



LESSOWAY  
MOIR  
PARTNERS

# ICY WATERS ENERGY REPORT

April 2003



*Prepared for:*  
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## **Executive Summary**

Lessoway Moir Partners was retained by Energy Solutions Centre in Whitehorse, Yukon to complete a study of two energy-saving alternatives at the Icy Waters Ltd. fish farm including;

1. Use of free cooling for the refrigeration units at the plant, and
2. Provision of a heat pump to heat and/or cool the hatchery process water.

The first energy option; installation of a free cooling system for the refrigeration units in the plant, was reviewed and estimated to result in annual energy savings of only \$200 to \$300. The estimated installation and design costs were excessive relative to the potential energy savings and resulted in a disproportionately long payback period. As such, provision of a free cooling system for the refrigeration units is not recommended.

The second energy-saving option reviewed; installation of a heat pump system for cooling the egg incubation water and heating frey tank water, would result in an increased window of export for the eggs, increased production in the frey, and significantly decreased operating costs compared to the existing oil boiler system. Application of the secondary sales program in conjunction with the installation is a strong contributor to the decreased operating costs with power rate of 3.3 cents per kWh and no demand charges. Total installation cost is estimated at \$415,000, with annual energy savings of \$86,000, a return on investment of 20% over 15 years, and a resulting simple payback of 4.8 years.

It should be noted that there is a also the option of eliminating the new electric boiler from the above design and using the existing oil boiler to supplement the heat pumps thereby reducing the total installation cost. With this option, however, the total installation cost is estimated at \$360,000 with annual energy savings of \$67,000, a return on investment of 17% over 15 years, and a resulting simple payback of 5.4 years.

## ***Introduction***

Icy Waters Ltd. is an Arctic Charr fish farm located in Whitehorse, Yukon. The farm encompasses all stages of fish development from the hatchery to the processing unit and is highly dependent on export of eggs as well as processed fish. Energy use is one of the greatest cost drivers of the farm and methods of reducing those costs are being sought. Some ideas were first presented in a grant application by Jonathan Lucas, General Manager of Icy Waters Ltd. (IWL), to the Yukon Innovation Technology Centre in early 2002, herein referred to as the YITC application. This application is found in Appendix 1 and the ideas that were identified in it are:

1. Free cooling in the processing plant freezer and cooler
2. Use of heat pump technology for cooling egg incubation water.
3. Use of heat pump technology for heating water for 12 frey tanks.

This report expands on these ideas and investigates the feasibility of them. A site visit was conducted on November 20, 2002 and information gathered both over the phone from staff at Icy Waters and from records held by the Energy Solutions Centre of previous investigations done in late 2001 and 2002.

## Free Cooling

### 1. Present conditions

Presently, there is one freezer and one cooler in use. These are both packaged units attached to the processing plant. The cooler has an approximate area of  $11\text{m}^2$  and is used for keeping fresh fish. It is designed to maintain a desired temperature of  $4^\circ\text{C}$  with a conventional electric chiller. The freezer that is being used is a "blast freezer" with an approximate area of  $21\text{m}^2$  and is used for keeping frozen fish. It is designed to maintain a desired temperature of  $-23^\circ\text{C}$ , also with a conventional electric chiller. Appendix 3 has the specifications of the existing chillers as well as the maintenance record for a one year period indicating that the cooler has very little maintenance associated with it.

### 2. Assumptions

1. the chillers are properly sized for both the cooler and freezer (and thus the supply temperatures of  $-6.7^\circ\text{C}$  and  $-40^\circ\text{C}$  respectively are required)
2. the cooler is 4 m long and 2.7 m wide, with a total volume of  $26.5\text{m}^3$ .
3. operation schedule for cooler is every day, 24 hours per day, excluding 2 days per month
4. blended electrical rate is 0.15  $\$/\text{kWh}$  (blending 0.1045  $\$/\text{kWh}$  + 6  $\$/\text{kWh}$ )

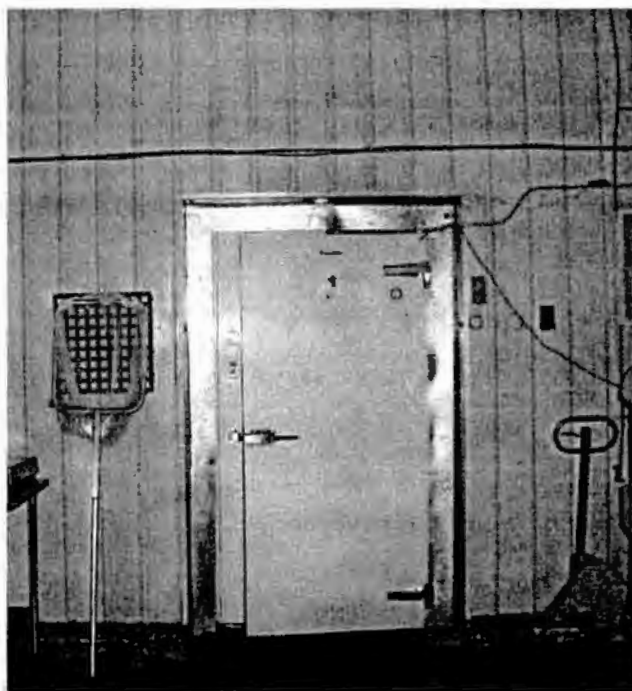


Figure 1 Fish Plant Cooler Unit

### 3. Free cooling options

The idea behind free cooling is to take advantage of cold winter outdoor temperatures to cool the required indoor spaces, in this case the cooler and freezer. There are a couple of methods of designing for free cooling, both of which are examined here. The first is known as the direct

method and involves blowing cold outside air into the cooler or freezer with a fan. It includes a temperature controller that shuts down the system once the outside air temperature rises above the desired indoor cooler or freezer temperature, and then the existing chiller resumes operation.

The second method requires a glycol-filled coil run in a loop between outside and inside, transferring the cold from out to in. Again, once the outside air temperature rises above the desired cooler or freezer temperature, the conventional chiller takes over. This method is more expensive to install and less efficient than the direct method, but it has other significant advantages. The glycol loop method allows for far greater control on the quality of air going through the cooler or freezer, as it is not as dependent on the quality of air being taken from outside. Fish products may be sensitive to humidity levels, potential vehicle or building exhaust, or dust particles that could be introduced in the direct free cooling system.

#### 4. Results

Using Whitehorse temperature data, it was calculated that free cooling is available for approximately 46% of the year for the cooler and less than 1% of the year for the freezer. The latter is due to the necessity of providing  $-40^{\circ}\text{C}$  to the freezer in order to maintain a temperature of  $-23^{\circ}\text{C}$ . Appendix 2 has a table showing these calculations, and also showing that there are approximately 14 degree days where free cooling is available at  $-40^{\circ}\text{C}$  supply temperature or lower, and approximately 1509 degree days where free cooling is available at  $-6.7^{\circ}\text{C}$  supply temperature or lower. Since free cooling is essentially unavailable for the freezer, no further investigation was done for it.

The following figure summarizes the calculations that are outlined in Appendix 2 for free cooling of the cooler using the direct method:

Heat gain for cooler	5855 Btuh
% of chiller unit operation time in winter (below $-6.7^{\circ}\text{C}$ )	34%
Effective run time of chiller in winter	1272 hrs
Outdoor air fan power costs per winter	\$143
Chiller unit costs per winter	\$373
<b>Savings achieved with free cooling per year</b>	<b>\$230</b>

Figure 2 Free Cooling Results

Since the cooler unit is mainly outdoors with only one wall affected by heat gain from the interior, the estimated chiller unit run time is 34% of the time that free cooling is available – that is 16% of the year (34% of 46%). This is the main reason that the savings are small for introducing free cooling. With total savings estimated at only \$230 per year it is clear that payback on installation of the free cooling system will be very long and it is not recommended to proceed with the installation.

The glycol loop method is even more expensive to install and is slightly less efficient resulting in lower savings and a higher payback period. It is not recommended to proceed with free cooling for the plant with either method.

Figure 4 12 Grey Frey Tanks

Figure 5 30 Frey Tanks in Hatchery

Fish production is dependent upon water temperature and for these twelve frey tanks the ideal temperature was given to be 14°C. The winter supply temperature for these tanks is the same as for the egg incubation trays, a chilly 2°C or so, however it is heated with an oil-fired boiler to approximately 8°C. Similarly, in summer it is heated from approximately 7°C to the desired temperature of close to 14°C. The maximum flow rate of this heated water at a turnover rate of 3 tanks per hour is 4L/s. The existing boilers & heat exchanger (see Figure 6 and equipment list in Appendix 10) have proven not to be of sufficient capacity to heat this quantity of winter water to the desired temperature.



Figure 6 Existing Alpha-Laval Heat Exchanger

### 3. Heat Pumps

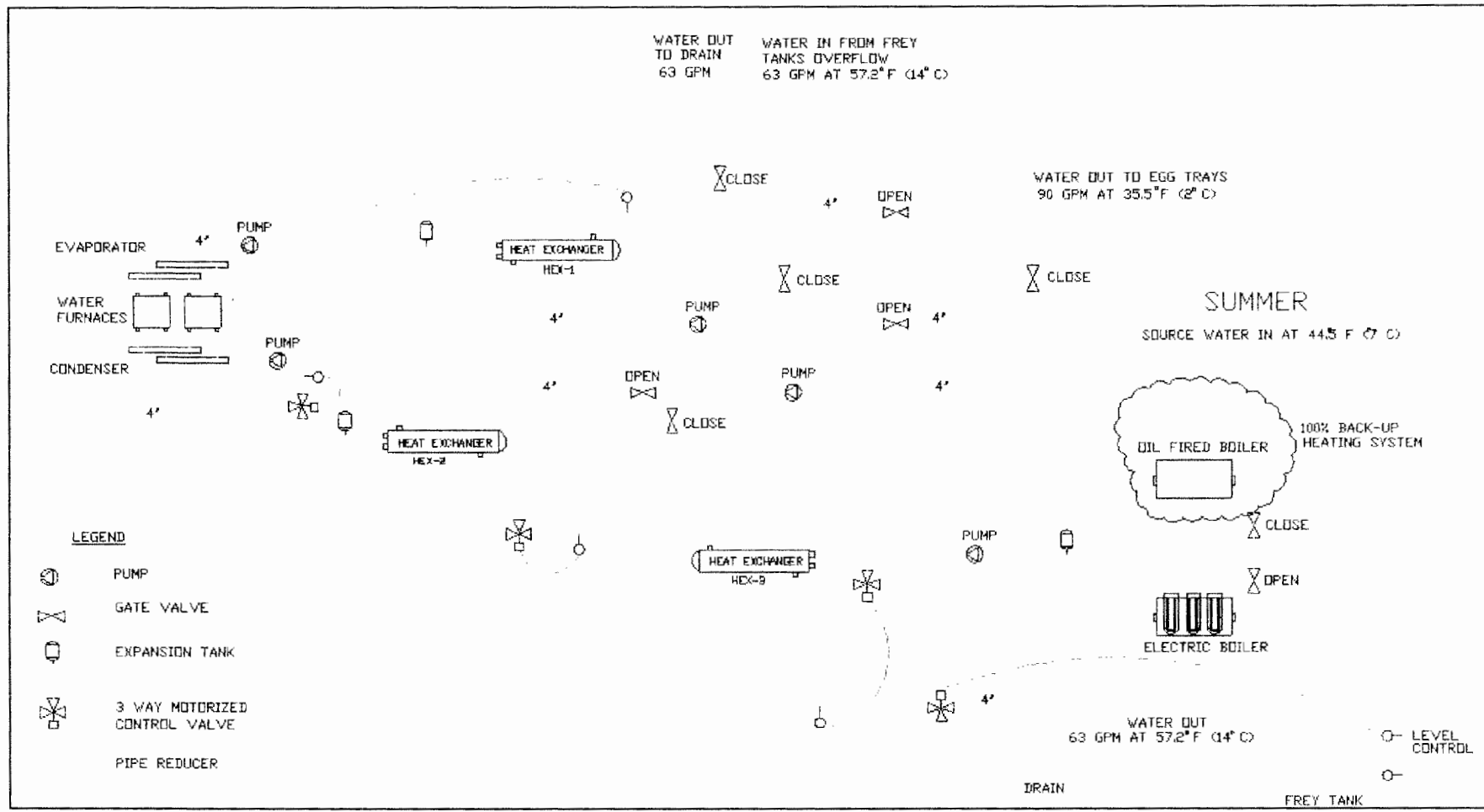
Whenever heating and cooling is needed within close proximity, heat pumps naturally come to mind since they are very energy efficient heating and cooling systems in one unit. This is an ideal application for a heat pump because the heat that is taken from the egg incubation water in the summer can be transferred to the frey tanks with a combination of heat pumps and heat exchangers. In the winter, the discharge from the frey tanks can potentially be used as the source for the heat pumps since the egg incubation water will not likely need any cooling. The quality of this water will have to be tested and it may need to be treated to keep from clogging the heat exchanger. The frey tank discharge will be approximately 14°C and will be cooled to 2°C or so, and that heat used for heating the incoming water to the frey tanks. The winter and summer schematics are found in the following 2 pages, showing the water flow and relative location of equipment. They include the heat pumps (shown as water furnaces), heat exchangers and an optional electric boiler.

The heat pump process involves a cycle of evaporation, compression, condensation and expansion. A refrigerant is used as the heat transfer medium, and it starts in the cycle as cold liquid that passes through the water-to-refrigerant heat exchanger (HEX-1) and absorbs heat from the water source, thus cooling the water for the eggs. The refrigerant evaporates into a gas as heat is absorbed. The gaseous refrigerant passes through a compressor where the refrigerant is pressurized, raising its temperature to over 80°C. The hot gas then circulates through a refrigerant-to-water heat exchanger (HEX-2) where heat is removed as the cooler water passes over it, thus heating the water to the frey tanks. The refrigerant in the mean time has released its heat energy and returns to the water-to-refrigerant heat exchanger (HEX-1) where the process is repeated.

Two 30-ton heat pumps will be needed to cool approximately 5.7 L/s (340 L/min) for the eggs while heating the estimated 4L/s for the frey in the summer. These same 2 heat pumps will be used to cool the 4L/s of frey discharge water to heat the 4L/s incoming frey water in the winter. An electric boiler is recommended for the shoulder seasons, for example in March when it is assumed that source water temperature is 3°C. At these times cooling is needed for the eggs but there is not enough heat extracted to heat the frey tanks. The electric boiler is far less energy efficient than the heat pumps but is necessary and still qualifies for secondary sales. It is sized for 100% backup to the heat pumps but may be sized for less than that if it is determined that it is advantageous to stretch the heat pump season, resulting in a lower cost. The advantage of having the electric boiler installed rather than using the existing oil boiler is to provide a complete electrical system that may take advantage of the secondary power sales program. This is discussed in more detail in the results section.

