PRELIMINARY FEASIBILITY REVIEW TO INSTALL A BIOMASS FIRED THERMAL ENERGY SYSTEM ON THE ALTURAS ELEMENTARY/MODOC MIDDLE SCHOOL CAMPUS IN ALTURAS, CALIFORNIA

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Prepared for:
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INTRODUCTION

TSS consultants (TSS) and Precision Energy Services (PES) were engaged by the North Cal-Neva Resource Conservation and Development Council, Inc. (RC&D) to perform a woody biomass-fueled heating system preliminary feasibility review. The scope of this review is intended to allow the Modoc Joint Unified School District to better understand the availability and cost of woody biomass fuels, make an initial equipment vendor selection, and secure an estimated cost of equipment associated with a woody biomass thermal energy system.

Specific tasks included in the initial scope of work included the following:

Task 1: Confirm availability and cost of woody biomass material meeting fuel specifications for a heating system.

Task 2: Select preferred location on the Modoc Middle School/Elementary School campus for co-location of a woody biomass-fired heating system.

Task 3: Review current thermal load and ability to readily modify existing heating system now in place.

Task 4: Review availability of suitable, cost-effective technologies that could support a woody biomass heating system fired on locally-available fuels, meeting local environmental permitting requirements.

Task 5: Working closely with the RC&D, select the preferred system for further analysis.

Task 6: Generate a cost estimate for the purchase and installation of equipment selected in Task 5.

In addition to the scope of work tasks listed above, the RC&D further requested that TSS and PES add the following tasks to this preliminary feasibility review:

Task 7:
- **a.** Economic analysis of what is currently being spent on heat utilizing the existing fuel sources and technology.
- **b.** How much money will be saved as a result of conversion to a biomass fired heating system?
- **c.** What is the payback period to recover the initial investment of converting to a biomass heating system?

Task 8: TSS be available to present preliminary feasibility study findings to the Modoc Joint Unified School District Board of Directors.

FINDINGS

Based on the findings of this report, TSS and PES have determined that a biomass thermal energy system while possible, remains economically unfeasible with the assumptions that were used. The total cost of a biomass system was estimated at 1.24 million dollars with the majority of the system cost being related to the infrastructure of the biomass system such as the buildings, foundations, and access. If the system capital costs can be reduced either through savings in the system infrastructure, particularly the main building used to house the heating system, or by securing outside grant funding, the economics may be greatly improved.

From a technical perspective, the project is certainly feasible and would offer an on-going operating cost savings over fuel oil in excess of $60,000 annually. The system would utilize approximately 280 to 360 green tons per year of woody biomass fuel, producing peak thermal outputs of 4MMBtu per hour. Additional findings are discussed in questions & answer correspondence between the RC&D, TSS and PES (see Appendix A).

Results addressing each of the above-listed task items:

TASK 1 - AVAILABILITY OF WOOD FUEL & FUEL COST ESTIMATE

Availability of woody biomass material meeting fuel specifications and that is economically accessible, is a key factor when considering the feasibility of a thermal energy project. The ready availability of contractors to provide biomass fuel is critical. Due to the development of several biomass power generation facilities in the region during the mid 1980's, there currently exist significant biomass fuel harvest, collection, process, and transport infrastructure in northeastern California.

TSS has conducted several woody biomass fuel availability assessment studies in the northeastern California region. The most recent fuel resource availability study was completed February 2006 for the Superior California Economic Development District. This report is available upon request.

The 2006 study found that there is a significant volume of woody biomass fuel potentially available within the northeastern California region – including Modoc County. The thermal energy project at Alturas would utilize approximately 280 to 360 green tons per year of woody biomass fuel. This amounts to about 12 to 15 truckloads of fuel annually.

Big Valley Power Company, LLC (BVP), located at Bieber, California, has volunteered to assist with fuel procurement efforts to provide a sustainable volume of fuel for the Alturas project. Due to the relatively small volume of woody biomass fuel required to sustain a thermal energy project at Alturas, TSS recommends that the School Board consider this arrangement if the project is implemented.

Representatives[1] from BVP noted that current biomass fuel prices for fuel delivered to the BVP facility at Bieber average approximately $44.50/bone dry ton[2] (BDT). Assuming an average moisture content of 45 percent and a haul cost of $240 to transport biomass fuel 50 miles from Bieber to Alturas, results in a fuel cost estimate of $34.50 per green ton delivered to the Alturas Elementary/Modoc Middle School campus.

Should BVP not be able to provide biomass fuel for a thermal energy project at Alturas, there are other commercial scale fuel suppliers in the region that could provide fuel.

As a prospective owner/operator, it is very important for the District to keep in mind that fuel quality and consistency issues are absolutely essential in the success of any biomass fueled system, particularly those of a capacity as contemplated here. Matching a system's equipment to a very specific range of fuel attributes and thereafter ensuring ongoing fuel quality compliance will be the single most significant contribution to a project's ultimate success.

TASK 2 - PREFERRED BIOMASS SYSTEM LOCATION

Based on several discussions with Jim Lloyd, director of operations and maintenance at the Modoc Joint Unified School District and the RC&D, TSS and PES determined that one location on the school district's property was well suited to hosting a new biomass heating facility.

The location chosen for the biomass system is slightly east of the Alturas Elementary School campus. Figure 1 (below) provides an aerial image of the campus and highlights the proposed location of the biomass heating facility and the existing location of the heat exchanger. As figure 1 indicates this location not only provides an access path for trucks to deliver fuel but also is in close proximity of the current heat exchanger enclosure which can be utilized to save on overall system costs. Utilizing the existing heat exchanger housing also limits required modifications to the existing hot water hydronic heating system and allows the current oil boilers to be used as standby backup sources of heat.

There will need to be access improvements and a transportation plan developed for fencing off the truck access route to prevent students from being in danger from truck traffic. The fuel delivery schedule can also be set to accommodate fuel deliveries during hours when school is not in session (e.g. late in the day or weekends) thereby minimizing potential hazards to the students.

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[1] Brad Seaberg, Forester, Big Valley Power Company, LLC. http://www.bigvalleynews.net/BigValleyPower/TourOfBigValleyPowerLLC.html

[2] Bone dry ton is a common unit of measure for wood fiber. One bone dry ton (BDT) represents 2,000 pounds of wood biomass material at zero percent moisture content, eg, BDT = GT * (1-%M)

Figure 1. Aerial View of Alturas Elementary/Modoc Middle School Campus

TASK 3 - THERMAL LOAD AND ABILITY TO MODIFY EXISTING HEATING SYSTEM

Based on historic oil delivery information provided by Jim Lloyd, PES reconstructed heating requirements over various time periods during the year. Using the oil usage and deliveries, PES then extrapolated the average daily heating oil usage and, using past experience and recommendations from heating, ventilation, air conditioning (HVAC) vendors, estimated the peak energy usage of the school heating system. The tabulated data on the past historical oil usage is provided as Appendix B.

PES assembled heating oil usage information for years 2003 through 2007 and determined system peak and average energy usage during this time period. It is assumed that, going forward, most heating seasons will fall within the ranges highlighted in this data set. The biomass system size and type has been selected to not only service the historic peak requirements but also to serve most of the heating load ranges the school campus can expect during a typical heating season.

Based on average and peak loads, PES performed detailed heat and material balance calculations to determine the biomass system fuel requirements to provide the peak and average loads at the middle/elementary school campus. The heat and material balance focused on the two most typical fuel moisture scenarios and, based on its results, determined both the anticipated fuel input and ash output. Results of these heat and material balance calculations are provided as Appendix C.

PES investigated the existing equipment on site at the school campus and found that the existing hydronic system would be compatible with a hot-water biomass energy system. The current heat exchanger unit, however, is undersized for this application. PES explored the possibility of expanding the current heat exchanger capacity by adding additional plates to the current unit. It was discovered that the current heat exchanger has titanium alloy plates, typically utilized for a geothermal heat source application. Adding additional plates to the previous titanium design was found to be cost prohibitive and an all-new heat exchanger of stainless steel (type 304) was chosen. The new heat exchanger would take the place of the existing unit. The new biomass system would be piped to the new heat exchanger and new pumps would circulate water from the biomass system to the heat exchanger. The existing school hydronic system will be compatible with the new heat exchanger.

TASK 4 - AVAILABILITY OF SUITABLE, COST-EFFECTIVE WOODY BIOMASS TECHNOLOGIES

TSS and PES utilized their extensive experience with biomass technologies to select two suitable vendors capable of providing a biomass system to meet the needs of the Modoc Joint Unified School District.

The vendors were chosen based on several criteria including experience, combustion technology, equipment robustness, fuel-handling equipment design, screening capacity, and potential air emissions. It should be noted that there are other biomass energy system vendors available in the marketplace but, based on the types of biomass fuel available and project scope, these two vendors were deemed to be the best fit.

Air quality emissions were an important criteria for both vendors chosen. Current information[3] indicates that a fabric filter “baghouse” will be required to meet local and state particulate emissions requirements. PES solicited quotes from several vendors to provide a cost estimate for the supply of a baghouse. The quoted baghouses will conform to the anticipated emissions requirements for local and state permitting agencies. There are other filtering technologies available but, based on cost effectiveness and scale, a baghouse is the most reasonable option available and would meet the Best Available Control Technology (BACT) requirements of the Modoc County Air Pollution Control District (APCD).

[3]As provided by the Modoc County Air Pollution Control District.

Additional controls would be required to properly operate and maintain the baghouse unit to prevent premature filter failure and to reliably achieve environmental compliance.

Current data indicates that additional emissions control devices beyond a baghouse would not be required for operating a biomass heating system. The APCD did indicate that an air quality permit will require an emission source test to be conducted after the startup of the biomass system.

As the biomass system would generate ash from the combustion process, such ash would have to either be delivered to the local landfill, or possibly used a product, such as a soil amendment (plowed into local rangeland) or in a composting operation for soil amendment products.

TASK 5 - SELECTION OF A PREFERRED SYSTEM VENDOR

Utilizing information provided to the RC&D by TSS and PES and based on the system scale and the availability of a fully automatic ash removal system, Advanced Recycling Equipment (ARE) was chosen as the preferred vendor for the cost analysis portion of this report. PES and TSS have carefully reviewed the details of ARE's scope to clarify what is and is not to be provided by the vendor. ARE's equipment specifications are provided as Appendix D.

The cost estimate spreadsheet provided as Appendix E also includes several equipment options for consideration by the school district for inclusion with the biomass system. TSS and PES have reviewed these options and provided recommendations for each option in the following cost estimate section of this report.

Based upon discussions with the APCD the school district should be able to secure the necessary air quality permits for construction and operation of the biomass system, particularly if the BACT requirements for particulate matter emissions as discussed in Task 4 are met.

TASK 6 - COST ESTIMATE FOR PURCHASE AND INSTALLATION OF EQUIPMENT

Based upon the scope provided by ARE and the anticipated needs of the biomass system to operate utilizing the existing school hydronic system, the following section outlines equipment purchases required to operate the biomass heating system. This section does not include the costs associated with air quality permitting, utility service interconnections (electrical, water, sewer), required construction permits, or any fire protection upgrades that may be needed. More detailed vendor and cost information is provided as Appendix F.

1) **Biomass System - $332,185**

    a. Combustion unit with hot water boiler and accessories
    b. Programmable Logic Controller (PLC) loop-based controls with touch-screen operator interface
    c. Forced and induced draft fans

d. Main feed auger system
e. Auto de-ash system
f. Multi-cyclone gas cleanup
g. 30 foot stack

2) Fuel Reclaim System - $86,541

a. Under-pile transfer augers
b. 12-foot tall fuel retaining wall
c. Belt conveyor for fuel transfer
d. Screw conveyor for fuel delivery to boiler

3) Pumps, Heat Exchanger, Piping and Expansion Tanks - $70,732

a. 250 gallon expansion tank: $7,398
b. Hot water piping, pre-insulated: $35,000
c. Two (2) Taco 300 gpm Pumps, 5HP each: $5,330
d. Misc control valves, trim, flow controls: $7,500
e. New heat exchanger, 304SS Graham: $2,704
f. Glycol mixing & handling system: $10,000
g. Motor Control Centers (MCC's) for Balance of Equipment: $2,800

4) Biomass System Installation Costs - $71,000

a. Primary biomass system: $15,000
b. Fuel handling system : $10,000
c. Pumps, heat exchangers etc. : $25,000
d. Controls programming, additional electrical: $21,000

5) Buildings, Roads, Fencing, Engineering Estimate - $588,600

a. Building cost estimated at $440.00 per square foot (30' x 40'): $528,000
b. Road cost for gravel road estimated at $3.00 per square foot (20' x 200'): $12,000
c. Fencing estimated at $25.00 per linear foot (200' long): $5,000
d. Engineering costs estimated at 8%: $43,600

6) Optional Equipment - $94,639

a. Baghouse, 2,000 cfm, Donaldson Torit Co.: $19,536
    i. Ceramic insulating coating: $4,260
b. Vibratory conveyor system for screening: $31,900
c. Additional 30-foot chimney height: $15,000
d. Combustion air pre-heater: $23,943

7) Total Estimated Cost

Biomass System :	**$332,185**
Fuel Reclaiming System :	**$86,541**
Pumps, Heat Ex., Piping :	**$70,732**
Installation Costs :	**$71,000**
Buildings, Roads, Engineering :	**$588,600**
Total without Optional Items:	**$1,149,058**
Optional Items:	**$94,639**
Total with all Optional Items:	**$1,243,697**

8) Exclusions from the Cost Estimate

a. Air quality permit & associated costs
b. Construction permits
c. Construction management costs, if required
d. Fire sprinkler system
e. Demolition, excavation outside of the biomass building
f. Contingencies
g. Bonding if required
h. Freight
i. Utility interconnection (water, sewer, electrical, phone)

Optional Equipment Recommendations

As discussed in the above cost estimate, TSS and PES recommend that a baghouse be included in the total system price. Ms. Kate Haas from the APCD indicated the baghouse would likely be necessary to permit the new wood-fired boiler.

TSS and PES also recommend a vibratory screening system be added in the system price estimate. Past experience with biomass fuels shows that no matter what fuel is delivered, no matter how well prepared, oversize material is virtually impossible to eliminate from the fuel stream. A screening system will minimize the likelihood that oversize material will cause system downtime and additional maintenance costs.

The taller stack should be left in the estimate only if the local permitting agency requires that it be added. The APCD indicated that it may be needed. The Federal Aviation Administration should be contacted as well to confirm that stack height meets federal regulations.

The need for the final optional item, the air heater, is entirely dependant on as-delivered fuel quality. Air heaters improve system performance by pre-heating combustion air and allowing the hot air to drive off some of the inherent moisture in the biomass fuel. Air heaters are an excellent way to ensure very wet fuel (up to 55% moisture content) can be burned. An alternative to leaving it in the project estimate at this juncture is to provide floor space for an air heater and add it at a later date if it is deemed necessary.

TASK 7 - CONSTRUCTION AND OPERATING COST PRO FORMA

TSS and PES developed a basic financial model of the proposed biomass heating project to facilitate evaluation of its economic feasibility. The model contemplates a maximum 15-year period over which the project must yield a positive net present value to the District. The model, while not comprehensive, is rigorous within its scope and, not surprisingly, indicates that project success is very sensitive to initial capital costs and projected escalation of oil and biomass fuel costs. A "base" case is provided as Appendix E using $1,243,697 capital costs, biomass fuel costs escalating at 4 percent per year, and heating oil escalating 7 percent per year. This case, even with its aggressive sustained increases in fuel oil costs does not yield a positive net present value. Securing grant funds, thereby reducing net capital expenditures, greatly improve results.

A working copy of this model has been previously provided to the North Cal Neva RC&D so that alternative scenarios may also be examined.

TASK 8 - DETAILED EQUIPMENT & ENGINEERING DATA

TSS and PES have included detailed data where available on selected equipment. These data sheets are provided with the understanding that these selections are only preliminary and due to change with final designs. The equipment selections were made based on past experience and general sizing criteria based on biomass system scale.

TASK 9 - ECONOMIC ANALYSIS OF BIOMASS SYSTEM VERSUS EXISTING HEATING OIL SYSTEM

Current heating expenses - based on a diesel price of $4.50 per gallon and a yearly fuel usage of around 20,000 gallons, results in an annual heating cost estimate of $90,000.

Projected heating expenses using a biomass system (capital cost, operating and maintenance, fuel cost, all in) - excluding service of capital, the yearly fuel cost for heating with biomass is expected to be a maximum of around $13,000 assuming delivered biomass fuel costs remain near the current $34.50 per green ton. Yearly operating and maintenance costs will vary but are expected to be around $3,500 per year for general maintenance so long as annual emissions source testing is not required.

Economic payback period to recover capital cost investment for a biomass system in the absence of additional capital funding (grant funding), will be more than 15 years.

REPORT CONCLUSIONS

If additional funding can be secured or building costs can be reduced, heating with biomass has the potential to provide the school district with significant cost savings in the long run.

Recommendations/Next Steps to consider:

1) Examine potential sources of grant funding.

2) Re-examine prospects to reduce the costs of the equipment building.

3) Evaluate prospects to expand the number of buildings or other infrastructure (pool?) served to improve economy of scale and overall project economics.

APPENDIX A

Summary of RC&D Questions and TSS/PES Answers

The following text is excerpted from a May 16, 2008 email from Mark Steffek, Executive Director, North Cal-Neva Resource Conservation and Development Council. TSS/PES response is highlighted in *blue* italicized text.

Good afternoon Tad,

Dina, Stacey and I met this afternoon and reviewed the financial analysis information you sent to us. We were looking for other ways to reduce costs in the proposed project and came up with a few questions that hopefully you can answer.

1. Capital Costs – How was the $113,980/year figure determined? Did you use some kind of amortization schedule based on a loan for $1,107,097? $113,980 X 15 years is $1,709,700.

Please note the notes in the "Assumptions" section. The $113,980 is an annualized payment for a "loan" of the $1.107M project cost over 15-year term at 6.0% interest (cost of capital). The cost of capital figure 6.0% is an arbitrary figure and should be revised to that used by the district for its standard financial modeling.

2. What if a substantial sized grant is obtained? Would that affect the financial feasibility of the project?

Under the scenario posed in the original financial model, a grant of about $500k would make the project results positive in all years; a $350k grant yields a marginally positive project result (npv in the black). I have revised the model so you can insert a grant value into the "Assumptions" to see how a given grant amount might affect results.

3. Fuel Oil prices – How were these prices projected into the future. It seems an 8 cent increase each year is not much. I think fuel is currently increasing about 8 cents a week and will probably hit $5.28 by the end of the year rather than 15 years from now. Would a greater rate of price increases show a greater savings in fuel costs over time?

The model was structured to allow the district to insert (again, in the "Assumptions" section) whatever diesel fuel escalation rate it judges prudent and appropriate. A greater diesel fuel rate of increase will generally yield substantial improvements in project results; just a 7% escalation puts the npv in the black. I've further revised the model so that wood and oil escalation rates may be entered individually. Please note your delivered wood fuel price is likely to be greatly influenced by, and may closely track, price trends of diesel fuel.

4. Will it be necessary to have the additional 30 feet of chimney? That would make for a total of 60 feet and an additional $15,000.

The height requirement of the chimney will ultimately be determined by requirements imposed by the local air quality district. The option for the higher stack is included in the capital cost to *provide for that eventuality. Sorry to seemingly duck the real question but Fred and Kate's investigations into permitting requirements will, ultimately, have to provide our best take on this issue.*

5. Will an expanded or additional heat exchanger be necessary?

Yes. The current heat exchanger is not sufficiently sized for a biomass system due to the lower operating temperatures of a biomass system resulting in a need for a greater surface area to accomplish the same heat transfer. The existing heat exchanger, intended for use with the more adverse water constituents typical of geothermal systems, has titanium alloy plates making the option of purchasing additional plates actually more expensive than an entirely new exchanger of more conventional construction.

6. Will a continuous emissions monitoring system be needed?

Based on TSS discussions with Modoc APCD, additional NOx control does not appear to be necessary, thus no need for CEMS.

Should the cost of that system be included in the financial analysis?

Modoc APCD believes a baghouse may be needed, and is attempting to get the modeling done to see if absolutely needed. Kate (APCD) suggested that we should include it in cost (and have an alternative cost without it).

Also, does initial source testing need to be done and its cost reflected in the analysis?

Initial source test will be required, figure around $8,500.

7. Can the narrative portion of the feasibility study include the potential of money earned through carbon credits and new business generated through the sale of ash as a soil amendment?

