F
- Heat sink types: Boiler feedwater, hot water return, hot water storage tank, condensate tank, process water

EM: ENERGY MANAGER SERIES





Condominium Complex, Milwaukee, Wisconsin
EM Series economizer, on top a domestic hot-water heater, preheating municipal water.

Industrial Laundry, Fresno, California
(2) EM Series, boiler economizers, preheating boiler feedwater for (2) 115 BHP Parker steam boilers.

EM SERIES MODEL SELECTION

The following model selections are determined by stack diameters and Btu/hr input using this simple selection chart. After the correct Energy Manager has been selected, contact your Cain representative to determine your fuel savings and provide a complete proposal with payback period. Stack diameters smaller than standard EM sizes can be accommodated simply with a pair of EM Model to Stack Transitions.

Model No.	Burner Input (Btu/hr)	Stack Diameter
EM-6	200,000	6"
EM-8	400,000	8"
EM-10	600,000	10"
EM-12	800,000	12"
EM 14	1,250,000	14"
EM-16	1,600,000	16"
EM-20	2,500,000	20"
EM-24	3,600,000	24"
EM-28	5,000,000	28"
EM-32	6,400,000	32"

SINGLE STAGE CONDENSING ECONOMIZER

The CXL Single Stage Condensing Exhaust Economizer is specifically designed to recover sensible heat from within the exhaust and, more importantly, to also recover additional valuable latent heat as the exhaust is condensed. Typically the recovered heat will be transferred to the cold makeup or process water, thereby increasing the overall efficiency and lowering the fuel demand. As the exhaust temperature is dramatically reduced to 120°F – 170°F, resulting condensation is safely captured and drained from the economizer and away from the boiler.

COMBUSTION SOURCES

Steam boilers, hot water boilers, and hot oil heaters with inputs up to 250,000,000 Btu/hr. (Natural gas fired)

Recovers both sensible and latent heat increasing the overall efficiency

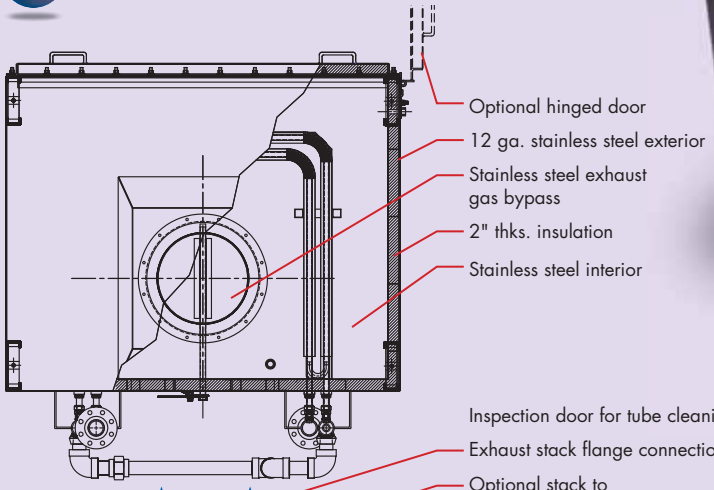
FEATURES

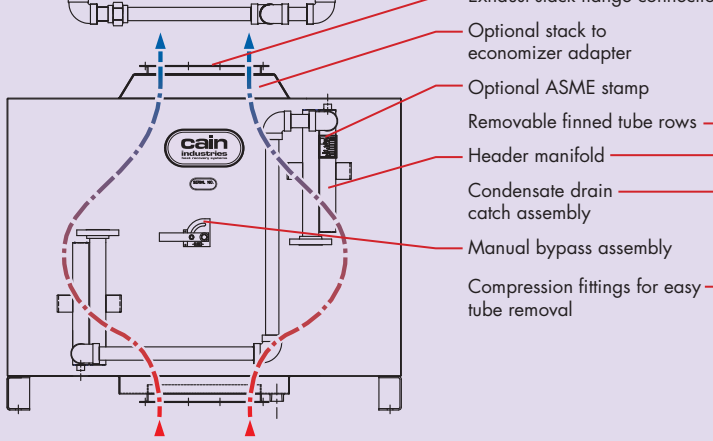
- Internal expansion design
- Mounting flanges for bolting to mating flanges/adapters
- Condensate drain catch ring assembly
- 12 ga. stainless steel exterior
- Stainless steel interior
- 2" factory insulation
- Removable access doors
- Stainless steel bypass
- Stainless steel header manifold for high liquid flow
- Compression fittings between finned tubes and the liquid manifolds for easy tube removal that requires no welding

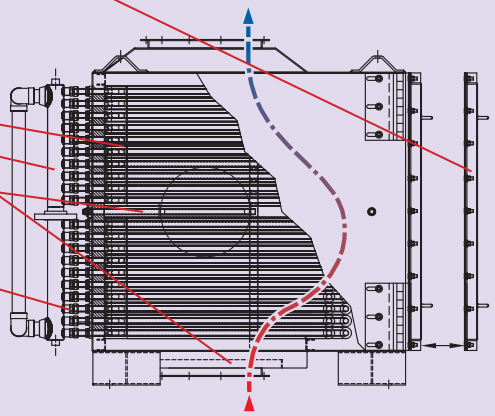
BOILER EXHAUST APPLICATION

- Capacity: to 250,000 lb/hr steam
- Entering gas temps: 300°F – 800°F
- Heat sink types: makeup water, process water

CXL: SINGLE STAGE CONDENSING ECONOMIZER







TWO STAGE CONDENSING ECONOMIZER

The DXL Two Stage Condensing Exhaust Economizer is specifically designed to recover sensible heat from within the exhaust and, more importantly, to also recover additional valuable latent heat as the exhaust is condensed. What makes the DXL Boiler Economizer unique is that it recovers heat in two stages. The first stage will preheat boiler feedwater and the second stage will preheat boiler make-up water. Final exhaust temperatures leaving typically range from 120°F – 170°F. This recovered heat will be transferred to feedwater and makeup water, thereby increasing the overall efficiency and lowering the fuel demand.

COMBUSTION SOURCES

Steam boilers, hot water boilers, and hot oil heaters with inputs up to 250,000,000 Btu/hr. (Natural gas fired)

FEATURES

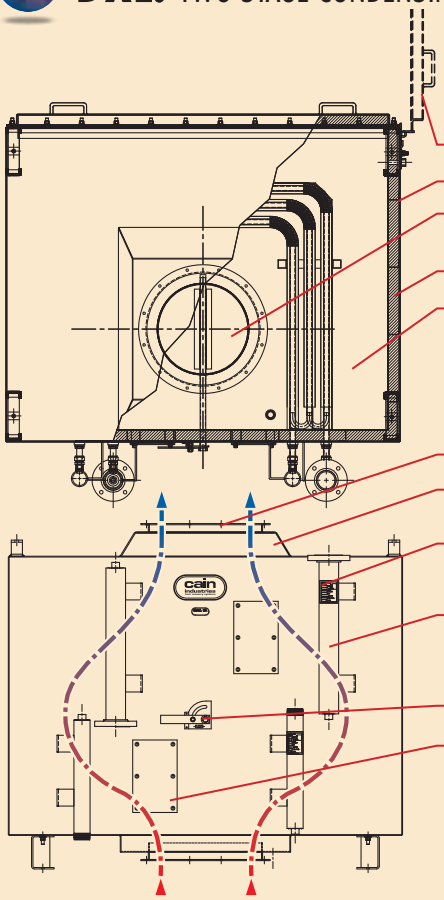
- Internal expansion design
- Mounting flanges for bolting to mating flanges/adapters
- Condensate drain catch ring assembly
- 12 ga. stainless steel exterior
- Stainless steel interior
- 2" factory insulation
- Removable access doors
- Stainless steel bypass
- Stainless steel header manifold for high liquid flow
- Compression fittings between finned tubes and the liquid manifolds for easy tube removal that requires no welding

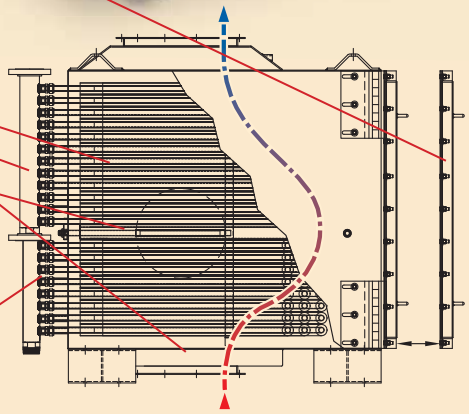
Preheats feedwater and makeup water for greater efficiency

BOILER EXHAUST APPLICATION

- Capacity: to 250,000 lb/hr steam
- Entering gas temps: 300°F – 800°F
- Heat sink types: Boiler feedwater, makeup water, hot water return, hot water storage tank, condensate tank, process water

DXL: TWO STAGE CONDENSING ECONOMIZER





SYSTEM COMPONENTS

Cain Industries offers a wide range of system components, pre-engineered specifically for each application. Every product has been tested, shown to be of the highest quality, and proven to be fully compatible with all Cain heat recovery products.

MATING FLANGES, AND GASKETS

Cain offers round, square, and rectangular mating flanges, transitions, and gasket sets to suit most any application. Flanges are black steel or stainless steel where appropriate.

CIRCULATING PUMP KIT ASSEMBLY

Cain offers all necessary pumps and related fittings for your heat recovery application – whether you need Shut off valves, Check valves, Relief valves, Vent valves, Steam Stop valves, Pressure or Temperature Control valves, or Drain valves.

DRAIN CATCH RING ASSEMBLY

Under various applications with natural gas combustion, condensation can accumulate within the economizer and/or stack outlet. The 'drain catch ring assembly' safely collects and drains away all possible condensation. It includes various NPT drain connection sizes, depending on the application.

SUPPORT STANDS

Cain offers structural steel support stands that easily bolt together for low cost and ease of field assembly.

LIQUID TEMPERATURE CONTROL

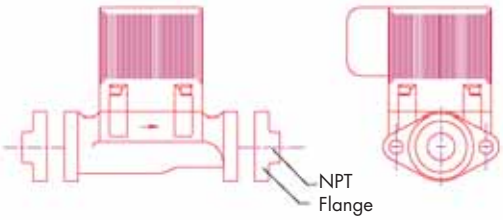
Cain Industries offers a sophisticated liquid temperature control which functions as follows: During a cold startup, the exhaust bypass will be powered to the normal operating position. As the liquid temperature rises and approaches a preset point, the Liquid Temperature Control signals the exhaust bypass diverter which will begin to move to the temperature control position. When the desired temperature is completely satisfied, the diverter actuator will move to the maximum open position. The heat recovery can be reduced by up to 50%. Included is a 4-20mA output controller, thermocouple, thermocouple weld and wire, as well as a modulating bypass actuator installed, wired, and tested (for a single 120 volt, 1ph, 60 hz connection).

STACK CORROSION CONTROL ASSEMBLY

This assembly includes: Control panel with digital controller, modulating diverter actuator, and thermocouple. The Cain Stack Corrosion Control assembly senses a minimum exhaust gas temperature leaving the economizer. During a cold startup, the diverter will be powered to the 'Maximum Open Position'. As the temperature rises above a preset minimum temperature, the diverter will begin to close to the 'Normal Operation Position'. As the percent of exhaust load conditions fluctuate to lower outputs, the diverter actuator will open accordingly to maintain a minimum preset outlet 'Temperature Control Position'.

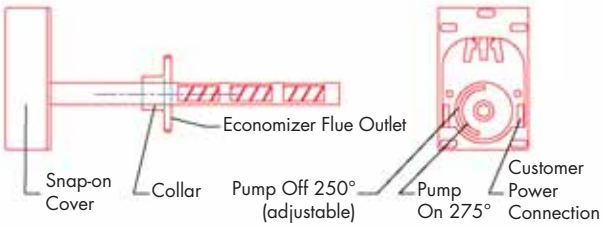
RTR Control panel shown with optional Modulating Bypass Diverter Actuator which powers the diverter to the desired position for maximum heat recovery.

Circulating Pump

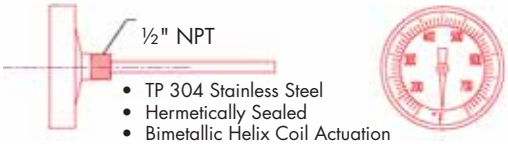


Flow Control Valve | Check Valve | Relief Valve

Pump Controller

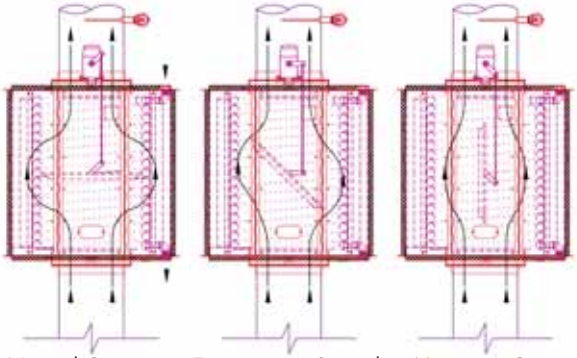


Thermometers

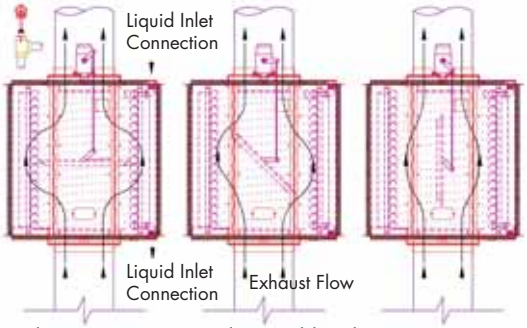


- TP 304 Stainless Steel
- Hermetically Sealed
- Bimetallic Helix Coil Actuation
- Accuracy +- 1% Range
- Adjustable Angle

Stack Corrosion Control Assembly



Normal Operating Position | Temperature Control Position | Maximum Open Position



Liquid Temperature Control Assembly (above)

REPLACING THE COMPETITION

Beyond the 5 boiler economizer product lines, including over 500 boiler exhaust economizers, the 'unique application' is no problem. Our team concept with the specifying engineer provides the solutions for the complete engineered system. These systems have ranged from modifying the RTR model to all stainless for condensing natural gas combustion below 150°F to preheating boiler feedwater from bio/landfill fired boiler exhaust.

Impossible to some, but for one of the largest hospitals in Manhattan we designed and manufactured a large customized RTR unit that could be shipped in small components and reassembled in the field. The objective was to provide a boiler economizer which would retrofit the exhaust of two of the five 125,000 pph boilers as located 3 stories below the street. All the components were shipped on two flat bed trucks. Upon jobsite arrival the components were manually carried down through a 3x3 foot square manway in the middle of the sidewalk. They were then assembled together as a single 250,000 pph boiler economizer within the two boiler's manifolded exhaust breaching. Since the boiler feedwater piping had been completed prior, the installation was finished in two weeks!.

The horizontal RTR shown above was custom engineered and

manufactured to replace a competitor's unit that failed. One of the problems causing the failure was poor performance due to an ineffective sootblower. Cain's exclusive Timed Automatic Sootblower provides total control for blowdown intervals to accommodate the specific soot buildup of every application. This unit was also designed to exactly match the exhaust flange dimensions and overall size for easy replacement.

The vertical RTR unit to the left also replaced a failed competitor's unit and was constructed to be a replacement fit and offer greater performance. ASME designed at 750 PSIG this RTR is rated for a 150,000 lb/hr steam boiler. With an exhaust gas flow rate of more than 36,000 SCFM, it saves the end user over $450,000 each year in fuel costs.

We engineer and manufacture combustion heat recovery systems for just about every type of combustion source. This ranges from the small multi-family residential natural draft boilers to the large high pressure industrial boiler feedwater preheater systems.

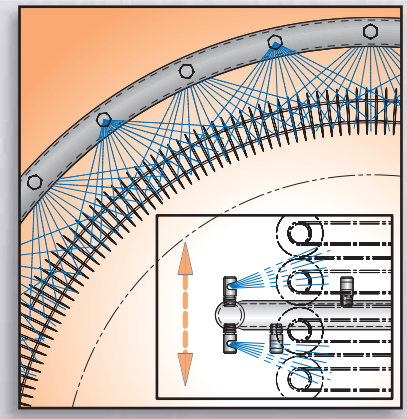
Whether you need a single straight forward economizer or you are planning a complex process application, we would like to discuss the ways that Cain Industries can dove-tail our engineering skills to meet your needs.

EXCLUSIVE OPTIONAL TIMED AUTOMATIC SOOTBLOWERS

The exclusive Cain Industries Timed Automatic Sootblower design is applied where the sulphur content is high and/or combustion efficiency is poor. When a soot layer accumulates on the heating surface to a thickness of 1/8", fuel consumption is increased by 8.5%. The sootblower is also applied when it is not cost-effective to open inspection doors and clean the exchanger by other means. The sootblower system will continually keep the heating surface at a high performance level and eliminate the day-to-day operator expense and operation down time.

The blowdown sequence occurs while the boiler is in full operation and is fully adjustable. The special flood-jet type nozzles achieve maximum cleaning velocity using steam or air as discharged through an electric control valve (included).

Together they form a 'continuous knife edge concentrated spray pattern' surrounding the heating surface. This 'ring nozzle assembly' is attached to a manifolded flexible steel hose assembly and powered up and down by a pneumatic drive cylinder. Dual timing relays allow complete control for cycle duration and interval specific to each application. The final results are a controlled double cleaning action, insuring that the maximum Btu recovery and anticipated savings are achieved.

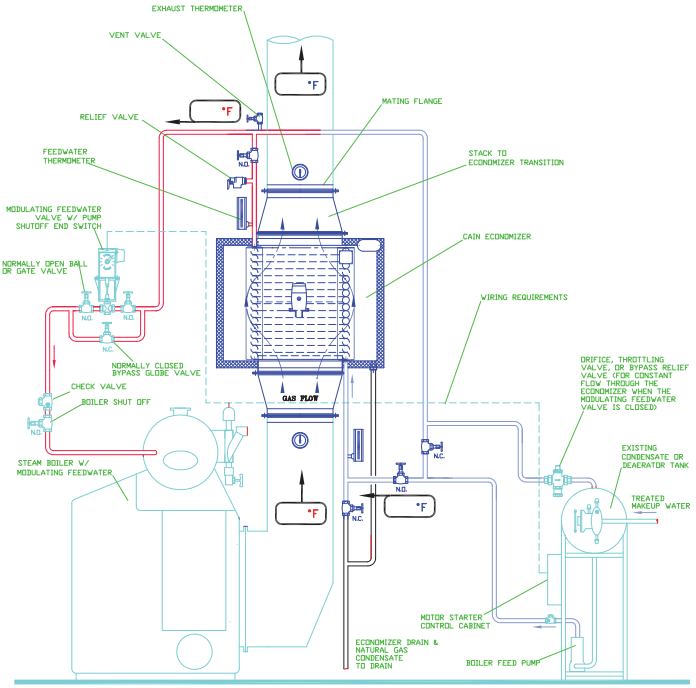


Flood-jet type nozzles together form a unique high velocity knifing action to allow full penetration of the complete heating surface.

PREHEATING BOILER FEEDWATER

For boilers with *continuous*, modulating feedwater.

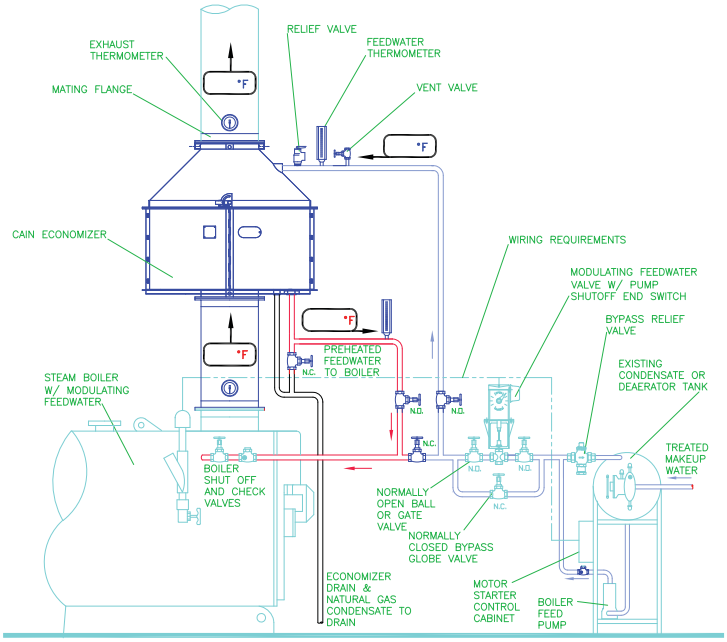
Steam Boiler Exhaust



PREHEATING BOILER FEEDWATER

For boilers with *continuous*, modulating feedwater.

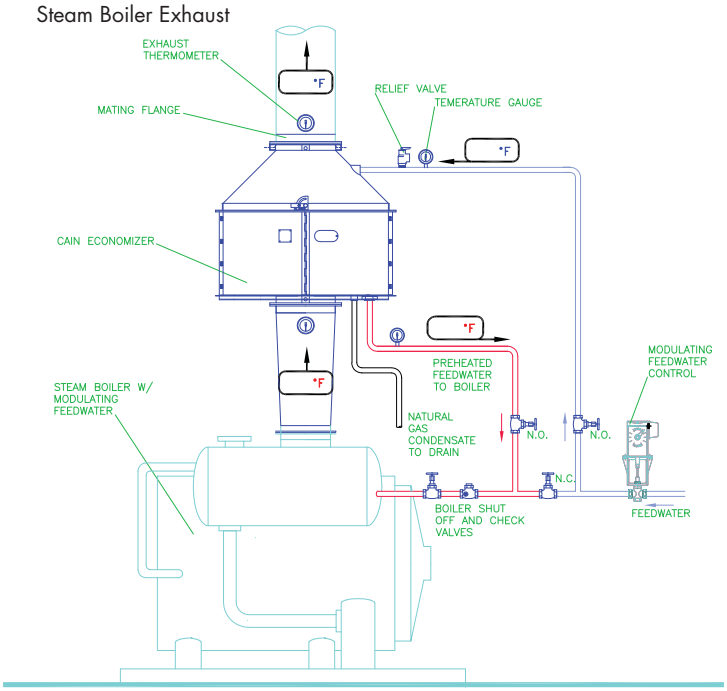
Firetube Steam Boiler Exhaust



PREHEATING BOILER FEEDWATER

For boilers with *continuous*, modulating feedwater.

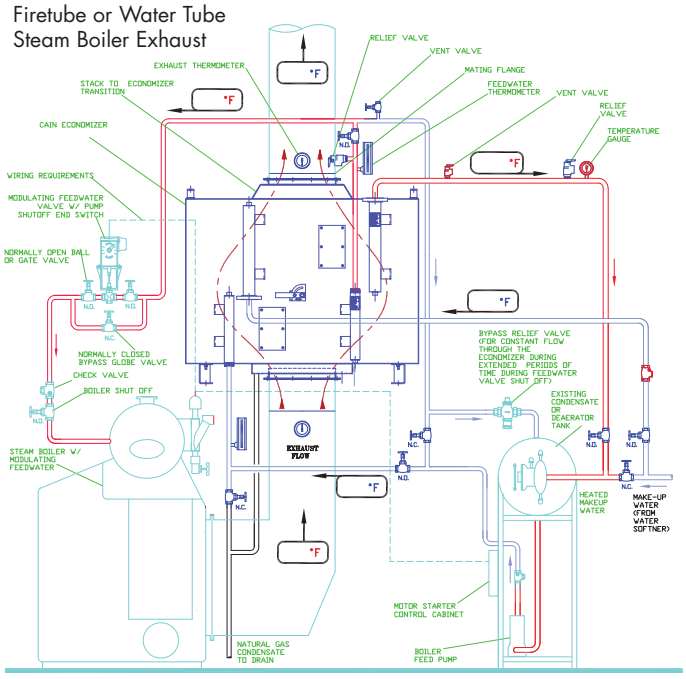
Water Tube
Steam Boiler Exhaust



PREHEATING BOILER FEEDWATER & MAKEUP WATER

For boilers with *continuous*, modulating feedwater and cold makeup water. (Condensing Heat Exchanger)

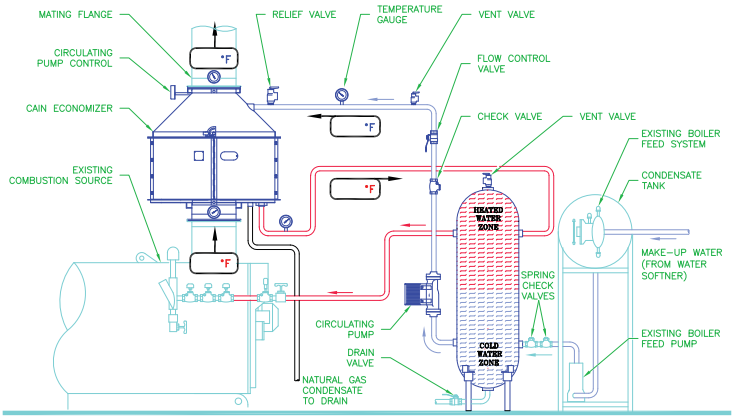
Firetube or Water Tube
Steam Boiler Exhaust



PREHEATING BOILER FEEDWATER

For boilers with on/off feedwater.

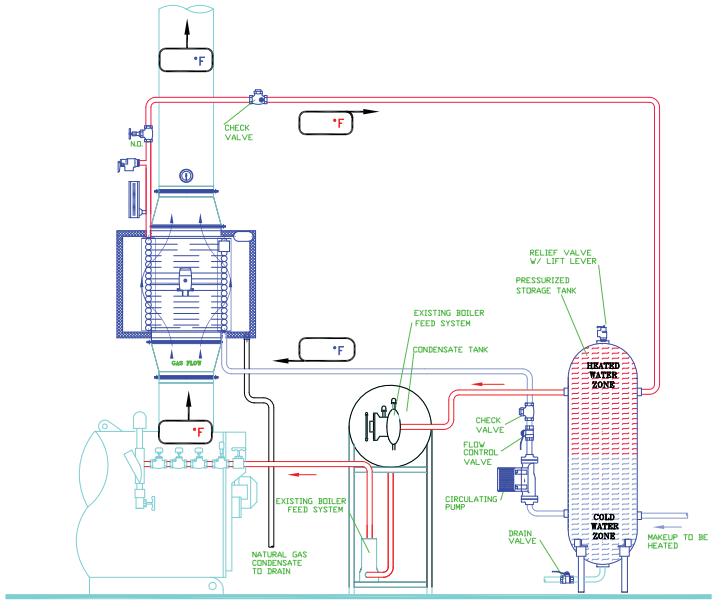
Steam Boiler Exhaust
(Circulating tank system)



PREHEATING MAKEUP WATER

For boilers with on/off makeup water.

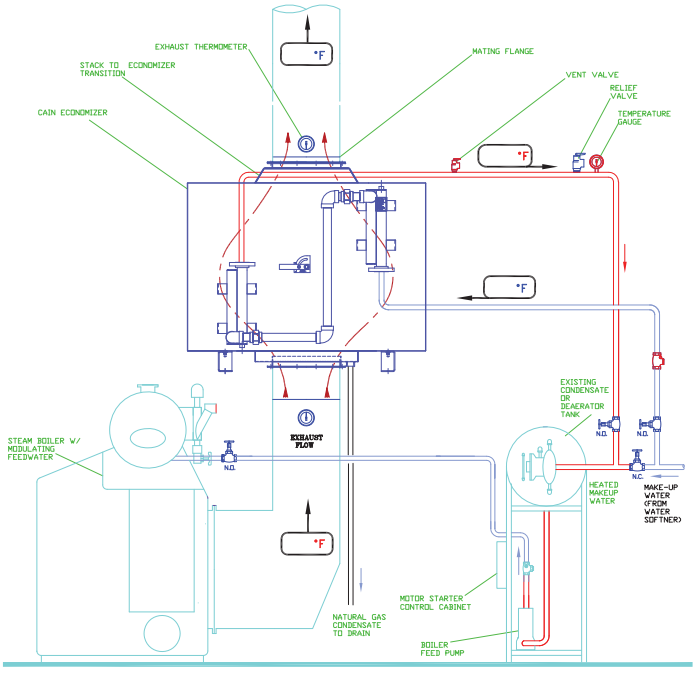
Steam Boiler Exhaust
(Circulating tank system)



PREHEATING MAKEUP WATER

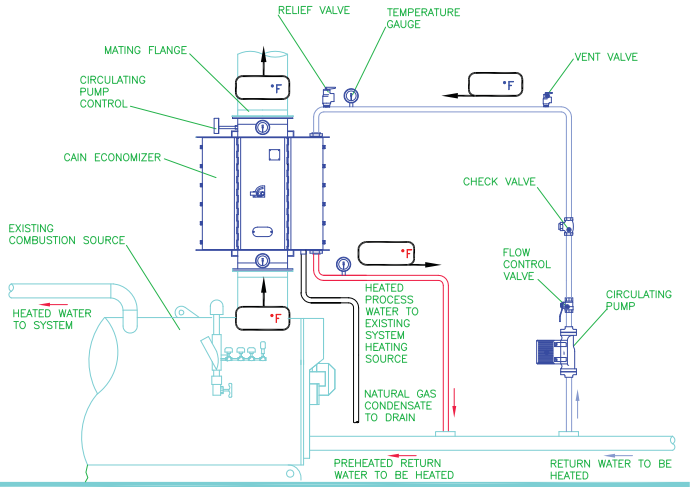
For boilers with *continuous*, cold makeup water. (Condensing Heat Exchanger)

Firetube or Water Tube
Steam Boiler Exhaust



PREHEATING HOT WATER RETURN

Hot Water Boiler



SAVINGS COMPARISON ANALYSIS

Four examples of typical combustion source types, and the results with a Cain Industries heat recovery system applied.

DATA without a Cain System	
Combustion Source: 1200 BHP **Steam Boiler**	
Heat Sink	Boiler Feed Water
Waste Exhaust Temp	405°F
Water Temp. Inlet	220°F
Btu/hr Burner Input	50,212,000
Fuel Type	Natural Gas
O_2 Content	3.5%
Excess Air	18.5%
Combustion Efficiency	82.8%
Fuel Cost Per Therm	$0.80
Annual Operating Hours	6,000

PERFORMANCE with a Cain System	
Model Selection	RTR-160H26ALS
Boiler Feed Water Flow	82.8 gpm
Final Exhaust Temp.	307°F
Water Temp. Outlet	250°F
Pressure Drop, Water	1.0 psig
Pressure Drop, Exhaust	0.49" WC
Btu/hr recovered	1,210,000
Btu/hr saved	1,468,200
Total Cost Installed	$38,380
Payback	**6.5 mo.**
Annual Return on Investment	**184%**
Annual Savings	**$70,472**

DATA without a Cain System	
Combustion Source: 800 BHP **Steam Boiler**	
Heat Sink	Boiler Feed Water
Waste Exhaust Temp	470°F
Water Temp. Inlet	210°F
Btu/hr Burner Input	33,580,000
Fuel Type	Natural Gas
O_2 Content	6%
Excess Air	36%
Combustion Efficiency	79.75%
Fuel Cost Per Therm	$0.80
Annual Operating Hours	6,000

PERFORMANCE with a Cain System	
Model Selection	RTR-148H26ALS
Boiler Feed Water Flow	55.2 gpm
Final Exhaust Temp.	335°F
Water Temp. Outlet	257.7°F
Pressure Drop, Water	2.0 psig
Pressure Drop, Exhaust	0.47" WC
Btu/hr recovered	1,267,000
Btu/hr saved	1,588,100
Total Cost Installed	$37,700
Payback	**5.9 mo.**
Annual Return on Investment	**202%**
Annual Savings	**$76,229**

DATA without a Cain System	
Combustion Source:	**1,250 kW Engine**
Heat Sink	50% Ethylene Glycol
Waste Exhaust Temp	968°F
Water Temp. Inlet	195°F
SCFM	3,667
Fuel Type	Natural Gas
O_2 Content	N/A
Excess Air	N/A
Combustion Efficiency (relative)	78%
Fuel Cost Per Therm	$0.80
Annual Operating Hours	6,000

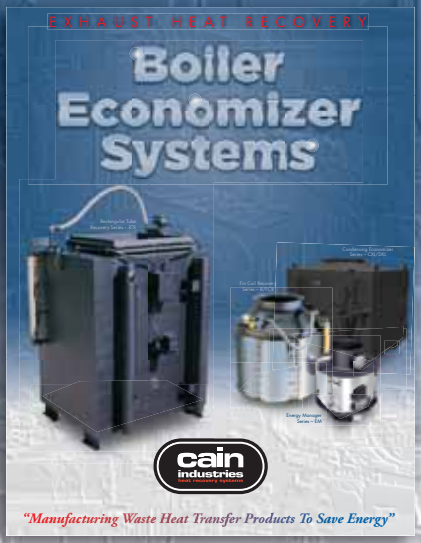
PERFORMANCE with a Cain System	
Model Selection	HRSR-336B28CSS
Circulating Liquid Flow	175 gpm
Final Exhaust Temp	330°F
Water Temp. Outlet	232.3°F
Pressure Drop, Water	8.3 psig
Pressure Drop, Exhaust	1.75" WC
Btu/hr recovered	2,864,000
Btu/hr saved	3,671,400
Total Cost Installed	$57,960
Payback	**3.9 mo.**
Annual Return on Investment	**304%**
Annual Savings	**$176,227**

DATA without a Cain System	
Combustion Source:	**1,700 kW Engine**
Heat Sink	Process Steam
Waste Exhaust Temp	783°F
Water Temp. Inlet	N/A
SCFM	5,222
Fuel Type	Natural Gas
O_2 Content	N/A
Excess Air	N/A
Combustion Efficiency (relative)	78%
Fuel Cost Per Therm	$0.80
Annual Operating Hours	6,000

PERFORMANCE with a Cain System	
Model Selection	ESG1-620D18CSS
Operating Steam Pressure	150 PSIG
Final Exhaust Temp	428°F
Boiler Horsepower	68 BHP
Equivalent Evaporation	2,339 pph
Pressure Drop, Exhaust	1.55" WC
Btu/hr recovered	2,269,000
Btu/hr saved	2,909,000
Total Cost Installed	$113,600
Payback	**9.8 mo.**
Annual Return on Investment	**123%**
Annual Savings	**$139,635**

Savings comparison data is based on a conservative fuel cost per therm (100,000 Btu), and approximate annual operating hours. Your results may vary. Total Cost Installed includes: Equipment, shipping, and complete installation. Contact Cain Industries for your FREE savings analysis proposal.

MARKET SPECIFIC PRODUCT LINES



Your Authorized Cain Representative

cain industries
heat recovery systems

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SD-II-6 ECON BoilerFeedwaterEconomizerAnalysisandQuote

60,000 PPH Steam Boiler Exhaust Economizer
*** Feedwater Preheater ***

Ref: 60673
Rep: 24675101
Rev: 0

Date: 11/7/2016
Page: 1

Engineered For:

Donelson Corporation
1723 SW Adams St.
Peoria, IL 61602-1713

Attn: Craig Martin
Ph: (309) 674-8068
Fax: (309) 674-0741

Consultant:

Henneman Engineering, Inc.
1232 Fourier Dr.
Suite 101
Madison, WI 53717-1960

Attn: Paul Boland
Ph: (608) 833-7000
Fax: (608) 833-6996

End User:

University of Wyoming
1000 E. University Ave.
Laramie, WY 82071

Ph: (307) 766-1121

System Description:

Cain Industries is pleased to propose the following RTR model exhaust economizer and components to recover exhaust heat from a 60,000 PPH, natural gas fired, steam boiler. The recovered heat will be transferred to boiler feedwater and boiler makeup water, thereby increasing the overall efficiency and lowering the fuel demand.

The RTR model features: individually removable, type 316L Stainless Steel tubes with aluminum fins (Al-Fuse fin to tube attachment); a Stainless Steel, internal, exhaust gas bypass; a Stainless Steel interior shell; 3" of factory insulation (less stack adapters and liquid headers); a 10 gauge carbon steel exterior shell; a hinged, full face, access door for inspecting and/or cleaning the finned tubing; and a condensate catch and drain.

Compression fitted tubes to headers do not require any welding in the event of tube replacement.

The annual operating hours and the cost per therm (100,000 Btu) of fuel were assumed.

60,000 PPH Steam Boiler Exhaust Economizer
*** Feedwater Preheater ***

Ref: 60673
Rep: 24675101
Rev: 0

Date: 11/7/2016

Quotation:

Qty	Part #	U/M	Description
1		EACH	RTR-172M26ALS
			-INCLUDING:
			Compression Fitted Fintubes
			Stainless Internal Bypass Assy
			Stainless Interior
			10ga. Carbon Steel Exterior
			3" Thks. Factory Insulation
			Inspection Door,(tube replace)
			Threaded Drain & Vent Conn.s
			-SYSTEM COMPONENTS:
1	962020	EACH	ASME Stamp-SEC.VIII;DIV.I(`U')
1	967100	EACH	Corros Resist Ctng & Drain Asy
1	967260	EACH	RTR HINGED DOOR: RTR-172
2	973200	EACH	72"x72" Mating Flange Gasket
	989950	EACH	Stack-Economizer Inlet Adapter
	989951	EACH	Economizer-Stk. Outlet Adapter
	989980	EACH	Adapter-Stack Mating Flanges
	989981	EACH	Adapter-Stack Mating Flange Gaskets
1	430056	EACH	3/4" NPT ASME Relief Val: 300 PSI
2	467200	EACH	T-METER,5"Dial 150-750'F
2	480191	EACH	3"Dial, bimetal 50-500 w/well

TOTAL PRICE (USD)	$54,452
ANNUAL RETURN ON INVESTMENT	121%
5 YEAR SAVINGS	$330,030
10 YEAR SAVINGS	$660,060
PAYBACK PERIOD, MONTHS	9.9

Terms of Sale:
* Estimated Shipping: 8 to 10 weeks after submittal approval
* Payment Terms: See Bulletin #25500
* See Bulletin 25500 including 'Warranty and Performance Guarantee'.

10:03:gs:r

Representative

Greg Schneider
Cain Industries, Inc.

60,000 PPH Steam Boiler Exhaust Economizer
*** Feedwater Preheater ***

Ref: 60673
Rep: 24675101
Rev: 0

Date: 11/7/2016
Page: 3

Waste Heat Exhaust:
Primary Fuel Type: Natural Gas
Secondary Fuel Type:
Fuel Cost per 100,000 BTU (USD): $0.50

Heat Source: 60,000 PPH Steam Boiler
Exhaust Flow: Vertical
Heat Sink: Boiler Feedwater

Model: RTR-172M26ALS

Overall Configuration, inches	114x96
Overall Height, inches	81.6
Liquid Connection	5
Exhaust Connection	30x48
Dry Weight, lbs.	4921
Wet Weight, lbs.	5200
Surface Area, Ft2	2,161
Design Pressure, PSIG	300
Hydrostatic Test Pressure, PSIG	450
@ Design Temperature, °F	650
Maximum Entering Temperature, °F	750

Performance:	**Load 1**	**Load 2**	**Load 3**
Load of Maximum Output, %	100%	60%	30%
Burner Input, MBTU/Hr	72772	43663	21831
Fuel to Output Efficiency, %	82.22%	82.35%	81.90%
O^2 Content, %	3.00	4.00	5.00
Excess Air, %	15.3	21.5	28.0
Exhaust Entering Temp, °F	425°	400°	400°
Exhaust Flow Rate, SCFM	14638	9216	4835
Exhaust Leaving Temp, °F	314°	296°	285°
Pressure Drop " W.C. Max	0.35	0.13	0.04
Liquid Entering Temp, °F	227.0°	227.0°	227.0°
Liquid Flow Rate, GPM	120.0	74.0	36.9
Liquid Leaving Temp, °F	260.5°	258.6°	263.7°
Pressure Drop, PSIG	0.25	0.10	0.03
Heat Recovered, MBTU/Hr	1938	1126	653

Savings:			
Heat Saved (x 100 MBTU/Hr)	23.566	13.670	7.974
Annual Hours of Operation	2920	2920	2920
ANNUAL SAVINGS (USD)	**$66,006**		

SUBMITTAL

DATE: 11/7/2016 REF#: **60673** REV#: **0**

FOR: Donelson Corporation
c/o: Cain Industries, Inc.