Three shell and tube heat exchangers are also needed, one for each side of the heat pumps and one for the boiler. The third one would replace the existing heat exchanger used with the oil boiler. These "OC" type shell and tube heat exchangers are designed specifically for ease of cleaning. In the past Icy Waters staff has had difficulty with their plate heat exchangers because of the frequency with which they needed cleaning. A level controller is also provided for the header for the frey tanks. This is to ensure that oxygenated water does not overflow into the drain.

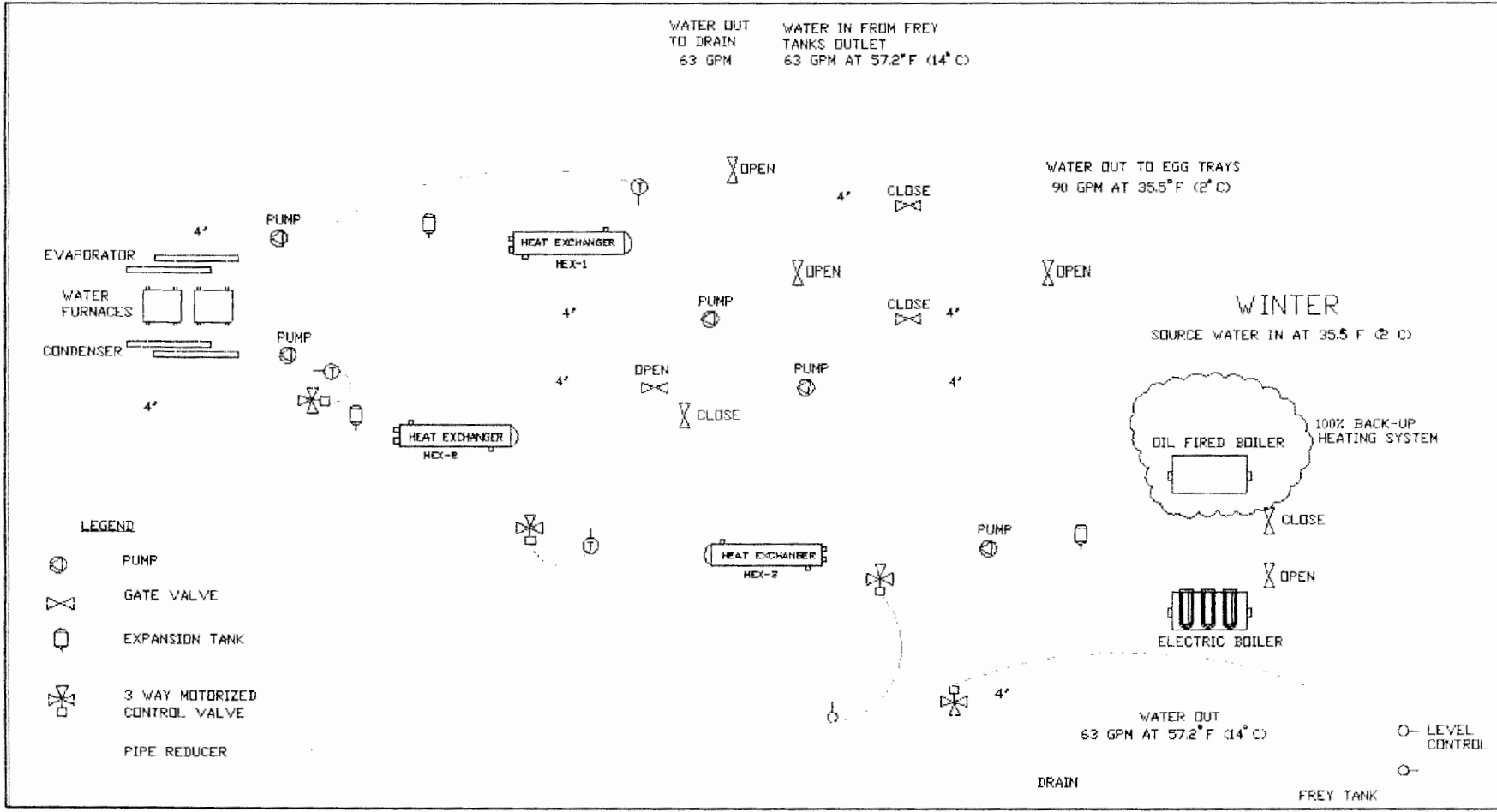
April 16, 2003



Schematic 1 Summer Schematic

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April 16, 2003



Schematic 2 Winter Schematic

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#### 4. Assumptions

1. the flow rates to the incubation trays and frey tanks is constant
2. frey tank turnover rate is 3 tanks per hour
3. operation is 24 hrs. per day, 365 days per year
4. water temperatures are as follows:  
 December, January, February = 2°C  
 November and March = 3°C  
 October and April = 4°C  
 September and May = 5°C  
 June, July, August = 7°C
5. head pressure of supply water insufficient for heat exchangers HEX-1 & HEX-2; pumps required
6. there is adequate space for the new equipment
7. oxygenation of frey tank water occurs in header
8. frey size is between 0.1 and 0.4 grams in the 12 frey tanks
9. food to weight gain conversion rate is 1 : 1.5

#### 5. Results

It is stated in the YITC application that by cooling the egg incubation water and maintaining 2°C, the window for shipment and sales of the eggs may be doubled. This would allow for more flexibility regarding customer requirements and for the ability to sell eggs over a longer period of time. It is difficult to quantify the financial benefits of this without knowing the fish farming business in more detail.

The YITC application also explains how fish growth is calculated based on water temperature, stage of growth, and conversion rate.

Temperature	2°C	7°C	14°C
Growth per day	1.6%	2.7%	3.9%
Time to reach 0.4 grams	12 weeks	7.5 weeks	5 weeks

Figure 7 Frey growth rates

Figure 7 above estimates the gain in production that could be attained by heating the frey water to 14°C. Frey growth from 0.1 grams to 0.4 grams in weight would be approximately 2.4 times faster in the winter compared to unheated water, and about 1.5 times faster in the summer. With a yearly average growth rate increase of 2 times, it can be predicted that frey production during this period will double what it would be without heated water. Some heating is done with the boilers now, so the new system will essentially result in growth rates of 1.5 times today's rates in the winter, and no increase in the summer.

To heat this water year-round to 14°C using the existing oil boilers, which have an estimated seasonal efficiency of 70%, would cost in the order of \$114,000 per year at \$0.60 per litre of oil, as calculated in Figure 8 below. The present day operational cost is estimated at \$82,000 per year since heating in winter is only to about 7°C rather than 14°C. With a new boiler with 85% efficiency the cost for year-round heating to 14°C would drop to an estimated \$94,000 per year,

still significantly higher than the heat pumps operational cost of approximately \$86,000 per year as calculated in Figure 9.

HEAT 12 FREY TANKS WITH OIL BOILER					
	$\Delta T$ (°C)	BTUH	Days	LITRES OF OIL CONSUMED	
				Boiler Efficiency (%)	
				70%	85%
Winter	12	684736	90	57587	47425
Nov & Mar	11	627675	61	35779	29465
Oct & Apr	10	570613	61	32526	26786
Sept & May	9	513552	61	29273	24107
Summer	7	399429	92	34339	28279
<b>Total Litres:</b>				<b>189504</b>	<b>156062</b>
<b>\$/Litre</b>				<b>COST OF OIL CONSUMPTION</b>	
\$ 0.60				\$ 113,702	\$ 93,637

Figure 8 Oil boiler consumption and cost

Electricity consumption with heat pumps and existing oil boiler									
Month	Spring Water Temp. (°C)	Heat Pump operation (%)	Heat Pump KW	Oil Boiler operation (%)	Oil Boiler Litres per Month	Pumps KW	Total KW per Hr.	Total KW per Day	Total KV per Mont
January	2	100	40	0%	0	8	48	1152	35712
February	2	100	40	0%	0	8	48	1152	32256
March	3	20	8	80%	14546	12	20	480	14880
April	4	40	16	60%	9598	12	28	672	20160
May	5	60	24	40%	5951	12	36	864	26784
June	7	100	40	0%	0	8	48	1152	34560
July	7	100	40	0%	0	8	48	1152	35712
August	7	100	40	0%	0	8	48	1152	35712
September	5	60	24	40%	5759	12	36	864	25920
October	4	40	16	60%	9918	12	28	672	20832
November	3	20	8	80%	14077	12	20	480	14400
December	2	100	40	0%	0	8	48	1152	35712
			40						
					TOTAL Litres per Year:	59848	TOTAL KW per Year:		332640
		kWh	\$/kWh	Litres	Total				
Regular Rate:		332640	0.15	59848	\$85,805				
Secondary Power:		332640	0.033	59848	\$46,886				
kWh x \$/kWh + litres x \$0.60/litre = \$/year									

Figure 9 Heat pump system operating costs with existing oil boiler

By taking advantage of the secondary power sales program, resulting yearly heating costs in the order of \$47,000 are achieved. The secondary power sales program is a Yukon Energy program which utilizes "surplus power". Since we are not connected to the main grid outside the territory we do not have the ability to sell off surplus power needed and produced for stable service. The utility has developed this program as a means to equalize the power consumption to the power production. The term "surplus power" refers to the times when the utility is producing more

hydro power than it is selling. The program consists of the installation of an electric heating system and a separate electrical service and meter. The system must have the ability of being turned off with 24 hours notice when Yukon Energy determines that surplus power is unavailable, and thus a 100% backup system is needed. In this case the backup system is the existing oil boiler system. This surplus power is sold at a fixed rate of 3.3 cents per kilowatt hour based on the meter reading of the system's independent meter, and there are no demand charges. This rate may change, as the rate is set at 10% less than the "avoided cost of diesel fuel oil".

The yearly heating cost of about \$47,000 may be further reduced by installing an electric boiler for the spring and fall seasons, dropping the use of the oil boiler even more. Under secondary sales the total heating costs would be in the order of \$28,000 – resulting in an estimated **savings of \$86,000 per year** compared to using the existing oil boiler for the full heating, or an estimated savings of \$54,000 per year compared to today's energy use.

Electricity consumption with heat pumps and new electric boiler									
Month	Spring Water Temp. (°C)	Heat Pump operation (%)	Heat Pump KW	Electric Boiler operation (%)	Electric Boiler KW	Pumps KW	Total KW per Hr.	Total KW per Day	Total KW per Month
January	2	100	40	0	0	8	48	1152	35712
February	2	100	40	0	0	8	48	1152	32256
March	3	20	8	80	160	12	180	4320	133920
April	4	40	16	60	120	12	148	3552	106560
May	5	60	24	40	80	12	116	2784	86304
June	7	100	40	0	0	8	48	1152	34560
July	7	100	40	0	0	8	48	1152	35712
August	7	100	40	0	0	8	48	1152	35712
September	5	60	24	40	80	12	116	2784	83520
October	4	40	16	60	120	12	148	3552	110112
November	3	20	8	80	160	12	180	4320	129600
December	2	100	40	0	0	8	48	1152	35712
			40		200				
							TOTAL KW per Year		859680
		kWh	X \$/kWh	= \$/year					
Regular Rate:		859680	0.15	<b>\$128,952</b>					
Secondary Power:		859680	0.033	<b>\$28,369</b>					

Figure 10 Heat pump system operating costs with electric boiler

The oil boiler is used for space heating of the residence upstairs as well, and the secondary sales program could also apply to it. No calculations were made for this but it is worth considering if an electric boiler is installed.

Figure 11 below summarizes the equipment selection for the heat pump system installation, along with the associated costs. Our opinion of probable cost for the total equipment and installation is \$415,000 and with the yearly savings estimated at \$86,000, a simple payback of 4.8 years results. This is without considering the increased fish production rate and the longer export time that will be available with the cooled incubation water.

Icy Waters Heat Pumps Cost Estimate				
Item	Description	No./lf	Item Cost	Total \$
Water Furnace (Heat Pump)	30 ton water to water heat pump	2	\$ 35,000	\$ 70,000
Heat exchanger	Cooling Side Heat Exchanger (HEX-1)	1	\$ 9,249	\$ 9,249
Heat exchanger	Heating Side Heat Exchanger (HEX-2 & HEX-3)	2	\$ 5,679	\$ 11,358
Electric Hot Water Boiler	210 KW (716000 btu/hr) CSA approved	1	\$ 27,000	\$ 27,000
Pumps	Base mounted centrifugal	5	\$ 2,000	\$ 10,000
Valves	4" Gate valve	27	\$ 680	\$ 18,360
Valves	4" check valve and strainer	10	\$ 500	\$ 5,000
Controls	Water level, sensors, wiring, etc	1	\$ 5,000	\$ 5,000
* Piping	4" Sch-40 Galvanized steel pipe (FT) <i>Sch 40 plastic pipe.</i>	650	\$ 34	\$ 21,775
Freight	to Whitehorse	1	\$ 8,000	\$ 8,000
Installation	Labour	1	\$ 120,000	\$ 120,000
Electrical service	New meter, service, etc.	1	\$ 25,000	\$ 25,000
Engineering fee	Electrical, Mechanical	1	\$ 35,000	\$ 35,000
Contingency	15%			\$ 49,611
<b>Grand Total Preliminary Estimate</b>				<b>\$ 415,353</b>

Figure 11 Equipment and installation costs

The specification information for the equipment is found in Appendix 11.

*8 faucets in spring - summer w/ 2 strainers*

## ***Recommendations***

### **1. Free Cooling**

Installation of a free cooling system will only result in energy savings of a couple of hundred dollars a year. The cost of installation and design therefore outweighs the benefits in operating costs. It is not recommended to install a free cooling system.

### **2. Heat Pumps**

It is recommended to install the heat pump system including the electric boiler for cooling the egg incubation water and heating the frey tank water. It is also recommended to apply for use of the secondary sales program in conjunction with the installation. The results would be increased window of export for the eggs, increased production rates in the frey, and significantly decreased operating costs as compared to the existing oil boiler system.

Total installation cost is approximately \$415,000, with annual energy savings of \$86,000, a return on investment of 20% over 15 years, and a resulting simple payback of 4.8 years.

Total installation cost without the electric boiler is approximately \$360,000 with annual energy savings of \$67,000, a return on investment of 17% over 15 years, and a resulting simple payback of 5.4 years.

## ***Appendices***

1. Grant application for innovative projects
2. Free cooling calculations
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## Icy Waters Ltd.

Innovative Projects for which funding is sought from the Yukon Technology Innovation Centre.

Three innovative projects using technology and applications new to the Yukon, Canada, and aquaculture have been identified at Icy Waters Ltd. As previously discussed each project will require a large amount of work to progress through the grant application stage. Consequently I would like to introduce each project in terms of its aims, the technology used and its application, and request that YTIC review these introductions. If the projects are deemed to fall within the scope of YTIC funding, detailed grant applications will follow.

### Company Background

Icy Waters Ltd. farms and produces Arctic Charr year round. The facility comprises a certified broodstock and hatchery unit, tank farm and ponds for grow-out, processing unit with freezers and coolers, and associated offices for administration. The company has 15 employees. Icy Waters Ltd. began fish farming in 1987, and has been expanding, evolving and developing since then. The following three projects have been identified as highly important to the increased efficiency and sustainability of the entire unit, and take advantage of new technology and its application.