Since the biomass itself is "carbon neutral", the CO_2 reduction benefits come from the displacement of the fuel oil being used in the school heating system. The conversion of CO_2 from using fuel oil is 22.4 pounds CO_2 per gallon, or 161.4 pounds per million BTU. Must subtract out the CO_2 emissions from any fossil fuel transport and electricity use in the biomass heating system. Electricity = 0.28 lbs./kWh (Oregon rate as Pacificorp services Alturas? If not then up to 0.61 lbs./kWh for CA average). Conversion data from U.S. Energy Information Administration. Diesel fuel CO_2 would be same as fuel oil (22.4 lb/gal diesel fuel combusted). Current price (5/16) for CO_2 at Chicago Climate Exchange is $7/metric ton (http://www.chicagoclimatex.com/index.jsf). In order to sell on the exchange the CO_2 credits would have to be verified by an independent verifiers.

APPENDIX B

Historic Fuel Oil Usage

Modoc / Alturas Elementary School

PRECISION ENERGY SERVICES INC.

Date	Delivered (Gal)	Type	# Of Days	Daily Usage (Gal)	MMBtu/Day	Avg. Btu/hr	Est. Peak Hourly Use*
7-Jan-2003	962	Winterized Furnace Oil	-	-	-	-	-
17-Jan-2003	900	Winterized Furnace Oil	10	90	12,510,000	521,250	1,563,750
27-Jan-2003	1100	Winterized Furnace Oil	10	110	15,290,000	637,083	1,911,250
6-Feb-2003	708	Winterized Furnace Oil	10	71	9,841,200	410,050	1,230,150
11-Feb-2003	750	Red Carb Diesel	5	150	20,850,000	868,750	2,606,250
17-Feb-2003	470	Winterized Furnace Oil	6	78	10,888,333	453,681	1,361,042
24-Feb-2003	950	Winterized Furnace Oil	7	136	18,864,286	786,012	2,358,036
10-Mar-2003	1403	Winterized Furnace Oil	14	100	13,929,786	580,408	1,741,223
27-Mar-2003	1328	Winterized Furnace Oil	17	78	10,858,353	452,431	1,357,294
11-Apr-2003	900	Winterized Furnace Oil	15	60	8,340,000	347,500	1,042,500
28-Apr-2003	1071	Winterized Furnace Oil	17	63	8,757,000	364,875	1,094,625
19-May-2003	480	Winterized Furnace Oil	21	23	3,177,143	132,381	397,143
16-Sep-2003	700	Winterized Furnace Oil	15	47	6,486,667	270,278	810,833
31-Oct-2003	850	Winterized Furnace Oil	45	19	2,625,556	109,398	328,194
10-Nov-2003	810	Winterized Furnace Oil	10	81	11,259,000	469,125	1,407,375
28-Nov-2003	1,000	Winterized Furnace Oil	18	56	7,722,222	321,759	965,278
5-Dec-2003	1,065	Winterized Furnace Oil	7	152	21,147,857	881,161	2,643,482
15-Dec-2003	884	Winterized Furnace Oil	10	88	12,287,600	511,983	1,535,950
24-Dec-2003	1,272	Winterized Furnace Oil	9	141	19,645,333	818,556	2,455,667
	2003 Total		**2003 Total**	**2003 Average**	**2004 Average**	**2005 Average**	**2006 Average**
	17,603.00		**246**	**71.6**	**9,946,411**	**414,434**	**1,243,301**

Historical Fuel Usage Chart 2003

***Peak Season Usage and Interval in Yellow, Peak Use estimated at 3X Average Loac**

Modoc / Alturas Elementary School

PRECISION ENERGY SERVICES INC.

Historical Fuel Usage Chart 2004

Date	Delivered (Gal)	Type	# Of Days	Daily Usage (Gal)	MMBtu/Day	Avg. Btu/hr	Est. Peak Hourly Use
6-Jan-2004	1345	Winterized Furnace Oil	15	90	12,463,667	519,319	1,557,958
14-Jan-2004	900	Winterized Furnace Oil	8	113	15,637,500	651,563	1,954,688
23-Jan-2004	906	Winterized Furnace Oil	9	101	13,992,667	583,028	1,749,083
2-Feb-2004	1375	Winterized Furnace Oil	10	138	19,112,500	796,354	2,389,063
14-Feb-2004	1458	Winterized Furnace Oil	12	122	16,888,500	703,688	2,111,063
25-Feb-2004	850	Winterized Furnace Oil	11	77	10,740,909	447,538	1,342,614
5-Mar-2004	1361	Winterized Furnace Oil	8	170	23,647,375	985,307	2,955,922
22-Mar-2004	650	Winterized Furnace Oil	17	38	5,314,706	221,446	664,338
6-Apr-2004	875	Winterized Furnace Oil	15	58	8,108,333	337,847	1,013,542
20-Apr-2004	700	Winterized Furnace Oil	14	50	6,950,000	289,583	868,750
26-May-2004	1522	Winterized Furnace Oil	36	42	5,876,611	244,859	734,576
5-Oct-2004	900	Winterized Furnace Oil	15	60	8,340,000	347,500	1,042,500
2-Nov-2004	1900	Winterized Furnace Oil	28	68	9,432,143	393,006	1,179,018
10-Nov-2004	580	Winterized Furnace Oil	8	73	10,077,500	419,896	1,259,688
20-Nov-2004	1095	Winterized Furnace Oil	10	110	15,220,500	634,188	1,902,563
10-Dec-2004	689	Winterized Furnace Oil	20	34	4,788,550	199,523	598,569
21-Dec-2004	1,780	Winterized Furnace Oil	11	162	22,492,727	937,197	2,811,591
28-Dec-2004	623	Winterized Furnace Oil	7	89	12,371,000	515,458	1,546,375
	2004 Total		**2004 Total**	**2004 Average**	**2004 Average**	**2004 Average**	**2004 Average**
	19,509.00		**254**	**76.8**	**10,676,185**	**444,841**	**1,334,523**
	***Peak Season Usage and Interval in Yellow, Peak Use estimated at 3X Average Loac**						

Modoc / Alturas Elementary School

PRECISION ENERGY SERVICES INC.

Historical Fuel Usage Chart 2005

Date	Delivered (Gal)	Type	# Of Days	Daily Usage (Gal)	MMBtu/Day	Avg. Btu/hr	Est. Peak Hourly Use
7-Jan-2005	1304	Winterized Furnace Oil	10	130	18,125,600	755,233	2,265,700
17-Jan-2005	1525	Winterized Furnace Oil	10	153	21,197,500	883,229	2,649,688
27-Jan-2005	730	Winterized Furnace Oil	10	73	10,147,000	422,792	1,268,375
4-Feb-2005	875	Winterized Furnace Oil	8	109	15,203,125	633,464	1,900,391
15-Feb-2005	1350	Winterized Furnace Oil	11	123	17,059,091	710,795	2,132,386
3-Mar-2005	1431	Winterized Furnace Oil	16	89	12,431,813	517,992	1,553,977
22-Mar-2005	1457	Winterized Furnace Oil	19	77	10,659,105	444,129	1,332,388
5-Apr-2005	1600	Winterized Furnace Oil	14	114	15,885,714	661,905	1,985,714
18-Apr-2005	828	Winterized Furnace Oil	13	64	8,853,231	368,885	1,106,654
23-May-2005	529	Winterized Furnace Oil	35	15	2,100,886	87,537	262,611
6-Oct-2005	1568	Winterized Furnace Oil	15	105	14,530,133	605,422	1,816,267
28-Oct-2005	1100	Winterized Furnace Oil	22	50	6,950,000	289,583	868,750
16-Nov-2005	1191	Winterized Furnace Oil	19	63	8,713,105	363,046	1,089,138
13-Dec-2005	1000	Winterized Furnace Oil	28	36	4,964,286	206,845	620,536
20-Dec-2005	592	Winterized Furnace Oil	7	85	11,755,429	489,810	1,469,429
	2005 Total		**2005 Total**	**2005 Average**	**2005 Average**	**2005 Average**	**2005 Average**
	17,080.00		**237**	**72.1**	**10,017,384**	**417,391**	**1,252,173**
	***Peak Season Usage and Interval in Yellow, Peak Use estimated at 3X Average Loac**						

Modoc / Alturas Elementary School

PRECISION ENERGY SERVICES INC.

Historical Fuel Usage Chart 2006

Date	Delivered (Gal)	Type	# Of Days	Daily Usage (Gal)	MMBtu/Day	Avg. Btu/hr	Est. Peak Hourly Use
4-Jan-2006	1125	Winterized Furnace Oil	14	80	11,169,643	465,402	1,396,205
16-Jan-2006	1015	Winterized Furnace Oil	12	85	11,757,083	489,878	1,469,635
6-Feb-2006	1410	Winterized Furnace Oil	21	67	9,332,857	388,869	1,166,607
15-Feb-2006	700	Winterized Furnace Oil	9	78	10,811,111	450,463	1,351,389
21-Mar-2006	1829	Winterized Furnace Oil	34	54	7,477,382	311,558	934,673
19-Apr-2006	800	Winterized Furnace Oil	29	28	3,834,483	159,770	479,310
12-Oct-2006	1237	Winterized Furnace Oil	15	82	11,462,867	477,619	1,432,858
24-Oct-2006	829	Winterized Furnace Oil	12	69	9,602,583	400,108	1,200,323
6-Nov-2006	1082	Winterized Furnace Oil	13	83	11,569,077	482,045	1,446,135
13-Nov-2006	424	Winterized Furnace Oil	7	61	8,419,429	350,810	1,052,429
27-Nov-2006	1223	Winterized Furnace Oil	14	87	12,142,643	505,943	1,517,830
8-Dec-2006	1300	Winterized Furnace Oil	11	118	16,427,273	684,470	2,053,409
22-Dec-2006	1620	Winterized Furnace Oil	14	116	16,084,286	670,179	2,010,536
	2006 Total		**2006 Total**	**2006 Average**	**2006 Average**	**2006 Average**	**2006 Average**
	14,594.00		**205**	**71.2**	**9,895,444**	**412,310**	**1,236,930**
	***Peak Season Usage and Interval in Yellow, Peak Use estimated at 3X Average Loac**						

Modoc / Alturas Elementary School

PRECISION ENERGY SERVICES INC.

Historical Fuel Usage Chart 2007

Date	Delivered (Gal)	Type	# Of Days	Daily Usage (Gal)	MMBtu/Day	Avg. Btu/hr	Est. Peak Hourly Use
4-Jan-2007	1386	Winterized Furnace Oil	13	107	14,819,538	617,481	1,852,442
18-Jan-2007	1685	Winterized Furnace Oil	14	120	16,729,643	697,068	2,091,205
26-Jan-2007	867	Winterized Furnace Oil	8	108	15,064,125	627,672	1,883,016
5-Feb-2007	845	Winterized Furnace Oil	10	85	11,745,500	489,396	1,468,188
20-Feb-2007	1034	Winterized Furnace Oil	15	69	9,581,733	399,239	1,197,717
6-Mar-2007	505	Winterized Furnace Oil	14	36	5,013,929	208,914	626,741
20-Mar-2007	606	Winterized Furnace Oil	14	43	6,016,714	250,696	752,089
30-Mar-2007	414	Winterized Furnace Oil	10	41	5,754,600	239,775	719,325
16-Apr-2007	464	Winterized Furnace Oil	17	27	3,793,882	158,078	474,235
3-Oct-2007	1809	Winterized Furnace Oil	20	90	12,572,550	523,856	1,571,569
25-Oct-2007	1084	Winterized Furnace Oil	22	49	6,848,909	285,371	856,114
7-Nov-2007	614	Winterized Furnace Oil	13	47	6,565,077	273,545	820,635
27-Nov-2007	828	Winterized Furnace Oil	20	41	5,754,600	239,775	719,325
5-Dec-2007	750	Winterized Furnace Oil	8	94	13,031,250	542,969	1,628,906
14-Dec-2007	874	Winterized Furnace Oil	9	97	13,498,444	562,435	1,687,306
	2007 Total		**2007 Total**	**2007 Average**	**2007 Average**	**2007 Average**	**2007 Average**
	13,765.00		**207**	**66.5**	**9,243,164**	**385,132**	**1,155,396**
	***Peak Season Usage and Interval in Yellow, Peak Use estimated at 3X Average Loac**						
2003-2007 Average Oil Delivered			**2003-2007 Average Heating Days**				
	16,510.20		**230**				

APPENDIX C

Heat and Material Balance Calculations

Boiler Heat & Material Balance Sheet - Modoc/Alturas- Estimate 40% Moisture Fuel

Basic Fuel Calculations - Wet Fuel						
Element	**Units**	**% by Weight Dry basis**				
C	%	50.31%	**Enter Carbon Percentage on a Dry basis**			
H_2	%	6.03%	**Enter Fuel Bound Hydrogen Percentage on a Dry basis**			
N_2	%	0.23%	**Enter Fuel Bound Nitrogen Percentage on a Dry basis**			
O_2	%	37.08%	**Enter Fuel Bound Oxygen Percentage on a Dry basis**			
S	%	0.03%	**Enter Sulfur Percentage on a Dry basis**			
Cl	%	0	**Enter Chlorine Percentage on a Dry basis**			
Ash	%	6.32%	**Enter Ash Percentage on a Dry basis**			
H_20 Content	%	40.0%	**Enter Fuel Moisture Content on a As-Received Basis**			
% Dry	%	60.0%				
Fuel Properties - As Received Basis - Wet Fuel						
	Units	**% by weight**				
C	%	30.19%				
H_2	%	3.62%				
N_2	%	0.14%				
O_2	%	22.25%				
S	%	0.02%				
Cl	%	0.00%				
H_2O	%	40.00%				
Ash/Mineral	%	3.79%				
Total		100.00%				
Heating Value (Net) - As Fired - Blended Fuel	Btu/lb	4443.10				
Dulong HHV	Btu/lb	5050.00				
Dulong LHV	Btu/lb	4254.33				
Combustion Air Req. at Stoich.	lb/lb Fuel	3.78				
Excess Air Percentage	%	70%	**Enter Excess Air Percentage**			
Excess Air weight	lb/lb Fuel	2.65				
Total Air	lb/lb Fuel	6.43				
Specific Heat of Air	Btu/lb*°F	0.2402				
Combustion Products Specific Heat	Btu/lb*°F	0.3202				
Final Combustion Chamber Temperature	°F	1866.77				
Elements in fuel						
C	Molar	12.01	lb/SCF	0.032		
H_2	Molar	2.02	lb/SCF	0.005		
S	Molar	32.06	lb/SCF	0.084		
CO	Molar	28.01	lb/SCF	0.074		
SO_2	Molar	64.06	lb/SCF	0.169		
N_2	Molar	28.02	lb/SCF	0.074		
O_2	Molar	32.00	lb/SCF	0.084		
Ar	Molar	39.95	lb/SCF	0.105		
H_2O	Molar	18.02	lb/SCF	0.047		
CO_2	Molar	44.01	lb/SCF	0.116		
N_2 + Ar	Molar	28.16	lb/SCF	0.074		
Air Volumes		**Dry Air**	**Density**	**Air @ 30% RH**	**Wet Air**	**Density for Air @ 30% Humidity**
N_2	% by Vol	78.09%	0.0576	0.7552	75.23%	21.076
O_2	% by Vol	20.95%	0.0177	0.2314	23.05%	7.376
Ar	% by Vol	0.93%	0.0010	0.0129	1.28%	0.513
H_2O	% by Vol	0.00%	0.00000	0.0039	0.39%	0.070
CO_2	% by Vol	0.03%	0.00004	0.0005	0.05%	0.022
Total		**100.00%**	**0.0763**	**1.0039**	**100%**	29.056
Air Density @ 30% Relative Humidity	lb/ft^3					0.07656
Products of Combustion						% by Weight
CO_2	lb/lb fuel	1.1093	SCFH	7,500		15.17%
H_2O	lb/lb fuel	0.7483	SCFH	12,361		10.24%
N_2 + Ar	lb/lb fuel	4.8418	SCFH	51,170		66.23%
O_2	lb/lb fuel	0.6107	SCFH	5,679		8.35%
SO_2	lb/lb fuel	0.0004	SCFH	2		0.00%
Cl	lb/lb fuel	0.0000	SCFH	0		0.00%
Total Gaseous PoC	lb	7.3104	SCFH	76,712		
Total Flow from boiler	SCFM	1,278.54				
Ash	lb/lb fuel	0.0379				
Total Weight of PoC + Ash	lb/lb fuel	7.3484				
Actual Input Weight of Air + Fuel	lb	7.43				
Total Air Required	lb/hr	5,045				

Boiler Btu Output (Net)	Btu/hr	2,600,000	**Enter Boiler Output (Net), Average Yearly Peak**
Ambient Air Temperature	°F	80.0	
Boiler Gas Exit Temp. (Estimated based on Zurn Data)	°F	600.0	
Radiation Losses	%	1.00%	
Unburnt Carbon Loss	%	1.00%	
MFR Margin	%	1.00%	
Dry Flue Gas Loss	%	6.61%	
Moisture Loss (Fuel and Produced)	%	15.60%	
Moisture Loss in Air	%	0.16%	
Total Losses	%	25.37%	
Boiler Efficiency For above Fuel	Eff.	74.63%	**Anticipated Boiler Efficiency - As Fired**
Gross Heat Release Required, Peak Firing	Btu/hr	**3,483,947**	
Fuel Requirement	lb/hr	**784.1**	
Estimated Flue Gas Exit Temperature	°F	**300**	**Actual outlet temperature will vary with fuel type**
Flue Gas Volumetric Flow Rate From Boiler	ACFM	**1,869**	
Flue Gas Mass Flow Rate	lb/hr	**5,829**	
Ash Output at Maximum Fire	lb/hr	**30**	
Tons of Wet Fuel Per Day, Peak Firing	Ton/Day	**9.41**	
Tons of Ash Per Day (Dry)	Ton/Day	**0.36**	
Estimated Heating Days Per Year	Days/Year	**200**	
Average Year Oil Usage (Historical 2003-2007)	Gal/Year	**18,161**	**Average usage + 10% to cover yearly variations**
Average Yearly BTU usage, Based on #2 Oil Usage	Btu/Year	**2,524,379,000**	
Average Daily Fuel Usage Expected	GT/Day	**1.42**	
Average Yearly Fuel Usage Expected	GT/Year	**284.08**	
Average Daily Ash Output	Ton/Day	**0.05**	
Average Yearly Ash Output	Ton/Year	**10.77**	
Cost of Wood Fuel (Green)	$/Ton	**$34.50**	
Estimated Yearly Oil Cost ($3.50/Gallon)	$/Year	**$63,563.50**	
Estimated Yearly Oil Cost ($3.75/Gallon)	$/Year	**$68,103.75**	
Estimated Yearly Oil Cost ($4.00/Gallon)	$/Year	**$72,644.00**	
Estimated Yearly Wood Cost	$/Year	**$9,800.72**	

Boiler Heat & Material Balance Sheet - Modoc/Alturas- Estimate 50% Moisture Fuel

PRECISION ENERGY SERVICES INC.

