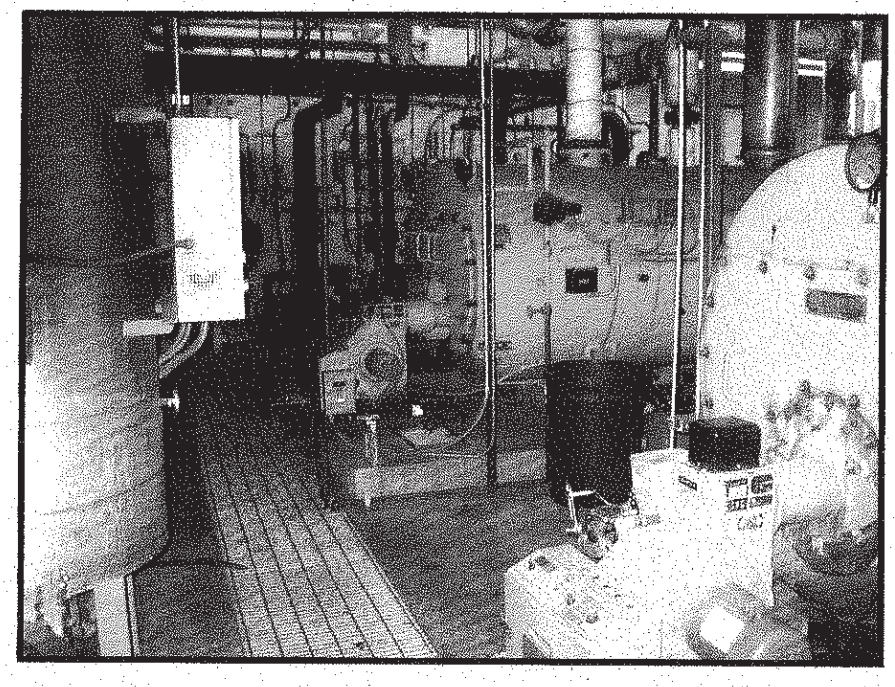
Kodiak FITC Boiler Conversion Evaluation

Kodiak, Alaska

Schematic Design Report



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October 12, 2010

1.0 Executive Summary

With annual fuel costs of $130,000 for 25,800 square feet of floor space the Fisheries Industry Technology Center is a very expensive building to operate. This report investigated both the hydronic heating system, the process steam system and the laboratory ventilation systems to identify ways to modify them and reduce operating costs. Six operating cost reduction options were identified and analyzed. The two with estimated simple paybacks of less than 10 years are:

- **Option S3**: Replace the existing steam boiler with a new electric boiler with a design capacity of 20 BHP at 60 PSI. Provide with 10:1 turndown ration and locate it in the Pilot Plant adjacent to the steam [Done] A vacuum condensate return system will be provided to allow the steam system to be on only when needed. The estimated cost is $263,800 with an estimated payback time of 7.9 years.
- **Option H3**: Convert the constant volume laboratory ventilation system to a variable volume ventilation system capable of a 2.5:1 turndown ratio on the outside air quantity. Remove two existing perchloric acid fume hoods and replace them with two standard laboratory fume hoods. Replace three existing constant volume fume hoods with variable volume fume hoods, and replace AHU-2 fan motor and install VFD. Remove EF-4 and EF-5 (perchloric acid fume hood exhaust fans).place EF-3 on each. Add modulating dampers to laboratory exhaust air ducts. Modify laboratory supply air system VAV box controls. Add differential controls to the 5 laboratory rooms. Balance entire system. The estimated cost is $223,700 with an estimated payback time of 9.4 years.

recommended next steps

Option	Simple Payback (Years)	Estimated Cost
S3 – Steam Boiler, Electric Point of Use	**7.9**	**$263,800**
H3 – Lab Ventilation Conversion	**9.4**	**$223,700**
S1 – Steam Boiler, Oil Fired	12.3	$216,500
S2 – Steam Boiler, Electric in Boiler Room	16.8	$252,800
H2 – Two Heating Boilers	21.3	$253,800
H1 – Three Heating Boilers	24.2	$288,250

2.0 Background

The University of Alaska Fisheries Industry Technology Center (FITC) in Kodiak, Alaska is a 25,800 square foot building of offices, classrooms and laboratories. The building was constructed from 1989 to 1991 and has operated continuously since that time.

There are two boiler systems in the facility. The hydronic heating system has a 2,000 MBH capacity. Its one boiler heats the building and domestic hot water. The process steam system has a 1380 PPH capacity at 100 PSI steam pressure. Its one boiler provides process steam to the Pilot Plant equipment. Originally, it also provided steam for the laboratory equipment and to humidify the building but those systems are disconnected. Both system boilers are oil-fired. Schematic drawings of the two systems are in Appendix A.

Evaluation of the fuel oil use at the facility raised concerns that the boilers were consuming much more fuel than is required to meet the current building heating, service water heating, and process

steam loads. In FYE 2009 and 2010 fuel costs were about $130,000; very high for a building in Kodiak. See Appendix B – Historical Fuel Use Data.

This report is a detailed examination of the current building heating and process steam loads with the intent of identifying ways to reduce fuel consumption primarily through modifications to the existing boilers.

3.0 Fuel Options

The existing boilers use No.2 fuel oil. Other boiler fuel options in Kodiak include propane and electricity. No.2 fuel oil costs $3.78 per gallon. Based on 138,500 Btu/gallon for No.2 fuel oil and 91,370 Btu per gallon for propane, the $4.86 per gallon cost of propane is equivalent to No.2 fuel oil priced at $7.35 per gallon. On a per Btu basis propane is almost twice the cost of No.2 fuel oil. Even with increased operating efficiencies of 5% to 10%, switching to propane will not reduce annual fuel costs. Accordingly, the use of propane-fired equipment is not considered in this report.

The FITC pays an equivalent of $0.14 to $0.16 per KWH used, depending on the demand charge. For this report, $0.17 per KWH is used for cost comparisons. Demand charges are based on Kodiak Electric Association's charge of $5.67 per KW over 50 KVA. Based on the higher efficiencies of electric boilers operating at low loads, the use of electric boilers is evaluated as part of this report.

4.0 Process Steam System Evaluation

The existing steam system was designed to provide a diversified load of 800 PPH of steam at 85 PSI and 2,000 PPH of steam at 15 PSI. The existing boiler is sized at 1,380 PPH at 100 PSIG. Humidification steam and laboratory steam is no longer connected. Currently the steam system serves only the Pilot Plant with an installed equipment start-up load of 840 PPH (25 BHP) at 60 PSI. The operational load is 20 BHP and the new boiler will be sized for this steam demand.

The actual use of the steam system is limited to only a few weeks each year. The retort is used about 80 hours a year and the steam kettle about 100 hours a year. Because steam systems degrade quickly if not kept hot, the existing system burns 1.5 gallons of fuel oil per hour, 365 days a year, to stay warm. This is equivalent to 13,140 gallons per year at a current cost of about $40,000.

With the reduction in operating pressure from 85 PSIG to 50 PSIG, and the reduced size of the system replacement of the existing, non-operating deaerator is not required. This eliminates another constant steam load on the system, and reduces maintenance costs.

Options

- **Option S1**: Replace the existing steam boiler with a new oil-fired boiler with a design capacity of 20 BHP at 60 PSI. Provide with a 3:1 turndown ratio, modulating burner and adjustable pressure set point controller allowing the boiler to idle at 15 PSI. The

pressure control will be manually adjusted to higher operating pressures when needed in the Pilot Plant.

- **Option S2**: Replace the existing steam boiler with a new electric boiler with a design capacity of 20 BHP at 60 PSI. Provide with 10:1 turndown ratio and an adjustable pressure set point controller allowing the boiler to idle at 15 PSI. The pressure control will be manually adjusted to higher operating pressures when needed in the Pilot Plant.
- **Option S3**: Replace the existing steam boiler with a new electric boiler with a design capacity of 20 BHP at 60 PSI. Provide with 10:1 turndown ration and locate it in the Pilot Plant adjacent to the steam consuming appliances. A new condensate return system will be provided to allow the steam system to be on only when needed.
- **Option S4**: Keep the existing steam boiler and replace the burner. Because the existing boiler is a 40 BHP model, with a 3:1 turndown ratio it will have a 440 MBH firing rate and inefficient short cycling will continue. Not recommended and payback not analyzed.

5.0 Hydronic Heating System Evaluation

The existing hydronic heating boiler system includes one, 2,000 MBH oil-fired hydronic boiler. Based on the design heating calculation included in Appendix C – Heat Loss Calculations, the existing winter design heating load is 2,000 MBH. The existing boiler is sufficient to meet the building heating load, but is oversized for average loads.

The heating load varies widely through the course of the year due to both seasonal climate variations and the intermittent use of large ventilation systems requiring the heating of the 100% makeup air. The building conduction and occupant ventilation air tempering winter design load is 667 MBH. The laboratory exhaust hood makeup air design heating load is 543 MBH and the Pilot Plant exhaust hood makeup air load is 790 MBH for a calculated total design load of 2,002 MBH. The service water heating load is small and not included in the analysis. The existing heating system seems adequately sized to meet the various heating demands and there have not been reports of underperformance.

The existing hydronic heating boiler burner is a low-high-low fire design. Assuming a 3:1 turn down, low fire output would be 670 MBH and for much of the year the boiler would short-cycle-fire to meet the average demand of 250 MBH to 400 MBH. This results in very inefficient operation due to the extensive pre- and post-purge of the burner during each firing cycle.

Options:

- **Option H1**: Replace the existing boiler with three 700 MBH (20 BHP) boilers with fully-modulating, 3:1 turndown ratio, fuel oil-fired burners.
- **Option H2**: Replace the existing boiler with two 1000 MBH (30 BHP) boilers with fully-modulating, 3:1 turndown ratio, fuel oil-fired burners.
- **Option H3**: Convert the constant volume laboratory ventilation system to a variable volume ventilation system capable of a 2.5:1 turndown ratio on the outside air quantity.

Remove two existing perchloric acid fume hoods and replace them with two standard laboratory fume hoods. Replace three existing constant volume fume hoods with variable volume fume hoods, and replace AHU-2 fan motor and install VFD. Remove EF-4 and EF-5 (perchloric acid fume hood exhaust fans).place EF-3 on each. Add modulating dampers to laboratory exhaust air ducts. Modify laboratory supply air system VAV box controls. Add differential controls to the 5 laboratory rooms. Balance entire system.

- **Option H4**: Replace the existing boiler burner with a fully modulating oil-fired burner. Since the existing boiler would still be rated at 60 HP (2,000 MBH output), and the turndown available on No.2 fuel oil is a maximum of 4:1, short-cycling will still occur due to the boiler's lowest output of 500 MBH being well above the average heating demand of 300 MBH. Not recommended and payback not analyzed.

7.0 Construction Cost Estimates and Payback Analyses

The costs of the Options and their simple paybacks are included in Appendix D. Costs are in 2010 dollars and include owner overhead and design fees. Simple paybacks are calculated by dividing the cost for each option by the anticipated annual energy cost savings.

Option	Simple Payback (Years)	Estimated Cost
S3 – Steam Boiler, Electric Point of Use	**7.9**	**$263,800**
H3 – Lab Ventilation Conversion	**9.4**	**$223,700**
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Product data sheets for the various options are included in Appendix E.

8.0 Recommendations

Based on the evaluated steam boiler system options, Option S3, installing an electric boiler in the Pilot Plant adjacent to the steam appliances, has the quickest payback at 7.9 years. Its estimated cost is $263,800.

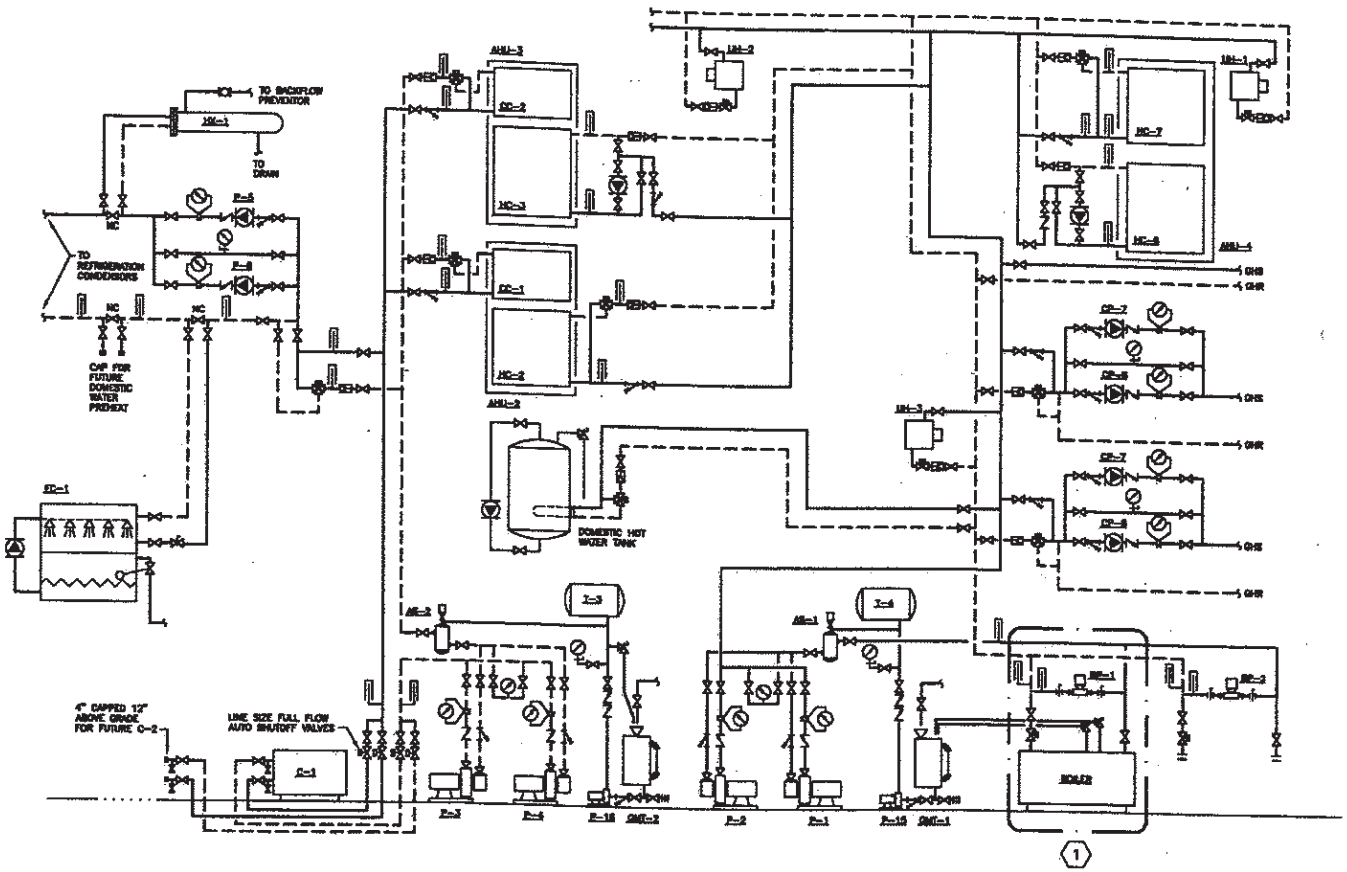
For the hydronic heating system, Option H3, converting the laboratory ventilation systems to variable volume operation has the fastest payback at 9.4 years and an estimated cost of $223,700. Option H2 is the heating system boiler conversion with the fastest payback at 21.3 years and an estimated cost of $253,800.

Options S3 and H3 have paybacks of less than 10 years and are recommended.