#### 1) Use of Chilled Water to Increase Fish Egg Incubation Time

Icy Waters Ltd. (IWL) has developed a broodstock program that allows eggs to be stripped from fish in the fall, and also springtime, by alteration of their photoperiod. A number of broodstock are kept in a light regime which is exactly opposite the natural cycle, thus these fish believe actual springtime to be their fall, thus they mature in spring. This allows IWL to harvest eggs twice per year.

IWL uses these eggs to produce its own fish, but also has egg sales in North and South America, Europe and Asia, thus exporting from both the Territory and Canada.

The physical movement of eggs is quite straightforward, and if properly packed eggs may be transported around the world for up to 72 hours. However transportation must be completed before the egg reaches the critical pre-hatch stage. During this stage any physical shock will cause the eggshell to rupture prematurely, leading to the death of the hatched alevin.

Fish egg development is controlled by temperature. Higher temperatures speed development, lower temperatures slow development (within biological limits). Development is measured in ATU (ambient temperature units) or DD (degree days), i.e. one day at 4°C is 4DD, or 4ATU. The critical pre-hatch stage of development begins at

360 DD and no transportation is possible after this time, i.e. if the eggs are not sold, or the customer is unable to accept the eggs before this time, then the eggs and/or sale is lost

Historically the incubation temperature of the water varies from 3-6°C for the fall eggs, and 3-7°C for the spring eggs, averaging around 4°C and 5.5°C respectively. If IWL were able to control and cool the incubation water to an average of 2°C and 3°C, it is clear that the window of sales and shipment would be doubled. This would allow IWL to sell eggs over a longer period of time and become considerably more flexible regarding customer requirements. Additionally egg quality and ensuing fry quality is improved if the incubation temperatures remain stable and below 7°C. Cooling would ensure this and will improve egg/fry quality

**Technology:** The water will be chilled using heat pump technology with supporting "free-cooling".

Heat pumps are considerably more efficient than conventional electric chillers, and whilst conventional chillers vent the removed heat to the atmosphere, heat pump technology allows this heat to be used elsewhere. The IWL hatchery has a requirement for heat in its hatchery fish tanks throughout the year, which is currently provided by oil burning boilers. It is envisaged some of this heat will be replaced from the cooling of the incubation water

"Free-cooling" involves taking advantage of the Yukon winter, and placing a glycol filled coil in the freezing air outside the hatchery. This coil is then run to another coil inside the hatchery placed in the water to be cooled. A small electric pump then circulates the glycol through the system, moving "cold" from the air outside the hatchery to the water inside the hatchery. Control equipment ensures the process is regulated, and if free-cooling is insufficient for the system requirements, the heat pump system is automatically activated.

## 2) Processing Plant: Innovative Systems for Freezer and Cooler Units

IWL processing plant has a cooler, main freezer, and blast freezer. These are presently cooled with compressors, the waste heat venting off to the atmosphere. It is planned to replace this system with heat pumps. The heat liberated by the heat pumps is to be used to reduce reliance on the oil burning boiler that presently heats the office/processing unit. As above, "free-cooling" units will be added, allowing IWL to take advantage of the freezing Yukon temperatures, the heat pumps acting as "support" cooling in winter and fully functional in summer. Control equipment will regulate the temperatures in each of the cold units and switch from "free-cooling" to heat pumps as required.

### 3) Juvenile Fish Stages – Growth Enhancement

Fish growth is temperature dependant. Within biological limits the warmer the water the faster the growth. Depending on the size of the fish, a rise of 2°C can result in a growth rate increase of between 10%-30%. Consequently water temperature is critical to fish production. The ability to raise fish rearing water temperatures economically has a huge, positive effect on productivity.

The juvenile stages of Arctic Charr rearing use less water than the grow out. Thus the costs of heating this amount of water is less than for the grow out stages. Juvenile stages grow faster (in percentage increase terms) than older fish. It is vital for the successful economics of the farm that fish in the juvenile stages grow as fast as possible to be of a large size, as early as possible, for stocking in the tank farm. At any temperature 200g juveniles will reach market size considerably faster than 100g juveniles, as the smaller fish will never catch up and the size difference will increase pro-rata as both groups of fish grow.

Conventional heating using oil-fired boilers is presently used in the hatchery to heat a small volume of water to increase growth in the youngest fish. This is expensive and inefficient. It is also totally impractical for larger volumes of water. It is proposed to replace the boilers with heat pumps, to increase temperature within the hatchery by an average of 5°C over the year. Additionally heat pump technology will be installed in our pre-grow out juvenile facility to increase the average water temperature by the same amount.

It is proposed that the average weight of our juveniles just prior to tank farm stocking could be increased to 200g. Presently these juveniles are stocked at an average of 70-80g. These juveniles would also be ready for transfer earlier in the year than under present rearing conditions. The subsequent shortening of the production cycle by at least 6 months will make a considerable difference to the economics of this company.

#### Project Background

The GM at IWL (Jonathan F. Lucas) believed savings in heat and power could be made throughout the facility by using new technology, or new applications of old technology, along with use of renewable sources of energy. Don Flynn and Doug MacLean at Yukon Energy Solutions were contacted, and it was felt the unique nature of the IWL facility lent itself to the introduction of heat pump technology. A site meeting was arranged with representatives of Histech Energy Solutions Inc, Calgary. Histech are highly interested in the possibilities afforded by the IWL facility and believe significant savings and

production gains can be made. The application of heat pump technology to aquaculture has never been undertaken in the Yukon, and only rarely (if ever) in Canada.

Cooling of water to delay development of eggs does occur in one specialised egg production farm in Scotland, UK. It does not presently occur in the Yukon. IWL is not aware of any companies practicing this with Arctic Charr, or other salmonids in Canada

However Histech and YES require a very considerable amount of work and information to be prepared before the project can be fully quantified, gains and savings confirmed, and quotes prepared.

IWL requests that YTIC consider these 3 projects before the closing date of 31<sup>st</sup> January 2002, and discuss with IWL whether they would be suitable for support from YTIC. If YTIC can support these projects IWL will go ahead to prepare the projects for Histech and YES, and submit a complete proposal to YTIC for each.

## Estimated Costs and Benefits of Installing Heat Pump Technology in a New Application at Icy Waters Ltd

### Introduction

Use of this technology in a new application is seen as a major component in allowing Icy Waters Ltd. achieve the following goals:

- 1) Growing Arctic Charr to market size faster
- 2) Growing Arctic Charr larger, i.e more fish in the larger market size bands, which are more valuable per lb than smaller fish.
- 3) Reduction of summer mortality due to high water temperatures
- 4) Satisfying customer demand. Presently Icy Waters Ltd cannot satisfy market demand for its fish. By shortening the growing cycle of the fish, Icy Waters Ltd will be able to increase the biomass of fish produced, without actually increasing the biomass of fish held on the farm. The fish will simply be required to be in the growing tanks for less time.
- 5) Consequently unit cost of fish production will decrease, making the farm more economical.
- 6) Additionally reliance on oil-fired heating will be removed, with the following benefits:
  - i) Heats pumps are electrically powered. This is produced in an environmentally friendly manner in the Yukon.
  - ii) Removal of oil burning removes a release of combustion products within the City of Whitehorse.
  - iii) Requirement for oil in the City of Whitehorse is decreased, decreasing trucking costs (environmental, road maintainance etc.)
  - iv) Heat pumps are more economical than oil burning boilers, thus the production of heat is cheaper, reducing costs to the farm.
  - v) Maintainance of heat pumps is more straightforward than oil-fired boilers.
  - vi) It would not be economically possible to heat this amount of water by this amount of degrees with oil-burning technology. Thus Icy Waters Ltd. could not fulfil the goals above.

Application of Heat Pump technology to aquaculture is unknown in the Yukon, and most of Canada. Should this project go ahead Icy Waters Ltd would view the investment as a showcase for other Yukon/Canadian businesses and these would be welcome to view the Icy Waters Ltd. installation, and discuss all aspects of the design, costs and benefits.

### Siting

It is envisioned that 2 systems be installed:

- A) To enable the water supplied to the production facilities of the hatchery to be raised by 5°C over the year. This would increase water temperatures from a range of 3-8°C, to 8-13°C.

B) To enable the water supplied to the juvenile production facilities to be raised by 6°C over the year. This would increase water temperatures from a range of 2-8°C, to 8-14°C.

A third system would ideally complete the system. This would be required to cool the tank farm water during summer. Presently this water can reach a high of 19°C.

Above 16°C feeding appetite begins to decrease rapidly, and at 18°C mortalities begin to occur due to heat stress. As the temperature rises beyond 18°C, mortalities increase still further (see extract "The Culture of Arctic Charr" 1 - A Literature Review, Lucas & Lucas, 1992, unpublished, for Skye & Lochalsh LEC/Highlands and Islands Enterprise Board, Scotland, UK.) Thus during the warmest months, Icy Waters Ltd. actually has restricted fish growth due to high temperatures, and increased mortalities. Additionally high water temperatures cannot hold as much dissolved oxygen as cooler temperatures, thus Icy Waters Ltd. must produce more oxygen in summer, to maintain fish that are on a restricted diet because the water temperature is too high. Reducing these summer temperatures by 3°C would reduce mortality due to heat stress significantly, and also significantly increase the opportunity for growth on the farm.

#### Growth Benefit

Growth of the fish is directly related to temperature. They will eat more, and convert this food into flesh more efficiently as the temperature rises. The maximum effect occurs at around 15-16°C, above which appetite and conversion decreases with temperature.

A considerable amount of research has been undertaken to establish the correct feeding rates for fish at various temperatures (see attached tables). As an example, if we look at 0.1-0.4g fish in the hatchery, at 4°C they require 2.8% bodyweight feed per day, therefore at a conversion rate of 1:1.5 (for example), they will increase weight by 1.86%/day. If the water temperature is raised to 8°C, feed requirement is 4.5%, and weight gain at the same conversion rate is 3%, or growth is increased by 1.6 times. Thus the time taken to grow from 0.1 to 0.4 g is reduced 1.6 times, if this was ordinarily 4 weeks at 4°C, it would now be 2.5 weeks.

Examining the juvenile situation: (eg) a 10g fish at 2°C feeds at 1%, and converts at 1:1.3, it would grow at 0.77%/day. At 6°C the same fish at the same conversion rate would grow at 1.08%/day, or 1.4 times faster; at 8°C this would be 1.7 times faster.

This growth increase in the hatchery and juvenile stages of the fish production means the fish will be larger, and be moved to the main grow out facility sooner than is presently the case. Additionally if the tank farm water can be cooled in the summer, growth can continue at the most optimal temperatures throughout the summer. The fish will therefore reach market size faster, be larger at market size, and also due to the speedier movement of fish through the system production biomass will increase. Thus allowing Icy Waters Ltd to fulfil its goals listed above.

## Capital Costs

Both IRAP, and Yukon Energy Solutions are being approached for support, and to explore further avenues for funding.

System A requires 7 heat pump units of size 30 tonnes each

System B requires 9 heat pump units of size 30 tonnes each

(tonnes refers to heat capacity, 1 tonne =12000 BTU)

Heat pumps have been quoted for by Histech, Calgary, Alberta. and cost is:

System A \$155,000

System B \$196,000

My experience in aquaculture estimates that installation costs will be 100% of system costs, thus total project costs will be \$702,000.

## Running Costs

The yearly operating costs indicate the incredible efficiency of these systems:

System A: \$30000 per year

System B: \$35000 per year

Tank farm cooling: FREE.

Whenever tank farm cooling is required System A and B will take their required heat from the tank farm water, thus cooling it. A and B will take enough heat to drop 200l/s of tank farm water by 2.7°C.

Present operating costs – oil costs for the hatchery boiler, to heat 13 l/s of water by an average of 4°C, with no cooling:

2000/2001: \$15841

2001/present: \$16671 (estimated year cost >\$20,000)

To operate this type of temperature manipulation using oil fired systems would cost the following:

System A: \$89,000

System B: \$107,000

With NO cooling.

Clearly oil burning is inefficient, uneconomic, and environmentally unfriendly.

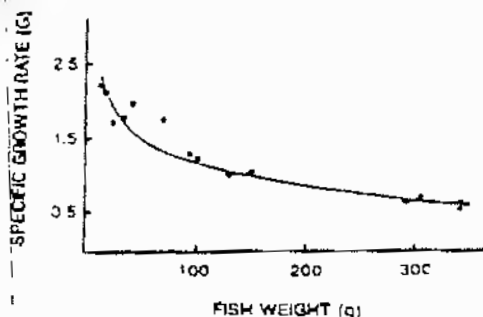
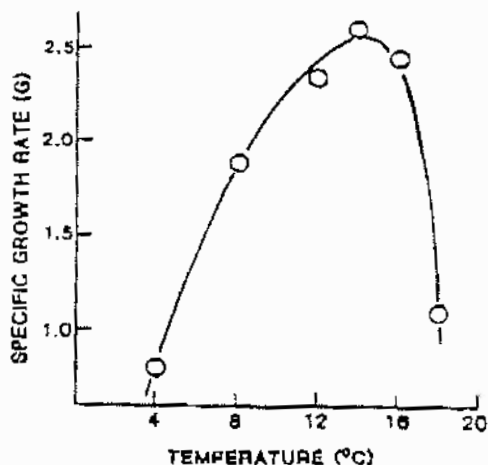
Installation of the Heat Pump Technology in this new application will allow Icy Waters Ltd. to achieve its goals.

Icy Waters Ltd. understands this to be a major innovative project, and is seeking support from YTIC. However Icy Waters Ltd. is actively seeking support elsewhere, and asks that YTIC consider supporting the project in association with other agencies

From: The Culture of Arctic Charr *Lusobius*

ONCROWING

The distribution of charr in the northern latitudes suggests that charr are well suited to growth in cold waters. Research supports this theory. At temperatures under 10 C young charr will outgrow salmon by a factor of 3-6. The Norwegians expect a charr to reach 200-350g after two years at 8-9 C. The optimum temperature for all strains of charr appears to be between 10 C and 13 C in Canada and 12-15 C in Norway. The upper maximum being 19 C after which large losses occur e.g. 2.6% per day with charr held in freshwater cages in the Nelson river, Manitoba when temperatures rose above 19 C.



Specific growth rates vary, but have generally been found to be between 1.33 and 3% per day, depending on the culture system and strain. However in comparable situations Norwegian charr are slower growing, have a greater nutritional requirement, and lose weight faster if starved than Canadian.