MODEL: RTR-172M26ALS
HEAT SOURCE: 60,000 PPH Steam Boiler

Bul.#10311

RTR

PARTS LIST
(SEE DESIGN DATA FOR CONSTRUCTION)

1. 10 GA. C.S. GAS TIGHT WELDED EXTERIOR
   STAINLESS STEEL EXTERIOR ☐ (OPTIONAL)
2. INSPECTION DOOR: TUBE CLEANING
3. HINGED DOOR ☑ (OPTIONAL)
4. STAINLESS STEEL EXHAUST BYPASS
5. STAINLESS STEEL INTERIOR
6. 2" THKS. INSULATION: 3" ☐ (OPTIONAL)
7. ASME STAMP: ☑ (OPTIONAL)
8. RTR TO STACK ADAPTER: ☑ (OPTIONAL)

VERTICAL
EXHAUST FLOW

NOTES:
* LIQUID CONNECTIONS
2" OR LESS = NPT

***FINTUBE MATERIALS:

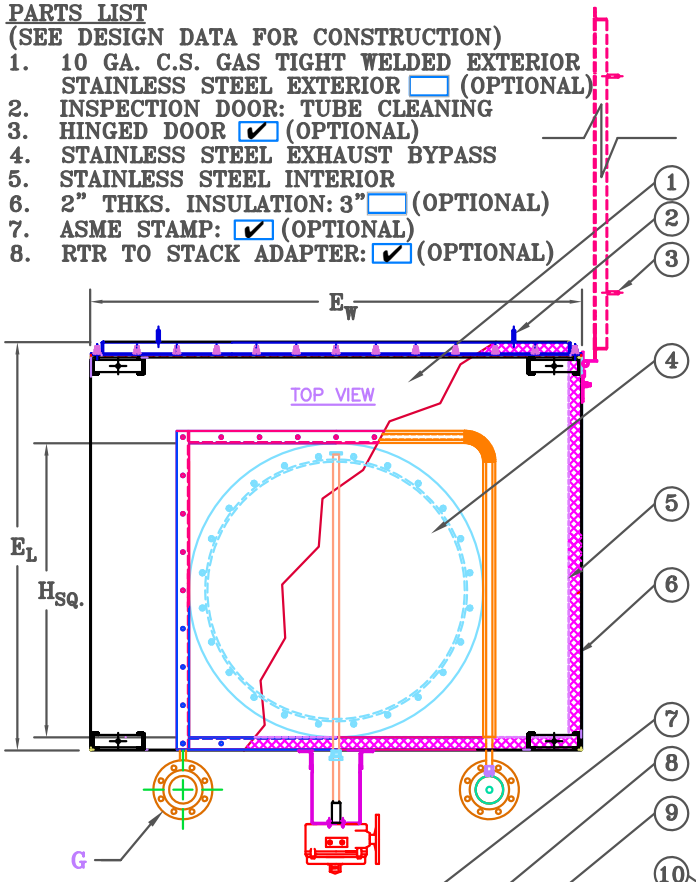
TUBE TYPE:
- ☐ CARBON STEEL
- ☑ TP316 STAINLESS
- ☐ DUPLEX STAINLESS

FIN TYPE:
- ☐ CARBON STEEL
- ☐ TP304 STAINLESS
- ☑ ALUMINUM

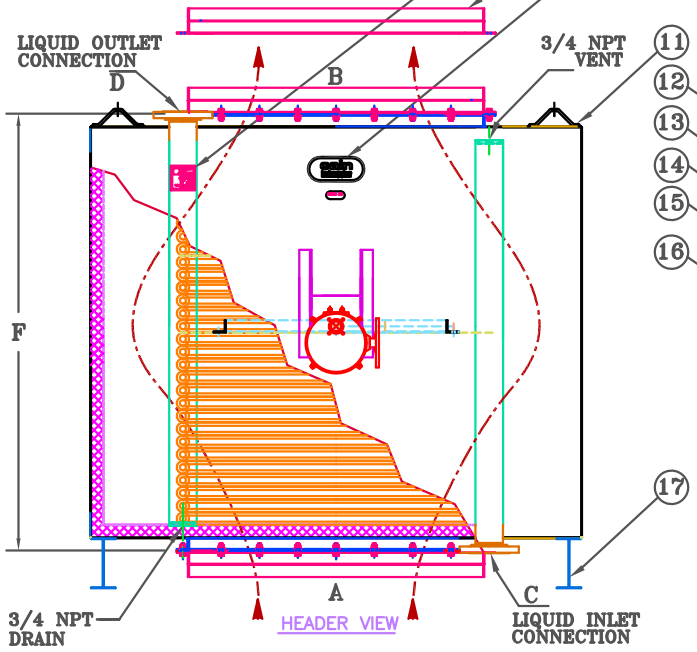
METHOD OF ATTACHMENT:
- ☐ COPPER BRAZED
- ☐ NICKEL BRAZED
- ☐ WELDED
- ☑ ALFUSE

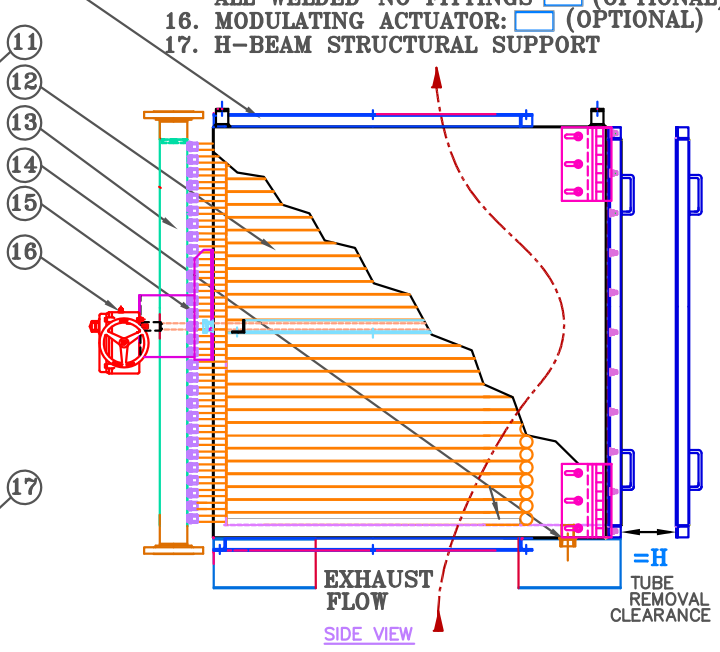
PERFORMANCE AND DIMENSION DATA

A.	425 °F
B.	314 °F
C.	227 °F
D.	260 °F
E.	114x96 "
F.	81.6 "
G.	5 " CONN.
H.	72x72 " CONN.
	2,161 H.S.
	4921 # WGT
	300 PSIG
	750 TEMP.



9. CAIN IND. LOGO & SERIAL NO. ID.
10. 2 x 2" GAS FLANGE CONNECTION:
    3 x 3" ANGLE: ☐ (OPTIONAL)
11. LIFTING LUGS
12. ***REMOVABLE FIN TUBE ROWS
13. HEADER MANIFOLD, LOW PRESS. DROP
14. DRAIN CATCH ASSEMBLY AND
    CONDENSATE DRAIN: ☑ (OPTIONAL)
15. COMPRESSION FITTING: TUBE REMOVAL
    ALL WELDED–NO FITTINGS ☐ (OPTIONAL)
16. MODULATING ACTUATOR: ☐ (OPTIONAL)
17. H–BEAM STRUCTURAL SUPPORT





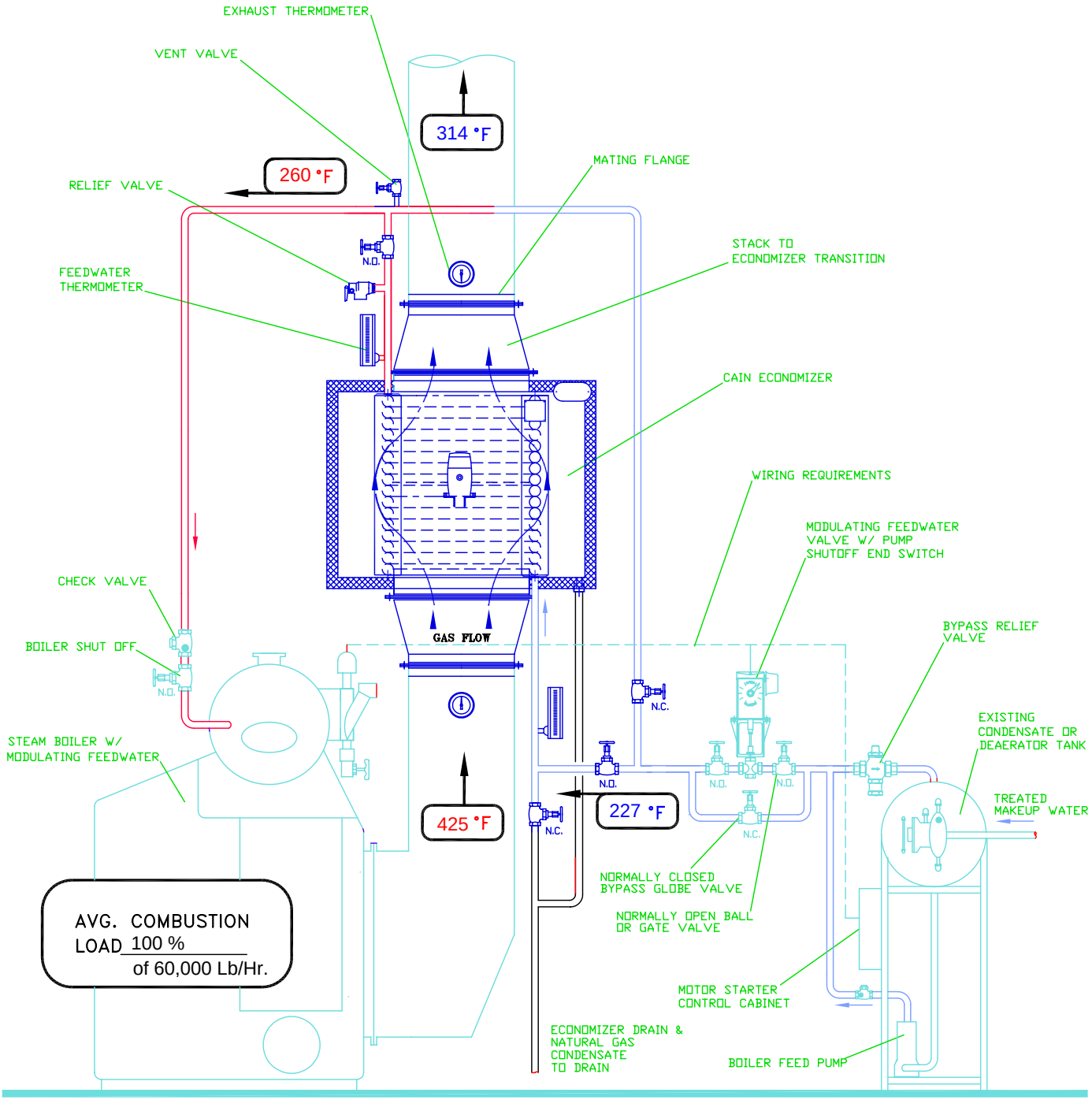
CAIN INDUSTRIES Inc. PO Box 189 W194 N11826 McCormick Drive Germantown, WI 53022
Phone (262) 251-0051 (800) 558-8690 Fax (262) 251-0118 sales@cainind.com www.cainind.com

SUBMITTAL

PREHEAT BOILER FEEDWATER

Bul.#23510

STEAM BOILER EXHAUST
PREHEATING BOILER FEEDWATER



THIS FLOW DIAGRAM SUGGESTS A BASIC FLOW DESIGN AVAILABLE FOR CONSIDERATION REGARDING THE INSTALLATION OF A CAIN EXHAUST STACK ECONOMIZER. AS IT MAY BE MODIFIED DEPENDING ON SPECIFIC INSTALLATION REQUIREMENTS OR AN ALTERNATE FLOW DESIGN WHICH MAY BE REQUIRED, CAIN INDUSTRIES IS NOT RESPONSIBLE FOR ANY MODIFICATIONS, CHANGES, OR SELECTIONS.

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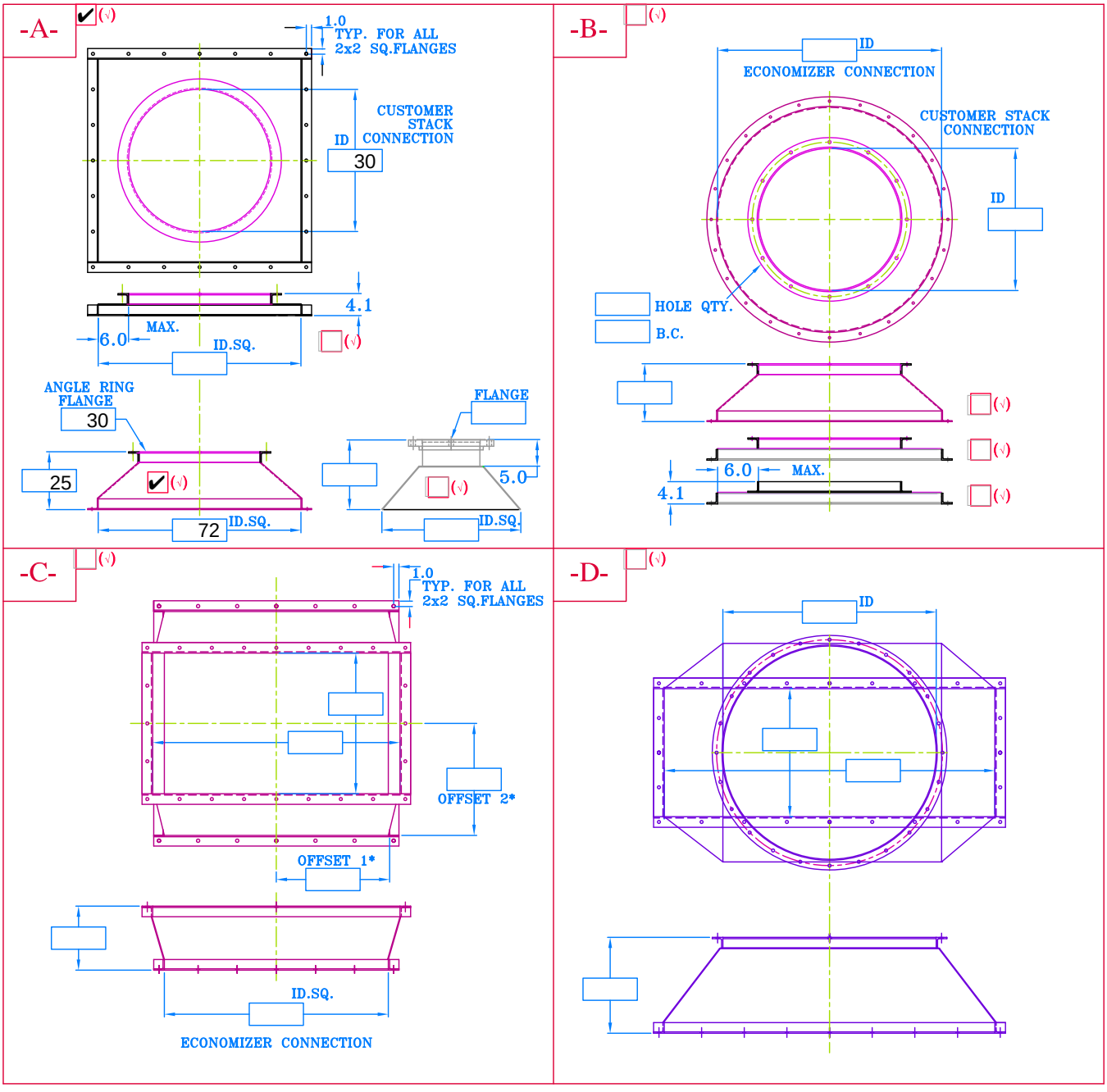
SUBMITTAL

STACK TO ECONOMIZER ADAPTERS

NOTES:

1. ADAPTER MATERIALS: CARBON STEEL (MIN. BREECHING THKS.: 12 GA.)
   −OPTIONAL STAINLESS STEEL: ☐
2. SQ. OR RECT. FLANGE CONNECTIONS TO CUSTOMER STACK: 2" x 2" FLANGE
   MIN. FLANGE THKS: 7 GA.
   −OPTIONAL .25" x 3" x 3" FLANGE: ☐
3. *OFFSET ADAPTER DIMENSIONS COMPLETE AS REQUIRED −OPTIONAL AND PRICED EXTRA
4. SLIP FIT CONNECTIONS CAN ALSO BE BUTT WELDED TO STACK BREECHING
5. SEE MATING FLANGE AND FLANGE GASKET LISTS FOR DIMENSIONS
6. CUSTOMER FLANGE CONNECTIONS ARE PROVIDED WITH A HOLE PATTERN (.5 ID MIN.) UNLESS OTHERWISE INDICATED.

Bul. #11040



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TERMS OF SALE

Bul. 25500

The terms of the attached Limited Warranty are included in these Terms of Sale and are incorporated by reference herein. The following "Terms of Sale" forms as a part of the Cain Industries equipment proposal as attached herein. All proposed pricing is quoted F.O.B. factory. All pricing is quoted in U.S. currency.

QUOTED DELIVERY TIME:
Delivery times quoted are appropriate for various product lines, and based on conditions at the time of quotation. Cain Industries, Inc. will, in good faith, attempt to deliver the equipment within the time quoted. In no case shall Cain Industries, Inc. be liable for incidental or consequential damages resulting from failure to meet requested or quoted delivery schedules. Quoted delivery time is based from the date of receipt of an approved written purchase order including written authorization to proceed with fabrication and the initial down payment if required, or from date of receipt of submittal drawings when required (less 10 working days).

OFFER EXPIRATION:
All offers expire 60 days from the quotation date unless otherwise stated and are subject to cancellation by Cain Industries, Inc. at any time prior to the formal acceptance of our offer to furnish equipment quoted.

SUBMITTAL DRAWINGS:
Submittal drawings are issued 5-10 working days from receipt of written purchase order, when required by either Cain Industries and/or the Buyer, and must be returned (marked "Approved for Production", signed, and dated) in order to initiate production. Production cannot begin until the approved submittal drawings are returned.

SHIPMENT OF GOODS:
Unless otherwise specifically agreed, all shipments are made F.O.B. Factory via "best way" and shipped freight collect. Cain Industries, Inc. responsibility ceases upon acceptance by the carrier. SHOULD GOODS BECOME LOST OR DAMAGED IN SHIPMENT, THE PURCHASER OR RECIPIENT OF THE GOODS MUST IMMEDIATELY NOTIFY AND PLACE CLAIM WITH THE CARRIER, ADVISE CAIN INDUSTRIES, INC. OF ANY DAMAGE OR DISCREPANCY, AND OBTAIN AUTHORIZATION FOR RETURN OR REPLACEMENT. As a courtesy, Cain Industries, Inc. will assist in tracing and recovering lost goods and the collection of just claims, but cannot guarantee safe delivery. Loss or damage in shipment does not release the purchaser from payment of the total invoice.

PAYMENT-ESTABLISHED ACCOUNTS:
Payments for established accounts with a credit limit are due on or before the Net 30 days from date of invoice due date, and coinciding with shipment date and/or 'ready for shipment date'.

EXPEDITING:
Expediting charges may be issued in order to improve delivery depending on the shorter delivery time required. Contact Cain Industries for pricing for the best possible delivery.

STORAGE:
When the equipment is ready for shipment, it will be shipped to the 'ship to' address noted on the Sales Order, unless other wise indicated. Should there be a request to hold the equipment beyond the 'ready for shipment date', Cain will store the equipment for up to 30 days at no cost providing storage space is available. Contact Cain Industries for storage costs when equipment is expected to be stored for more than 30 days. If storage space is unavailable, the buyer agrees to make provisions to receive the equipment when it becomes ready for shipment.

MINIMUM BILLING:
The minimum order is $100.00, plus shipping costs.

CREDIT LIMIT:
Accounts over credit limit will be on a "Cash with Order" basis until account is brought to below "Credit Limit" status. Special circumstances may occur where credit limits may be adjusted for companies with past credit history satisfactory to Cain Industries, Inc.

TAXES OR SURCHARGES:
Quoted prices do not include sales, use, excise, occupation, processing transportation or other similar taxes which Cain Industries, Inc. may be required to pay or collect with respect to any of the quoted materials. Such taxes which are or may be incurred shall be paid by the purchaser.

PAYMENT-NEW ACCOUNTS:
An initial purchase order received from a new account shall require a 50% down payment with the order, receipt of the completed credit application for immediate processing, and the balance due prior to shipment; or 30% with purchase order and receipt of the completed credit application (order will be held until credit limit has been established) in conjunction with credit limit and/or progress payment schedules. Allow a 3 week processing period to complete the credit check.

PAYMENT-ORDERS OUTSIDE THE UNITED STATES:
For purchase orders received wherein the the final installation and/or the Buyer is located outside the United States, payments shall be made according to the guide lines as set forth herein. It is recommended that a Letter of Credit be created and issued with the purchase order for immediate order processing. All costs associated with international payments such as but not limited to: proforma invoicing, letter of credit, agents of record processing, currency adjustments, tariffs and special taxes, etc. shall be the responsibility of the purchaser. All payments shall be made in U.S. currency and shall be paid in full prior to shipment outside the United States.

SERVICE CHARGE:
A 2% per month service charge will be assessed on all past due amounts.

PROGRESS PAYMENT SCHEDULES:
The following are payment schedules for orders exceeding credit limit:
- For purchase orders of $25,000 to $50,000:
  - -30% due with purchase order
  - -30% due at 45 days from receipt of approval drawings
  - -Balance due 30 days from shipment.
- Over $50,000 or required for the ESG product orders:
  - -15% due with purchase order
  - -15% due with submittal approval drawings
  - -30% due 45 days from receipt of approved submittal drawings
  - -30% due prior to shipment
  - -Balance due 30 days from shipment.

CANCELLATION AND CHANGES:
As many Cain Industries, Inc. products are manufactured and/or adjusted "to order", orders accepted and acknowledged by Cain Industries, Inc. are not subject to change or cancellation without prior consent of Cain Industries, Inc. Order quantity reductions or cancellations, if granted, will be subject to cancellation charges consistent with components "restockability versus made to order specifications" percent of production completion, etc.

EQUIPMENT STARTUP & SERVICE:
Pricing for equipment requiring startup or service: $1100 per day for installations located within the continental United States; $1300 per day for installations located in Canada; all other installation locations are quoted per application. Travel, lodging, and subsistence expenses are in addition. Startup can only be initiated upon receipt of completed Pre-Startup form. ESG & ESG1 boiler startups must be completed by authorized Cain personnel to allow the warranty to become effective, unless otherwise stated in a written agreement issued by Cain Industries to the Buyer.

RETURN OF GOODS FOR WARRANTY REPAIR, REPLACEMENT, OR CREDIT:
Authorization to return goods for any reason must be obtained from Cain Industries, Inc. prior to the return of the shipment being made. All items returned for repair, replacement or credit shall be returned freight prepaid. Freight collect shipments will not be accepted. A 30% "minimum" restocking charge will be made on all items returned for credit. Cancellation and/or restocking charges will apply to the balance of the order pending with a maximum of 90% as determined at the point of cancellation dependent on the work in process. Quantities shipped prior to the point of cancellation shall be issued an additional invoice for the difference in price breaks between the original quantity ordered and the total shipped up to the point of cancellation.

PROPRIETARY DATA:
All manufacturing drawings, specifications and technical material submitted by Cain Industries, Inc. are the property of Cain Industries, Inc. and are to be considered as confidential. Except for its original intent the submittal information supplied herein attached cannot be copied, transferred, or used in any way without the express written authorization from Cain Industries, Inc.

LIMITATION OF REMEDIES:
Cain's liability is limited exclusively to its obligations under the attached **Limited Warranty**, the terms of which are incorporated by reference herein. Buyer agrees that in no event will Cain be liable for cost of processing, loss of profits, or any other consequential or incidental damages or cost of any kind resulting from the order and or use of its product, whether arising from breach of warranty, non-conformity to order specifications, delay in delivery or any other loss sustained by buyer.

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LIMITED WARRANTY AND PERFORMANCE GUARANTEE

Bul. 25500

LIMITED WARRANTY AND PERFORMANCE GUARANTEE

Cain Industries, Inc. warrants all products manufactured to be free from defects in material or workmanship under normal use and conditions for a period of one year from the date of startup or 18 months from date of shipment from our factory whichever occurs first. Cain Industries liability under this warranty to the buyer shall be limited to Cain's decision to repair or replace, all its factory items deemed defective after inspection at the factory or in the field. When field service is deemed necessary in order to determine a warranty claim, the costs associated with travel, lodging, etc. shall be the responsibility of the buyer except under prior agreement for a field inspection. All warranty claim requests must be initiated with a Material Return Authorization (MRA) number for processing and tracking purposes. The MRA number shall be issued to the buyer upon Cain's receipt of a purchase order for replacement component(s) required immediately and prior to warranty claim approval and/or a field inspection. No agent or employee of Cain Industries, Inc. has any authority to make verbal representation or warranty of any goods manufactured and sold by Cain Industries, Inc. without written authorization signed by an executive officer of Cain Industries, Inc. Cain Industries, Inc. warrants the equipment designed and fabricated to perform in accordance with the specifications as stated in the proposal for the equipment, and while the equipment is in new and clean condition and properly operated within the specific design limits for that equipment. Should any piece of equipment designed by Cain Industries, Inc. not meet performance requirements when determined by standard test procedures, Cain will make corrections it deems necessary at its option under the limitations of this warranty. Any alterations or repair of Cain equipment by personnel other than those directly employed by Cain shall void this warranty unless otherwise stated under a specific written guideline issued by Cain Industries to the buyer. The ESG1 and ESG boiler startup must be completed by authorized Cain personnel to allow the warranty to take effect unless otherwise stated in a written agreement issued by Cain Industries to the buyer. This warranty does not cover damage resulting from misapplying Cain Industries products and/or improper installation. This warranty does not cover corrosion resulting from the effects of physical or chemical properties of water, steam or the liquids or gases used in the equipment. This warranty does not cover damage resulting from combustion source backfires or explosions which exceed Cain Industries product specific maximum design pressure and/or when explosion hatches are not properly installed where required. This warranty does not cover damage resulting from excessive vibration resulting from isolating vibration protection not properly installed where required. This warranty does not cover damage resulting from expansion due to expansion joints not properly installed where required. This warranty does not cover damage or lost performance due to combustion source related deficiency such as soot build up on the heating surface. Cain makes no other warranties of performance or product either expressed or implied which extends beyond the limits contained within this instrument. All acceptance tests shall be conducted at the buyer's expense. Any such tests shall be made when the equipment is new, clean, and before being placed into service, and shall be made within 120 days of delivery. Where field test are required, the following procedures are to be used. The exhaust gas and liquid inlet and outlet temperatures shall be recorded simultaneously and measured at a minimum distance of 6 pipe diameters from the equipment. Exhaust gas and liquid volumes shall be determined by actual measurement, if practical, or by calculations if necessary. All factors of O2, CO2, excess air, full input, altitude and the operating efficiency of the primary direct fired unit, shall be incorporated in the final determination and calculation of the volume of the exhaust gas. The expense incurred for such test shall be the responsibility of the buyer and a copy of the test procedures conducted, data accumulated, and calculations used to arrive at the final results shall be submitted to Cain Industries. All workmanship, material and performance requirements shall be deemed to have been met if a contrary report has not been furnished within 120 days of delivery. This "Limited Warranty and Performance Guarantee" forms as a part of the Cain Industries equipment proposal as attached herein.

IN NO EVENT SHALL SELLER BE LIABLE FOR CLAIMS (BASED UPON BREACH OF EXPRESS OR IMPLIED WARRANTY, NEGLIGENCE OR OTHERWISE) FOR ANY DAMAGES, WHETHER DIRECT, IMMEDIATE, INCIDENTAL, FORESEEABLE, CONSEQUENTIAL, OR SPECIAL.

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SD-II-7 STOKER Powerplant
Reference for Underthrow Stoker

POWER Engineering

By Ann Chambers,
Associate Editor

Manitowoc Overcomes Coal Firing Challenge

MANITOWOC PUBLIC Utilities (MPU) is Wisconsin's largest municipally owned generating utility. Located on the western shore of Lake Michigan, it provides electricity and water to the city of Manitowoc and provides low pressure steam to local customers. Total generating capacity of the power plant is about 89 MWe.

MPU has completed several projects to extend the life of the existing plant and to improve its operating efficiency and flexibility. One of these initiatives involved fuel switching to reduce operating costs.

The plant needed to use less expensive run-of-mine and/or western coals. The less expensive fuels caused the plant problems, however, because of the large percentage of fines. When using a conventional feeder, coal with a high percentage of fines may be unevenly distributed front to back, resulting in elevated grate temperatures in the rear due to intermittent ash cover. This will eventually result in reduced life of the stoker firing equipment.

MPU uses three Detroit Stoker RotoGrate stokers at the plant, so the utility approached Detroit Stoker asking for a solution. Detroit designed and manufactured a new feeder that could handle lower quality coals that are typically friable and produce a lot of fines. Feeder problems of material bridging, binding, and poor front to rear fuel distribution in the stoker are minimized with the new design. The new feeders combine air assist with an underthrow rotor mechanism. The new feeder design also has fewer moving parts and offers more protection from overheating problems associated with other feeder designs.

Detroit stoker provided six new feeders for boiler unit No. 6. The feeders were designed to fit into the existing 18 in. opening with no modifications required to the stoker front plate or the boiler pressure parts. The feeders are capable of delivering more fuel than the old style reciprocating feeders so steam boiler capacity was never an issue. Four feeders would have been adequate, but it was more economical to place new feeders in the existing spaces than to close off two of the boiler openings.

The feeder design discharges the fuel in the underside of the rotor, enabling the blades to contact the coal for a longer period of time. This design feature, in conjunction with the pneumatic distributor plate, facilitates a more horizontal trajectory of the fuel, which distributes the fine particles more consistently onto the bed area. This leads to better combustion efficiency and an LOI reduction.

Manitowoc Public Utilities power plant in Wisconsin.

"We have had Detroit Underthrow Feeders operating at Manitowoc Public Utilities since June 1997. Consequently, we have been able to switch from expensive eastern stoker coal to run-of-mine fuel with fines in excess of 60 percent," said Ray Sturzl, MPU electric production manager. "This has resulted in an appreciable fuel cost savings for MPU. The fuel and efficiency savings have provided us the flexibility necessary to compete in the emerging deregulated 'power choice' market. The coal feeders' successful performance and operation have led to our purchase of six additional feeders for another boiler unit at our facility."

Detroit Underthrow fuel distributors.

Reprinted from the June 1999 edition of **POWER ENGINEERING**
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Detroit Stoker Company
"Our Opportunities Are Always Growing"™
1510 East First Street • Monroe, MI 48161 • 1.800.STOKER4 • Fax: 734.241.7126 • www.detroitstoker.com • sales@detroitstoker.com

September 6, 2016 **E-MAILED: pboland@henneman.com**

Henneman Engineering, Inc.
1605 South State Street
Champaign, IL 61820

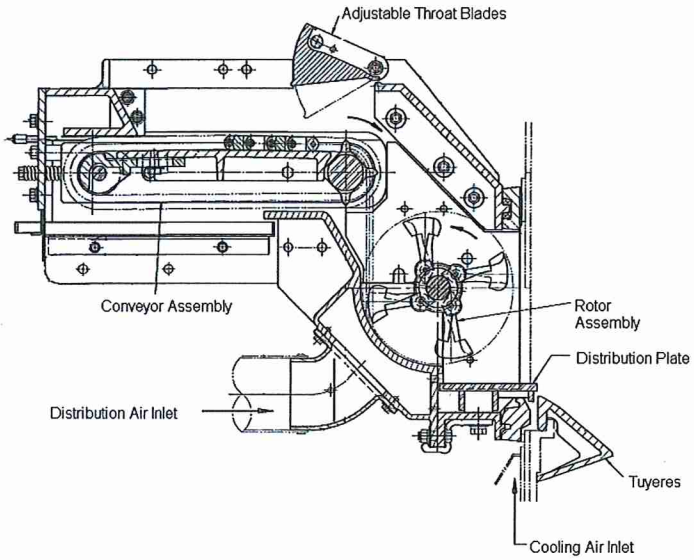
ATTENTION: Mr. Paul Boland

SUBJECT: University of Wyoming
Laramie, WY
DSC Proposal No. 7401AB1G

Dear Mr. Boland:

Detroit Stoker Company (DSC) is pleased to submit for your purposes one (1) copy of the above listed revised Proposal and Standard Terms and Conditions of Sales, Form 407B dated 1/24/11. Our offering covers the supply of nine (9) (3 – per boiler) new 18" Detroit Underthrow Fuel Distributors to replace the chain feeders originally supplied on each of the three (3) coal fired 60,000 lb/hr IBW Boilers with 9'-1 ½" wide x 13'-8" long (12'-0" net) Detroit RotoGrates (Job No. RG-967) at the subject plant.

Underthrow Coal Distributor



Detroit Underthrow Coal Distributor

The following describes the benefits of the new feeders we are offering:

Coal Feeder Design

The feeder design combines air assist with an Underthrow rotor mechanism. This unique design discharges the fuel in the underside of the rotor, enabling the blades to contact the coal for a longer period of time. This design feature, in conjunction with the pneumatic distributor plate, facilitates a more horizontal trajectory of the fuel, which

distributes the fine particles more consistently onto the bed area. This promotes better combustion efficiency by reducing the carbon content of the ash.

Features and Benefits

Promotes combustion efficiency.
Ideal for distributing fuels inconsistent in size and moisture content.
Distributes fuels more consistently and evenly than other feeders.
Ideal for distributing coals with a large amount of fines and other inconsistent material on longer stokers.
Improved distribution of fuel promotes less suspension firing resulting in lower loss of ignition.

Cost Effective

Our innovative design makes the Underthrow ideal for lower quality, less expensive fuel.

Reduced Maintenance Time and Fewer Replacement Parts

Fewer moving parts to maintain than other feeders.
The chain conveying carriage is protected from direct radiant heat exposure.
Reduces deterioration of parts from heat.
Reduces the need for replacement parts.
Internal parts removable in two main assemblies (rotor drum assembly and conveyor carriage assembly) from the front of the distributor without removing feeder from the stoker front plate.

The Underthrow coal feeders require two variable frequency drives (VFD) for each feeder. One VFD operates the rotor motor and is manually adjusted by the boiler operator. The second VFD operates the coal conveyor motor and is adjusted automatically by the combustion control system's boiler master signal. The Underthrow coal feeders also require an air supply for the distribution air. Therefore in the proposal we have offered for the following:

1. Coal Feeders with distribution air system.

2. VFD Control Panel

We trust you will find our offering to be complete. Should you have any further questions or comments, please do not hesitate to contact us.

Sincerely,

Douglas A. Perkins
Manager Aftermarket Contracts

tsa
Enclosures

CC: Utah Rep – **E-MAILED**

DETROIT STOKER COMPANY

SPECIFICATIONS AND PROPOSAL

September 6, 2016

Detroit Stoker Company (hereinafter called the Company) proposes to sell to the following (hereinafter called the Purchaser):

PURCHASER:
Henneman Engineering, Inc.
1605 South State Street
Champaign, IL 61820

The following described Detroit Stoker equipment, auxiliaries and services.

PLANT:
University of Wyoming
Laramie, WY

PROPRIETARY INFORMATION NOTICE

This proposal document is proprietary to Detroit Stoker Company (DSC) and is furnished in confidence solely for use in considering the merits of the proposal and for no other direct or indirect use. By accepting this document from DSC, the recipient agrees: (1) to use this document and information it contains exclusively for the above-stated purpose and to avoid use of the information for performance of the proposed work by recipient itself or disclosure of information to and for use by competitors of DSC on behalf of recipient, (2) to avoid publication or other unrestricted disclosure of this document or the information it contains, (3) to make no copies of any part hereof without the prior written permission of DSC and (4) to return this document when it is no longer needed for the purpose for which furnished or upon the request of DSC.

Intellectual Property

The product offered in this Proposal is proprietary to DSC. The Purchaser shall agree to the following provisions:

- Product equipment will be installed only on the plant specifically being discussed and will not be transferred to any other plant without written permission from DSC.

- Product equipment will be operated exclusively for the purpose stated in this Agreement.

Detroit Stoker Company will provide the following equipment:

Underthrow Fuel Distributors

Detroit Stoker Company proposes to furnish nine (9) 18" Detroit® Underthrow Fuel Distributors to replace the customer's existing coal feeders on the existing IBW Boilers. Refer to DSC Drawing No's 9B-13784, -1 and -2. The fuel distributors described are designed to handle coal with a maximum top size of 1.25" and maximum of 65% less than ¼" (See the attached fuel sizing curve).

The Detroit Underthrow Coal Distributor is a combination coal feeding and distributing device, which introduces coal fuels continuously into a combustion chamber at variable rates to follow load demands.

A continuously moving chain type conveyor picks up coal from the bottom of the integral hopper and delivers it to an underthrow rotor and air swept chute. The rotating rotor, and air which is forced along the bottom of the air swept chute, combine to project the coal particles into the combustion chamber.

The quantity of coal required, to follow the load demand, is varied by changing the speed of the chain conveyor. The distribution pattern of the fuel is adjusted by varying the speed of the rotor and pressure of the distributing air supply, regardless of the amount of coal fed by the conveyor.

Manual adjusting points are provided on the coal distributor to compensate for coal quality and to alter the pattern of distribution. Automatic adjustment of the quantity of fuel supplied to follow load demand is provided by electrical/electronic motor controls which are connected to the boiler combustion control system.

Stoker Feeders

Dual drive, Underthrow, pneumatically assisted, spreader type consisting of the following:

Nine	Rotor Assembly: 4 rows of hinged type replaceable cast stainless steel rotor blades, spherical roller bearings housed in a cast iron water cooled casing spaced from the distributor side plates to prevent exposure to heat and dust infiltration. The drive end of the rotor shaft is supplied with a hex head to allow the shaft to be manually jogged should the rotor become jammed. The rotor assembly to be replaced without having to remove the coal feeder from the boiler front wall.
Nine	Conveyor Assembly: Endless chain type with austempered ductile iron (ADI) link bars, cast steel splined drive shaft and idler shaft with permanently lubricated sealed yoke type cam followers. Conveyor assembly to be replaced without having to remove the coal feeder from the boiler front wall. The conveyor chain tension mechanism is spring loaded and adjustable externally of the feeder.
Nine	Coal Hopper: Dustless, 3/16" mild steel construction.
Nine	Adjustable Throat Blade: Cast iron, heavy duty, externally adjustable to set coal depth on conveyor assembly and provide upward flexibility to allow tramp material to pass through feeder.
Nine	Distribution Assembly: Chromium carbide wear plate and distribution air ports adequately sized to distribute fuel with up to 65% fines.
Nine	Miscellaneous material: Apron air tuyeres, base plate, deflector tuyeres for feeder opening and necessary hardware and fasteners.

Feeder Drives

Integrally mounted to feeder housing, chain driven conveyor, belt driven rotor, guards, and mounting brackets.

Eighteen	Drive Motors: Separate motors for conveyor and rotor drum assemblies, 1 HP, 460 V, 1200 RPM, TENV, commercial grade, inverter duty, specifically designed for use with variable frequency drives and to optimize efficiency performance at partial load conditions typically encountered in stoker feeder applications.
Nine	Gear Reducer: For conveyor drive only, right angle worm gear with C face input sized to meet specific fuel capacity requirements.
35 lbs.	High temperature grease.

Tachometer/Zero Speed Switch

NIne	Tachometer/Zero speed switch arrangements for rotor shaft only. Switch to monitor speed and indicate stalled condition. Zero speed to be interfaced through stoker controls to shutdown coal feed conveyor in case of stalled rotor condition. Tachometer controller (mounted in control panel) will be capable of returning a 4 - 20 mA signal back to the main boiler control. Hardware: Magnetic strip disk, sensing head, terminal strip box, mounting brackets and fasteners.

Miscellaneous

-	Necessary hardware and fasteners.
Two	Sets of application drawings consisting of general arrangement (with bill of material) of stoker front illustrating interface of coal feeders assembly drawings complete with bill of material, electrical schematics and logic diagrams of tachometer/zero speed switch arrangement.
Two	Sets of installation, operation and maintenance manuals.
Three	Distribution air fan complete with 15HP 3600 RPM motor and inlet screen, to be mounted within 25 ft. of front corner of the boiler to provide approximately 725 cfm of air per feeder @ 70°F and 20" W.C. for each feeder to be used for distribution purposes. Fan design will be for 2,175 cfm at 26" W.C.
Three	Manual control damper at fan.
Nine	Flex hoses with clamps between air header and feeder inlets.
Three	Lot of 10" dia. 10 GA air duct and hangers including expansion joint from fan discharge terminated at coal feeders. Additional support steel required for attachment of hangers is not furnished by DSC and must be furnished by others.

Control Panel

Three — NEMA 12 free standing control panel with panel components prewired to terminal strip and shop tested. Please note that the purchaser is to furnish a 4-20mA control signal. If the current control signal is pneumatic, purchaser will furnish any transducers required to convert the signal to 4-20mA. Each panel will be provided with the following:

Six — Allen Bradley 2 HP AC variable frequency drives are provided to control the speed of each stoker rotor 1 HP motor and each conveyor drive 1 HP motor.

Each drive is equipped with 3 pole circuit breaker to isolate each drive for maintenance purposes.

Each drive is equipped with an input line reactor to prevent undesirable third order harmonic distortion from going back on to the incoming power line.

If the length of the motor wiring from the drive panel to the coal feeders exceeds 50', each drive will be required to have an output line reactor for protection of the motor windings. This prevents damage from reflective wave electrical spikes. There will be an extra charge for these reactors

NOTE: Purchaser to supply additional wiring and labor to complete field modifications to the control panel.

FURNISHED BY PURCHASER

Freight, jobsite cartage, unloading

Erection labor, tools

Start Up & Operation consultant service

Electrical wiring and conduit

Water pipe and valvng

Motor starters and control centers

Maintenance gates above feeder hopper

Repair of frontwall refractory openings

Fan foundation, vibration isolators, grouting, shims and anchors

Field painting

NOTE: Equipment furnished by Purchaser as listed above are those items which we would like to bring to the attention of the Purchaser. It is not to be considered a complete list. Only items outlined in the equipment description are provided by Detroit Stoker Company.

DETROIT STOKER COMPANY STANDARD PAINTING PROCEDURES

Detroit Stoker Company's standard painting method is application of one (1) shop coat of Sherwin Williams red oxide alkyd, high solids, low VOC primer (eggshell finish) 3.0 mil thick. The VOC content shall not exceed 3.5 lb VOC/gal. Detroit Stoker Company uses Sherwin Williams grey high temperature paint (450˚F/171˚C) for high temperature applications (air swept distributors, coal feeders and rotary seal feeders) and uses red oxide paint for all other applications, which are lagged and insulated.