End of Report

Kodiak FITC Boiler Conversion Analysis
Kodiak, Alaska

Appendix A – Schematic Drawings



1 SCHEMATIC- HYDRONNIC HEATING SYSTEM

NOT TO SCALE

NOTES

1. REMOVE EXISTING BOILER AND PUMP. REPLACE WITH NEW.

Bell Design Group LLC
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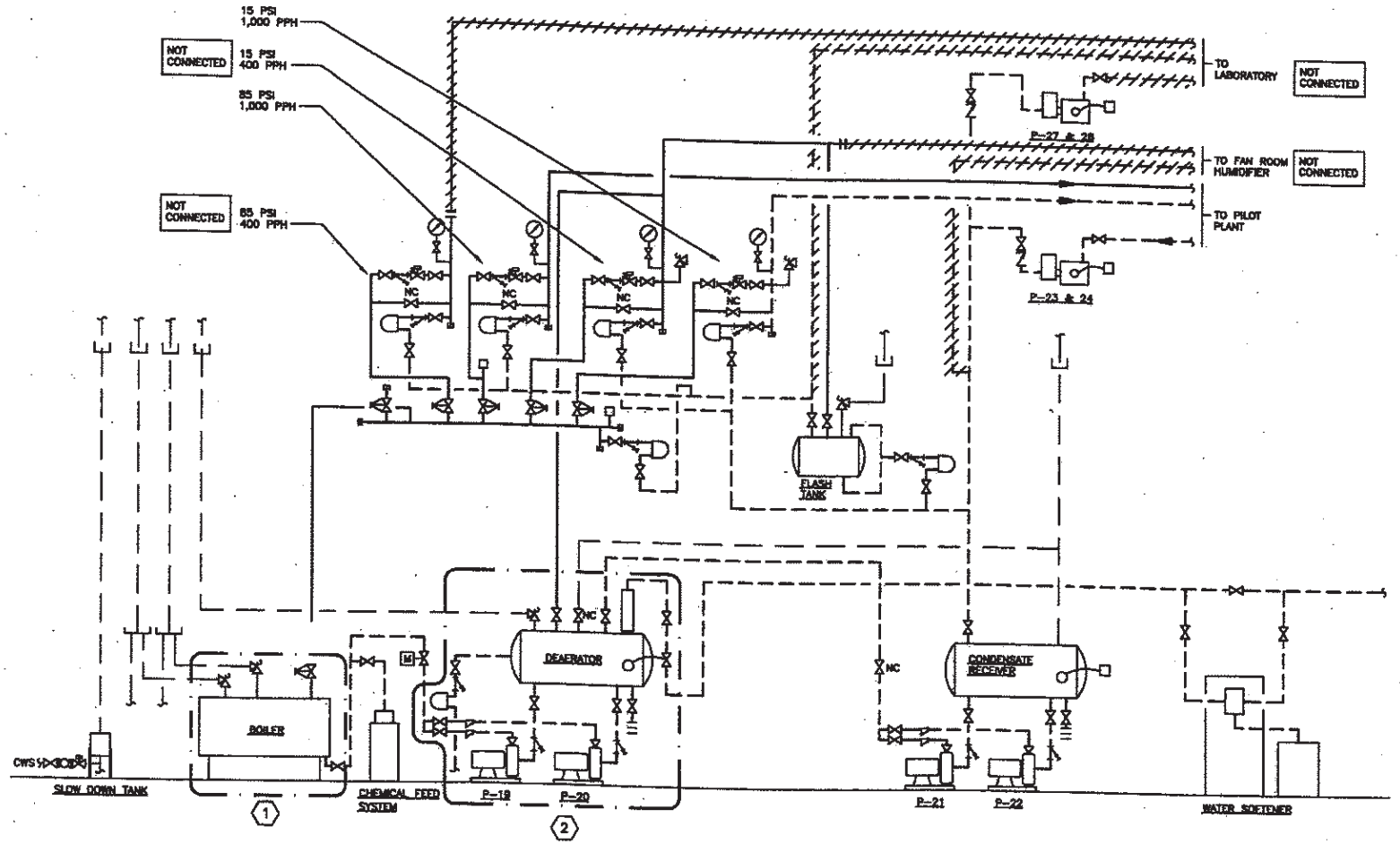
P.O. Box 81765 Fairbanks, AK 99708 (907) 388-2605

KODIAK FITC BOILER CONVERSION ANALYSIS
UAF PROJECT 2011043 KDBC

DATE 10/4/10
DRAWN LDS
CHECKED SVB
SHEET M1



NOTES

1. REMOVE EXISTING BOILER AND PUMPS. REPLACE WITH NEW.
2. REMOVE EXISTING DEAERATOR SYSTEM.

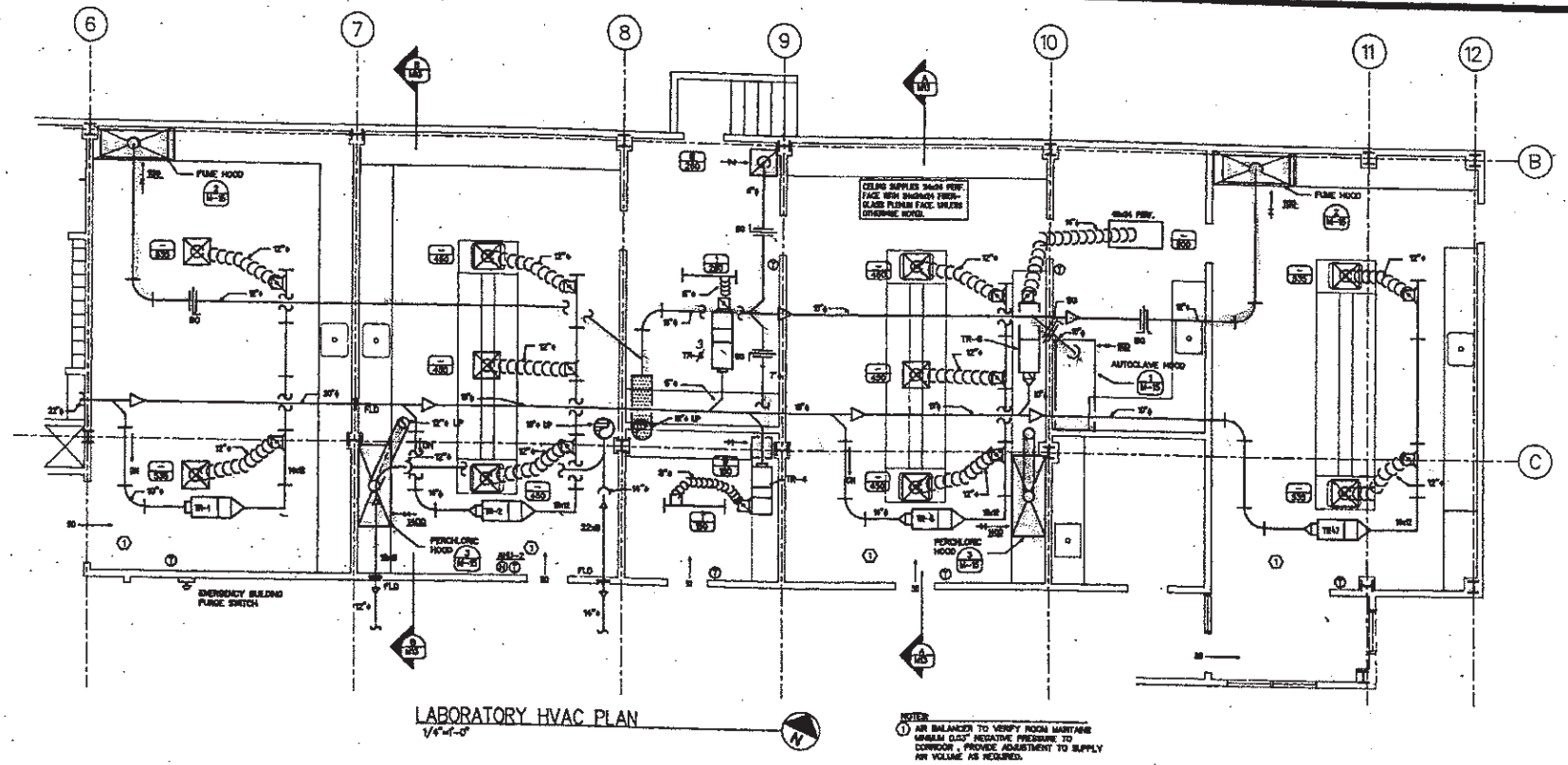
1 SCHEMATIC- PROCESS STEAM SYSTEM

NOT TO SCALE

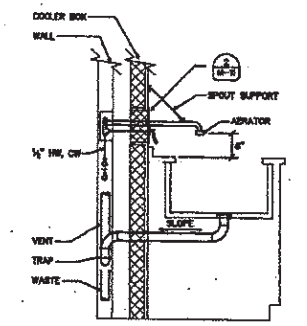
Bell Design Group LLC
Mechanical & Fire Protection Engineering
P.O. Box 81788 Fairbanks, AK 99708 (907) 388-3888

KODIAK FITC BOILER CONVERSION ANALYSIS
UAF PROJECT 2011043 KDBC

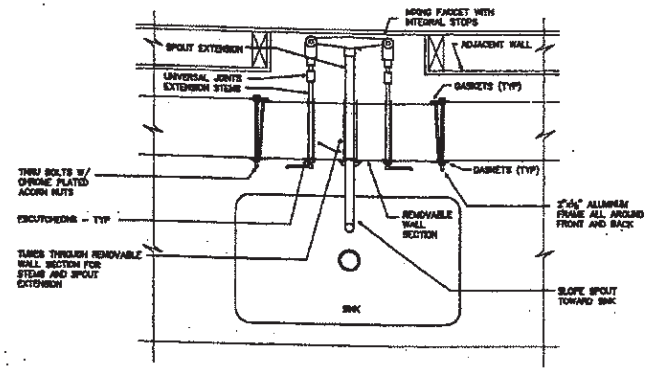
DATE 10/4/10
DRAWN LDS
CHECKED SVB
SHEET M2



LABORATORY HVAC PLAN
1/4"=1'-0"



1 / M-11 COLD LAB SINK (S-5)
NO SCALE



2 / M-11 SINK DETAIL (S-5)
NO SCALE

FISHERY INDUSTRIAL TECHNOLOGY CENTER
• University of Alaska •

Parsichiste Engineers, Inc.

LABORATORY HVAC PLAN

PROJECT NO. 959079

SHEET
M-11
of 34

FAN SCHEDULE

DESIG	SERVICE	TYPE	CFM	SP	BHP	MHP	EFF. *	BASIS OF DESIGN
† AHU-1	BLDG VENTILATION	VAV CABINET	13,055	4"	12.1	15	XH	PACE A-24AF IN A-27 CABINET
AHU-2	LAB VENTILATION	CV CABINET	10523	4"	9.41	10	XH	PACE A-22AF IN A-24 CABINET
~~AHU-3~~	~~BOILER RM VENT~~	~~CABINET~~	~~3,000~~	~~1~~	~~1.15~~	~~1½~~	~~HE~~	~~PACE A-14-FC~~
† #2 AHU-4	PILOT PLANT MAKE-UP	CABINET	10,000	1	3.35	5	HE	PACE A-24-FC
EF-1	1ST FLR TOILET EXHAUST	SMALL CABINET	800	½	.12	¼	SE	PACE SCF-87-A
† #2 EF-2	2ND FLR TOILET EXHAUST	SMALL CABINET	480	½	.12	⅙	SE	PACE SCF-75-A
EF-3	LAB EXHAUST	UTILITY	3560	2	1.6	2	XH	PACE U-20B IN SOUND ENCLOSURE
EF-4	PERCHLORIC HOOD	ACID RESISTENT	1400	1½	-	1	SE	HOOD MANUFACTURER
EF-5	PERCHLORIC HOOD	ACID RESISTENT	1400	1½	-	1	SE	HOOD MANUFACTURER
EF-6	KITCHEN HOOD (GRILLE)	ROOF MTD	1,750	1¾	1.11	1½	HE	ACME
† #2 EF-7	PILOT PLANT HOOD	UTILITY	10,000	1	2.9	5	HE	PACE U-30-F
EF-8	UTILITY TUNNEL VENT.	SMALL CABINET	670	1	0.26	⅓	XH	PACE SCF-73A
EF-9	UTILITY TUNNEL VENT.	SMALL CABINET	670	1	0.26	⅓	XH	PACE SCF-73A
EF-10	ELEC. RM EXHAUST	PANEL FAN	2,000	⅛	0.15	¼	HE	PACE 18"ϕ TYPE PM
EF-11	STORE RM. EXHAUST	SMALL CABINET	900	½	0.2	¼	SE	PACE SCF-86A
† RF-1	BLDG RELEF	VAV CABINET	10,135	1"	2.6	3	XH	PACE A-24B1
SF-1 & 2	BOILER ROOM SUP.	PANEL FAN	3488	¼	0.28	⅓	SE	PACE 21"ϕ TYPE PM

* MOTOR EFFICIENCY (SE) = STANDARD EFFICIENCY; (HE) = HIGH EFFICINCY; (XH) = EXTRA HIGH EFFICIENCY. SEE SPEC SECTION 15036

† CAPACITY FOR BASE BID, ALT #1 & #2, SEE BASE BID SCHEDULE.

COIL SCHEDULE

	DESIG	SERVICE	CFM	MAX FACE VELOCITY	DRY BULB ENT	DRY BULB LEA	WET BULB ENT	WET BULB LEA	FLUID TYPE	GPM	AIR ENT	AIR LEA	AIR PD	H_2O PD
	HC-2	AHU-1 HEAT	13055	900	55	95	–	–	40/60 GLYCOL	62	180	160	0.3"	5'
	CC-1	AHU-1 COOLING	13055	550	69	55	58	53.6	30/70 GLYCOL	49	42	49	0.4"	20'
	HC-3	AHU-2 PRE-HEAT	10520	900	13	60	–	–	40/60 GLYCOL	58	180	160	0.3"	5'
DELETED	~~HC-4~~	~~AHU-2 HEAT~~	~~11000~~	~~900~~	~~60~~	~~95~~	~~–~~	~~–~~	~~40/60 GLYCOL~~	~~1~~	~~180~~	~~160~~	~~0.3"~~	~~5'~~
	CC-2	AHU-2 COOLING	10520	550	69	55	58	53.6	30/70 GLYCOL	39	42	49	0.4"	20'
DELETED	~~HC-5~~	~~AHU-3 HEAT~~	~~3000~~	~~900~~	~~13~~	~~60~~	~~–~~	~~–~~	~~50/50 GLYCOL~~	~~1~~	~~180~~	~~160~~	~~0.3"~~	~~5'~~
ALT #2	HC-6	AHU-4 PRE-HEAT	10000	900	13	50	–	–	40/60 GLYCOL	45	180	160	0.3"	5'
ALT #2	HC-7	AHU-4 HEAT	10000	900	45	95	–	–	40/60 GLYCOL	59	180	160	0.3"	5'
								(2)	(2)	(2)		(2)	(2)	(2)

7-G

BOILER SCHEDULE

η=75%

18 GPH?

DESIG	SERVES	FLUID	PRESSURE	ENT	LEA	OUTPUT	INPUT *	FUEL	BASIS OF DESIGN
B-1	BLDG HEAT	40/60 GLYCOL	30	180	180	2024 MBH	15 GPH	OIL	CLEAVER BROOKS CB-60
B-2	BLDG HEAT	40/60 GLYCOL	30	180	180	2024 MBH	15 GPH	OIL	CLEAVER BROOKS CB-60 (FUTURE)
ALT #2 B-3	PROCESS STEAM	STEAM	100	-	-	1380 lbs/HR	12 GPH	OIL	CLEAVER BROOKS CBH-40
		(2)							(2)

* AT 140 MBH/GAL

UNIT COOLER SCHEDULE - ALTERNATE #2

DESIG	BTU/HR	ΔT	FAN HP	DEFROST KW	MAX. FINS/INCH	REFRIGERANT	BASIS OF DESIGN
UC-1	7,775	6.6	¼	3.4	4	R-12	
UC-2	7,775	6.6	¼	3.4	4	R-12	
UC-3	50,500	14	2 ● ½	6.9	5	R-502	COLMAC "HIGH PROFILE"
UC-4	50,500	14	2 ● ½	6.9	5	R-502	COLMAC "HIGH PROFILE"
UC-5	25,800	10	2 ● ½	6.9	4	R-502	COLMAC "HIGH PROFILE"
UC-6	25,800	10	2 ● ½	6.9	4	R-502	COLMAC "HIGH PROFILE"