Strain	Specific Growth Rate (SGR) for experimental trials with Arctic Charr	Weight (g)	Specific Growth Rate (%)	Source
Arctic Charr				
15	1.5	100	1.5	Canada
12	1.8	150	1.8	Canada
13	2.3	200	2.3	Canada
16	2.4	250	2.4	Canada
19	1.1	300	1.1	Canada
Rainbow Trout				
13	1.0	100	1.0	Canada
15	1.2	150	1.2	Canada
18	1.5	200	1.5	Canada
20	1.8	250	1.8	Canada

ICY WATERS LTD.  
GROW OUT - CHARR PRODUCTION

4/96

FEEDING GUIDELINES

Average Fish Size Weight (gms)	Pellet Size mm	Percent of Body Weight Fed Per Day Water Temperature (C)							
		2	4	6	8	10	12	14	16
0.05 - 0.1	mash	2.7	3.2	4.1	5.3	6.0	6.3	6.5	7.8
0.1 - 0.4	#0	2.4	2.8	3.6	4.5	5.0	5.4	5.8	6.2
0.4 - 4.0	#1	2.0	2.4	2.8	3.2	3.8	4.2	5.0	5.5
4.0 - 10	#2	1.3	1.7	1.9	2.0	2.2	2.6	2.9	3.2
10 - 25	1.2 / 1.5	1.0	1.3	1.4	1.7	2.0	2.3	2.6	3.0
25 - 50	1.5	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.3
50 - 100	2.0	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.0
100 - 150	2.0 / 2.5	0.7	0.9	1.1	1.3	1.5	1.7	1.9	1.9
150 - 250	2.5	0.6	0.8	1.0	1.2	1.4	1.6	1.8	1.8
250 - 450	2.5	0.5	0.7	0.9	1.1	1.3	1.5	1.7	1.7
450 - 750	3.5	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.6
750 - 1000	3.5	0.3	0.5	0.7	0.9	1.1	1.3	1.5	1.5
1000 - 2000	5.0	0.2	0.4	0.6	0.8	1.0	1.2	1.2	1.2
2000 +	6.5	0.2	0.4	0.5	0.6	0.7	0.8	0.8	0.8

1. Feeding Table should be used as a guide to calculate pellet size and daily ration.
2. Careful observation of feeding response is critical to determine actual daily food intake.
3. Good environmental conditions are important in order to achieve maximum feeding levels.
4. Feed should be presented over a period of 12 hours or longer. Frequent small meals may provide optimal results.
5. Automatic feeders should be supplemented with hand feeding to gauge feeding system efficiency.
6. Wasted feed may indicate that meal size is too large or daily ration is too high. Make changes as needed.
7. Feed cautiously at high temperatures when metabolic rates are high to avoid oxygen depletion.

P.6:  
360 273 7197  
N  
ICY WATERS US  
PM 03:41  
NO 03:41  
NO 03:41



### HEAT GAIN CALCULATION FOR CHILLER ROOM #1

\* ALL CALCULATIONS ARE BASED ON WINTER DESIGN CONDITIONS.

#### LIGHTING LOAD: ▶

- A WATTAGE OF 1 W/FT<sup>2</sup> WAS USED.

$$q = (3.41)(W)(F_{HL})(F_{SA})$$
$$= (3.41)(184)(1.0)(1.0) = \boxed{902 \text{ Btu/hr}}$$

#### PEOPLE LOAD: ▶

- THE HEAT GAIN FROM PEOPLE IS NOT INCLUDED IN REFRIGERATION CALCS

$$= \boxed{0 \text{ Btu/hr}}$$

#### POWER LOAD: ▶

- REFRIGERATION SYSTEM EQUIPMENT (SUCH AS EVAPORATOR FANS) IS NOT INCLUDED IN REFRIG. CALCS.

$$= \boxed{0 \text{ Btu/hr}}$$

#### SOLAR LOAD: ▶

- SOLAR RADIATION EFFECTS ARE NOT INCLUDED IN REFRIGERATION CALCULATIONS

$$= \boxed{0 \text{ Btu/hr}}$$

#### SLAB CONDUCTION: ▶

$$q = (K/A)$$
$$= (4 \text{ Btu/hr/ft}^2)(118 \text{ ft}^2) = \boxed{472 \text{ Btu/hr}}$$



### WALL CONDUCTION ▶

- 3 EXTERIOR WALLS W/ NO CONDUCTION; 1 INTERIOR WALL
- SEE U-VALUE CALCULATION FOR DETERMINATION OF U-VALUE

$$q = UA(\Delta T)$$
$$= (0.028)(13 \text{ ft})(8 \text{ ft})(68 - 40^\circ\text{F}) = \boxed{82 \text{ Btu/hr}}$$

### ROOF CONDUCTION ▶

$$q = UA(\Delta T)$$
$$= (0.028)(117 \text{ ft}^2)(40 - 40^\circ\text{F}) = \boxed{0 \text{ Btu/hr}}$$

### PERIMETER INFILTRATION ▶

- EDGE FACTOR (F) ASSUMED TO BE 0.5

$$q = FP(\Delta T)$$
$$= (0.5 \text{ Btu/hr/ft})(13 \text{ ft})(68 - 40^\circ\text{F}) = \boxed{187 \text{ Btu/hr}}$$

### WALK-IN DOOR INFILTRATION

- CHILLER ROOM IS ACCESSED 60 TIMES IN A DAY OR (APPROX 8 TIMES / HOUR) HOWEVER ASHRAE PROCEDURES ARE USED TO CALCULATE IT.

VOLUME  $\approx 936 \text{ ft}^3$ ;  $\approx 10$  AIR CHANGES / HR

$$q = 1.08 \left( \frac{936 \text{ ft}^3}{\text{AC}} \right) \left( \frac{10 \text{ AC}}{\text{hr}} \right) \left( \frac{\text{hr}}{60 \text{ min}} \right) (18 - 40^\circ\text{F}) = \boxed{4,717 \text{ Btu/hr}}$$

APPROXIMATE TOTAL HEAT GAIN =  $\boxed{5,855 \text{ Btu/hr}}$



### CALCULATION OF APPROXIMATE U-FACTOR FOR CHILLER ROOM

INSULATION := PREFABRICATED PANELS "FORMED IN PLACE"  
(INJECTED) WITH U.L. LISTED CLASS 1  
URETHANE FOAM INSULATION. "K" FACTOR  
IS APPROXIMATELY 0.12 Btu/hr/ft<sup>2</sup>/°F/in.

$$K = \frac{(0.12 \text{ Btu} \cdot \text{in})}{\text{hr} \cdot \text{ft}^2 \cdot \text{°F}} \quad \therefore \quad C = \frac{(0.12 \text{ Btu} \cdot \text{in})}{\text{hr} \cdot \text{ft}^2 \cdot \text{°F} \cdot \text{in}} \left( \frac{1}{9 \text{ in}} \right) = \frac{0.03 \text{ Btu}}{\text{hr} \cdot \text{ft}^2 \cdot \text{°F}}$$

$$R_i = \frac{1}{C} = \frac{\text{hr} \cdot \text{ft}^2 \cdot \text{°F}}{0.03 \text{ Btu}} = 33.33 \frac{\text{hr} \cdot \text{ft}^2 \cdot \text{°F}}{\text{Btu}}$$

$$R_{\text{AIR, INSIDE}} = 0.68 \frac{\text{hr} \cdot \text{ft}^2 \cdot \text{°F}}{\text{Btu}}$$

$$R_{\text{AIR, OUTSIDE}} = 0.17 \frac{\text{hr} \cdot \text{ft}^2 \cdot \text{°F}}{\text{Btu}} \quad (\text{15 mph})$$

$$R_{\text{METAL SLUG}} = 1.64 \frac{\text{hr} \cdot \text{ft}^2 \cdot \text{°F}}{\text{Btu}}$$

$$U_T = \frac{1}{R_T} = \frac{1}{33.33 + 0.17 + 0.68 + 1.64} = \frac{1}{35.82}$$

$$U = 0.028 \frac{\text{Btu}}{\text{hr} \cdot \text{ft}^2 \cdot \text{°F}}$$



**CALCULATION OF OPERABLE HOURS  
PER YEAR FOR THE CHILLER UNIT  
SERVING CHILLER ROOM # 1**

**EXISTING CONDITIONS:**

- SPACE DESIGN TEMPERATURE =  $4^{\circ}\text{C}$  ( $40^{\circ}\text{F}$ )
- SUPPLY AIR TEMPERATURE =  $-6.7^{\circ}\text{C}$  ( $20^{\circ}\text{F}$ )  
(FROM EVAPORATORS)
- HEAT PUMP CAPACITY =  $5000\text{W}$  ( $17,000\text{ Btu/hr}$ )

**APPROXIMATE SUPPLY AIR VOLUME FLOW RATE:**

$$\text{CFM} = \frac{2}{1.08 (\Delta T)}$$
$$= \frac{17,000 \text{ Btu/hr}}{1.08 (40^{\circ}\text{F} - 20^{\circ}\text{F})} \approx 790 \text{ CFM}$$

**APPROXIMATION OF HOW MANY TIMES THE COMPRESSOR  
RUNS IN 1 HR.**

$$Q_{\text{pick-up}} = Q_{\text{TOTAL}} - Q_{\text{HEAT LOSS}}$$
$$= 17,000 \frac{\text{Btu}}{\text{hr}} - 5,855 \frac{\text{Btu}}{\text{hr}} \quad (* \text{ SEE HEAT LOSS CALCULATIONS})$$
$$Q_{\text{pick-up}} = 11,145 \frac{\text{Btu}}{\text{hr}}$$
$$\% \text{ OPERATIONS} = \frac{5,855 \text{ Btu/hr}}{17,000 \text{ Btu/hr}} \approx 3.4\% \text{ OF THE TIME}$$

\* NOTE: THIS VALUE IS APPROXIMATE AND WILL DEPEND ON MANY FACTORS SUCH AS TIME OF DAY, YEAR, INTERNAL LOADS AT ANY GIVEN TIME, ETC.  
(IN WINTER, BELOW  $-6.7^{\circ}\text{C}$ )



CHILLER ROOM IS IN OPERATION :=

USAGE : EVERYDAY 24 HRS A DAY EXCEPT 2 WEEKENDS PER MONTH.

$$\text{USAGE} = 365 - (2 \times 12) = 341 \text{ DAYS / YEAR} \times 46\% = 157 \text{d/yr}$$

EFFECTIVE RUNNING TIME OF CHILLER

$$= \left( \frac{157 \text{ DAYS}}{\text{YR}} \right) (0.34) = \boxed{53 \frac{\text{DAYS}}{\text{YR}}}$$

$$= \left( \frac{53 \text{ DAYS}}{\text{YR}} \right) \left( \frac{24 \text{ HRS}}{\text{DAY}} \right) = \boxed{1272 \frac{\text{HRS}}{\text{YR}} \text{ (WINTER)}}$$



OUTDOOR AIR VOLUME FLOW RATE CALCULATION

$$\begin{aligned} \text{CFM} &= \frac{2}{1.08 (\text{AT})} \\ &= \frac{17,000 \text{ BTU/hr}}{1.08 (90^\circ\text{F} - 20^\circ\text{F})} \\ &= \boxed{820 \text{ CFM}} \end{aligned}$$

NOTE: WINTER DESIGN TEMPERATURE IN WHITEHORSE IS  $-9.6^\circ\text{F}$ . THIS MEANS EITHER THE FAN MUST CYCLE ON AND OFF OR THE VOLUME FLOW RATE MUST BE ADJUSTED TO SUPPLY THE SAME AMOUNT OF COOLING.

ESTIMATION OF EXTERNAL STATIC PRESSURE ON THE FAN

SUPPLY AIR LOUVER	0.3"
SUPPLY AIR FILTER	1.0"
SUPPLY AIR DAMPER	0.2"
SUPPLY AIR GRILLE	0.1"
DUCTWORK	0.1"
EXHAUST AIR GRILLE	0.1"
EXHAUST AIR DAMPER	0.2"
EXHAUST AIR LOUVER	0.3"
	<u>2.3"</u>

APPROXIMATE TOTAL EXTERNAL RESISTANCE =  $\boxed{2.3 \text{ "W.C.}}$



SELECTION OF AN APPROPRIATE FAN:

- $Q = 790 \text{ CFM}$
- S.P. =  $2.3 \text{ W.C.}$

SELECT A FORWARD CURVED CENTRIFUGAL UTILITY FAN WITH A 1 HP MOTOR.

- EFFICIENCY = 0.79
- ELECTRICAL RATE = \$0.15 / KW·hr ASSUMED

$$P = (1.0 \text{ HP}) \left( \frac{745 \text{ W}}{\text{HP}} \right) = 745 \text{ W} \quad (< 0.795 \text{ KW})$$

$$C = \frac{(\text{POWER})(\text{RATE})(\text{OPERATIONAL HOURS})}{\text{EFFICIENCY}}$$

NOTE: FREE COOLING FOR THIS ROOM BASED ON A DESIGN TEMPERATURE OF  $-6.7^\circ\text{C}$  ( $20^\circ\text{F}$ ) IS AVAILABLE 46% OF THE TIME IN A YEAR BASED ON MEAN DEGREE-DAYS.

$$\left( \frac{391 \text{ DAYS}}{\text{YR}} \right) (0.46) = \frac{157 \text{ DAYS}}{\text{YR}} \quad \text{FREE COOLING IS AVAILABLE}$$

$$C = \frac{(0.745 \text{ KW}) \left( \frac{\$0.15}{\text{KW·hr}} \right) \left( \frac{157 \text{ DAYS}}{\text{YR}} \right) \left( \frac{24 \text{ HR}}{\text{DAY}} \right) \times 0.34}{0.79}$$

↖ running time

$$C_{\text{FEC}} = \frac{\$143.39}{\text{WINTER}}$$



### CALCULATION OF YEARLY POWER COSTS FOR CHILLER ROOM # 1

#### CONDENSING UNIT (INCLUDING COMPRESSOR/CONDENSER) :-

- POWER = 1 1/2 MOTOR
- EFFICIENCY = ASSUMED 80% (ASHRAE)
- ELECTRICAL RATE = \$0.15 / KW.HR ASSUMED

$$P = (1.5 \text{ HP}) \left( \frac{745 \text{ W}}{\text{HP}} \right) = 1117.5 \text{ W} < 1.1175 \text{ KW} >$$

$$C = \frac{(\text{POWER})(\text{RATE})(\text{OPERATIONAL HOURS})}{\text{EFFICIENCY}}$$

$$C_{cu} = \frac{(1.1175 \text{ KW}) \left( \frac{\$ 0.15}{\text{KW.HR}} \right) \left( \frac{1272 \text{ HR}}{\text{YEAR}} \right)}{0.8} = \boxed{\$ \frac{266.50}{\text{WINTER}}}$$

#### EVAPORATOR FANS

- ASSUME (2) EVAPORATORS, EACH WITH 3 FANS
- ASSUME 40% EFFICIENCY (ASHRAE)
- ASSUME 1/20 HP MOTORS

$$P_{ev} = (6) \left( \frac{1 \text{ HP}}{20} \right) \left( \frac{1745 \text{ W}}{\text{HP}} \right) = 223.5 \text{ W} < 0.223 \text{ KW} >$$

$$C_{ev} = \frac{(0.223 \text{ KW}) \left( \frac{\$ 0.15}{\text{KW.HR}} \right) \left( \frac{1272 \text{ HR}}{\text{YEAR}} \right)}{0.4} = \boxed{\$ \frac{106.37}{\text{WINTER}}}$$

TOTAL POWER COST FOR CHILLER FOR WINTER (K-67°C)

$$\boxed{\$ \frac{372.89}{\text{WINTER}}}$$

Youngs Refrigeration  
 180 COPPER RD. P.O. BOX 2008  
 WHITEHORSE VIA 507

ICY WATERS  
 P.O. Box 21351 ST. MAIN  
 WHITEHORSE YUKON VIA-6R7

DEAR SIR,

SUMMARY OF ONE YEARS INVOICES OF PARTS  
 AND LABOUR FOR ICY WATERS BY YOUNG'S REFRIGERATION.