Basic Fuel Calculations - Wet Fuel						
Element	**Units**	**% by Weight Dry basis**				
C	%	50.31%	**Enter Carbon Percentage on a Dry basis**			
H_2	%	6.03%	**Enter Fuel Bound Hydrogen Percentage on a Dry basis**			
N_2	%	0.23%	**Enter Fuel Bound Nitrogen Percentage on a Dry basis**			
O_2	%	37.08%	**Enter Fuel Bound Oxygen Percentage on a Dry basis**			
S	%	0.03%	**Enter Sulfur Percentage on a Dry basis**			
Cl	%	0	**Enter Chlorine Percentage on a Dry basis**			
Ash	%	6.32%	**Enter Ash Percentage on a Dry basis**			
H_20 Content	%	50.0%	**Enter Fuel Moisture Content on a As-Received Basis**			
% Dry	%	50.0%				
Fuel Properties - As Received Basis - Wet Fuel						
	Units	**% by weight**				
C	%	25.16%				
H_2	%	3.02%				
N_2	%	0.12%				
O_2	%	18.54%				
S	%	0.02%				
Cl	%	0.00%				
H_2O	%	50.00%				
Ash/Mineral	%	3.16%				
Total		100.00%				
Heating Value (Net) - As Fired - Blended Fuel	Btu/lb	3520.84				
Dulong HHV	Btu/lb	4208.33				
Dulong LHV	Btu/lb	3360.27				
Combustion Air Req. at Stoich.	lb/lb Fuel	3.15				
Excess Air Percentage	%	60%	**Enter Excess Air Percentage**			
Excess Air weight	lb/lb Fuel	1.89				
Total Air	lb/lb Fuel	5.05				
Specific Heat of Air	Btu/lb*°F	0.2402				
Combustion Products Specific Heat	Btu/lb*°F	0.3297				
Final Combustion Chamber Temperature	°F	1766.07				
Elements in fuel						
C	Molar	12.01	lb/SCF	0.032		
H_2	Molar	2.02	lb/SCF	0.005		
S	Molar	32.06	lb/SCF	0.084		
CO	Molar	28.01	lb/SCF	0.074		
SO_2	Molar	64.06	lb/SCF	0.169		
N_2	Molar	28.02	lb/SCF	0.074		
O_2	Molar	32.00	lb/SCF	0.084		
Ar	Molar	39.95	lb/SCF	0.105		
H_2O	Molar	18.02	lb/SCF	0.047		
CO_2	Molar	44.01	lb/SCF	0.116		
N_2 + Ar	Molar	28.16	lb/SCF	0.074		
Air Volumes		**Dry Air**	**Density**	**Air @ 30% RH**	**Wet Air**	**Density for Air @ 30% Humidity**
N_2	% by Vol	78.09%	0.0576	0.7552	75.23%	21.076
O_2	% by Vol	20.95%	0.0177	0.2314	23.05%	7.376
Ar	% by Vol	0.93%	0.0010	0.0129	1.28%	0.513
H_2O	% by Vol	0.00%	0.00000	0.0039	0.39%	0.070
CO_2	% by Vol	0.03%	0.00004	0.0005	0.05%	0.022
Total		**100.00%**	**0.0763**	**1.0039**	**100%**	29.056
Air Density @ 30% Relative Humidity	lb/ft^3					0.07656
Products of Combustion						% by Weight
CO_2	lb/lb fuel	0.9242	SCFH	8,368		15.54%
H_2O	lb/lb fuel	0.7890	SCFH	17,451		13.27%
N_2 + Ar	lb/lb fuel	3.7976	SCFH	53,739		63.85%
O_2	lb/lb fuel	0.4362	SCFH	5,431		7.33%
SO_2	lb/lb fuel	0.0003	SCFH	2		0.01%
Cl	lb/lb fuel	0.0000	SCFH	0		0.00%
Total Gaseous PoC	lb	5.9473	SCFH	84,991		
Total Flow from boiler	SCFM	1,416.51				
Ash	lb/lb fuel	0.0316				
Total Weight of PoC + Ash	lb/lb fuel	5.9789				
Actual Input Weight of Air + Fuel	lb	6.05				
Total Air Required	lb/hr	5,298				

Boiler Btu Output (Net)	Btu/hr	2,600,000	**Enter Boiler Output (Net), Average Yearly Peak**
Ambient Air Temperature	°F	80.0	
Boiler Gas Exit Temp. (Estimated based on Zurn Data)	°F	600.0	
Radiation Losses	%	1.00%	
Unburnt Carbon Loss	%	1.00%	
MFR Margin	%	1.00%	
Dry Flue Gas Loss	%	6.61%	
Moisture Loss (Fuel and Produced)	%	19.89%	
Moisture Loss in Air	%	0.16%	
Total Losses	%	29.67%	
Boiler Efficiency For above Fuel	Eff.	70.34%	**Anticipated Boiler Efficiency - As Fired**
Gross Heat Release Required, Peak Firing	Btu/hr	**3,696,595**	
Fuel Requirement	lb/hr	**1,049.9**	
Estimated Flue Gas Exit Temperature	°F	**300**	**Actual outlet temperature will vary with fuel type**
Flue Gas Volumetric Flow Rate From Boiler	ACFM	**2,070**	
Flue Gas Mass Flow Rate	lb/hr	**6,348**	
Ash Output at Maximum Fire	lb/hr	**33**	
Tons of Wet Fuel Per Day, Peak Firing	Ton/Day	**12.60**	
Tons of Ash Per Day (Dry)	Ton/Day	**0.40**	
Estimated Heating Days Per Year	Days/Year	**200**	
Average Year Oil Usage (Historical 2003-2007)	Gal/Year	**18,161**	**Average usage + 10% to cover yearly variations**
Average Yearly BTU usage, Based on #2 Oil Usage	Btu/Year	**2,524,379,000**	
Average Daily Fuel Usage Expected	GT/Day	**1.79**	
Average Yearly Fuel Usage Expected	GT/Year	**358.49**	
Average Daily Ash Output	Ton/Day	**0.06**	
Average Yearly Ash Output	Ton/Year	**11.33**	
Cost of Wood Fuel (Green)	$/Ton	**$34.50**	
Estimated Yearly Oil Cost ($3.50/Gallon)	$/Year	**$63,563.50**	
Estimated Yearly Oil Cost ($3.75/Gallon)	$/Year	**$68,103.75**	
Estimated Yearly Oil Cost ($4.00/Gallon)	$/Year	**$72,644.00**	
Estimated Yearly Wood Cost	$/Year	**$12,367.96**	

APPENDIX D

Advanced Recycling Equipment Specifications

REVISIONS			
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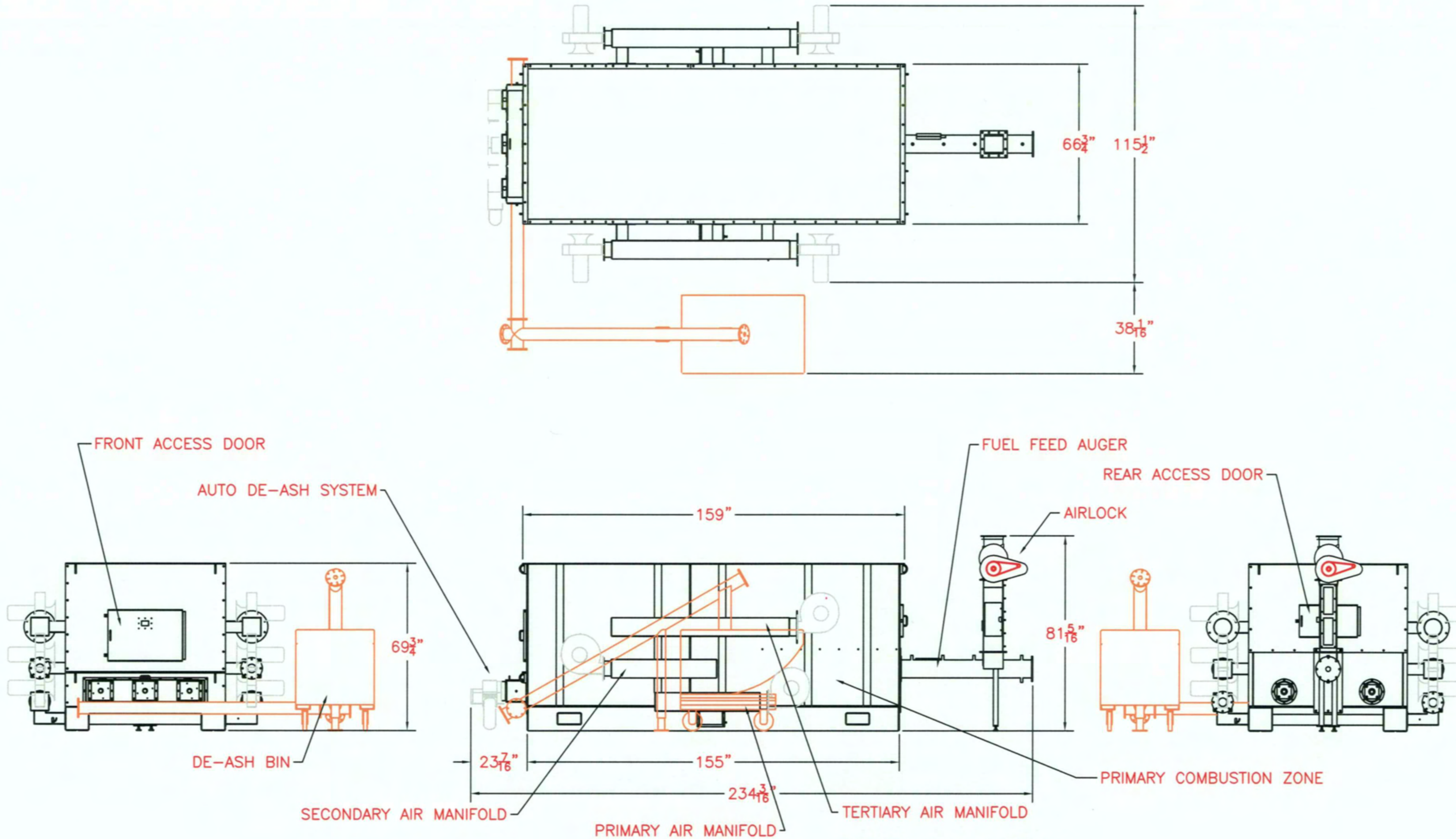

PRELIMINARY

TITLE TSS CONSULTANTS MODOC/ALTURAS PROJECT

SERIAL NUMBER CCU-405 COMBUSTION UNIT

DRAWN 3-28-08 DATE 3-28-08 PART AUTHOR CJC

CHECKED— CHECKED DATE —

DRAWING BASED ON

MACHINED SURFACE FINISH 125 Mu in./ N8

ADVANCED RECYCLING EQUIPMENT, INC.

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DIMENSIONAL TOLERANCES UNLESS OTHERWISE NOTED

FRACTION		DECIMAL		ANGLE	HOLE DIAMETER TOLERANCES		
0-12"	±1/32"	0-12"	±.005"	±1/2°	0-.250" +.003" -.002"	.250"-.500" +.005" -.003"	.500" + +.010" -.005"
12-78"	±1/16"	12-78"	±.031"				
78" +	±1/8"	78" +	±.10"				

SIZE	DRAWING NUMBER	REV.
B	DWG# 1	0

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REVISIONS

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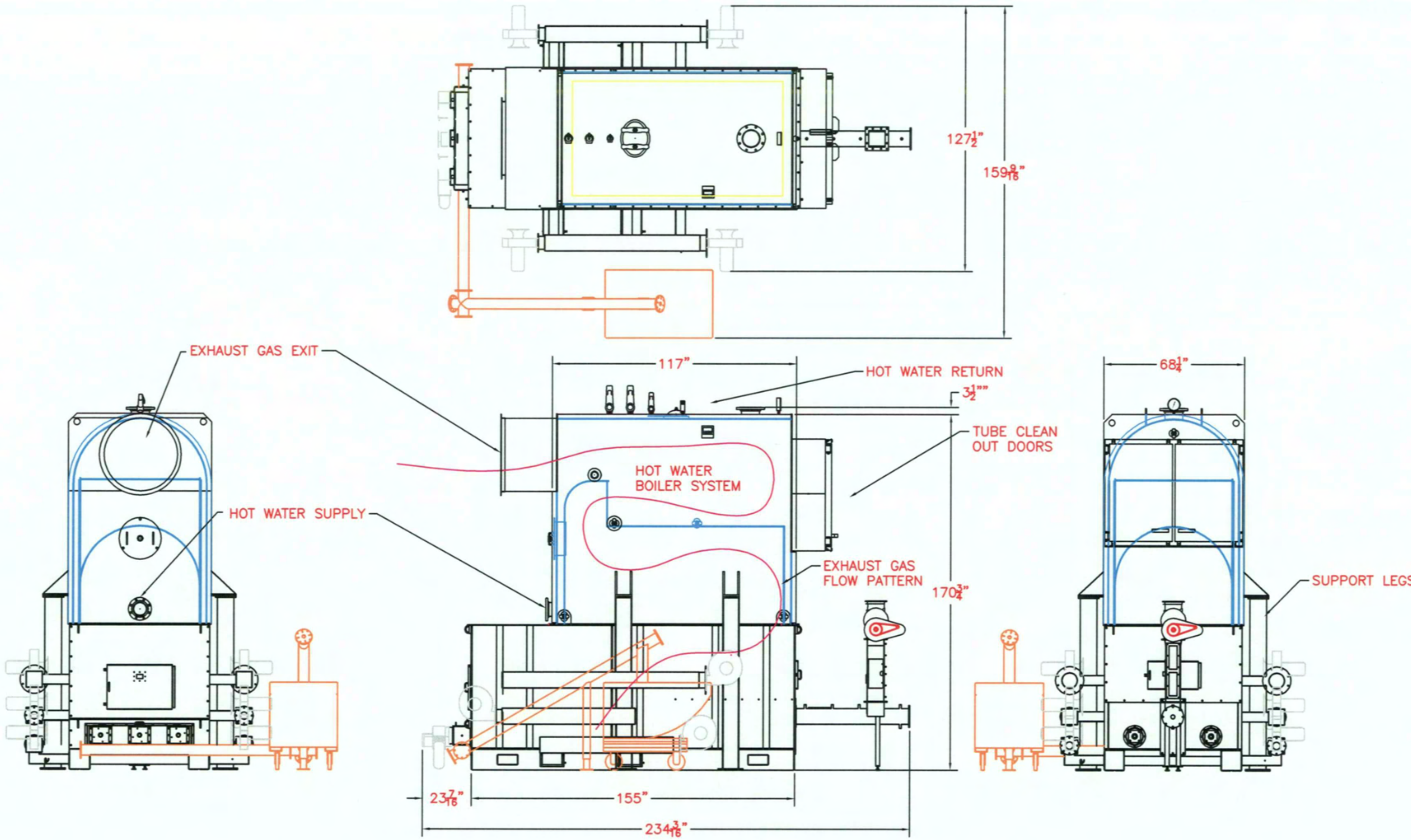

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TITLE TSS CONSULTANTS MODOC/ALTURAS PROJECT

SERIAL NUMBER CCUE-405 COMBUSTION UNIT W/ BURNHAM BOILER

DRAWN 3-28-08 DATE 3-28-08 PART AUTHOR CJC

CHECKED — CHECKED DATE —

DRAWING BASED ON

MACHINED SURFACE FINISH 125 Mu in./ N8

ADVANCED RECYCLING EQUIPMENT, INC.

DIMENSIONAL TOLERANCES UNLESS OTHERWISE NOTED

FRACTION		DECIMAL		ANGLE	HOLE DIAMETER TOLERANCES		
0-12"	±1/32"	0-12"	±.005"	±1/2°	0-.250" +.003" -.002"	.250"-.500" +.005" -.003"	.500" + +.010" -.005"
12-78"	±1/16"	12-78"	±.031"				
78" +	±1/8"	78" +	±.10"				

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REVISIONS

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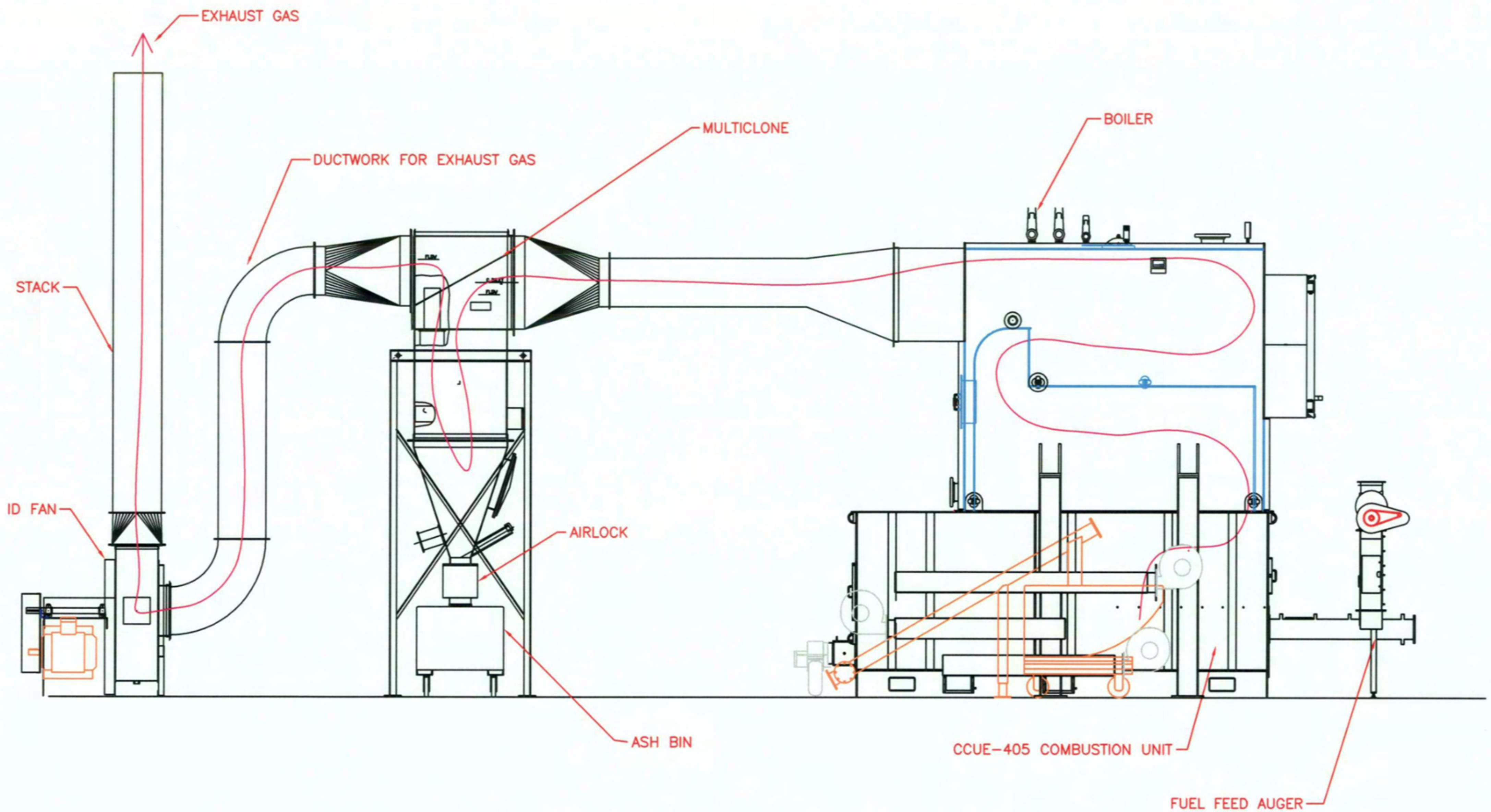

STRAIGHT LINE EXHAUST GAS FLOW ILLUSTRATION

PRELIMINARY

TITLE TSS CONSULTANTS MODOC/ALTURAS PROJECT

SERIAL NUMBER STRAIGHT LINE GAS FLOW OF CCUE-405-W W/ BOILER

DRAWN 3-28-08 DATE 3-28-08 PART AUTHOR CJC

CHECKED — CHECKED DATE —

DRAWING BASED ON

MACHINED SURFACE FINISH 125 Mu in./ N8

DIMENSIONAL TOLERANCES UNLESS OTHERWISE NOTED

FRACTION		DECIMAL		ANGLE	HOLE DIAMETER TOLERANCES
0-12"	±1/32"	0-12"	±.005"	±1/2°	0-.250" +.003" -.002"
12-78"	±1/16"	12-78"	±.031"		.250"-.500" +.005" -.003"
78" +	±1/8"	78" +	±.10"		.500" + +.010" -.005"

ADVANCED RECYCLING EQUIPMENT, INC.