Kodiak FITC Boiler Conversion Analysis
Kodiak, Alaska

Appendix B – Historical Fuel Use Data

Kodiak FITC Fuel Oil Usage

date	cumulative days	gallons	gal/day	unit cost	delivery cost	total inv		
7/1/2006		2330		$ 2.24		$ 5,224.79		
7/26/2006	25	2100	84	$ 2.51		$ 5,269.95		
8/24/2006	29	1748	60	$ 2.82		$ 4,934.60		
9/19/2006	26	2450	94	$ 2.32		$ 5,234.18		
10/16/2006	27	2660	99	$ 1.89		$ 5,029.53		
10/20/2006	4		0			$ 1.40		
10/25/2006	5		0			$ 1.56		
12/11/2006	47		0			$ 6,632.08		
12/20/2006	9	2200	244	$ 2.27		$ 4,990.48		
1/11/2007	22		0			$ 3,533.85		
1/11/2007	0	2905	#DIV/0!	$ 2.21		$ 6,420.05		
1/29/2007	18	2700	150	$ 1.88	$ 5,067.09	$ 5,069.79		
2/14/2007	16	1860	116	$ 1.97	$ 3,669.41	$ 3,671.27		
2/27/2007	13	2050	158	$ 2.03	$ 4,166.42	$ 4,168.47		
3/12/2007	13	3000	231	$ 2.18	$ 6,525.90	$ 6,528.90		
3/26/2007	14	3353	240	$ 2.09	$ 7,005.42	$ 7,008.78		
4/9/2007	14	2680	191	$ 2.30	$ 6,176.06	$ 6,178.74		
5/2/2007	23	3570	155	$ 2.37	$ 8,453.05	$ 8,456.62		
5/17/2007	15	2400	160	$ 2.26	$ 5,435.76	$ 5,438.16		
5/30/2007	13	1280	98	$ 2.32	$ 2,973.44	$ 2,974.72		
6/14/2007	15	915	61	$ 2.33	$ 2,135.98	$ 2,136.89	$ 100,257.87	Total FYE07 expense
							40,801	Total FYE07 gallons

date	cumulative days	gallons	gal/day	unit cost	delivery cost	total inv		
7/11/2007	27	1200	44	$ 2.25	$ 2,704.92	$ 2,706.12		
8/8/2007	28	1989	71	$ 2.53	$ 5,022.23	$ 5,024.21		
8/23/2007	15	2097	140	$ 2.38	$ 4,993.17	$ 4,995.26		
9/13/2007	21	1643	78	$ 2.38	$ 3,903.77	$ 3,905.41		
10/10/2007	27	2599	96	$ 2.89	$ 7,511.11	$ 7,513.71		
11/7/2007	28	3063	109	$ 3.06	$ 9,362.37	$ 9,365.43		
11/19/2007	12	1500	125	$ 3.01	$ 4,510.80	$ 4,512.30		
12/4/2007	15	1891	126	$ 2.76	$ 5,223.13	$ 5,225.02		
12/19/2007	30	2310	77	$ 2.79	$ 6,436.82	$ 6,439.13		
1/16/2008	28	3809	136	$ 2.65	$ 10,106.80	$ 10,110.61		
1/31/2008	15	1940	129	$ 2.45	$ 4,756.30	$ 4,758.24		
2/13/2008	13	2271	175	$ 2.72	$ 6,168.94	$ 6,171.22		
2/26/2008	13	1900	146	$ 3.07	$ 5,827.87	$ 5,829.77		
3/13/2008	16	2359	147	$ 3.28	$ 7,734.93	$ 7,737.28		
3/27/2008	14	1992	142	$ 3.40	$ 6,772.60	$ 6,774.59		
4/15/2008	19	2600	137	$ 3.71	$ 9,639.76	$ 9,642.36		
4/29/2008	14	1601	114	$ 3.75	$ 6,010.15	$ 6,011.76		
5/19/2008	20	2070	104	$ 4.00	$ 8,276.90	$ 8,278.97		
6/17/2008	29	2150	74	$ 4.07	$ 8,753.30	$ 8,755.45	$ 126,116.73	Total FYE08 expense
							44,197	Total FYE08 gallons

date	cumulative days	gallons	gal/day	unit cost	delivery cost	total inv		
7/30/2008	43	2860	67	$ 3.89	$ 11,135.98	$ 11,138.84		
8/27/2008	28	1854	66	$ 3.59	$ 6,652.71	$ 6,654.56		
10/7/2008					$ 6,815.25			
11/3/2008					$ 5,777.37			
11/17/2008					$ 7,760.57			
11/24/2008					$ 6,956.57			
12/24/2008					$ 6,555.01			
12/24/2008					$ 10,156.58			
1/20/2009					$ 10,419.45			
2/3/2009					$ 5,316.97			
2/16/2009					$ 6,182.34			
3/3/2009					$ 5,869.22			
3/23/2009					$ 8,913.76			
4/27/2009					$ 4,996.50			
4/24/2009					$ 9,196.76			
5/12/2009					$ 6,685.77			
6/1/2009					$ 4,957.33			
6/9/2009					$ 4,621.50			
6/30/2009					$ 4,621.50		$ 125,257.65	Total FYE09 expense
							Unknown	Total FYE09 gallons
date	cumulative days	gallons	gal/day	unit cost	delivery cost	total inv		
7/1/2009		3067		$ 3.18	$ 9,753.06			
7/22/2009		1876		$ 3.18	$ 5,965.68			
8/12/2009		1722		$ 3.18	$ 5,475.96			
9/15/2009		2050		$ 3.43	$ 7,031.50			
10/7/2009		2990		$ 3.43	$ 10,255.70			
10/29/2009		3520		$ 3.43	$ 12,073.60			
11/20/2009		2683		$ 3.43	$ 9,202.69			
12/2/2009		1382		$ 3.43	$ 4,740.26			
1/6/2010		2112		$ 3.43	$ 7,244.16			
1/20/2010		1524		$ 3.43	$ 5,227.32			
2/3/2010		1514		$ 3.43	$ 5,193.02			
2/23/2010		2213		$ 3.43	$ 7,590.59			
3/17/2010		2560		$ 3.46	$ 8,857.60			
4/7/2010		2914		$ 3.46	$ 10,082.44			
4/28/2010		2634		$ 3.78	$ 9,956.52			
5/18/2010		2429		$ 3.78	$ 9,181.62			
6/9/2010		2018		$ 3.78	$ 7,628.04		$ 135,459.76	Total FYE10 expense
							39,208	Total FYE10 gallons
date	cumulative days	gallons	gal/day	unit cost	delivery cost	total inv		
6/30/2010		1639		$ 3.78	$ 6,195.42			
7/26/2010		2696		$ 3.78	$ 10,190.88			
8/5/2010		341		$ 3.81	$ 1,299.21			
8/17/2010		1042		$ 3.78	$ 3,938.76			
8/31/2010		1248		$ 3.78	$ 4,717.44			

Kodiak FITC Boiler Conversion Analysis
Kodiak, Alaska

Appendix C – Heat Loss Calculations

UAF Kodiak Fisheries Boiler
HVAC Load Analysis

for

UAF

COMMERCIAL
HVAC LOADS

Prepared By:

Thursday, September 30, 2010

Building Envelope Report

Envelope Report Using Summer U-Factors

Material Types		Gross Area	Glass Area	Net Area	-U- Factor	Area x U-Factor	Average U-Factor
Roof	1	11,298.0	0.0	11,298.0	0.039	438.362	0.039
Tot.Roof		11,298.0	0.0	11,298.0	N/A	438.362	0.039
Wall	1	10,864.0	1,417.0	9,447.0	0.053	497.857	0.053
Wall	2	3,142.0	0.0	3,142.0	0.044	137.305	0.044
Wall	3	5,003.2	0.0	5,003.2	0.057	285.182	0.057
Wall	4	317.0	0.0	317.0	0.330	104.610	0.330
Wall	5	210.0	0.0	210.0	1.000	210.000	1.000
Tot.Wall		19,536.2	1,417.0	18,119.2	N/A	1,234.955	0.068
Glass	1	1,417.0	N/A	1,417.0	0.560	793.520	0.560
Tot.Glass		1,417.0	N/A	1,417.0	N/A	793.520	0.560
Totals				30,834.2		2,466.837	0.080

Wall Direction	Wall Area	Glass Area	Wall Net Area	Wall Avg U-Factor	Glass Avg U-Factor	Glass Avg Shd.Coef
N	3,925.2	210.0	3,715.2	0.055	0.560	0.950
NE	2,360.4	120.0	2,240.4	0.053	0.560	0.950
E	2,128.0	105.0	2,023.0	0.056	0.560	0.950
SE	773.0	0.0	773.0	0.061	0.000	0.000
S	4,392.2	885.0	3,507.2	0.054	0.560	0.950
SW	2,771.8	85.0	2,686.8	0.053	0.560	0.950
W	272.0	0.0	272.0	0.048	0.000	0.000
NW	2,913.6	12.0	2,901.6	0.140	0.560	0.950
Totals	19,536.2	1,417.0	18,119.2	0.068	0.560	0.950

Building Summary Loads

Bldg Load Descriptions	Area Quan	Sen Loss	%Tot Loss	Lat Gain	Sen Gain	Net Gain	%Net Gain
Roof	11,298	36,165	18.51	0	0	0	0.00
Wall	18,119	101,884	52.16	0	0	0	0.00
Glass	1,417	57,282	29.33	0	0	0	0.00
Floor Slab	0	0	0.00	0	0	0	0.00
Skin Loads		195,331	100.00	0	0	0	0.00
Lighting	38,748	0	0.00	0	0	0	0.00
Equipment	25,832	0	0.00	0	0	0	0.00
People	0	0	0.00	0	0	0	0.00
Partition	0	0	0.00	0	0	0	0.00
Cool. Pret.	0	0	0.00	0	0	0	0.00
Heat. Pret.	0	0	0.00	0	0	0	0.00
Cool. Vent.	0	0	0.00	0	0	0	0.00
Heat. Vent.	0	0	0.00	0	0	0	0.00
Cool. Infil.	0	0	0.00	0	0	0	0.00
Heat. Infil.	0	0	0.00	0	0	0	0.00
Draw-Thru Fan	0	0	0.00	0	0	0	0.00
Blow-Thru Fan	0	0	0.00	0	0	0	0.00
Reserve Cap.	0	0	0.00	0	0	0	0.00
Reheat Cap.	0	0	0.00	0	0	0	0.00
Supply Duct	0	0	0.00	0	0	0	0.00
Return Duct	0	0	0.00	0	0	0	0.00
Misc. Supply	0	0	0.00	0	0	0	0.00
Misc. Return	0	0	0.00	0	0	0	0.00
Building Totals		195,331	100.00	0	0	0	0.00

Building Summary	Sen Loss	%Tot Loss	Lat Gain	Sen Gain	Net Gain	%Net Gain
Ventilation	0	0.00	0	0	0	0.00
Infiltration	0	0.00	0	0	0	0.00
Pretreated Air	0	0.00	0	0	0	0.00
Zone Loads	195,331	100.00	0	0	0	0.00
Plenum Loads	0	0.00	0	0	0	0.00
Fan & Duct Loads	0	0.00	0	0	0	0.00
Building Totals	195,331	100.00	0	0	0	0.00

Check Figures

Total Building Supply Air (based on a 20° TD):	9,067	CFM
Total Building Vent. Air (0.00% of Supply):	0	CFM
Total Conditioned Air Space:	25,832	Sq.ft
Supply Air Per Unit Area:	0.3510	CFM/Sq.ft
Area Per Cooling Capacity:	0.0	Sq.ft/Ton
Cooling Capacity Per Area:	0.0000	Tons/Sq.ft
Heating Capacity Per Area:	7.56	Btuh/Sq.ft
Total Heating Required With Outside Air:	195,331	Btuh
Total Cooling Required With Outside Air:	0.00	Tons

Air Handler #1 - AHU 1 - Summary Loads

Zn No	Description Zone Peak Time	Area People Volume	Htg.Loss Htg.CFM CFM/Sqft	Sen.Gain Clg.CFM CFM/Sqft	Lat.Gain S.Exh W.Exh	Htg.O.A. Req.CFM Act.CFM	Clg.O.A. Req.CFM Act.CFM
1	FF East	256	5,882	0	0	None	None
	-	0	273	0	0	0	0
		2,304	1.07	0.00	0	0	0
2	FF Middle	6,250	16,805	0	0	None	None
	-	0	780	0	0	0	0
		56,250	0.12	0.00	0	0	0
3	FF South	900	19,076	0	0	None	None
	-	0	886	0	0	0	0
		8,100	0.98	0.00	0	0	0
4	FF West	5,848	14,658	0	0	None	None
	-	0	680	0	0	0	0
		52,632	0.12	0.00	0	0	0
5	FF Southwest	480	7,038	0	0	None	None
	-	0	327	0	0	0	0
		4,320	0.68	0.00	0	0	0
6	SF East	6,250	73,759	0	0	None	None
	-	0	3,424	0	0	0	0
		56,250	0.55	0.00	0	0	0
7	SF West	5,848	58,113	0	0	None	None
	-	0	2,698	0	0	0	0
		70,176	0.46	0.00	0	0	0
	Zone Peak Totals:	25,832	195,331	0	0		
	Total Zones: 7	0	9,067	0	0	0	0
	Unique Zones: 7	250,032	0.35	0.00	0	0	0

Air Handler #1 - AHU 1 - Total Load Summary

Air Handler Description:	AHU 1 Constant Volume - Proportion
Supply Air Fan:	Draw-Thru with program estimated horsepower of 0.00 HP
Fan Input:	0% motor and fan efficiency with 0 in. water across the fan
Outdoor Conditions:	0° DB (System is Heating Only)
Indoor Conditions:	75° DB

Winter: Exhaust controls outside air.

Zone Space sensible loss:	195,331 Btuh		
Infiltration sensible loss:	0 Btuh	0 CFM	
Outside Air sensible loss:	0 Btuh	0 CFM	
Supply Duct sensible loss:	0 Btuh		
Return Duct sensible loss:	0 Btuh		
Return Plenum sensible loss:	0 Btuh		
Total System sensible loss:			195,331 Btuh
Heating Supply Air: 195,331 / (.997 X 1.08 X 20) =		9,067 CFM	
Winter Vent Outside Air (0.0% of supply) =		0 CFM	
Zone space sensible gain:	0 Btuh		
Infiltration sensible gain:	0 Btuh		
Draw-thru fan sensible gain:	0 Btuh		
Supply duct sensible gain:	0 Btuh		
Reserve sensible gain:	0 Btuh		
Total sensible gain on supply side of coil:			0 Btuh
Cooling Supply Air: 0 / (.997 X 1.1 X 0) =		0 CFM	
Summer Vent Outside Air (0.0% of supply) =		0 CFM	
Return duct sensible gain:	0 Btuh		
Return plenum sensible gain:	0 Btuh		
Outside air sensible gain:	0 Btuh	0 CFM	
Blow-thru fan sensible gain:	0 Btuh		
Total sensible gain on return side of coil:			0 Btuh
Total sensible gain on air handling system:			0 Btuh
Zone space latent gain:	0 Btuh		
Infiltration latent gain:	0 Btuh		
Outside air latent gain:	0 Btuh		
Total latent gain on air handling system:			0 Btuh
Total system sensible and latent gain:			0 Btuh

Check Figures

Total Air Handler Supply Air (based on a 20° TD):	9,067 CFM
Total Air Handler Vent. Air (0.00% of Supply):	0 CFM
Total Conditioned Air Space:	25,832 Sq.ft
Supply Air Per Unit Area:	0.3510 CFM/Sq.ft
Area Per Cooling Capacity:	0.0 Sq.ft/Ton
Cooling Capacity Per Area:	0.0000 Tons/Sq.ft
Heating Capacity Per Area:	7.56 Btuh/Sq.ft
Total Heating Required With Outside Air:	195,331 Btuh
Total Cooling Required With Outside Air:	0.00 Tons

Zone Detailed Loads (At Zone Peak Times)