All auxiliary equipment will be painted according to their standard painting procedures.

Prior to painting, all steel work is to be cleaned by hand wire brushing, or other suitable methods, of loose mill scale, loose rust, weld slag or flux deposit, dirt or other foreign matter. Oil and grease deposits are to be removed by using a solvent cleaner, per SSPC codes (up to SSPC-SP3).

ELECTRICAL SUPPLY POWER

Detroit Stoker Company assumes that the electrical power provided to the electrical equipment is free from surges, spikes, sags, over-voltages, brownouts and electrical noise, and any additional equipment required to accomplish this is to be supplied by others.

ERECTION AND OPERATING CONSULTANT SERVICE

If desired, and ordered by Purchaser, and unless agreed otherwise herein, Company will furnish the services of an Erection Consultant to be available during the installation of all materials furnished by Company at Company's standard per diem rate in effect at time service is desired, (Current per diem rate is $935.00 Dollars per eight-hour day), and/or the services of an Operating Consultant to be available during the starting of all materials furnished by Company at Company's per diem rate in effect at time service is desired, (Current per diem rate is $985.00 Dollars per eight-hour day). These services are for work on Mondays thru Fridays (except upon holidays occurring upon those days), plus traveling time and all traveling and living expenses. If such services are desired for more than eight hours per day, or on Saturdays, Sundays, or holidays, it will be necessary to discuss special arrangements for such services with Purchaser. After arrival of Company's Erection or Operating Consultant at Purchaser's request, Purchaser agrees to pay Company at the above per diem rate, plus expenses, until he is released by Purchaser.

Days spent at the site by the Erection or Operating Consultant during which no work is performed due to delays beyond the control of the Company will be billed to the Purchaser at the Company's published per diem rate.

ERECTION LABOR

Adequate and competent labor for erecting the equipment and materials shall be furnished by Purchaser. If the Company provides an estimate of man-hours required for erection, it must be understood that these hours are to be used as a guide and in no way can be guaranteed since so many variables such as job site conditions, experience of labor force, union regulations, etc., will affect amount of labor required. The Purchaser should consult with the parties furnishing labor for specific information pertaining to this project.

O.S.H.A.

The equipment manufactured by the Company complies with the requirements of the Occupational Safety and Health Act of 1970 as of this date. Some of the equipment we will be supplying, however, may not comply with the sound levels listed under Permissible Noise Exposures, Table G-16, paragraph 1910-95, Occupational Noise Exposure.

PRICE

The Purchaser agrees to pay to the Company, for the equipment herein specified, free of exchange at its office in Monroe, Michigan, the sum of FIVE HUNDRED NINE THOUSAND, THREE HUNDRED TEN ($509,310.00) DOLLARS, EX WORKS Monroe, Michigan.

Above prices are valid for 30 days and firm for 2017 Shipment.

TERMS OF PAYMENT

Amount due and payable, 10% with order, 25% with drawing submittal and 65% upon shipment. All invoices are net 30 days.

All prices are EX WORKS Monroe, Michigan and are based on Terms and Payments above, Progress Schedule below, and attached Terms and Conditions of Sale, Form 407B dated 1/24/11.

DELIVERY SCHEDULE	Submittal of Standard Drawings	6	weeks ARO
	Approval Time Allocated	1	week after submittal
	Shipment of Equipment from Monroe, MI	15	weeks after approval
	Total Lead Time	22	Weeks ARO

This contract is made in Monroe, Michigan. Acceptance in writing hereunder by the Purchaser when approved by the Company will constitute a contract.

Accepted by the Purchaser:

DATED_____

BY _____
Signature of Purchaser

Approved by the Company:

Douglas A. Perkins

BY _____
Douglas A. Perkins

DETROIT STOKER COMPANY

Detroit® Underthrow Coal Distributor

Shown in Figure 4 is a diagram of the Detroit® Underthrow Coal Distributor.

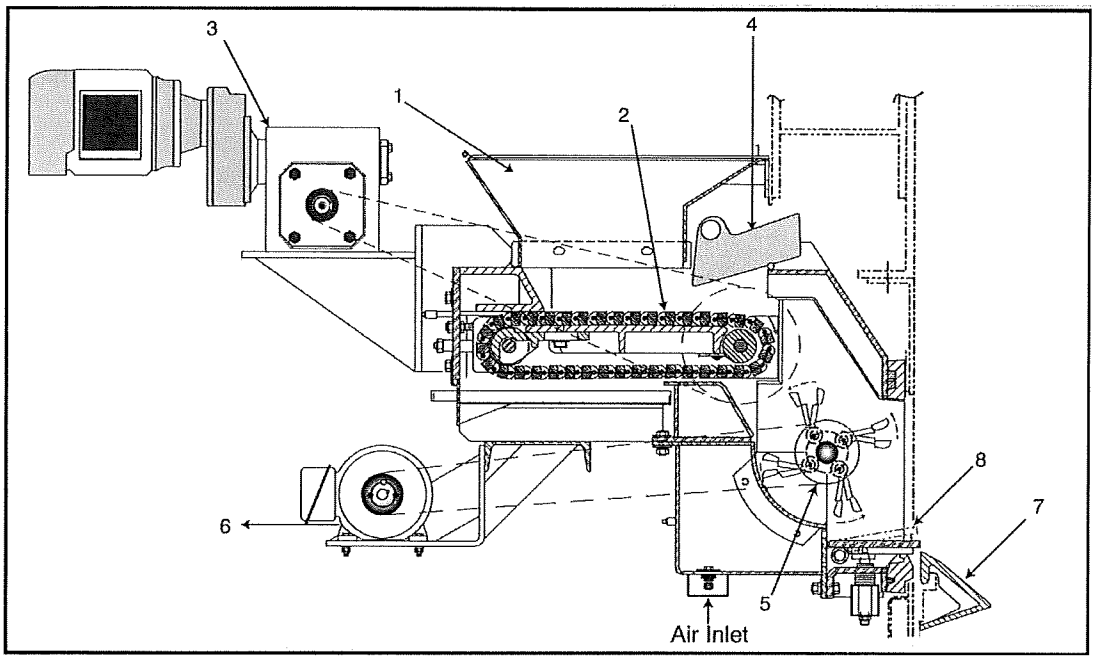


Figure 4

1	Fuel Hopper
2	Chain Conveyor Carriage
3	Carriage Drive
4	Adjustable Throat Blade
5	Distributing Underthrow Rotor
6	Rotor Drive
7	Air Cooled Apron Tuyere
8	Adjustable Distributor Plate

GENERAL DESCRIPTION AND OPERATION

The Detroit Underthrow Coal Distributor is a combination coal feeding and distributing device, which introduces coal fuels continuously into a combustion chamber at variable rates to follow load demands.

A continuously moving chain type conveyor picks up coal from the bottom of the integral hopper and delivers it to an underthrow rotor and air swept chute. The rotating rotor, and air* which is forced along the bottom of the air swept chute, combine to project the coal particles into the combustion chamber.

*Fluegas may be utilized in lieu of air as the distribution media on projects where additional NOx reduction is desired.

The quantity of coal required, to follow the load demand, is varied by changing the speed of the chain conveyor. The distribution pattern of the fuel is adjusted by varying the speed of the rotor and pressure of the distributing air supply, regardless of the amount of coal fed by the conveyor.

Manual adjustments can be made to the coal distributor to compensate for coal quality and to alter the pattern of distribution. Automatic adjustment of the quantity of fuel supplied to follow load demand, is provided by electrical/electronic motor controls which are connected to the boiler combustion control system.

ADJUSTMENTS

The throat blade height and drive chain tension adjustments are the same as the Ultrafeed adjustments described on pages 9 & 10. In addition to these adjustments, the Underthrow Distributor also has an air box inlet damper which may be manually adjusted to alter the depth of the coal throw.

COAL DISTRIBUTION

The minimum setting of the air damper should be such that there will be some air passing through the distributor throat to provide cooling air at all times there is heat in the combustion chamber. Thus, during start up, or any time that the coal distributor motors must be shut off to stop coal delivery to the combustion chamber, there must be a continuous supply of cooling air through the distributor.

The rotor drive electronic motor control can be set to oscillate the rotor speed, from high speed to low speed, on a variable time cycle. This allows the trajectory of the coal to vary with time and provides for better fuel distribution from front to back. Refer to the manufacturer's instruction sheets for detailed information on these adjustments. The variable speed gives additional control of the distribution of coal into the combustion chamber.

The variable speed motor control receives a 4-20 ma. signal from the combustion control system to follow the load demand. (Refer to the motor control manufacturer's instructions for setting the minimum and maximum motor speeds for the coal feed conveyor operation).

In the event that more or less coal must be delivered by one or more distributors due to coal quality or size segregation at the hoppers, the conveyor drive speed can be biased.

The depth of coal on the distributor conveyor is controlled by the height at which the throat blade is set. The distributor throat opening is adjustable from 2 1/4" to 4 1/2 " and has four settings which can be adjusted by moving the adjustment pins from one set of holes to the next. It is recommended that, as a starting point, the throat opening be set at 3" on all coal distributors. The 3" opening position is determined by setting the pins in the top hole which allows the throat blade to its minimum setting. To increase the coal feed capacity, raise the adjusting throat blade. To decrease the coal feed capacity, lower the throat blade. This adjustment is usually only required if fuel quality changes drastically.

The height of the throat blade will depend primarily on the maximum coal feeding capacity range required. Coal size, will have a large affect on the adjustment.

FEEDER AIR ADJUSTMENT

Equal distribution over the entire fuel bed surface is obtained, and the fuel bed is kept level, by maintaining the proper adjustments of the air/flue gas pressure to the distributor and the proper rotor speed.

To feed the coal farther toward the rear of the combustion chamber, increase the air pressure and/or increase rotor speed. To feed the coal farther forward, or towards the front of the combustion chamber, decrease air pressure and/or decrease rotor speed.

Coarse, wet coal will feed closer to the front of the combustion chamber than will fine, dry coal, at the same setting. Wet fine coal will require an increase in air pressure to properly distribute the coal and avoid a plugged condition.

Final distributor adjustment should provide even coal distribution over the entire fuel bed.

APRON TUYERE AIR ADJUSTMENT

The apron tuyere air adjustments are the same as the Detroit® Reciprocating Coal Distributor described on page 6.

COAL SIZING REQUIREMENTS

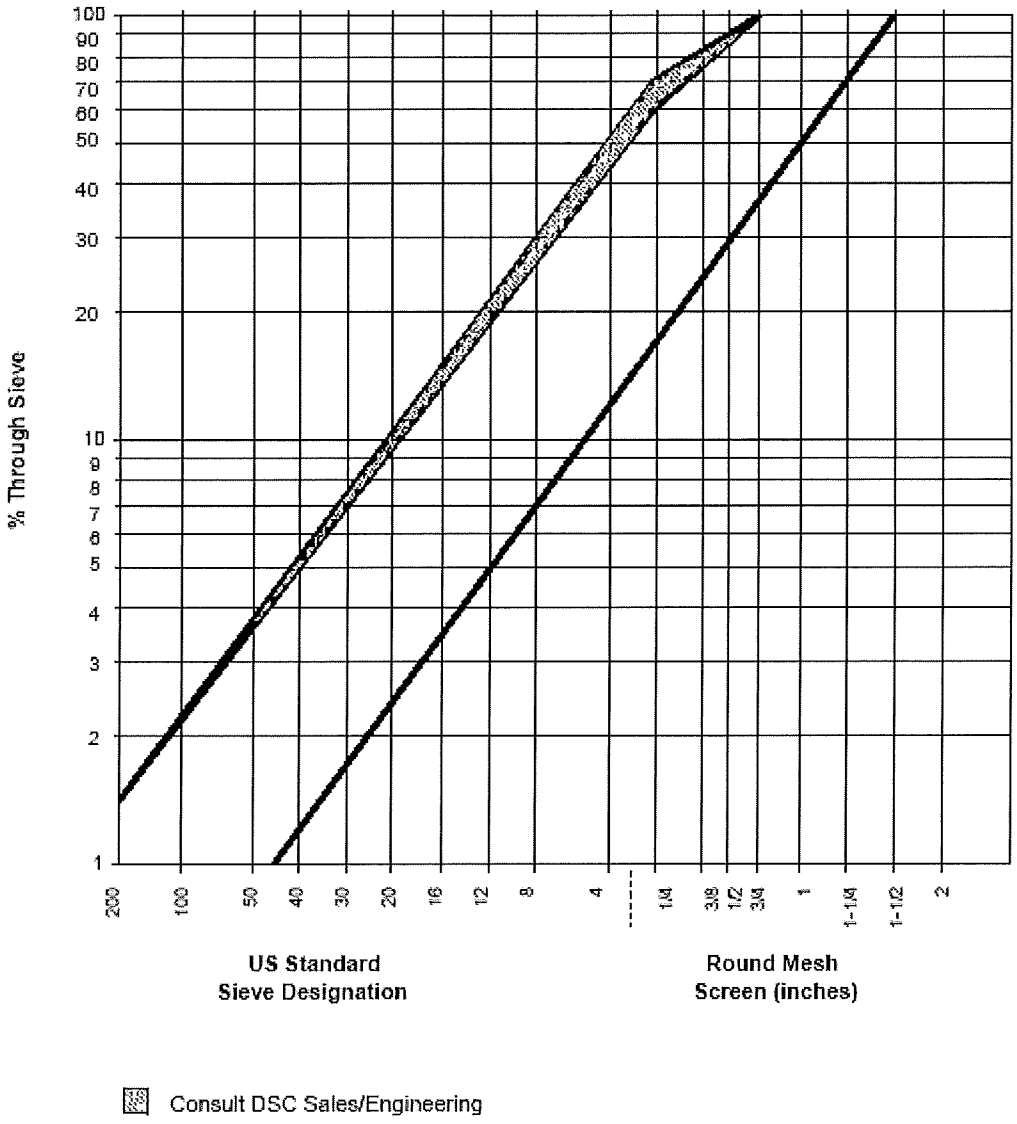
As mentioned above, any spreader coal feeder requires a specific size range and percentage of different sizes of coal. The required Detroit® Underthrow Coal Distributor coal size is given as 1 ½ " maximum top size and a maximum of 80% less than ¼".

Coal size is very important to a spreader stoker. If the coal is too coarse the stoker will not have enough coal burning in suspension and the boiler will not be able to change loads quickly. If the coal is too fine the stoker will have too much coal burning in suspension and the atmosphere within the boiler can become unstable. The fine coal also presents a problem with the feeder's ability to throw the fine coal to the rear of the stoker; however, the air assist on the Underthrow distributor helps overcome this problem.

Graphically the require coal sizing is shown on a Detroit Stoker Company coal sizing curve, Figure 5.

Distribution of Sizes of Coal

Recommended Limits of Coal for Underthrow Distributors.
Fuel to be delivered across stoker hopper without size segregation.
All Coal to pass through 1-1/2" mesh screen sieve size.



Consult DSC Sales/Engineering

Rev. Date: 4/29/05

Figure 5

SELECTING WHICH TYPE OF COAL DISTRIBUTOR

Detroit Stoker Company offers three different types of coal distributor, so that we can best fit the customers needs and to have available the correct coal distributor for the application. The pro's and con's of each distributor is listed below to assist with determining the proper selection. Detroit Stoker Company personnel are always available to review the operating conditions, the coal used and to make coal distributor recommendations.

*Detroit® Reciprocating Coal Distributor

Pro's	Con's
Lower Capital Cost	Non-Continuous Coal Delivery
Long Operating History	Higher Maintenance Cost
	Inability to Distribute Fine Size Coal

Detroit® Ultrafeed Coal Distributor

Pro's	Con's
Continuous Coal Delivery	Inability to Distribute Fine Size Coal
Long Operating History	
Independent Rotor Speed and Coal Feed Rate	
Higher Coal Feed Capacity	

Detroit® Underthrow Coal Distributor

Pro's	Con's
Continuous Coal Delivery	Inability to Handle Coal sizes over 2".
Ability to utilize fluegas recirculation (FGR) as NOx reducing fuel distribution media	
Long Operating History	
Independent Rotor Speed and Coal Feed Rate	
Ability to Distribute Fine Size Coal	
Higher Coal Feed Capacity	

*The Reciprocating Coal Distributor is seldom supplied as a new feeder today. The choice is between the Ultrafeed Coal Distributor and the Underthrow Coal Distributor and the available coal will usually decide this choice.

SD-II-10-Low Nox Burner Quote

JOHN ZINK HAMWORTHY COMBUSTION

HAMWORTHY PEABODY | COEN | TODD

(3) Windbox-QLN LOW NOx NG Packages

(existing equipment by Coen - BMJ-20D-7829 and SO-9162693 BMS)

SUBMITTED TO

Paul G. Boland, P.E.

Vice President, Director of Champaign Office

Henneman Engineering, Inc. | energy. focused.

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www.henneman.com | pboland@henneman.com

FOR

University of Wyoming
Laramie, Wyoming
(3) 60,000 pph Cross Drum Watertube Boilers

Proposal Number:	201610-70434-A
Application Engineer:	Wayne A. Wieszczyk
Tel:	650-522-2128
Email:	wayne.wieszczyk@coen.com
Date Prepared:	November 8, 2016

PROPOSAL CONTENTS

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1.0 Overview

Based upon the burner design specification presented in Section 2, the John Zink Company, LLC is pleased to offer a Budget proposal for (3) three Windbox-Dual QLN Low NOx NG packages for the retrofit of (3) three IBW Cross Drum Boilers. The boiler currently operates with Coal firing over a grate with (2) Coen SAZ-22 NG/Oil burners fired in the side wall. After close review, NOx desired of 30 ppm can be achieved by removing the existing SAZ burners, removing the Coal grate and install a new refractory floor to mount the new Dual QLN packages, which will achieve 30 ppm NOx without FGR and with the existing preheated air of 350 °F. Option for Turnkey portion is included.

2.0 Burner Design Basis and Specifications

2.1 Boiler Information

Number of boilers	3
Number of burners per boiler	2
Boiler manufacturer	IBW
Boiler designation	Coal Stoker
Furnace dimensions: Width (floor) (feet)	10'
Depth (floor) (feet)	11.58'
Height (vertical up fired) (feet)	18.7'
Height for flame (vertical up fired) (feet)	17'
Steam capacity (pph)	60,000
Design boiler HHV BTU input (mmbtu/hr) NG total/burner	77.3 / 38.65
Boiler furnace pressure at proposed conditions ("w.c.)	-0.15
Steam pressure (psig)	125
Steam temperature (°F)	351 SAT
Boiler Feedwater temperature (°F)	220
Boiler efficiency	---
Maximum boiler stack height (feet)	100
Location	Indoor
Economizer used	Yes

2.2 Electrical & Utilities

Fan electrical characteristics (v/hz/ph)	440/60/3
Panel and instrument power electrical characteristics (v/hz/ph)	120/60/1
Instrument air supply (clean, dry, and oil-free) process/mechanical	90 psig

2.3 Codes

Area classification	Non-Hazardous
NEMA class rating	NEMA 4,
Code requirements	NFPA 85 Ch 5
	2-fired-as-1
Piping requirements	ANSI-31.3
Individual electrical components requirements	UL or FM

2.4 Combustion Air and FGR

Combustion air temperature (°F)	350
Air humidity (%)	50
Air density at standard conditions (lbm/ft^3)	0.075
Design combustion air density (lbm/ft^3)	0.037
Plant elevation (FASL)	7,260
Combustion air pre-heat	Yes

2.5 Fuels

Main gas fuel ..... Natural Gas
Ignition fuel ..... Natural Gas

Natural Gas Details:
Higher heating value (btu/scf) HHV 1000
Specific gravity 0.60

2.6 Burner Performance

Burner pressure drop ("w.c.) 5.76
Burner excess air (%) 15
Burner FGR (%) 0
Boiler turndown based on steam output 8:1
Burner model/throat diameter (mm) QLN-28
NG supply at burner header (psig) 24
NG regulated supply at train inlet (psig) 40

3.0 Burner Performance

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:

NOx - 30 ppm
CO - 100 ppm
PM - 0.007 lb/MMbtu

- *'ppm' emissions are referenced to 3% dry stack O2.*
- *All emissions are relevant to the fuel(s) specified in this proposal only, based on HHV.*
- *All information provided in the Burner Design Basis and Specifications is preliminary only and is subject to change after the detailed Engineering stage on the contract is completed.*
- *Particulate matter includes unburnt compounds derived from the fuel and excludes any ash present in the fuel and any inorganic or non-combustible material present in the ambient air used for combustion.*

B. The burner(s) flame will have no deleterious impingement over the entire burner turndown range as per the American Boiler Manufacturers Association Definition: "Flame impingement is defined as the condition which exists when the flame resulting from the combustion of the fuel comes into contact with any interior surface of the furnace in such a way as to result in localized incomplete combustion of the fuel and such condition manifests itself in the formation of hard carbonaceous deposits at the contact location. Flame impingement is a condition of firing a fuel which may cause failure and/or excessive maintenance of combustion chamber wall surfaces".

C. 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 A).

D. Testing for performance guarantees shall be run within thirty (30) days after the equipment has been installed and operated. Others shall furnish all operating personnel and equipment for such tests. A qualified service engineer familiar with the specific equipment 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. John Zink'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. John Zink will be supplied a complete copy of all test results and data.

E. 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, John Zink reserves the right to change or replace, on a straight time basis, the equipment furnished so that the guaranteed performance will be obtained.

4.0 Equipment Description

Windbox (Qty: 1)

One (1) windbox, insulated, will be fabricated of ASTM A-36 carbon steel plate, and complete with required structural framing, support legs, access door, lifting lugs, and baffles for balancing air flow distribution to the burner. The windbox is designed for (2) QLN burners and will be provided with an inlet opening for connection to the forced draft fan discharge ducting. The windbox will be painted with manufacturer standard. The windbox will be seal welded to the new boiler floor.

A jackshaft control drive system is mounted on the windbox front and includes:

- Purge and low fire position switches
- Ball bearing pillow blocks, self-aligning, and permanently lubricated
- Mechanical linkage constructed from 1/2" pipe with heavy duty, aircraft type ends to eliminate backlash.
- Jackshaft, 1-3/16 solid round stock

The jackshaft must be driven by an actuator and will be linked to the following components:

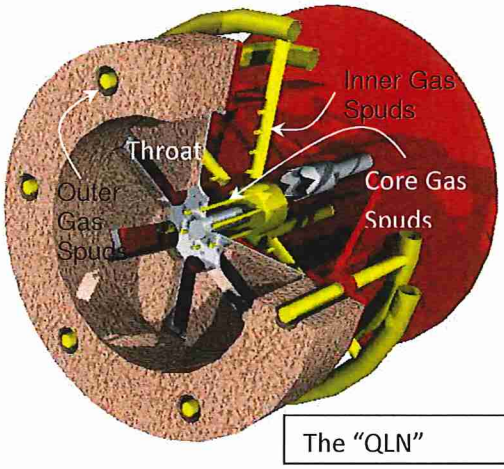
- AC fuel Main gas flow control valve (existing)
- AC fuel Trim gas flow control valve
- Windbox fan damper

A combustion air damper is mounted on windbox. The damper is a slow opening, multibladed, streamline design. It is designed to have a relatively straight line characteristic in respect to air flow versus damper positions. The maximum air leakage will not exceed 10% in the closed position.

QLN Burner (Qty: 2)
Register, type QLN with insulated front plate contains three separate fuel zones for reduced thermal and prompt NOx. The gas burner consists of two sets of multi-spud type tips, located within the burner and outside the burner exit to achieve the desired low NOx performance. The burner has no adjustable louvers nor moving parts under normal operation.

The QLN burners fire together and will have the following extended gas train valves:

- Outer trim control valve, AC
- Outer spuds valve, butterfly
- Outer spuds pressure gage
- Inner spuds valve, butterfly
- Inner spuds pressure gage
- Core gas orifice
- Core gas low fire orifice
- Core gas scanner test
- Core gas pressure gage



The "QLN"

Natural Gas Pilot (Qty: 2)

The pilot is electrically ignited and is interruptible per NFPA Class III requirements. The pilot electrode is sparked by a 6000 Volt transformer.

5.0 Paint and Finish

Surface preparation and painting will be as per John Zink's standard specifications.

6.0 Notes and Clarifications

All the proposed equipment will be designed, manufactured and finished as per John Zink's Standards.

John Zink reserves the right to modify this proposal technically and commercially if any of the above listed specifications are revised, changed or modified during the project execution.

All removal of the coal equipment including the coal from the site will be by others or as state in the option below.

Fuel pressure to train inlet to be increased to 40 psig.

FD fan w/preheater to be reused. JZ will require curves and Preheater information to confirm if 100% capacity can be maintained or a slight derate will be required.

7.0 Budget Pricing

John Zink has provided a budget price relative to the scope of supply and the stated prices are valid for estimating purposes only. Any firm offer or binding quotation will be the subject of a formal proposal at a future date.

Budget price for three (3) units as detailed in the foregoing proposal ..... **$550,000.**

Option 1:
Turnkey budget add for the removal, modifications to boiler, installation and start-up for the three units will be ..... **$925,000.**

The Turnkey budget includes the following:

-Site engineering trip for construction drawings of the proposed retrofit.
-Remove existing ignitor, oil gun, scanners, wiring and piping frame from the front of the windbox
-Remove the SAZ-22 burners
-Remove combustion air duct to windbox inlet.
-Remove existing windboxes
-Remove the burner throat.
-Remove and replace boiler tubes on the side wall to close opening.
-Remove all coal grates, operators, shoots, supports, etc.
-Remove grate and install new structural steel floor
-Install side wall flex seal to minimize tramp air induction.
-Furnish and install floor refractory and insulation. Install refractory repairs from burner demolition.
-Inspect boiler for air bypass potential and seal potential gaps/openings.
-Boiler pressure test.
-Install new burner throat in floor
-Install new windbox
-New combustion air ducting from old windbox to new windbox section including supports, expansion joint (as required).
-Install new QLN burners with new ignitors and piping
-Reuse scanners, install and wire to existing JB and to BMS panel
-Reuse ignitor train components including modification for connection to new ignitor connections.
-Reuse main gas train including modifications for connection to QLN piping connections.
-Wire and instrument tubing of valves, switches, scanners, etc. to the Fry-Logix BMS panel and Controls panel.
-Check-out of limits, BMS and CCS.
-Boilout and cure refractory

-Start-up burners
-Preliminary Emissions testing.
-Removal, Disposal, Installation and Clean-up and exit facility.

Note: -Freight for equipment furnished by others
-Sales or Use Tax, permits, air permit, license or fees.
-The cost of bond or special insurance.
-Field over time.
-Hazardous materials abatement or delays caused by suspect materials or testing of suspect materials.

Price Validity: This is a budgetary proposal and is intended only as an estimate to facilitate your planning processes and does not constitute a commitment or offer to sell goods or services at the prices and terms referenced herein.

Quoted prices are ex-works (EXW) (Incoterms 2010), exclusive of freight and any applicable sales, use or excise taxes.

8.0 Service

Field service is not included in this quotation, but it is available at per diem rates. Field service, whether paid service or no-charge warranty service, is provided in accordance with our standard Technical Assistance Agreement in effect at the time the service is provided. Any pre-paid service is payable with final equipment invoice submitted at time of shipment.

9.0 Schedule

Drawings will be submitted (6-8) weeks after receipt of purchase order and all engineering information. Shipment will be (12-16) weeks from receipt of approved drawings.
The following drawings/documents will be submitted for approval:

Construction portion is estimated at 30 weeks including commissioning.

10.0 Terms & Conditions of Sale

Equipment and/or services quoted are subject to the attached John Zink Company, LLC. General Terms and Conditions of Sale (the "T&Cs"), and is an offer to sell the goods or services specifically contingent upon acceptance of the T&Cs. This proposal (including, without limitation, the T&Cs), if resulting in an order, shall be incorporated by reference into any resulting contract documents. In the case of a conflict among the contract documents, then the terms of the proposal (including, without limitation, the T&Cs) shall take precedence.

This proposal document is confidential and intended solely for the use of the individual or entity to which it is addressed. If you have received this proposal in error, please contact the sender and destroy all copies of the original message.

We thank you for the opportunity to present this proposal and look forward to working with you on this project.

Wayne A. Wieszczyk | Application Engineer
John Zink Company LLC
2151 River Plaza Drive, #200 | Sacramento, CA 95833
T: +1.650.522.2128
M: +1.530.867.2856
E: wayne.wieszczyk@coen.com

Enclosures: General Terms and Conditions of Sale

SD-II-11 Wyoming Boilers Subject to Clean Power Plan

Attachment , Wyoming Electric Generating Powerplants Subject to Clean Power Plan Emission Regulations

Category	State	State-Region	Plant Name	ORIS Code	Generator ID	Fuel type	Prime mover type	Nameplate Capacity (MW)	Summer Capacity (MW)	Heat Input Capacity (mmBtu/hr)	Electric Generation (MWh)	Carbon Dioxide Emissions (tons)	UNITKEEP (CA<25 part of CC with CT>25)	Source Category	Cogn Flag Y/N	Unit Status	Unit Retirement Year	Exclusion Description	Commenced Operations in Data Year	NERC Interconnection
EXCLUDE	WY	WY-Western	Boysen	505	1	WAT	HY	7.5	8.6	0.0	19,072.50	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Boysen	505	2	WAT	HY	7.5	8.6	0.0	19,072.50	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Pilot Butte	674	1	WAT	HY	0.8	0.8	0.0	0.00	0.00		Electric Utility	N	OS		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Pilot Butte	674	2	WAT	HY	0.8	0.8	0.0	0.00	0.00		Electric Utility	N	OS		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	10	WND	WT	0.7	0.7	0.0	2,007.39	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	11	WND	WT	0.7	0.7	0.0	2,007.39	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	12	WND	WT	0.7	0.7	0.0	0.00	0.00		Electric Utility	N	IP		Status of Operation (IP, L, P, T)		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	13	WND	WT	0.7	0.7	0.0	0.00	0.00		Electric Utility	N	IP		Status of Operation (IP, L, P, T)		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	1A	WND	WT	0.6	0.6	0.0	1,720.62	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	2A	WND	WT	0.6	0.6	0.0	1,720.62	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	3	WND	WT	0.1	0.1	0.0	0.00	0.00		Electric Utility	N	RE	2005	Retired prior to 2012		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	5	WND	WT	0.7	0.7	0.0	2,007.39	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	6	WND	WT	0.7	0.7	0.0	2,007.39	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	7	WND	WT	0.7	0.7	0.0	2,007.39	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	8	WND	WT	0.7	0.7	0.0	2,007.39	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	9	WND	WT	0.7	0.7	0.0	2,007.39	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Medicine Bow	692	CLIP	WND	WT	2.5	2.5	0.0	0.00	0.00		Electric Utility	N	RE	2011	Retired prior to 2012		Western
EXCLUDE	WY	WY-Western	Old Faithful	2196	1	DFO	IC	1.0	1.0	0.0	0.00	0.00		Electric Utility	N	SB		Internal Combustion		Western
EXCLUDE	WY	WY-Western	Old Faithful	2196	2	DFO	IC	1.0	1.0	0.0	0.00	0.00		Electric Utility	N	SB		Internal Combustion		Western
EXCLUDE	WY	WY-Western	Neil Simpson	4150	5	SUB	ST	21.7	14.6	0.0	153,616.00	233,596.43		Electric Utility	N	OP	2014	Steam unit (PRMVR=ST) less than or equal to 25MW (i.e. 250 MMBtu/hr)		Western
EXCLUDE	WY	WY-Western	Osage	4151	1	SUB	ST	11.5	10.1	0.0	0.00	0.00		Electric Utility	N	SB	2014	Steam unit (PRMVR=ST) less than or equal to 25MW (i.e. 250 MMBtu/hr)		Western
EXCLUDE	WY	WY-Western	Osage	4151	2	SUB	ST	11.5	10.1	0.0	0.00	0.00		Electric Utility	N	SB	2014	Steam unit (PRMVR=ST) less than or equal to 25MW (i.e. 250 MMBtu/hr)		Western
EXCLUDE	WY	WY-Western	Osage	4151	3	SUB	ST	11.5	10.1	0.0	0.00	0.00		Electric Utility	N	SB	2014	Steam unit (PRMVR=ST) less than or equal to 25MW (i.e. 250 MMBtu/hr)		Western
COALST	WY	WY-Western	Dave Johnston	4158	1	SUB	ST	113.6	105.0	1,674.0	692,109.00	817,262.97		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Dave Johnston	4158	2	SUB	ST	113.6	105.0	1,672.0	750,365.00	905,645.72		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Dave Johnston	4158	3	SUB	ST	229.5	220.0	3,349.0	1,388,671.00	1,666,913.98		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Dave Johnston	4158	4	SUB	ST	360.0	330.0	4,700.0	2,075,365.00	2,330,848.09		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Naughton	4162	1	SUB	ST	163.2	156.0	2,958.0	962,641.00	1,115,225.76		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Naughton	4162	2	SUB	ST	217.6	201.0	2,852.0	1,574,178.00	1,736,918.16		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Naughton	4162	3	SUB	ST	326.4	330.0	4,932.0	2,527,480.00	2,809,786.36		Electric Utility	N	OP				Western
EXCLUDE	WY	WY-Western	Fremont Canyon	4176	1	WAT	HY	33.4	33.4	0.0	87,807.50	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Fremont Canyon	4176	2	WAT	HY	33.4	33.4	0.0	87,807.50	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Glendo	4177	1	WAT	HY	19.0	19.0	0.0	45,297.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Glendo	4177	2	WAT	HY	19.0	19.0	0.0	45,297.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Guernsey	4178	1	WAT	HY	3.2	3.2	0.0	9,103.50	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Guernsey	4178	2	WAT	HY	3.2	3.2	0.0	9,103.50	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Kortes	4180	1	WAT	HY	12.0	12.2	0.0	42,488.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Kortes	4180	2	WAT	HY	12.0	12.2	0.0	42,488.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Kortes	4180	3	WAT	HY	12.0	12.2	0.0	42,488.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Seminoe	4182	1	WAT	HY	17.2	17.2	0.0	39,448.33	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Seminoe	4182	2	WAT	HY	17.2	17.2	0.0	39,448.33	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Seminoe	4182	3	WAT	HY	17.2	17.2	0.0	39,448.33	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Shoshone	4183	1	WAT	HY	3.0	3.0	0.0	16,000.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Fontenelle	4185	1	WAT	HY	10.0	11.2	0.0	51,830.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
COALST	WY	WY-Western	Wyodak	6101	1	SUB	ST	362.0	332.0	5,302.0	2,524,024.00	3,315,332.30		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Laramie River Station	6204.1	1	SUB	ST	570.0	570.0	7,000.0	2,474,390.00	3,035,926.14		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Laramie River Station	6204.2	2	SUB	ST	570.0	570.0	7,000.0	4,423,340.00	5,050,085.24		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Laramie River Station	6204.2	3	SUB	ST	570.0	570.0	7,600.0	4,100,123.00	5,238,291.28		Electric Utility	N	OP				Western
EXCLUDE	WY	WY-Western	Strawberry Creek	6393	1	WAT	HY	0.5	0.5	0.0	3,412.33	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Strawberry Creek	6393	2	WAT	HY	0.5	0.5	0.0	3,412.33	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Strawberry Creek	6393	3	WAT	HY	0.5	0.5	0.0	3,412.33	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Swift Creek	6394	1	WAT	HY	0.4	0.4	0.0	0.00	0.00		Electric Utility	N	RE	1988	Retired prior to 2012		Western
EXCLUDE	WY	WY-Western	Swift Creek	6394	2	WAT	HY	0.4	0.4	0.0	0.00	0.00		Electric Utility	N	RE	1988	Retired prior to 2012		Western
EXCLUDE	WY	WY-Western	Swift Creek	6394	3	WAT	HY	0.8	0.8	0.0	3,279.53	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Swift Creek	6394	4	WAT	HY	0.6	0.6	0.0	2,459.65	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Swift Creek	6394	5	WAT	HY	0.3	0.3	0.0	1,229.82	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Heart Mountain	6408	1	WAT	HY	5.0	5.0	0.0	14,121.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Alcova	6409	1	WAT	HY	20.7	20.7	0.0	65,988.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Alcova	6409	2	WAT	HY	20.7	20.7	0.0	65,988.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Lake	7039	1	DFO	IC	2.7	2.7	0.0	0.00	0.00		Electric Utility	N	SB		Internal Combustion		Western
EXCLUDE	WY	WY-Western	Buffalo Bill	7317	1	WAT	HY	6.0	6.0	0.0	21,994.33	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Buffalo Bill	7317	2	WAT	HY	6.0	6.0	0.0	21,994.33	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Buffalo Bill	7317	3	WAT	HY	6.0	6.0	0.0	21,994.33	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
COALST	WY	WY-Western	Neil Simpson II	7504	2	SUB	ST	80.0	80.0	1,300.0	568,601.00	780,568.09		Electric Utility	N	OP				Western
EXCLUDE	WY	WY-Western	Neil Simpson II	7504	GT1	NG	GT	40.0	34.0	380.0	16,698.00	9,775.11		Electric Utility	N	OP		Simple cycle unit		Western
EXCLUDE	WY	WY-Western	Spirit Mountain	7541	1	WAT	HY	4.5	4.5	0.0	17,800.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Hartzog	8026	1	NG	GT	7.5	5.0	0.0	133.33	121.39		Electric Utility	N	OP		Simple cycle unit		Western
EXCLUDE	WY	WY-Western	Hartzog	8026	2	NG	GT	7.5	5.0	0.0	133.33	121.39		Electric Utility	N	OP		Simple cycle unit		Western
EXCLUDE	WY	WY-Western	Hartzog	8026	3	NG	GT	7.5	5.0	0.0	133.33	121.39		Electric Utility	N	OP		Simple cycle unit		Western
EXCLUDE	WY	WY-Western	Arvada	8028	1	NG	GT	7.5	5.0	0.0	109.33	104.54		Electric Utility	N	OP		Simple cycle unit		Western
EXCLUDE	WY	WY-Western	Arvada	8028	2	NG	GT	7.5	5.0	0.0	109.33	104.54		Electric Utility	N	OP		Simple cycle unit		Western
EXCLUDE	WY	WY-Western	Arvada	8028	3	NG	GT	7.5	5.0	0.0	109.33	104.54		Electric Utility	N	OP		Simple cycle unit		Western
EXCLUDE	WY	WY-Western	Barber Creek	8030	1	NG	GT	7.5	5.0	0.0	86.00	83.40		Electric Utility	N	OP		Simple cycle unit		Western
EXCLUDE	WY	WY-Western	Barber Creek	8030	2	NG	GT	7.5	5.0	0.0	86.00	83.40		Electric Utility	N	OP		Simple cycle unit		Western
EXCLUDE	WY	WY-Western	Barber Creek	8030	3	NG	GT	7.5	5.0	0.0	86.00	83.40		Electric Utility	N	OP		Simple cycle unit		Western
COALST	WY	WY-Western	Jim Bridger	8066	1	SUB	ST	577.9	531.0	7,875.0	3,585,983.00	3,784,653.91		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Jim Bridger	8066	2	SUB	ST	577.9	527.0	7,875.0	3,342,425.00	3,885,459.82		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Jim Bridger	8066	3	SUB	ST	577.9	523.0	7,458.0	3,615,122.00	3,906,655.69		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Jim Bridger	8066	4	SUB	ST	584.0	530.0	7,536.0	3,081,605.00	3,418,116.72		Electric Utility	N	OP				Western
EXCLUDE	WY	WY-Western	Elk Basin Gasoline Plant	52127	GEN1	OG	ST	1.0	0.8	0.0	5,394.00	24,166.37		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Elk Basin Gasoline Plant	52127	GEN2	OG	ST	1.0	0.8	0.0	5,394.00	24,166.37		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Elk Basin Gasoline Plant	52127	GEN3	OG	ST	0.5	0.4	0.0	0.00	0.00		Industrial CHP	N	RE	2007	Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	General Chemical	54318	TG1	BIT	ST	15.0	15.0	0.0	108,781.83	672,807.05		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	General Chemical	54318	TG2	BIT	ST	15.0	15.0	0.0	113,411.43	701,440.76		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Sinclair Oil Refinery	54374	2002	NG	IC	1.3	1.3	0.0	0.00	0.00		Industrial CHP	N	RE	2012	Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Sinclair Oil Refinery	54374	2004	NG	IC	1.3	1.3	0.0	0.00	0.00		Industrial CHP	N	OP		Commercial/Industrial Unit	Yes	Western
EXCLUDE	WY	WY-Western	Sinclair Oil Refinery	54374	2006	NG	IC	1.3	1.3	0.0	0.00	0.00		Industrial CHP	N	OP		Commercial/Industrial Unit	Yes	Western
EXCLUDE	WY	WY-Western	Sinclair Oil Refinery	54374	2008	NG	IC	1.3	1.3	0.0	0.00	0.00		Industrial CHP	N	OP		Commercial/Industrial Unit	Yes	Western
EXCLUDE	WY	WY-Western	Sinclair Oil Refinery	54374	NO1	NG	ST	0.4	0.4	0.0	1,443.05	24,692.00		Industrial CHP	Y	OS	2013	Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Sinclair Oil Refinery	54374	NO2	NG	ST	0.4	0.4	0.0	1,443.05	24,692.00		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Sinclair Oil Refinery	54374	NO3	NG	ST	1.3	1.3	0.0	4,689.90	80,249.00		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Sinclair Oil Refinery	54374	NO5	DFO	IC	1.1	1.1	0.0	0.00	0.00		Industrial CHP	N	SB		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Simplot Phosphates	54472	GEN1	OTH	ST	11.5	11.5	0.0	77,011.21	0.00		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Beaver Creek Gas Plant	55278	1	NG	GT	2.5	1.8	0.0	0.00	5,489.46		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Beaver Creek Gas Plant	55278	2	NG	GT	2.5	1.8	0.0	0.00	5,489.46		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Two Elk Generating Station	55360	GEN1	WC	ST	320.0	275.0	0.0	0.00	0.00		IPP Non-CHP	N	U		Status of Operation (IP, L, P, T)		Western
EXCLUDE	WY	WY-Western	Neil Simpson Gas Turbine #2	55477	GT2	NG	GT	40.0	34.0	373.0	15,176.00	8,415.54		IPP Non-CHP	N	OP		Simple cycle unit		Western
COALST	WY	WY-Western	Wygen 1	55479	0001	SUB	ST	88.0	70.0	1,300.0	684,671.00	895,125.96		IPP Non-CHP	N	OP				Western
EXCLUDE	WY	WY-Western	Foote Creek I	55607	GEN1	WND	WT	41.4	41.4	0.0	108,555.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Foote Creek II	55608	GEN1	WND	WT	1.8	1.8	0.0	5,498.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Foote Creek III	55609	GEN1	WND	WT	24.8	24.8	0.0	72,490.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Foote Creek IV	55610	GEN1	WND	WT	16.8	16.8	0.0	53,878.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Rock River I LLC	55740	GEN1	WND	WT	50.0	50.0	0.0	135,098.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Wyoming Wind Energy Center	56093	GE15	WND	WT	144.0	144.0	0.0	384,066.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Shute Creek Facility	56312	021A	OG	GT	36.0	30.6	0.0	223,397.86	160,632.00		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Shute Creek Facility	56312	021B	OG	GT	36.0	30.6	0.0	223,397.86	160,632.00		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Shute Creek Facility	56312	021C	OG	GT	36.0	30.6	0.0	223,397.86	160,632.00		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
COALST	WY	WY-Western	Wygen 2	56319	0001	SUB	ST	95.0	85.0	1,300.0	587,832.00	745,459.23		Electric Utility	N	OP				Western
EXCLUDE	WY	WY-Western	Medicine Bow Fuel & Power LLC	56452	1	BIT	CC	350.0	350.0	0.0	0.00	0.00		IPP Non-CHP	N	P		Status of Operation (IP, L, P, T)		Western
COALST	WY	WY-Western	Wygen III	56596	5	SUB	ST	116.2	100.0	1,300.0	855,131.00	1,004,747.78		Electric Utility	N	OP				Western
COALST	WY	WY-Western	Dry Fork Station	56609	01	SUB	ST	390.0	380.0	6,066.0	3,093,371.02	3,555,712.92		Electric Utility	N	OP				Western
EXCLUDE	WY	WY-Western	Mountain Wind Power LLC	56752	1	WND	WT	61.0	61.0	0.0	171,517.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Mountain Wind Power II LLC	56753	1	WND	WT	80.0	80.0	0.0	227,793.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Glenrock	56841	1	WND	WT	103.3	99.0	0.0	306,406.45	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Glenrock	56841	2	WND	WT	40.7	39.0	0.0	120,723.55	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Rolling Hills	56842	1	WND	WT	103.3	99.0	0.0	292,022.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Seven Mile Hill	56843	1	WND	WT	103.3	99.0	0.0	346,631.67	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Seven Mile Hill	56843	2	WND	WT	20.3	19.5	0.0	68,118.33	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Happy Jack Windpower Project	56960	HJW01	WND	WT	29.4	29.4	0.0	85,028.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	McFadden Ridge	57039	1	WND	WT	29.7	28.5	0.0	94,789.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	High Plains	57040	1	WND	WT	103.3	99.0	0.0	316,599.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Campbell Hill Windpower	57090	CHWF	WND	WT	99.0	99.0	0.0	339,071.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Silver-Sage Windpower	57091	SSW01	WND	WT	42.0	42.0	0.0	128,867.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Casper Wind Farm	57093	CWGT	WND	WT	17.0	17.0	0.0	45,768.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Simpson Ridge Wind Farm LLC	57117	GEN1	WND	WT	200.0	200.0	0.0	0.00	0.00		IPP Non-CHP	N	P		Status of Operation (IP, L, P, T)		Western
EXCLUDE	WY	WY-Western	Dunlap	57299	1	WND	WT	115.8	111.0	0.0	387,973.00	0.00		Electric Utility	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Top of the World Windpower Project	57327	TOTW1	WND	WT	200.0	200.0	0.0	660,722.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
EXCLUDE	WY	WY-Western	Garland Canal Power Plant	57551	MAIN	WAT	HY	2.9	2.6	0.0	10,184.00	0.00		IPP Non-CHP	N	OP		Non Combustion (NUC, WAT, WND, GEO, or SUN)		Western
UC-NGCC	WY	WY-Western	Cheyenne Prairie Generating Station	57703	01A	NG	CC	40.0	40.0	0.0	0.00	0.00		IPP Non-CHP	N	P				Western
UC-NGCC	WY	WY-Western	Cheyenne Prairie Generating Station	57703	01B	NG	CC	40.0	40.0	0.0	0.00	0.00		IPP Non-CHP	N	P				Western
UC-NGCC	WY	WY-Western	Cheyenne Prairie Generating Station	57703	01C	WH	CC	20.0	20.0	0.0	0.00	0.00		IPP Non-CHP	N	P				Western
EXCLUDE	WY	WY-Western	Cheyenne Prairie Generating Station	57703	02A	NG	GT	40.0	40.0	0.0	0.00	0.00		IPP Non-CHP	N	P		Status of Operation (IP, L, P, T)		Western
EXCLUDE	WY	WY-Western	Cheyenne Prairie Generating Station	57703	02B	NG	GT	40.0	40.0	0.0	0.00	0.00		IPP Non-CHP	N	P		Status of Operation (IP, L, P, T)		Western
EXCLUDE	WY	WY-Western	Cheyenne Prairie Generating Station	57703	03A	NG	GT	40.0	40.0	0.0	0.00	0.00		IPP Non-CHP	N	P		Status of Operation (IP, L, P, T)		Western
EXCLUDE	WY	WY-Western	FMC Westvaco	57915	1	SUB	ST	3.5	3.5	0.0	24,555.97	144,412.88		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	FMC Westvaco	57915	2	SUB	ST	3.5	3.5	0.0	20,006.56	117,657.97		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	FMC Westvaco	57915	3	SUB	ST	4.0	3.5	0.0	23,082.35	135,746.56		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	FMC Westvaco	57915	4	SUB	ST	10.0	10.0	0.0	35,560.60	209,130.78		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	FMC Westvaco	57915	5	SUB	ST	10.0	10.0	0.0	64,564.44	379,701.43		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	FMC Westvaco	57915	6	SUB	ST	10.0	10.0	0.0	72,847.26	428,412.44		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western
EXCLUDE	WY	WY-Western	Western Sugar Coop - Torrington	57967	GEGEN	SUB	ST	2.0	2.0	0.0	2,640.00	25,471.71		Industrial CHP	Y	OP		Commercial/Industrial Unit		Western