SIZE	DRAWING NUMBER	REV.
B	DWG# 30	

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REVISIONS			
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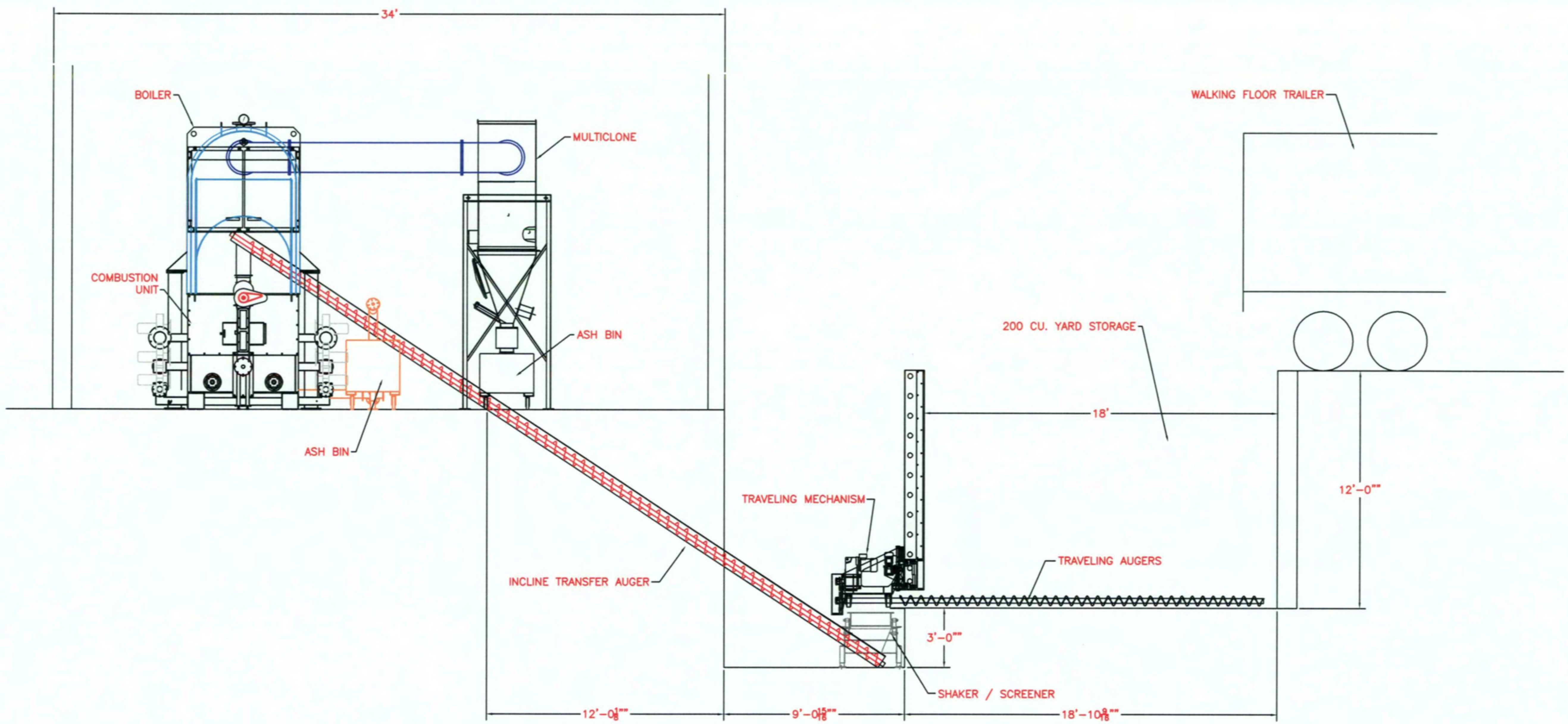

PRELIMINARY

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TITLE TSS CONSULTANTS MODOC/ALTURAS PROJECT

SERIAL NUMBER SIDE VIEW WITH EQUIPMENT

DRAWN 3-28-08 DATE 3-28-08 PART AUTHOR CJC

CHECKED — CHECKED DATE —

DRAWING BASED ON

MACHINED SURFACE FINISH 125 Mu in./ N8

DIMENSIONAL TOLERANCES UNLESS OTHERWISE NOTED

FRACTION		DECIMAL		ANGLE	HOLE DIAMETER TOLERANCES		
0-12"	±1/32"	0-12"	±.005"	±1/2"	0-.250" +.003" -.002"	.250"-.500" +.005" -.003"	.500" + +.010" -.005"
12-78"	±1/16"	12-78"	±.031"				
78" +	±1/8"	78" +	±.10"				

ADVANCED RECYCLING EQUIPMENT, INC.

SIZE	DRAWING NUMBER	REV.
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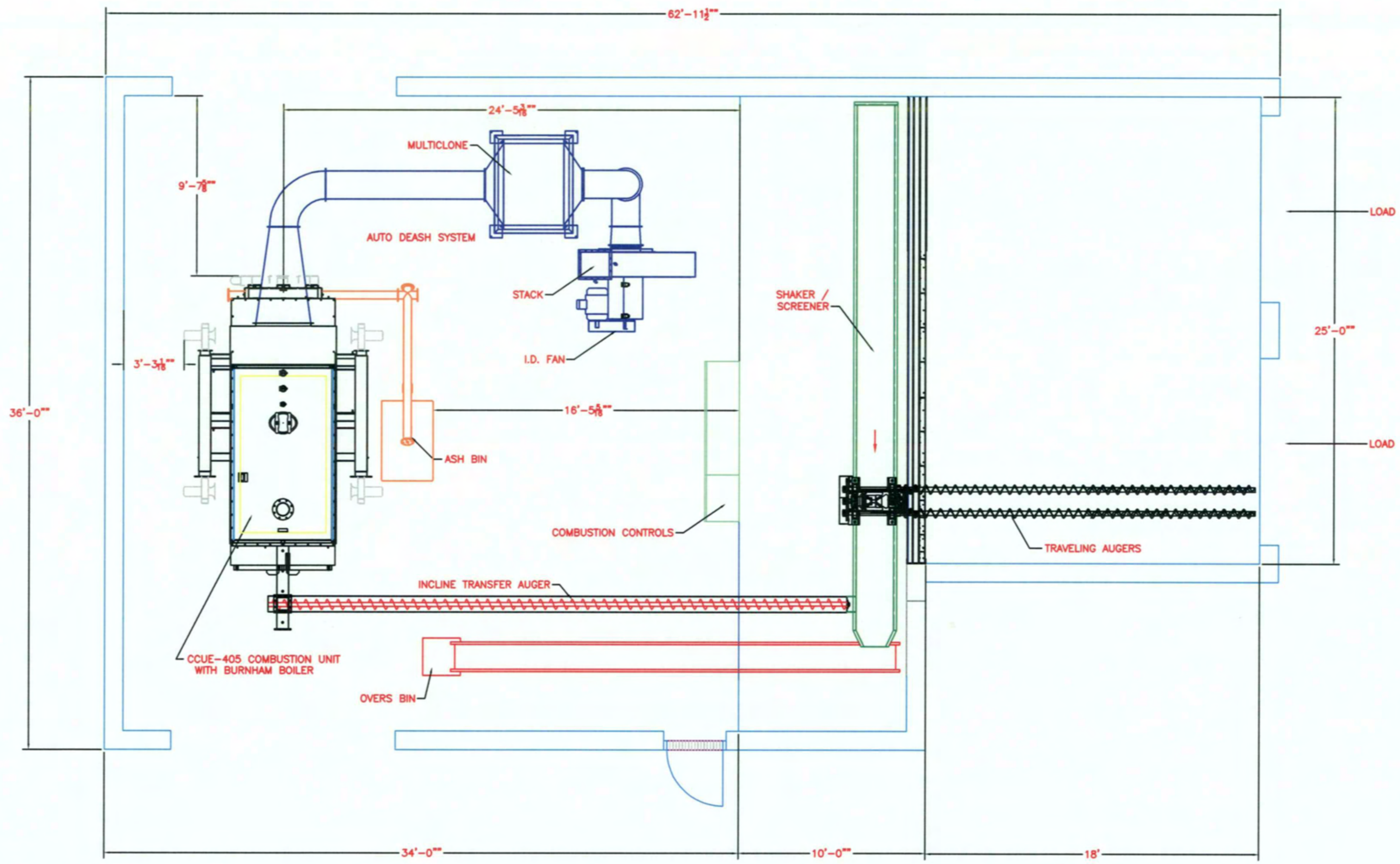
REVISIONS

REV. NO.	DESCRIPTION	CHECKED	DATE



PRELIMINARY

TITLE TSS CONSULTANTS MODOC/ALTURAS PROJECT

SERIAL NUMBER PLAN VIEW WITH EQUIPMENT

DRAWN 3-28-08 DATE 3-28-08 PART AUTHOR CJC

CHECKED— CHECKED DATE —

MACHINED SURFACE FINISH 125 Mu in./ N8

DRAWING BASED ON

DIMENSIONAL TOLERANCES UNLESS OTHERWISE NOTED

FRACTION		DECIMAL		ANGLE	HOLE DIAMETER TOLERANCES
0-12"	±1/32"	0-12"	±.005"	±1/2"	0-.250" +.003" -.002"
12-78"	±1/16"	12-78"	±.031"		.250"-.500" +.005" -.003"
78" +	±1/8"	78" +	±.10"		.500" + +.010" -.005"

ADVANCED RECYCLING EQUIPMENT, INC.

SIZE	DRAWING NUMBER	REV.
B	DWG# 5	0

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APPENDIX E

Cost Estimate and Financial ProForma

Modoc Middle School - Alturas, California

Woody Biomass Heating Study - Financial Analysis

net present value: ($152,476)

	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Annual Heating Load															
[MMBtu/year]	2,524	2,549	2,575	2,600	2,626	2,653	2,679	2,706	2,733	2,760	2,788	2,816	2,844	2,873	2,901
Fuel Oil Only (Current)															
fo use [gal]	**20,000**	20,200	20,402	20,606	20,812	21,020	21,230	21,443	21,657	21,874	22,092	22,313	22,537	22,762	22,989
fo price [$/gal]	**$4.00**	$4.28	$4.58	$4.90	$5.24	$5.61	$6.00	$6.42	$6.87	$7.35	$7.87	$8.42	$9.01	$9.64	$10.31
fo option expense	**$80,000**	**$86,456**	**$93,433**	**$100,973**	**$109,122**	**$117,928**	**$127,444**	**$137,729**	**$148,844**	**$160,856**	**$173,837**	**$187,865**	**$203,026**	**$219,410**	**$237,117**
Wood Fuel/Fuel Oil Backup															
fuel oil use [gal]	**600**	606	612	618	624	631	637	643	650	656	663	669	676	683	690
fuel oil price [$/gal]	**$4.00**	$4.28	$4.58	$4.90	$5.24	$5.61	$6.00	$6.42	$6.87	$7.35	$7.87	$8.42	$9.01	$9.64	$10.31
fuel oil expense	$2,400	$2,594	$2,803	$3,029	$3,274	$3,538	$3,823	$4,132	$4,465	$4,826	$5,215	$5,636	$6,091	$6,582	$7,114
wood fuel use [gt]	**360**	364	367	371	375	378	382	386	390	394	398	402	406	410	414
wood fuel price [$/gt]	**$34.50**	$35.88	$37.32	$38.81	$40.36	$41.97	$43.65	$45.40	$47.22	$49.10	$51.07	$53.11	$55.24	$57.45	$59.74
wood fuel expense	$12,420	$13,046	$13,703	$14,394	$15,120	$15,882	$16,682	$17,523	$18,406	$19,334	$20,308	$21,332	$22,407	$23,536	$24,722
wood fuel ash [tpy]	11.2	11.3	11.4	11.5	11.6	11.7	11.8	12.0	12.1	12.2	12.3	12.5	12.6	12.7	12.8
ash disposal rate	$30.00	$32.10	$34.35	$36.75	$39.32	$42.08	$45.02	$48.17	$51.55	$55.15	$59.01	$63.15	$67.57	$72.30	$77.36
ash disposal expense	$335	$362	$391	$423	$457	$494	$533	$576	$623	$673	$728	$786	$850	$918	$992
wf option expense	**$15,155**	**$16,001**	**$16,897**	**$17,846**	**$18,850**	**$19,913**	**$21,039**	**$22,231**	**$23,494**	**$24,833**	**$26,251**	**$27,754**	**$29,347**	**$31,037**	**$32,828**
Summary															
gross benefit	$64,845	$70,455	$76,536	$83,127	$90,272	$98,015	$106,406	$115,498	$125,350	$136,023	$147,586	$160,112	$173,679	$188,374	$204,289
capital	($128,054)	($128,054)	($128,054)	($128,054)	($128,054)	($128,054)	($128,054)	($128,054)	($128,054)	($128,054)	($128,054)	($128,054)	($128,054)	($128,054)	($128,054)
net benefit	**($63,209)**	**($57,600)**	**($51,519)**	**($44,927)**	**($37,783)**	**($30,040)**	**($21,649)**	**($12,556)**	**($2,705)**	**$7,969**	**$19,532**	**$32,057**	**$45,624**	**$60,319**	**$76,234**

Assumptions		
		General: This business model uses the 50% moisture fuel heat rate case and assumes no incremental O&M other than ash disposal.
heating load escalation	**1.0%**	annual escalation in heating loads
oil price escalation	**7.0%**	escalation of oil fuel prices and of ash disposal cost
wood price escalation	**4.0%**	escalation of wood fuel prices and of ash disposal cost
wood fuel moisture	**50.0%**	average wood fuel moisture content (by weight, wet basis)
ash content [% by weight]	**3.1%**	ash and noncombustible content of wood fuel
total capital cost	**$1,243,697**	procure and install wood heat system (see "capital" worksheet)
capital grant		grant funding that partially offsets installation capital requirements
cost of capital	**6.0%**	cost of borrowing capital investment
term [years]	**15**	term for capital payback
npv discount rate	**6.0%**	discount rate to calculate net present value

Info Only	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
wood fuel use [bdt]	180	182	184	185	187	189	191	193	195	197	199	201	203	205	207
wood fuel price [$/bdt]	$69.00	$71.76	$74.63	$77.62	$80.72	$83.95	$87.31	$90.80	$94.43	$98.21	$102.14	$106.22	$110.47	$114.89	$119.49

Modoc Middle School - Alturas, California
Woody Biomass Heating Study - Financial Analysis

item	description	capital cost
01	**biomass system**	$332,185
02	**fuel reclaim**	$86,541
03	**mechanical**	$70,732
04	**installation**	$71,000
05	**civil**	$588,600
06	**options**	
	baghouse	$19,536
	baghouse refractory	$4,260
	vibratory screen	$31,900
	30-ft stack adder	$15,000
	comb. Air preheat	$23,943
	total	**$1,243,697**

note: cost figures taken from draft report "cost estimate" section

note: total copied to "model" worksheet

civil cost estimate

building	1200	sf	$440	$528,000
fence	200	ft	$25	$5,000
road	4000	sf	$3	$12,000
subtotal				**$545,000**
engineering			8%	$43,600
				$588,600

Version xx **JASteigers/PES** **2008Jun26-1216**

APPENDIX F

Detailed Equipment Cost Estimates

AMTROL INC.

Engineered Products

EXTROL® ASME
EXPANSION TANKS
For Closed Hydronic Heating & Chilled Water Systems

AMTROL INC.

Quality ASME Expansion Tanks

Table of Contents

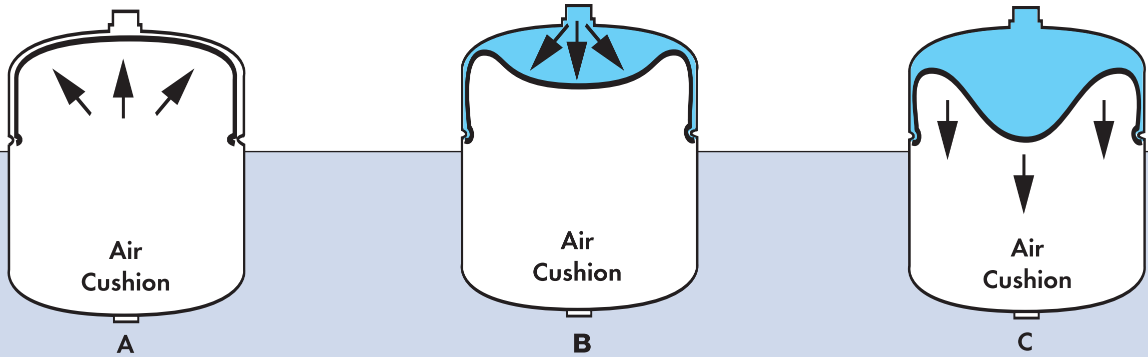
The First in the Industry

AMTROL® designed and patented the first EXTROL® expansion tank in 1954, redefining hydronic heating systems. For over four decades our unique, pre-pressurized, diaphragm-design EXTROL has been the world's leading expansion tank. EXTROL was designed to control system pressure and help reduce energy consumption of heating and circulating operations. Today, AMTROL offers a broad range of both bladder and diaphragm expansion tanks.

The AMTROL Advantage

- AMTROL and its subsidiaries offer a complete line of quality engineered products for heating and water systems throughout the world.
- ISO 9001-2000 Certification reflects AMTROL's worldwide vision and commitment to excellence.
- Full technical support is available.

How AMTROL Expansion Tanks Work



When the system is first filled with cold water, the EXTROL's pre-charge pressure, which is equal to the fill pressure, keeps the diaphragm flush against the tank.

As the system water temperature increases, the expanded water is received by the EXTROL tank.

As the system water temperature reaches its maximum, the EXTROL diaphragm flexes against the air cushion to allow for the increased water expansion.

The EXTROL® System

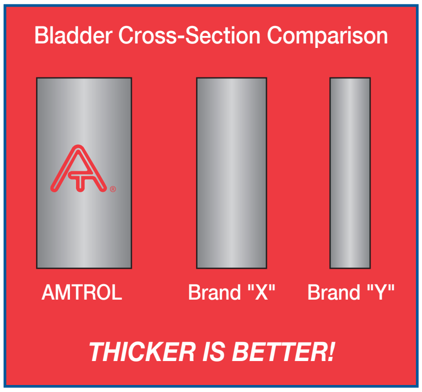
The Function of Hydro-Pneumatic Tank Water Heating and Chilled Water Systems

The primary device in pressurizing and maintaining pressure control in a closed system is the hydro-pneumatic tank, also known, traditionally, as the expansion tank.

Its function in the pressurization process is as follows:

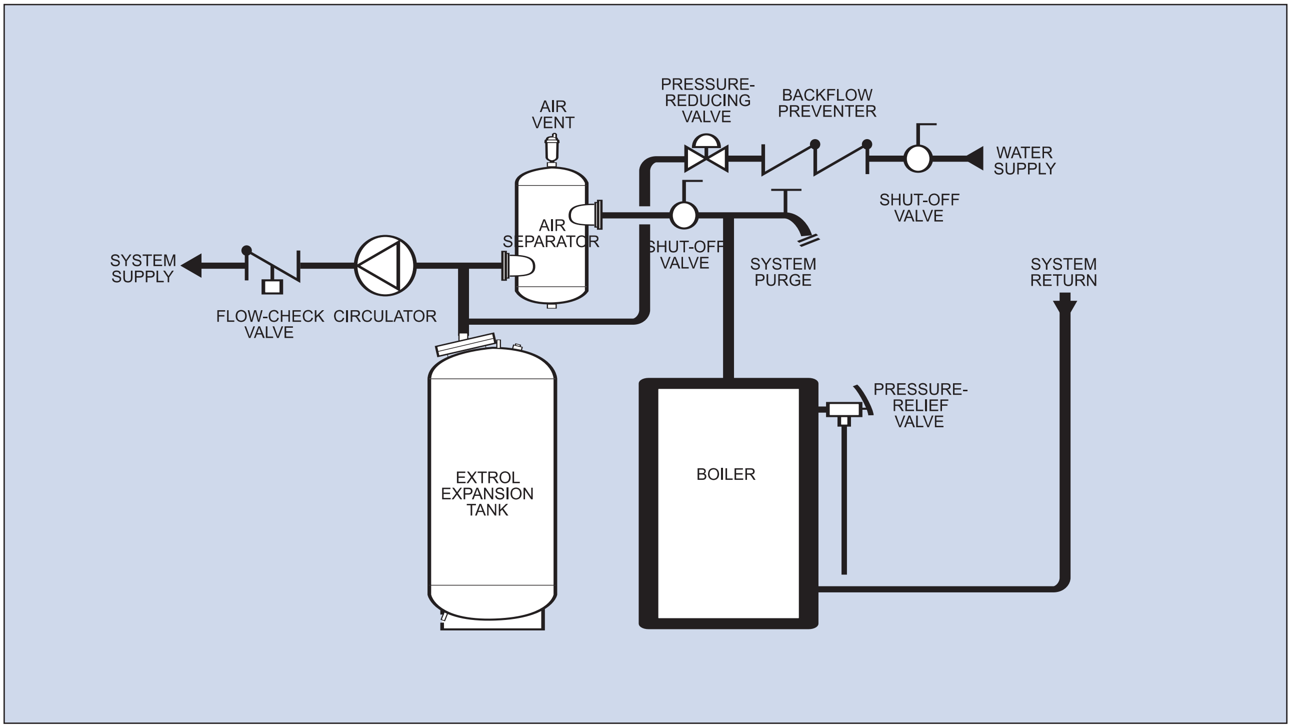
1. Through the use of a pneumatic cushion (air), it maintains positive minimum pressure throughout the system when it is initially filled.
2. As temperature rises, it provides an additional space in the system for the expanded volume of water that results. This is accomplished as the pneumatic cushion is compressed as system pressure increases, creating additional space for the increased volume of water. As the system temperature drops, the compressed pneumatic cushion forces water back into the system, maintaining a positive pressure on the system during all temperatures in the system's operating range.
3. Properly sized, the hydro-pneumatic tank will maintain maximum system pressures within the working pressure limitations of the system equipment and components.
4. By maintaining a positive pressure on the system throughout all the operating temperature range, the hydro-pneumatic tank enables the designer to constantly vent excess air through the use of automatically operating float type air vents.