Load Description	Unit Quan	-SC- CFAC	CLTD SHGF	U.Fac -CLF-	Sen. Gain	Lat. Gain	Htg. Mult.	Htg. Loss
Zone 1-FF East, Air Handler 1 (AHU 1), Group 0, 32.0 x 8.0, Construction Type: 1 (Light)								
Roof-1-1-Susp.C-L	128	0.50	-31.3	0.039	0		2.910	372
Roof-2-1-Susp.C-L	128	0.50	-31.3	0.039	0		2.910	372
Wall-1-0-G-M	48	0.83	-29.4	0.053	0		3.953	190
Wall-2-90-G-M	288	0.83	-32.7	0.053	0		3.953	1,138
Wall-3-0-C-M	24	0.83	-35.2	0.044	0		3.278	79
Wall-4-180-G-M	72	0.83	-17.4	0.053	0		3.953	285
Wall-5-180-C-M	64	0.83	-13.2	0.044	0		3.278	210
Wall-6-90-C-M	256	0.83	-23.6	0.044	0		3.278	839
Wall-7-0-G-M	50	0.83	-29.4	0.057	0		4.275	215
Wall-8-90-G-M	335	0.83	-32.7	0.057	0		4.275	1,431
Wall-9-180-G-M	50	0.83	-17.4	0.057	0		4.275	215
Sub-total					0	0		5,347
Safety factors:					+0%	+0%		+10%
Total w/ safety factors:					0	0		5,882
Zone 2-FF Middle, Air Handler 1 (AHU 1), Group 0, 125.0 x 50.0, Construction Type: 1 (Light)								
Wall-1-0-G-M	1,044	0.83	-29.4	0.053	0		3.953	4,126
Wall-2-0-C-M	928	0.83	-35.2	0.044	0		3.278	3,042
Wall-3-180-G-M	381	0.83	-17.4	0.053	0		3.953	1,506
Wall-4-180-C-M	392	0.83	-13.2	0.044	0		3.278	1,285
Wall-5-90-G-M	129	0.83	-32.7	0.053	0		3.953	510
Wall-6-90-C-M	128	0.83	-23.6	0.044	0		3.278	420
Wall-7-270-G-M	36	0.83	-8.6	0.053	0		3.953	142
Wall-8-270-C-M	32	0.83	-24.4	0.044	0		3.278	105
Wall-9-90-G-M	21	0.83	-32.7	0.330	0		24.750	520
Wall-10-180-G-M	35	0.83	-17.4	0.330	0		24.750	866
Gls-90°-1-90-Tran	15.0	1.000	-34	0.560	0		36.750	551
0%S-0-NS-Solar	15.0	0.950	173	0.150	0			
Gls-180°-1-90-Tran	60.0	1.000	-34	0.560	0		36.750	2,205
0%S-0-NS-Solar	60.0	0.950	242	0.280	0			
Sub-total					0	0		15,277
Safety factors:					+0%	+0%		+10%
Total w/ safety factors:					0	0		16,805
Zone 3-FF South, Air Handler 1 (AHU 1), Group 0, 75.0 x 12.0, Construction Type: 1 (Light)								
Roof-1-1-Susp.C-L	900	0.50	-31.3	0.039	0		2.910	2,619
Wall-1-180-G-M	390	0.83	-17.4	0.053	0		3.953	1,541
Wall-2-180-C-M	600	0.83	-13.2	0.044	0		3.278	1,967
Wall-3-270-G-M	108	0.83	-8.6	0.053	0		3.953	427
Wall-4-270-C-M	96	0.83	-24.4	0.044	0		3.278	315
Gls-180°-1-90-Tran	285.0	1.000	-34	0.560	0		36.750	10,474
0%S-0-NS-Solar	285.0	0.950	242	0.280	0			
Sub-total					0	0		17,342
Safety factors:					+0%	+0%		+10%
Total w/ safety factors:					0	0		19,076

Zone Detailed Loads (At Zone Peak Times) (cont'd)

Load Description	Unit Quan	-SC- CFAC	CLTD SHGF	U.Fac -CLF-	Sen. Gain	Lat. Gain	Htg. Mult.	Htg. Loss
Zone 4-FF West, Air Handler 1 (AHU 1), Group 0, 86.0 x 68.0, Construction Type: 1 (Light)								
Wall-1-NE-G-M	540	0.83	-35.2	0.053	0		3.953	2,134
Wall-2-NE-C-M	234	0.83	-31.1	0.044	0		3.278	767
Wall-3-NW-G-M	600	0.83	-16.1	0.053	0		3.953	2,372
Wall-4-NW-C-M	136	0.83	-31.9	0.044	0		3.278	446
Wall-5-SW-G-M	414	0.83	-10.3	0.053	0		3.953	1,636
Wall-6-SW-C-M	92	0.83	-16.9	0.044	0		3.278	302
Wall-7-SE-G-M	144	0.83	-25.2	0.053	0		3.953	569
Wall-8-SE-C-M	32	0.83	-16.9	0.044	0		3.278	105
Wall-9-NW-G-M	63	0.83	-16.1	0.330	0		24.750	1,559
Wall-10-NW-G-M	121	0.83	-16.1	0.330	0		24.750	2,995
Gls-NW-1-90-Tran	12.0	1.000	-34	0.560	0		36.750	441
0%S-0-NS-Solar	12.0	0.950	56	0.420	0			
Sub-total					0	0		13,325
Safety factors:					+0%	+0%		+10%
Total w/ safety factors:					0	0		14,658
Zone 5-FF Southwest, Air Handler 1 (AHU 1), Group 0, 40.0 x 12.0, Construction Type: 1 (Light)								
Roof-1-1-Susp.C-L	480	0.50	-31.3	0.039	0		2.910	1,397
Wall-1-SE-G-M	108	0.83	-25.2	0.053	0		3.953	427
Wall-2-SE-C-M	24	0.83	-16.9	0.044	0		3.278	79
Wall-3-SE-G-M	90	0.83	-25.2	0.057	0		4.275	385
Wall-4-SE-G-M	21	0.83	-25.2	0.330	0		24.750	520
Wall-5-SW-G-M	360	0.83	-10.3	0.053	0		3.953	1,423
Wall-6-SW-C-M	80	0.83	-16.9	0.044	0		3.278	262
Wall-7-SW-G-M	252	0.83	-10.3	0.057	0		4.275	1,077
Wall-8-NW-G-M	108	0.83	-16.1	0.053	0		3.953	427
Wall-9-NW-C-M	24	0.83	-31.9	0.044	0		3.278	79
Wall-10-NW-G-M	76	0.83	-16.1	0.057	0		4.275	323
Sub-total					0	0		6,398
Safety factors:					+0%	+0%		+10%
Total w/ safety factors:					0	0		7,038
Zone 6-SF East, Air Handler 1 (AHU 1), Group 0, 125.0 x 50.0, Construction Type: 1 (Light)								
Roof-1-1-Susp.C-L	3,050	0.50	-31.3	0.039	0		2.910	8,876
Roof-2-1-Susp.C-L	3,300	0.50	-31.3	0.039	0		2.910	9,603
Wall-1-N-G-M	834	0.83	-29.4	0.053	0		3.953	3,296
Wall-2-N-G-M	731	0.83	-29.4	0.057	0		4.275	3,124
Wall-3-E-G-M	310	0.83	-32.7	0.053	0		3.953	1,225
Wall-4-E-G-M	556	0.83	-32.7	0.057	0		4.275	2,378
Wall-5-S-G-M	666	0.83	-17.4	0.053	0		3.953	2,632
Wall-6-S-G-M	857	0.83	-17.4	0.057	0		4.275	3,663
Wall-7-N-G-M	56	0.83	-29.4	0.330	0		24.750	1,386
Gls-N-1-90-Tran	210.0	1.000	-34	0.560	0		36.750	7,718
0%S-0-NS-Solar	210.0	0.950	20	0.610	0			
Gls-E-1-90-Tran	90.0	1.000	-34	0.560	0		36.750	3,308
0%S-0-NS-Solar	90.0	0.950	173	0.150	0			
Gls-S-1-90-Tran	420.0	1.000	-34	0.560	0		36.750	15,435
0%S-0-NS-Solar	420.0	0.950	242	0.280	0			

Zone Detailed Loads (At Zone Peak Times) (cont'd)

Load Description	Unit Quan	-SC- CFAC	CLTD SHGF	U.Fac -CLF-	Sen. Gain	Lat. Gain	Htg. Mult.	Htg. Loss
Gls-S-1-90-Tran	120.0	1.000	-34	0.560	0		36.750	4,410
0%S-0-NS-Solar	120.0	0.950	242	0.280	0			
Sub-total					0	0		67,053
Safety factors:					+0%	+0%		+10%
Total w/ safety factors:					0	0		73,759

Zone 7-SF West, Air Handler 1 (AHU 1), Group 0, 86.0 x 68.0, Construction Type: 1 (Light)

Roof-1-1-Susp.C-L	1,620	0.50	-31.3	0.039	0		2.910	4,714
Roof-2-1-Susp.C-L	1,692	0.50	-31.3	0.039	0		2.910	4,924
Wall-1-NE-G-M	912	0.83	-35.2	0.053	0		3.953	3,605
Wall-2-NE-G-M	554	0.83	-35.2	0.057	0		4.275	2,370
Wall-3-SE-G-M	192	0.83	-25.2	0.053	0		3.953	759
Wall-4-SE-G-M	162	0.83	-25.2	0.057	0		4.275	693
Wall-5-SW-G-M	947	0.83	-10.3	0.053	0		3.953	3,743
Wall-6-SW-G-M	542	0.83	-10.3	0.057	0		4.275	2,316
Wall-7-NW-G-M	816	0.83	-16.1	0.053	0		3.953	3,225
Wall-8-NW-G-M	748	0.83	-16.1	0.057	0		4.275	3,198
Wall-9-NW-G-L	210	0.65	-22.1	1.000	0		75.000	15,750
Gls-NE-1-90-Tran	120.0	1.000	-34	0.560	0		36.750	4,410
0%S-0-NS-Solar	120.0	0.950	56	0.150	0			
Gls-SW-1-90-Tran	45.0	1.000	-34	0.560	0		36.750	1,654
0%S-0-NS-Solar	45.0	0.950	234	0.430	0			
Gls-SW-1-90-Tran	40.0	1.000	-34	0.560	0		36.750	1,470
0%S-0-NS-Solar	40.0	0.950	234	0.430	0			
Sub-total					0	0		52,830
Safety factors:					+0%	+0%		+10%
Total w/ safety factors:					0	0		58,113

Bell Design Group, LLC
P.O. Box 81795
Fairbanks, Alaska 99708
907-388-2603

JOB 1701 : KODIAK BOILER

SHEET NO. 1 OF

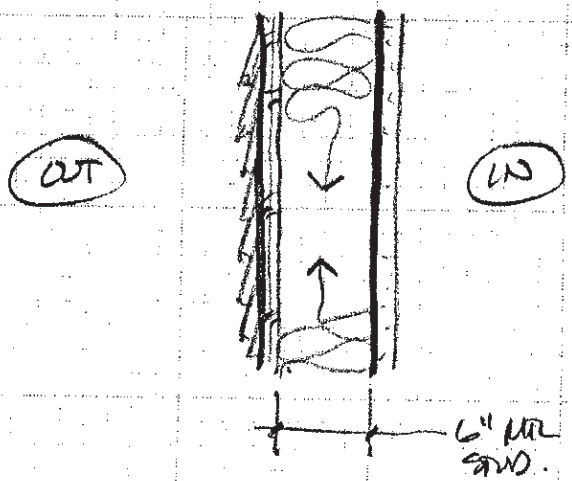
CALCULATED BY SWB DATE 9/20/10

CHECKED BY DATE

SCALE

HEAT LOSS CALCS

1. WALL R-VALUE (ABOVE GRADE)

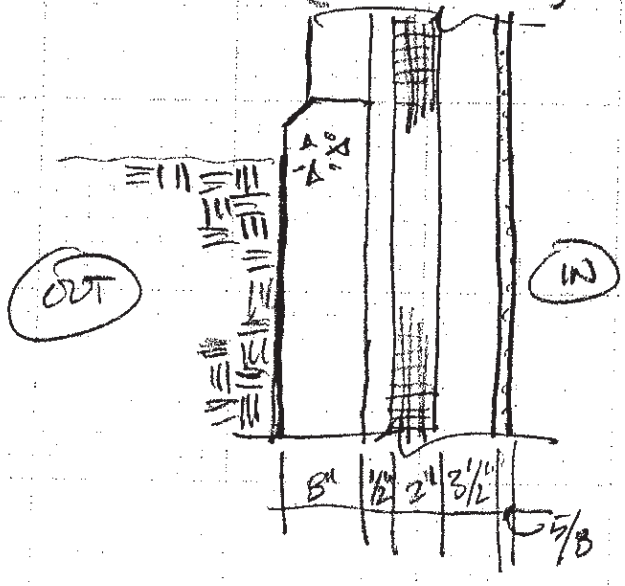


.85 TO ACCT FOR CONDUCTANCE THRU MTL STUDS

	R
O/S AIR FILM	0.17
SHIPLAP SIDING	0.81
BLDG PAPER	0
1/2" CDX PLY	0.62
6" MTL STDS + 6" F.G.	(R-12)(.85) = 16.1
VAPOR BARRIER	0 0
5/8" GWB	0.56
I/S AIR FILM	0.68
	18.99
	(19)

U = 0.0527

2. WALL R-VALUE (BELOW GRADE)



	R
⊛ SOIL	6.45
CC WALL (8") (R 1/FT) =	.67
1/2" AIR SPACE	2.25
2" FOAM	10.0
3 1/2" AIR SPACE	2.25
5/8" GWB	0.56
I/S AIR FILM	0.68
	22.86

U = 0.0437

⊛ SOIL:
3' BELOW GRADE (AVG) = 6.45

Bell Design Group, LLC
P.O. Box 81795
Fairbanks, Alaska 99708
907-388-2603

JOB 1701 - KODIAK BOILER

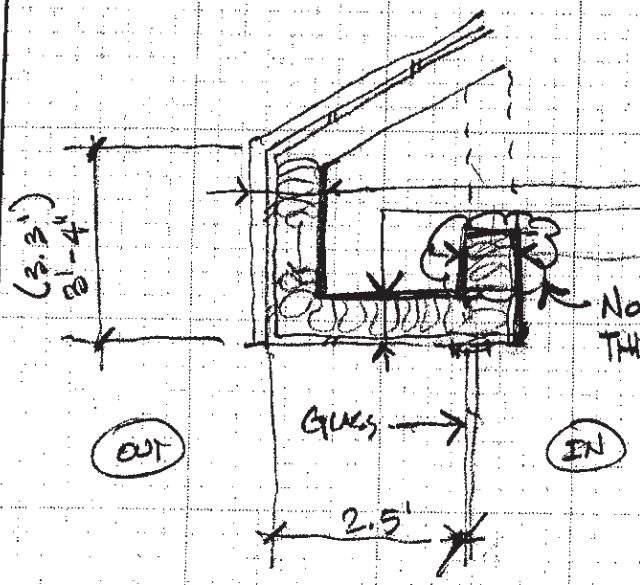
SHEET NO. 2 OF

CALCULATED BY SUB DATE 9/20/10

CHECKED BY DATE

SCALE

3. WALL #3 IS THE ROOF FASCIA SYSTEM



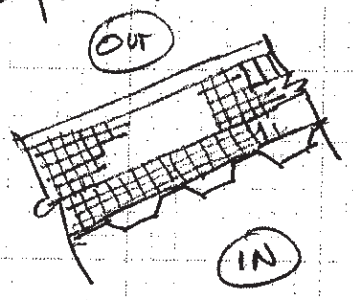
	R
O/S ASPHALT	0.17
1/2" PLY	0.62
6" MTL STUD	16.1
6" FG BATT'N	
I/S AIR FILM	
	Φ
	0.68

NO HEAT LOSS THRU THIS WALL SECTION.