SD-II-12 Powerplant Training Courses

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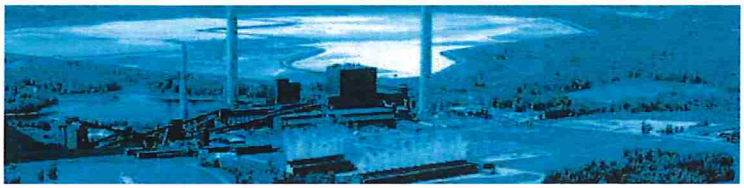
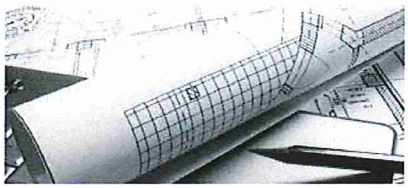


Power Plant Fundamentals

Course DESCRIPTION (4 Days)

This instructor-led course is designed as an overview and process description of electric generation in fossil-fueled power plants. The fundamentals required to understand the process, common equipment, and primary systems in power plant operations are emphasized. The discussions also target the roles of operations and mechanical staff in power plant operations.

Prerequisites

Students should be entry-level power plant personnel with basic power plant understanding.

Who Should Attend?

This course is designed for new power plant operators, maintenance personnel, and management as a process overview for those entering the power industry but will be of interest to all personnel working in a generating facility who wish to learn more about fossil-fueled power plants. System operators/dispatchers will also find the material covered in this course beneficial for system operations and planning.

Course CONTENT

- Basic Electricity
- Print Reading
- Basic Power Plant Equipment
- Essentials of Producing Electrical Energy
- Power Plant Systems
- Steam Turbine
- Generator

Course OBJECTIVES

At the end of this course, students should be able to:

- Restate the laws of thermodynamics and energy conversion
- Recognize process and instrument diagrams
- Use a steam table to look up the properties of steam and water
- Explain the primary flow paths for fuel, air, steam, cooling water and power
- Describe the purpose and primary function of each major component
- Discuss the general purpose and basic operation of a boiler, steam turbine and generator

REGISTRATION

Customized classes and site-specific training are available. Call GP Strategies™ Energy Services for pricing and course details. To obtain more information, visit us online at http://fossilfuelcourses.gpstrategies.com/reg/ or call 800.803.6737.

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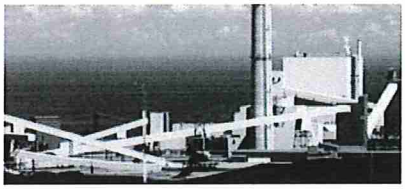
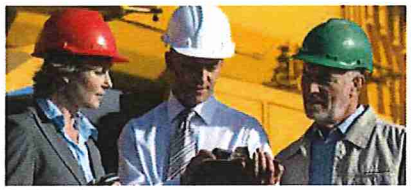

Fundamentals of Power Plant Performance for Utility Engineers

Course DESCRIPTION (4½ Days)

This 4½-day course teaches attendees how to test and monitor power plant equipment and improve unit heat rate. The course presents design and operating theories of power plant equipment. It also emphasizes efficiency and testing with full consideration given to the expectations and limits of component equipment. The laws of thermodynamics and the principles of heat transfer are reviewed and applied to equipment operation and efficiency. Actual test data is used to calculate turbine efficiency, condenser cleanliness, turbine cycle heat rate, turbine cycle heat rate corrections, boiler efficiency, and feedwater heater performance.

Prerequisites

Good working skills in algebra and graphical interpretation.

Who Should Attend?

This course is designed for engineers, engineering managers, and plant engineers.

Course CONTENT

- Overview of ASME Performance Test Codes
- Thermodynamics Review
- Boilers
- Turbines
- Feedwater Heaters
- Test Instrumentation
- Data Evaluation
- Pumps
- Condensers
- Cooling Towers

Course OBJECTIVES

At the end of this course, students should be able to:

- Recognize and use standard testing methods
- Determine the performance levels of major plant equipment
- Test performance accurately and interpret results
- Improve the efficiency of plant operations

Course MATERIALS

The textbook *Fundamentals of Power Plant Performance* and steam tables are provided. Attendees are advised to bring a scientific calculator to class with them.

REGISTRATION

To register for open enrollment courses or to obtain more information, contact GP Strategies™ Energy Services at +1 716.799.1080 or 800.803.6737. Visit us online at http://fossilfuelcourses.gpstrategies.com/crs.aspx

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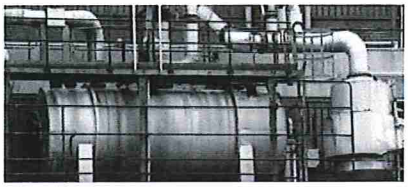


Utility Boiler Operations

Course DESCRIPTION (4½ Days)

This instructor-led course is designed for plant operators and managers in the power industry, but will be of interest to personnel with management, operations, maintenance or supervisory experience who wish to learn more about power plants with large utility type boilers. System operators/dispatchers will also find the material covered in this course beneficial for system operations and planning.

Prerequisites

Students should have a plant operations and/or maintenance background and responsibility for operating or maintaining the facility.

Who Should Attend?

This course is designed for personnel with, at minimum, basic power plant knowledge. It is most applicable for operations personnel.

Course CONTENT

- Steam and Water Fundamentals
- Basic Concepts of Heat Transfer
- Basic Metallurgy
- Boiler Systems
- Boiler Auxiliary Equipment
- Principles of Control
- Boiler/Plant Operations
- Factors Affecting Plant Efficiency
- Operators Controllable Losses

Course OBJECTIVES

At the end of this course, students should be able to:

- Discuss steam and water fundamentals, heat transfer concepts, and basic metallurgy
- Describe factors affecting plant efficiency
- Discuss the operation of boiler auxiliary equipment
- Describe different types of process controls for boilers and turbines

REGISTRATION

Customized classes and site-specific training are available. Call GP Strategies™ Energy Services for pricing and course details. To obtain more information, visit us online at http://fossilfuelcourses.gpstrategies.com/reg/ or call 800.803.6737.

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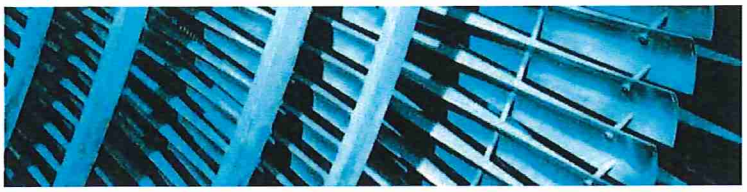
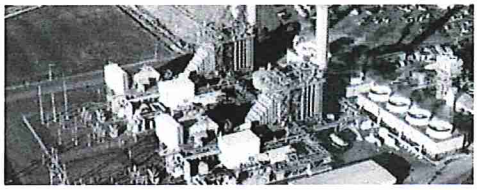


Combined Cycle Power Plant Performance

Course DESCRIPTION (2½ Days)

This 2½-day course is focused on improving the availability, reliability, capacity, and efficiency of the combined cycle power plant. It teaches attendees how to diagnose root causes of combined cycle power plant performance deficiencies using a case study-based approach. Diagnostic flowcharts are provided and used interactively for the solutions to the case studies.

Prerequisites

Basic understanding of power plant thermodynamics and operations.

Who Should Attend?

This course is designed for experienced combined cycle operators, supervisors, engineers, and management personnel.

Course CONTENT

- Introduction to Combined Cycle Plant Performance
- Power Plant Thermodynamics Review
- Brayton Cycle Performance
- Rankine Cycle Performance
- Rankine Cycle Equipment Performance
- Evaluating and Troubleshooting Performance

Course OBJECTIVES

At the end of this course, students should be able to:

- Identify and diagnose root causes of capacity and efficiency degradation
- Quantify the benefits of performance recovery

Course MATERIALS

The textbook *Combined Cycle Power Plant Performance*, with troubleshooting flowcharts, is provided.

REGISTRATION

Customized classes and site-specific training are available. Call GP Strategies™ Energy Services for pricing and course details. To obtain more information, visit us online at http://fossilfuelcourses.gpstrategies.com/reg/ or call 800.803.6737.

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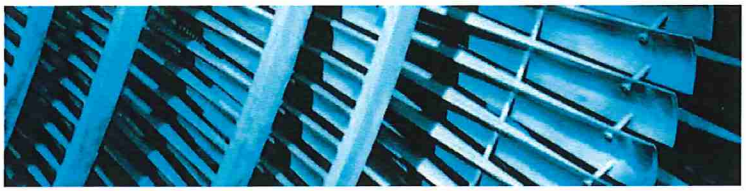
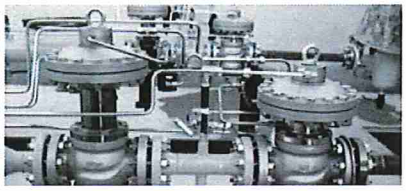


Advanced Performance Analysis and Troubleshooting for Power Plants

Course DESCRIPTION (4½ Days)

This 4½-day course teaches attendees how to diagnose root causes of fossil and combined cycle power plant performance deficiencies. Over 25 different case studies are presented and solved, beginning with test data on specific components, followed by pertinent performance calculations, and ending with a "root cause" analysis of the problem. Diagnostic flowpaths, using expert system techniques, are provided for many of the case studies. The case studies are based on GP Strategies' extensive experience in troubleshooting and testing all types of power plant equipment. Topics are optimally arranged to allow engineers from both plant types to pick and choose the equipment of most interest to them without any loss of continuity. Attendees have the option of attending the first 3½ days on the Rankine cycle plant, the last 3½ days on the combined cycle plant, or the full 4½-day program.

Prerequisites

Basic familiarity with equipment performance test methods and power plant thermodynamics.

Who Should Attend?

This course is for experienced power plant engineers and managers who are familiar with the ASME Performance Test Codes and knowledgeable in power plant components/systems.

Course CONTENT

- Boilers and Air Heaters
- Feedwater Heaters
- HRSGs
- Steam Turbines
- Gas Turbines
- Pumps
- Condensers and Auxiliaries
- Combined Cycle

Course OBJECTIVES

At the end of this course, students should be able to:

- Recognize the principles of thermodynamics and heat transfer
- Identify where thermal losses occur
- Determine if problems are due to equipment or operational difficulties
- Act to effectively control heat rate
- Monitor improvements and continually reassess strategies for optimum performance

Course MATERIALS

The textbook *Advanced Performance Analysis*, diagnostic flowpaths, steam tables, and performance software are provided. Attendees are requested to bring a laptop computer with Microsoft® Excel™. Each attendee will receive a personal copy of the latest version of GPCALCS™ Software.

REGISTRATION

To register for open enrollment courses or to obtain more information, contact GP Strategies™ Energy Services at +1 716.799.1080 or 800.803.6737. Visit us online at http://fossilfuelcourses.gpstrategies.com/crs.aspx

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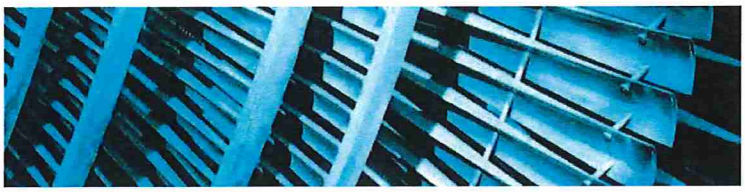

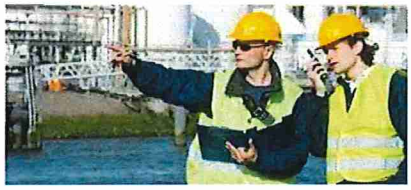

Heat Rate Awareness

Course DESCRIPTION (2½ Days)

This 2½-day course provides attendees with heat rate concepts, controllable and non-controllable losses, and the effects of component performance on operating costs. The focus will be on developing a detailed understanding of the heat rate effects of operating practices, unit optimization, and environmental compliance.

Prerequisites

Basic understanding of power plant operations. This course incorporates material created under the sponsorship of the Electric Power Research Institute (EPRI).

Who Should Attend?

This course is designed for operators, supervisors, engineers, and management who are directly involved in the daily operation of the plant.

Course CONTENT

- Power Plant Thermodynamics Review
- Calculating the Cost of Heat Rate Deviations
- Controllable Losses
- Boiler
- Turbine
- Condenser
- Feedwater Heaters
- Ancillary Equipment
- Optimization Tools
- Cycle Isolation
- Instrumentation Effects on Heat Rate
- How Does My Job Relate to Heat Rate?

Course OBJECTIVES

At the end of this course, students should be able to:

- Discuss the details of heat rate concepts
- Explain controllable and non-controllable losses
- Explain the effects of component performance on operating costs
- Discuss how heat rate affects operating practices, unit optimization, and environmental compliance

Course MATERIALS

The textbook Heat Rate Awareness, steam tables, and a calculator are provided.

REGISTRATION

To register for open enrollment courses or to obtain more information, contact GP Strategies™ Energy Services at +1 716.799.1080 or 800.803.6737. Visit us online at http://fossilfuelcourses.gpstrategies.com/crs.aspx

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SD-II-13 Employee Training Certification

UNIVERSITY OF
AT URBANA-CHAMPAIGN

Facilities & Services

September 9, 2016

Re:

Mike.

I am recommending that be promoted to the Steam & Power Plant III Tier IV level effective September 9, 2016. has successfully completed all of the contractual requirements to be promoted including time in the position, successfully completing all of the training modules assigned to him, successfully completing the exams at a score of 80 % or higher, successfully completing the proctored comprehensive exams at a score of 85% or higher, successfully completing all job performance walk downs, and passing all of the management evaluations including the performance demonstrations. successfully completed the following"

- ***Tier I*** - 56 training modules, 56 exams, 3 comprehensive proctored exams, job performance walk downs and a management evaluation.
- ***Tier II*** - 110 training modules, 110 exams, 5 comprehensive proctored exams, job performance walk downs, and a management evaluation.
- ***Tier III*** - 67 training modules, 67 exams, 3 comprehensive proctored exams, job performance walk downs, and a management evaluation.
- ***Tier IV*** - 31 training modules, 31 exams, 2 comprehensive proctored exams, job performance walk downs, and a management evaluation.

I recommend for the above listed promotion without reservation. Please let me know if you need further information.

Regards,

CC:

telephone 217-333-0723 • *fax* 217-333-7660
www.fs.illinois.edu

Boiler #6 Operating Procedure
06-B6-001

STEAM & POWER PLANT III & IV OPERATORS

OPERATOR RESPONSIBILITIES

Date 10 - 17-16 Revision A

Draft – For Review Only

This procedure supersedes all previous versions prior to this revision date.

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Step	Activity	Initials Completed	Time Completed
1.0	**Scope**		
1.1	This procedure pertains to the operation of Boiler 6.		
2.0	**Purpose**		
2.1	Provide detailed sequential actions for Boiler 6 to accomplish: ➢ Cold start up ➢ Normal Shutdown ➢ Shutdown with Dry Layup		
3.0	**References**		
3.1	➢ Babcock & Wilcox Operating Instructions for Boiler #6 ➢ SOP 06-CM-001 Fuel Tech Chemical Injection ➢ Boiler 6 Igniter BMS, Detailed Design Specification, Novaspect, March 18,2014 ➢ Babcock & Wilcox Drawing B0276461E Erection Arrangements, FPS lighters ➢ P&ID Vents and Drains, Sargent and Lundy 120-M-11.		
4.0	**Responsibility**		
4.1	Overall responsibility for the start-up of the Boiler rests with the Steam and Power Plant Level IV operator. Operational steps are executed by the Steam and Power Plant Level III operator assigned to the Boiler.		
5.0	**Prerequisites**		
5.1	A source of feedwater must be aligned to the economizer inlet. Normally condensate from a deaerating heater must be aligned to a boiler feed pump. The boiler fill should always be accomplished with de-oxygenated water to prevent corrosion of boiler internals.		
5.2	The boiler output must be aligned with a load that can accept its output: either a turbine in isolation or a high pressure steam header fed from other sources.		
5.3	The CO2 scrubber must be operational and aligned with the Boiler 6 gas path.		
5.4	Valve alignment for startup is given in Attachment "A".		
5.5	Electrical switches must be aligned according to Attachment "B".		
5.6	Natural gas system must be available and valves aligned to fuel regulator PCV-NG-3156.		
5.7	Chemical feed systems must be in service, with chemical tank inventory at sufficient levels for sustained operation.		

Start-Up/Shutdown Date:_____

5.8	CONFIRM all manways (Attachment "D" are closed, all equipment is cleared of Lock-Out/Tag-Outs and ready for service.		
5.9	VERIFY the forced draft fan and over fire air damper inlet and the controls are free of obstructions.		
5.10	VERIFY that the compressed air system is in service.		
5.11	VERIFY coal silo levels at a minimum of 50%.		
5.12	VERIFY coal belts are operational, and a supply is in place at the feeder.		
5.13	VERIFY that the CEMs are in service and self-calibrating on schedule.		
5.14	Run ash system for at least 16 hours before Boiler 6 start-up		
5.15	Run coal grates for at least 8 hours and up to 24 hours prior to boiler start-up.		
5.16	Run coal feeder rotors for at least 8 hours and up to 24 hours prior to boiler start-up.		

6.0	**Precautions, Limitations, and Actions**		
6.1	Temperature increase of the boiler water during startup should be limited to a maximum of 100 F per hour to insure that stress in the pressure parts remains at tolerable levels.		
6.2	A main fuel trip occurs if drum level falls below control range in the steam drum. Fuel on the grate will continue to burn. Drum level can be restored since the feedwater in the economizer is still close to boiler water temperature.		
6.3	ID fan and boiler damper are interlocked. ID fan will not start if damper closed indication is energized on ID fan drive.		
6.4	FD fan interlocked with ID fan. FD fan will not start if ID fan is not running.		
6.5	Coal feeders are interlocked with FD fan		

7.0	**Definitions**
7.1	***BIAS*** - Determines Boiler Lead/Lag with control in AUTOMATIC
7.2	***FD Fan*** - Forced Draft Fan
7.3	***FEGT*** - Furnace Exit Gas Temperature
7.4	***FPS Igniter*** - Fossil Power System brand igniter
7.5	***ID Fan*** - Induced Draft Fan
7.6	***LSP*** - Local Set Point with control in MANUAL
7.7	***PV*** - Process Variable
7.8	***RSP*** - Remote Set Point

8.0	**Pre-Light Off Preparation**		
8.1	VERIFY precipitator hoppers are clear of ash and doors closed and locked.		

8.2	VERIFY all boiler, sight glass, economizer, rear and side wall header drains are closed.		
8.3	VERIFY safety relief valves are installed and not gagged.		
8.4	OPEN / VERIFY open drum vent valves		
8.5	OPEN non-return valve.		
8.6	VERIFY sight glass block valves are open		
8.7	VERIFY boiler caustic injection valves are open.		
8.8	OPEN the economizer recirculation valves.		
8.9	VERIFY mechanical ash hoppers are clear of ash.		
8.10	VERIFY ash re-injection hoppers and re-injectors are clear of ash.		
8.11	CLOSE all doors/inspection ports on boiler, economizer, and air heater according to Appendix "D" Section 12.4.		
8.12	VERIFY bottom ash hoppers are clear of ash.		
8.13	VERIFY drip hoppers are clear of ash and doors closed.		
8.14	RUN ESP V/I curves for precipitator cells and store.		
8.15	VERIFY precipitator ash system and mechanical ash hoppers in service.		
8.16	OPEN super-heater intermediate drain.		
8.17	OPEN super-heater drain.		
8.18	VERIFY main steam stop valve is closed and above seat drain is open.		
8.19	Exercise the Feedwater Level Control Valve as follows: • VERIFY automatic feed water valve is isolated. • Manually increase feed water controller output to 100%. • VERIFY automatic feed water valve open 100%. • Return automatic feed water control output to 0%. • VERIFY automatic feed water valve is closed.		
8.20	VERIFY that both boiler dampers are open.		
8.21	VERIFY proper ID fan bearing oil levels		
8.22	START ID fan and place control in automatic set control LSP/BIAS at -.08.		
8.23	With forced draft control in manual increase output to 100%.		
8.24	VERIFY forced draft fan vanes open 100%.		
8.25	Return control output to 0% and VERIFY forced draft fan vanes are closed.		
8.26	Verify proper bearing oil levels and TEST run forced draft fan.		
8.27	Verify proper greasing and TEST run over-fire air fan.		
8.28	VERIFY grate inspection man way on north and south side of boiler closed.		
8.29	Test run boiler grates (See 5.15 above).		
8.30	Line up cooling water to coal distributors / feeders. (See 5.15 above).		
8.31	Grease feeders.		
8.32	Bring water level in boiler to light off level, -2" to -3" water column.		

Start-Up/Shutdown Date:_____

8.33	RECORD coal scale totalizer reading and start coal scales.		
	Totalizer #1: _____ Totalizer #2: _____		
8.34	OPEN / VERIFY open bunker coal feed to coal scales.		
8.35	Enable boiler ash system (See 5.14).		

9.0	**Boiler 6 Heat-Up Procedure With Gas Igniter**		
9.1	Start / verify running the B6 Induced draft Fan as follows		
9.2	From Delta-V Boiler 6 CONTROL SCREEN click on FURNACE DRAFT to open control face plate PIC-FG6001.		
9.3	Set control set point at -0.080.		
9.4	From Delta-V Boiler 6 CONTROL SCREEN click on ID FAN to open face plate HS-B66003.		
9.5	Start ID fan		
9.6	Place furnace draft in AUTO (PIC-FG6001).		
9.7	Line up feed water to HP Heater serving boiler and crack in steam supply to warm up heater.		
9.8	Place / verify CEM system in service.		
9.9	If no coal boilers are on-line, then open / verify open Scrubber Bypass.		
NOTE:	**15 psi Startup Igniter Gas Pressure provides 10% boiler heat rate. Igniters are interlocked with boiler safeties (ID / FD fans running and level). If a boiler trip occurs, then the igniter will also trip**		
9.10	Insert Left and Right igniters and observe limit switches make up.		
9.11	Open igniter gas manual isolation valve.		
9.12	Start/verify running the Igniter Combustion Air Blower.		
9.13	Open igniter air isolation valve and verify greater than furnace pressure.		
9.14	Place the Igniter Local Lockout Switches ON.		
9.15	Set FD fan control at minimum output and start FD fan.		
9.16	Set grate output control at about 10% and start grate.		
9.17	Verify ID and FD fans have run for a minimum 5 minute purge. Air flow will need to be between 25% and 40% and the Over Fire Air fan will need to be running at least until there is a fire in the boiler.		
NOTE:	**The right igniter points slightly forward, provides a more uniform temperature profile across the furnace and is the preferred unit to start with.**		
9.18	Start the right igniter and verify: • Gas valves open and vent valve closed • Spark energizes • Igniter Flame On		
9.19	Start the alternate igniter, and stop the running igniter every 30 minutes until pressure temperature curve requires both igniters.		

9.20	Monitor boiler pressure and temperature and allow to come up in accordance with attached Babcock and Wilcox heat up curve		
9.21	When air heater outlet temperature reaches 260°F place electronic precipitators (ESP's) in service.		
NOTE:	**ESP's should be up to temperature before injecting coal to minimize smoking.**		
9.22	Start coal distributors/feeders and adjust feed rate to maintain fire.		
9.23	Stop igniters one at a time and increase coal feed rate.		
9.24	Verify Gas Valve closes and Gas vent Valve opens.		
9.25	Pull igniter pins, retract Left and Right igniter tips and insert plugs.		
9.26	Adjust Purge Air to 20-30%. Continue boiler startup at section 11.0		

10.0	**Boiler 6 Heat-Up Procedure Without Gas Igniter**		
10.1	START / VERIFY running the B6 induced draft Fan as follows.		
10.2	From Delta-V Boiler 6 control screen CLICK on "Furnace Draft" to open face plate PIC-FG6001.		
10.3	Set control set point at -0.080.		
10.4	From Delta-V Boiler 6 control screen CLICK on "ID FAN" to open face plate HS-B66003.		
10.5	START ID fan		
10.6	Place furnace draft in AUTO (PIC-FG6001), if conditions allow.		
10.7	Line up feed water to HP Heater serving boiler and crack in steam supply to warm up heater.		
10.8	At coal scales control panel, VERIFY power to coal scales # 1 and # 2 on.		
10.9	RECORD coal scale reading from # 1 and # 2.		
	#1 Scale Reading _____ #2 Scale Reading _____		
10.10			
10.11	From control panel Select "REMOTE".		
10.12	OPEN bunker coal feed to coal scales		
10.13	From Delta-V Boiler 6 control screen CLICK on "COAL SCALE #1" to open control face plate HS-CH6001 CLICK on "START".		
10.14	From Delta-V Boiler 6 control screen CLICK on "COAL SCALE #2" to open control face plate HS-CH6002 CLICK on "START".		
10.15	Line up cooling water to coal distributors/feeders.		
10.16	To start coal distributors and coal feeders, from Boiler 6 stoker control panel verify power available.		
10.17	Turn coal distributors on in HAND.		
10.18	Turn coal feeders on in AUTO.		

10.19	From Delta-V Boiler 6 control screen CLICK on "ROTOR DRIVE (1-4)" to open control face plate. It will be necessary to set output % for each rotor drive 1 through 4 at 650 to 700 RPM depending on coal quality and distribution in furnace.		
10.20	CHANGE rotor drive output % to set "Rotor Speed".		
10.21	From Delta-V Boiler 6 control screen CLICK on "Coal Feeder #1" to open control faceplate.		
10.22	CLICK on "START".		
10.23	Repeat steps to start feeders 2 through 4.		
10.24	Open feeder SPEED CONTROL faceplate 1-4 and set output 0 and place in CASCADE.		
10.25	From Delta-V Boiler 6 control screen CLICK on "STOKERS" to open stoker control face plate HIC-B66001.		
10.26	Increase stoker output to increase coal feed (must be in CASCADE).		
10.27	Run coal feed until grate is covered by 2 to 3 inches of coal.		
10.28	STOP coal feeders.		
10.29	Distribute paper and wood on top of coal in rear 2/3 of firebox.		
NOTE:	**If CEM is not in service it should be placed in service at this time. If another coal boiler is on line do not bypass Scrubber to start additional boilers.**		
10.30	Enable boiler ash system (Refer to 5.14).		
10.31	Light fire and close front doors.		
10.32	CLOSE drip hopper doors after about one hour.		
10.33	At Boiler 6 control screen VERIFY FD fan damper is at minimum.		
10.34	CLICK on "FORCED DRAFT FAN" to open faceplate HS-B66001.		
10.35	CLICK on "START" (forced draft fan damper control may be placed in CASCADE at this time).		
10.36	Allow boiler pressure and temperature to come up in accordance with Babcock and Wilcox heat up curve Attachment "C" Section 12.3.		

11.0	**Boiler 6 Start-Up**		
11.1	Continue to monitor boiler drum level and pressure, close drum vent when drum pressure reaches 50 psi.		
11.2	CLOSE super-heater intermediate drain when the drum reaches 200 psi.		
11.3	When drum pressure reaches 600 psi. OPEN main steam stop valve.		
11.4	CLOSE main steam stop valve above seat drain.		
11.5	OPEN isolation valves at automatic drum level control valve.		
11.6	From Delta-V Boiler 6 control screen CLICK on "OFA FAN" to open control faceplate HS-B66002 and CLICK on "START".		

11.7	When boiler drum pressure reaches header pressure gradually increase coal feed until boiler comes on line.		
11.8	From Delta-V Boiler 6 control screen CLICK on "FDF DAMPER" to open control faceplate FIC-B66001 CLICK on "CASCADE". Maintain 5% to 7% excess O2.		
11.9	From Delta-V Boiler 6 control screen CLICK on "FEED WATER CONTROL VALVE" to open control faceplate LIC B66000. Put automatic feed water valve in AUTO and verify drum level control.		
11.10	Gradually increase coal feed until boiler is operating at about 50,000 pounds of steam per hour.		
11.11	Place grate drive output in CASCADE.		
NOTE:	**After boiler has been on line 1 to 2 hours it may be necessary to bias grate speed + or – to maintain a 2 to 3 inch ash bed.**		
11.12	CLOSE super-heater high pressure drain.		
11.13	CLOSE economizer recirculation valves.		
11.14	Put steam on to HP Heater serving boiler.		
11.15	Match grate speed control output with coal feed output.		
11.16	Put coal feed control in AUTO.		
11.17	Put grate speed control in AUTO		
11.18	From Delta-V Boiler 6 control screen CLICK on "STOKERS" to open faceplate HIC-B66001 Stoker Control and CLICK on "CASCADE".		
11.19	From Delta-V Boiler 6 control screen CLICK on "BOILER MASTER" to open control faceplate HC-B66001 < - > boiler load to match PLANT MASTER output.		
11.20	PLACE boiler master in CASCADE.		
11.21	VERIFY plant master in AUTO and controlling boiler.		
Note:	**Controls can only be placed in AUTO in a right to left sequence. FD fan control must be in AUTO before coal feed control can be put in AUTO.**		
11.22	Drum level control is independent and can be placed in AUTO or MAN anytime.		
11.23	Change boiler load as desired with boiler master in MAN.		
11.24	Place boiler master in AUTO, plant master will now control load.		
11.25	If boiler is operating alone, then set boiler master LSP/BIAS at 0.		
11.26	If boiler is operating in parallel, then adjust boiler lead/lag by gradually changing boiler master LSP/BIAS as desired between -20 and +10.		
11.27	Monitor boiler for leaks, re-injector operation, or unusual conditions.		
11.28	Log time boiler on line and in AUTO in operators Log Book.		
11.29	Notify Fuel Tec to start injection chemicals to boiler furnace.		

Start-Up/Shutdown Date:_____

12.0 Boiler Shutdown

Caution:	**During shutdown if leaks are detected in boiler immediately isolate boiler from ash system. Pull ash on ash hoppers that are verified to be dry only. All necessary steps to prevent water from being pulled into the ash system should be taken.**		
12.1	Place boiler master control in manual and gradually reduce load to 50M.		
12.2	Shut down Fuel Tec chemical injection and remove injectors from boiler in accordance with SOP #06-CM-001.		
12.3	Adjust plant load to accommodate boiler coming off line.		
12.4	CLOSE inlet to coal scales from coal bunker.		
12.5	OPEN economizer recirculation valves.		
12.6	CLOSE steam supply to high pressure heater supplying water to boiler.		
12.7	OPEN super-heater high pressure drain.		
12.8	Allow boiler to operate at low load until all coal is out of coal scales, conicales, and feeders.		
12.9	Shutdown FD fan as follows:		
12.10	Place FD fan controller in Manual and lower output to 0%.		
12.11	STOP FD fan.		
12.12	After re-injector hoppers are verified clear, shut down over-fire air fan.		
12.13	CLOSE steam header stop valve (Drum pressure should be below 800 lbs prior to closing).		
12.14	OPEN stop valve above seat drain.		
12.15	Shut down feed water chemical injection to boiler.		
12.16	Monitor boiler water level. Continue to keep boiler at normal operating water level. Close isolation valves when necessary.		
12.17	When drum pressure reaches 400 psi, blow down water wall headers one at a time until all headers have been blown.		
12.18	When drum pressure reaches 200 psi, open intermediate super-heater drain, if equipped.		
12.19	Continue to run grate and feeders until all ash is off grate.		
12.20	Lower grate control output to 0% and shutdown grate.		
12.21	Lower feeder control output to 0% and shutdown feeders.		
12.22	Shutdown coal distributors.		
12.23	When all ash hoppers are verified clear of ash isolate boiler from ash system.		
12.24	Shut down boiler ESP's.		
12.25	Shut down CEMs unless there is another boiler in operation.		
12.26	Allow ID fan to continue to run for one hour.		
12.27	Put ID fan control in manual and set output to 0%.		

Start-Up/Shutdown Date:_____

12.28	Shutdown ID fan.		
12.29	Log time boiler off line and shutdown as well as the final coal scale numbers in the control room operating log book.		
	Boiler Steam Off-Line Time: _____ Boiler Shutdown (CEMs) Time: _____ Coal Scale #1: _____ Coal Scale #2: _____		
12.30	Continue to maintain normal water level during boiler cool down.		
12.31	When drum pressure reaches 50 psi, open boiler drum vent.		

13.0 Chain of Responsibility

Persons responsible for Performing this Procedure :

_____ _____
Steam & Power Plant IV Date and time signed on:

Transferred to : Current step in procedure:_____

_____ _____
Steam & Power Plant IV Date and time signed on:

Transferred to : Current step in procedure:_____

_____ _____
Steam & Power Plant IV Date and time signed on:

Transferred to : Current step in procedure:_____

_____ _____
Steam & Power Plant IV Date and time signed on:

14.0 Version History

Revision	Date	Action
A		
0		
1		
2		
3		
4		

Start-Up/Shutdown Date:_____

15.0 ATTACHMENTS

Attachment A

15.1 VALVE LINE-UP

Startup: The startup valve position is the valve position required prior to placing the system or component in service.
Normal: The normal valve position is the valve position when the system or component is operating.