FEB 26/02 - INV 7252 - FREEZER NOT COLD ENOUGH  
 LAB - 5 HRS - FEB 25-26-27 - 325<sup>00</sup>  
 PTS - 25# Q/L R404/MP62 - FITTING-ADAPTER 729.75  
 GST 73.83  
TOTAL 1128.58

MAY 1/02 INV 7283 - ICE MACHINE - START-REPAIR  
 LAB MAY 1-7-8/02 4 HRS @ 65<sup>00</sup> 260<sup>00</sup>  
 PTS 1 REMLC 015-435-70 157.50  
 GST 29.2  
TOTAL 446.73

SEPT. 3/02 7363 - FREEZER TOO WARM  
 SEPT 3-20/02 LAB - 3 HRS @ 65<sup>00</sup> 195<sup>00</sup>  
 PTS R404 (MP62) - STEM CAP 1049.50  
 GST 87.11  
TOTAL 1331.61

OCT 22/02 - 7385 RECORDER CHART - CR PIN  
 PTS - 124.50  
 GST 871  
TOTAL 133.23

JAN 16/03 7411 - START BLAST FREEZER  
 PTS 22.50  
 LAB 97.50  
 GST 8.40  
TOTAL 128.40

ONE YEAR SUMMARY OF TOTAL INV. PTS, LAB, GST

	INV. Y	PTS	LAB	GST	TOTAL
FEB-JAN					
FEB/02	7252	729.75	325 <sup>00</sup>	73.83	1128.58
MAY/02	7283	157.50	260 <sup>00</sup>	29.22	446.73
SEPT/02	7363	1049.50	195 <sup>00</sup>	87.11	1331.61
OCT/02	7385	124.52	—	8.71	133.23
JAN/03	7411	22.50	97.50	8.40	128.40
<u>TOTAL</u>	<u>2083.77</u>	<u>877.50</u>	<u>207.23</u>	<u>207.23</u>	<u>3168.54</u>



# Copeland

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## A History of Excellence... A Tradition of Innovation

View in Metric Units

### SUMMARY INFORMATION

#### 2DA3-0600-TFC

Application: Low Temperature

Refrigerant: R-22

Frequency: 60 Hz

Phase: 3

Nominal Voltage: 208/230

Low Voltage Station: Available for sale to all U.S. customers. Please check with your local distributor for availability and international availability.

#### PERFORMANCE

	Cond. 1	Cond. 2
Evaporating (°F)	-25	-40
Condensing (°F)	105	105
Return Gas (°F)	65	65
Liquid Temperature (°F)	105	105
Capacity (BTU/hr)	18800	10200
Power (Watts)	3850	2920
Current (Amp)	14.8	13.2
EER (BTU/Watt-hr)	4.9	3.5
Mass Flow (lbs/hr)	253	136

Rating Curve 1 22LD-10

Rating Table 1 22LD-10

#### ELECTRICAL

MCC	35.6
RLA	28.8
LRA-Low	*
LRA-High	161.0
LRA-Half Winding	*



## A History of Excellence... A Tradition of Innovation

View in English Units

### SUMMARY INFORMATION

#### CRA1-0150-PFV

Application: High Temperature

Refrigerant: R-22

Frequency: 50 Hz

Phase: 1

Nominal Voltage: 200

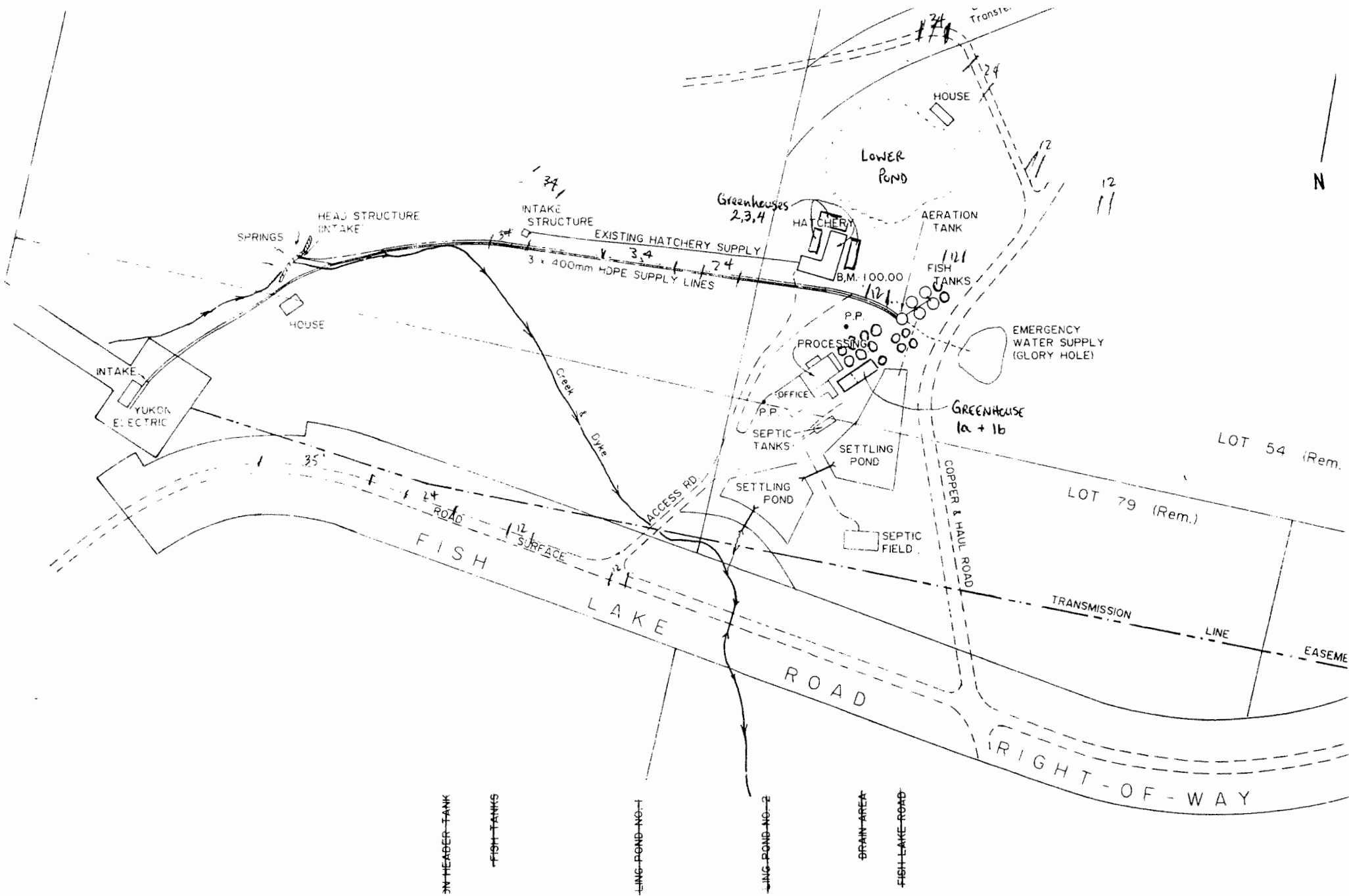
Production Status: Available for sale to all U.S. customers. Please check with your local Copeland representative for international availability.

#### PERFORMANCE

	Cond. 1	Cond. 2
Evaporating (°C)	7.2	-6.7
Condensing (°C)	54.4	48.9
Return Gas (°C)	18.3	18.3
Liquid Temperature (°C)	54.4	48.9
Capacity (Watts)	4050	2250
Power (Watts)	1580	1240
Current (Amp)	8.6	7.1
EER (COP)	2.58	1.82
Mass Flow (kg/hr)	100	51.5

#### ELECTRICAL

MCC	15.1
RLA	10.8
LRA-Low	*
LRA-High	48.0
LRA-Half Winding	*
Med Volts	*
High Volts	200
Phase	1



IN-HEADER-TANK

FISH-TANKS

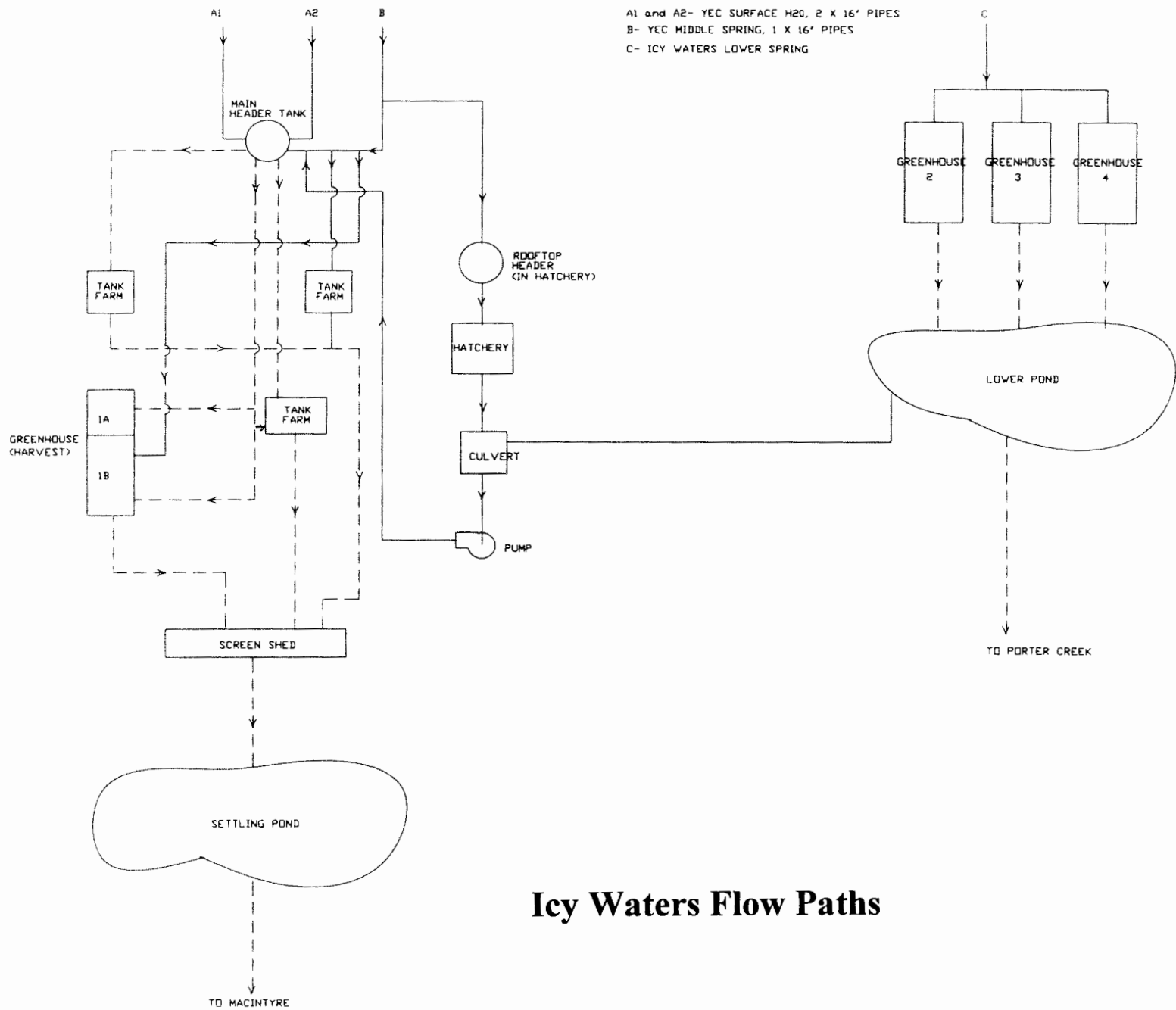
LING-POND-NO-1

LING-POND-NO-2

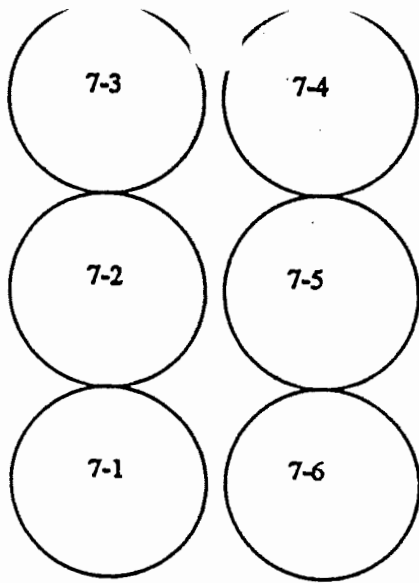
GRAIN-AREA

FISH-LAKE-ROAD





## Icy Waters Flow Paths



Tank Farm Comaex (B)

7-1-7-6 : 84m<sup>3</sup> tanks  
7-7-7-10 : 76m<sup>3</sup> tanks  
9-1-9-8 : 96m<sup>3</sup> tanks

Greenhouse (1b)

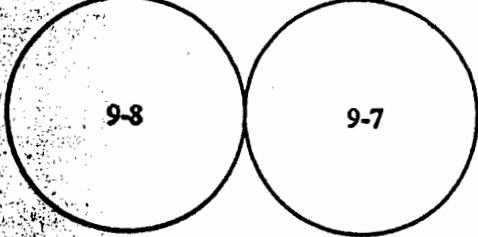
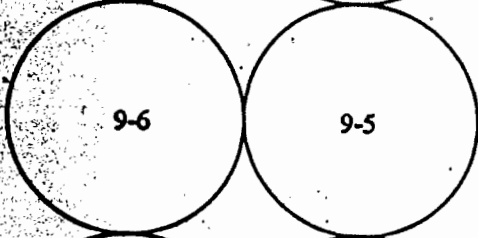
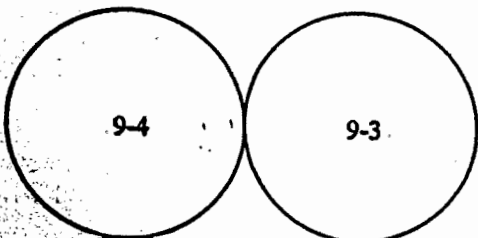
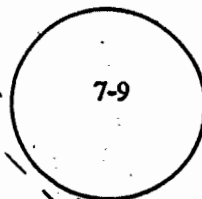
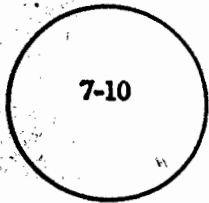
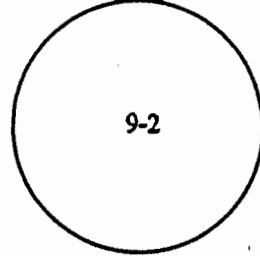
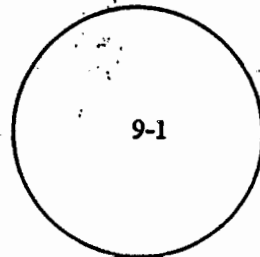
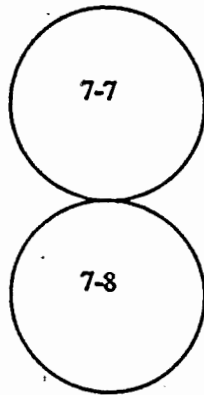
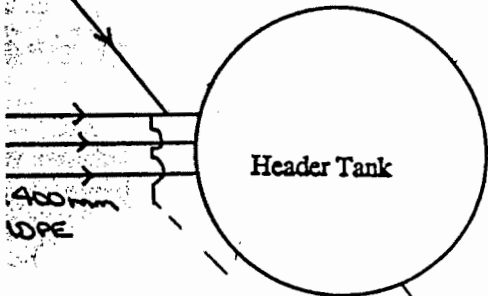
22 x 22m<sup>3</sup> tanks } "J" tanks  
1 x 2.5m<sup>3</sup> tank