Superior Performance with AMTROL's Heavy-Duty Butyl Bladder



L-Series and LBC Series (Models 130-600)

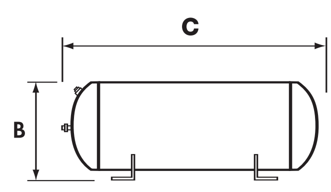
Typical Installation of Commercial Models

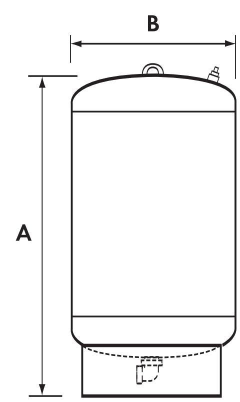


AX-Series EXTROL®

AX-Series EXTROL®
Horizontal & Vertical Models

- Proven diaphragm design since 1954
- Designed and constructed per ASME Section VIII, Division 1 standards
- Horizontal models are available with optional saddles
- Factory pre-charged to 12 psig (0.83 bar)
- Maximum working pressure is 125 psig (8.6 bar)
- Maximum operating temperature is 240°F (115° C)





AX-Series Specifications

Model Number	Tank Volume		Max. Accept.		A – Vert. Height		C – Horiz. Length		B Diameter		System Conn.[1]	Ship Weight w/o saddles		Ship Weight w/ saddles		Vertical Ship.Wt.	
	Gallons	Liters	Gallons	Liters	Inches	mm	Inches	mm	Inches	mm	Inches	lbs.	kg	lbs.	kg	lbs.	kg
AX-15(V)*	8.0	30.3	2.4	9.1	19 ½	495	19 ¼	489	12	305	½	37	17	41	19	43	20
AX-20(V)	10.9	41.3	2.4	9.1	26 ½	673	26 ¼	607	12	305	½	46	21	50	23	45	21
AX-40(V)	21.7	82.2	11.3	42.8	29 ½	749	29	737	16 ¼	356	½	82	37	96	44	90	41
AX-60(V)	33.6	127.2	11.3	42.8	45 ⅛	1146	43	1073	16 ¼	356	½	103	47	116	53	110	50
AX-80(V)	44.4	168.1	22.6	85.5	29	737	28 9/16	725	24	610	1	127	58	104	47	146	66
AX-100(V)	55.7	211.8	22.6	85.5	33 11/16	856	33	840	24	610	1	137	62	114	52	167	76
AX-120(V)	68.0	257.4	34.0	128.7	47 ⅜	1203	41 3/16	1051	24	610	1	210	95	235	107	224	102
AX-144(V)	77.0	291.5	34.0	128.7	52 ¼	1327	46	1170	24	610	1	240	109	246	112	244	111
AX-180(V)	90.0	340.7	34.0	128.7	59 ⅝	1514	53 7/16	1357	24	610	1	242	110	248	113	266	121
AX-200(V)	110.0	416.4	34.0	128.7	66 ⅛	1680	64	1624	24	610	1	275	125	306	139	296	134
AX-240(V)	132.0	500.0	46.0	174.0	57 ⅞	1470	51	1295	30	762	1	398	181	428	194	427	194
AX-260(V)	159.0	600.0	56.0	212.0	64 ¾	1645	62 ¼	1581	30	762	1¼	449	204	480	218	476	216
AX-280(V)	211.0	800.0	84.0	318.0	81 ¾	2076	80	2032	30	762	1¼	630	286	660	299	645	293

[1] System Connection for models AX-15 through AX-100 (vertical and horizontal) and models AX-120V through AX-240V are NPTF, models AX-260 through AX-280 (vertical and horizontal) and AX-120 through AX-240 are NPTM.

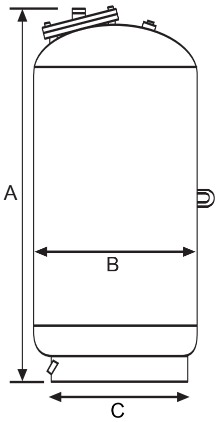
To specify vertical models AX -15V – AX-280V, include V after the model number; other options available on horizontal models: • Bulls Eye Sight Glass • Seismic Anchor Brackets

All dimensions and weights are approximate.

L-Series EXTROL®

L-Series EXTROL®

- Replaceable bladder design
- Designed and constructed per ASME Section VIII, Division 1 standards
- Free-standing on integral floor stands
- Easily installed
- Factory pre-charged to 12 psig (0.83 bar)
- Maximum working pressure is 125 psig (8.6 bar)
- Available with optional 175 psig (12 bar) or 250 psig (17 bar) for high-pressure applications "L" Series
- Maximum operating temperature is 240°F (115°C)



L Series EXTROL

L-Series Specifications

Model Number	Tank Volume		A Height		B Diameter		C Standard Diameterr		System Conn.[1]		Shipping Weight	
	Gallons	Liters	Inches	mm	Inches	mm	Inches	mm	Inches	mm	lbs.	kg
200-L	53	200	37⅝	956	24	610	19	483	1	25	192	87
300-L	80	300	51½	1308	24	610	19	483	1	25	268	122
400-L	106	400	65⁷⁄₁₆	1662	24	610	19	483	1	25	309	140
500-L	132	500	79	2006	24	610	19	483	1	25	328	149
600-L	158	600	63¾	1619	30	762	24	610	1½	38	510	231
800-L	211	800	81¾	2076	30	762	24	610	1½	38	565	256
1000-L	264	1000	73½	1867	36	914	30	762	1½	38	691	313
1200-L	317	1200	85⅞	2181	36	914	30	762	1½	38	779	353
1400-L	370	1400	98¼	2496	36	914	30	762	1½	38	905	411
1600-L	422	1600	69⅛	1756	48	1219	42	1067	1½	38	1,183	537
2000-L	528	2000	84	2145	48	1219	42	1067	1½	38	1,264	573
2500-L	660	2500	100⅞	2562	48	1219	42	1067	2	50	1,445	655
3000-L	792	3000	118⅛	3000	48	1219	42	1067	2	50	1,630	739
3500-L	925	3500	111	2820	54	1372	42	1067	2	50	2,110	957
4000-L	1057	4000	125	3175	54	1372	42	1067	2	50	2,230	1012
5000-L	1321	5000	128	3251	60	1524	42	1067	2	50	2,450	1111

[1] System Connection is NPTF

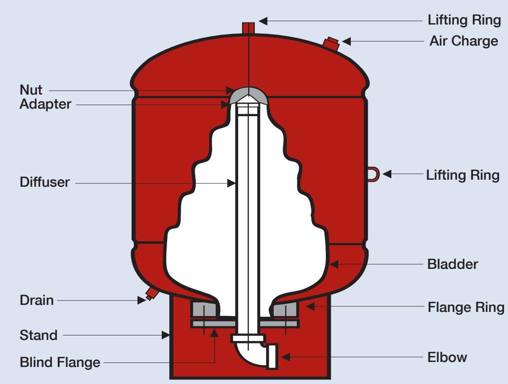
All dimensions and weights are approximate.

LBC-Series EXTROL®

LBC-Series EXTROL®

The LBC bottom connection bladder series incorporates a partial acceptance replaceable bladder made of a heavy-duty butyl material. The seamless bladder construction and contoured bladder design ensures repeatable and predictable long-life expectancy.

- Designed and constructed per ASME Section VIII, Division 1 standards
- Replaceable bladder design
- Maximum working pressure is 125 psig (8.6 bar)
- Maximum operating temperature is 240°F (115° C)
- Broad range of sizes from 10 gal. (35 lit.) to 158 gal. (600 lit.)
- Factory pre-charged to 12 psig (8.6 bar)
- Available with optional seismic restraints and site glass



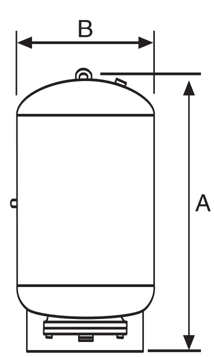
LBC Series Tank

LBC-Series Specifications

Model	Tank Volume		Accept. Volume		A Height		B Diameter		System Conn.[1]		Shipping Weight	
Number	Gallons	Liters	Gallons	Liters	Inches	mm	Inches	mm	Inches	mm	lbs.	kg
35-LBC	10	35	10	35	$38\frac{13}{16}$	985	10	254	1	25	65	29
50-LBC	13	50	11	40	$38\frac{13}{16}$	985	12	305	1	25	72	33
85-LBC	22	85	11	40	$37\frac{7}{16}$	951	16	406	1	25	88	40
100-LBC	26	100	11	40	$42\frac{1}{8}$	1070	16	406	1	25	94	43
130-LBC	34	130	27	100	$37\frac{7}{8}$	962	20	508	1	25	130	59
165-LBC	44	165	27	100	$42\frac{7}{8}$	1089	20	508	1	25	140	64
200-LBC	53	200	27	100	$40\frac{7}{8}$	1039	24	610	1	25	192	87
300-LBC	80	300	27	100	56	1423	24	610	1	25	230	104
400-LBC	106	400	53	200	$68\frac{5}{8}$	1743	24	610	1	25	274	124
500-LBC	132	500	53	200	$82\frac{1}{2}$	2096	24	610	1	25	308	140
600-LBC	158	600	53	200	67	1702	30	762	1	25	442	200

[1] System Connection is NPTF

All dimensions and weights are approximate.



LBC Series EXTROL

Sizing Commercial ASME Models

Precise Sizing of AX, L and LBC-Series EXTROL®s

Things you must know:

1. Total System Volume..(1)_____ gal. (lit.)
2. Minimum System Temperature................................(2)_____ °F (°C)
3. Maximum System Temperature ....(3)_____ °F (°C)
4. Minimum Operating Pressure at EXTROL Tank .... (4)_____ psig (bar)
5. Maximum Operating Pressure at EXTROL Tank .... (5)_____ psig (bar)

Selection of EXTROL Model:

6. Find and enter "Net Expansion Factor"................... (6)_____ (see Table 1)
7. Amount of Expanded Water = line (1) x line (6) ...... (7)_____ gallon (lit.)
8. Find and enter "Acceptance Factor" .... (8)_____ (see Table 2)
9. Minimum Total EXTROL Volume = line (7) ÷ line (8) (9)_____ gallons (lit.)
10. Using Specifications, select an EXTROL that is at least equal to line (9) for "Total Volume" and line (7) for Max. Expanded Water Acceptance Gallons.

Table 1. Net Expansion of Water

Max. System Temperature		Minimum System Temperature						
°F	°C	40°F / 4°C	50°F / 10°C	60°F / 16°C	70°F / 21°C	80°F / 27°C	90°F / 32°C	100°F / 38°C
60°F	16	.0005	.0049	—	—	—	—	—
70°F	21	.00149	.00143	.00094	—	—	—	—
80°F	27	.00260	.00254	.00204	.00111	—	—	—
90°F	32	.00405	.00399	.00350	.00256	.00145	—	—
100°F	38	.00575	.00569	.00520	.00426	.00315	.00170	—
110°F	43	.00771	.00765	.00716	.00622	.00511	.00366	.00196
120°F	49	.0100	.0099	.0095	.0086	.0074	.0060	.0043
130°F	54	.0124	.0123	.0118	.0109	.0098	.0083	.0066
140°F	60	.0150	.0149	.0145	.0135	.0124	.0110	.0093
150°F	66	.0179	.0178	.0173	.0164	.0153	.0133	.0121
160°F	71	.0209	.0208	.0204	.0194	.0181	.0165	.0148
170°F	77	.0242	.0241	.0236	.0227	.0216	.0201	.0184
180°F	82	.0276	.0275	.0271	.0261	.0250	.0236	.0219
190°F	88	.0313	.0312	.0307	.0298	.0287	.0272	.0255
200°F	93	.0351	.0350	.0346	.0336	.0325	.0311	.0294
210°F	99	.0391	.0390	.0386	.0376	.0365	.0351	.0334
220°F	104	.0434	.0433	.0428	.0419	.0408	.0393	.0376
230°F	110	.0476	.0475	.0471	.0461	.0450	.0436	.0419
240°F	116	.0522	.0521	.0517	.0507	.0496	.0482	.0465

Note: For 50/50 ethylene glycol and for 50/50 propylene glycol contact AMTROL technical services.

Table 2. Acceptance Factors*

Maximum Operating Pressure at Tank		Minimum Operating Pressure at Tank										
		5 psig/0.34 bar	10 psig/0.68 bar	12 psig/0.82 bar	15 psig/1 bar	20 psig/1.37 bar	30 psig/2 bar	40 psig/2.8 bar	50 psig/3.44 bar	60 psig/4 bar	70 psig/4.8 bar	80 psig/5.5 bar
27 psig	1.8 bar	0.527	0.408	0.360	0.288	0.168	—	—	—	—	—	—
30 psig	2.0 bar	0.560	0.447	0.403	0.336	0.224	—	—	—	—	—	
35 psig	2.4 bar	0.604	0.503	0.463	0.403	0.302	0.101	—	—	—	—	—
40 psig	2.8 bar	0.640	0.548	0.512	0.457	0.366	0.183	—	—	—	—	—
45 psig	3.0 bar	0.670	0.586	0.553	0.503	0.419	0.251	0.084	—	—	—	—
50 psig	3.4 bar	0.696	0.618	0.587	0.541	0.464	0.309	0.155	—	—	—	—
55 psig	3.79 bar	0.717	0.646	0.617	0.574	0.502	0.359	0.215	0.072	—	—	—
60 psig	4.0 bar	0.736	0.669	0.643	0.602	0.536	0.402	0.268	0.134	—	—	—
65 psig	4.4 bar	0.753	0.690	0.665	0.627	0.565	0.439	0.314	0.188	0.062	—	—
70 psig	4.8 bar	0.767	0.708	0.685	0.649	0.590	0.472	0.354	0.236	0.118	—	—
75 psig	5.0 bar	0.780	0.725	0.702	0.669	0.613	0.502	0.390	0.279	0.167	0.056	—
80 psig	5.5 bar	0.792	0.739	0.718	0.686	0.634	0.528	0.422	0.317	0.211	0.106	—
90 psig	6.2 bar	0.812	0.764	0.745	0.716	0.669	0.573	0.478	0.382	0.287	0.191	0.096
100 psig	7.0 bar	0.828	0.785	0.767	0.741	0.698	0.610	0.523	0.436	0.347	0.261	0.174
110 psig	7.5 bar	0.842	0.802	0.786	0.762	0.723	0.642	0.561	0.481	0.401	0.321	0.241

** Acceptance factors based on EXTROL being charged while empty of liquid to minimum operating pr essure.*

Typical Specification for Extrol®

Hydronic Expansion Tank "Typical Specification ASME Vessels"

AX Series Expansion Tank (Diaphragm type pre-pressurized)

The pressurization system shall include an EXTROL®, diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at those components in the system to the maximum allowable pressure at those components. It shall maintain minimum operating pressure necessary to eliminate all air. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank, Model No.____________. Dimensions shall be as indicated on the drawings.

The expansion tank shall be welded steel, constructed, tested and stamped in accordance with Section VIII, Division 1 of the ASME Code for a working pressure of (125 psig/8.6 bar) (_______) and air pre-charged.

The tank shall be supported by steel legs or a base (integral ring mount) for a vertical installation or steel saddles for horizontal installations. Each tank will have a heavy- duty butyl/EPDM diaphragm with code approvals ANSI/NSF 61.

The manufacturer shall be AMTROL Inc. The manufacturer shall have at least five years experience in the fabrication of diaphragm-type ASME expansion tanks.

L & LBC Series Expansion Tank (replaceable bladder-type pre-pressurized)

The pressurization system shall include an EXTROL®, replaceable bladder-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at those components in the system to the maximum allowable pressure at those components. It shall maintain minimum operating pressure necessary to eliminate all air. The only air in the system shall be the permanent sealed-in air cushion contained in the replaceable bladder-type tank, Model No.____________. Dimensions shall be as indicated on the drawings.

The expansion tank shall be welded steel, constructed, tested and stamped in accordance with Section VIII, Division 1 of the ASME Code for a working pressure of (125 psig/86 bar) (175 psig/12 bar) (250 psig/17 bar) (_______) and air pre-charged.

The tank shall be supported by steel legs or a base (integral ring mount) for a vertical installation. Each tank will have a heavy-duty replaceable butyl bladder (ANSI/NSF 61 "L" Series).

The manufacturer shall be AMTROL Inc. The manufacturer shall have at least five years experience in the fabrication of bladder-type ASME expansion tanks.

*Refer to installation manual for warranty information or visit our website at **www.amtrol.com**

AMTROL INC.® Engineered Products

w w w . a m t r o l . c o m

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Part # 9017-105 (08/04) MC# 2682

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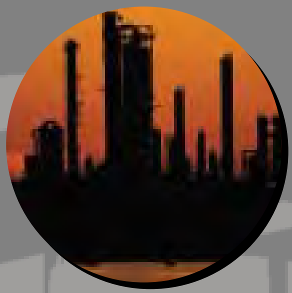
  

Vacuum Systems and Heat Transfer Products

GRAHAM
ENGINEERING ANSWERS

Graham engineers analyze

your specific vacuum and

heat transfer requirements to

maximize the efficiency and

performance of your process.

Because it's not just about

engineering products, it's about

engineering answers.

Find Your Answer with Graham

Products

Our leadership position in vacuum systems and heat transfer equipment is based on decades of proven experience, and backed by thousands of units designed to maximize efficiency and to operate with trouble-free performance.

VACUUM SYSTEM PRODUCTS

Ejectors

- Steam jet ejectors
- Organic motivated ejectors
- Thermocompressors
- Steam vacuum refrigeration systems

Liquid Ring Pumps

- Vacuum
- Compressors
- Packaged vacuum systems
- Hybrid systems

Dry Vacuum Pumps

Process Vacuum Condensers

HEAT TRANSFER PRODUCTS

Steam Surface Condensers

- Turbine-generator condensers
- Mechanical drive condensers

Heliflow Heat Exchangers

- Cryogenic vaporizers and coolers
- Vent condensers
- Vaporizers
- Gas coolers
- Liquid to liquid
- Sample coolers
- Seal coolers

Plate Heat Exchangers

Micro-Mix II Instantaneous Hot Water Heaters

Clean Steam Generators

Desuperheaters

High Standards

All Graham equipment is built to the world's most exacting standards and codes, such as ASME Section VIII, Div. 1; TEMA C, B and R; Heat Exchange Institute; American Petroleum Institute; ISO 9001; and the Chinese Safety Quality License for Stationary Pressure Vessels.

Single-Unit Responsibility

Graham engineers and designs all work in-house to ensure performance and delivery you can rely on. This single-unit responsibility is unique, as we are one of the few manufacturers in the business that designs, manufactures, and tests our components in our own facilities.

Testing

To ensure efficient, trouble-free equipment, Graham can assemble and type-test certain products prior to shipment. Complementing our manufacturing capability is a separate research and development facility that is continually searching for better methods of designing and applying technology.

Responsive Service

Graham recognizes the need for fast and efficient responses to our customers' requirements. Our in-house capability ensures that equipment and drawings are delivered on schedule.

Expert Personnel

We have a complete staff of highly trained service engineers, available at a moment's notice, to be at a job site to offer technical assistance. Our sales representatives are factory trained engineers capable of discussing Graham's product lines in detail, conducting in-house seminars for customers, and offering technical assistance.

Something Extra

- *Application Appraisal* Our extensive experience in the process, power and marine industries makes us experts in applying Graham equipment to the overall process. A member of Graham's engineering or sales staff can survey your process to tell you how best to apply our equipment.

- *Personnel Training* In-house seminars conducted by our specialists teach customers how to operate, apply, maintain and service our products.

- *Facility Start-Up* Graham engineers are always available to supervise installation and start-up, and instruct your operating personnel.

- *Equipment Service* Graham service engineers will travel anywhere in the world to service Graham equipment.

- *Product Application Facilities* Graham's Research and Development department and Production Test Floor works closely with you on special projects requiring laboratory or prototype work.

Vacuum System Products

Steam Jet Ejectors:

Vacuum Performance Made Simple, Rugged, and Trouble-Free

Graham pioneered the modern steam jet ejector system, and continues to improve its efficiency and performance. We are the only steam jet ejector manufacturer that designs and manufactures all major components of the system. This single-unit responsibility allows us to guarantee unmatched ejector performance.