O=Open, C=Closed, T=Throttled

Valve EIN	Valve Name	Startup	Normal

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Start-Up/Shutdown Date:_____

Valve EIN	Valve Name	Startup	Normal

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Start-Up/Shutdown Date:_____

Attachment B

15.2 Electrical Line-Up

Switchgear Number	Compartment	Description	Startup Position
CG41E	102A	FG06X ID FAN TRANSFORMER	RACKED IN AND CLOSED
		ABB ACH500 CABINET DRIVE BREAKER	CLOSED
		W. SIDE OF FG06X DISCONNECT FOR A/C (2)	CLOSED
CG41E	101A	CA06F B6 FD FAN	RACKED IN AND CLOSED REMOTELY
AP46E	3D	CA61F B6 OVERFIRE AIR FAN	RACKED IN AND CLOSED REMOTELY
AP66E	SWITCH 3	FEED TO SOOTBLOWER CABINET	CLOSED
AP66E	SWITCH 4	FEED TO CH61M COAL SCALE 6-1	CLOSED
AP66E	SWITCH 5	FEED TO CH62M COAL SCALE 6-2	CLOSED
AP66E	SWITCH 10	FEED TO B6 COAL FEEDER PANEL	CLOSED
		LOACL DISCONNECT ON COAL FEEDER PANEL	CLOSED

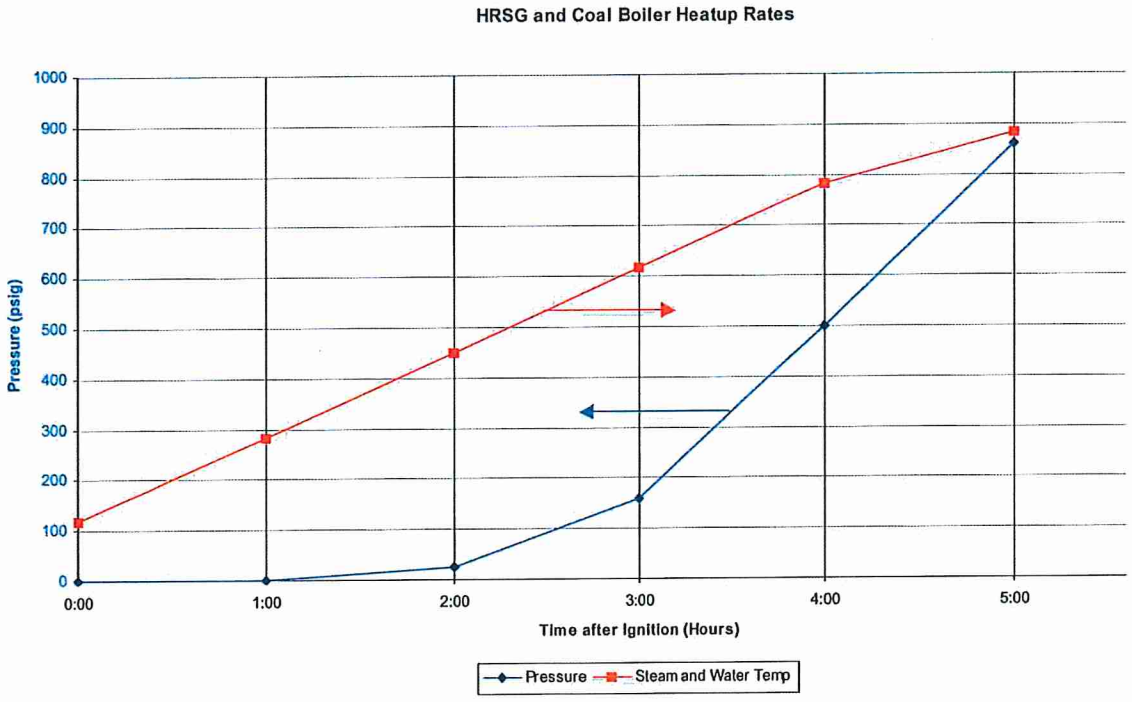
Switchgear Number	Compartment	Description	Startup Position
		LOCAL DISCONNECT ON COAL SCALE 6-1	CLOSED
		LOCAL DISCONNECT ON COAL SCALE 6-2	CLOSED
		LOCAL DISCONNECT ON IK-1 SOOTBLOWER (S. LOWER)	CLOSED
		LOCAL DISCONNECT ON IK-2 SOOTBLOWER (N. LOWER)	CLOSED
		LOCAL DISCONNECT ON IK-3 SOOTBLOWER (S. UPPER)	CLOSED
		LOCAL DISCONNECT ON IK-4 SOOTBLOWER (N. UPPER)	CLOSED
		B6 N. ROTARY SOOTBLOWER PANEL LOCAL DISCONNECT	CLOSED
		B6 S. ROTARY SOOTBLOWER PANEL LOCAL DISCONNECT	CLOSED
		SOOTBLOWER MOV LOCAL SWITCH	REMOTE
AP46E	3B	FEED TO FG06E PRECIPITATOR PANEL	RACKED IN AND CLOSED
FG06E	SWITCH 1	FEED TO HOPPER VIBRATORS	CLOSED
FGO6E	SWITCH 8	FEED TO INLET TIR SEER	CLOSED
FG06E	SWITCH 10	FEED TO MIDDLE TIR SET	CLOSED
FG06E	SWITCH 12	FEED TO OUTLET TIR SET	CLOSED

Switchgear Number	Compartment	Description	Startup Position
FG06E	SWITCH 14	FEED TO PURGE AIR / HEAT SYSTEM	CLOSED
FG06E	SWITCH 5	FEED TO RAPPER CONTROL	CLOSED
ESP TIR SET GEAR	2B	B6 INLET TIR CONTROLLER	CLOSED
ESP TIR SET GEAR	3A	B6 MIDDLE TIR CONTROLLER	CLOSED
ESP TIR SET GEAR	3B	B6 OUTLET TIR CONTROLLER	CLOSED
		RAPPER CONTROLLER LOCAL DISCONNECT PENTHOUSE	CLOSED
		PURGE AIR / HEATER CONTROLLER LOCAL DISCONNECT	CLOSED

Start-Up/Shutdown Date:_____

Attachment C

15.3 B&W Heat Up Curve



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Start-Up/Shutdown Date:_____

Attachment D

15.4 Manways & Doors			
Name	Location	Initials Completed	Time Completed
Firebox Inspection Port	1st Floor, North Side, East Port		
Firebox Inspection Port	1st Floor, North Side, Mid-East Port		
Firebox Inspection Port	1st Floor, North Side, 10' up		
Firebox Inspection Port	1st Floor, N. Side, Mid-West Port		
Under Grate Access Panel	1st Floor, North Side, Floor Level		
Firebox Inspection Port	1st Floor, North Side, West Port		
Ash Re-injector Clean Out Ports	1st Floor, West Side of B6		
Firebox Inspection Port	1st Floor, W. B6, above Re-injectors		
Superheater Duct Plenum Access	1st Floor, West Wall		
Superheater Return Duct Hatch	1st Floor, W. of B6, East side of Hall		
B6 FD Fan Casing Access Hatch	1st Floor, S. side of B6 FD Fan		
Firebox Inspection Port	1st Floor, South Side, West Port		
Firebox Inspection Port	1st Floor, South Side, East Port		
Mud Drum Hatch	2nd Floor, North Side B6		
Furnace Observation Door	2nd Floor, N. Side B6, East of Drum		
Furnace Observation Door	2nd Floor, N. Side B6, West of Drum		
Furnace Observation Door	3rd Floor, North Side, East Door		
Furnace Observation Door	3rd Floor, North Side, West Door		
Furnace Observation Door	3rd Floor, North Side		
Furnace Observation Door	2nd Floor, West Side, North Door		
Furnace Observation Door	2nd Floor, West Side, South Door		
Superheater Access Hatch	3rd Floor West Wall		
S.H. Ash Hopper Access Hatch	3rd Floor, W. Wall, 10' up, N. Hatch		
S.H. Ash Hopper Access Hatch	3rd Floor, W. Wall, 10' up, M. Hatch		
S.H. Ash Hopper Access Hatch	3rd Floor, W. Wall, 10' up, S. Hatch		
Access Hatch	4th Floor, North Side		
Steam Drum Hatch	4th Floor, North Side		
Superheater Observation Door	4th Floor, North Side, East Door		
Superheater Observation Door	4th Floor, North Side, West Door		
Access Hatch	4th Floor, South Side		
Steam Drum Hatch	4th Floor, South Side		
Superheater Observation Door	4th Floor, South Side, East Door		
Superheater Observation Door	4th Floor, South Side, West Door		
Access Hatch	3rd Floor, South Side, East Hatch		
Access Hatch	3rd Floor, South Side, West Hatch		

Start-Up/Shutdown Date:_____

Mud Drum Access Hatch	2nd Floor, South Side		
Furnace Access Hatch	2nd Floor, South Side, East Hatch		
Furnace Access Hatch	2nd Floor, South Side, West Hatch		
Coal Scale Hatches	2nd Floor, East of B6, North Scale		
Coal Scale Hatches	2nd Floor, East of B6, South Scale		
Ash Grinder Access Panel	Basement, East Side, North Grinder		
Ash Grinder Access Panel	Basement, East Side, South Grinder		
Ash Grinder Observation Port	Basement, West Side, North Grinder		
Ash Grinder Observation Port	Basement, West Side, South Grinder		
Drip Hopper Access Door	Basement, B6, North West Hopper		
Drip Hopper Access Door	Basement, B6, South West Hopper		
Drip Hopper Access Door	Basement, B6, North East Hopper		
Drip Hopper Access Door	Basement, B6, South East Hopper		

Start-Up/Shutdown Date:_____

BOILER OPERATOR BOX

Boiler 6

BOILER 6 OPERATING PARAMETERS		
PARAMETERS	**BOILER 6**	**COMMENTS**
Main Steam PSI	875 psi.	
Main Steam °F	760°F	
Maximum Steam Flow	150,000 #/HR	
Maximum Steam Pressure	960 psi.	
FURNANCE PSI	-0.5 " WC	
Furnace Draft Trip	-7"low +6"high	
Drum #1 Safety	975 psi	
Main #1 Safety	915 psi	
Excess O2	2.5%	
Min Air Flow	25%	
Min Air Flow Trip	20%	
Drum Level High	+3" Alarm +6" Trip	
Drum Level Low	-3" Alarm	
Low Water Cutout	-6.5" Trip	
Heat Up max/hr	180°F	
Cool Down/hr	200°F	

Macawber

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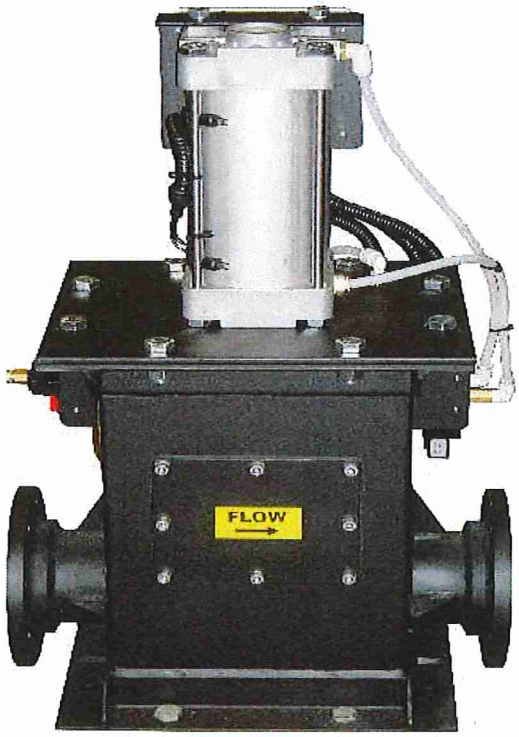
INFORMATION SHEET 1–2

DUMP VALVE



The **Dump Valve** is a very convenient method of distributing material into many reception locations in a pneumatic conveying system. It is mounted onto the top of the reception hopper or silo connected to a simple rectangular flange.

A rectangular casing encloses a shoe containing two material direction arrangements supported by an air cylinder. The air cylinder drives the shoe between two positions.

In the up position a deflector casting causes the material to be sent downwards into the silo. In the down position a pipe section is aligned between both inlet and outlet ports to allow the material to pass directly through the valve. Inflatable seals in each end of the pipe section prevent leakage of material into the hopper when the material is passing to a subsequent destination.

Operation of the valves is controlled by the conveying system controls to signal for the correct valve position in response to the operator's or process requirements. The valve changes position if required at the period when the conveying pipeline is not passing material. Correct valve position is confirmed with proximity sensors for both valve positions.

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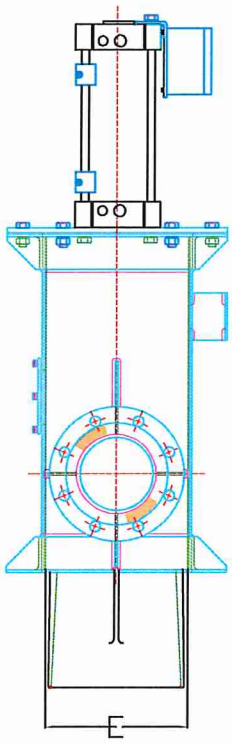
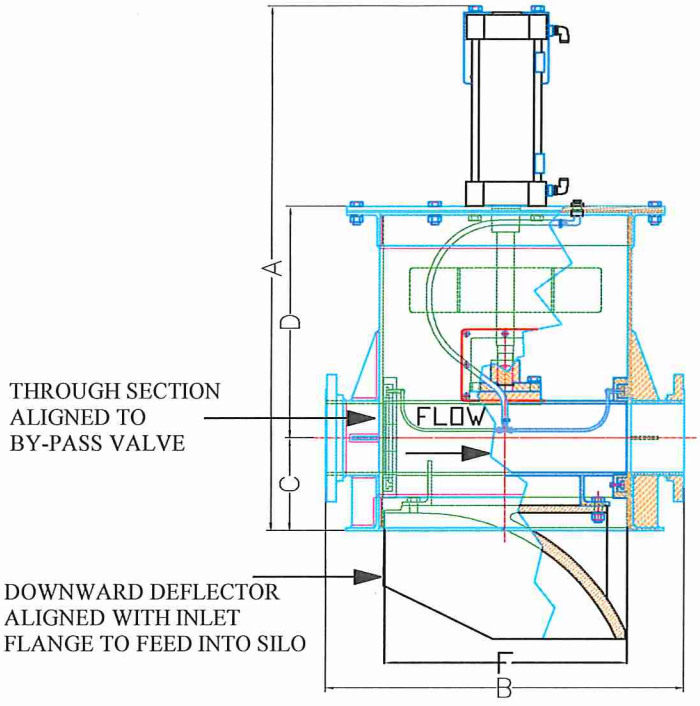
INFORMATION SHEET	1–2

DUMP VALVE





MODEL (PIPE SIZE)	DIMENSIONS (INCH)						NET WT. (LBS)
	A	B	C	D	E	F	
2"	23 1/8	14 1/2	4	9 3/8	6	9	134
3"	25 3/4	18	4 3/4	10 5/8	8	11 1/4	225
4"	25 5/8	19 1/2	5	10 3/8	8	11 1/4	249
5"	35 1/8	22 1/8	6	15 7/8	9 1/4	11 1/4	311
6"	39 1/2	31 3/4	8	17 1/4	12	21 5/8	590
8"	47 1/2	33 1/2	9	21 3/8	12 5/8	23 5/8	983
10"	58 3/4	43 1/4	11 1/2	28 1/8	16 1/2	29 1/2	1342
12"	62 7/8	48	13 1/4	28 1/2	20	37	1452

INFORMATION NOT CERTIFIED FOR INSTALLATION PURPOSES

Macawber

Engineering Inc.,

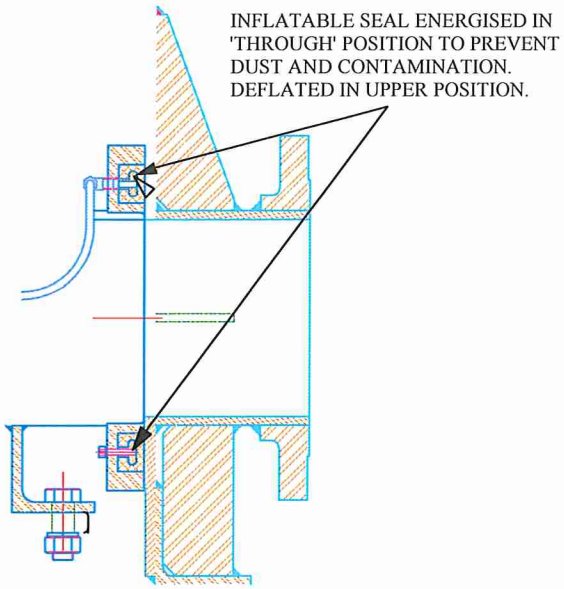
ADVANCED PNEUMATIC CONVEYING & INJECTION SYSTEMS
VALVES FOR ABRASIVE MATERIALS AND PRESSURE DUTY
BATCH MIXING AND INGREDIENT CONTROL
COMPLETE BULK MATERIAL SYSTEM DESIGN AND TURNKEY SUPPLY

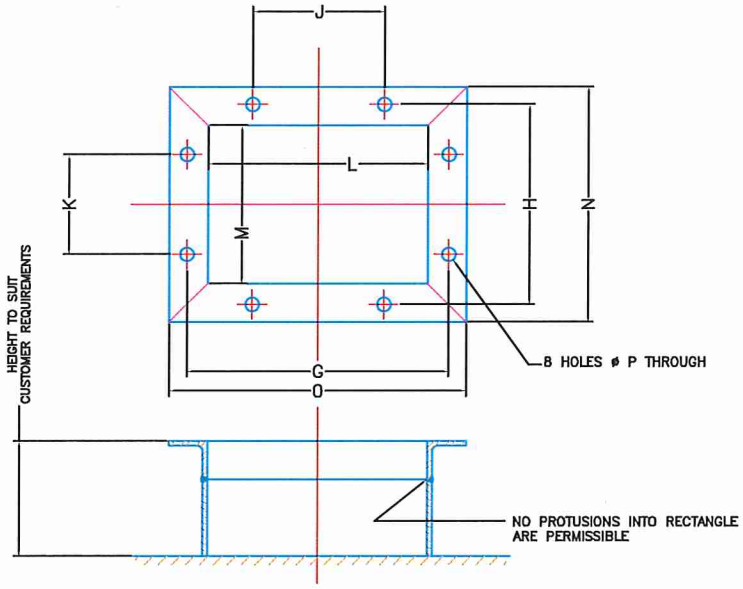
1829 Clydesdale Street, Maryville, Tennessee 37801-3796, USA E-mail:sales@macawber.com - www.macawber.com - Tel:+001 865 984 5286 - Fax:+001 865 977 4131

Macawber
Engineering Inc.,

INFORMATION SHEET	1–2

DUMP VALVE





MODEL (PIPE SIZE)	DIMENSIONS (INCH)								
	G	H	J	K	L	M	N	O	øP
2"	11	4	6 1/4	4 3/4	9 1/2	6 1/4	9 1/2	12 1/2	1/2
3"	13 3/8	10 1/4	6 3/4	5 1/8	11 1/2	8 3/8	12 1/4	15 1/2	3/4
4"	13 3/8	10 1/4	6 3/4	5 1/8	11 1/2	8 3/8	12 1/4	15 1/2	3/4
5"	17 1/2	11 1/2	9 1/2	5 1/2	15 1/2	5 1/2	13 1/2	19 1/2	3/4
6"	26 3/8	16	12 1/2	9	22 1/4	12 1/2	18 3/8	28 1/8	3/4
8"	28 3/8	17 3/8	14 1/4	9 7/8	23 5/8	12 3/4	18 1/2	29 1/2	3/4

INFORMATION NOT CERTIFIED FOR INSTALLATION PURPOSES

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	CEP MAJOR MAINTENANCE ITEMS	Guestimate
1	Replace switch valve boxes quantity 2	$ 160,000
2	Baghouse Bags (total replacement 1155 for 7 cells, 250 for invetory/stock)	$ 125,000
3	Replace condensate line from pump to feed water supply at DA tank	$ 20,000
4	Replace condensate pumps (3 each)	$ 60,000
5	Replace breaching elbows on #2, #3, and #4	$ 30,000
6	Spare 200 Hp motor for ID fans	$ 30,000
7	New primary and secondary ash separator in the ash silo	$ 10,000
7	New air wash assembly in the ash silo	$ 10,000
8	Repair of roots blower and redesign of inlet vacuum piping	$ 18,000
9	Connect all VFD's to a modbuss network and integrate to metasys	$ 5,000
10	Dump Valve box replace quantity 10	$ 1,000,000
11	Enclose bag house perimeter and provide lighting	$ 25,000
12	Line condensate return tank	
13	Gas supply to Plant strainer install	
14	Line the bunkers with low friction coefficient material	$ 10,000
15	Replace of the stoker clutch (lineshaft) all three boilers	$ 50,000
16	Boiler side wall replacement #2 boiler	$ 1,000,000
17	Integrate delta V to metasys	$ 5,000
18	Upgrade of VFD's on ID fans	
19	Replace Mcquay chiller - 2 400 ton limit - 800 ton.	
20	Redo chiller plant distribution	
21	Filtering system for roots blower (line 8)	
22	Drag conveyor chain	$ 15,143
23	Baghouse inlet damper seals (3 dampers)	
24	Boiler Non-return valve rebuild (2 each @ approx 15,000 each)	$ 30,000
25	Rebuild/ Replace Keeler Boiler Non-Return and Header Stop	
26	Replace boiler bottom drain line with schedule 80 pipe	

Clean Power Plan V Final Rule

SD-II-18 EPA Rule

FEDERAL REGISTER

Vol. 80 Friday,
No. 205 October 23, 2015
Book 2 of 2 Books
Pages 64661–65120

Part III

Environmental Protection Agency

40 CFR Part 60
Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units; Final Rule

Only fossil fuel-fired electric utility steam generating units and stationary combustion

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 60

[EPA–HQ–OAR–2013–0602; FRL–9930–65–OAR]

RIN 2060–AR33

Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: In this action, the Environmental Protection Agency (EPA) is establishing final emission guidelines for states to follow in developing plans to reduce greenhouse gas (GHG) emissions from existing fossil fuel-fired electric generating units (EGUs). Specifically, the EPA is establishing: Carbon dioxide (CO_2) emission performance rates representing the best system of emission reduction (BSER) for two subcategories of existing fossil fuel-fired EGUs—fossil fuel-fired electric utility steam generating units and stationary combustion turbines; state-specific CO_2 goals reflecting the CO_2 emission performance rates; and guidelines for the development, submittal and implementation of state plans that establish emission standards or other measures to implement the CO_2 emission performance rates, which may be accomplished by meeting the state goals. This final rule will continue progress already underway in the U.S. to reduce CO_2 emissions from the utility power sector.

DATES: This final rule is effective on December 22, 2015.

ADDRESSES: *Docket.* The EPA has established a docket for this action under Docket No. EPA–HQ–OAR–2013–0602. All documents in the docket are listed in the *http://www.regulations.gov* index. Although listed in the index, some information is not publicly available (*e.g.*, confidential business information (CBI) or other information for which disclosure is restricted by statute). Certain other material, such as copyrighted material, will be publicly available only in hard copy. Publicly available docket materials are available either electronically in *http://www.regulations.gov* or in hard copy at the EPA Docket Center, EPA WJC West Building, Room 3334, 1301 Constitution Ave. NW., Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding federal holidays. The telephone number for the Public Reading Room is (202) 566–1744, and the telephone number for the Air Docket is (202) 566–1742. For additional information about the EPA's public docket, visit the EPA Docket Center homepage at *http://www2.epa.gov/dockets.*

World Wide Web. In addition to being available in the docket, an electronic copy of this final rule will be available on the World Wide Web (WWW). Following signature, a copy of this final rule will be posted at the following address: *http://www.epa.gov/cleanpowerplan/.* A number of documents relevant to this rulemaking, including technical support documents (TSDs), a legal memorandum, and the regulatory impact analysis (RIA), are also available at *http://www.epa.gov/cleanpowerplan/.* These and other related documents are also available for inspection and copying in the EPA docket for this rulemaking.

FOR FURTHER INFORMATION CONTACT: Ms. Amy Vasu, Sector Policies and Programs Division (D205–01), U.S. EPA, Research Triangle Park, NC 27711; telephone number (919) 541–0107, facsimile number (919) 541–4991; email address: *vasu.amy@epa.gov* or Mr. Colin Boswell, Measurements Policy Group (D243–05), Sector Policies and Programs Division, U.S. EPA, Research Triangle Park, NC 27711; telephone number (919) 541–2034, facsimile number (919) 541–4991; email address: *boswell.colin@epa.gov.*

SUPPLEMENTARY INFORMATION:

Acronyms. A number of acronyms and chemical symbols are used in this preamble. While this may not be an exhaustive list, to ease the reading of this preamble and for reference purposes, the following terms and acronyms are defined as follows:

ACEEE American Council for an Energy-Efficient Economy
AEO Annual Energy Outlook
AFL-CIO American Federation of Labor and Congress of Industrial Organizations
ASTM American Society for Testing and Materials
BSER Best System of Emission Reduction
Btu/kWh British Thermal Units per Kilowatt-hour
CAA Clean Air Act
CBI Confidential Business Information
CCS Carbon Capture and Storage (or Sequestration)
CEIP Clean Energy Incentive Program
CEMS Continuous Emissions Monitoring System
CHP Combined Heat and Power
CO_2 Carbon Dioxide
DOE U.S. Department of Energy
ECMPS Emission Collection and Monitoring Plan System
EE Energy Efficiency
EERS Energy Efficiency Resource Standard
EGU Electric Generating Unit
EIA Energy Information Administration
EM&V Evaluation, Measurement and Verification
EO Executive Order
EPA Environmental Protection Agency
FERC Federal Energy Regulatory Commission
ERC Emission Rate Credit
FR Federal Register
GHG Greenhouse Gas
GW Gigawatt
HAP Hazardous Air Pollutant
HRSG Heat Recovery Steam Generator
IGCC Integrated Gasification Combined Cycle
IPCC Intergovernmental Panel on Climate Change
IPM Integrated Planning Model
IRP Integrated Resource Plan
ISO Independent System Operator
kW Kilowatt
kWh Kilowatt-hour
lb CO_2/MWh Pounds of CO_2 per Megawatt-hour
LBNL Lawrence Berkeley National Laboratory
MMBtu Million British Thermal Units
MW Megawatt
MWh Megawatt-hour
NAAQS National Ambient Air Quality Standards
NAICS North American Industry Classification System
NAS National Academy of Sciences
NGCC Natural Gas Combined Cycle
NO_X Nitrogen Oxides
NRC National Research Council
NSPS New Source Performance Standard
NSR New Source Review
NTTAA National Technology Transfer and Advancement Act
OMB Office of Management and Budget
PM Particulate Matter
$PM_{2.5}$ Fine Particulate Matter
PRA Paperwork Reduction Act
PUC Public Utilities Commission
RE Renewable Energy
REC Renewable Energy Credit
RES Renewable Energy Standard
RFA Regulatory Flexibility Act
RGGI Regional Greenhouse Gas Initiative
RIA Regulatory Impact Analysis
RPS Renewable Portfolio Standard
RTO Regional Transmission Organization
SBA Small Business Administration
SCC Social Cost of Carbon
SIP State Implementation Plan
SO_2 Sulfur Dioxide
Tg Teragram (one trillion (10^{12}) grams)
TSD Technical Support Document
TTN Technology Transfer Network
UMRA Unfunded Mandates Reform Act of 1995
UNFCCC United Nations Framework Convention on Climate Change
USGCRP U.S. Global Change Research Program
VCS Voluntary Consensus Standard

Organization of This Document. The information presented in this preamble is organized as follows:

I. General Information
A. Executive Summary
B. Organization and Approach for This Final Rule

Donelson Corporation

EST. 1965

BOILERS ♦ MECHANICAL EQUIPMENT ♦ PROCESS FILTRATION

BUDGETARY PRICING

TO: **Henneman Engineering**

ATTN: **Paul Boland**

JOB: **University of Wyoming – Hurst Budget Pricing**

Thursday, August 18, 2016

WE ARE PLEASED TO QUOTE THE FOLLOWING EQUIPMENT:

One (1) ***Hurst Series 500 Model S500-W-1000-G0-150S Scotch Marine 150 psig Steam Boiler(s)*** completely packaged with a Webster model JBEX9-500N-NX6100-M.30VGD-UL-ASME CSD-1-IRI-NFPA8501 combination natural gas and air atomized burner(s). Each packaged unit will be a minimum of 82% efficient, each having a firing rate of 42,000 mbh and an output of 33,475 mbh (1000 hp) when supplied with 5# of gas pressure, 100# of oil pressure and 480/60/3 electrical supply. The boiler will be **FOUR PASS WETBACK DESIGN for maximum fuel savings.** Unit(s) will be factory packaged & assembled and ready for fuel, electrical, vent, blow down and supply/return connections and will come be factory fire tested prior to shipment. The following trim and features are included with each boiler intending to meet the requested specifications: (based on operating @ 125 PSIG)

- **Boiler**
  - FOUR pass wetback design
  - Low Nox burner connection piped from the burner to the front of the smokebox
  - ASME full capacity relief valve(s) ~ KUNKLE
  - Compound pressure gauge ~ 6”
  - Honeywell operating pressurestat
  - Honeywell manual reset, high limit pressurestat
  - Fireye 0-300 PSIG modulating transducer
  - Honeywell low fire hold aquastat
  - McDonnell & Miller #194-7B low water cut-off/ and modulating pump control with gauge glass assembly, tri-cocks and blow down valve
  - Secondary McDonnell & Miller #150M float type, manual reset, low water cut-off
  - McDonnell Miller #150 high water alarm & cut-off
  - Stack damper Stack thermometer
  - Surface skimmer – mounted
  - Automatic surface blow down system with control system, conductivity probe, metering valve, electric actuated valve
  - 10” supply outlet in lieu of standard 8” to operate at 125 PSIG
  - SFV/Honeywell electric modulating feed water assembly 1-1/4” flanged - mounted

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E-mail: sales@donelsoncorp.com ▪ Visit our website at www.donelsoncorp.com

- Feed water stop and check valves 2-1/2" flanged - mounted
- Feed water three valve bypass 2-1/2" flanged - mounted
- Two (2) quick 2" and (1) slow 2" opening bottom blow down valves – mounted to a common discharge
- Davis 30FGAW 300# 10" OS&Y VALVE
- Davis 30ASC 300# 8" Non-Return valve
- Two (2) ASME 8" x 10" spool pieces with ¾" free flow drain valves
- 2" chemical feed connection
- Second hydro-test

■ **Burner Miscellaneous**

- 10-1 High turndown, modulating operation
- 30 PPM low Nox operation
- Fireye Nexus 6100 linkageless control system
- Nexus 6100 O2 trim system
- Refractory front plate
- Stainless steel combustion head
- Lancôme high turndown louver box

■ **Control Cabinet**

- NEMA 12 enclosure
- Single point power connection
- Burner switch
- Manual -Auto switch
- Purge air switch
- Manual reset "power failure" switch
- 6 indicating lights
- Alarm bell with silencing switch
- Fireye Nexus 6100 touchscreen control
- Fireye Nexus 6100 fuel air ratio controller complete with servo motors for primary air, gas, low Nox connection and oil factory mounted and wired
- Fireye Nexus 6100 O2 trim package complete with expansion board, ambient temperature sensor, and O2 probe assembly
- Motor contactor with overload protection
- Relays, fuses, etc.
- Color coded wiring and numbered terminal strips

■ **Gas Train Components ~ 3" Siemens VGD Integrated Gas Train**

- ASME CSD-1, UL, FM, IRI, NFPA-8501 code compliant

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- ♦ (2) main shutoff valves with permanently attached handles
- ♦ Gas strainer
- ♦ 3" Sensus 121-12 gas pressure regulator for high pressure service
- ♦ Dual motorized gas valves each with proof of closure
- ♦ Normally open vent valve with locking type vent ball valve
- ♦ High and low gas pressure switches
- ♦ Butterfly gas valve
- ♦ (2) leak test "ball type" valves
- ♦ (2) gas pressure gauges with gauge shutoff valves

▪ **Pilot Gas Train**

- ♦ Shutoff valve
- ♦ High pressure regulator
- ♦ Dual pilot solenoid valves
- ♦ Normally open vent valve

▪ Air Atomizing Oil System

- ♦ Air compressor
- ♦ (2) low atomizing air pressure switch
- ♦ Back pressure regulating and relief valve
- ♦ Flexible air supply line
- ♦ Air pressure regulating valve
- ♦ Air pressure gauges
- ♦ Air metering valve
- ♦ Air check valve
- ♦ Oil drawer assembly with air diffuser
- ♦ (2) motorized oil valves each with proof of closure
- ♦ Low oil pressure switch
- ♦ Manual valve
- ♦ Oil pressure gauges
- ♦ Oil metering valve
- ♦ Air atomizing oil nozzle
- ♦ Oil pressure regulator
- ♦ Flexible metal oil supply hose
- ♦ High and low oil temperature switches
- ♦ Leak test "ball type" valves
- ♦ (3) Oil gauges w/gauge shutoff valves

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BUDGETARY PRICING

- Freight included; unloaded by others
- Equipment start-up & training included

TOTAL NET PRICE FOB FACTORY, FFA: $362,450.00 EACH.

Delivery:

1. Delivery of equipment is 16-20 weeks ARO, based on production schedule at time of release.

Warranties

1. Warranty on package equipment is 12 months from start-up or 18 months from time of delivery, whichever comes first.

Terms & Conditions:

1. Pricing is good for 30 days then subject to review due to rising raw material costs
2. Payment Terms: Due to the cost of the equipment and in order to hold pricing, the manufacturer requires progressive payments as follows:
    i. 35% payment at time of order
    ii. 35% payment at scheduled completion prior to shipment
    iii. 30% payment net 30
3. The manufacture nor the supplier will not be liable for delays in shipping due to material shortages from our suppliers, or delays in securing a truck to ship the equipment.
4. Prices do not include any applicable taxes.

Quotation prepared by:

Craig Martin
DONELSON CORPORATION

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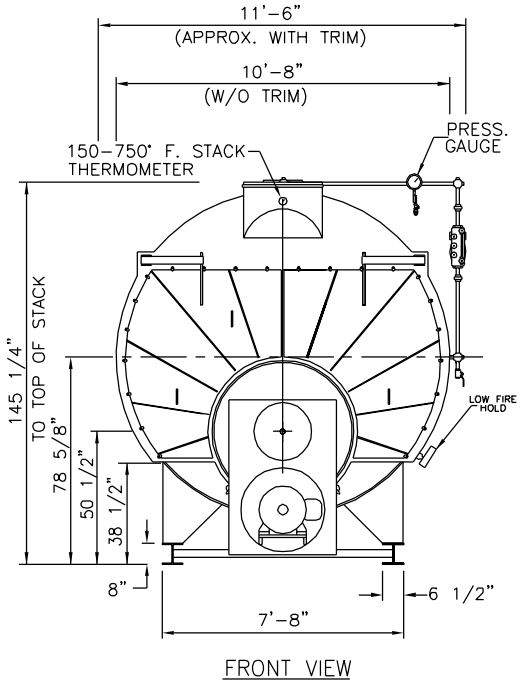
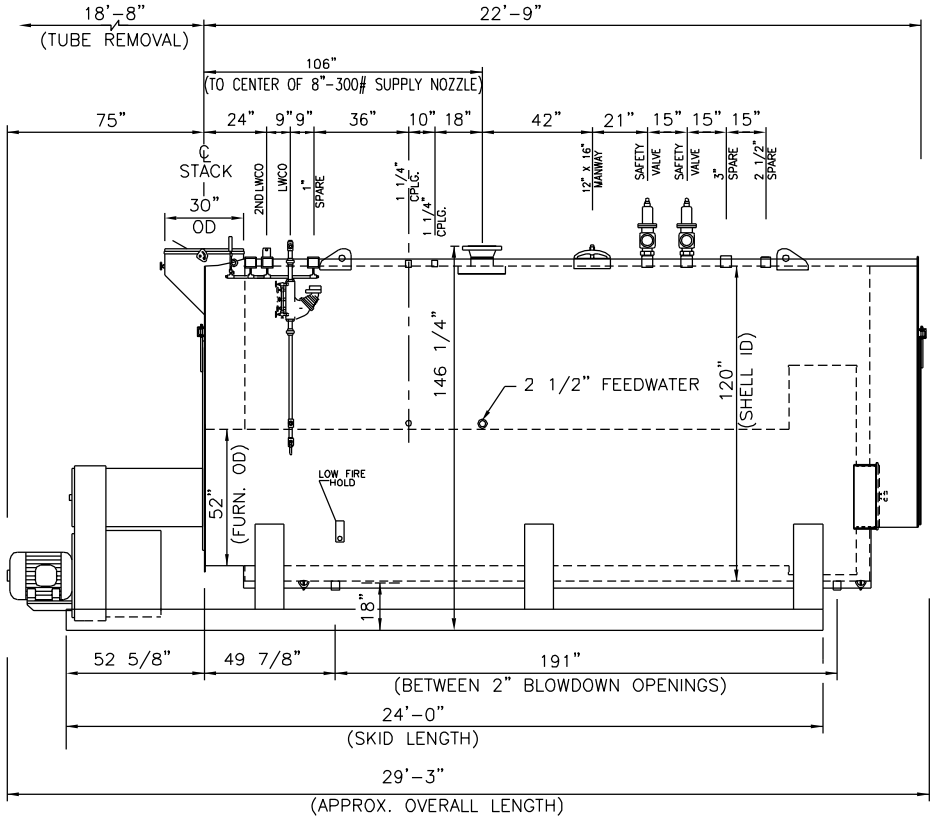
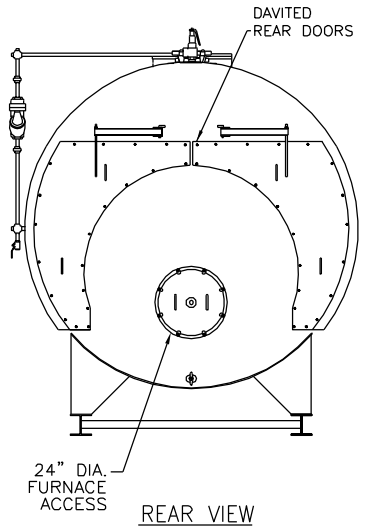


FRONT VIEW



RIGHT SIDE VIEW



REAR VIEW

NOTE

Overall dimension will vary depending on the burner manufacturer used.

BOILER SPECIFICATION CHART			
BUILT TO ASME CODE SECTION 1 FOR:	150 PSI	WATER CAPACITY (OPERATING)	5,010 GALS.
HEATING SURFACE	5000 SQ. FT.	WATER CAPACITY (FLOODED)	6,908 GALS.
FURNACE OUTSIDE DIA.	52 INCHES	SHIPPING WEIGHT	66,500 LBS.
FURN. VOL. (FURN. & TURNAROUND)	297 CU. FT.		

R	BY:	DATE:	CHK'D.	REASON FOR CHANGE

THIS DRAWING IS THE PROPERTY OF HURST BOILER AND WELDING CO., INC. AND MAY NOT BE COPIED OR REPRODUCED IN ANY WAY UNLESS AUTHORIZED IN WRITING BY HURST BOILER AND WELDING CO., AND MUST BE RETURNED UPON REQUEST

HURST BOILER & WELDING CO., INC.

SERIES 500 - 4 PASS WETBACK SCOTCH BOILER
1000 HP - 150 PSI STEAM

SCALE:	DWN. BY:	DATE:	CHK'D. BY:	DRAWING NO.:	R
NTS 48	JGF	3/4/08	JHO	S5-_-1000-150	

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ROCKY MOUNTAIN POWER

Amended Original Sheet No. 46-1

P.S.C. Wyoming No. 16

SD-III-1 Power Rate Structure

Large General Service
Time of Use - 1,000 KW and Over
Schedule 46

Available

In all territory served by the Company in the State of Wyoming.

Applicable

To non-residential Customers for all electric service required on the Customer's premises. Service under this Schedule is limited to electric service loads which have exceeded 999 kW in more than one month of a consecutive 18-month period. This Schedule will remain applicable until Customer fails to exceed 999 kW for 36 consecutive months. Deliveries at more than one point, or more than one voltage and phase classification, will be separately metered and billed. Service for loads that are intermittent, partial requirements, or highly fluctuating or seasonally disconnected (during any one year period) will be available only under a special contract.

Partial requirements service for loads of 1,000 kW and over will be provided under the provisions of Schedule 33.

Monthly Billing

The sum of the Basic, Demand, Energy and Reactive Power Charges. All Monthly Billings shall be adjusted in accordance with Schedules 92, 93, 95 and 191.

	Delivery	Transmission	Generation (Non ECAM)	Total
Secondary:				
Basic Charge				
Load Size ≤ 3,000 kW per month	$625.00			$625.00
Load Size > 3,000 kW per month	$1,090.00			$1,090.00
Load Size Charge*				
≤3,000 kW per kW Load Size	$2.26			$2.26
>3,000 kW per kW Load Size	$2.02			$2.02
Demand Charge				
On-Peak Period Demand				
(Monday through Friday: 7:00am to 11:00pm)				
Per kW for all kW of On-Peak Period Billing Demand	$0.33	$2.64	$12.44	$15.41
Energy Charge				
Per kWh		0.174¢	0.821¢	0.995¢

(continued)

ROCKY MOUNTAIN POWER

Amended Original Sheet No. 46-2

P.S.C. Wyoming No. 16

Large General Service
Time of Use - 1,000 KW and Over
Schedule 46

Monthly Billing (continued)

	Delivery	Transmission	Generation (Non ECAM)	Total
Primary:				
Basic Charge				
Load Size ≤ 3,000 kW per month	$810.00			$810.00
Load Size > 3,000 kW per month	$1,380.00			$1,380.00
Load Size Charge*				
≤3,000 kW per kW Load Size	$2.54			$2.54
>3,000 kW per kW Load Size	$2.43			$2.43
Demand Charge				
On-Peak Period Demand				
(Monday through Friday: 7:00am to 11:00pm)				
Per kW for all kW of On-Peak Period Billing Demand	$0.33	$2.63	$12.35	$15.31
Energy Charge				
Per kWh		0.164¢	0.773¢	0.937 ¢

***Note:** The kW load size shall be the greater of:
1. kW load size, for the determination of the Load Size Charge, shall be the average of the two greatest non-zero monthly demands established anytime during the 12-month period which includes and ends with the current billing month, or
2. 1,000 kW

Minimum Charge

The Basic Charge plus the Demand Charge for the current month. A higher minimum may be required under contract to cover special conditions.

Reactive Power Charge

	Delivery	Transmission	Generation (Non ECAM)	Total
Per kVar		11¢	49¢	60¢

The maximum 15-minute reactive Demand for the month in kVar in excess of 40% of the measured kW Demand for the same month will be billed per kVar of such excess reactive Demand.

(continued)

On-Peak Period Billing Demand

The measured On-Peak Period kW shown by or computed from the readings of Company's Demand meter for the 15-minute period of greatest use during the billing month, determined to the nearest whole kW.

Due to the expansions of Daylight Saving Time (DST) as adopted under Section 110 of the U.S. Energy Policy Act of 2005 the time periods shown above will begin and end one hour later for the period between the second Sunday in March and the first Sunday in April, and for the period between the last Sunday in October and the first Sunday in November.