Harvest Room (1a)

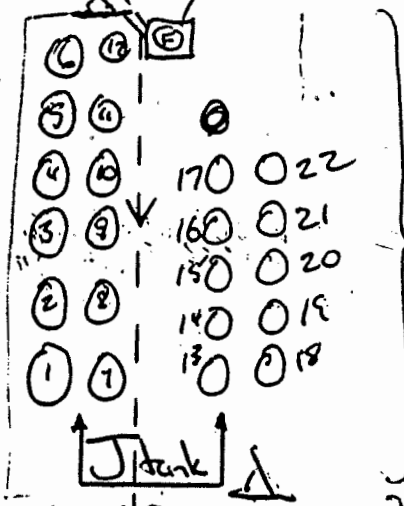
4 x 10m<sup>3</sup> tanks "H" tanks

SETTLEMENT POND (5)

Pump House



greenhouse header

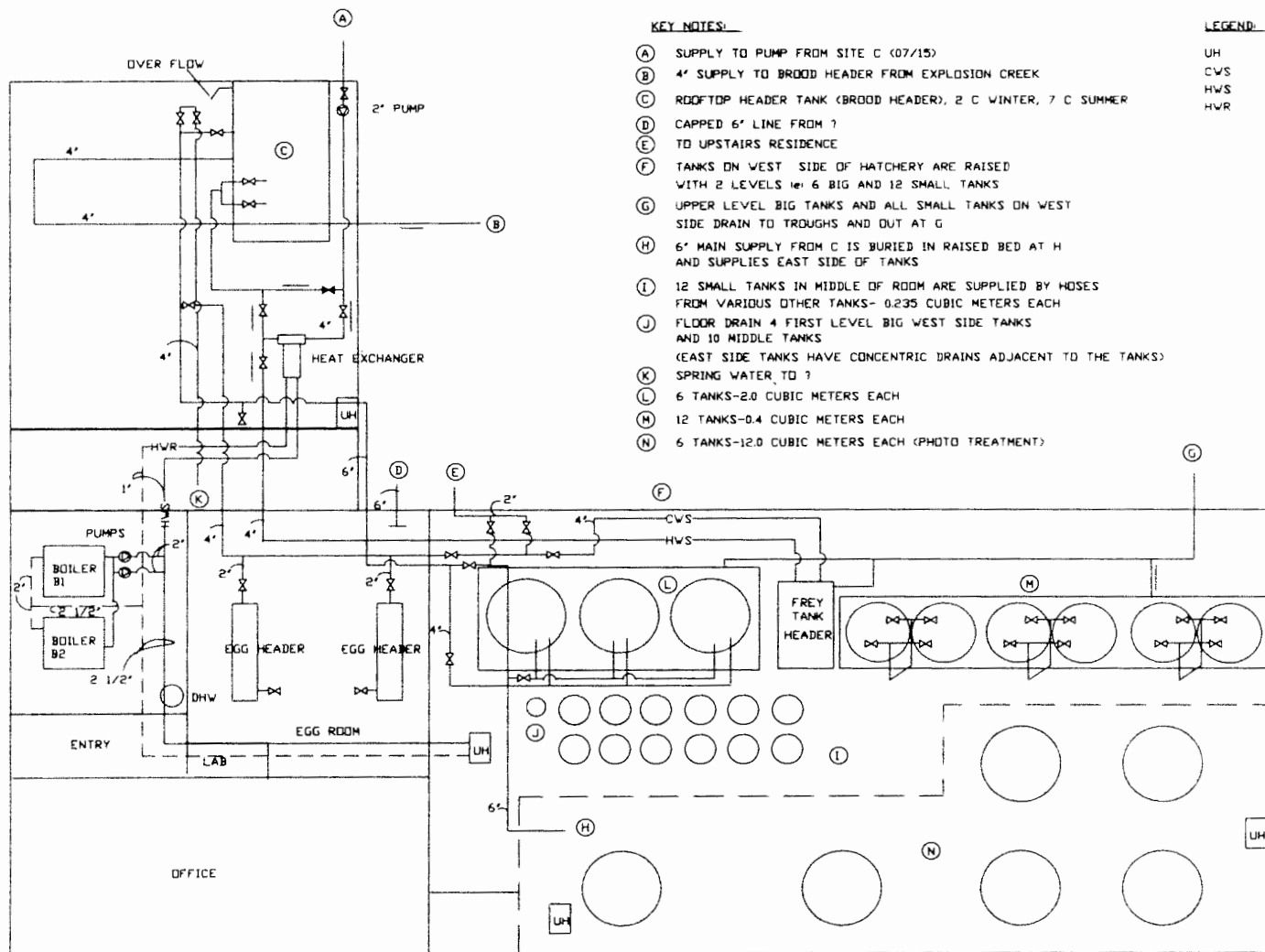


"Greenhouse"

H tank

"Harvest Room"

Electrical



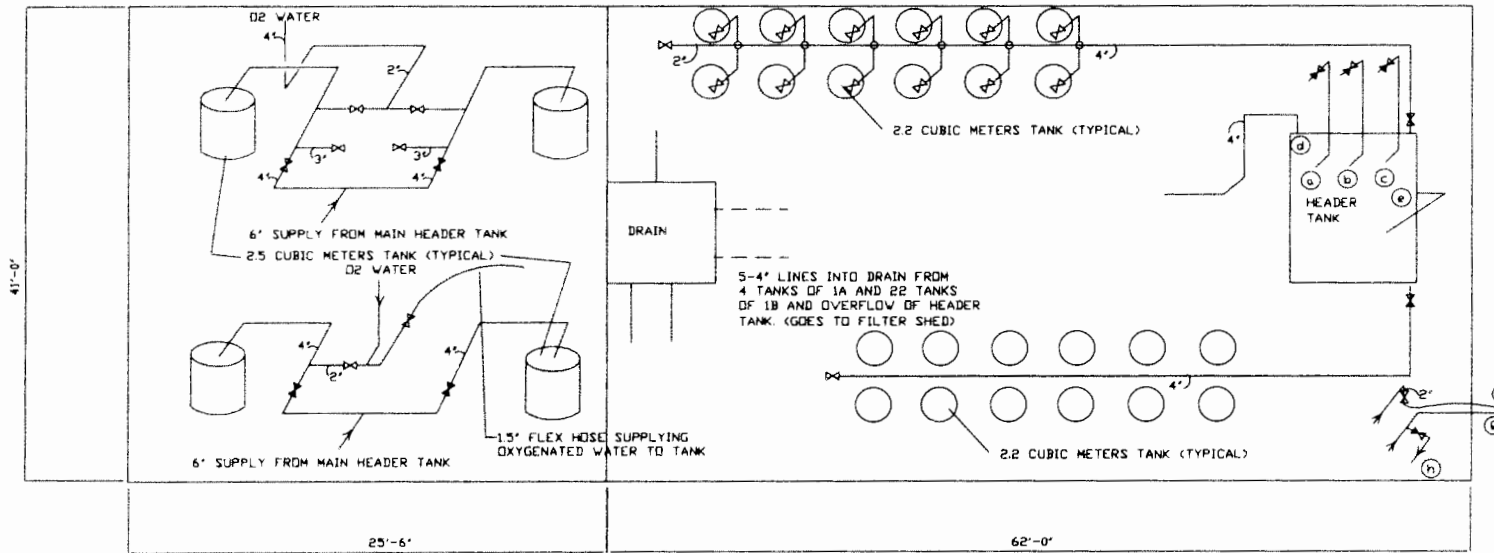
HATCHERY

NOTES:

1. ALL TANKS HAVE DRAINS FROM TANK CENTRE TO ADJACENT 2' RISER THAT CONCENTRIC WITH 4' DRAIN
2. 1B IS UNINSULATED AND HAS 6 MIL POLY INTERIOR
3. LIGHTING= 4 X 60 WATTS INCANDESCENT
4. OXYGENATED WATER OVERFLOW DOWN DRAIN

GREENHOUSE 1A  
(UNHEATED)

GREENHOUSE 1B  
(HEATED)



KEY NOTES

- (a) 4" OXYGENATED LINE FROM O2 SHED (DROPS DOWN TO 2")
- (b) 6" LINE FROM TEE OFF B LINE INTO MAIN HEADER TANK
- (c) 6" LINE FROM MAIN HEADER TANK
- (d) OVERFLOW TO DRAIN
- (e) TO F
- (f) O2 LINE FROM HEADER TANK TO TANK 7-9, FLEX HOSE
- (g) 6" LINE FROM MAIN HEADER TANK TO TANK 7-9
- (h) 2" LINE TO SPRAY BARS OF FILTER SHED

GREENHOUSE 1A AND 1B

# HATCHERY 1st WATER

## Water Use

6 x Photobowl (H)

16 x 12 m <sup>3</sup> tanks	= 192 m <sup>3</sup>	PIT B11-16 (x2) PIT B1-
4 x 10 m <sup>3</sup>	= 40 m <sup>3</sup>	Polybowl B11-16
2 x 26 m <sup>3</sup>	= 52 m <sup>3</sup>	Polybowl B9 + B10
6 x 2 m <sup>3</sup>	= 12 m <sup>3</sup>	H. B23-28 Green
12 x 0.4 m <sup>3</sup>	= 4.8 m <sup>3</sup>	H. P1-12 Grey
12 x 0.235 m <sup>3</sup>	= 2.8 m <sup>3</sup>	H. I1-12 Green (re)

303.6 m<sup>3</sup>

Egg room = 340 L/min

303,600 L/hr

5000 L/min

84/sec

total = 89.6 L/sec for facility  
~ 90 L/sec

Goal: 1 turnover/hr.

60 small tanks

40 Eggs

20 big tanks

for every tank  
except a) + b) 203 turn/hr.

0.4/sec

## Icy Waters Equipment

### **Plant**

Processing Room

Room 1: Chiller, 4 C

Room 2: Blast freezer (not used)

Room 3: Freezer -23 C

Mechanical Room:

1. Boiler to heat slab in processing room
  - a. Beckett/Hydrotherm HY201
  - b. Model #: OR140
  - c. Fuel: Oil
  - d. Output: 112,000 Btu/h
2. Compressor for chiller
  - a. Copeland condensing unit
  - b. Model #: F3W0-01510CFV-001
  - c. A: 13.5
3. 2 x Compressors for blast freezers (not used)
  - a. Copeland condensing unit
  - b. Model #: W3DL-1500TSC050
  - c. A: 76.2
4. Compressor for freezer (too high to see, assume same as blast freezer compressor).
  - a. Copeland condensing unit
  - b. Model #: W3DL-1500TSC050
  - c. A: 76.2

### **Office**

1. 2 x DMO Industries oil furnaces:
  - a. Model #: AF65XN
  - b. No other specs. available

### **Hatchery**

Boiler Room

1. Boiler #1
  - a. Calortecnica (Y-3117)
  - b. Model #: CB4A
  - c. Fuel: Oil
  - d. Output: ? Btu/h
  - e. Year 1996
2. Boiler #2 (turned off)
  - a. Super Hot
  - b. Model #: AO490

- c. Fuel: Oil
- d. Output: 392,000 Btu/h
- e. Year: ?
- 3. Pump
  - a. Baldor industrial motor
  - b. Cat. #: 84 Z01024
  - c. Size: 0.5 hp
- 4. Hot water tank
  - a. John Wood Ltd.
  - b. Model #: 1W 75250F
  - c. Size: 40 gallon

#### Rooftop Header Tank Room

- 1. Heat exchanger #1
  - a. Alpha Laval Plate Heat Exchanger
  - b. Type: A10-BFG
  - c. Pmax = 150 psig
  - d. Tmax = 150 F
- 2. Heat exchanger #2 (not used)
  - a. Mueller Accu-Therm Plate Heat Exchanger (Gea-Ahlborn, Germany)
  - b. Model #: AT80 B-20
  - c. Pmax: 100 psi
  - d. Tmax: 150 F
- 3. Pump
  - a. Baldor
  - b. Cat. #: VM3613T (Spec: 36A03X100)
  - c. Size: 5 hp, 3450 rpm
  - d. Nema nom. eff.: 85.5 %

#### **Pumphouse**

- 1. Electric submersible pump
  - a. Grindex
  - b. Type: fixed speed
  - c. Size: 18 hp (6")
- 2. Electric submersible pump backup
  - a. Grindex
  - b. Type: fixed speed
  - c. Size: 12 hp (4"?)