R = 17.57
U = 0.057

(*) PER EACH LINEAR FOOT OF WALL THERE IS 2.5' + 3.3' + .5' = 6.3' SF OF WALL

4. ROOF SYSTEM



	R
STANDING SEAM MTL ROOF	Φ
5" FOAM (R-5/in)	25
MTL DECK	Φ
O/S AIR FILM	0.17
I/S AIR FILM	0.62
	25.79

U = 0.0388

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JOB 17101 KODIAK BOILER
SHEET NO. 3 OF
CALCULATED BY BNB DATE 9/20/10
CHECKED BY DATE
SCALE

5. DOUBLE-GLAZING (1991)
- ASSUME WOOD FRAMING ($\frac{U}{0.45}$) FIXED WINDOWS, 1/2" AIR SPACE FROM ASHRAE 2005 FUNDAMENTALS CHAPTER 31, TABLE 4: U=0.50

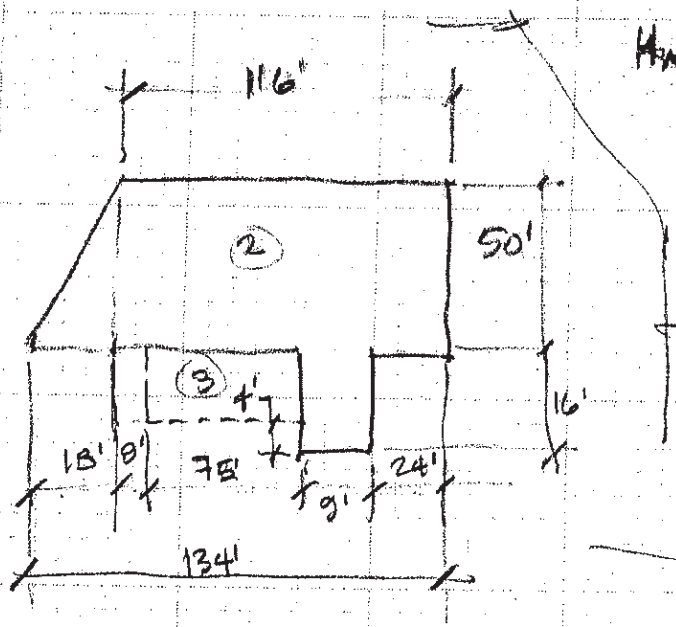
6. DOOR: (WALL #4): R=3.0, U=0.33

7. LOUVER: (WALL #5) R=1.0, U=1.0

ZONES

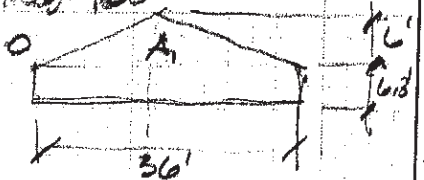
(1) 8' x 32', NO WINDOWS, SEE A4's FOR ELEVATIONS

(2) 50'



$A_1 = \frac{1}{2}(6 \times 36) = 108\ SF$

$H_{AVG} = \frac{108}{36} = 3.0$



~~$A_2 = (6.3 + 3.0 + 9.3')(96') =$~~

$AVG\ L = \frac{116 + 134}{2} = 125'$

- NO ROOF

(3) 12' x 75'
- SWING SLOPING ROOF
- (2) S. WINDOWS 3' x 5' (H)

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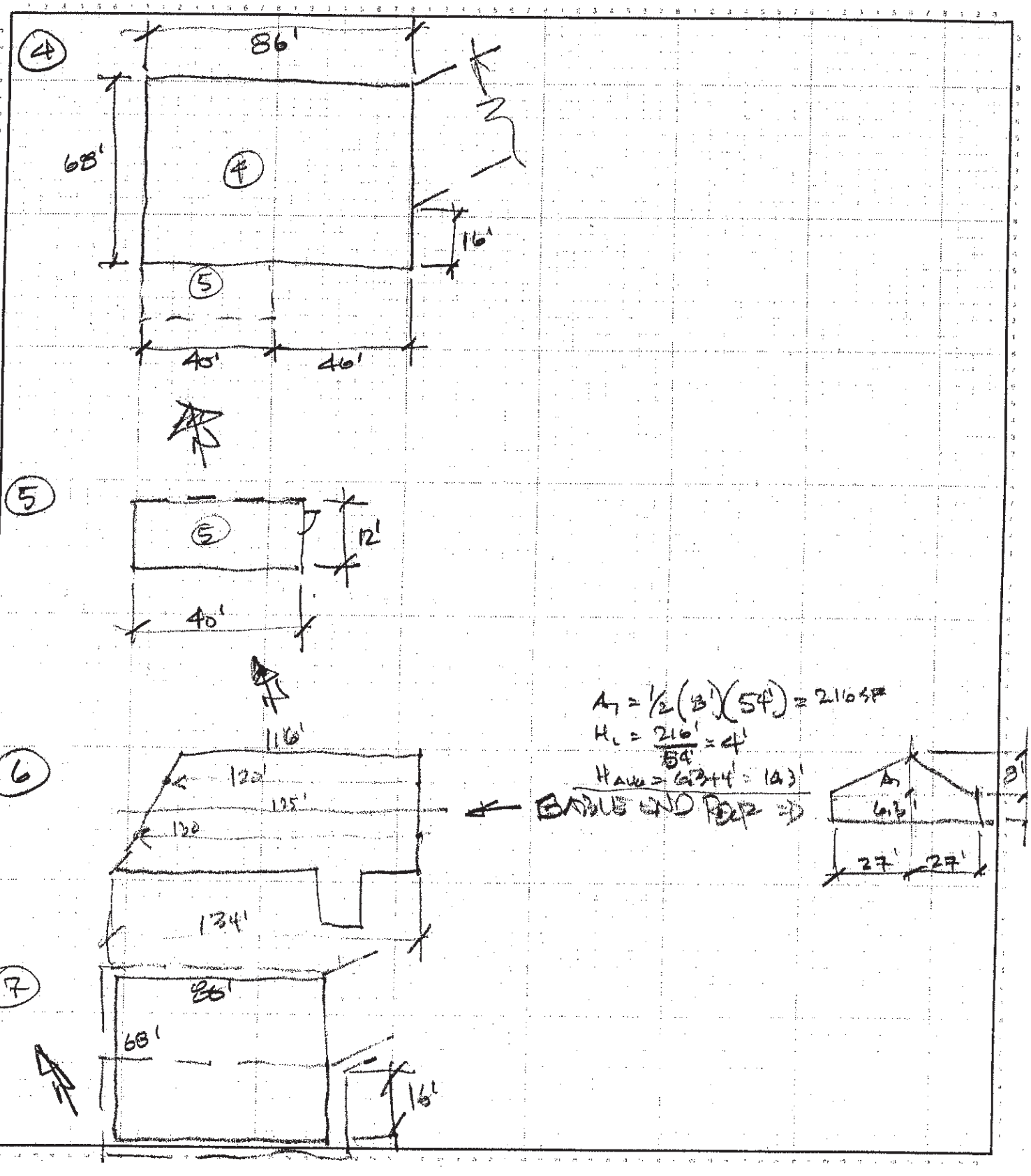
JOB 1705 KODIAK BLVD

SHEET NO. 4 OF

CALCULATED BY SVB DATE 9.20.10

CHECKED BY DATE

SCALE



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JOB 171.01 KODIAK BOILER
SHEET NO. 5 OF
CALCULATED BY [illegible] DATE 9/20/10
CHECKED BY DATE
SCALE

REVIEW MECH PLANS FOR VENTILATION

1991:

M29 → FD (&ES)
M30 130 (SCHEDULES)
M31 ART SCHEDULES

		CFM
AHU-1	BLOCK VENT	13,055
AHU-2	LABS VENT	10,720
AHU-3 (DELETED)		
AHU-4	PILOT PLANT MUA	10,000
EF. 7	PILOT PLANT E/A	10,000

> 100% O/A [AHU #2]

BLOCK E/A

		CFM
EF-1		800
EF-2		480
EF-6	KITCHEN GRILLE	1750
BLOCK RE		10,135
		13,165

	CFM
AHU-1 :	13,055
BLOCK E/A :	-13,165
	-110 CFM

Δ ≅ ∅ (< 1%)
ASSUME O/A = EF 1, 2, 6
= 3,030 CFM

LABS E/A

		CFM
EF. 3		3,560
EF. 5	PC AREA	1400
EF. 6	" "	1400
EF. 8	UTILITY ROOMS	670
EF. 9	" "	670
EF. 10	ELECT. RM	2000
EF. 11	STORES ROOM	900
		10,600

	CFM
AHU-2 :	10,520
LABS E/A :	-10,600
	-80

Δ ≅ ∅
ASSUME O/A = 100%

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JOB 171-01 Kodiak Boozer
SHEET NO. 6 OF
CALCULATED BY SNB DATE 9/20/10
CHECKED BY DATE
SCALE

BLDG AHU SYSTEM: AHU-1, EF-1,2,6, RE-1.

3,030 CFM O/A = 23.2%
13,055 CFM TOTAL

HC.1: 13,055 CFM @ 55° to 90° ⇒ Q = 1.1(13,055)(35°) = 502,618 BTUH

LAB VENT

HC.3 (O/A PHC): Q = 1.1 (10,520 CFM)(60°-12°) = 543,484 BTUH

BLDG + LAB VENT ⟶ 1,118,304 BTUH

ALT #2 PILOT PLT

HC.6 (PHC): Q = 1.1 (10000)(50°-13°) = 407,000 BTUH

HC.7 (HTG): Q = 1.1 (10,000)(95°-45°)/(85°-50°) = 385,000 BTUH

792,000 BTUH

TOTAL (DESIGN) O/A VENT RATE ⟶ 2,020,304 BTUH
(WITH PILOT PLANT)

FROM ELITE HEATING LOADS.
COND. LOSS = 105,331 BTUH / 25,832 SF = 4.1 / 7.6 BTUH/SF (a Reasonable Conduction Loss)
→ WITH 15% S.F. USE 166 MBH FOR DESIGN CASE

COND + BOILER VENT = 165 MBH + 502 MBH = 667 MBH / 25,832 SF = 26 BTUH/SF.
COND + BOILER VENT + LAB VENT = 667 MBH + 543 MBH = 1,210,000 BTUH / 25,832 SF = 47 BTUH/SF

COND + BOILER VENT + LAB VENT + PLT VENT = 1,210,000 BTUH + 792 MBH = 2,002 MBH / 25,832 = 76 / SF

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JOB 171.01 KODIAK FITC

SHEET NO. _____ OF _____

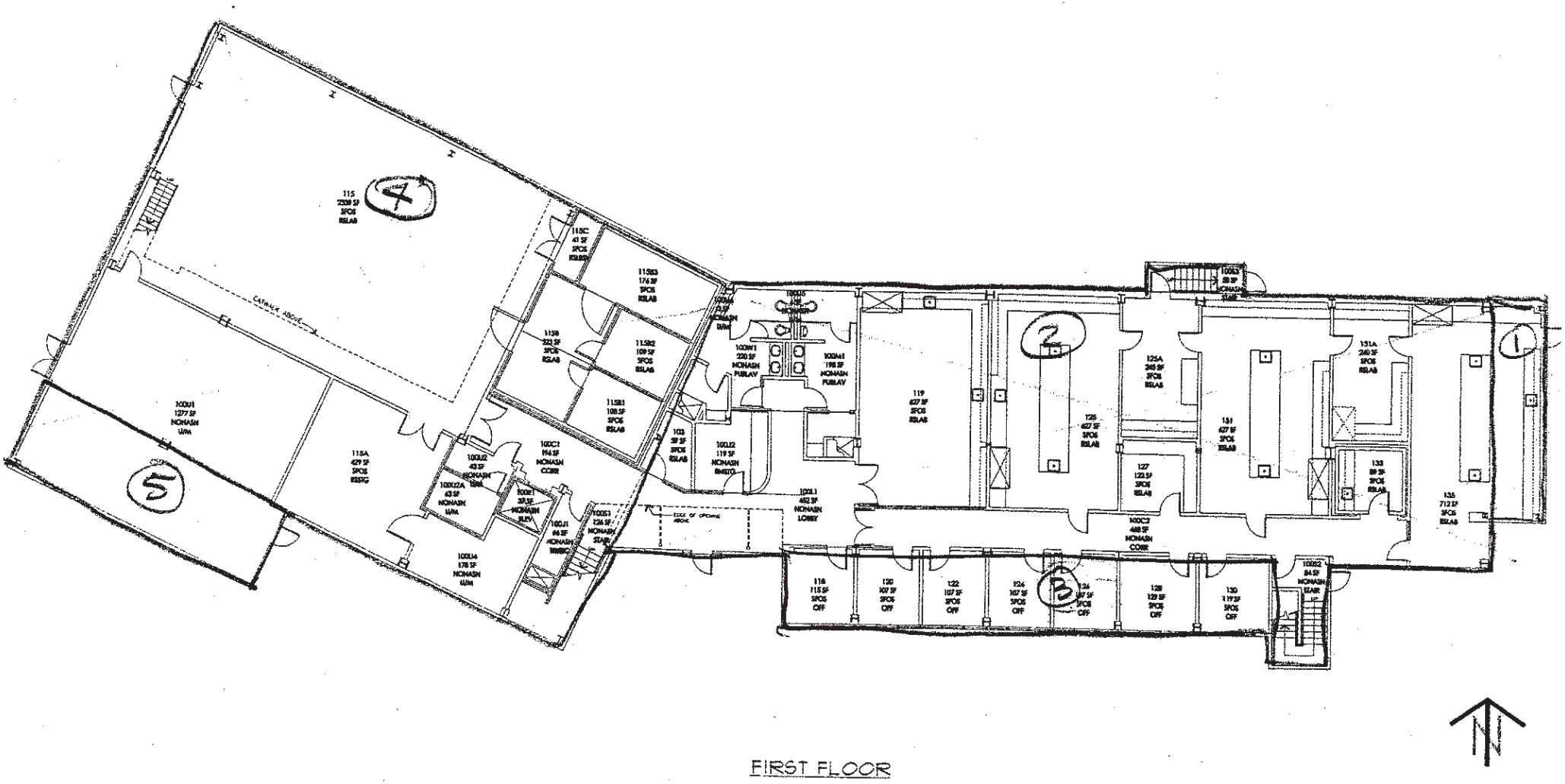
CALCULATED BY SWB DATE 10/4/10

CHECKED BY _____ DATE _____

SCALE _____

LAB VENT - CONVERSION TO VAV.

- REMOVE 2 P.C. ACID HOODS @ 1400 CFM EACH.
- REMAINING LAB E/A = 2,800 CFM FROM LABS. (PER 1991 DWG SCHD = 3,560 CFM)
  40% OF 2,800 CFM = 1,120 CFM MIN. VENT.
- CURRENT LAB MUA AHU-2 IS 19,520 CFM. (IT MUST PROVIDE MUA TO MORE THAN THE LABS.) W/ 4 PCA HOODS REMAINING, AHU-2 CHANGES TO 10,520 - 2,800 CFM = 7,720 CFM
  40% OF 10,520 CFM = 4,208 CFM
  40% OF 7,720 CFM = 3,088 CFM
- REBALANCE AHU-2 TO 7,720 CFM.
  REPLACE AHU-2 10 HP MOTOR WITH NEW 7.5HP
  ADD VFD TO NEW 7.5 HP MOTOR.
- REPLACE EF-3 (LABS) MOTOR (2 HP) WITH NEW 7.5 HP.
  ADD VFD TO NEW 2 HP MOTOR.
  KEEP EA @ 3,500 CFM AT THIS TIME. NEED SITE VISIT TO CONFIRM IF EA IS 3,560 OR 2300 CFM (EXISTING).


4
5
1
2
3
CATWALK ABOVE
EDGE OF OPENING ABOVE
115
2208 SF
SPOS
RSLAB
115A
429 SF
SPOS
RSTG
115B
41 SF
SPOS
RSLAB
115B3
176 SF
SPOS
RSLAB
115B2
109 SF
SPOS
RSLAB
115B1
108 SF
SPOS
RSLAB
115B
352 SF
SPOS
RSLAB
100U1
1277 SF
NONASN
UPA
100U2
43 SF
NONASN
UPA
100U2A
43 SF
NONASN
UPA
100U4
178 SF
NONASN
UPA
100C1
956 SF
NONASN
CORR
100E1
38 SF
NONASN
ELEV
100J1
66 SF
NONASN
STAIR
100S3
336 SF
NONASN
STAIR
100W1
220 SF
NONASN
PUBLAV
100M1
198 SF
NONASN
PUBLAV
100L2
119 SF
NONASN
JANITO
103
58 SF
SPOS
RSLAB
100L1
482 SF
NONASN
LOBBY
119
627 SF
SPOS
RSLAB
125
627 SF
SPOS
RSLAB
125A
245 SF
SPOS
RSLAB
127
123 SF
SPOS
RSLAB
100C2
448 SF
NONASN
CORR
131
627 SF
SPOS
RSLAB
131A
260 SF
SPOS
RSLAB
133
89 SF
SPOS
RSLAB
135
712 SF
SPOS
RSLAB
100S2
84 SF
NONASN
STAIR
116
115 SF
SPOS
OFF
120
107 SF
SPOS
OFF
122
107 SF
SPOS
OFF
124
107 SF
SPOS
OFF
126
107 SF
SPOS
OFF
128
139 SF
SPOS
OFF
130
119 SF
SPOS
OFF

FIRST FLOOR

Kodiak FITC Boiler Conversion Analysis
Kodiak, Alaska

Appendix D – Construction Costs and Payback Calculations

Kodiak Boiler Analysis

Building Area (SF)	25,832						
Design Heat Load Conditions	**Heat Loss (BtuH)**	**Density (BtuH/SF)**	**Running Tally (BtuH)**	**Density (BtuH/SF)**	**Heat Load as Percent of Boiler Output**	**UA factor**	**Remarks**
Conduction Heat Load (BtuH)	165,000	6.4	165,000	6.4	8.2%		Calculated using Elite CHVAC program (Zero F Winter Design)
Non-Lab Building Ventilation Heat Load (BtuH)	502,000	19.4	667,000	25.8	33.2%		Hand calculated from 1991 heating coil schedule information
Laboratory Ventilation Heat Load (BtuH)	543,000	21.0	1,210,000	46.8	60.2%		Hand calculated from 1991 heating coil schedule information
Pilot Plant Ventilation Heat Load (BtuH)	792,000	30.7	2,002,000	77.5	99.7%		Hand calculated from 1991 heating coil schedule information
	2,002,000	77.5					
The original Cleaver-Brook Boiler is still in use and it has a design output of 2,009 MBH.							