Force Majeure

The Company shall not be subject to any liability or damages for inability to provide service, and the Customer shall not be subject to any liability or damage for such inability to receive service, to the extent that such inability shall be due to causes beyond the control of the party as specified in Rule 4, Part II, Section C of this Tariff.

Should any of the foregoing occur, the minimum Billing Demands that would otherwise be applicable under this Schedule shall be waived and the Customer will have no liability for service until such time as the Customer is able to resume service. The Customer will have no liability for full service until such time as the Customer is able to resume such service, except for any term minimum guarantees designed to cover special facilities extension costs, if any. The party claiming Force Majeure under this provision shall make every reasonable attempt to remedy the cause thereof as diligently and expeditiously as possible.

Term of Contract

Company may require the Customer to sign a written contract with a minimum term of one year.

Continuing Service

This Schedule is based on Continuing Service at each service location. Disconnect

(continued)

Large General Service
Time of Use - 1,000 KW and Over
Schedule 46

Continuing Service (continued)

and reconnect transactions shall be subject to the provisions set forth in Rule 3, Section VI of this tariff.

Rules

Service under this Schedule is subject to the General Rules contained in the tariff of which this Schedule is a part, and to those prescribed by the Wyoming Public Service Commission.

GLHN ARCHITECTS & ENGINEERS, INC
2939 E Broadway Blvd | Tucson, AZ 85716
T520.881.4546 | F520.795.1822 | GLHN.com

ORDER OF MAGNITUDE COST ESTIMATE
OPTION:CEP-C1
CENTRAL ENERGY PLANT-CHILLER ADDITION

SD-IV-1 CEP-C1 Cost Estimate

ORDER OF MAGNITUDE COST ESTIMATE-CHILLED WATER EXPANSION OPTION CEP-C1

PROJECT: University of Wyoming-West Campus Satellite Plant
PROJ.No.: 16051.00
DATE: August, 2016
DEPT: All
SHEET No.: 0 of 0
COMPUTED BY: GLHN
CHECKED BY: GLHN

OPINION OF PROBABLE CONSTRUCTION COST

BASIS FOR ESTIMATE

- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Finished design)
- [ ] OTHER (Change Order)

SUMMARY	QUANTITY	MATERIAL		LABOR		TOTAL COST
	# UNITS	PER UNIT	TOTAL	PER UNIT	TOTAL	
SITE IMPROVEMENTS						
Utility Relocation Allowance-West Campus-CEP Interconnect	1	$50,000	$50,000	$50,000	$50,000	$100,000
West Plant CHW Feed (Additional Piping between CEP and West Campus) 14" Direct Buried Piping, Insulated, Supply/Return	5000	$350	$1,750,000	$350	$1,750,000	$3,500,000
CEP Building Site allowance	1	$25,000	$25,000	$15,000	$15,000	$40,000
ARCHITECTURAL/STRUCTURAL						
Cooling Tower structure and pump vault	1	$110,000	$110,000	$25,000	$25,000	$135,000
Condenser Water Remote Sump Vault	1	$110,000	$110,000	$25,000	$25,000	$135,000
Chiller Bay Expansion, 600 sqft, building appurtenances	1	$180,000	$180,000	$180,000	$180,000	$360,000
MECHANICAL						
CHW Plant Piping (supports, insulation, fittings, valves, 14" steel)	600	$150	$90,000	$110	$66,000	$156,000
CW Header Improvements (supports, insulation, fittings, valves, 14" steel)	200	$150	$30,000	$110	$22,000	$52,000
Additional Air/Dirt Separation, 18" with strainer	1	$45,000	$45,000	$8,000	$8,000	$53,000
1,200 Ton Chiller w/ VFD	1	$500,000	$500,000	$25,000	$25,000	$525,000
1,200 Ton Cooling Tower	1	$200,000	$200,000	$50,000	$50,000	$250,000
Valves	10	$2,500	$25,000	$800	$8,000	$33,000
CW Pumps, 75HP, branch piping, instrumentation	2	$25,000	$50,000	$12,000	$24,000	$74,000
Controls	30	$500	$15,000	$500	$15,000	$30,000
Heat Exchanger, plate and frame, 500 tons, assocaited branch piping, instrumentation	2	$140,000	$280,000	$25,000	$50,000	$330,000
ELECTRICAL						
(2) 75 HP CW Pump VFDs	2	$15,000	$30,000	$3,000	$6,000	$36,000
(2) 25 HP Cooling Tower Fan VFDs	2	$6,000	$12,000	$2,000	$4,000	$16,000
Electrical Connections	1	$12,000	$12,000	$8,000	$8,000	$20,000
Addition power and lighting	1	$15,000	$15,000	$10,000	$10,000	$25,000
TELECOMMUNICATIONS						
			$0		$0	$0
Subtotal			$3,529,000		$2,341,000	**$5,870,000**
					Contingency 20%	$1,174,000
					Contractor P/O 15%	$880,500
					Liability/Bond/Tax 5%	$337,525
					Design Services 10%	$587,000
					University Fees 5%	$293,500
					TOTAL CONSTRUCTION COST	**$9,142,525**

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ORDER OF MAGNITUDE COST ESTIMATE
OPTION:CEP-C2
CENTRAL ENERGY PLANT-THERMAL ENERGY STORAGE

SD-IV-2 CEP-C2 Cost Estimate

ORDER OF MAGNITUDE COST ESTIMATE-CHILLED WATER EXPANSION OPTION CEP-C2

PROJECT: University of Wyoming-West Campus Satellite Plant
PROJ.No.: 16051.00
DATE: August, 2016
DEPT: All
SHEET No.: 0 of 0
COMPUTED BY: GLHN
CHECKED BY: GLHN

OPINION OF PROBABLE CONSTRUCTION COST

BASIS FOR ESTIMATE

- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Finished design)
- [ ] OTHER (Change Order)

SUMMARY	QUANTITY	MATERIAL		LABOR		TOTAL COST
	# UNITS	PER UNIT	TOTAL	PER UNIT	TOTAL	
SITE IMPROVEMENTS						
Utility Relocation Allowance-West Campus-CEP Interconnect	1	$50,000	$50,000	$50,000	$50,000	$100,000
West Plant CHW Feed (Additional Piping between CEP and West Campus) 14" Direct Buried Piping, Insulated, Supply/Return	5000	$350	$1,750,000	$350	$1,750,000	$3,500,000
CEP Building Site allowance	1	$25,000	$25,000	$15,000	$15,000	$40,000
ARCHITECTURAL/STRUCTURAL						
TES Tank Façade (Not Required for CEP-C2 Option)	1	$0	$0	$0	$0	$0
TES Tank Foundatoin	1	$300,000	$300,000	$100,000	$100,000	$400,000
Cooling Tower structure and pump vault	1	$110,000	$110,000	$25,000	$25,000	$135,000
Condenser Water Remote Sump Vault	1	$110,000	$110,000	$25,000	$25,000	$135,000
Chiller Bay Expansion, 600 sqft, building appurtenances	1	$180,000	$180,000	$180,000	$180,000	$360,000
MECHANICAL						
CHW Plant Piping (supports, insulation, fittings, valves, 14" steel)	600	$150	$90,000	$110	$66,000	$156,000
CW Header Improvements (supports, insulation, fittings, valves, 14" steel)	200	$150	$30,000	$110	$22,000	$52,000
Additional Air/Dirt Separation, 18" with strainer	1	$45,000	$45,000	$8,000	$8,000	$53,000
1,200 Ton Chiller w/ VFD	1	$500,000	$500,000	$25,000	$25,000	$525,000
1,200 Ton Cooling Tower	1	$200,000	$200,000	$50,000	$50,000	$250,000
Valves	20	$2,500	$50,000	$800	$16,000	$66,000
CW Pumps, 75HP, branch piping, instrumentation	2	$25,000	$50,000	$12,000	$24,000	$74,000
Controls	45	$500	$22,500	$500	$22,500	$45,000
TES Tank, steel tank, 1.5M gallons, interior and exterior coating	1	$750,000	$750,000	$750,000	$750,000	$1,500,000
TES Associated Piping	400	$150	$60,000	$110	$44,000	$104,000
TES Pumps, 150 HP	4	$50,000	$200,000	$20,000	$80,000	$280,000
Heat Exchanger, plate and frame, 500 tons, assocaited branch piping, instrumentation	2	$140,000	$280,000	$25,000	$50,000	$330,000
ELECTRICAL						
(2) 75 HP CW Pump VFDs	2	$15,000	$30,000	$3,000	$6,000	$36,000
(2) 25 HP Cooling Tower Fan VFDs	2	$6,000	$12,000	$2,000	$4,000	$16,000
(4) 150 HP TES Pump VFDs	4	$22,000	$88,000	$35,000	$140,000	$228,000
Chiller Electrical Connection	1	$12,000	$12,000	$8,000	$8,000	$20,000
Chiller Addition Power, lighting	1	$15,000	$15,000	$10,000	$10,000	$25,000
TELECOMMUNICATIONS						
			$0		$0	$0
Subtotal			$4,959,500		$3,470,500	**$8,430,000**
				Contingency 20%		$1,686,000
				Contractor P/O 15%		$1,264,500
				Liability/Bond/Tax 5%		$484,725
				Design Services 10%		$843,000
				University Fees 5%		$421,500
				TOTAL CONSTRUCTION COST		**$13,129,725**

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ORDER OF MAGNITUDE COST ESTIMATE
OPTION:WCE-C1 C2 WEST CAMPUS EXPANSION-THERMAL ENERGY STORAGE
BUREAU OF MINES OR NORTH OF AGRICULTURE

ORDER OF MAGNITUDE COST ESTIMATE-CHILLED WATER EXPANSION OPTIONS WCE-C1 AND WCE-C2

PROJECT: University of Wyoming-West Campus Satellite Plant — PROJ.No.: 16051.00
Thermal Energy Storage Option — DATE: August, 2016
DEPT: All
SHEET No.: 0 of 0
COMPUTED BY: GLHN
CHECKED BY: GLHN

OPINION OF PROBABLE CONSTRUCTION COST

BASIS FOR ESTIMATE

- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Finished design)
- [ ] OTHER (Change Order)

SUMMARY	QUANTITY	MATERIAL		LABOR		TOTAL COST
	# UNITS	PER UNIT	TOTAL	PER UNIT	TOTAL	
SITE IMPROVEMENTS						
Utility Relocation Allowance-Lewis	1	$25,000	$25,000	$25,000	$25,000	
West Campus distribution Piping along Lewis 14" Direct Buried Piping, Insulated, Supply/Return	1500	$350	$525,000	$350	$525,000	
Building Site allowance	1	$25,000	$25,000	$15,000	$15,000	
Existing Tunnel Bridging under TES tank	1	$50,000.00	$50,000.00	$30,000.00	$30,000.00	
West Campus power to new pump house	300	$40	$12,000	$40	$12,000	
ARCHITECTURAL/STRUCTURAL						
TES Tank Façade	1	$100,000	$100,000	$100,000	$100,000	
TES Tank Foundatoin	1	$300,000	$300,000	$100,000	$100,000	
CEP Cooling Tower structure and pump vault	1	$110,000	$110,000	$25,000	$25,000	
CEP Condenser Water Remote Sump Vault	1	$110,000	$110,000	$25,000	$25,000	
Chiller Bay Expansion, 600 sqft, building appurtenances	1	$180,000	$180,000	$180,000	$180,000	
Site pump house	1	$50,000.00	$50,000.00	$50,000.00	$50,000.00	
MECHANICAL						
CHW Plant Piping (supports, insulation, fittings, valves, 14" steel)	200	$150	$30,000	$110	$22,000	$52,000
CW Header Improvements (supports, insulation, fittings, valves, 14" steel)	200	$150	$30,000	$110	$22,000	$52,000
Additional Air/Dirt Separation, 18" with strainer	1	$45,000	$45,000	$8,000	$8,000	$53,000
1,200 Ton Chiller w/ VFD	1	$500,000	$500,000	$25,000	$25,000	$525,000
1,200 Ton Cooling Tower	1	$200,000	$200,000	$50,000	$50,000	
Valves	20	$2,500	$50,000	$800	$16,000	$66,000
CW Pumps, 75HP, branch piping, instrumentation	2	$25,000	$50,000	$12,000	$24,000	
Controls	45	$500	$22,500	$500	$22,500	$45,000
TES Tank, steel tank, 1.5M gallons, interior and exterior coating and insulation	1	$750,000	$750,000	$750,000	$750,000	
TES Associated Piping	400	$150	$60,000	$110	$44,000	
TES Pumps, 150 HP	4	$50,000	$200,000	$20,000	$80,000	
CEP Heat Exchanger, plate and frame, 500 tons, assocaited branch piping, instrumentation	2	$140,000	$280,000	$25,000	$50,000	$330,000
ELECTRICAL						
(2) 75 HP CW Pump VFDs at CEP	2	$15,000	$30,000	$3,000	$6,000	
(2) 25 HP Cooling Tower Fan VFDs at CEP	2	$6,000	$12,000	$2,000	$4,000	
(4) 150 HP TES Pump VFDs at new pumphouse	4	$22,000	$88,000	$35,000	$140,000	
Medium Voltage Switch, S&C Style 9	1	$40,000	$40,000	$20,000	$20,000	
Chiller Electrical Connection at CEP	1	$12,000	$12,000	$8,000	$8,000	$20,000
Addition power and lighting at CEP	1	$15,000	$15,000	$10,000	$10,000	
New 1000A switch board	1	$23,100	$23,100	$8,150	$8,150	
New 600 kW gen set	1	$300,000	$300,000	$300,000	$300,000	
TELECOMMUNICATIONS						
			$0.00		$0.00	$0.00
Subtotal			$4,224,600.00		$2,696,650.00	**$1,143,000.00**
				Contingency 20%		$228,600.00
				Contractor P/O 15%		$171,450.00
				Liability/Bond/Tax 5%		$65,722.50
				Design Services 10%		$114,300.00
				University Fees 5%		$57,150.00
				TOTAL CONSTRUCTION COST		**$1,780,222.50**

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ORDER OF MAGNITUDE COST ESTIMATE
OPTION:SAT-1 SAT-2 WEST CAMPUS EXPANSION
ENERGY PLANT NORTH OF AGRICULTURE AND BUREAU OF MINES

SD-IV-4 SAT-1 and 2 Cost Estimate

ORDER OF MAGNITUDE COST ESTIMATE-SATELLITE PLANT OPTIONS SAT-1 AND SAT-2

PROJECT: University of Wyoming-West Campus Satellite Plant
PROJ.No.: 16051.00
DATE: August, 2016
DEPT: All
SHEET No.: 0 of 0
COMPUTED BY: GLHN
CHECKED BY: GLHN

OPINION OF PROBABLE CONSTRUCTION COST

BASIS FOR ESTIMATE

- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Finished design)
- [ ] OTHER (Change Order)

SUMMARY	QUANTITY	MATERIAL		LABOR		TOTAL COST
	# UNITS	PER UNIT	TOTAL	PER UNIT	TOTAL	
SITE IMPROVEMENTS						
Utility Relocation Allowance-Lewis	1	$25,000	$25,000	$25,000	$25,000	$50,000
West Campus CHW distribution Piping along Lewis 14" Direct Buried Piping, Insulated, Supply/Return	1,500	$350	$525,000	$350	$525,000	$1,050,000
Building Site allowance	1	$50,000	$50,000	$15,000	$50,000	$100,000
Natural Gas extension to site	1,500	$30	$45,000	$20	$30,000	$75,000
Steam extension to site	300	$300	$90,000	$200	$60,000	$150,000
Power Distribution to site	1,000	$40	$40,000	$40	$40,000	$80,000
Water extension to site	150	$20	$3,000	$20	$3,000	$6,000
Sewer extension to site	150	$25	$3,750	$25	$3,750	$7,500
Chilled Water extension to site	150	$350	$52,500	$350	$52,500	$105,000
Communications extension to site	150	$12	$1,800	$12	$1,800	$3,600
Site Paving	1	$30,000	$30,000	$15,000	$15,000	$45,000
Site Landscaping	1	$50,000	$50,000	$10,000	$10,000	$60,000
Earthwork	1	$80,000	$80,000	$80,000	$80,000	$160,000
ARCHITECTURAL/STRUCTURAL						
New Satellite Plant building, multilevel						
Concrete	8,800	$20	$176,000	$55	$484,000	$660,000
Masonry and Stone	8,800	$30	$264,000	$40	$352,000	$616,000
Structural Steel	8,800	$25	$220,000	$35	$308,000	$528,000
Woods & Plastic	8,800	$5	$44,000	$10	$88,000	$132,000
Thermal and Moisture Protection	8,800	$15	$132,000	$21	$184,800	$316,800
Openings	8,800	$28	$246,400	$13	$114,400	$360,800
Finishes	8,800	$12	$105,600	$12	$105,600	$211,200
Information Specialties	8,800	$2	$17,600	$4	$35,200	$52,800
Furnishings	8,800	$3	$26,400	$3	$26,400	$52,800
Special Construction	8,800	$15	$132,000	$12	$105,600	$237,600
Conveying Equip	8,800	$8	$70,400	$8	$70,400	$140,800
MECHANICAL						
COOLING EQUIPMENT						
CHW Plant Piping (supports, insulation, fittings, valves, 14" steel)	1,000	$150	$150,000	$110	$110,000	$260,000
CW Plant Piping (supports, insulation, fittings, valves, 14" steel)	1,200	$150	$180,000	$110	$132,000	$312,000
CHW Air/Dirt Separation, 14" with strainer	1	$40,000	$40,000	$8,000	$8,000	$48,000
700 Ton Chiller w/ VFD	2	$350,000	$700,000	$20,000	$40,000	$740,000
700 Ton Cooling Tower	2	$100,000	$200,000	$25,000	$50,000	$250,000
Valves	20	$2,500	$50,000	$800	$16,000	$66,000
CHW Pumps, 150 HP, branch piping, instrumentation	2	$45,000	$90,000	$20,000	$40,000	$130,000
CW Pumps, 100HP, branch piping, instrumentation	3	$35,000	$105,000	$15,000	$45,000	$150,000
Controls	60	$500	$30,000	$500	$30,000	$60,000
Heat Exchanger, plate and frame, 500 tons, associated branch piping, instrumentation	2	$140,000	$280,000	$25,000	$50,000	$330,000
CHW Expansion Tank and associated piping	1	$7,500	$7,500	$2,500	$2,500	$10,000
Steel Condenser water sumps	3	$50,000	$150,000	$10,000	$30,000	$180,000
Refrigerant Monitoring and Detection System, exhaust	1	$55,000	$55,000	$15,000	$15,000	$70,000
HEATING EQUIPMENT						
HW Plant Piping (supports, insulation, fittings, valves, 10" steel)	1,500	$100	$150,000	$70	$105,000	$255,000
HW Air/Dirt Separation, 10" with strainer	2	$40,000	$80,000	$6,000	$15,000	$95,000
HW Boilers, 5MM BTU, Natural Gas fired	10	$100,000	$1,000,000	$25,000	$250,000	$1,250,000
Boiler Stacks (individual)	10	$35,000	$350,000	$10,000	$100,000	$450,000
Gas Piping	150	$25	$3,750	$25	$3,750	$7,500
Shell and Tube Heat Exchanger and associated piping	1	$400,000	$400,000	$25,000	$50,000	$450,000
HW pumps, 75 HP, branch piping, instrumentation	8	$15,000	$120,000	$5,000	$40,000	$160,000
HW Expansion Tank and associated piping	1	$7,500	$7,500	$2,500	$2,500	$10,000
Controls	60	$500	$30,000	$500	$30,000	$60,000
Valves	40	$2,500	$100,000	$800	$32,000	$132,000
GENERAL						
Plant Air Handling Equipment, ductwork, piping, power	1	$50,000	$50,000	$20,000	$20,000	$70,000
Plumbing	1	$200,000	$200,000	$75,000	$75,000	$275,000
Fire Protection	1	$40,000	$40,000	$15,000	$15,000	$55,000
ELECTRICAL						
100 HP CW Pump VFDs	2	$15,000	$30,000	$3,000	$6,000	$36,000
25 HP Cooling Tower Fan VFDs	2	$6,000	$12,000	$2,000	$4,000	$16,000
150 HP CHW Pump VFDs	2	$22,000	$44,000	$5,000	$10,000	$54,000
75 HP HW Pump VFDs	6	$11,000	$66,000	$4,000	$24,000	$90,000
Medium Voltage Switch, S&C Style 9	1	$40,000	$40,000	$20,000	$20,000	$60,000
Chiller Electrical Connection	2	$12,000	$24,000	$8,000	$16,000	$40,000
General Power, lighting	1	$50,000	$50,000	$20,000	$20,000	$70,000
1500 kW generator with 24-hour skid-mounted diesel tank	1	$500,000	$500,000	$1,000,000	$1,000,000	$1,500,000
New 2000A switchboard	1	$20,000	$20,000	$18,000	$18,000	$38,000
Power for Boilers	1	$15,000	$15,000	$12,000	$12,000	$27,000
TELECOMMUNICATIONS						
			$0		$0	$0
Subtotal			$7,800,200		$5,207,200	**$13,007,400**
				Contingency 20%		$2,601,480
				Contractor P/O 15%		$1,951,110
				Liability/Bond/Tax 5%		$747,926
				Design Services 10%		$1,300,740
				University Fees 5%		$650,370
				TOTAL CONSTRUCTION COST		**$20,259,026**

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ORDER OF MAGNITUDE COST ESTIMATE
OPTION:WCE-H1H2-WEST CAMPUS EXPANSION
BOILERS AT BUREAU OF MINES AND BIOSCIENCES

SD-IV-5 WCE-H1 Cost Estimate

ORDER OF MAGNITUDE COST ESTIMATE-HEATING EXPANSION OPTIONS WCE-H1

PROJECT: University of Wyoming-West Campus Satellite Plant
PROJ.No.: 16051.00
Bureau of Mines Site
DATE: September, 2016
DEPT: All
SHEET No.: 0 of 0
COMPUTED BY: GLHN
CHECKED BY: GLHN

OPINION OF PROBABLE CONSTRUCTION COST

BASIS FOR ESTIMATE

- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Finished design)
- [ ] OTHER (Change Order)

SUMMARY	QUANTITY	MATERIAL		LABOR		TOTAL COST
	# UNITS	PER UNIT	TOTAL	PER UNIT	TOTAL	
SITE IMPROVEMENTS						
Natural Gas extension to site	150	$30	$4,500	$20	$3,000	$7,500
Steam extension to site	150	$300	$45,000	$200	$30,000	$75,000
Site Repair	5	$25,000	$125,000	$15,000	$75,000	$200,000
ARCHITECTURAL/STRUCTURAL						
Flue Chase	50	$250	$12,500	$250	$12,500	$25,000
Existing space demolition	1	$5,000	$5,000	$15,000	$15,000	$20,000
Existing space modifications	1	$25,000	$25,000	$15,000	$15,000	$40,000
Equipment bases	1	$20,000	$20,000	$8,000	$8,000	$28,000
Pipe Supports	1	$30,000	$30,000	$10,000	$10,000	$40,000
MECHANICAL						
Site Specific Direct Burried HW piping to main loop, 12"	1,230	$325	$399,750	$325	$399,750	$799,500
HW Plant Piping (supports, insulation, fittings, valves, 10" steel)	800	$100	$80,000	$70	$56,000	$136,000
HW Air/Dirt Separation, 10" with strainer	1	$20,000	$20,000	$6,000	$6,000	$26,000
HW Boilers, 5MM BTU, Natural Gas fired	6	$145,000	$870,000	$25,000	$150,000	$1,020,000
Boiler Flue Pipe, stainless steel, double wall, 18" diameter	600	$151	$90,600	$22	$12,900	$103,500
Gas Piping	150	$25	$3,750	$25	$3,750	$7,500
Shell and Tube Heat Exchanger and associated piping	2	$45,000	$90,000	$25,000	$50,000	$140,000
HW pumps, 75 HP, branch piping, instrumentation	6	$15,000	$90,000	$5,000	$30,000	$120,000
HW Expansion Tank and associated piping	1	$7,500	$7,500	$2,500	$2,500	$10,000
Controls	120	$500	$60,000	$500	$60,000	$120,000
Valves	30	$1,500	$45,000	$800	$24,000	$69,000
Plumbing	1	$30,000	$30,000	$801	$10,000	$40,000
ELECTRICAL						
75 HP HW Pump VFDs	6	$11,000	$66,000	$4,000	$24,000	$90,000
Power for distribution pumps	1	$15,000	$15,000	$12,000	$12,000	$27,000
Power for Boilers	1	$15,000	$15,000	$12,000	$12,000	$27,000
250 kW gen set	0	$150,000	$0	$100,000	$0	$0
New switchgear	1	$9,000	$9,000	$3,000	$3,000	$12,000
TELECOMMUNICATIONS						
			$0		$0	$0
Subtotal			$2,158,600		$1,024,400	**$3,183,000**
					Contingency 20%	$636,600
					Contractor P/O 15%	$477,450
					Liability/Bond/Tax 5%	$183,023
					Design Services 10%	$318,300
					University Fees 5%	$159,150
					TOTAL CONSTRUCTION COST	**$4,957,523**

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ORDER OF MAGNITUDE COST ESTIMATE
OPTION:WCE-H1H2-WEST CAMPUS EXPANSION
BOILERS AT BUREAU OF MINES AND BIOSCIENCES

SD-IV-6 WCE-H2 Cost Estimate

ORDER OF MAGNITUDE COST ESTIMATE-HEATING EXPANSION OPTIONS WCE-H2

PROJECT: University of Wyoming-West Campus Satellite Plant
PROJ.No.: 16051.00
Biosciences Site
DATE: September, 2016
DEPT: All
SHEET No.: 0 of 0
COMPUTED BY: GLHN
CHECKED BY: GLHN

OPINION OF PROBABLE CONSTRUCTION COST

BASIS FOR ESTIMATE

- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Finished design)
- [ ] OTHER (Change Order)

SUMMARY	QUANTITY	MATERIAL		LABOR		TOTAL COST
	# UNITS	PER UNIT	TOTAL	PER UNIT	TOTAL	
SITE IMPROVEMENTS						
Natural Gas extension to site	1000	$30	$30,000	$20	$20,000	$50,000
Steam extension to site	1000	$300	$300,000	$200	$200,000	$500,000
Site Repair	5	$25,000	$125,000	$15,000	$75,000	$200,000
ARCHITECTURAL/STRUCTURAL						
Flue Chase, 14'x30"	75	$250	$18,750	$250	$18,750	$37,500
Existing space demolition	1	$5,000	$5,000	$15,000	$15,000	$20,000
Existing space modifications	1	$25,000	$25,000	$15,000	$15,000	$40,000
Equipment bases	1	$20,000	$20,000	$8,000	$8,000	$28,000
Pipe Supports	1	$30,000	$30,000	$10,000	$10,000	$40,000
MECHANICAL						
Site Specific Direct Burried HW piping to main loop, 12"	440	$325	$143,000	$325	$143,000	$286,000
HW Plant Piping (supports, insulation, fittings, valves, 10" steel)	800	$100	$80,000	$70	$56,000	$136,000
HW Air/Dirt Separation, 10" with strainer	1	$20,000	$20,000	$6,000	$6,000	$26,000
HW Boilers, 5MM BTU, Natural Gas fired	6	$145,000	$870,000	$25,000	$150,000	$1,020,000
Boiler Flue Pipe, stainless steel, double wall, 18" diameter	900	$151	$135,900	$22	$19,350	$155,250
Gas Piping	300	$25	$7,500	$25	$7,500	$15,000
Shell and Tube Heat Exchanger and associated piping	2	$45,000	$90,000	$25,000	$50,000	$140,000
HW pumps, 75 HP, branch piping, instrumentation	6	$15,000	$90,000	$5,000	$30,000	$120,000
HW Expansion Tank and associated piping	1	$7,500	$7,500	$2,500	$2,500	$10,000
Controls	120	$500	$60,000	$500	$60,000	$120,000
Valves	30	$1,500	$45,000	$800	$24,000	$69,000
Plumbing	1	$30,000	$30,000	$801	$10,000	$40,000
ELECTRICAL						
75 HP HW Pump VFDs	6	$11,000	$66,000	$4,000	$24,000	$90,000
Power for distribution pumps	1	$15,000	$15,000	$12,000	$12,000	$27,000
Power for Boilers	1	$15,000	$15,000	$12,000	$12,000	$27,000
250 kW gen set	0	$150,000	$0	$100,000	$0	$0
New switchgear	1	$9,000	$9,000	$3,000	$3,000	$12,000
TELECOMMUNICATIONS						
			$0		$0	$0
Subtotal			$2,237,650		$971,100	**$3,208,750**
				Contingency 20%		$641,750
				Contractor P/O 15%		$481,313
				Liability/Bond/Tax 5%		$184,503
				Design Services 10%		$320,875
				University Fees 5%		$160,438
				TOTAL CONSTRUCTION COST		**$4,997,628**

GLHN ARCHITECTS & ENGINEERS, INC
2939 E Broadway Blvd | Tucson, AZ 85716
t520.881.4546 | f520.795.1822 | GLHN.com

ORDER OF MAGNITUDE COST ESTIMATE
OPTION:CEP-H1
CENTRAL ENERGY PLANT-BOILER ADDITION

SD-IV-7 CEP-H1 Cost Estimate

ORDER OF MAGNITUDE COST ESTIMATE

PROJECT: University of Wyoming-West Campus Satellite Plant
PROJ.No.: 16051.00
DATE: August, 2016
DEPT: All
SHEET No.: 0 of 0
COMPUTED BY: GLHN
CHECKED BY: GLHN

OPINION OF PROBABLE CONSTRUCTION COST

BASIS FOR ESTIMATE

- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Finished design)
- [ ] OTHER (Change Order)

SUMMARY	QUANTITY	MATERIAL		LABOR		TOTAL COST
	# UNITS	PER UNIT	TOTAL	PER UNIT	TOTAL	
CEP Building Site allowance	1	$25,000	$25,000	$15,000	$15,000	$40,000
ARCHITECTURAL/STRUCTURAL						
Cooling Tower structure and pump vault	1	$110,000	$110,000	$25,000	$25,000	$135,000
Condenser Water Remote Sump Vault	1	$110,000	$110,000	$25,000	$25,000	$135,000
Chiller Bay Expansion, 600 sqft, building appurtenances	1	$180,000	$180,000	$180,000	$180,000	$360,000
MECHANICAL						
CHW Plant Piping (supports, insulation, fittings, valves, 14" steel)	600	$150	$90,000	$110	$66,000	$156,000
CW Header Improvements (supports, insulation, fittings, valves, 14" steel)	200	$150	$30,000	$110	$22,000	$52,000
Additional Air/Dirt Separation, 18" with strainer	1	$45,000	$45,000	$8,000	$8,000	$53,000
1,200 Ton Chiller w/ VFD	1	$500,000	$500,000	$25,000	$25,000	$525,000
1,200 Ton Cooling Tower	1	$200,000	$200,000	$50,000	$50,000	$250,000
Valves	10	$2,500	$25,000	$800	$8,000	$33,000
CW Pumps, 75HP, branch piping, instrumentation	2	$25,000	$50,000	$12,000	$24,000	$74,000
Controls	30	$500	$15,000	$500	$15,000	$30,000
Heat Exchanger, plate and frame, 500 tons, assocaited branch piping, instrumentation	2	$140,000	$280,000	$25,000	$50,000	$330,000
ELECTRICAL						
(2) 75 HP CW Pump VFDs	2	$15,000	$30,000	$3,000	$6,000	$36,000
(2) 25 HP Cooling Tower Fan VFDs	2	$6,000	$12,000	$2,000	$4,000	$16,000
Electrical Connections	1	$12,000	$12,000	$8,000	$8,000	$20,000
Addition power and lighting	1	$15,000	$15,000	$10,000	$10,000	$25,000
TELECOMMUNICATIONS						
Subtotal			$1,729,000.00		$541,000.00	**$2,270,000.00**
				Contingency 20%		$454,000.00
				Contractor P/O 15%		$340,500.00
				Liability/Bond/Tax 5%		$130,525.00
				Design Services 10%		$227,000.00
				University Fees 5%		$113,500.00
				TOTAL CONSTRUCTION COST		**$3,535,525.00**

GLHN ARCHITECTS & ENGINEERS, INC
2939 E Broadway Blvd | Tucson, AZ 85716
t520.881.4546 | f520.795.1822 | GLHN.com

ORDER OF MAGNITUDE COST ESTIMATE
OPTION:WCE-H3 WEST CAMPUS EXPANSION
STEAM CONVERTER AT ANTHROPOLOGY WITH HW DISTRIBUTION PIPING

SD-IV-8 WCE-H3 Cost Estimate

ORDER OF MAGNITUDE COST ESTIMATE-HEATING EXPANSION OPTION WCE-H3

PROJECT: University of Wyoming-West Campus Satellite Plant
PROJ.No.: 16051.00
DATE: August, 2016
DEPT: All
SHEET No.: 0 of 0
COMPUTED BY: GLHN
CHECKED BY: GLHN

OPINION OF PROBABLE CONSTRUCTION COST

BASIS FOR ESTIMATE

- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Finished design)
- [ ] OTHER (Change Order)

SUMMARY	QUANTITY	MATERIAL		LABOR		TOTAL COST
	# UNITS	PER UNIT	TOTAL	PER UNIT	TOTAL	
SITE IMPROVEMENTS						
Steam extension to mech room	80	$300	$24,000	$200	$16,000	$40,000
10" Direct Burried insulated HW piping, Prexy's loop-Phase I	2500	$250	$625,000	$250	$625,000	$1,250,000
10" Direct Burried insulated HW piping, Interconect between new Prexy's Loop and Anthropology	1200	$250	$300,000	$250	$300,000	$600,000
10" Tunnel Piping-pair of 10" lines	6200	$325	$2,015,000	$325	$2,015,000	$4,030,000
4" Direct Burried insulated HW piping to individual buldings, assumed 20 buildings @ 60' each	1200	$100	$120,000	$100	$120,000	$240,000
Site Repair	1	$75,000	$75,000	$50,000	$50,000	$125,000
ARCHITECTURAL/STRUCTURAL						
Equipment bases	20	$10,000	$200,000	$8,000	$160,000	$360,000
Pipe Supports	20	$20,000	$400,000	$10,000	$200,000	$600,000
MECHANICAL						
HEAT EXCHANGER MECHANICAL ROOM EQUIPMENT						
Shell and Tube Heat Exchanger and associated piping	3	$45,000	$135,000	$25,000	$75,000	$210,000
HW pumps, 75 HP, branch piping, instrumentation	3	$15,000	$45,000	$5,000	$15,000	$60,000
HW Expansion Tank and associated piping	1	$7,500	$7,500	$2,500	$2,500	$10,000
Controls	30	$500	$15,000	$500	$15,000	$30,000
Valves	20	$1,500	$30,000	$800	$16,000	$46,000
INDIVIDUAL BUILDING CONVERSION						
Existing equipment demolition	20	$5,000	$100,000	$5,000	$100,000	$200,000
4" HW piping within buildings , assumed 300' per building	20	$12,000	$240,000	$9,000	$180,000	$420,000
Controls	20	$7,500	$150,000	$7,500	$150,000	$300,000
ELECTRICAL						
75 HP HW Pump VFDs	2	$11,000	$22,000	$4,000	$8,000	$30,000
Power for distribution pumps	1	$15,000	$15,000	$12,000	$12,000	$27,000
Power for Boilers	1	$15,000	$15,000	$12,000	$12,000	$27,000
250 kW gen set	1	$150,000	$150,000	$100,000	$100,000	$250,000
New switchgear	1	$9,000	$9,000	$3,000	$3,000	$12,000
TELECOMMUNICATIONS						
			$0		$0	$0
Subtotal			$4,692,500		$4,174,500	**$8,867,000**
				Contingency 20%		$1,773,400
				Contractor P/O 15%		$1,330,050
				Liability/Bond/Tax 5%		$509,853
				Design Services 10%		$886,700
				University Fees 5%		$443,350
				TOTAL CONSTRUCTION COST		**$13,810,353**

SD-V-1 Boiler Quotation

McCOOK BOILER & PUMP
www.mccookbp.com

CORPORATE OFFICE
P.O. Box 26643
1063 E. 36th Street
Tucson, AZ 85726
Phone 520-623-5788

UTAH OFFICE
63 East 11400 South #174
Sandy, UT 84070
Phone 801-360-2044

NEVADA OFFICE
4291 Polaris Ave, Unit H
Las Vegas, NV 89103
Phone 702-241-1690

To:	**Rider Levett Bucknall**
	Attn: Blake Hyte
	Phone: 602-443-4848
	Email: blake.hyte@us.rlb.com

Quotation #	**Q1702-17B**
Date	2/17/17
Terms	BUDGET
F.O.B.	FACTORY FFA
Delivery	12 weeks ARO

Quantity	Description	Price
	University of Wyoming - West Campus Engineering Plant	
10	Parker model #TC1450 "Industrial Condensing Firetube Boilers" with 316L stainless steel construction on tubes, heads, and combustion chamber, Input 5,447,000 BTU each with ETL certified efficiency of 97%, natural gas fired power burners, by Riello, with full modulation control and 5:1 turndown, includes all standard trim and control features plus CSD-1 compliance, UL listing, and National Board registered.	**$1,163,800.00**
1	Parker View Lead Lag comprehensive control platform for remote monitoring and control of all 10 Parker Boilers, with 10" full color touch screen panel, cascade sequence control, fully adjustable parameters and settings, to integrate with campus BMS control system through BACnet gateway communication.	**$14,850.00**
1	Schebler Chimney Systems "SDC" SEQENCE DRAFT CONTROL package for complete venting system solution for the above 10 boilers. Package to inlcude modulating damper package and pressure sensor with controller for each of the 10 boilers. Package will also include double wall chimney constructed of AL29-4C inner wall, 1" pre-insulated and 304SS outer shell. All boiler adapters, elbows, fittings, drain sections, supports, and terminations as required for complete and operable venting design solution. The design intent is two have two sets of (5) boilers common-vented into the SDC system.	**$212,690.00**
	TOTAL	**$1,391,340.00**
	PLUS TAX	

*PLEASE MAKE PO OUT TO:

McCook Boiler & Pump
PO Box 26643
Tucson, AZ 85726

FULL FREIGHT ALLOWED TO JOB
FACTORY STARTUP INCLUDED

Note: This quotation may be withdrawn by us if not accepted within 30 days.

Submitted: McCook Boiler & Pump Company

All material is guaranteed to be as specified. Any alteration or deviation from above specifications involving extra costs will be executed only upon written orders, and will become an extra charge over and above the estimate.

Signature
By Quinton Lamoreaux
Title Engineered Products Manager

Accepted:

The above prices, specifications and conditions are satisfactory and are hereby accepted. You are authorized to do the work as specified. Payment will be made as outlined above.

Signature
By
Title

ETF WEST LLC
Division of Energy Task Force LLC
Pre-insulated pipe
7700 W Olive Ave - Peoria, AZ - 85345 - 407-523-3770 - 407-523-3722

Quotation
#021617L

To: Rider Levett & Bucknall
Blake Hyte

Re: University of Wyoming Budget Pricing

February 24, 2017

ETF West LLC is pleased to offer the following bill of material for the above project. Items on drawings or stated in specifications that are not included in this quotation must be provided by others. Sales, excise, or similar taxes are not included in this quotation. This quotation is valid for 30 days. F.O.B. Shipping Point with freight prepaid to jobsite.

Carrier Pipe: SDR 11 HDPE
Jacket: High Density polyethylene (HDPE), casing type lll, Category 5, Class C conforming to ASTM D-1248
Insulation: Factory injected polyurethane foam
End Seal**:** Heat Shrink End seals
Fittings: Prefabricated and Pre-insulated
Joint closures: Sleeve, poured foam and Heat Shrink Sleeve
No taxes, wall sleeves, link seals, valves, or flanges included.

Chilled Water Phase 1

Length	Pipe Size	Insulation Thickness	Jacket Size	90° Elbows	45° Elbows	Red Tee's	Joint Closure
2360'	14"	1.8"	18"	12	0	8	59
880'	12"	1.7"	16"	8	6	2	22
360'	8"	1.6"	12"	2	0	0	9

Total Price: $280,044.00 delivered to the job

Chilled Water Phase 2

Length	Pipe Size	Insulation Thickness	Jacket Size	90° Elbows	45° Elbows	Red Tee's	Joint Closure
2880'	14"	1.8"	18"	6	2	0	72

Total Price: $207,791.00 delivered to the job

ETF WEST LLC
Division of Energy Task Force LLC
Pre-insulated pipe
7700 W Olive Ave - Peoria, AZ - 85345 - 407-523-3770 - 407-523-3722

Carrier Pipe: Standard Weight .375 wall Steel 12" and above, Sch 40 ERW Grade B Steel 10" and below
Jacket: High Density polyethylene (HDPE), casing type lll, Category 5, Class C conforming to ASTM D-1248
Insulation: Factory injected polyurethane foam
End Seal**:** Heat Shrink End seals
Fittings: Prefabricated and Pre-insulated
Joint closures: Sleeve, poured foam and Heat Shrink Sleeve
No taxes, wall sleeves, link seals, valves, or flanges included.