#### **O<sub>2</sub> Shed**

- 1. 2 x compressors for oxygen - Photo: P5140002
  - a. Sullair screw compressors, Tatung Co. Ultra Power Series
  - b. Model: TB0154DBA
  - c. Size: 15 hp, 1750 rpm
  - d. Nema f.l. eff.: 88.5
  - e. Date: 1993

2. 2 x separators - Photo P5140001
  - a. AirSep
  - b. no specs.
3. 2 x tanks - Photo P5140003
  - a. Enermax
  - b. Serial #: 9631B (crn 1051.4)
  - c. Size: 50 psig
  - d. Date: 1995
4. Pump
  - a. Size: 30 hp
5. Backup pump
  - a. Size: 20 hp

### ***Filter Shed***

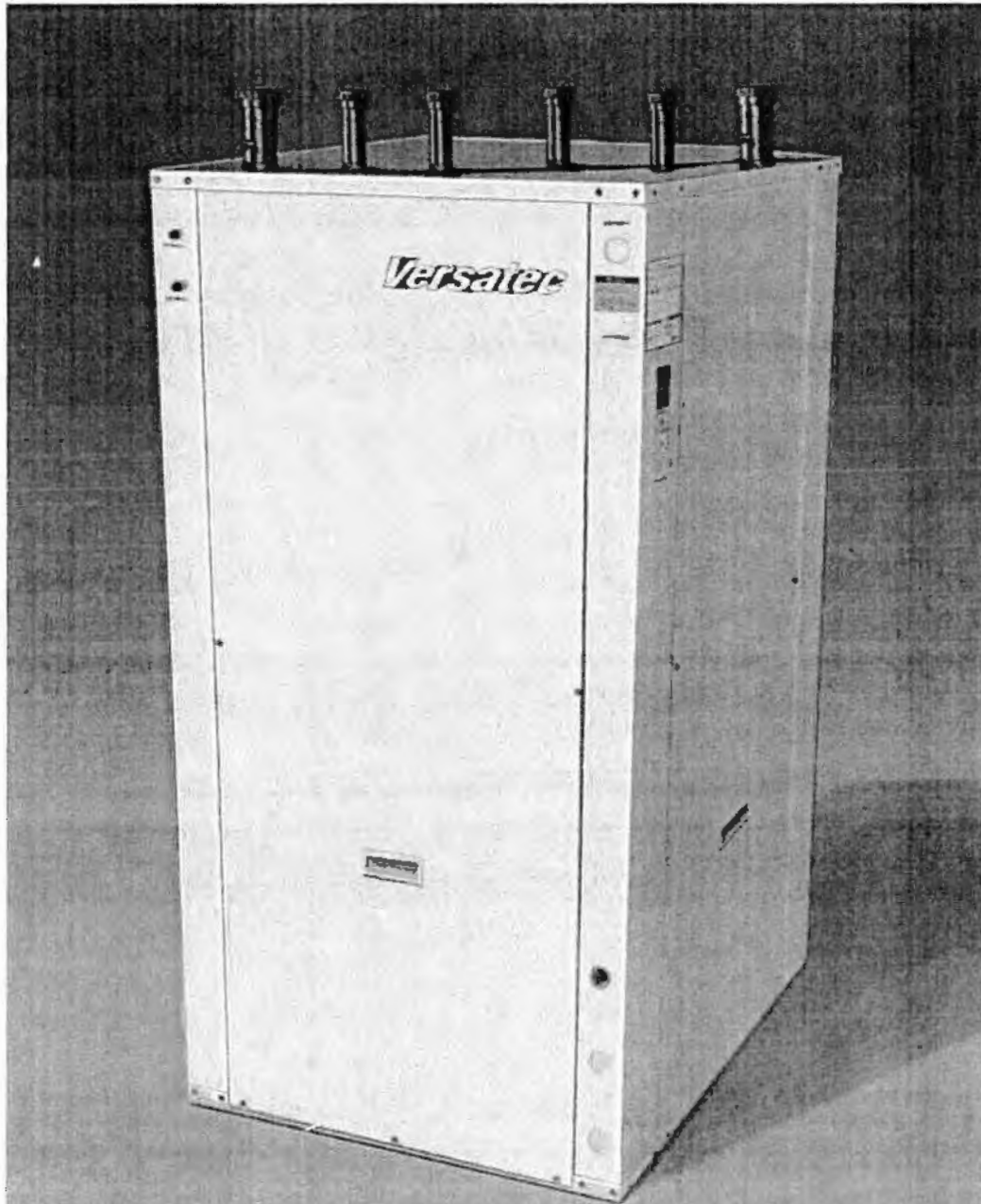
1. 2 x pumps
  - a. Berkeley (Berkeley #: MGP20F-02)
  - b. Model: C48M2EC15
  - c. Size: 1.5 hp, 40 psi
2. 2 x filters
  - a. P.R.A. Rotofilter
  - b. Model: RFM 4872
  - c. Size: 0.33hp, 12gpm backflush
  - d. Ultramite motor; input 0.88hp @ 1750 rpm

### ***Greenhouse 1b***

1. Suspended radiant heater - Photo P5080020
  - a. Gordon Ray IR Radiant Heater
  - b. Model: RTH-75B
  - c. Input: 75,000 Btu/h Output: 67,500 Btu/h
  - d. Fuel: LPG (propane)

# Versatec

Water-to-Water Heat Pumps:  
Nominal 15 and 30 Ton Capacities



Commercial Models  
Specifications Catalog

- Process Heating/Cooling
- Swimming Pool Heating/Cooling
- Outside Air Tempering
- Fan Coil Systems
- Radiant Heating

**WaterFurnace**<sup>®</sup>  
Heating • Cooling • Hot Water



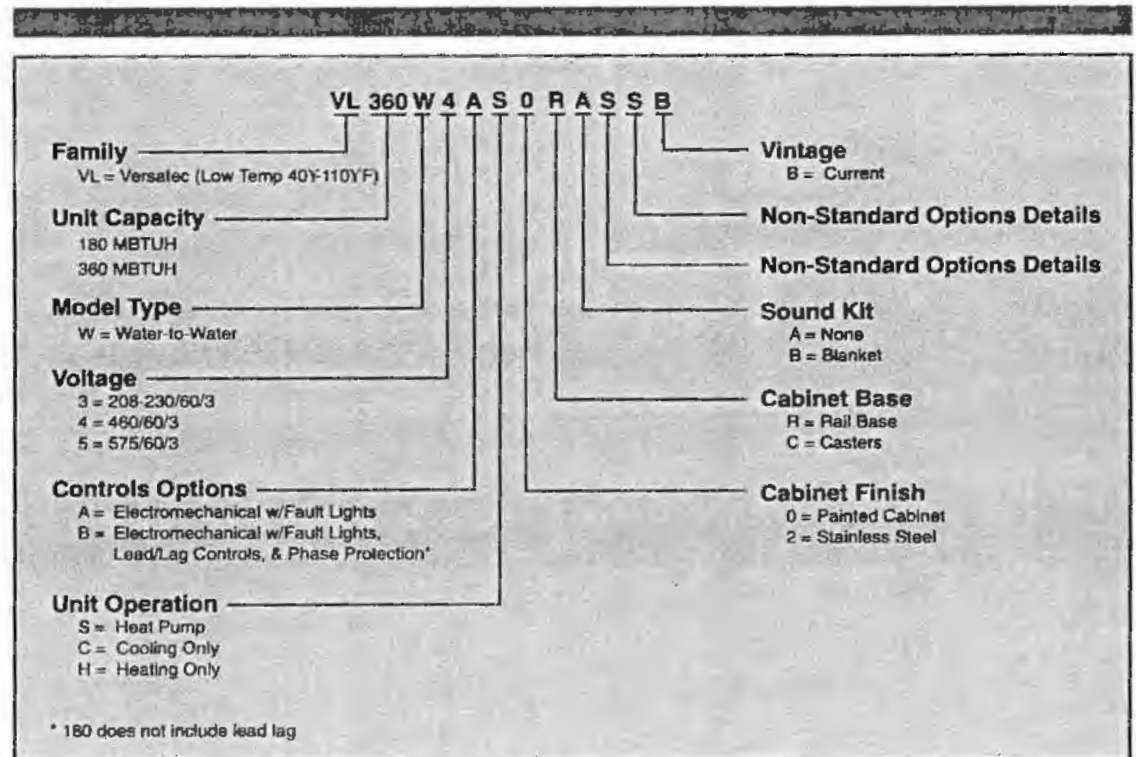
# Versatec

## Water-to-Water Heat Pumps: Water-Cooled Chiller Water-Source Boiler Specifications Catalog

### Contents

Model Nomenclature	Inside Front Cover	Electrical Data	7
VLW Features	3	Physical Dimensions	8
Design Features	4	Physical Data	8
Reference Calculations	4	Piping Configuration	8
Legend	4	Engineering Guide Specifications	9
Per Circuit Heating and Cooling Capacity Data	5-6	Accessories and Other Options	9
Field Connections	7		

### Model Nomenclature



## Versatec 15 and 30 Ton Commercial Specifications Catalog

### **Flexibility:**

- Designed to operate with liquid temperatures of 20°F to 120°F (20-90 EST, 30-120 ELT)
- Heated and chilled water from the same machine
- Modularized design for optimum capacity matching and staging
- Compact size allows passage through most doors
- Fast response lessens system changeover time on two-pipe fan-coil systems
- Replacement for low efficiency water-cooled chillers
- Replacement for electric boilers
- Used for tempering of outside air

### **Efficiency:**

- High cooling EERs
- High heating COPs

### **Quality:**

- Stainless steel brazed plate heat exchangers
- Long-life hermetic compressors
- Bidirectional thermostatic expansion valves

- Heavy duty FPT liquid fittings
- Environmentally friendly HCFC 22
- Compressor control module
- Liquid line filter-dryers
- 24 VAC-75 VA controls transformer with circuit breaker

### **Options:**

- Choice of rail base or casters
- Lead-lag controls with phase protection (180 phase protection only)
- Stainless steel cabinet
- Cooling only or heating only units
- Sound attenuation package

### **Accessories (Field Installed)**

- Tower/boiler loop control panel
- Hose kits
- Solenoid Valve
- Ball Values
- External heat exchangers
- Freeze Protection

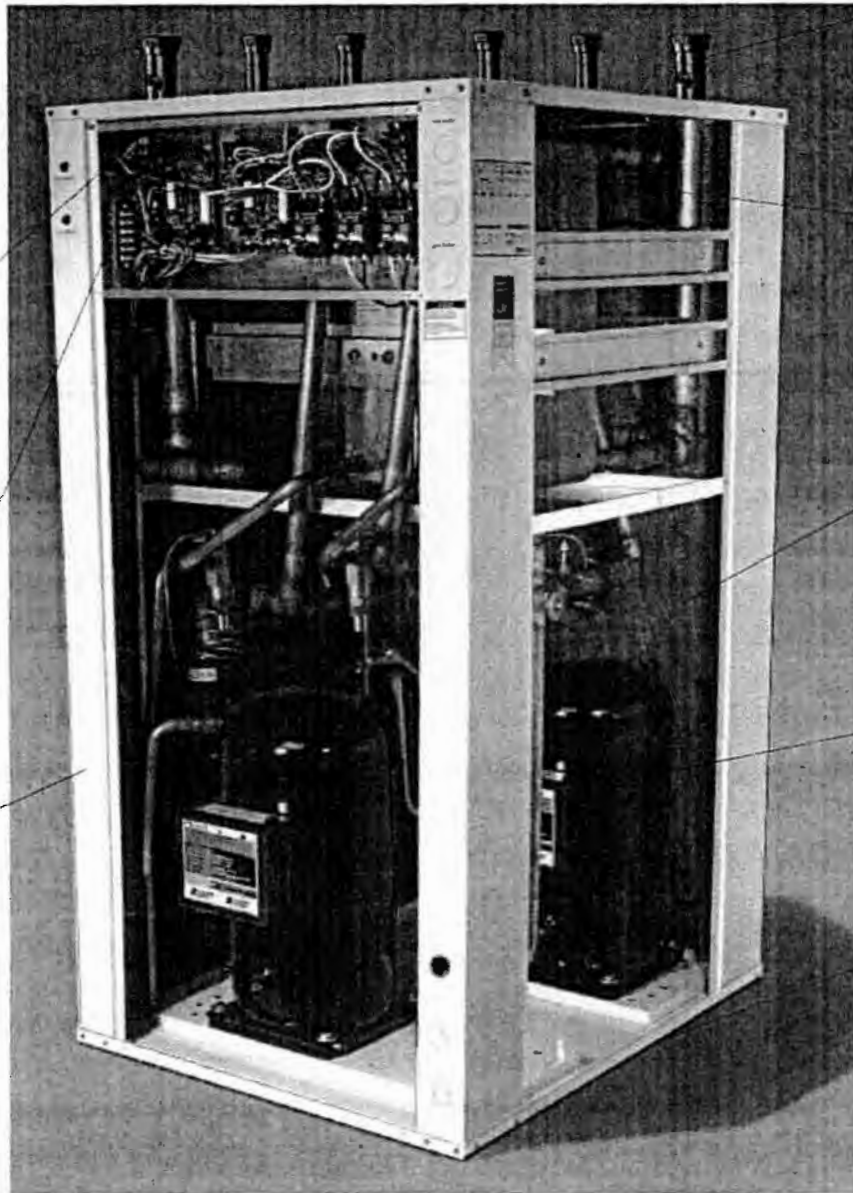
## **VLW Features**

**Design Features**

Conveniently located control box

Electromechanical controls with fault lights

Heavy gauge painted cabinet



FPT copper fitting

Brazed plate stainless steel heat exchangers

Insulated cabinet for quiet operation

High efficiency scroll compressor(s)

Choice of rail base or casters (not shown)

**Reference Calculations**

**Heating Calculations:**

$$LWT = EWT - \frac{HE}{GPM \times 500}$$

**Cooling Calculations:**

$$LWT = EWT + \frac{HR}{GPM \times 500}$$

**Legend**

ELT = entering load fluid temperature to heat pump  
 SWPD = source coax water pressure drop  
 LLT = leaving load fluid temperature from heat pump  
 PSI = pressure drop in pounds per square inch  
 LGPM = load flow in gallons per minute  
 FT HD = pressure drop in feet of head  
 LWPD = load coax water pressure drop  
 LWT = leaving water temperature  
 EWT = entering water temperature

kW = kilowatts  
 EST = entering source fluid temperature to heat pump  
 HE = heat extracted in BTUH  
 LST = leaving source fluid temperature from heat pump  
 HC = total heating capacity in BTUH  
 COP = coefficient of performance, heating [HC/(kW x 3.413)]  
 EER = energy efficiency ratio, cooling  
 TC = total cooling capacity in BTUH  
 HR = heat rejected in BTUH