Construction Cost Estimate

Kodiak FITC Boiler Conversion Analysis

Option S1, Replace Steam Boiler with New, Smaller Boiler - Oil Fired: The current steam design load is 20 BHP at 60 PSI. This option removes the existing boiler and replaces with a fully-modulating fuel oil-fired boiler with a 3:1 turndown, manually controlled pressure set point (10 PSI to 60 PSI), and new, low-pressure deaerator.

				Materials		Labor			Total
Item	Description	Quantity	Units	Unit Cost	Total Cost	$/HR	Hour	Cost	Cost
1	Demo existing steam boiler	1	EA	$ 1,500	$ 1,500	$65	40	$2,600	$ 4,100
2	Demo existing steam piping	1	EA	$ 500	$ 500	$65	40	$2,600	$ 3,100
3	Demo existing deaerator	1	EA	$ 1,500	$ 1,500	$65	40	$2,600	$ 4,100
4	New 20 BHP steam boiler	1	EA	$ 30,000	$ 30,000	$65	160	$10,400	$ 40,400
5	Controls	1	EA	$ 10,000	$ 10,000	$65	40	$2,600	$ 12,600
6	New piping	150	LF	$ 10.00	$ 1,500	$65	1	$9,750	$ 11,250
7	New chimney connection	1	EA	$ 2,500	$ 2,500	$65	40	$2,600	$ 5,100
8	Electrical reconnections	1	LUMP	$ 10,000	$ 10,000	$65	80	$5,200	$ 15,200
9	Pipe Insulation	150	LF	$ 5.00	$ 750	$65	0.25	$2,438	$ 3,188
10	Mob/Demob/Overhead	1	EA	$ 20,000	$ 20,000	$65	200	$13,000	$ 33,000
11	Startup	1	EA	$ 5,000	$ 5,000	$65	120	$7,800	$ 12,800
	Subtotal				$ 83,250		761.25	$ 61,588	$ 144,838
	Administration	15%							$ 21,726
	Engineering	15%							$ 21,726
	Subtotal								$ 188,289
	Estimating Contingency	15%							$ 28,243
	Total Construction Cost Estimate								**$ 216,532**

Simple Payback Analysis

Construction Cost	$ 216,532
Annual Energy Cost Savings	$ 17,671
Simple Payback (years)	12.25

Construction Cost Estimate

Kodiak FITC Boiler Conversion Analysis

Option S2, Replace Steam Boiler with New, Smaller Boiler - Electric Fired: The current steam design load is 20 BHP at 60 PSI. This option removes the existing boiler and replaces with a multi-stage, electric boiler with a 10:1 turndown, and new condensate return system, both located in the boiler room.

				Materials		Labor			Total
Item	Description	Quantity	Units	Unit Cost	Total Cost	$/HR	Hour	Cost	Cost
1	Demo existing steam boiler	1	EA	$ 8,000	$ 8,000	$65	100	$6,500	$ 14,500
2	Demo existing steam piping	1	EA	$ 2,500	$ 2,500	$65	60	$3,900	$ 6,400
3	Demo existing deaerator	1	EA	$ 3,500	$ 3,500	$65	80	$5,200	$ 8,700
4	New 20 BHP steam boiler - elect	1	EA	$ 33,000	$ 33,000	$65	68	$4,420	$ 37,420
5	Controls	1	EA	$ 10,000	$ 10,000	$65	24	$1,560	$ 11,560
6	New piping	80	LF	$ 10.00	$ 800	$65	1	$5,200	$ 6,000
7	Blank off chimney connection	1	EA	$ 1,500	$ 1,500	$65	24	$1,560	$ 3,060
8	New Condensate Return System	1	EA	$ 12,000	$ 12,000	$65	40	$2,600	$ 14,600
9	Electrical reconnections	1	LUMP	$ 20,000	$ 20,000	$65	140	$9,100	$ 29,100
10	Pipe Insulation	150	LF	$ 5.00	$ 750	$65	0.25	$2,438	$ 3,188
11	Mob/Demob/Overhead	1	EA	$ 20,000	$ 20,000	$65	200	$13,000	$ 33,000
12	Startup	1	EA	$ 500	$ 500	$65	16	$1,040	$ 1,540
	Subtotal				$112,550		753.25	$ 56,518	$ 169,068
	Administration	15%							$ 25,360
	Engineering	15%							$ 25,360
	Subtotal								$ 219,788
	Estimating Contingency	15%							$ 32,968
	Total Construction Cost Estimate								**$ 252,756**

Simple Payback Analysis

Construction Cost	$ 252,756
Annual Energy Cost Savings	$ 15,076
Simple Payback (years)	16.77

Construction Cost Estimate

Kodiak FITC Boiler Conversion Analysis

Option S3, Replace Steam Boiler with New, Smaller Boiler - Electric Fired in Pilot Plant: The current steam design load is 20 BHP at 60 PSI. This option removes the existing boiler and replaces with a multi-stage electric boiler with a 10:1 turndown, and new condensate return system, both located in the Pilot Plant.

				Materials		Labor			Total
Item	Description	Quantity	Units	Unit Cost	Total Cost	$/HR	Hour	Cost	Cost
1	Demo existing steam boiler	1	EA	$ 8,000	$ 8,000	$65	100	$6,500	$ 14,500
2	Demo existing steam piping	1	EA	$ 6,000	$ 6,000	$65	120	$7,800	$ 13,800
3	Demo existing deaerator	1	EA	$ 3,500	$ 3,500	$65	80	$5,200	$ 8,700
4	New 20 BHP steam boiler - elect	1	EA	$ 33,000	$ 33,000	$65	68	$4,420	$ 37,420
5	Controls	1	EA	$ 10,000	$ 10,000	$65	24	$1,560	$ 11,560
6	New piping	80	LF	$ 10.00	$ 800	$65	1	$5,200	$ 6,000
7	Blank off chimney connection	1	EA	$ 1,500	$ 1,500	$65	24	$1,560	$ 3,060
8	New Condensate Return System	1	EA	$ 12,000	$ 12,000	$65	40	$2,600	$ 14,600
9	Electrical reconnections	1	LUMP	$ 20,000	$ 20,000	$65	140	$9,100	$ 29,100
10	Pipe Insulation	150	LF	$ 5.00	$ 750	$65	0.25	$2,438	$ 3,188
11	Mob/Demob/Overhead	1	EA	$ 20,000	$ 20,000	$65	200	$13,000	$ 33,000
12	Startup	1	EA	$ 500	$ 500	$65	16	$1,040	$ 1,540
	Subtotal				$116,050		813.25	$ 60,418	$ 176,468
	Administration	15%							$ 26,470
	Engineering	15%							$ 26,470
	Subtotal								$ 229,408
	Estimating Contingency	15%							$ 34,411
	Total Construction Cost Estimate								**$ 263,819**

Simple Payback Analysis	
Construction Cost	$ 263,819
Annual Energy Cost Savings	$ 33,623
Simple Payback (years)	7.85

Construction Cost Estimate

Kodiak FITC Boiler Conversion Analysis

Option H1, Replace Hydronic Boiler with Three Smaller Boilers - Oil-Fired: The current steam design load is 60 BHP (2,000 MBH) at 30 PSI. This option removes the existing boiler and replaces it with three, 20 BHP, oil-fired boilers; each with a 3:1 turndown burner.

				Materials		Labor			Total	
Item	Description	Quantity	Units	Unit Cost	Total Cost	$/HR	Hour	Cost	Cost	
1	Demo existing hydronic boiler	1	EA	$ 1,500	$ 1,500	$65	40	$2,600	$ 4,100	
2	Demo existing hydronic piping	1	EA	$ 500	$ 500	$65	40	$2,600	$ 3,100	
3	Demo existing blr circ pump	1	EA	$ 1,500	$ 1,500	$65	40	$2,600	$ 4,100	
4	New 20 BHP hydronic boiler	3	EA	$ 20,000	$ 60,000	$65	80	$15,600	$ 75,600	ESTIMATED
5	Controls	1	EA	$ 3,000	$ 3,000	$65	24	$1,560	$ 4,560	
6	New piping	200	LF	$ 10.00	$ 2,000	$65	1	$13,000	$ 15,000	
7	New chimney manifold	1	EA	$ 4,500	$ 4,500	$65	60	$3,900	$ 8,400	
8	New boiler circ pump	3	EA	$ 2,500	$ 7,500	$65	40	$7,800	$ 15,300	ESTIMATED
9	Electrical connections	1	LUMP	$ 10,000	$ 10,000	$65	40	$2,600	$ 12,600	
10	Pipe Insulation	200	LF	$ 5.00	$ 1,000	$65	0.25	$3,250	$ 4,250	
11	Mob/Demob/Overhead	1	EA	$ 20,000	$ 20,000	$65	200	$13,000	$ 33,000	
12	Startup	1	EA	$ 5,000	$ 5,000	$65	120	$7,800	$ 12,800	
	Subtotal				$ 116,500		685.25	$ 76,310	$ 192,810	
	Administration	15%							$ 28,922	
	Engineering	15%							$ 28,922	
	Subtotal								$ 250,653	
	Estimating Contingency	15%							$ 37,598	
	Total Construction Cost Estimate								**$ 288,251**	

Simple Payback Analysis

Construction Cost	$ 288,251
Annual Energy Cost Savings	$ 11,911
Simple Payback (years)	24.20

Construction Cost Estimate

Kodiak FITC Boiler Conversion Analysis

Option H2, Replace Hydronic Boiler with Two Smaller Boilers - Oil-Fired: The current steam design load is 60 BHP (2,000 MBH) at 30 PSI. This option removes the existing boiler and replaces it with two oil-fired boilers. One will be 20 BHP and one will be 40 BHP; each with a 3:1 turndown burner.

				Materials		Labor			Total	
Item	Description	Quantity	Units	Unit Cost	Total Cost	$/HR	Hour	Cost	Cost	
1	Demo existing hydronic boiler	1	EA	$ 1,500	$ 1,500	$65	40	$2,600	$ 4,100	
2	Demo existing hydronic piping	1	EA	$ 500	$ 500	$65	40	$2,600	$ 3,100	
3	Demo existing blr circ pump	1	EA	$ 1,500	$ 1,500	$65	40	$2,600	$ 4,100	
4	New 30 BHP hydronic boiler	2	EA	$ 26,000	$ 52,000	$65	90	$11,700	$ 63,700	ESTIMATED
5	Controls	1	EA	$ 3,000	$ 3,000	$65	24	$1,560	$ 4,560	
6	New piping	200	LF	$ 10.00	$ 2,000	$65	1	$13,000	$ 15,000	
7	New chimney manifold	1	EA	$ 3,500	$ 3,500	$65	48	$3,120	$ 6,620	
8	New boiler circ pump	2	EA	$ 3,500	$ 7,000	$65	32	$4,160	$ 11,160	ESTIMATED
9	Electrical connections	1	LUMP	$ 10,000	$ 10,000	$65	40	$2,600	$ 12,600	
10	Pipe Insulation	200	LF	$ 5.00	$ 1,000	$65	0.25	$3,250	$ 4,250	
11	Mob/Demob/Overhead	1	EA	$ 20,000	$ 20,000	$65	200	$13,000	$ 33,000	
12	Startup	1	EA	$ 5,000	$ 5,000	$65	40	$2,600	$ 7,600	
	Subtotal	15%			$ 107,000		595.25	$ 62,790	$ 169,790	
	Administration	15%							$ 25,469	
	Engineering	15%							$ 25,469	
	Subtotal								$ 220,727	
	Estimating Contingency	15%							$ 33,109	
	Total Construction Cost Estimate								**$ 253,836**	

Simple Payback Analysis

Construction Cost	$ 253,836
Annual Energy Cost Savings	$ 11,911
Simple Payback (years)	21.31

Construction Cost Estimate

Kodiak FITC Boiler Conversion Analysis

Option H3, Convert existing laboratory ventilation system from constant volume to variable air volume (VAV) system. Current design airflow rate is 10,520 CFM. Two perchloric acid hoods will also be removed. New SA airflow rate to be 7,720 CFM. EF-3 stays at 3,560 CFM.

Item	Description	Quantity	Units	Materials		Labor			Total Cost
				Unit Cost	Total Cost	$/HR	Hour	Cost	
1	Remove fume hoods	5	EA	$ 500	$ 2,500	$65	8	$2,600	$ 5,100
2	Remove PAH ducts and fans	2	EA	$ 500	$ 1,000	$65	16	$2,080	$ 3,080
3	Provide new VAV fume hoods	5	EA	$ 2,000	$ 10,000	$65	16	$5,200	$ 15,200
4	AHU-2: Install new 7.5 HP motor.	1	EA	$ 4,000	$ 4,000	$65	24	$1,560	$ 5,560
5	AHU-2: Install new 7.5 HP VFD.	1	EA	$ 2,500	$ 2,500	$65	24	$1,560	$ 4,060
6	Replace EF-3 with 3 HP + VFD	1	EA	$ 2,000	$ 2,000	$65	18	$1,170	$ 3,170
7	Modify EA ductwork	60	LF	$ 10	$ 600	$65	4	$15,600	$ 16,200
8	Balance system	1	LUMP	$ 500	$ 500	$65	120	$7,800	$ 8,300
9	Lab SA duct damper	7	EA	$ 1,000	$ 7,000	$65	8	$3,640	$ 10,640
10	Lab EA duct damper	7	EA	$ 2,500	$ 17,500	$65	16	$7,280	$ 24,780
11	Lab Ventilation Controls	12	EA	$ 2,000	$ 24,000	$65	8	$6,240	$ 30,240
12	Electrical connections	1	LUMP	$ 8,500	$ 8,500	$65	80	$5,200	$ 13,700
13	Mob/Demob/Overhead	1	EA	$ 10,000	$ 10,000	$65	120	$7,800	$ 17,800
14			EA		$ -	$65		$0	$ -
	Subtotal	15%			$ 86,600		438	$ 63,050	$ 149,650
	Administration	15%							$ 22,448
	Engineering	15%							$ 22,448
	Subtotal								$ 194,545
	Estimating Contingency	15%							$ 29,182
	Total Construction Cost Estimate								**$ 223,727**

Simple Payback Analysis

Construction Cost	$ 223,727
Annual Energy Cost Savings	$ 23,930
Simple Payback (years)	9.35