Hot Water Phase 1

Length	Pipe Size	Insulation Thickness	Jacket Size	90° Elbows	45° Elbows	Red Tee's	Anchors	Joint Closure
1512'	14"	1.8"	18"	8	6	4	6	36
9849'	12"	1.7"	16"	80	8	24	36	235
3003'	6"	1.7"	10"	100	74	0	62	72

Total Price: $1,303,046.00 delivered to the job

Hot Water Phase 2 North

Length	Pipe Size	Insulation Thickness	Jacket Size	90° Elbows	45° Elbows	Red Tee's	Anchors	Joint Closure
2352'	10"	1.6"	14"	40	0	2	16	56

Total Price: $198,043.00 delivered to the job

Hot Water Phase 2 South

Length	Pipe Size	Insulation Thickness	Jacket Size	90° Elbows	45° Elbows	Red Tee's	Anchors	Joint Closure
3339'	10"	1.6"	14"	20	0	2	8	80

Total Price: $254,757.00 delivered to the job

ETF WEST LLC
Division of Energy Task Force LLC
Pre-insulated pipe
7700 W Olive Ave - Peoria, AZ - 85345 - 407-523-3770 - 407-523-3722

Steam / Condensate Piping – ETF-HT
Carrier: Steam - Schedule 40 A53 ERW Steel
Carrier: Condensate - Schedule 80 A53 ERW Steel
Jacket: Black high density polyethylene per ASTM D1248
Insulation: Inner layer Cal Sil / Outer layer polyurethane foam
End Seal: Heat shrink factory applied to joint ends
Fittings: Prefabricated and Pre-insulated
Joint closures: HDPE rock shield, foam Half Shells and heat shrink sleeve
No taxes, wall sleeves, link seals, valves, weld caps or flanges included.

Length	Pipe Size	Insulation Thickness	Jacket Size	90° Elbows	45° Elbows	Red Tee's	Anchors	Joint Closure
525'	10"	2.6"	16.0"	10	0	0	4	13
504'	6"	2.8"	12.4"	6	0	0	4	12
504'	4"	2.6"	10.0"	12	0	0	4	12
210'	2"	2.7"	8.0"	4	0	0	0	5

Total Price: $221,111.00 delivered to the job

TERMS:
Terms of payment are net 30 days from date of invoice. ETF West LLC reserves the right to require payment in advance or COD or otherwise modify credit terms. In all other respects, this quotation shall be subject to ETF West LLC terms and conditions of sale.

Sincerely,

Les Genninger
ETF West LLC

Archived: Friday, February 24, 2017 7:06:11 AM
From: Blake Hyte
To: Damon Kaska
Subject: RE: Budget Numbers Taco
Importance: Normal

Thank you Damon

From: Damon Kaska [mailto:DKaska@mccoysales.com]
Sent: Monday, February 6, 2017 10:10 AM
To: Blake Hyte <blake.hyte@us.rlb.com>
Subject: Budget Numbers Taco

Blake here is a quick budget number for the pumps and accessories per your schedule sent over.
I assumed a 125# Working pressure for each pump. A support stand for each, Bronze Fitted Construction, AEGIS Grounded Motors for use with VFD;s.
The VFD are provided by others at this time, as they are not included in the budget price below.

If you'd like me to provide submittal or any other supporting documents, please do not hesitate to let me know.
Thank you…

ET-1&2
Taco CA1400-125 ASME Bladder Type Expansion Tank
370gallon volume
Net Each $4314.00

ADS-1 & 2
Taco 4914AD-125 14" ASME Micro-Bubble Air & Dirt Separator Complete with high capacity air vent & blow-down
Net Each $9675.00

CHWP-4,5, & 6
Taco KS8016 8"x8" Bronze Fitted Vertical Split Coupled Inline with Support Stand
1500gpm @ 160'hd
100hp Prem. Eff. Baldor Super-E w/ AEGIS Shaft Grounding Ring – 1750rpm – 460v/3ø
Net Each $15881.00

HWP-1 through HWP-8
Taco KS6013 6"x6" Bronze Fitted Vertical Split Coupled Inline with Support Stand
700gpm @ 140'hd
50hp Prem. Eff. Baldor Super-E w/ AEGIS Shaft Grounding Ring – 1750rpm – 460v/3ø
Net Each $8825.00

McCOY
SALES CORPORATION

Damon Kaska / Estimator & Sales
Ph: 303.762.8012 F: 303.762.6539
426 S Arthur Ave / Louisville CO 80027 / McCoy Sales.com

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Archived: Friday, February 24, 2017 7:12:48 AM
From: Blake Hyte
To: Chris Lehman
Subject: RE: University of Wyoming (Laramie) abatement budget
Importance: Normal

Thank you Chris

From: Chris Lehman [mailto:clehman@coloradohazard.com]
Sent: Wednesday, February 15, 2017 2:44 PM
To: Blake Hyte <blake.hyte@us.rlb.com>
Cc: Brian Ross <bross@coloradohazard.com>
Subject: RE: University of Wyoming (Laramie) abatement budget

Blake,

Based on our previous tunnel abatements at the University of Wyoming. We are at an average of $43.58 per lineal foot, use $50 for budgeting. Assuming a minimum of 200 feet of tunnel. The price will fluctuate with how much actual pipe is present. For mobilizations, waste transportation / disposal, unforeseen circumstances, etc add 25-30% if that's reasonable.

Thanks,

Chris Lehman
CHC
COLORADO HAZARD CONTROL

Corporate Office:
1775 West 55th Avenue
Denver, CO 80221
(303) 410-4941 – phone
(303) 412-8565 – fax

South Office:
28 N. Mission Drive
Pueblo West, CO 81007
(719) 547-2785 – phone
(719) 547-2788 – fax

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Visit our website at www.coloradohazard.com

Find us on Facebook

GSA Schedule Contract GS-00F-156DA

From: Blake Hyte [mailto:blake.hyte@us.rlb.com]
Sent: Monday, February 13, 2017 3:58 PM
To: Chris Lehman <clehman@coloradohazard.com>
Subject: University of Wyoming (Laramie) abatement budget

Chris, see attached tunnel demo sketch that depicts sections to be abandoned (hatched areas) the drawing calls out for each section what pipe stays and what pipes are to be removed. I believe the drawing is to scale however I used google earth for measuring. There are also 30 buildings that are getting a new heat exchanger in lieu of the existing steam to hot water heat exchangers so there will be some pipe demo to those buildings as well (probably 6")

Ive also included the sketch for the steam pipe to remain (might be helpful) they want to keep some buildings on steam for the time being.
Ive also included the mechanical narrative for your use it calls out estimated footages of steam pipe to be removed etc.
Thanks Chris

Blake Hyte LEED AP BD+C
M.E.P. Cost Manager

Rider Levett Bucknall
4343 East Camelback Road, Suite 350
Phoenix, Arizona 85018
Office: +1 602 443 4848
Fax: +1 602 443 4850
E-mail: blake.hyte@us.rl.b.com
Website: www.rlb.com
Twitter: rlbamericas

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Archived: Friday, February 24, 2017 7:18:20 AM
From: Blake Hyte
To: Bill N Shelton
Subject: RE: University of Wyoming (Laramie) budget
Importance: Normal

Perfect!! Thank you Bill

From: Bill N Shelton [mailto:Bill.N.Shelton@jci.com]
Sent: Thursday, February 16, 2017 3:14 PM
To: Blake Hyte <blake.hyte@us.rlb.com>
Subject: RE: University of Wyoming (Laramie) budget

Blake
Controls budget

Thermal storage budget $87,199
Boiler\HWS plant $214, 855 includes Cadillac steam meter an point not shown
2 HX per building times 30 buildings $739,449
New chiller and flat plate $43,232

Bill Shelton
Senior Account Executive
Johnson Controls Inc
307-634-5815

From: Blake Hyte [mailto:blake.hyte@us.rlb.com]
Sent: Thursday, February 02, 2017 2:33 PM
To: Bill N Shelton <Bill.N.Shelton@jci.com>
Subject: University of Wyoming (Laramie) budget

Bill, it was great speaking with you today. Ive attached the mechanical narrative describing the new systems as well as schedules and site renderings that depict routing etc.
Thank you, we'll talk soon

Blake Hyte LEED AP BD+C
M.E.P. Cost Manager

Rider Levett Bucknall
4343 East Camelback Road, Suite 350
Phoenix, Arizona 85018
Office: +1 602 443 4848
Fax: +1 602 443 4850
E-mail: blake.hyte@us.rl.b.com
Website: www.rlb.com
Twitter: rlbamericas

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Great Basin Industrial
www.greatbasinindustrial.com
1284 W. Flint Meadow Dr. #A
Kaysville, Utah 84037 801.543.2100

Rider Levett Bucknall.
4343 East Camelback Road, Suite 350
Phoenix, AZ 85018

2/15/17
Phone: 602-443-4848
Fax: 602-443-4850

Ref: University of Wyoming West Campus Satellite Plant Chilled Water Tank

Attn: Blake Hyte

Great Basin Industrial is pleased to submit this budget proposal for the design, fabrication and erection of the chilled water tank for the University of Wyoming.

As part of our Proposal are the following documents:

a) GBI's Commercial & Technical Clarifications
b) GBI's Standard Construction Conditions

If you have any questions regarding this quote or would like to discuss it further please feel free to contact me at 801-543-2100 ext. 123 or E-mail me at kareyp@mygbi.com

Sincerely,

Karey Poulson
Sales and Estimating
Bid ltr #1
Est. # 17-0077

Great Basin Industrial
Commercial & Technical Clarifications

1. Budget Pricing ±20 Percent

55' Ø x 90' 1.5MM Gallon Chilled Water Tank
Approximate Shipping Weight 337,000 lbs.

Engineering/Materials/Shop Fabrication	$417,713.00
Tank Erection	$533,733.00
Field Paint	$350,076.00
Insulation	$321,023.00
Taxes	None Included
Freight	Included
Total	$1,622,545.00

2. Period of Validity

a. Pricing is Valid for 30 days.
b. Due to the volatility of the steel market we reserve the right to re-price the material based on current steel pricing at time of purchasing.

3. Terms of Payment

a. 10% of contract value will be invoiced upon commencement of the engineering
b. 40% of contract value will be invoiced once material has been purchased.
c. 35% of contract value will be invoiced once we have begun to mobilize on site.
d. 15% of the contract value will be invoiced once our work is complete.
e. Invoice payable within 30 days of date of invoice.

4. Warranty

a. GBI makes no warranty on the materials of construction because of damaging service conditions encountered, including, but not limited to, electrolytic, chemical or abrasive action.
b. We will warrant our labor and material for 12 months after completion of our scope of work.
c. In no case shall GBI be liable for any incidental or consequential damages including but not limited to the cleaning of the tank.

5. Schedule

a. Drawings will take six (6) weeks after receipt of award with full information.
b. Fabrication will take three (3) weeks after receipt of approval drawings.

c. Field Erection will take approximately six (6) weeks.
d. Insulation will take approximately four (4) weeks.

6. Liquidated Damages / Bonds

a. We have not included for liquidated damages in any form or type
b. We have not included for a performance and/or payment bond.

7. Surface Preparation / Shop Prime

a. We have included for surface preparation and/or coating of the tank.

8. Taxes

a. We have not included any sales tax in our pricing.
b. If this is not a tax exempt job all taxes will be prepaid and added to the contract value as a separate line item.

9. Included Items

a. We have included for 24 inch upper and lower internal distribution/collector diffusers.
b. We have included for a four (4) inch make-up water line with an eight (8) inch manifold diffuser.
c. We have included for a weir collection box and a four (4) inch overflow drain pipe. . (Size may need to change based upon engineering requirements for potential water flow if a pump fails to stop.)
d. We have included for hot dipped galvanized spiral stairs, single handrail, rest landings and platforms that go from the ground level of the tank to the roof of the tank.
e. We have included for 30 two (2) inch nozzles that spiral along the included spiral stairs for temperature sensors (sensors and their installation not included).
f. We have included for blasting and coatings: interior includes one (1) coat of primer and two (2) coats of approved epoxy; exterior include one (1) coat of primer.
g. We have included for the installation of two and one half (2 1/2) inches of rigid interlocking insulation and a neutral color aluminum jacketing on the exterior walls and roof of the tank. . (Thickness may need to change based upon engineering requirements for maintaining required temperatures in the tank.)
h. We have included for two (2) 30 inch manways, one (1) on the lower side of the tank wall and one (1) on the roof.
i. We have included for a 24 inch mushroom vent with a bird screen for the center of the roof. (Size may need to change based upon engineering requirements for air flow to prevent vacuum.)

j. We have included for anodic protection tabs to be welded on the tank.
k. We have included for the grounding tabs to be welded on the tank.

10. Excluded Items

a. We have not included for the foundations of the tank, the customer is responsible for providing a level ring wall in compliance with API 650 and ASME Section IX requirements.
b. We have not include for the required Soil Report.
c. We have not included for any local, state or federal permits, they are the responsibility of the client.
d. We have not included for any Civil work on the site.
e. We have not included for any Mechanical work beyond the tank's first nozzle connection points.
f. We have not include for any Electrical/Instrumentation work on the tank or surrounding areas.
g. We will provide MTR's for the material used on the tanks. We will not trace which MTR belongs to each individual plate or piece of the tanks.
h. We will not be responsible for any incidental or consequential damages.
i. We have not included for the calibration of the tank.
j. We have not included for any valves or gauges.
k. We have not included for any piping past the first connection outside the tank wall.
l. We have not included for the radiography of the tank.
m. We have not included for the anodic protection of the tank (this is typically done by electricians).
n. We have not included for the grounding of the tank (this is typically done by electricians).
o. We have not provided for the cleaning of the tank after coatings have been applied.
p. We have not provided for anchor chairs or bolts, if the local seismic, weather and/or soil reports require them they will be added to the costs after the completion of engineering.
q. We have not included for a safety railing around the roof perimeter.

11. Inspection

a. We have NOT included for spot radiography of the tank.
b. We have included for a hydro test of the tank per our construction conditions.
c. Great Basin Industrial will not be responsible for the supplying of Hydro Test water or the cleaning of Hydro Test water before disposing of it. If cleaning is required it will be done on a T&M basis.
d. We will oil penetrant test the shell to bottom joint.
e. We will vacuum box test the bottom.
f. We have included for 100% visual inspection of all welds.
g. We have not included for any other inspections other than mentioned above.

h. All NDE including, but not limited to Magnetic Particle Testing (MT), Liquid Dye Penetrant Testing (PT), Visual Examination (VT), Vacuum Box Testing and Oil Testing will be performed by GBI personnel that comply with the requirements of API 650.
i. Only Radiography (RT) and Ultrasonic Testing (UT) will be performed by third party ASNT, SNT-TC-A, Level II personnel if required by the client under a change order.

12. Welding

a. We will be using SAW, SMAW and FCAW welding processes.
b. We will clean up all slag and weld splatter.
c. We have not included for any special grinding of the tank.
d. The welds, weld procedures and welder qualifications will be per API 650 and ASME section IX.
e. We leave the welds in an as welded condition.
f. We have not included for pickling, passivation, iron freeing or cleanup of the heat affected zones.

Great Basin Industrial

STANDARD CONSTRUCTION CONDITIONS

GBI's Proposal is based on the following jobsite construction conditions:

1. Foundations to be furnished by purchaser. All anchor bolts are by purchaser. All Grouting is by others.

2. We have assumed that an access roadway to the site and around the structure would be provided and maintained by the purchaser. The access roadway is to be suitable for steel hauling trucks to move under their own power.

3. We have assumed that the purchaser would supply adequate access around the structure for movement of a crane, storage of material, and to build substructures adjacent to the structure such that the crane can pick, swing, and set with out moving.

4. For structures requiring hydrostatic tests, the hydrostatic test water is to be pumped, piped, valved, disposed of, and provided by the purchaser.

5. Prior to starting work, purchaser shall make area safe from such conditions as high voltage power lines, pipelines, flammable gasses and other hazards.

6. The Schedule proposed by GBI is based on one mobilization and demobilization by Tank Erectors and/or any Sub-Contractors. It is also based on continuous work by each and does not included delays beyond our control.

7. Proposal pricing is based on working standard work hours. Additional cost for overtime work, shift work and loss of efficiency to accelerate the schedule for purchaser's convenience shall be for purchaser's account. Price is based on using our normal wage rates. GBI works as an open shop. We have no Union Affiliations.

8. GBI will be responsible for all permits and licenses required to operate as a contractor. Purchaser shall obtain without cost to GBI all permits and licenses for the structure.

9. GBI has included for standard safety procedures as required by OSHA. We have not included for any special safety procedure, which may be unique to the particulate jobsite.

10. GBI has not included for a non-productive *Fire* or *Hole Watch* in our pricing. We have assumed that the new structure is a non-permitted confined space. If one is required and the customer would like GBI to provide this service, we will do so on a cost plus basis.

11. GBI has not included for a *Dedicated Safety Man* on site. Our foreman will act as our onsite safety person.

12. GBI's foreman will act as our QA/QC representative along with his other responsibilities. We have not included for a separate full time QA/QC representative.

imagination at work

SD-V-7 Switchboard and Panelboard

5464 S. Dunkirk Way
Centennial, CO 80015
Email: joe.rushin@ge.com

Date: 2/16/2017
Telephone: 303-263-1506
Fax:
Speedi Version: V 11.80

Bill of Material

Blake Hyte

All Net prices in US$

WIN Proposal #: USR1-021617
Proposal/Quote Type: Base Bid

Valued Customer,

We are pleased to offer this proposal for your review. Thank you for allowing us the opportunity to participate on this project. Please do not hesitate to contact us with any questions.

Item#	Qty	Description	Unit Price	Total Price
1	1	Spectra Bolt-On AV5 Swb (108A) **SES**		

3 Section(s) Service Entrance

Estimated Shipping Weight:1835 lbs

1 Service Entrance Labeling
3P4W/480/277V/60Hz
1200A 100 kAIC Fully Rated
Incoming Feed: Bottom
Incoming Left Feeding Right
Type 1 Enclosure
Front/Rear Lineup
Front Only Access
Full Height Panel Bus Option

1 Main Section 30W

1 Individually Mounted Feeder Section 30W

1 Group Mounted Feeder Section 45W

3 Bus Bracing 100000 AIC

3 Fully Rated Copper Bus 1000 A/Sq. in.

3 Ground: Equipment U/L With Lugs

2 Full Height Side Barriers

Main Breaker

1 1200A 3 Pole SKPC12 (1200A Frame) Indiv. Mtd. Main
Manually Operated MAIN
Programmer(MET) LSIG

1 RELT

1 STANDARD PADLOCK PROVISIONS

16 Compression (1 Hole) AL Line Lugs

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Name: **Blake Hyte** Date: 02/16/2017
Prop: USR1-021617

Item#	Qty	Description	Unit Price	Total Price

Feeders

1 1200A 3 Pole SKPC12 (1200A Frame) Indiv. Mtd.
Programmer(MET) LSIA
1 RELT
12 Mechanical AL Load Lugs
1 500A 3 Pole SGPC6 (600A Frame)
Programmer (MET) LSI
2 Mechanical AL Load Lugs
2 300A 3 Pole SGPC4 (400A Frame)
Programmer (MET) LSI
4 Mechanical AL Load Lugs
3 200A 3 Pole SGPC4 (400A Frame)
Programmer (MET) LSI
6 Mechanical AL Load Lugs
1 125A 3 Pole SGPC1 (150A Frame)
Programmer (MET) LSI
2 Mechanical AL Load Lugs
3 100A 3 Pole SGPC1 (150A Frame)
Programmer (MET) LSI
6 Mechanical AL Load Lugs
1 60A 3 Pole SGPC1 (150A Frame)
Programmer (MET) LSI
2 Mechanical AL Load Lugs
1 60A 3 Pole SGPC1 (150A Frame)
Programmer (MET) LSI
2 Mechanical AL Load Lugs

Monitoring/Control Devices

3 Power Supply Plate

Others

14 Engraved Nameplates
14 Screw-On Nameplates
1 Lifting Brackets
1 Spectra Bolt-On (C/B feeders only) 43X
1 6P SGPC6/SGPC4 Double BR Module
2 6P SGPC4 Double BR Module
3 6P SGPC1 Double BR Module
32 Equipment Ground Lugs
1 Ground Lug
6 Neutral Lugs
8 Neutral Lugs
10 Neutral Lugs

Item#	Qty	Description	Unit Price	Total Price
	4	Neutral Lugs		
	1	Bonding Jumper		
		Item Net Price (US$):	41,869.00	41,869.00
2	1	Spectra Bolt-On Panel (101) **CH1** Single Section Panel Bottom Feed Surface Mnt 3P4W 480Y/277V 42 KAIC 500A 3 Pole SGLC6 Main		
	1	LSI		
	1	1-LUG/PH 1-CABLE/LUG #8 -600 MCM OR 1-LUG/PH 2-CABLE/LUG 2/0 -500 MCM		
	1	100A 3 Pole SELA10		
	4	200A 3 Pole SFLA		
	1	MET Volt 24V DC Battery Pack TVPBP		
	1	Aluminum Bus Heat Rated		
	1	Grnd-Box bonded AEG10		
	1	APB3165B Box		
	1	APF6523C Front		
	1	APNB2306FH1A Interior		
		Item Net Price (US$):	3,704.60	3,704.60
3	1	Spectra Bolt-On Panel (101) **HW1** Single Section Panel Bottom Feed Surface Mnt 3P4W 480Y/277V 42 KAIC 300A 3 Pole SGLC4 Main		
	1	LSI		
	1	1-LUG/PH 1-CABLE/LUG #8 -600 MCM OR 1-LUG/PH 2-CABLE/LUG 2/0 -500 MCM		
	5	100A 3 Pole SELA10		
	1	200A 3 Pole SFLA		
	1	Aluminum Bus Heat Rated		
	1	MET Volt 24V DC Battery Pack TVPBP		
	1	Grnd-Box bonded AEG10		
	1	APB2765AS Box		
	1	APFT6518SFP Front		
	1	APNB1804FH1A Interior		
		Item Net Price (US$):	2,704.40	2,704.40
4	1	Spectra Bolt-On Panel (101) **HW2** Single Section Panel Bottom Feed Surface Mnt		

Item#	Qty	Description	Unit Price	Total Price
		3P4W 480Y/277V 42 KAIC		
		300A 3 Pole SGLC4 Main		
	1	LSI		
	1	1-LUG/PH 1-CABLE/LUG #8 -600 MCM OR 1-LUG/PH 2-CABLE/LUG 2/0 -500 MCM		
	1	20A 3 Pole SELA3		
	6	100A 3 Pole SELA10		
	1	Aluminum Bus Heat Rated		
	1	MET Volt 24V DC Battery Pack TVPBP		
	1	Grnd-Box bonded AEG10		
	1	APB2765AS Box		
	1	APFT6518SFP Front		
	1	APNB1804FH1A Interior		
		Item Net Price (US$):	2,610.00	2,610.00
5	1	Panelboard, Type AQ (101) **PANEL B**		
		Sec-1		
		Section 1 of 2 Bottom Feed Surface Mnt 24 Ckts 3P4W 208Y/120V 10 KAIC		
		300A 3 Pole SGHC4 Main		
	1	1-LUG/PH 2-CABLE/LUG 2/0 -500 MCM		
	8	30A 3 Pole THQB		
	1	Feed Thru Lugs		
	1	Aluminum Bus Heat Rated		
	1	Same Box Size		
	2	Ground main lug TGL20		
	2	Ground-Box bonded TGL2		
	1	AB55B Box		
	1	AF55S Front		
	1	AQF3244JBX Interior AXT1		
		Sec-2		
		Section 2 of 2 Top Feed Surface Mnt 24 Ckts 3P4W 208Y/120V 10 KAIC		
		400A Main Lugs		
	1	1-LUG/PH 1-CABLE/LUG #4 -600 MCM OR 1-LUG/PH 2-CABLE/LUG 1/0 -250 MCM		
	8	30A 3 Pole THQB		
	1	Aluminum Bus Heat Rated		
	1	Same Box Size		
	1	Ground main lug TGL20		
	2	Ground-Box bonded TGL2		

imagination at work

Name: **Blake Hyte** Date: 02/16/2017
Prop: USR1-021617

Item#	Qty	Description	Unit Price	Total Price
	1	AB55B Box		
	1	AF55S Front		
	1	AQF3244MTX Interior AXP3		
		Item Net Price (US$):	2,412.24	2,412.24

Total Lot Price $_____ Price to follow

imagination at work

Name: **Blake Hyte** Date: 02/16/2017
Prop: USR1-021617

FACTORY TESTS:

Standard factory test procedures will be performed. Field testing, customer inspections, customer witness tests and any other non-standard test procedures are not included unless specifically noted herein.

WARRANTY:

1. The warranty for Products shall expire one (1) year from first use or eighteen (18) months from delivery, whichever occurs first, except that software is warranted for ninety (90) days from delivery. The warranty for Services shall expire one (1) year after performance of the Service, except that software-related Services are warranted for ninety (90) days.
2. Additional 12 months available for 2% adder, 24 months for 4% adder.

Limited Warranty for all Core/Standard and Stand-Alone Drive Panels (including 18 Pulse / MultiPulse Panel products but excluding DV300 DC Drives): 36 months from date of shipment. An additional 12 months (a total of 48 months) are available for 10% Net Price adder, or an additional 24 months (the maximum of 60 months) for 20% Net Price adder. Contact GE 1 Stop when order is placed to include extended warranty on item(s). DV300 DC Drives have a warranty period of 18 months after shipment only.

TERMS OF PAYMENT:

All projects are:

- Net 30 days
- Price Clause 1Q
- For projects up to $250,000 terms of payment are 100% net 30 days from invoice date.
- If project value exceeds $250,000 net, progress payments are required payable at the following milestones:
  -20% upon delivery of drawings -30% upon release of equipment -Balance due upon shipment

POLICIES AND CONDITIONS OF SALE:

1. **Sales to Authorized GE Distributor:** This quotation is offered subject to the Apparatus Distributor Agreement between GE and Distributor. **Sales to Direct-Served Accounts: See Form ES104 (Rev. 4),** except as specifically noted herein and for **GE Critical Power** products, see non-standard warranty terms defined in following link: http://apps.geindustrial.com/publibrary/checkout/Catalogs%20and%20Buyers%20Guides%7CCPB-WR%7Cgeneric
2. To the extent the Buy American Act, Trade Agreements Act, or other domestic preference requirements are applicable to this Contract, the country of origin of Products is unknown unless otherwise specifically stated by Seller in this Contract. The customer (distributor or direct-served customer, as applicable) warrants that there are no governmental contracting requirements or regulations that apply to this transaction (including without limitation any Federal Acquisition Regulations), other than such terms as have been disclosed to Seller and agreed to by Seller in writing prior to Seller agreeing to this transaction.
3. This quotation expires in 30 calendar days unless terminated sooner by notice.
4. Order must be released for manufacture within 90 days. If drawings are required they must be returned approved for release within 60 days of mailing. If not, and/or shipment is delayed for any reason, the price will increase 1.5% for each partial/full month that shipment is delayed after the 90-day period.
5. Price(s) quoted are for estimated lead-times given; expedited schedule may require additional charges.
6. For Branded Products, quotation expires in 30 calendar days unless terminated sooner by notice. If approval drawings are required they must be returned approved for release within 60 days of mailing. If not, and/or shipment is delayed for any reason beyond 6 months from order entry, the price will be subject to change based on current market conditions. Please contact Branded Product upfront regarding any special commercial terms not covered here for vendor consideration.

ORDER CANCELLATION - SCHEDULE OF CHARGES:

10% - Order received and entered on factory, work not started, material not ordered.
30% - Drawings for approval submitted.
60% - Approved drawings returned. Job released for manufacture and shipment.
80% - Material accumulated and production started.
100% - Manufacturing completed.

DELIVERY AND TRANSPORTATION:

1. EXW GE’s facility, place of manufacture or warehouse (Incoterms 2000). Title passes upon shipment.
2. GE will assume the risk of loss or damage to the destination for a 2% adder (but not less than $500 net) applied to the total price of the equipment. "Destination" is defined as GE's common carrier's delivery point nearest first destination or point of export within the continental U.S.

3. Unless otherwise noted in this quotation, normal transportation and handling, is allowed on orders of $500 net or more to common-carrier point nearest destination within the Continental US (excluding Alaska and Hawaii). For orders below $500 net, a $50 handling charge will be added to the Invoice. The $50 handling charge is waived for premium freight paid by the customer or ex-works orders picked up by the customer at Seller's facility.
4. Shipment via Air or Open -Top/Flatbed/Lift gate truck not included unless specifically listed herein.
5. Special Instruction - The Receiving Associate is required to sign, date and note specific visible or concealed damage on Bill of Lading at time of delivery. Freight Company Associate is required to witness Receiver's signature, date and damage claim annotations. GE's Post Sales Service Department must be provided with copy of annotated BOL within five (5) days of delivery or Shipper's responsibility ends.

The lead-times quoted are for Estimating Purposes Only. Actual drawing and shipping schedules will be based on factory load, receipt of order with complete technical information, and the date GE receives authorized release to manufacture.

The accompanying Bill of Material is our interpretation of what is required to meet the intent of the listed Drawings and Specifications. Please review thoroughly for accuracy and completeness, and advise immediately if any revisions are required. This proposal is limited to the attached Bill of Material only. Start-up Services and Training are not included unless specifically noted herein. Changes to scope will require a revised proposal.

The devices listed on this bill of material may have selective coordination over the long time, short time and instantaneous range. GE's selective capabilities are listed in publication DET-537. It is recommended that a qualified engineer be employed to determine selective coordination as required for the project and in accordance with applicable local codes and acceptable engineering practices. Selective coordination may require significant changes to the system design, equipment sizing and cost.

GE Proprietary Information

The information contained in this document is GE Proprietary Information and is disclosed in confidence. It is the property of GE and shall not be used, disclosed to others or reproduced without the express written consent of GE.

XenSpeedi-03

Spectra Series™ Switchboard

ACCESS TO:	Front Only	PHASE:	3P4W
CLASS:	5	AMPERE:	1200A
LABEL:	U/L SE	BUS MTL:	Cu 1000A/in²
VOLTAGE:	480/277V	PLATE:	Silver Plate
STYLE:	Bolt-On	RATING:	Fully Rated
BUS BRACING (RMS SYM):			100000A
DEV.MIN.INT.RATING (RMS SYM):			100000A

Switchboard / Device Information

Circuit No.	Device	Amps	Poles	Nameplates	Lugs/Cable Size	Notes
Main	SKPC12	1200	3			9,11,13,14,15
1	SKPC12	1200	3		(4) - 250 - 500 MCM CU - Mech. AL	10,12,13,15
2	SGPC1	100	3		(2) - 2/0 - 250 MCM CU - Mech. AL	8
3	SGPC1	100	3		(2) - 2/0 - 250 MCM CU - Mech. AL	8
4	SGPC4	200	3		(2) - 2/0 - 250 MCM CU - Mech. AL	8
5	SGPC4	200	3		(2) - 2/0 - 250 MCM CU - Mech. AL	8
6	SGPC6	500	3		(2) - 300 - 500 MCM CU - Mech. AL	8
7	SGPC4	300	3		(2) - 2/0 - 250 MCM CU - Mech. AL	8
8	SGPC4	300	3		(2) - 2/0 - 250 MCM CU - Mech. AL	8
9	SGPC4	200	3		(2) - 2/0 - 250 MCM CU - Mech. AL	8
10	SGPC1	125	3		(2) - 2/0 - 250 MCM CU - Mech. AL	8
11	SGPC1	100	3		(2) - 2/0 - 250 MCM CU - Mech. AL	8
12	SGPC1	60	3		(2) - 2/0 - 250 MCM CU - Mech. AL	8
13	SGPC1	60	3		(2) - 2/0 - 250 MCM CU - Mech. AL	8

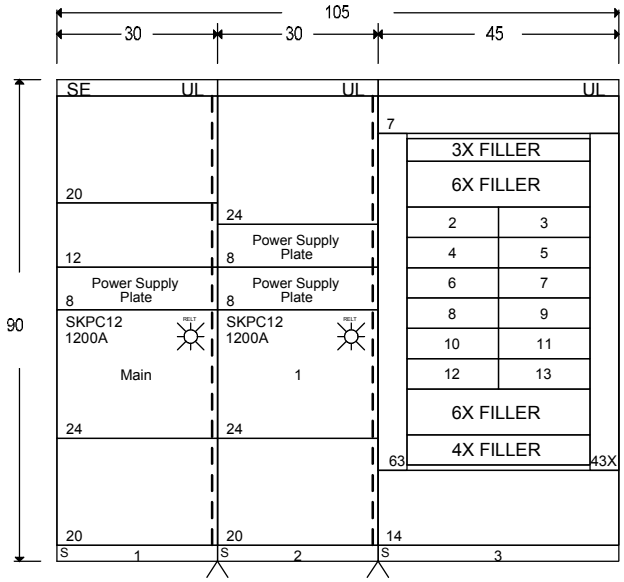
NOTES:

1. Equipment ground bus furnished with lugs.
2. Copper ground bus furnished.
3. Switchboard furnished with Nameplates.
4. All Nameplates to be fastened with screws.
5. Shipping splits between each section, ship each section separately.
6. Switchboard furnished with full height vertical bus for distribution sections.
7. Switchboard furnished with fully rated panel.
8. Device furnished with MET (LSI) programmer.
9. Device furnished with MET (LSIG) programmer.
10. Device furnished with MET (LSIA) programmer.
11. Device is furnished with integral ground fault protection.
12. Device is furnished with ground fault alarm.
13. Device is furnished with RELT (Reduced Energy Let Through).
14. Device furnished with padlocking provisions.
15. Device requires RELT or ZSI feature if Authority having jurisdiction has adopted NEC 2014 code requirements.
16. Estimated shipping weight for the lineup is 1835 lbs

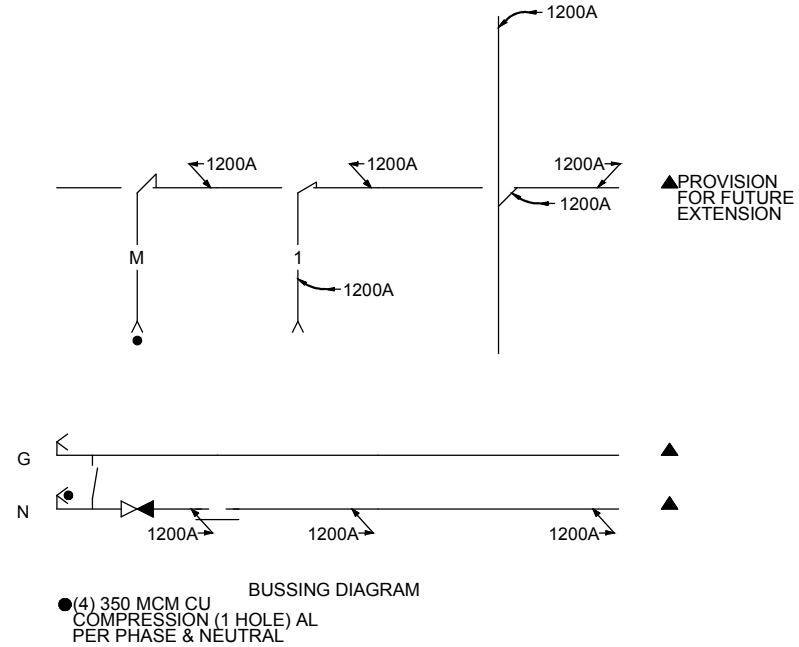
JOB NAME: Blake Hyte		CUSTOMER:			PLANT: MEBANE		MARK: SES
MADE BY:	ISSUED:	CUST. ORDER NO:	NO	DATE	REVISIONS	INITIALS	USR1-021617
REL BY:	XenSpeed	REQN. NO:					SHEET 1 of 3 ITEM 1
		ORDER NO:					

Spectra Series™ Switchboard

ACCESS TO:	Front Only	PHASE:	3P4W
CLASS:	5	AMPERE:	1200A
LABEL:	U/L SE	BUS MTL:	Cu 1000A/in²
VOLTAGE:	480/277V	PLATE:	Silver Plate
STYLE:	Bolt-On	RATING:	Fully Rated
BUS BRACING (RMS SYM):			100000A
DEV.MIN.INT.RATING (RMS SYM):			100000A



FRONT VIEW



BUSSING DIAGRAM

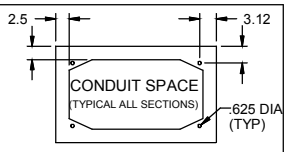
●(4) 350 MCM CU COMPRESSION (1 HOLE) AL PER PHASE & NEUTRAL

JOB NAME: Blake Hyte		CUSTOMER:			PLANT: MEBANE	MARK: SES
MADE BY:	ISSUED:	CUST. ORDER NO:	NO	DATE	REVISIONS INITIALS	USR1-021617
REL BY:	XenSpeed	REQN. NO:				
		ORDER NO:				SHEET 2 of 3 ITEM 1

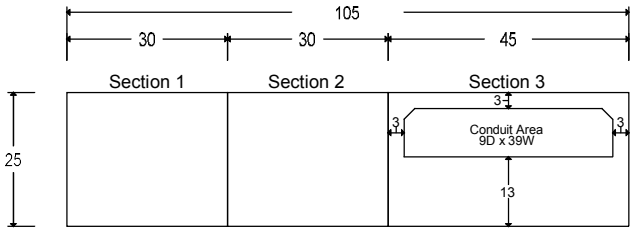
W11.80 Date:02/16/2017 4:28:25 PM

Spectra Series™ Switchboard

ACCESS TO:	Front Only	PHASE:	3P4W
CLASS:	5	AMPERE:	1200A
LABEL:	U/L SE	BUS MTL:	Cu 1000A/in²
VOLTAGE:	480/277V	PLATE:	Silver Plate
STYLE:	Bolt-On	RATING:	Fully Rated
BUS BRACING (RMS SYM):			100000A
DEV.MIN.INT.RATING (RMS SYM):			100000A

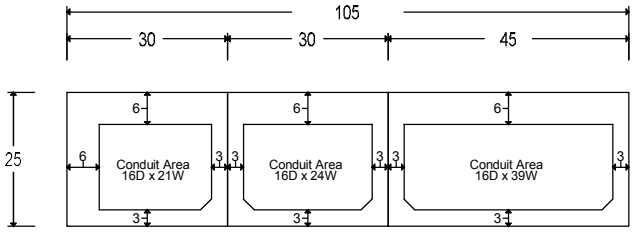


Top Conduit Area



Front Plan View

Bottom Conduit Area



Front Plan View

JOB NAME: Blake Hyte		CUSTOMER:			PLANT: MEBANE	MARK: SES
MADE BY:	ISSUED:	CUST. ORDER NO:	NO	DATE	REVISIONS INITIALS	USR1-021617
		REQN. NO:				
REL BY:	XenSpeed	ORDER NO:				SHEET 3 of 3 ITEM 1

Spectra Panelboard Item 2 CH1

Panel Description

GE Type SBO Panelboard
Qty 1
600 Amp,480Y/277V
3P4W
42 KAIC SC Fully Rated
Aluminum Bus
Nema 1 Enclosure
Surface Mounted
Bottom Feed

Main Description

Amps: 500 Amp
Poles: 3 Pole
Type: Main Breaker
Cat No.: SGLC3606L3XX+
Acc:
LSI
GTP0500U0613
Rating Plg
1TCLK365
Lug Kit
Lugs: 1-lug/ph 1-cable/lug
#8 -600 mcm
or
1-lug/ph 2-cable/lug
2/0 -500 mcm

Options Included

1 - MET Volt 24V DC Battery Pack TVPBP
1 - Aluminum Bus Heat Rated
1 - Grnd-Box bonded AEG10

Branch Devices

Qty	Amps/P	Cat#
1	100A/3P	SELA36AT0100+
1	Rating Plg	SRPE100A100
1	Lug Kit	3TCAL18
4	200A/3P	SFLA36AT0250+
4	Rating Plg	SRPF250A200
4	Lug Kit	3TCAL29

Panel Interior

10 X FILLER

Ckt	Type	Amps/P	Type	Amps/P	Ckt
1	**SELA10**	100/3	**Spaces**	-	
	-	-	**-**	-	
	-	-	**-**	-	
7	**SFLA**	200/3	**SFLA**	200/3	8
	-	-	**-**	-	
	-	-	**-**	-	
13	**SFLA**	200/3	**SFLA**	200/3	14
	-	-	**-**	-	
	-	-	**-**	-	

500A 3P SGLC6F

*** Drawing not to scale**

Job Name:	Blake Hyte		
Prop#:	USR1-021617	**GEReq#:**	
PO#:			
Marks:	CH1	**Dated:**	02/16/2017

2A Interior	APNB2306FH1A
2B Box	APB3165B
2C Front	APF6523C
Dimensions	64.63"H x 31"W x 11.5"D

Spectra Panelboard Item 3 HW1

Panel Description

GE Type SBO Panelboard
Qty 1
400 Amp,480Y/277V
3P4W
42 KAIC SC Fully Rated
Aluminum Bus
Nema 1 Enclosure
Surface Mounted
Bottom Feed

Main Description

Amps: 300 Amp
Poles: 3 Pole
Type: Main Breaker
Cat No.: SGLC3604L3XX+
Acc:
LSI
GTP0300U0408
Rating Plg
1TCLK365
Lug Kit
Lugs: 1-lug/ph 1-cable/lug
#8 -600 mcm
or
1-lug/ph 2-cable/lug
2/0 -500 mcm

Options Included

1 - Aluminum Bus Heat Rated
1 - MET Volt 24V DC Battery Pack TVPBP
1 - Grnd-Box bonded AEG10

Branch Devices

Qty	Amps/P	Cat#
5	100A/3P	SELA36AT0100+
5	Rating Plg	SRPE100A100
5	Lug Kit	3TCAL18
1	200A/3P	SFLA36AT0250+
1	Rating Plg	SRPF250A200
1	Lug Kit	3TCAL29