Combination vacuum systems, commonly called hybrid systems, combine our steam jet ejectors, condensers, and liquid ring pumps for enhanced efficiency and performance.

Graham makes all types of multi-stage ejector systems, and has supplied the majority of the world's refinery vacuum distillation tower ejector systems.

Graham ejector systems are designed to use steam or organic vapors as the motive fluid, and are available in a wide range of metals and non-metallic, corrosion- and erosion-resistant materials. Our most popular sized models have pre-engineered components, however, we work with customers to custom design ejector systems of any size.

Steam jet ejectors are simple, rugged devices that produce vacuum without moving parts. Vibration, as well as high electricity costs and bearing or seal problems, are eliminated. Our ejectors are explosion-proof, can be installed indoors or outdoors, and are noted for their long life, low noise levels, and minimal maintenance requirements.

With more than 65 years of experience, Graham Corporation continues to lead the world in the manufacturing of ejector systems.

Our steam jet ejectors are used successfully for many applications, including filtration, distillation, impregnation, drying, degassing, deodorizing, deaerating, evaporation, desalination and crystallization.

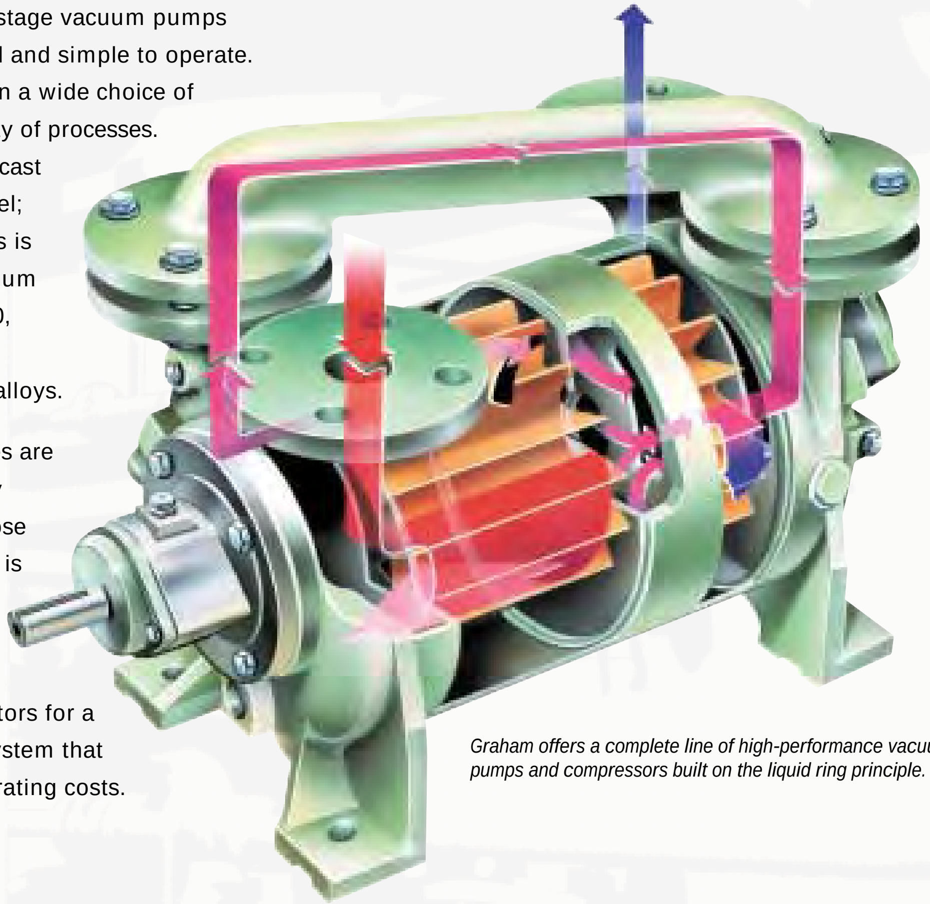
Vacuum System Products

Liquid Ring Vacuum Pumps and Compressors:

A robust machine that keeps getting better

Graham's single and two-stage vacuum pumps are designed to be rugged and simple to operate. The pumps are available in a wide choice of materials to match a variety of processes. Standard pumps come in cast iron, steel or stainless steel; while the Cor-Resist series is available in nickel, aluminum bronze, Hastelloy, Alloy 20, Ni-resist, titanium, duplex stainless steel, and other alloys.

These versatile workhorses are designed to excel in many processes, particularly those where condensable vapor is present. Graham vacuum systems can include both liquid ring vacuum pumps and steam jet ejectors for a highly efficient vacuum system that optimizes capital and operating costs.



Graham offers a complete line of high-performance vacuum pumps and compressors built on the liquid ring principle.

Designed to meet the needs of many industries, Graham liquid ring vacuum pumps and compressors are available in cast iron, steel, stainless steel, bronze, and many other corrosion-resistant materials.

Our liquid ring vacuum pump packages are engineered from the ground up based on the premise "Keep it simple, build it tough."

Vacuum System Products

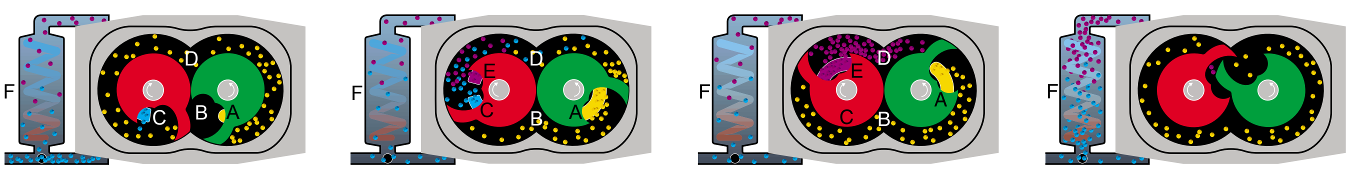
DRYFLO Dry Vacuum Pumps:

Ready to Meet Your Needs Today, and Expand with Them Tomorrow

Graham DRYFLO dry vacuum pumps run without working fluids such as steam or water. As a result, they run clean, eliminating environmental worries and the cost of disposing contaminates. DRYFLO pumps operate either hot or cool depending on customers' process requirements, and because they feature a modular design, Graham can custom build a DRYFLO model to meet specific application requirements.

DRYFLO's modular design makes it easy to convert and configure, and additional components can be easily added to build a tough, environmentally friendly vacuum system fitted specifically to meet customers' processing needs. Only Graham DRYFLO pumps offer this kind of flexibility.

Graham DRYFLO pumps run cooler and more efficiently than other pumps because they use cooled process gas to create compression rather than hot exhaust gas or by mechanically reducing chamber volumes.



As the hook-and-claw rotors in the Graham DRYFLO type ALLex pump turn, gases are moved through the pumping stages without internal compression.

Graham DRYFLO pumps are so remarkable because:

- They don't need lubricating or sealing fluids.
- The pump is easily disassembled for maintenance.
- They run clean with no contaminated liquid to dispose of.
- They don't require steam to produce vacuum.
- Their no-wear, hook-and-claw design uses a direct gas cooling process that keeps the pump's internal temperature low, reducing chances of overheating.
- Their modular design allows them to be easily upgraded with additional condensers and mechanical boosters to meet various demands.

Vacuum System Products

Process Vacuum Condensers:

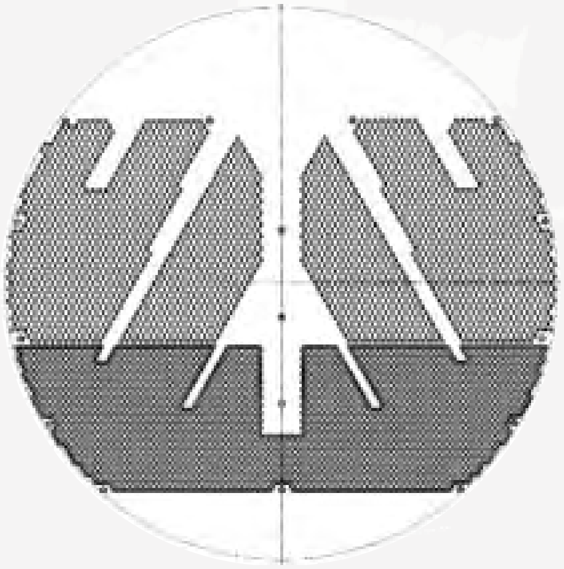
An Integral Part of the Vacuum System Design

Graham has the experience and proven design methods to build reliable, problem-free condensers, which when used as precondensers, permit reclamation of high-value product, and reduce operating costs when applied as intercondensers. Both pre and intercondensers support the total vacuum system to achieve optimum efficiency and maximum performance.

At Graham, we design with a systems approach, assessing appropriate layout and configuration of the entire vacuum system. And because proper installation of a vacuum condenser is as important to a smooth operation as its design, we work with customers to identify exactly where to position them — either ahead of, or into, their total vacuum system. We also work with customers to determine which model is best, and fully design, build and guarantee all of our vacuum systems. That's the Graham advantage.

Graham's condensers are designed to reclaim valuable product and minimize pressure drop to keep operating costs low and reduce environmental concerns.

Our freeze condensers trap and solidify product on heat transfer surfaces to improve reclamation and reduce carry-over into the downstream vacuum system.



Graham has the knowledge and experience to thermally and hydraulically design and build condensers capable of operating at pressures as low as 0.4 Torr. The above illustrates a tube field layout for a high vacuum process condenser in the production of nylon intermediates.

Graham: Engineering Answers

Vacuum System Products in Action

Four-stage vegetable oil deodorization vacuum system at a U.S., West Coast edible oil refinery.

Nickel-aluminum-bronze Cor-Resist liquid ring vacuum pumps for a salt water deaeration application

Mechanical booster combined with a DRYFLO type ALLEX dry vacuum pump system for a drying application at

A combination mechanical booster and liquid ring vacuum pump system for a plastics and resins plant in Canada.

Vacuum precondenser on a visbreaker at a South American lube oil refinery. Vacuum system supplied as unitized system,

Heat Transfer Products

Heliflow Heat Exchangers:

The Fit-Anywhere, Do-Anything, Gold Standard

The Heliflow heat exchanger is invaluable as a heater, cooler, condenser, or vaporizer. It can transfer heat up to 40 percent more efficiently than equivalent straight-tube exchangers, and their spiral design eliminates baffles and maldistribution. For these reasons, and its many unique attributes, the Heliflow has replaced the straight tube heat exchanger in many applications.

Compact

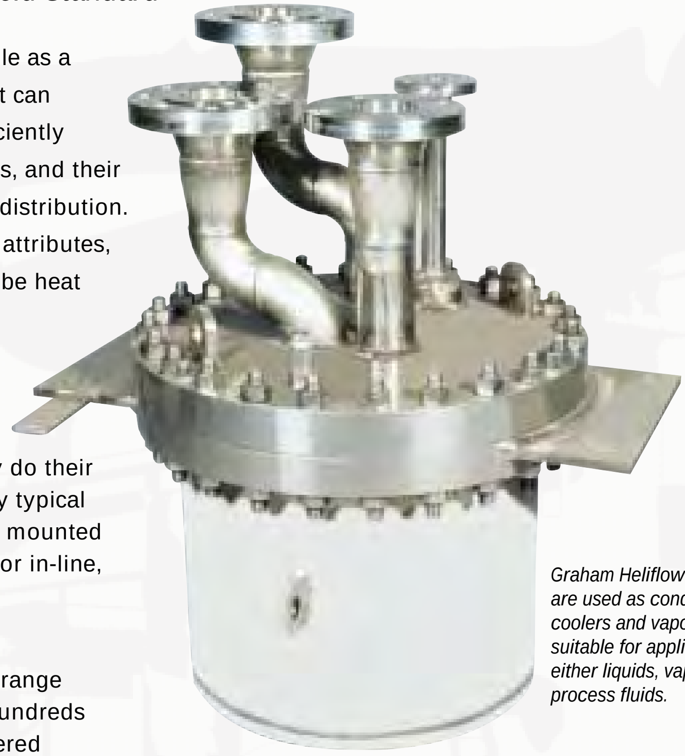
With only three main components, Heliflow heat exchangers are compact, easy to disassemble and maintain. They do their job in a fraction of the space required by typical shell-and-tube exchangers. They can be mounted on columns, nozzles, walls and ceilings or in-line, and certain sizes require no support.

Standardized and Custom Built

Heliflow models are available in a wide range of sizes and materials. Graham builds hundreds of standard models, which can be delivered rapidly, and can custom build units for specialized applications. In either case, all models are built to fully comply with applicable codes.

Infinite Applications

The Heliflow is unmatched for many highly specialized applications and can be used as a high-pressure air or gas cooler, process cooler or heater, vent condenser, reflux or tower-top condenser, acid heater or cooler, feedwater and blowdown exchanger, jacket water cooler, freon or refrigerant cooler, hydraulic oil cooler, cryogenic exchanger, cooler for electroplating solutions, hot water heater, mechanical seal cooler, and sample cooler. The applications are countless.



Graham Heliflow heat exchangers are used as condensers, heaters, coolers and vaporizers, and are suitable for applications that use either liquids, vapors or gases as process fluids.

Heliflow heat exchangers come in standard sizes or units which can be custom-designed for each particular application.

The unique design of Heliflow heat exchangers makes them strong, compact, efficient, reliable, versatile and exceptionally easy to disassemble.

Heat Transfer Products

MicroMix II Instantaneous Steam-Fired Water Heater:

Fits Almost Anywhere for Instant, Unlimited Hot Water

The MicroMix II uses Graham's proven Heliflow heat exchanger and a unique feed forward blending valve to provide hot water on demand, instantly and safely. The system senses demand requirements for hot water and provides blended hot water at a preset temperature throughout all rated flow capacities.

Each MicroMix II water heater is a simple, compact, pre-piped package that can deliver hot water within +/- 4 degrees F of a preset temperature. Capacities are up to 120 GPM; units are available in standard materials, stainless steel for pharmaceutical applications and double wall construction. And each system requires less than six square-feet of floor space. Every MicroMix II unit is designed to ASME Section VIII, Division 1 and is fully certified.

Standard MicroMix packages are completely assembled as shown. There are four standard MicroMix II models, which include accessories and frames.

Clean Steam Generators:

Clean, chemical-free steam from plant steam

Graham Clean Steam Generators are ideal for sterilization, clean-in-place applications, autoclaves, direct injection heating, food processing and humidification. They are available in standard sizes for quick delivery, or can be custom designed to fit specific requirements. Standard materials are copper heat transfer components, and stainless steel is available for improved corrosion protection and to minimize contamination of production steam.

Our Steam Generators are compact, highly efficient vertical units that consistently deliver clean chemical-free steam. All within a very small footprint.

Clean steam generator, including accessories for hospital humidification.

Heat Transfer Products

Graham Plate Heat Exchangers:

Designed to Seal Out Leaks and Lock in Performance

Graham Plate Heat Exchangers deliver extremely efficient heat transfer. Their asymmetrical channel design permits independent optimization of the hot and cold side fluids for top efficiency.

When plate bundles are clamped into the frame, our gasket system forms an extremely tight seal that virtually eliminates fluid leaks and reduces downtime.

Graham plate heat exchangers feature a unique gasket system that locks plates in place, eliminating leakage and providing high-thermal performance.

The unique patterns on our heat transfer plates promote high turbulence, discourage fouling and eliminate unwanted maldistribution.

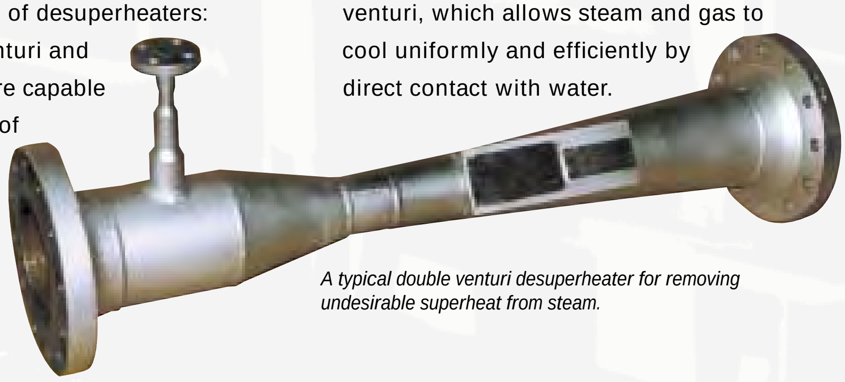
Graham Plate Heat Exchangers are available in stainless steel, titanium, and other corrosion-resistant metals. Graham provides a full range of plate and gasket materials for premium performance with your particular process fluids.

Desuperheaters:

Reliable Steam Conditioning

Graham supplies three types of desuperheaters: Steam atomizing, double venturi and single venturi, all of which are capable of handling virtually any set of conditions when cooling steam or processing gas.

The superiority of Graham desuperheaters comes from our unequalled experience designing and applying the venturi, which allows steam and gas to cool uniformly and efficiently by direct contact with water.



A typical double venturi desuperheater for removing undesirable superheat from steam.

Heat Transfer Products

Steam Surface Condensers:
Building Bigger, Better and Stronger

Graham is one of the industry's leading manufacturers of shop-tubed steam surface condensers for mechanical drive turbines or power plant turbine-generator sets.

Our condensers have substantial proven experience in ammonia, ethylene, refinery, and methanol plant surface condenser applications, and our steam surface condensers are preferred for mechanical drive turbine services. Graham also matches steam jet ejectors and liquid ring vacuum pumps to the condenser for a more efficient and reliable operation.

Graham surface condensers are available as stand alone or packaged units, in either circular or rectangular units, with surface areas exceeding 200,000 square feet.

A large rectangular condenser for a U.S., Gulf Coast merchant power plant.

For merchant and cogeneration power plants, where large rectangular condensers are required, Graham builds the largest units in modular components to be assembled on site. For applications involving aerated makeup water, Graham can integrate its DO2 system into the condenser and venting package design. The DO2 system guarentees that dissolved oxygen levels in condensate exiting the condenser hotwell are below 7ppb.

Graham has been designing and manufacturing condensers for more than 65 years.

Graham: Engineering Answers

Heat Transfer Products in Action

One of six large high-pressure Heliflow heat exchangers in a super-critical water treatment process.

Mechanical drive turbine exhaust condenser at a U.S., West Coast chemical company.

Plate heat exchangers ready for shipment.

One of two direct contact turbine exhaust condensers made for a Southeast Asian geothermal power plant

Graham MicroMix II hot water heater for hospital.

A large stainless steel condenser for a geothermal power plant on the U.S., West Coast

A cryogenically cooled vent condenser at a chemical storage facility that reclaims 98 percent of VOC vapors as condensate.

Engineering, Manufacturing, Research

Graham has complete engineering departments at their headquarters in Batavia, New York, U.S.A., and at Graham Precision Pumps Limited in Congleton, England. Each includes CAD, design and project engineers, who oversee every detail from a project's conception to the time the equipment is installed and operating successfully.

Solving Problems

After the equipment is installed, a full team of highly trained service engineers is available to respond to customers' calls for technical assistance.

Engineering Answers

Graham in Action

- All engineering is done "in-house."
- We performance-test our jet ejector systems and other units of new design or of unusual performance conditions.

- Quality control department works closely with our engineers, designers and manufacturing department to ensure that equipment is fabricated according to exact code requirements and specifications.
- Computer programs aid product design, engineering and performance.
- In-house training seminars keep Graham's engineering staff fully acquainted with the latest developments.

Manufacturing Facilities

Each of Graham's facilities is modern and fully equipped to manufacture equipment produced there. And, at both locations, our fundamental concern is the integration of fabrication, assembly, testing and quality control.

Engineering Answers

Our manufacturing capabilities include:

- Modern machine tools including three automatic drills with 37 and 23 spindles, automatic welding equipment, tape controlled drills and turret lathes.

- Non-destructive testing equipment.
- A complete line of calibrated precision measuring equipment and pressure gauges.
- Code welders qualified to domestic and international codes.
- More than 200,000 square feet in fabrication bays.
- Paint and sandblast.
- Quality control departments that coordinate closely with all engineering and fabricating departments.
- Production control departments that closely monitor workflow in the shop to meet required delivery schedules.
- Experienced shop and supervisory personnel, many of whom have been with Graham more than 30 years.

In-House Manufacturing

Modern facilities enable us to manufacture all equipment "in-house," eliminating the uncertainties that come with subcontracting and reducing the chance that components could be misaligned – which causes numerous delays and problems later on. Graham's emphasis on in-house design and manufacturing results in equipment that's fully integrated to your exacting requirements.