Boiler Efficiency Comparison

Kodiak FITC Boiler Conversion - Steam Boilers

		Heating Load (PPH)	Steam Pressure (PSIG)	Fuel Type	Boiler Efficiency	Short Cycling Factor	Fuel Input (GPH)	Hours/ Day	Days/ Year	GPY	$/Gal	$/Year	Annual Savings ($)
Existing	Standby mode (Low Fire)	125	85	No.2 Oil	72%	75%	1.49	24	329	11,732	$ 3.78	$ 44,347	
	Steam Retort (32 PSIG)	466	60	No.2 Oil	72%	75%	5.61	8	10	449	$ 3.78	$ 1,696	
	Steam Kettle (25 PSIG)	375	60	No.2 Oil	72%	75%	4.51	8	13	469	$ 3.78	$ 1,774	
												$ 47,817	Existing
Option S1	Standby mode (3:1 TD ratio)	100	15	No.2 Oil	82%	90%	0.93	24	329	7,339	$ 3.78	$ 27,741	
	Steam Retort (32 PSIG)	466	60	No.2 Oil	82%	95%	3.89	8	10	311	$ 3.78	$ 1,176	
	Steam Kettle (25 PSIG)	375	60	No.2 Oil	82%	95%	3.13	8	13	325	$ 3.78	$ 1,230	
												$ 30,146	$ 17,671
							Fuel Input (KW)			KWH/YR	$/KWH		
Option S2	Standby mode (10:1 TD ratio)	50	15	Electricity	99%	99%	13.29	24	342	109,101	$ 0.17	$ 18,547	
	Steam Retort (32 PSIG)	466	60	No.2 Oil	99%	99%	125.41	8	10	10,033	$ 0.17	$ 1,706	
	Steam Kettle (25 PSIG)	375	60	No.2 Oil	99%	99%	100.92	8	13	10,496	$ 0.17	$ 1,784	
												$ 22,037	
	Demand Charge based on worst case of 157 KVA, and $5.67/KW. Equivalent to $892 per month, $10,704 per year.											$ 10,704	$ 15,076
							Fuel Input (KW)			KWH/YR	$/KWH		
Option S3	Standby mode (10:1 TD ratio)	0	15	Electricity	99%	99%	0.00	0	0	0	$ 0.17	$ -	
(POU Elec)	Steam Retort (32 PSIG)	466	60	No.2 Oil	99%	99%	125.41	8	10	10,033	$ 0.17	$ 1,706	
	Steam Kettle (25 PSIG)	375	60	No.2 Oil	99%	99%	100.92	8	13	10,496	$ 0.17	$ 1,784	
												$ 3,490	
	Demand Charge based on worst case of 157 KVA, and $5.67/KW. Equivalent to $892 per month, $10,704 per year.											$ 10,704	$ 33,623
Option S4	Standby mode (5:1 TD ratio)	100	15	Propane	98%	95%	1.12	24	329	8,818	$ 4.86	$ 42,856	
	Steam Retort (32 PSIG)	466	60	Propane	87%	97%	3.59	8	10	287	$ 4.86	$ 1,395	
	Steam Kettle (25 PSIG)	375	60	Propane	87%	97%	2.89	8	13	300	$ 4.86	$ 1,459	
												$ 45,711	$ 2,106

	15%	Propane	Electricity	
Fuel Heating Value (Btu/Gallon)	138,500	91,370	3,412	(Btu/KW)
Cost in Kodiak	$ 3.78	$ 4.86	$ 0.17	

Kodiak FITC Boiler Conversion Analysis
Kodiak, Alaska

Appendix E – Product Data Sheets

FULTON ELECTRIC BOILER

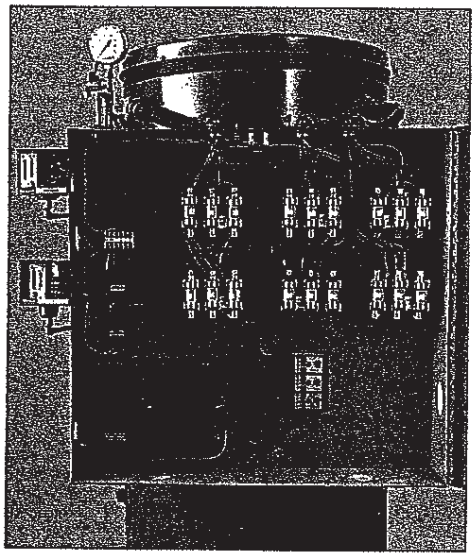
Specifications

Model FB-L		012	015	018	024	030	036	050	075	100	150	200	300	500	750	1000
Number of Elements		1	1	1	2	2	2	2	3	4	6	4	4	7	10	14
Output	1000 BTU/HR	41	51	61	82	102	123	171	256	341	512	683	1025	1708	2561	3416
	1000 KCAL/HR	10	13	15	21	26	31	43	64	86	129	172	258	430	645	860
Steam Output**	LB/HR	40	50	60	81	101	121	169	252	336	505	674	1011	1684	2526	3368
	KG/HR	18	23	27	37	46	55	77	115	153	230	306	460	765	1148	1530
Approx. Shipping Weight	LB	420	420	420	440	450	450	580	850	970	1225	1380	1440	1850	2150	2300
	KG	191	191	191	200	204	204	263	386	440	556	623	655	839	977	1043
Water Capacity	GALLONS	7	7	7	7	7	7	13	39	39	50	79	115	195	270	360
	LITERS	26	26	26	26	26	26	49	148	148	189	299	435	738	1022	1362
Boiler Connection Sizes																
Steam Outlet 15 PSI	IN	.75	.75	.75	.75	.75	.75	1	1.5	1.5	2	3	3	4	4	6
	MM	19	19	19	19	19	19	25	38	38	51	76	76	100	100	150
Steam Outlet 16-300 PSI	IN	75	.75	.75	.75	.75	.75	.75	1	1	1.25	1.5	2	3	3	3
	MM	19	19	19	19	19	19	19	25	25	32	38	51	76	76	76
Feedwater Inlet	IN	.75	.75	.75	.75	.75	.75	.75	1	1	1	1	1	1	1	1.25
	MM	19	19	19	19	19	19	19	25	25	25	25	25	25	25	32
Blowdown Outlet	IN	1	1	1	1	1	1	1	1	1	1	1.25	1.25	1.5	1.5	2
	MM	25	25	25	25	25	25	25	25	25	25	32	32	38	38	51
Water Col. Blowdown Outlet	IN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	.75	.75	.75	75
	MM	–	–	–	–	–	–	–	–	–	–	–	19	19	19	19
Sight Glass Blowdown Outlet	IN	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25
	MM	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Safety Valve 15 PSI	IN	.75	.75	.75	.75	.75	.75	1	1	1	1.25	1.50	1.5	1.5	2	2.5
	MM	19	19	19	19	19	19	25	25	25	32	38	38	38	51	64
Safety Valve 16-300 PSI	IN	.50	.50	.50	.50	.50	.50	.75	.75	.75	.75	1	1	1.25	1.5	2
	MM	13	13	13	13	13	13	19	19	19	19	25	25	32	38	51
Electrical Power Requirements (In Amps)																
208V 3 Phase		34	42	50	67	84	100	139	208	278	416	556	832	*	*	*
230V 1 Phase		52	65	78	–	–	–	–	–	–	–	–	–	–	–	–
230V 3 Phase		30	35	46	60	76	92	126	188	252	378	512	756	*	*	*
460V 3Phase		15	19	23	30	38	46	63	94	126	189	256	378	630	941	1260
575V 3 Phase		13	16	18	24	30	36	50	76	101	150	201	301	502	756	1004

Dimensions are approximate. We reserve the right to change specifications.
Voltage applied higher than above ratings will result in higher amp draws.

Probe liquid level control is standard on all units.
Optional Water Level Controls
Watts 142-5
McDonnell Miller 53-2
McDonnell Miller 157 - 157M

Notes:
–Indicates not available.
* Indicates voltages available at special request.
**Steam output ratings, at 180°F (82°C) feedwater temperature,(0 PSIG).



Standard Electrical Control Panel Components

- Low Water Relay
- Water Level Relay
- High Limit Pressure Control Switch w/manual reset
- Operating Pressure Control Element Contactor(s) Switch
- Pump Starter (1 phase)
- Power Switch
- Power Lamp
- Element Energized Lamp
- CSD-1 Low Water Relay With Manual Reset (75 kW-1000kW)

Models FB-L 100 to FB-L 1000 include a step sequencer.

Dimensions

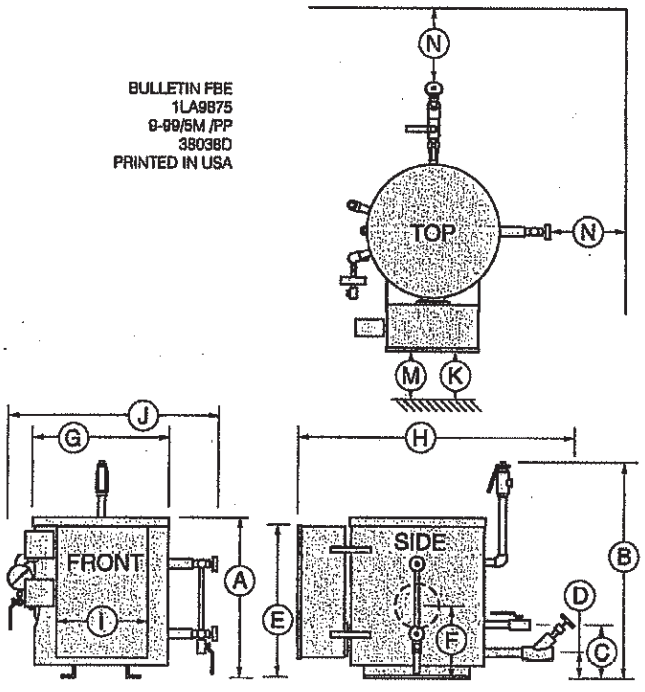
Model FB-L		012	015	018	024	030	036	050	075	100	150	200	300	500	750	1000
Unit Size:	kW	12	15	18	24	30	36	50	75	100	150	200	300	500	750	1000
	HP	1.2	1.5	1.8	2.4	3.0	3.5	5.0	7.5	10	15	20	30	50	75	100
Height																
(A) Boiler Overall	IN	24	24	24	24	24	24	55	55	55	55	55	75	75	75	75
	MM	610	610	610	610	610	610	1397	1397	1397	1397	1397	1905	1905	1905	1905
(B) Boiler w/Piping	IN	30	30	30	30	30	30	65	65	65	65	71	80	80	80	80
	MM	762	762	762	762	762	762	1651	1651	1651	1651	1803	2032	2032	2032	2032
(C) Feedwater Inlet	IN	8	8	8	8	8	8	16	16	16	16	16	24	24	24	24
	MM	203	203	203	203	203	203	406	406	406	406	406	610	610	610	610
(D) Blowdown Outlet	IN	4	4	4	4	4	4	6	6	6	6	6	6.5	6.5	6.5	6.5
	MM	102	102	102	102	102	102	152	152	152	152	152	165	165	165	165
(E) Electric Control Box	IN	20.5	20.5	20.5	20.5	20.5	20.5	50	50	50	50	48	64	64	64	64
	MM	521	521	521	521	521	521	1270	1270	1270	1270	1219	1626	1626	1626	1626
(F) Hand Hole	IN	11	11	11	11	11	11	38	38	38	38	38	55	55	55	55
	MM	279	279	279	279	279	279	965	965	965	965	965	1397	1397	1397	1397
Width & Depth																
(G) Boiler Only	IN	20	20	20	20	20	20	17	24	24	28	32	36	44	50	63
	MM	508	508	508	508	508	508	432	610	610	711	813	914	1118	1270	1600
(H) Overall Depth Electric	IN	30	30	30	30	30	30	35	35	35	39	46	46	56	62	83
Panel to Blowdown	MM	762	762	762	762	762	762	899	899	899	991	1168	1168	1442	1575	2108
(I) Electric Panel Width	IN	14	14	14	14	14	14	17	17	32	32	40	52	64	64	64
	MM	356	356	356	356	356	356	432	432	813	813	1016	1321	1626	1626	1626
(J) Boiler Width Overall	IN	33	33	33	33	33	33	35	42	42	46	52	56	64	72	91
	MM	838	838	838	838	838	838	889	1067	1067	1168	1321	1422	1625	1829	2311
Minimum Clearances																
(K) Horizontal	IN	14	14	14	14	14	14	–	–	–	–	–	–	–	–	–
to remove elements	MM	356	356	356	356	356	356	–	–	–	–	–	–	–	–	–
(L) Floor to Ceiling	IN	–	–	–	–	–	–	95	95	95	95	95	139	139	139	139
to remove elements	MM	–	–	–	–	–	–	2413	2413	2413	2413	2413	3531	3531	3531	3531
(M) Front of Boiler	IN	24	24	24	24	24	24	24	32	32	32	34	34	36	36	36
	MM	610	610	610	610	610	610	610	813	813	813	864	864	914	914	914
(N) Sides & Rear of Boiler	IN	12	12	12	12	12	12	12	12	12	12	24	24	24	24	24
	MM	305	305	305	305	305	305	305	305	305	305	610	610	610	610	610

Dimensions are approximate. We reserve the right to change specifications.
–Indicates not available.
Panel Box size may change depending on voltage.

BULLETIN FBE
1LA9875
9-99/5M /PP
38038D
PRINTED IN USA

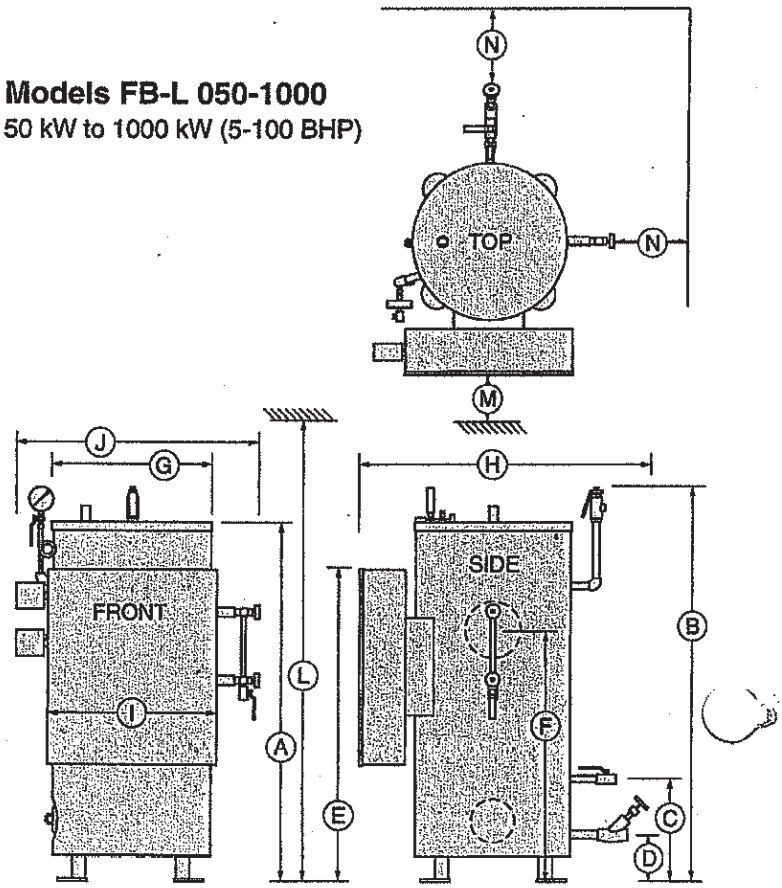
Models FB-L 012-036

12 to 36 kW (1.2 to 3.6 BHP)



Models FB-L 050-1000

50 kW to 1000 kW (5-100 BHP)