Panel Interior

2 X FILLER

Ckt	Type	Amps/P	Type	Amps/P	Ckt
1	**SELA10**	100/3	**Spaces**	-	
	-	-	**-**	-	
	-	-	**-**	-	
7	**SELA10**	100/3	**SELA10**	100/3	8
	-	-	**-**	-	
	-	-	**-**	-	
13	**SELA10**	100/3	**SELA10**	100/3	14
	-	-	**-**	-	
	-	-	**-**	-	
19	**SFLA**	200/3	**-**	-	
	-	-	**-**	-	
	-	-	**-**	-	

300A 3P SGLC4F

*** Drawing not to scale**

Job Name:	Blake Hyte		
Prop#:	USR1-021617	**GEReq#:**	
PO#:			
Marks:	HW1	**Dated:**	02/16/2017

3A Interior	APNB1804FH1A
3B Box	APB2765AS
3C Front	APFT6518SFP
Dimensions	64.63"H x 27"W x 11.5"D

Spectra Panelboard Item 4 HW2

Panel Description

GE Type SBO Panelboard
Qty 1
400 Amp,480Y/277V
3P4W
42 KAIC SC Fully Rated
Aluminum Bus
Nema 1 Enclosure
Surface Mounted
Bottom Feed

Main Description

Amps: 300 Amp
Poles: 3 Pole
Type: Main Breaker
Cat No.: SGLC3604L3XX+
Acc:
LSI
GTP0300U0408
Rating Plg
1TCLK365
Lug Kit
Lugs: 1-lug/ph 1-cable/lug
#8 -600 mcm
or
1-lug/ph 2-cable/lug
2/0 -500 mcm

Options Included

1 - Aluminum Bus Heat Rated
1 - MET Volt 24V DC Battery Pack TVPBP
1 - Grnd-Box bonded AEG10

Branch Devices

Qty	Amps/P	Cat#
1	20A/3P	SELA36AT0030+
1	Rating Plg	SRPE30A20
1	Lug Kit	3TCAL18
6	100A/3P	SELA36AT0100+
6	Rating Plg	SRPE100A100
6	Lug Kit	3TCAL18

Panel Interior

2 X FILLER

Ckt	Type	Amps/P	Type	Amps/P	Ckt
1	**SELA3**	20/3	**Spaces**	-	
	-	-	**-**	-	
	-	-	**-**	-	
7	**SELA10**	100/3	**SELA10**	100/3	8
	-	-	**-**	-	
	-	-	**-**	-	
13	**SELA10**	100/3	**SELA10**	100/3	14
	-	-	**-**	-	
	-	-	**-**	-	
19	**SELA10**	100/3	**SELA10**	100/3	20
	-	-	**-**	-	
	-	-	**-**	-	

300A 3P SGLC4F

*** Drawing not to scale**

Job Name:	Blake Hyte		
Prop#:	USR1-021617	**GEReq#:**	
PO#:			
Marks:	HW2	**Dated:**	02/16/2017

4A Interior	APNB1804FH1A
4B Box	APB2765AS
4C Front	APFT6518SFP
Dimensions	64.63"H x 27"W x 11.5"D

A Series Panelboard

Item 5 PANEL B

Panel Description

GE Type AQ Panelboard
Qty 1
400 Amp,208Y/120V
3P4W, Section 1 of 2
10 KAIC SC Fully Rated
Aluminum Bus
Nema 1 Enclosure
Surface Mounted
Bottom Feed

Main Description

Amps: 300 Amp
Poles: 3 Pole
Type: Main Breaker
Cat No.: SGHC3604L3XX+
Acc: GTP0300U0408
Rating Plg
1TCLK365
Lug Kit
Lugs: 1-lug/ph 2-cable/lug
2/0 -500 mcm

Options Included

1 - Feed Thru Lugs
1 - Aluminum Bus Heat Rated
1 - Same Box Size

2 - Ground main lug TGL20
2 - Ground-Box bonded TGL2

Branch Devices

Qty	Amps/P	Cat#
8	30A/3P	THQB32030

Panel Interior

400A FEED THRU LUGS

Ckt	Type	Amps/P	Type	Amps/P	Ckt
1	**THQB**	30/3	**THQB**	30/3	2
	-	-	**-**	-	
	-	-	**-**	-	
7	**THQB**	30/3	**THQB**	30/3	8
	-	-	**-**	-	
	-	-	**-**	-	
13	**THQB**	30/3	**THQB**	30/3	14
	-	-	**-**	-	
	-	-	**-**	-	
19	**THQB**	30/3	**THQB**	30/3	20
	-	-	**-**	-	
	-	-	**-**	-	

400A VERTICAL MAIN BREAKER WITH NEUTRAL

*** Drawing not to scale**

Job Name:	Blake Hyte		
Prop#:	USR1-021617	**GEReq#:**	
PO#:			
Marks:	PANEL B	**Dated:**	02/16/2017

5-1A Interior	AQF3244JBX AXT1
5-1B Box	AB55B
5-1C Front	AF55S
Dimensions	55.5"H x 20"W x 5.75"D

A Series Panelboard

Item 5 PANEL B

Panel Description

GE Type AQ Panelboard
Qty 1
400 Amp,208Y/120V
3P4W, Section 2 of 2
10 KAIC SC Fully Rated
Aluminum Bus
Nema 1 Enclosure
Surface Mounted
Bottom Feed

Main Description

Amps: 400 Amp
Type: Main Lugs
Lugs: 1-lug/ph 1-cable/lug
#4 -600 mcm
or
1-lug/ph 2-cable/lug
1/0 -250 mcm

Options Included

1 - Aluminum Bus Heat Rated
1 - Same Box Size
1 - Ground main lug TGL20
2 - Ground-Box bonded TGL2

Branch Devices

Qty	Amps/P	Cat#
8	30A/3P	THQB32030

Panel Interior

400A MAIN LUGS WITH NEUTRAL

Ckt	Type	Amps/P	Type	Amps/P	Ckt
1	**THQB**	30/3	**THQB**	30/3	2
	-	-	**-**	-	
	-	-	**-**	-	
7	**THQB**	30/3	**THQB**	30/3	8
	-	-	**-**	-	
	-	-	**-**	-	
13	**THQB**	30/3	**THQB**	30/3	14
	-	-	**-**	-	
	-	-	**-**	-	
19	**THQB**	30/3	**THQB**	30/3	20
	-	-	**-**	-	
	-	-	**-**	-	

400A PANEL END FILLER

*** Drawing not to scale**

Job Name:	Blake Hyte		
Prop#:	USR1-021617	**GEReq#:**	
PO#:			
Marks:	PANEL B	**Dated:**	02/16/2017

5-2A Interior	AQF3244MTX AXP3
5-2B Box	AB55B
5-2C Front	AF55S
Dimensions	55.5"H x 20"W x 5.75"D

Stabilize exhaust flow

Systems with inadequate natural draft may utilize Schebler's *WingFan* draft inducer to ensure stable exhaust flow regardless of the number of appliances operating or firing rates. A breeching mounted pressure sensor monitors and maintains stack pressure and a VFD controls draft inducer speed.

Rely on Schebler Chimney for complete system designs.

Special Gas Venting Systems – UL1738-listed products, single and double wall, 3 year leak free guarantee, lifetime warranty

Grease Duct Systems – UL 2221 classified products, zero-clearance to combustibles, two-hour fire-rated

Generator Exhaust Systems – UL 103-listed products listed for 1400° continuous operation, positive pressure rated for 60" WC

Boiler Flue Systems – UL 103-listed products for safe and proper boiler performance

Engineered Stacks – designed to ASTM STS-1-2000, SMACNA guidelines and standard engineering practices

Reasons to choose Schebler Chimney products include:

- Proudly made with Union labor
- Meet *Buy American* requirements
- Delivered with product warranties

Contact us today for more information.

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www.scheblerchimney.com

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eVent DualSeal, patent pending.
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AMG - 1116 - POS

SD-V-8 Schebler Sequence Draft Control

Sequence Draft Control™

Schebler Chimney Systems

Taking value to the highest levels

Engineered for peak performance.

Building owners pay a premium for high efficiency boilers and water heaters to save energy and money. But just starting up the equipment doesn't ensure they'll perform at their ideal Category IV performance rating.

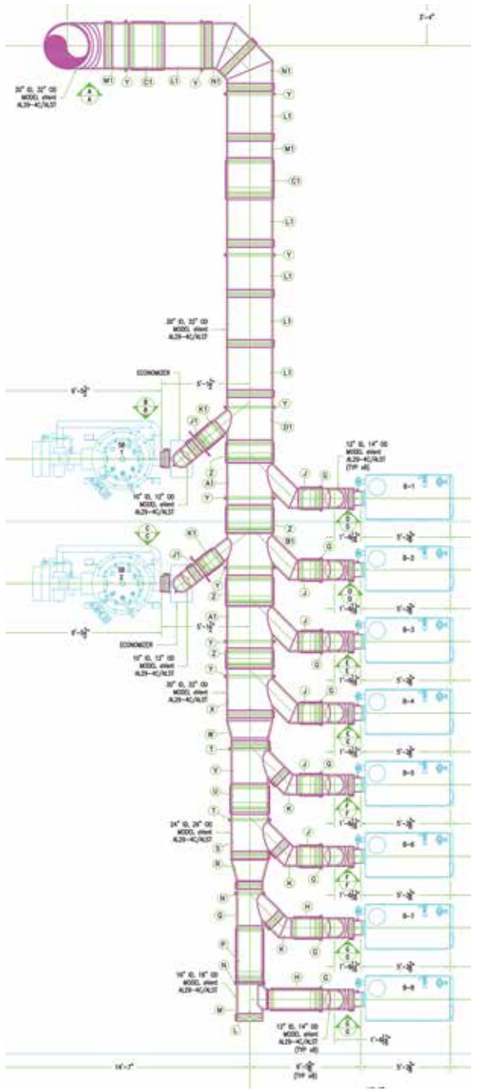
A complete engineered venting system is a critical part of the equation – and **Schebler's Sequence Draft Control**™ (SDC) design service is the answer.

SDC maintains the desired condensing dew point of combustion, preventing excess draft which impacts efficiency and fuel/air ratio's – especially with high turndown modulating burners.

Versatile draft control

Hybrid systems utilizing condensing and non-condensing boilers are an ideal match for Sequence Draft Control. Each appliance outlet pressure is individually monitored and controlled to obtain the highest level of overall performance. Each damper has a dedicated circuit so only one appliance would be affected should a failure occur, ensuring full operation of other appliances.

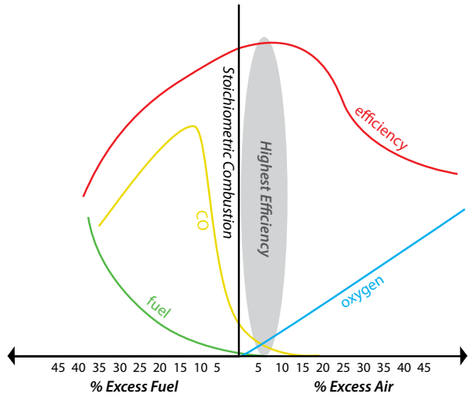
And the versatile SDC design is well suited for all venting categories – including I, II, III and IV.



Schebler Chimney Systems

Get the most efficiency from your boilers.

Achieve combustion efficiency



This graph illustrates when fuel and oxygen from the air are in perfect balance. Five to ten percent excess air is required to reach peak efficiency for natural gas burning boilers and hot water heaters.

SDC controls excess air to achieve the desired increased efficiencies.

Source: Engineering Toolbox

Account for outside conditions

Schebler eVent™ Series modulating dampers with pressure transducers are located at the outlet of each appliance to maintain the factory recommended firebox positive pressure or negative draft condition at all times. The damper accounts for:

- Appliance firing rate – anywhere between high fire and low fire
- Stack temperature
- Outside air temperature
- Other operational anomalies such as summer/winter operation and appliance proximity to the common stack

Sequence Draft Control™ also improves system start up by reducing draft conditions during ignition. The damper is placed in a pre-purge position to allow easy ignition and eliminate flame failure conditions which are typical in common vented systems.

SD-V-9-RLB Cost Estimate

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

February 24 2017

University of Wyoming - Infrastructure Improvements
Revised Conceptual Cost Estimate

Project Details

Description

Basis of Estimate

This document has been prepared at the request of GLHN Architects & Engineers to provide a conceptual cost estimate for the University of Wyoming Infrastructure upgrades to their campus in Laramie. The owner of the project is the University of Wyoming.

It should be noted by all parties reviewing our cost estimate that we have not field verified any of the quantities issued within our report but instead are relying on the detail provided to us within the conceptual package delivered to us via Dropbox on January 26 2017. Where information was insufficient, assumptions and allowances were made based wherever possible on discussions with the architect and engineers.

Should any parties reviewing this document have query with any of our quantities and or assumptions made, please make us aware of any queries immediately so we may amend the cost estimate if necessary.

We understand the project is being procured under a design-bid-build procurement.

Unit pricing is based on February 2017 costs with construction to commence in the 4th Quarter of 2017 with a contract duration not to exceed 24 months.

Items Specifically Included

As per estimate detail.

Items Specifically Excluded

. Hard Rock excavation
. Costs associated with phasing the construction work
. Out of hour’s work
. Photovoltaics and other renewable energy resources
. Furniture, Fittings and Equipment (FF&E)
. Audio / Visual systems
. Telecom / Data systems
. Work outside the site boundaries unless noted otherwise
. Utility tap fees and charges
. Land and legal costs
. Items marked as "Excl." in the estimate
- Sole sourced materials

Documents

As per the basis of estimate.

University of Wyoming - Infrastructure Improvements
Revised Conceptual Cost Estimate

Location Summary

Rates Current At February 2017

Location			Total Cost
PH1	**PHASE 1 SITEWORK**		**9,900,480**
PH2	**PHASE 2 SITEWORK**		**2,756,345**
BP	**BOILER PLANT**		**8,704,640**
CEP	**CENTRAL ENERGY PLANT**		**1,699,865**
		ESTIMATED NET COST	**$23,061,330**
MARGINS & ADJUSTMENTS			
General Conditions & Temporary Requirements		15 %	$3,459,200
Design Estimating Contingency		20 %	$5,304,106
Escalation		9 %	$2,864,217
Overhead & Profit		5 %	$1,734,443
Bonds & Insurance		2.5 %	$910,582
State Sales Tax (65% of 6.0%)		3.9 %	$1,456,021
Soft Costs		20 %	$7,757,980
		ESTIMATED TOTAL COST	**$46,547,879**

University of Wyoming - Infrastructure Improvements
Revised Conceptual Cost Estimate

Location Summary

Rates Current At February 2017

Location		Total Cost
PH1 PHASE 1 SITEWORK		**9,900,480**
	ESTIMATED NET COST	**$9,900,480**
MARGINS & ADJUSTMENTS		
General Conditions & Temporary Requirements	15 %	$1,485,072
Design Estimating Contingency	20 %	$2,277,111
Escalation	9 %	$1,229,640
Overhead & Profit	5 %	$744,615
Bonds & Insurance	2.5 %	$390,922
State Sales Tax (65% of 6.0%)	3.9 %	$625,086
Soft Costs	20 %	$3,330,585
	ESTIMATED TOTAL COST	**$19,983,511**

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

Location Elements/Divisions Item

PH1 PHASE 1 SITEWORK Rates Current At February 2017

Description		Unit	Qty	Rate	Total
D2020	**Domestic Water Distribution**				
22	**Plumbing**				
53	Heat exchanger, brazed plate and frame, 0.35 mmbtu for domestic water (allowance)	EA	30	975.00	29,250
56	Domestic water piping connections to plate and frame heat exchangers	EA	30	3,500.00	105,000
	Plumbing				***$134,250***
	Domestic Water Distribution				***$134,250***
D3010	**Energy Supply**				
23	**Heating, Ventilating, and Air Conditioning**				
54	Remove existing shell and tube steam to hot water heat exchanger / steam piping / controls / etc.	EA	30	2,500.00	75,000
52	Heat exchanger, plate and frame, 1.5 mmbtu, 100 gpm for heating water (allowance)	EA	30	25,000.00	750,000
	Heating, Ventilating, and Air Conditioning				***$825,000***
	Energy Supply				***$825,000***
D3060	**Controls & Instrumentations**				
23	**Heating, Ventilating, and Air Conditioning**				
148	DDC controls / instrumentation / interlocking / monitoring / etc. for 30 building HX replacement (allowance JCI)	LS	1	887,340.00	887,340
	Heating, Ventilating, and Air Conditioning				***$887,340***
	Controls & Instrumentations				***$887,340***
D3070	**Systems Testing & Balancing**				
23	**Heating, Ventilating, and Air Conditioning**				
48	HVAC systems test and balance misc building (allowance)	LS	1	7,200.00	7,200
	Heating, Ventilating, and Air Conditioning				***$7,200***
	Systems Testing & Balancing				***$7,200***
D3090	**Other HVAC Systems & Equipment**				
23	**Heating, Ventilating, and Air Conditioning**				
57	HVAC systems starrt up and commission assist misc. buildings (allowance)	LS	1	10,000.00	10,000
	Heating, Ventilating, and Air Conditioning				***$10,000***
	Other HVAC Systems & Equipment				***$10,000***
G1020	**Site Demolition and Relocations**				
02	**Existing Conditions**				
143	Steam pipe insulation abatement (allowance)	LS	1	180,000.00	180,000
142	Remove existing direct buried and tunnel routed steam piping (allowance)	LS	1	320,000.00	320,000
	Existing Conditions				***$500,000***
	Site Demolition and Relocations				***$500,000***

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

Location Elements/Divisions Item

PH1 PHASE 1 SITEWORK (continued) Rates Current At February 2017

Description		Unit	Qty	Rate	Total
G1030	**Site Earthwork**				
31	**Earthwork**				
136	Allow for excavation to accommodate direct buried pipes (gypsum below 3'-0")	CY	3,734	60.00	224,040
141	Backfill to accommodate direct buried pipe	CY	3,734	25.00	93,350
	Earthwork				***$317,390***
	Site Earthwork				***$317,390***
G2010	**Roadways**				
03	**Concrete**				
140	Replace asphalt roadway	SF	12,600	8.00	100,800
	Concrete				***$100,800***
	Roadways				***$100,800***
G2040	**Site Development**				
02	**Existing Conditions**				
137	Allow for sawcutting and breaking out of existing roadway	SF	12,600	2.00	25,200
	Existing Conditions				***$25,200***
32	**Exterior Improvements**				
154	ADA Access between streets (cost allowance only)	Item			350,000
	Exterior Improvements				***$350,000***
	Site Development				***$375,200***
G3010	**Water Supply**				
33	**Utilities**				
62	Domestic / fire water 8" service distribution to boiler plant, DIP pipe / fittings / connection / valves / restraints / trenching / etc. (allowance)	LS	1	30,000.00	30,000
	Utilities				***$30,000***
	Water Supply				***$30,000***
G3020	**Sanitary Water**				
33	**Utilities**				
63	Sanitary sewer 6" service distribution from boiler plant PVC pipe / fittings / connections / cleanouts / trenching / etc (allowance)	LS	1	15,000.00	15,000
	Utilities				***$15,000***
	Sanitary Water				***$15,000***
G3040	**Heating Distribution**				
33	**Utilities**				
67	Steam distribution to boiler plant and Merica Hall 10" preinsulated seamless steel pipe / fittings / anchors / connections / valves / flush / test / etc. (allowance)	LS	1	415,000.00	415,000
125	Misc. steam connections / tunnel cross connections / etc. (allowance)	LS	1	750,000.00	750,000
153	Replace existing steam pipe insulation for piping to remain (allowance)	LS	1	125,000.00	125,000

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

Location Elements/Divisions Item

PH1 PHASE 1 SITEWORK (continued) Rates Current At February 2017

Description		Unit	Qty	Rate	Total
130	Heating water preinsulated steel pipe / fittings / connections / anchors / valves / flush / test / etc. (allowance)	LS	1	3,643,950.00	3,643,950
	Utilities				***$4,933,950***
	Heating Distribution				***$4,933,950***
G3050	**Cooling Distribution**				
33	**Utilities**				
132	Chilled water preinsulated HDPE pipe / fittings / connections / valves / etc. (allowance)	LS	1	585,000.00	585,000
128	Chilled water preinsulated HDPE pipe / fittings / valves / connections / etc. for future North campus loop (allowance)	LS	1	370,650.00	370,650
	Utilities				***$955,650***
	Cooling Distribution				***$955,650***
G3090	**Other Site Mechanical Utilities**				
33	**Utilities**				
64	Natural gas 6" service to boiler plant pipe / fittings / connections / regulator / meter / trenching / etc. (allowance)	LS	1	15,000.00	15,000
65	Compressed air service 2" service to boiler plant (allowance)	LS	1	7,000.00	7,000
	Utilities				***$22,000***
	Other Site Mechanical Utilities				***$22,000***
G4010	**Electrical Distribution**				
26	**Electrical**				
76	Intercept / splice existing 15kv feeder in manhole	LS	1	3,500.00	3,500
77	Feeders 15kv from existing manhole to new switch (conduit / wire / trench / concrete / backfill)	LF	50	223.00	11,150
75	Pad mounted 2 way switching cabinet, (1 spare) includes concrete pad	EA	1	30,000.00	30,000
74	Feeder 15kv from switch to new transformer (conduit / wire / trench / concrete / backfill)	LF	10	80.00	800
72	Transformer,oil filled, pad mounted, 750KVA including precast pad / vault	EA	1	37,000.00	37,000
73	Feeder from transformer to SES includes 1 spare (conduit / wire / trench / concrete / backfill)	LF	50	87.00	4,350
81	Feeder generator to building (conduit / wire / trench / concrete / backfill)	LS	1	3,800.00	3,800
	Electrical				***$90,600***
	Electrical Distribution				***$90,600***
G4030	**Site Communications & Security**				
27	**Communications**				
79	Communications incoming conduit / campus backbone / trench / backfill to boiler plant (allowance)	LS	1	30,000.00	30,000

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

Location Elements/Divisions Item

PH1 PHASE 1 SITEWORK (continued) Rates Current At February 2017

Description		Unit	Qty	Rate	Total
80	Reroute existing communications fiber at demolished tunnels to direct bury (allowance)	LS	1	200,000.00	200,000
	Communications				***$230,000***
	Site Communications & Security				***$230,000***
G9010	**Service and Pedestrian Tunnels**				
02	**Existing Conditions**				
121	Demolish / abandon existing tunnel. Infill with flowable fill	CY	3,679	50.00	183,950
122	Repair existing tunnel (cost allowance only)	SF	6,255	30.00	187,650
	Existing Conditions				***$371,600***
	Service and Pedestrian Tunnels				***$371,600***
PH	**Phasing / Temporary Work**				
02	**Existing Conditions**				
139	Trench boxes	SF	12,600	7.50	94,500
	Existing Conditions				***$94,500***
	Phasing / Temporary Work				***$94,500***
	PHASE 1 SITEWORK				***$9,900,480***

University of Wyoming - Infrastructure Improvements
Revised Conceptual Cost Estimate

Location Summary

Rates Current At February 2017

Location			Total Cost
PH2 PHASE 2 SITEWORK			**2,756,345**
	ESTIMATED NET COST		**$2,756,345**
MARGINS & ADJUSTMENTS			
General Conditions & Temporary Requirements		15 %	$413,452
Design Estimating Contingency		20 %	$633,959
Escalation		9 %	$342,338
Overhead & Profit		5 %	$207,305
Bonds & Insurance		2.5 %	$108,835
State Sales Tax (65% of 6.0%)		3.9 %	$174,027
Soft Costs		20 %	$927,252
	ESTIMATED TOTAL COST		**$5,563,513**

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

Location Elements/Divisions Item

PH2 PHASE 2 SITEWORK Rates Current At February 2017

Description		Unit	Qty	Rate	Total
G1030	**Site Earthwork**				
31	**Earthwork**				
136	Allow for excavation to accommodate direct buried pipes (gypsum below 3'-0")	CY	11,586	60.00	695,160
141	Backfill to accommodate direct buried pipe	CY	11,586	25.00	289,650
	Earthwork				***$984,810***
	Site Earthwork				***$984,810***
G2010	**Roadways**				
03	**Concrete**				
140	Replace asphalt roadway	SF	39,102	8.00	312,816
	Concrete				***$312,816***
	Roadways				***$312,816***
G2040	**Site Development**				
02	**Existing Conditions**				
137	Allow for sawcutting and breaking out of existing roadway	SF	39,102	2.00	78,204
	Existing Conditions				***$78,204***
	Site Development				***$78,204***
G3040	**Heating Distribution**				
33	**Utilities**				
133	Heating water preinsulated steel pipe / fittings / anchors /valves / flush / test / etc. for future N campus loop (allowance)	LS	1	550,750.00	550,750
134	Heating water preinsulated steel pipe / fittings / valves / flush / test /etc. for future S campus loop (allowance)	LS	1	720,250.00	720,250
	Utilities				***$1,271,000***
	Heating Distribution				***$1,271,000***
PH	**Phasing / Temporary Work**				
02	**Existing Conditions**				
139	Trench boxes	SF	14,602	7.50	109,515
	Existing Conditions				***$109,515***
	Phasing / Temporary Work				***$109,515***
	PHASE 2 SITEWORK				***$2,756,345***

University of Wyoming - Infrastructure Improvements
Revised Conceptual Cost Estimate

Location Summary

Rates Current At February 2017

Location		Total Cost
BP BOILER PLANT		**8,704,640**
	ESTIMATED NET COST	**$8,704,640**
MARGINS & ADJUSTMENTS		
General Conditions & Temporary Requirements	15 %	$1,305,696
Design Estimating Contingency	20 %	$2,002,067
Escalation	9 %	$1,081,116
Overhead & Profit	5 %	$654,676
Bonds & Insurance	2.5 %	$343,705
State Sales Tax (65% of 6.0%)	3.9 %	$549,584
Soft Costs	20 %	$2,928,297
	ESTIMATED TOTAL COST	**$17,569,781**

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

Location Elements/Divisions Item

BP BOILER PLANT Rates Current At February 2017

Description		Unit	Qty	Rate	Total
A1020	**Special Foundations**				
13	**Special Construction**				
150	Foundations to accommodate new tank	SF	3,604	50.00	180,200
	Special Construction				***$180,200***
	Special Foundations				***$180,200***
D2010	**Plumbing Fixtures**				
22	**Plumbing**				
1	Plumbing fixture allowance (water closet / lavatory / mop sink / emergency eyewash / hose bibs / etc.)	LS	1	7,500.00	7,500
	Plumbing				***$7,500***
	Plumbing Fixtures				***$7,500***
D2020	**Domestic Water Distribution**				
22	**Plumbing**				
2	Domestic water distribution allowance (meter / backflow / type L pipe and fittings / valves / insulation / etc.)	LS	1	15,500.00	15,500
	Plumbing				***$15,500***
	Domestic Water Distribution				***$15,500***
D2030	**Sanitary Waste**				
22	**Plumbing**				
3	Sanitary waste and vent distribution allowance (floor drains / floor sinks / trap primers / cast iron pipe and fittings / connections / ejector pump / etc.)	LS	1	26,500.00	26,500
	Plumbing				***$26,500***
	Sanitary Waste				***$26,500***
D2040	**Rain Water Drainage**				
22	**Plumbing**				
4	Rainwater drainage allowance (roof drains / cast iron pipe and fittings / insulation / nozzles / etc.)	LS	1	11,500.00	11,500
	Plumbing				***$11,500***
	Rain Water Drainage				***$11,500***
D2090	**Other Plumbing Systems**				
22	**Plumbing**				
5	Natural gas distribution allowance (pipe / fittings / valves / regulators / connections / etc.)	LS	1	23,500.00	23,500
25	Compressed air distribution allowance (pipe / fittings / valves / nozzles / regulators / etc.)	LS	1	7,500.00	7,500
26	Flush / test / treat domestic water systems piping allowance	LS	1	1,500.00	1,500
28	Label / tag / ID plumbing piping systems	LS	1	1,500.00	1,500
	Plumbing				***$34,000***
	Other Plumbing Systems				***$34,000***

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

Location Elements/Divisions Item

BP BOILER PLANT (continued) Rates Current At February 2017

Description		Unit	Qty	Rate	Total
D3010	**Energy Supply**				
23	**Heating, Ventilating, and Air Conditioning**				
15	HXP-1 Steam to hot water heat exchanger packaged skid, Quad pumps, 510 GPM each, 30,000 total MBH	EA	1	200,000.00	200,000
14	CRU-1 Steam condensate return packaged skid, triplex, 35 GPM each, with 100 gallon reciever	EA	1	20,000.00	20,000
16	Steam pipe / fittings / valves / connections / instrumentation / insulation (allowance)	LS	1	23,650.00	23,650
	Heating, Ventilating, and Air Conditioning				***$243,650***
	Energy Supply				***$243,650***
D3020	**Heat Generating Systems**				
23	**Heating, Ventilating, and Air Conditioning**				
7	Boiler, 5171 MBH natural gas, 345 GPM condensing, for heating hot water (assume University to direct purchase)	EA	10	149,500.00	1,495,000
8	Boiler chimney venting with modulating draft controls (allowance)	LS	1	290,000.00	290,000
9	Heating water pump, vertical inline, 700 GPM, 50 HP, 460V	EA	8	9,540.00	76,320
10	Heating water 14" air / dirt combination separator, 2530 GPM	EA	2	12,035.00	24,070
11	Heating water bladder expansion tank, steel, ASME, 370 galllon capacity including piping	EA	2	5,800.00	11,600
38	Expansion tank piping / valves / connections / insulation / etc.	EA	2	3,000.00	6,000
	Heating, Ventilating, and Air Conditioning				***$1,902,990***
	Heat Generating Systems				***$1,902,990***
D3030	**Cooling Generating Systems**				
23	**Heating, Ventilating, and Air Conditioning**				
69	Thermal storage tank 1.5 million gallon capacity, site built, welded steel with interior coatings and external insulation (assume University to direct purchase)	LS	1	1,700,000.00	1,700,000
39	Chilled water pump, vertical inline, 1500 GPM, 100 HP, 460V	EA	3	19,560.00	58,680
	Heating, Ventilating, and Air Conditioning				***$1,758,680***
	Cooling Generating Systems				***$1,758,680***
D3040	**Distribution Systems**				
23	**Heating, Ventilating, and Air Conditioning**				
12	Heating water pipe / fittings / valves / connections / insulation / instrumentation / supports (allowance)	LS	1	635,750.00	635,750
13	Chilled water pipe / fittings / valves / connections / insulation / instrumentation / suppoets (allowance)	LS	1	320,275.00	320,275
35	Fan coils / piping /ductwork / grilles / diffusers for boiler plant (allowance)	LS	1	25,000.00	25,000
42	General exhaust fans / louvers for boiler plant (allowance)	LS	1	10,000.00	10,000
	Heating, Ventilating, and Air Conditioning				***$991,025***
	Distribution Systems				***$991,025***

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

Location Elements/Divisions Item

BP BOILER PLANT (continued) Rates Current At February 2017

Description		Unit	Qty	Rate	Total
D3060	**Controls & Instrumentations**				
23	**Heating, Ventilating, and Air Conditioning**				
34	DDC controls / instrumentation / interlocking / monitoring / etc. for boiler plant and storage tank (allowance JCI)	LS	1	362,465.00	362,465
	Heating, Ventilating, and Air Conditioning				***$362,465***
	Controls & Instrumentations				***$362,465***
D3070	**Systems Testing & Balancing**				
23	**Heating, Ventilating, and Air Conditioning**				
37	HVAC systems test and balance boiler plant (allowance)	LS	1	4,800.00	4,800
	Heating, Ventilating, and Air Conditioning				***$4,800***
	Systems Testing & Balancing				***$4,800***
D3090	**Other HVAC Systems & Equipment**				
23	**Heating, Ventilating, and Air Conditioning**				
51	Make up water to expansion tank 1-1/2" pipe / fittings / backflow preventor / etc. (allowance)	LS	1	3,000.00	3,000
50	Make up water to thermal storage tank 4" pipe / fittings / backflow preventor / etc. (allowance)	LS	1	12,500.00	12,500
33	Chemical pot feeder, 10 gallon including piping	EA	1	2,500.00	2,500
32	Flush / test / treat hydronic piping systems allowance	LS	1	10,000.00	10,000
31	Label / tag / ID hydronic piping systems allowance	LS	1	3,500.00	3,500
36	HVAC systems starrt up and commission assist for boiler plant (allowance)	LS	2	20,000.00	40,000
41	Equipment hoisting / offloading / handling for boiler plant (allowance)	LS	1	6,500.00	6,500
	Heating, Ventilating, and Air Conditioning				***$78,000***
	Other HVAC Systems & Equipment				***$78,000***
D4010	**Sprinklers**				
21	**Fire Suppression**				
6	Fire suppression allowance (pipe / fittings / valves / heads / riser / backflow / FDC / etc.)	LS	1	30,000.00	30,000
	Fire Suppression				***$30,000***
	Sprinklers				***$30,000***
D5010	**Electrical Service & Distribution**				
26	**Electrical**				
49	Emergency diesel generator 600kw "Cummins" with fuel storage	EA	1	225,000.00	225,000
82	DMC 1500 generator paralleling control panel	EA	1	215,000.00	215,000
44	SES Service entrance switchgear, 1200A, 480 / 277V, 100 KAIC	EA	1	52,300.00	52,300
91	Distribution board CH1, 600A, 480/277V, 42 KAIC	EA	1	5,650.00	5,650
93	Distribution board HW1, 600A, 480/277V, 42 KAIC	EA	1	4,260.00	4,260
92	Distribution board HW2, 400A, 480/277V, 42 KAIC	EA	1	4,150.00	4,150
90	Distribution board B, 400A, 480/277V, 42 KAIC	EA	1	3,925.00	3,925

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

Location Elements/Divisions Item

BP BOILER PLANT (continued) Rates Current At February 2017

	Description	Unit	Qty	Rate	Total
110	Transformer 75 KVA, 480V to 208V NEMA 1	EA	1	5,900.00	5,900
109	Transformer, 30 KVA, 480V to 208V NEMA 1	EA	1	3,600.00	3,600
112	Panelboard (equipment) 100A, 208/120V, 3P, 4W, 42 ckt	EA	1	3,200.00	3,200
113	Panelboard (lighting) 60A, 480/277V, 3P, 4W, 30 ckt	EA	1	2,400.00	2,400
114	VFD, 100HP, 480V 3P, NEMA 1, ACH 550 (no bypass) for chilled water pumps	EA	3	6,825.00	20,475
115	VFD, 50HP, 480V 3P, NEMA 1, ACH 550 (no bypass) for heating water pumps	EA	8	4,775.00	38,200
116	VFD, 3HP, 480V 3P, NEMA 1, ACH 550 (no bypass) for CRU	EA	1	970.00	970
101	Disconnect switch, 30A, 3P, 250V fusible, NEMA 1	EA	10	160.00	1,600
104	Disconnect switch, 30A, 3P, 480V fusible, NEMA 1	EA	1	300.00	300
103	Disconnect switch, 200A, 3P, 480V fusible, NEMA 1	SF	11	1,100.00	12,100
24	Mechanical motor connections and terminations	LS	1	5,700.00	5,700
95	Feeder conduit and wire	LS	1	26,500.00	26,500
117	Electrical systems grounding (allowance)	LS	1	2,850.00	2,850
120	Electrical coordination / arc flash study / etc.	LS	1	5,000.00	5,000
	Electrical				***$639,080***
	Electrical Service & Distribution				***$639,080***
D5020	**Lighting and Branch Wiring**				
26	**Electrical**				
23	Lighting fixtures / controls / conduit / wire / etc. (allowance)	LS	1	35,000.00	35,000
22	Power receptacles / switches / conduit / wire (allowance)	LS	1	10,000.00	10,000
	Electrical				***$45,000***
	Lighting and Branch Wiring				***$45,000***
D5030	**Communications & Security**				
27	**Communications**				
20	Tel / data communications outlets / WIFI / conduit / cable / cable tray / room prep (allowance)	LS	1	25,000.00	25,000
	Communications				***$25,000***
28	**Electronic Safety and Security**				
18	Fire alarm system allowance (panels / innitiating and annunciating devices / conduit / cable / test and verification / etc.)	LS	1	25,000.00	25,000
19	Security access control / CCTV systems allowance (card readers / cameras / conduit / cable / etc.)	LS	1	30,000.00	30,000
	Electronic Safety and Security				***$55,000***
	Communications & Security				***$80,000***
D5090	**Other Electrical Systems**				
26	**Electrical**				
46	Temporary power and lighting (allowance)	LS	1	3,500.00	3,500
60	Electrical hoisting / offloading (allowance)	LS	1	1,000.00	1,000

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

Location Elements/Divisions Item

BP BOILER PLANT (continued) Rates Current At February 2017

	Description	Unit	Qty	Rate	Total
61	Electrical systems commissioning assistance (allowance)	LS	1	7,500.00	7,500
	Electrical				***$12,000***
	Other Electrical Systems				***$12,000***
F1010	**Special Structures**				
13	**Special Construction**				
118	New Thermal Storage Energy Plant (all as per Architectural narrative & drawings WCE-C1.2 to WCE-C1.52)	SF	9,000	220.00	1,980,000
	Special Construction				***$1,980,000***
	Special Structures				***$1,980,000***
G1030	**Site Earthwork**				
31	**Earthwork**				
151	Excavate and dispose of soils for thermal energy storage tank	CY	2,670	25.00	66,750
	Earthwork				***$66,750***
	Site Earthwork				***$66,750***
G2040	**Site Development**				
32	**Exterior Improvements**				
119	Site improvements to area surrounding Boiler Plant	Item			50,000
	Exterior Improvements				***$50,000***
	Site Development				***$50,000***
G4010	**Electrical Distribution**				
26	**Electrical**				
146	Corrosion protection for thermal storage tank, Interior cathodic protection / exterior anodic protection (allowance)	LS	1	120,000.00	120,000
145	Grounding and lightning protection for thermal storage tank (allowance)	LS	1	65,000.00	65,000
	Electrical				***$185,000***
	Electrical Distribution				***$185,000***
	BOILER PLANT				***$8,704,640***

University of Wyoming - Infrastructure Improvements
Revised Conceptual Cost Estimate

Location Summary

Rates Current At February 2017

Location		Total Cost
CEP CENTRAL ENERGY PLANT		**1,699,865**
	ESTIMATED NET COST	**$1,699,865**
MARGINS & ADJUSTMENTS		
General Conditions & Temporary Requirements	15 %	$254,980
Design Estimating Contingency	20 %	$390,969
Escalation	9 %	$211,123
Overhead & Profit	5 %	$127,847
Bonds & Insurance	2.5 %	$67,120
State Sales Tax (65% of 6.0%)	3.9 %	$107,324
Soft Costs	20 %	$571,846
	ESTIMATED TOTAL COST	**$3,431,074**

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

Location Elements/Divisions Item

CEP CENTRAL ENERGY PLANT Rates Current At February 2017

Description		Unit	Qty	Rate	Total
D3020	**Heat Generating Systems**				
23	**Heating, Ventilating, and Air Conditioning**				
89	Provide additional plate and frame heat exchanger capacity for CEP 1500 GPM (allowance) includes piping	LS	1	40,950.00	40,950
	Heating, Ventilating, and Air Conditioning				***$40,950***
	Heat Generating Systems				***$40,950***
D3030	**Cooling Generating Systems**				
23	**Heating, Ventilating, and Air Conditioning**				
40	Remove and replace existing 800 ton chiller at CEP with new 1200 chiller (assume University to direct purchase)	EA	1	895,000.00	895,000
	Heating, Ventilating, and Air Conditioning				***$895,000***
	Cooling Generating Systems				***$895,000***
D3040	**Distribution Systems**				
23	**Heating, Ventilating, and Air Conditioning**				
55	Heating water piping connections to plate and frame heat exchangers (allowance)	EA	30	20,000.00	600,000
68	Chilled water manifold piping modifications for chiller replacement (allowance)	LS	1	60,000.00	60,000
	Heating, Ventilating, and Air Conditioning				***$660,000***
	Distribution Systems				***$660,000***
D3060	**Controls & Instrumentations**				
23	**Heating, Ventilating, and Air Conditioning**				
147	DDC controls / instrumentation / interlocking / monitoring / etc. for chiller replacement (allowance JCI)	LS	1	51,875.00	51,875
	Heating, Ventilating, and Air Conditioning				***$51,875***
	Controls & Instrumentations				***$51,875***
D3070	**Systems Testing & Balancing**				
23	**Heating, Ventilating, and Air Conditioning**				
47	HVAC systems test and balance for chiller replacement (allowance)	LS	1	240.00	240
	Heating, Ventilating, and Air Conditioning				***$240***
	Systems Testing & Balancing				***$240***
D3090	**Other HVAC Systems & Equipment**				
23	**Heating, Ventilating, and Air Conditioning**				
58	HVAC systems starrt up and commission assist for chiller (allowance)	LS	1	1,200.00	1,200
59	Chiller hoisting / offloading / handling (allowance)	LS	1	2,500.00	2,500
	Heating, Ventilating, and Air Conditioning				***$3,700***
	Other HVAC Systems & Equipment				***$3,700***
D5010	**Electrical Service & Distribution**				
26	**Electrical**				
83	1600A framed air breaker for chiller replacement "Eaton MDNC16"	EA	1	8,850.00	8,850

University of Wyoming - Infrastructure Improvements

Revised Conceptual Cost Estimate

Location Elements/Divisions Item

CEP CENTRAL ENERGY PLANT (continued) Rates Current At February 2017

	Description	Unit	Qty	Rate	Total
71	Replace existing feeder conduit and wire / motor connections / disconnects for chiller replacement	LS	1	39,250.00	39,250
	Electrical				***$48,100***
	Electrical Service & Distribution				***$48,100***
	CENTRAL ENERGY PLANT				***$1,699,865***

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