Research and Development

Graham's central research and development facility in Batavia, New York, U.S.A., is completely equipped to perform testing of steam jet ejectors, heat exchangers, liquid ring pumps, and other Graham products.

This modern laboratory develops and improves products and finds new applications for existing products. The facility also works closely with customers who have unique concerns that may require laboratory or prototype work.

A freeze condenser undergoing performance evaluation in the R&D facility.

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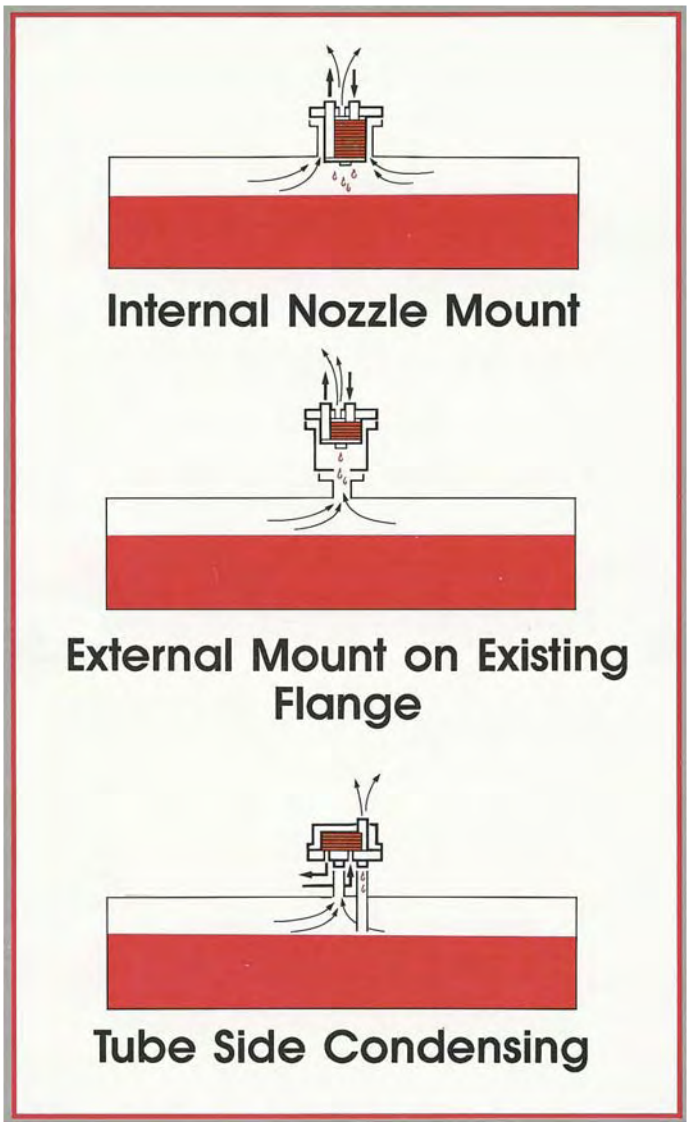
e-mail: equipment@graham-mfg.com

GRAHAM
ENGINEERING ANSWERS

GRAHAM HELIFLOW VENT CONDENSERS

For
- *STORAGE TANKS*
- *DISTILLATION COLUMNS*
- *PROCESS REACTORS/REFLUXING*
- *VAPOR RECOVERY SYSTEMS*



Minimize Air Contaminants

Recover Valuable Solvents

Cryogenic, Water or Brine Cooled

Counter Flow Maximizes Vapor Removal

Proven Design with Low Pressure Loss

Compact Design for Easy Installation

Accommodates Mounting of Conservation Vents and Flame Arresters

Wide Range of Metallurgies

Eighty Standard Sizes

graham Heliflow® HEAT EXCHANGERS

GRAHAM HELFLOW®
Vent Condenser Design Advantages

The unique Heliflow® counter flow heat exchanger, long noted for its spiral counter flow design, has now been adapted for storage tank vent condensing applications.

To prevent pressure build up or collapse under vacuum, liquid storage tanks are vented to the atmosphere. Loss of vapor from atmospheric storage tanks can, under some circumstances, be surprisingly large and costly.

As storage tanks are warmed by the sun during the day, liquid is vaporized and is vented to the atmosphere.

At night, vapor and liquid volume decrease and air is drawn in, only to be re-expelled together with its saturation vapor component during the next temperature rise.

A similar situation occurs when the tank is filled or drained, with vapor exiting during filling and air entering during drainage.

The loss of vapor during these episodes may or may not be a major cost factor, but increasing government environmental regulations require that even the escape of relatively small vapor quantities be limited.

Graham Corporation has developed several versions of its world famous Heliflow spiral counter flow heat exchanger, which can be readily installed in or on existing, as well as new, storage tanks.

These compact counter flow devices assure that the vented gases are stripped of saturation vapors by optimizing cooling as exiting gases are sub cooled by the "coldest" entering cooling medium.

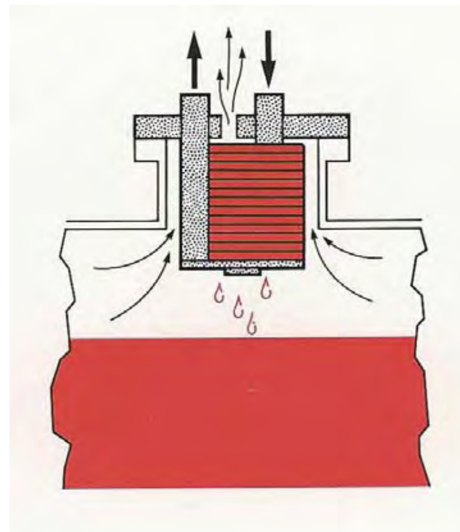
The Heliflow's unique coil design allows it to operate under extremes of temperature and pressure. This ability to absorb thermal stresses proves ideal in vent condenser applications where cooling mediums of chilled thermal fluids, refrigerants and liquified gases can be utilized by sub zero cooing of process vent gases.

The unique Heliflow design forces the vapor around the long spiral path, counter flow to the coolant. Designs are available for vapor flow within the tubes as well as on the shell side. In all cases, the same spiral counter flow arrangement is utilized.

Even at low velocity, the vapors are caused to constantly change direction as they impact the spiral tube barrier, yet pressure drop is minimized because both tube and shell side are fed in parallel.

Unlike shell and tube exchangers, the Heliflow design has the thermal characteristics of a double pipe exchanger, yet provides equipment compactness. Since the flow path continuously turns, the Heliflow has the added advantage of the vapor not slipping along the tube but must constantly change direction and impinge on the tube surface, thus assuring contact and condensation, wringing moisture from exiting gases as they are cooled by the cold entering cooling medium.

VCIN
Internal Nozzle Mount

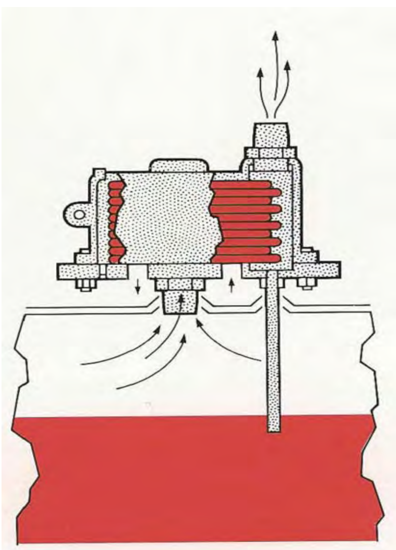


VCIN Internal Nozzle Mount
This model is supplied with the bundle mounted on the base plate for installation directly inside the nozzle of a storage tank or process vessel. A baffle plate is positioned on the bottom of the bundle parallel to the base plate. This forms a flow channel that directs the vapor into the bundle at the location where the cooling media exists. Vapors are then directed through the spiral path toward the cooling media inlet connection. This insures a fully counter current flow for optimal cooling and subsequent condensation.

Condensed vapors collect on the baffle plate and drip back into the process vessel or storage tank. This design offers the lowest profile and avoids the cost of a casing.

Graham Heliflow® Vent Condensers available in a wide range of styles and areas 1 ft.^{2} to 650 ft.^{2}

VCT
Tube Side
Condensing

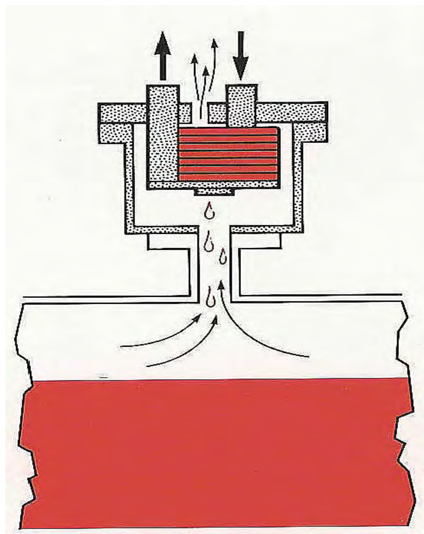


VCT Tube Side Condensing
When corrosive vapors require special metallurgy, the vapors can be condensed tube side, thus limiting special materials to the bundle only.

Vapors entering the bundle are contained within the manifold and parallel tubes. Entrance is adjacent to shell side coolant outlet. The vapors must follow the spiral tube path in counter flow to coolant, and exit adjacent to the shell side cooling inlet.

Condensed liquid drains down the exhaust manifold into the storage tank, or via piping to external receiver.

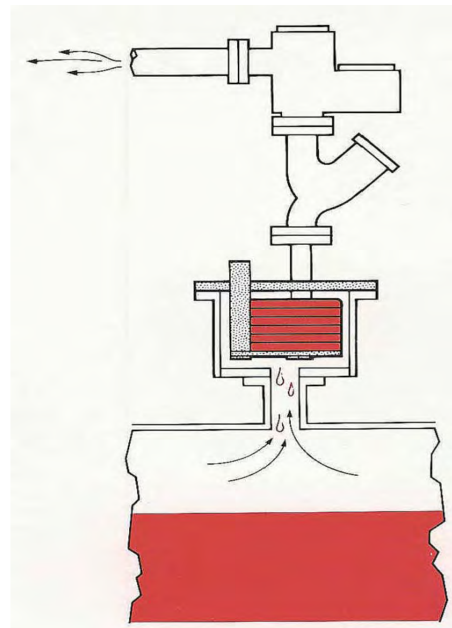
VCON
External Mount on
Existing Flange



VCON External Mount on Existing Flange
If the existing flange on the storage tank is too small to accommodate the VCIN internal nozzle mount, this version can be utilized.

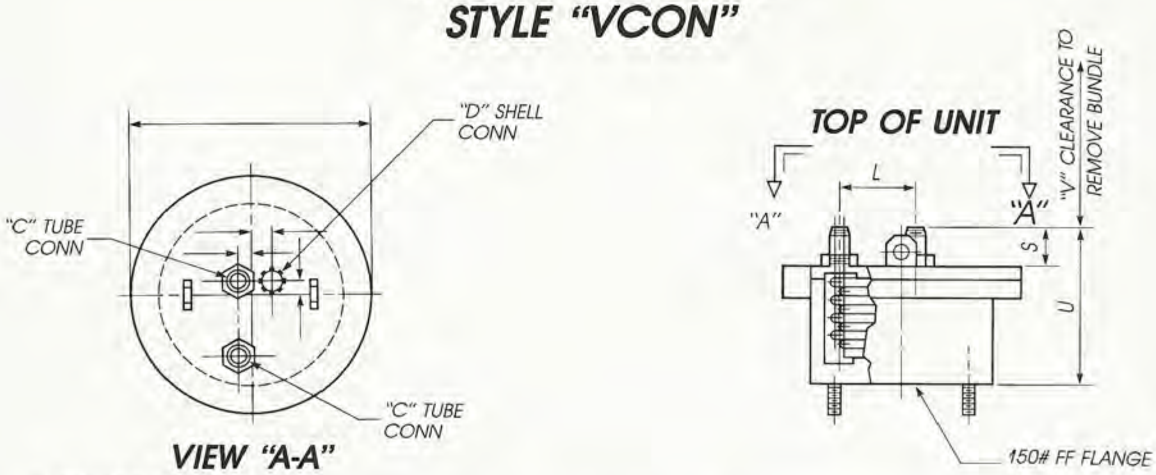
Vapors rising from the tank enter the bottom of the extended Heliflow casing. The bundle and base plate are identical to the VCIN design. Vapor flow is forced to follow the same horizontal spiral counter flow path, exiting the base plate adjacent to the coolant inlet manifold. Condensate drips off the bottom baffle and back into the storage tank though the flanged nozzle, or via drain piping to external receiver.

VCON/VCIN
with
FLAME ARRESTER
and/or
CONSERVATION VENT



Direct Mounting
The compact design and unique orientation of the Heliflow VCON and VCN styles accommodates the direct mounting of a flame arrester and/or conservation vent on the vent condenser outlet connection. This feature eliminates extensive interconnecting piping and supports making installation simple and economical.

HELIFLOW VENT CONDENSER
STYLE "VCON"



FEMALE THREADS

ALL DIMENSIONS ARE IN INCHES														
SIZE					A	C	D*	G	H	L	S	U	V	W
4-10	3-10				12 1/8	1/2	1/2	5/8	7/8	3 1/16	1 1/2	4 7/8	4	1
8-10					12 1/8	1/2	1/2	5/8	7/8	3 1/16	1 1/2	5 3/8	5	1
4-12					14 5/8	1 1/4	1	1	1 1/16	4 1/4	2 1/2	6 5/8	5	1
8-12	6-12	12-12			14 5/8	1 1/4	1	1	1 1/16	4 1/4	2 1/2	7 5/8	5	1
9-14S	12-14S	18-14S			16 7/8	1 1/4	1 1/2	15/16	1 5/16	5 3/8	2 11/16	9 13/16	8	1
15-14L	12-14L	20-14L	30-14L		16 7/8	1 1/4	1 1/2	15/16	1 5/16	5 3/8	2 11/16	12 13/16	11	1
9-16S	12-16S	18-16S			20	2	2	1 7/16	1 9/16	6 7/8	2 13/16	10 3/16	8	1 1/2
15-16L	10-16L	12-16L	20-16L	30-16L	20	2	2	1 7/16	1 9/16	6 7/8	2 13/16	13 3/16	11	1 1/2
30-16LL					20	2	2	1 7/16	1 9/16	6 7/8	2 13/16	20 11/16	19	1 1/2
15-18S	10-18S	12-18S	20-18S		22 3/8	2 1/2	2 1/2	1 13/16	1 13/16	8	3 3/8	14 1/4	12	1 9/16
30-18L	24-18L	20-18L			22 3/8	2 1/2	2 1/2	1 13/16	1 13/16	8	3 3/8	21 3/4	19	1 9/16
12-20S	10-20S	15-20S	20-20S		25	2 1/2	2 1/2	1 13/16	1 13/16	9	3 1/4	14 3/8	12	1 1/2
30-20L	20-20L	24-20L			25	2 1/2	2 1/2	1 13/16	1 13/16	9	3 1/4	21 7/8	19	1 1/2
12-22S	10-22S	15-22S	20-22S		26 7/8	2 1/2	2 1/2	2 1/8	2	10 3/8	3 3/16	14 1/2	12	1 7/8
24-22L	20-22L	30-22L			26 7/8	2 1/2	2 1/2	2 1/8	2	10 3/8	3 3/16	22	19	1 7/8
12-24S	10-24S	15-24S	20-24S		30 1/8	2 1/2	2 1/2	2 1/8	2 1/8	12	2 15/16	14 3/4	12	2 1/4
24-24L	20-24L	30-24L			30 1/8	2 1/2	2 1/2	2 1/8	2 1/8	12	2 15/16	22 1/4	19	2 1/4
12-26S	10-26S	15-26S			31 7/8	2 1/2	2 1/2	2 1/8	2 1/8	13	2 13/16	14 7/8	12	2 1/4
24-26L	20-26L	30-26L			31 7/8	2 1/2	2 1/2	2 1/8	2 1/8	13	2 13/16	22 3/8	19	2 1/4
12-28S	10-28S	15-28S			36 7/8	3	3	2 5/8	2 5/8	14 1/2	3 3/8	15 7/8	12	2
24-28L	20-28L	30-28L			36 7/8	3	3	2 5/8	2 5/8	14 1/2	3 3/8	23 3/8	19	2

NOTE: ALL DIMENSIONS ARE SUBJECT TO CHANGE DEPENDING ON CUSTOMER REQUIREMENTS AND DESIGN CONDITIONS.

Graham provides vacuum and heat transfer equipment to the chemical, petrochemical, pharmaceutical, power and process industries – Our products include:

- Heliflow Heat Exchangers
- Desuperheaters
- Steam Jet Ejectors
- Plate Heat Exchangers
- Steam Surface Condensers
- Atmospheric Relief Valves
- Steam Vacuum Refrigeration Systems
- Liquid Ring Vacuum Pumps
- Micro Mix II Water Heaters

Heliflow®

Graham Corporation
20 Florence Avenue
Batavia, NY 14020
585-343-2216 Fax: 585-343-1097

Bulletin VC94-2

GRAHAM
ENGINEERING ANSWERS

PLATE HEAT EXCHANGER SPECIFICATIONS

Customer:	R.D. Miner Company	Graham Job#	94-18998PE
Customer Ref:	PO# 548-0367	Graham Ref:	1467SF93
Item:	HX-1	Date:	12/23/94
		Engineer:	SCC

	HOT SIDE	COLD SIDE
Fluids:	WELL WATER	BOILER WATER
Flow (gpm)	165.00	165.00
Flow (pph)	81002.53	81217.96
T-in (deg. F)	170.00	100.00
T-out (deg. F)	110.00	160.00
Specific Gravity	0.98	0.98
Specific Heat (Btu/lb./F)	1.00	1.00
Thermal Conductivity	0.37	0.37
Viscosity (cp)	0.47	0.52
Operating Pressure (psig)	100.00	130.00
Pressure Drops (psi)	9.71	7.02
Passes	2.	2.
Nozzle Diameter (inches)	4.0	4.0
Nozzle Material	Titanium	Titanium

Heat Exchanged (Btu/hr)	4853454.
Surface (sq.ft.)	469.
LMTD (deg. F)	10.00
Transfer Rate (Btu/hr sq.ft. deg. F)	1035.

Model	UFX-42
No.Plates	101
Plate Thickness (inches)	0.0197
Plate Material	Titanium
Gasket Material	EPDM
Frame Material	CARBON STEEL
Design/Test Pressure (psig)	150./195.
Design Temperature (deg. F)	220.
Est. Weight: empty/flooded (lbs.)	2220./ 2510.

Remarks:

Shipment stated reflects current inventory and manufacturing schedules. Improvement in shipment may be possible upon your request.

Customer to verify suitability of materials.

Performance is guaranteed in accordance with data and operating conditions stated herein.

Terms & Conditions of Sale per GMC-1002-E unless otherwise indicated.

18998PE.UFX / J1899800.SPC

GRAHAM
ENGINEERING ANSWERS

PLATE HEAT EXCHANGER SPECIFICATIONS

Graham Job#	94-18998PE
Graham Ref:	1467SF93
Date:	12/23/94
Engineer:	SCC

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Terms & Conditions of Sale per GMC-1002-E unless otherwise indicated.

18998PE.UFX / J1899800.SPC

Graham Corporation, 20 Florence Avenue, Batavia, NY 14020 USA
Phone: 585-343-2216 • Fax: 585-343-1097 • email: equipment@graham-mfg.com • Web site: www.graham-mfg.com

KELLER SUPPLY COMPANY

KELLER SUPPLY COEUR D'ALENE #35
WEST DALTON AVENUE
COEUR D ALENE ID 83815
208-665-7070 Fax 208-667-9687

Quotation

QUOTE DATE	QUOTE NUMBER
04/22/08	S002318011

ORDER TO:	PAGE NO.
KELLER SUPPLY COEUR D'ALENE #3 680 WEST DALTON AVENUE COEUR D ALENE ID 83815 208-665-7070 Fax 208-667-9687	1

QUOTE TO:
PRECISION ENERGY SERVICES
8152 WAYNE BOULEVARD
PO BOX 1004
HAYDEN, ID 83835

SHIP TO:
PRECISION ENERGY SERVICES
8152 WAYNE BOULEVARD
PO BOX 1004
HAYDEN, ID 83835

CUSTOMER NUMBER	CUSTOMER ORDER NUMBER	RELEASE NUMBER	SALESPERSON
80586	TACO		HOUSE35

WRITER	SHIP VIA	TERMS	SHIP DATE	FREIGHT ALLOWED
Debbie Oberhofer		Cash or Check, 0	04/22/08	No

ORDER QTY	PART NO	DESCRIPTION	Net Prc	Ext Prc
		*** This quote expires on 04/29/08 ***		
2ea	333870	TACO FI3007 300@38' 5HP 208/3	1924.075	3848.15
		(PLEASE VERIFY ELECTRICAL)		
		ADD BELOW/IF REQUIRED		
2ea	239641	TACO MPV-030-4 3IN MULTI VALVE	310.850	621.70
		NS		
2ea	334432	TACO SD040040-4 4X4 SUCT DFS	430.138	860.28
		NS		
		Pn:		
		TAXES NOT INCLUDED		

This quotation has been prepared for your convenience per our interpretation of the specifications sent to us. Your protection is a recheck of the material contained herein. Fixtures are white except where noted. Prices quoted are guaranteed for a period of (7) days, unless otherwise stated, from the date of this quote. Clerical errors are subject to correction.