FULTON ELECTRIC BOILER

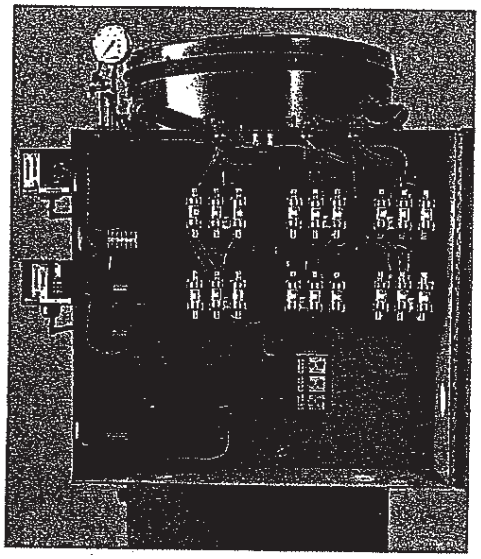
Specifications

Model FB-L		012	015	018	024	030	036	050	075	100	150	200	300	500	750	1000
Number of Elements		1	1	1	2	2	2	2	3	4	6	4	4	7	10	14
Output	1000 BTU/HR	41	51	61	82	102	123	171	256	341	512	683	1025	1708	2561	3416
	1000 KCAL/HR	10	13	15	21	26	31	43	64	86	129	172	258	430	645	860
Steam Output**	LB/HR	40	50	60	81	101	121	169	252	336	505	674	1011	1684	2526	3368
	KG/HR	18	23	27	37	46	55	77	115	153	230	306	460	765	1148	1530
Approx. Shipping Weight	LB	420	420	420	440	450	450	580	850	970	1225	1380	1440	1850	2150	2300
	KG	191	191	191	200	204	204	263	386	440	556	623	655	839	977	1043
Water Capacity	GALLONS	7	7	7	7	7	7	13	39	39	50	79	115	195	270	360
	LITERS	26	26	26	26	26	26	49	148	148	189	299	435	738	1022	1362
Boiler Connection Sizes																
Steam Outlet 15 PSI	IN	.75	.75	.75	.75	.75	.75	1	1.5	1.5	2	3	3	4	4	6
	MM	19	19	19	19	19	19	25	38	38	51	76	76	100	100	150
Steam Outlet 16-300 PSI	IN	75	.75	.75	.75	.75	.75	.75	1	1	1.25	1.5	2	3	3	3
	MM	19	19	19	19	19	19	19	25	25	32	38	51	76	76	76
Feedwater Inlet	IN	.75	.75	.75	.75	.75	.75	.75	1	1	1	1	1	1	1	1.25
	MM	19	19	19	19	19	19	19	25	25	25	25	25	25	25	32
Blowdown Outlet	IN	1	1	1	1	1	1	1	1	1	1	1.25	1.25	1.5	1.5	2
	MM	25	25	25	25	25	25	25	25	25	25	32	32	38	38	51
Water Col. Blowdown Outlet	IN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	.75	.75	.75	75
	MM	–	–	–	–	–	–	–	–	–	–	–	19	19	19	19
Sight Glass Blowdown Outlet	IN	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25
	MM	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Safety Valve 15 PSI	IN	.75	.75	.75	.75	.75	.75	1	1	1	1.25	1.50	1.5	1.5	2	2.5
	MM	19	19	19	19	19	19	25	25	25	32	38	38	38	51	64
Safety Valve 16-300 PSI	IN	.50	.50	.50	.50	.50	.50	.75	.75	.75	.75	1	1	1.25	1.5	2
	MM	13	13	13	13	13	13	19	19	19	19	25	25	32	38	51
Electrical Power Requirements (In Amps)																
208V 3 Phase		34	42	50	67	84	100	139	208	278	416	556	832	*	*	*
230V 1 Phase		52	65	78	–	–	–	–	–	–	–	–	–	–	–	–
230V 3 Phase		30	35	46	60	76	92	126	188	252	378	512	756	*	*	*
460V 3Phase		15	19	23	30	38	46	63	94	126	189	256	378	630	941	1260
575V 3 Phase		13	16	18	24	30	36	50	76	101	150	201	301	502	756	1004

Dimensions are approximate. We reserve the right to change specifications.
Voltage applied higher than above ratings will result in higher amp draws.

Probe liquid level control is standard on all units.
Optional Water Level Controls
Watts 142-5
McDonnell Miller 53-2
McDonnell Miller 157 - 157M

Notes:
–Indicates not available.
* Indicates voltages available at special request.
**Steam output ratings, at 180°F (82°C) feedwater temperature,(0 PSIG).



Standard Electrical Control Panel Components

- Low Water Relay
- Water Level Relay
- High Limit Pressure Control Switch w/manual reset
- Operating Pressure Control Element Contactor(s) Switch
- Pump Starter (1 phase)
- Power Switch
- Power Lamp
- Element Energized Lamp
- CSD-1 Low Water Relay With Manual Reset (75 kW-1000kW) Models FB-L 100 to FB-L 1000 include a step sequencer.

Dimensions

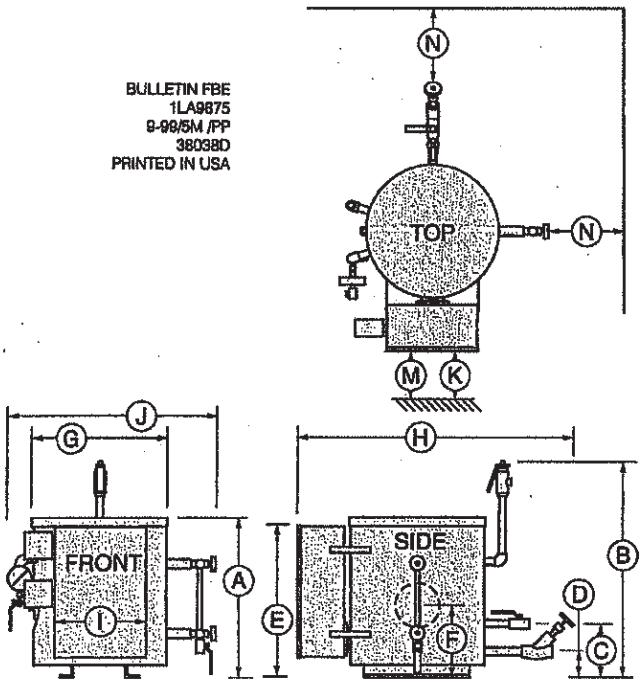
Model FB-L		012	015	018	024	030	036	050	075	100	150	200	300	500	750	1000
Unit Size:	kW	12	15	18	24	30	36	50	75	100	150	200	300	500	750	1000
	HP	1.2	1.5	1.8	2.4	3.0	3.5	5.0	7.5	10	15	20	30	50	75	100
Height																
(A) Boiler Overall	IN	24	24	24	24	24	24	55	55	55	55	55	75	75	75	75
	MM	610	610	610	610	610	610	1397	1397	1397	1397	1397	1905	1905	1905	1905
(B) Boiler w/Piping	IN	30	30	30	30	30	30	65	65	65	65	71	80	80	80	80
	MM	762	762	762	762	762	762	1651	1651	1651	1651	1803	2032	2032	2032	2032
(C) Feedwater Inlet	IN	8	8	8	8	8	8	16	16	16	16	16	24	24	24	24
	MM	203	203	203	203	203	203	406	406	406	406	406	610	610	610	610
(D) Blowdown Outlet	IN	4	4	4	4	4	4	6	6	6	6	6	6.5	6.5	6.5	6.5
	MM	102	102	102	102	102	102	152	152	152	152	152	165	165	165	165
(E) Electric Control Box	IN	20.5	20.5	20.5	20.5	20.5	20.5	50	50	50	50	48	64	64	64	64
	MM	521	521	521	521	521	521	1270	1270	1270	1270	1219	1626	1626	1626	1626
(F) Hand Hole	IN	11	11	11	11	11	11	38	38	38	38	38	55	55	55	55
	MM	279	279	279	279	279	279	965	965	965	965	965	1397	1397	1397	1397
Width & Depth																
(G) Boiler Only	IN	20	20	20	20	20	20	17	24	24	28	32	36	44	50	63
	MM	508	508	508	508	508	508	432	610	610	711	813	914	1118	1270	1600
(H) Overall Depth Electric	IN	30	30	30	30	30	30	35	35	35	39	46	46	56	62	83
Panel to Blowdown	MM	762	762	762	762	762	762	899	899	899	991	1168	1168	1442	1575	2108
(I) Electric Panel Width	IN	14	14	14	14	14	14	17	17	32	32	40	52	64	64	64
	MM	356	356	356	356	356	356	432	432	813	813	1016	1321	1626	1626	1626
(J) Boiler Width Overall	IN	33	33	33	33	33	33	35	42	42	46	52	56	64	72	91
	MM	838	838	838	838	838	838	889	1067	1067	1168	1321	1422	1625	1829	2311
Minimum Clearances																
(K) Horizontal	IN	14	14	14	14	14	14	–	–	–	–	–	–	–	–	–
to remove elements	MM	356	356	356	356	356	356	–	–	–	–	–	–	–	–	–
(L) Floor to Ceiling	IN	–	–	–	–	–	–	95	95	95	95	95	139	139	139	139
to remove elements	MM	–	–	–	–	–	–	2413	2413	2413	2413	2413	3531	3531	3531	3531
(M) Front of Boiler	IN	24	24	24	24	24	24	24	32	32	32	34	34	36	36	36
	MM	610	610	610	610	610	610	610	813	813	813	864	864	914	914	914
(N) Sides & Rear of Boiler	IN	12	12	12	12	12	12	12	12	12	12	24	24	24	24	24
	MM	305	305	305	305	305	305	305	305	305	305	610	610	610	610	610

Dimensions are approximate. We reserve the right to change specifications.
–Indicates not available.
Panel Box size may change depending on voltage.

BULLETIN FBE
1LA9875
9-98/5M /PP
38038D
PRINTED IN USA

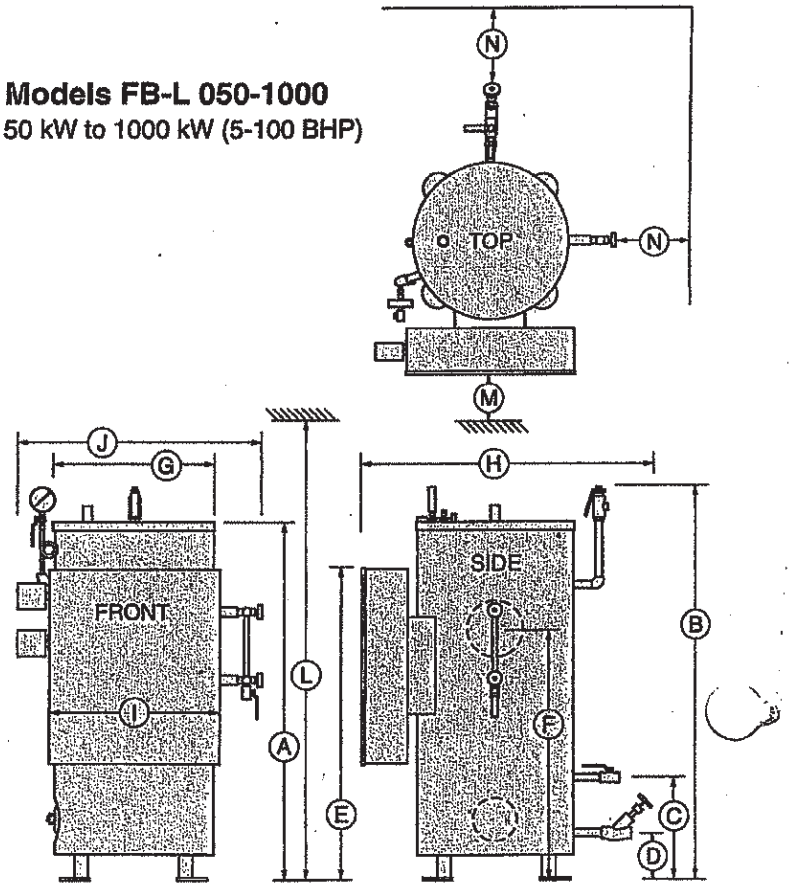
Models FB-L 012-036

12 to 36 kW (1.2 to 3.6 BHP)



Models FB-L 050-1000

50 kW to 1000 kW (5-100 BHP)



OIL-FIRED BOILERS

Fulton Thermal Corporation

Product Data Submittal

Fulton Models ICS4 - ICS60 and Models ICX4 - ICX30

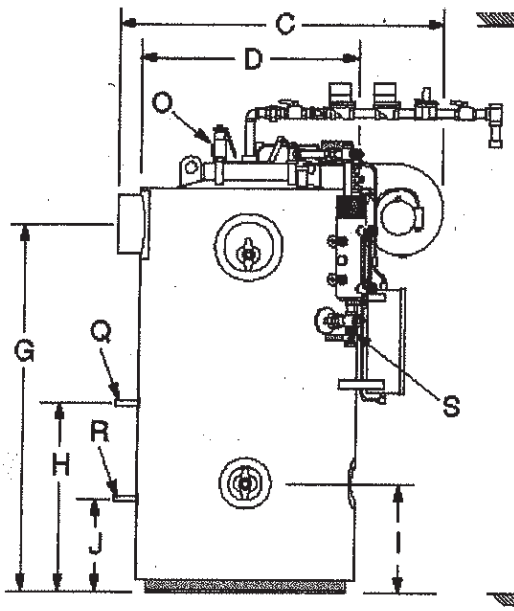
Fulton Gas & Oil Fired Vertical Tubeless Steam Boilers

(Standard Burner)

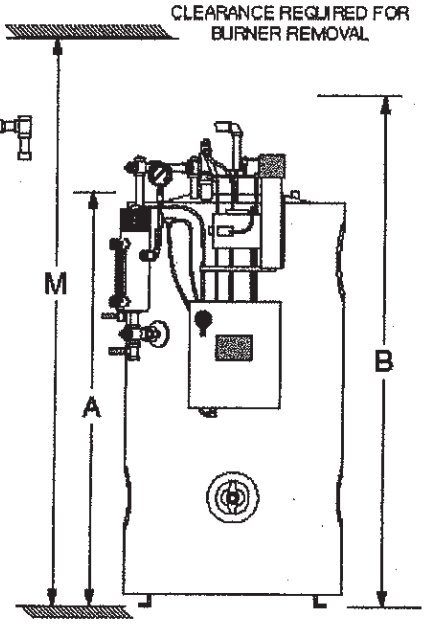
Dimensions

Standard Models ICS / Models ICX		4 / 4	6 / 6	9.5 / 9.5	10 / 10	15 / 15	20 / 20	25	30 / 30	50	60
Unit Size:	BHP	4	6	9.5	10	15	20	25	30	50	60
A. Boiler Height	IN	47.5	57.5	67.5	63.5	69.5	72.5	75	82.5	87.5	93.5
	MM	1207	1461	1715	1613	1765	1842	1905	2069	2223	2375
B. Boiler Height With Trim*	IN	65	75	85	80.5	86.5	92.5	95	102	106.5	120
& Fuel Train Assembly	MM	1651	1905	2159	2045	2197	2350	2413	2591	2705	3048
C. Overall Depth Stack	IN	44	44	44	46	47	58	59	67	78	78
to Burner Fan Housing	MM	1118	1118	1118	1168	1194	1474	1499	1702	1981	1981
D. Boiler Diameter	IN	26	26	26	28	30	39	39	46	55	55
	MM	660	660	660	710	760	990	990	1170	1400	1400
E. Overall Width	IN	33	33	33	33.5	35.5	43	43	49	57	57
with Water Column	MM	838	838	838	851	902	1091	1091	1244	1448	1448
F. Flue Outlet Diameter	IN	6	6	6	6	8	10	10	12	12	12
	MM	152	152	152	152	203	254	245	305	305	305
G. To Center of Flue Outlet	IN	42	52	62	58	63	66	68	73.5	79	85
	MM	1070	1320	1575	1473	1600	1675	1728	1867	2007	2159
H. Feedwater Inlet	IN	27	33	33.5	33	33.5	34	34	34	35	35
	MM	685	840	851	840	851	865	865	865	890	890
I. Handholes	IN	19	19	19	19	19	19	19	19	20	20
	MM	485	485	485	485	485	485	485	485	510	510
J. Blowdown Outlet	IN	15	15	15.5	15.5	15.5	16.5	16.5	16.5	17.5	17.5
	MM	380	380	394	394	394	420	420	420	445	445
K. Water Column Extension	IN	14	14	14	14	14	14	14	14	14	14
	MM	355	355	355	355	355	355	355	355	355	355
L. Gas Train Extension	IN	22.5	22.5	25	21.5	20.5	25	25	27	22.5	34
(CSD-1)	MM	572	572	635	546	521	635	635	686	572	867
M. Clearance Required	IN	72	82	92	86	92	96	98	106	114	124
for Burner Removal *	MM	1828	2083	2337	2184	2337	2438	2490	2692	2896	3150
Weights											
Approx. Shipping Weight	LB	1400	1700	1900	2000	2280	3400	3500	4780	6526	7280
	KG	635	773	862	910	1036	1545	1591	2173	2966	330

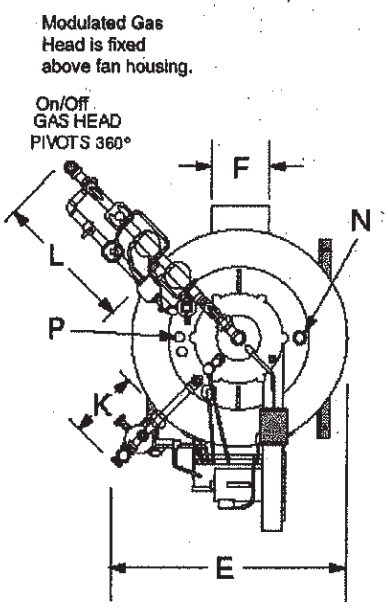
*This dimension is 6" less for oil fired units 4-50 HP and 12" less for oil fired units 60 HP.



Side View



Front View



Top View