Subtotal	5330.13
S&H CHGS	0.00
Amount Due	5330.13

Taco®

Submittal Data Information

KV Series Vertical Close Coupled Pumps

301-1100T

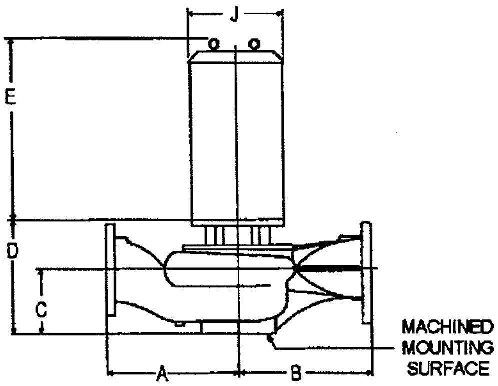
MODEL 4007 **1760 RPM**

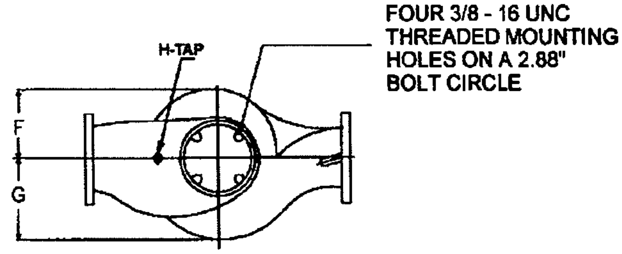
JOB: CONTRACTOR:

ENGINEER: REP:

COMMENTS:

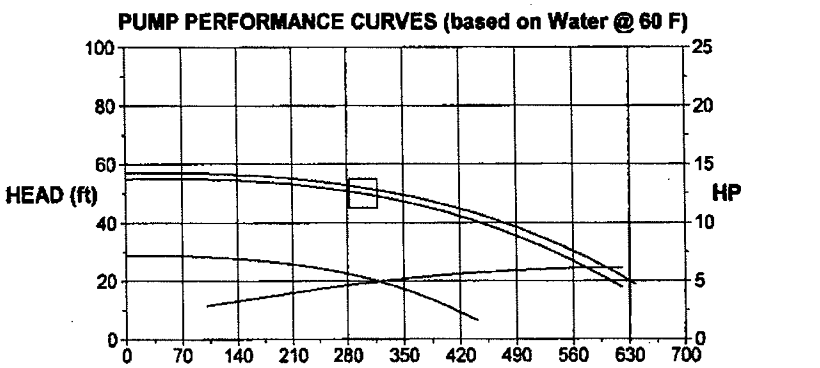
ITEM NO.	MODEL NO.	IMP. DIAM. / IN.	FLOW / GPM	HEAD / FT	POWER / HP	ELEC. CHARS
	KV4007	7.4	300	50	5	

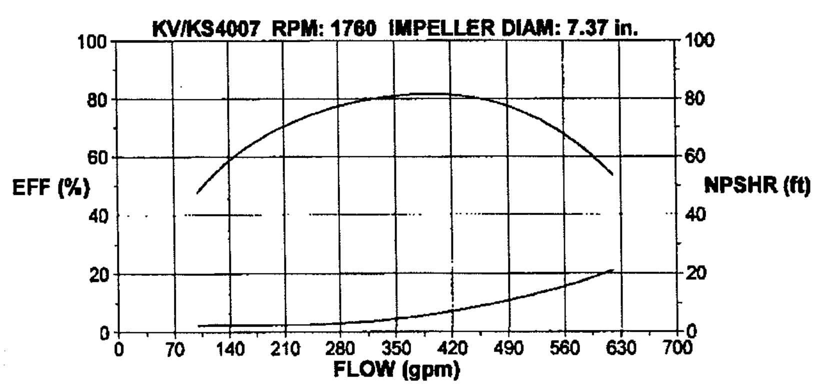




* Dimensions in inches. Do not use for construction purposes unless certified.

CONN.	HP	FRAME	Flange Size ASA	125 psi Flange A	125 psi Flange B	C	D	E	F	G	H	J
4x4	5	184JM	4	11	11	6.59	11.21	15.58	5.64	6.80	.25	7.88





Item	BRONZE FITTED Standard	BRONZE FITTED Optional		
Casing	Cast Iron ASTM A48 Class 30A			
Impeller	Bronze ASTM B584-836	CF		
Wear Ring	None			
Shaft	Carbon Steel			
Shaft Sleeve	Bronze ASTM B584-932 SAE660			
Mech. Seal	Ceramic EPT			
Seal Flush Line	Copper	CF		

OPERATING SPECIFICATIONS	Standard		Optional
Flange	125# 860K	250# 1720	
Pressure	175 PSIG 1210 KPA	300 PSIG 2070 KPA	CF CF
Temperature	250F 120C	250F 120C	CF

CF - Consult Factory

Do it once. Do it right.

TACO, INC., 1160 Cranston Street, Cranston, RI 02920 Telephone: (401)942-8000 FAX: (401)942-2360.
TACO (Canada), Ltd.,6180 Ordan Drive, Mississauga, Ontario L5T 2B3. Telephone:905/564-9422. FAX: 905/564-9436

Taco® Submittal Data Information
FI Series Pumps

301-1416T

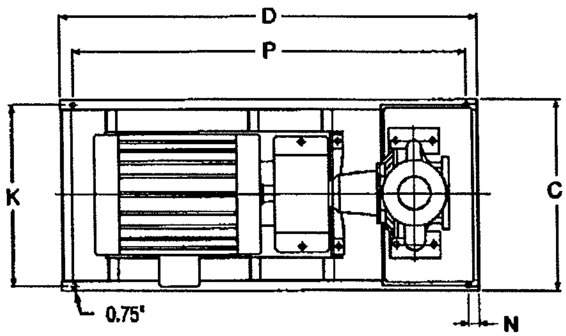
MODEL 3007 **1760 RPM**

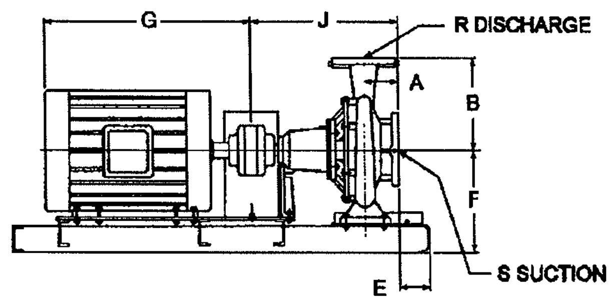
JOB: CONTRACTOR:

ENGINEER: REP:

COMMENTS:

ITEM NO.	MODEL NO.	IMP. DIAM. / IN.	FLOW / GPM	HEAD / FT	POWER / HP	ELEC. CHARS
	FI3007	7.3	300	50	5	

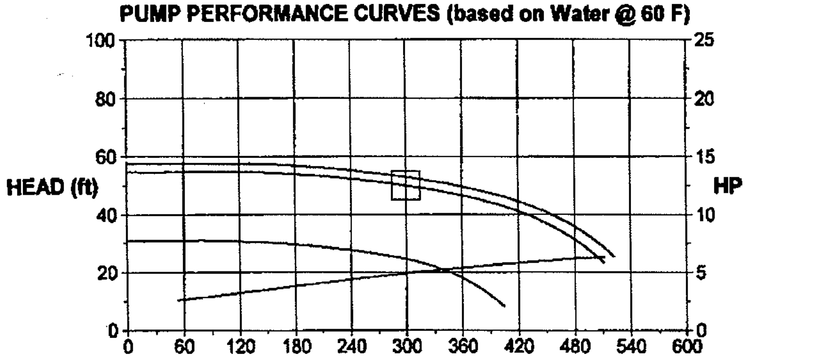




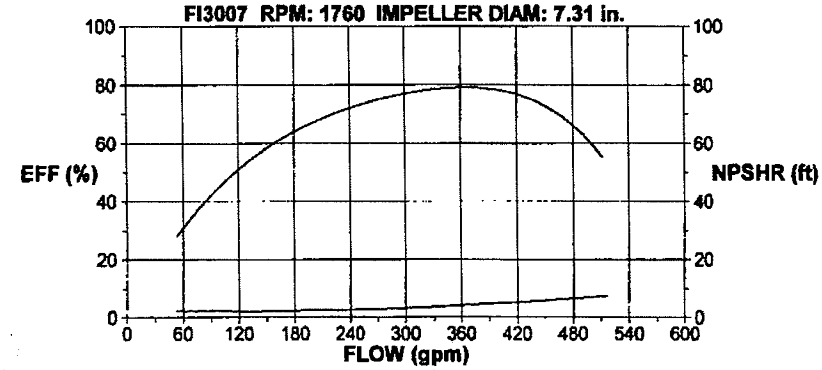
* Dimensions in inches. Do not use for construction purposes unless certified.

HP	FRAME	A	B	C	D	E	F	G	J	K	N	P	R	S
5	184T	4.72	10	16.17	41.5	1.05	11.4	16.56	23.92	14.67	2	37.5	3	4

PUMP PERFORMANCE CURVES (based on Water @ 60 F)



FI3007 RPM: 1760 IMPELLER DIAM: 7.31 in.



Item	BRONZE FITTED			
	Std. Pump Constr.	Optional		
Casing	Cast Iron ASTM A48 Cl.30A			
Impeller	Bronze ASTM B584-836			
Wear Ring				
Shaft	Carbon Steel AISI 1045			
Shaft Sleeve	Bronze SAE 660			
Mech. Seal	Ceramic			
Seal Flush Line	Copper			

OPERATING SPECIFICATIONS		
	Standard	Optional
Flange	125#	
Pressure	175 PSIG*	
Temperature	250 F	

Motors: All NEMA Standard (T Frame)
* In Accordance with ANSI Standard B16.1 Class 125
** In Accordance with ANSI Standard B16.1 Class 250 Dim.

Do it once. Do it right.

TACO, INC., 1160 Cranston Street, Cranston, RI 02920 Telephone: (401)942-8000 FAX: (401)942-2360.
TACO (Canada), Ltd.,6180 Ordan Drive, Mississauga, Ontario L5T 2B3. Telephone:905/564-9422. FAX: 905/564-9436

From the Desk of **Jay Wellan**
12625 NE Woodinville Drive
Woodinville, WA 98072
Tel: (425) 486-6666
Fax: (425) 486-8260
Web: http://www.baxair.com
Email: jay@baxair.com

Date: 4/21/2008

Precision Energy Services
8152 Wayne Blvd
Hayden, ID 83835

Attn: Tom Monter

Reference: Wood Fly Ash Dust Collector System

Tom,
Thank you for the opportunity to offer a quotation on a Donaldson Torit dust collector for your high temperature fly ash application. We suggest using our 54MBT-8 for the 2000 cfm 275°F airstream. We are pleased to offer the following:

5500 CFM DUST COLLECTOR
Donaldson Co. Torit Division
Size 54 MBT-8 Baghouse Bin Vent
691 sq. ft. Filter Area, 2.9 A/C ratio @ 2000 cfm
Includes:

- Walk on clean air plenum with roof railing
- Clean side removal of bags and frames
- 54 – Nomex round snap ring bags – 8' Long
- 54 - Galvanized steel cages – 8' Long
- Photohelic gauge
- Timer in NEMA 4 enclosure
- Ladder
- Roof railing
- Support legs with 48" clearance under hopper opening
- High temperature construction to 400º F
- High temperature coating
- High temperature drum cover

Price $19,536.00 each fob Nicholasville, KY

Option:
TC Industrial Ceramic Coating – 70 mils applied at the factory
Add $4260.00

PAGE 2

Leadtime: 7 -8 weeks to ship + 1 week in transit

Please contact me if you have any questions or comments.

Best regards,
Jay Wellan
Baxter Air Engineering

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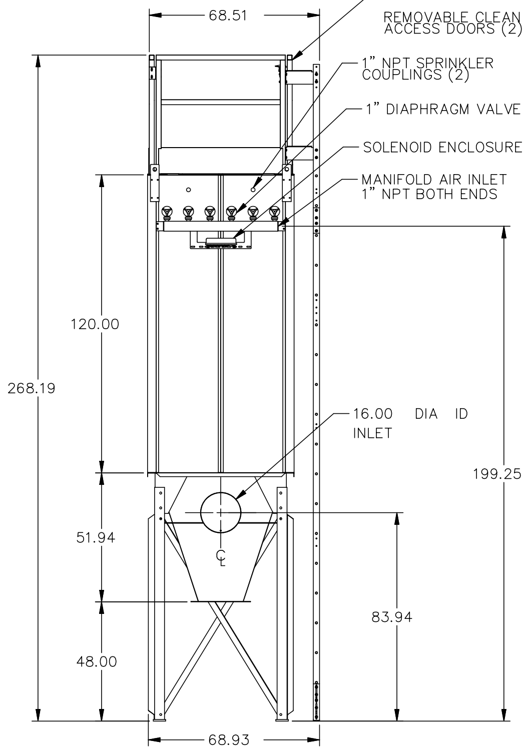
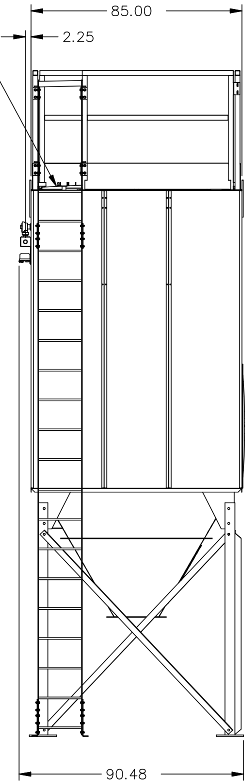
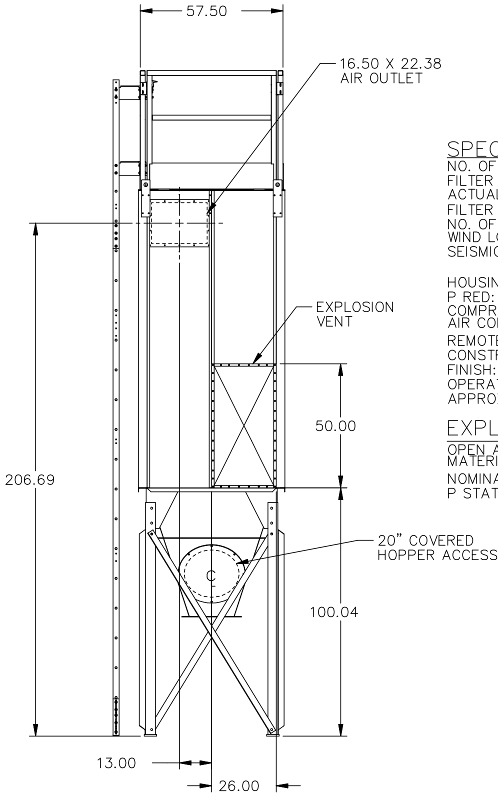
REV	ZONE	REVISION DESCRIPTION	APPROVAL/DATE
1		ADDED 57.50 DIM,REMOVED TOL, ADDED (OPTIONAL), AIR CONSUMPTION WAS 1.16, 1.19 WAS 1.12 2005A6068	J.LINEHAN OCT 18, 2004







SPECIFICATIONS FOR 54MBT8

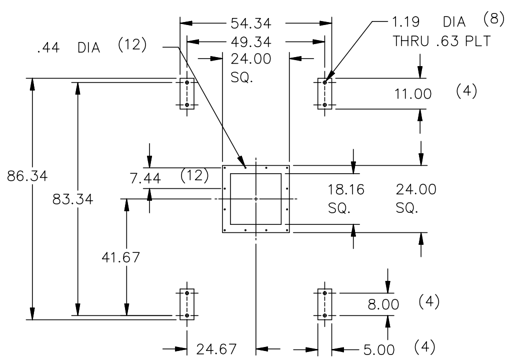
NO. OF FILTER BAGS: 54
FILTER BAG DIM'S: 6.125 DIA X 96" LG
ACTUAL FILTER AREA: 691 SQ FT
FILTER MEDIA: DURA-LIFE
NO. OF VALVES: 6
WIND LOAD RATING: 90 MPH, EXPOSURE C PER IBC 2003
SEISMIC RATING: SPECTRAL ACCEL., S_s=1.5 & S_1=0.6
SITE CLASS D PER IBC 2003
HOUSING RATING: ±20" H_2O
P RED: 0.34 BAR
COMPRESSED AIR REQUIRED: 90-100 PSI
AIR CONSUMPTION: 1.77 SCF @ 90 PSI/PULSE
REMOTE MOUNTED TIMER: 120 VAC 50-60 HZ NEMA 4
CONSTRUCTION: 12 GA MILD STEEL
FINISH: BLUE
OPERATING TEMPERATURE: 150 °F MAX
APPROXIMATE WEIGHT: 4200 LBS

EXPLOSION VENT (OPTIONAL)

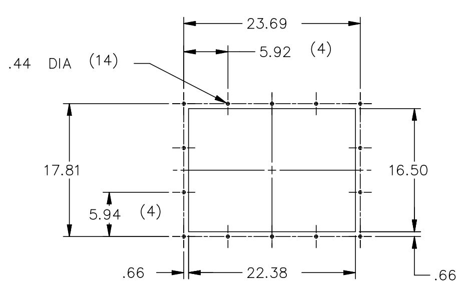
OPEN AREA PER VENT: 24" X 48"
MATERIALS: 316 SST/TEFLON/316 SST
NOMINAL BURST PRESSURE: 1.6 PSIG @ 100 °F
P STAT: 0.11 BAR

NOTES:

1. USE SPREADER BARS TO LIFT COLLECTOR HOUSING OR ASSEMBLED COLLECTOR. CLEVIS CONNECTORS NOT HOOKS, MUST BE USED ON LIFTING SLINGS. ALL COLLECTOR LIFT EYES MUST BE USED WHEN LIFTING THE COLLECTOR OR ASSEMBLED COLLECTOR.
2. LEG ANCHOR BOLTS 2 PER LEG TO BE HILTI SS 1"DIA HVA ADHESIVE SUPER ANCHORS WITH 8-1/4 MIN. EMBEDMENT IN 3 ksi (MIN) CONCRETE. EXPANSION TYPE ANCHORS WILL PULL OUT AT DESIGN LOADS.



HOPPER FLANGE ANCHOR BOLT PLAN



16.50 X 22.38 AIR OUTLET DETAIL

THIS PRINT IS NOT CERTIFIED FOR CONSTRUCTION PURPOSES.
THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE.

MATERIAL	RELEASE NO. 2004A7000	TITLE 54MBT8 DUST COLLECTOR 48" LEG PACK
	DATE AUG 11, 2004	
	EXP DATE	NUMBER
	DWN T DESCHEPPER	MBT AD3430402
REFERENCE	DATE AUG 11, 2004	
	CHK M.ESPEDAL	SCALE NONE · SHEET 1OF 1 · REVISION 1
	DATE AUG 11, 2004	C/C UG/CADD
PREVIOUS DRAWING NO.	APVD D.JOHNSON	SECTIONAL SIZE · OUTLINE SIZE
DO NOT SCALE · TOLERANCES UNLESS OTHERWISE SPECIFIED · 2 PL ± · 3 PL ± · ANGLES ±°	DATE AUG 11, 2004	DESIGN CONTROL A004 · DWG LOCATION A101 · VERSION A
	THIRD ANGLE PROJECTION	COPYRIGHT DONALDSON COMPANY, INC.

Donaldson® Donaldson Co.,Inc. Minneapolis, MN USA
IAF

TORIT MODULAR BAGHOUSE TOP