Versatec 15 and 30 Ton Commercial Specifications Catalog

**VL180W Heating Capacity Data**

ELT	EST	LGPM	LWPD		SOURCE 34.0 GPM						SWPD		SOURCE 45.0 GPM						SWPD	
			PSI	FT HD	LLT	HC	KW	HE	COP	LST	PSI	FT HD	LLT	HC	KW	HE	COP	LST	PSI	FT HD
60	20	34.0	9.3	21.5	66.5	107.0	7.08	82.8	4.4	14.4	10.0	23.1	66.7	110.1	7.28	85.3	4.4	16.1	16.6	38.3
		45.0	15.6	36.0	64.9	106.7	6.90	83.2	4.5	14.3	10.0	23.1	65.0	110.0	7.05	85.9	4.6	16.1	16.6	38.3
	30	34.0	9.3	21.5	67.5	124.6	7.03	100.5	5.2	23.2	9.7	22.4	67.8	128.5	7.29	103.6	5.2	25.3	16.2	37.4
		45.0	15.6	36.0	65.7	123.9	6.76	100.8	5.4	23.2	9.7	22.4	65.9	128.4	6.95	104.7	5.4	25.2	16.2	37.4
	40	34.0	9.3	21.5	69.2	152.1	7.14	127.8	6.2	31.3	9.6	22.2	69.6	157.8	7.13	133.3	6.5	33.9	16.0	37.0
		45.0	15.6	36.0	66.9	150.9	7.12	126.6	6.2	31.8	9.6	22.2	67.0	152.0	7.32	127.0	6.1	34.2	16.0	37.0
	50	34.0	9.3	21.5	70.9	179.8	7.25	155.1	7.3	39.5	9.4	21.7	71.3	186.8	7.28	162.0	7.5	42.6	15.8	36.5
		45.0	15.6	36.0	68.2	178.0	7.47	152.5	7.0	39.6	9.4	21.7	68.4	184.1	7.99	156.8	6.8	42.8	15.8	36.5
	60	34.0	9.3	21.5	72.2	200.4	7.70	174.1	7.6	48.2	9.3	21.5	72.6	208.6	7.94	181.5	7.7	51.7	15.6	36.0
		45.0	15.6	36.0	69.1	198.0	7.63	172.0	7.6	48.3	9.3	21.5	69.4	204.6	8.12	176.9	7.4	51.9	15.6	36.0
	70	34.0	9.3	21.5	73.4	221.0	8.16	193.1	7.9	56.9	9.2	21.3	74.0	230.3	8.62	200.9	7.8	60.8	15.5	35.8
		45.0	15.6	36.0	70.0	218.0	7.80	191.4	8.2	57.0	9.2	21.3	70.3	225.1	8.26	196.9	8.0	61.0	15.5	35.8
80	20	34.0	9.1	21.0	86.4	106.1	9.00	75.4	3.5	14.9	10.0	23.1	86.6	109.2	9.06	78.3	3.5	16.4	16.6	38.3
		45.0	15.4	35.6	84.8	105.8	8.84	75.6	3.5	14.9	10.0	23.1	85.0	109.0	8.88	78.6	3.6	16.4	16.6	38.3
	30	34.0	9.1	21.0	87.4	122.6	9.30	90.9	3.9	23.8	9.7	22.4	87.7	126.4	9.38	94.4	4.0	25.7	16.2	37.4
		45.0	15.4	35.6	85.6	122.1	9.09	91.0	3.9	23.8	9.7	22.4	85.8	126.2	9.16	95.0	4.0	25.6	16.2	37.4
	40	34.0	9.1	21.0	88.9	146.8	9.63	113.9	4.5	32.3	9.6	22.2	89.2	151.6	9.71	118.5	4.6	34.6	16.0	37.0
		45.0	15.4	35.6	86.7	145.9	9.36	113.9	4.6	32.5	9.6	22.2	86.9	150.7	9.45	118.4	4.7	34.6	16.0	37.0
	50	34.0	9.1	21.0	90.4	170.9	9.98	137.0	5.0	40.7	9.4	21.7	90.7	176.8	10.04	142.5	5.2	43.5	15.8	36.5
		45.0	15.4	35.6	87.8	169.8	9.66	136.9	5.2	40.7	9.4	21.7	88.0	175.1	9.75	141.8	5.3	43.5	15.8	36.5
	60	34.0	9.1	21.0	91.5	190.1	10.29	155.0	5.4	49.5	9.3	21.5	91.9	196.8	10.37	161.4	5.6	52.6	15.6	36.0
		45.0	15.4	35.6	88.7	188.8	9.95	154.8	5.6	49.5	9.3	21.5	88.9	194.5	10.04	160.2	5.7	52.7	15.6	36.0
	70	34.0	9.1	21.0	92.7	209.3	10.62	173.1	5.8	58.3	9.2	21.3	93.2	216.9	10.71	180.3	5.9	61.7	15.5	35.8
		45.0	15.4	35.6	89.5	207.7	10.23	172.8	5.9	58.3	9.2	21.3	89.8	213.8	10.34	178.5	6.1	61.8	15.5	35.8
100	20	34.0	9.0	20.8	106.4	105.0	11.55	65.6	2.7	15.5	10.0	23.1	106.5	107.9	11.66	68.1	2.7	16.9	16.6	38.3
		45.0	15.1	34.9	104.8	104.7	11.40	65.7	2.7	15.5	10.0	23.1	104.9	107.7	11.53	68.3	2.7	16.9	16.6	38.3
	30	34.0	9.0	20.8	107.3	120.8	11.87	80.3	3.0	24.5	9.7	22.4	107.5	124.3	12.06	83.1	3.0	26.2	16.2	37.4
		45.0	15.1	34.9	105.5	120.3	11.71	80.3	3.0	24.5	9.7	22.4	105.7	124.0	11.94	83.3	3.0	26.2	16.2	37.4
	40	34.0	9.0	20.8	108.7	144.1	12.27	102.2	3.4	33.1	9.6	22.2	109.0	148.2	12.44	105.8	3.5	35.2	16.0	37.0
		45.0	15.1	34.9	106.6	143.6	12.04	102.5	3.5	33.0	9.6	22.2	106.8	147.8	12.24	106.0	3.5	35.1	16.0	37.0
	50	34.0	9.0	20.8	110.1	167.3	12.67	124.1	3.9	41.6	9.4	21.7	110.4	172.2	12.82	128.4	3.9	44.1	15.8	36.5
		45.0	15.1	34.9	107.6	166.9	12.37	124.6	4.0	41.5	9.4	21.7	107.9	171.5	12.55	128.7	4.0	44.1	15.8	36.5
	60	34.0	9.0	20.8	111.3	185.7	13.07	141.1	4.2	50.4	9.3	21.5	111.6	191.1	13.20	146.1	4.2	53.3	15.6	36.0
		45.0	15.1	34.9	108.5	185.3	12.71	142.0	4.3	50.3	9.3	21.5	108.7	190.3	12.86	146.4	4.3	53.3	15.6	36.0
	70	34.0	9.0	20.8	112.4	204.1	13.48	158.1	4.4	59.3	9.2	21.3	112.7	210.1	13.58	163.7	4.5	62.5	15.5	35.8
		45.0	15.1	34.9	109.3	203.8	13.04	159.3	4.6	59.2	9.2	21.3	109.6	209.0	13.17	164.1	4.7	62.5	15.5	35.8
120	30	34.0	8.9	20.6	127.2	119.0	14.44	69.7	2.4	25.3	9.7	22.4	127.4	122.2	14.74	71.9	2.4	26.7	16.2	37.4
		45.0	14.9	34.4	125.4	118.5	14.32	69.6	2.4	25.3	9.7	22.4	125.6	121.8	14.72	71.6	2.4	26.7	16.2	37.4
	40	34.0	8.9	20.6	128.6	141.3	14.91	90.4	2.8	33.8	9.6	22.2	128.8	144.9	15.17	93.1	2.8	35.7	16.0	37.0
		45.0	14.9	34.4	126.5	141.2	14.70	91.0	2.8	34.0	9.6	22.2	126.6	144.9	15.04	93.5	2.8	35.7	16.0	37.0
	50	34.0	8.9	20.6	129.9	163.7	15.39	111.2	3.1	42.4	9.4	21.7	130.2	167.6	15.60	114.4	3.1	44.8	15.8	36.5
		45.0	14.9	34.4	127.5	163.9	15.09	112.4	3.2	42.3	9.4	21.7	127.7	167.9	15.36	115.5	3.2	44.7	15.8	36.5
	60	34.0	8.9	20.6	131.0	181.3	15.86	127.1	3.3	51.3	9.3	21.5	131.2	185.4	16.02	130.8	3.4	54.0	15.6	36.0
		45.0	14.9	34.4	128.3	181.9	15.47	129.1	3.4	51.2	9.3	21.5	128.5	186.1	15.68	132.6	3.5	53.9	15.6	36.0
	70	34.0	8.9	20.6	132.1	198.8	16.33	143.1	3.6	60.3	9.2	21.3	132.3	203.3	16.45	147.1	3.6	63.3	15.5	35.8
		45.0	14.9	34.4	129.2	199.8	15.86	145.7	3.7	60.1	9.2	21.3	129.4	204.2	16.00	149.7	3.7	63.1	15.5	35.8

**VL180W Cooling Capacity Data**

ELT	EST	LGPM	LWPD		SOURCE 34.0 GPM						SWPD		SOURCE 45.0 GPM						SWPD	
			PSI	FT HD	LLT	TC	KW	HR	EER	LST	PSI	FT HD	LLT	TC	KW	HR	EER	LST	PSI	FT HD
30	50	34.0	9.7	22.4	23.8	102.9	6.96	126.7	14.8	57.7	9.4	21.7	26.2	106.6	6.89	130.1	15.5	54.7	15.8	36.5
		45.0	16.2	37.4	25.3	103.4	7.06	127.5	14.6	56.8	9.4	21.7	26.0	108.8	6.87	132.2	15.8	54.9	15.8	36.5
	70	34.0	9.7	22.4	24.2	95.4	8.7	125.0	11.6	57.6	9.2	21.3	26.5	98.4	8.5	127.5	12.2	54.6	15.5	35.8
		45.0	16.2	37.4	25.5	97.6	8.8	127.6	11.7	55.8	9.2	21.3	26.3	101.5	8.6	130.8	12.5	54.8	15.5	35.8
	90	34.0	9.7	22.4	24.7	87.8	10.41	123.4	8.4	57.5	9.1	21.0	26.8	90.2	10.18	124.9	8.9	54.5	15.3	35.3
		45.0	16.2	37.4	25.8	91.8	10.48	127.6	8.8	55.8	9.1	21.0	26.5	94.2	10.30	129.3	9.1	54.8	15.3	35.3
50	30	34.0	9.4	21.7	40.3	160.4	6.52	182.7	24.6	41.1	9.7	22.4	40.3	160.7	6.68	183.5	24.1	38.4	16.2	37.4
		45.0	15.8	36.5	42.3	167.7	6.65	190.5	25.2	41.5	9.7	22.4	42.2	170.4	6.66	193.2	25.6	38.9	16.2	37.4
	50	34.0	9.4	21.7	40.9	149.7	7.81	176.4	19.2	60.7	9.4	21.7	40.9	150.7	7.54	176.5	20.0	58.1	15.8	36.5
		45.0	15.8	36.5	42.8	156.1	7.93	183.1	19.7	61.1	9.4	21.7	42.7	158.6	7.56	184.4	21.0	58.5	15.8	36.5
	70	34.0	9.4	21.7	41.6	138.2	9.51	170.7	14.5	80.4	9.2									

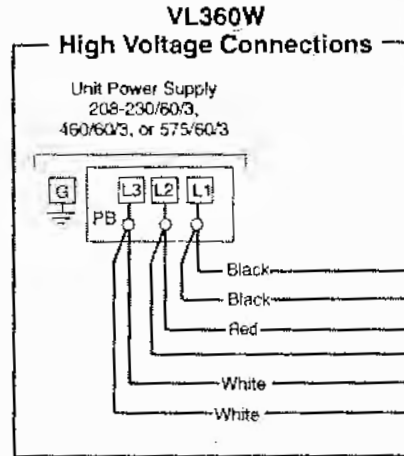
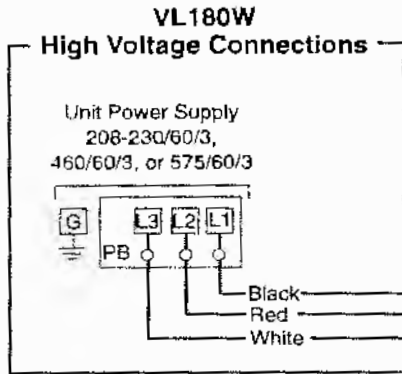
**VL360W Heating Capacity Data**

ELT	EST	LGPM	LWPD		SOURCE 68.0 GPM						SWPD		SOURCE 90.0 GPM						SWPD	
			PSI	FT HD	LLT	HC	KW	HE	COP	LST	PSI	FT HD	LLT	HC	KW	HE	COP	LST	PSI	FT HD
60	20	68.0	9.3	21.5	66.5	214.0	14.2	165.7	4.4	14.4	10.0	23.1	66.7	220.2	14.6	170.5	4.4	16.1	16.6	38.3
		90.0	15.6	36.0	64.9	213.4	13.8	166.3	4.5	14.3	10.0	23.1	65.0	219.9	14.1	171.7	4.6	15.1	16.6	38.3
	30	68.0	9.3	21.5	67.5	248.9	14.1	200.9	5.2	23.2	9.7	22.4	67.8	257.0	14.6	207.2	5.2	25.3	16.2	37.4
		90.0	15.6	36.0	65.7	247.7	13.5	201.5	5.4	23.2	9.7	22.4	65.9	256.8	13.9	209.4	5.4	25.2	16.2	37.4
	40	68.0	9.3	21.5	69.2	304.3	14.3	255.6	6.2	31.3	9.6	22.2	69.6	315.3	14.3	266.6	6.5	33.9	16.0	37.0
		90.0	15.6	36.0	66.9	301.8	14.2	253.3	6.2	31.8	9.6	22.2	67.0	304.0	14.6	254.1	6.1	34.2	16.0	37.0
50	68.0	9.3	21.5	70.9	359.6	14.5	310.2	7.3	39.5	9.4	21.7	71.3	373.6	14.5	324.0	7.5	42.8	15.8	36.5	
	90.0	15.6	36.0	68.2	356.0	14.9	305.0	7.0	39.6	9.4	21.7	68.4	368.1	16.0	313.6	6.8	42.8	15.8	36.5	
60	68.0	9.3	21.5	72.2	400.8	15.4	348.2	7.6	48.2	9.3	21.5	72.6	417.1	15.9	362.9	7.7	51.7	15.6	36.0	
	90.0	15.6	36.0	69.1	396.0	15.3	343.9	7.6	48.3	9.3	21.5	69.4	409.2	16.2	353.7	7.4	51.9	15.6	36.0	
80	68.0	9.3	21.5	73.4	442.0	16.3	386.3	7.9	56.9	9.2	21.3	74.0	460.7	17.2	401.9	7.8	60.8	15.5	35.8	
	90.0	15.6	36.0	70.0	436.1	15.6	382.9	8.2	57.0	9.2	21.3	70.3	450.3	16.5	393.9	8.0	61.0	15.5	35.8	
90	20	68.0	9.1	21.0	86.4	212.2	18.0	150.7	3.5	14.9	10.0	23.1	86.6	218.5	18.1	156.6	3.5	16.4	16.6	38.3
		90.0	15.4	35.6	84.8	211.6	17.7	151.2	3.5	14.9	10.0	23.1	85.0	217.9	17.8	157.3	3.6	16.4	16.6	38.3
	30	68.0	9.1	21.0	87.4	245.3	18.6	181.8	3.9	23.8	9.7	22.4	87.7	252.8	18.8	188.8	4.0	25.7	16.2	37.4
		90.0	15.4	35.6	85.6	244.1	18.2	182.1	3.9	23.8	9.7	22.4	85.6	252.4	18.3	189.9	4.0	25.6	16.2	37.4
	40	68.0	9.1	21.0	88.9	293.6	19.3	227.8	4.5	32.3	9.6	22.2	89.2	303.2	19.4	236.9	4.6	34.6	16.0	37.0
		90.0	15.4	35.6	86.7	291.9	18.8	227.9	4.6	32.5	9.6	22.2	86.9	301.3	18.9	236.8	4.7	34.6	16.0	37.0
50	68.0	9.1	21.0	90.4	341.9	19.9	273.9	5.0	40.7	9.4	21.7	90.7	353.5	20.1	285.0	5.2	43.5	15.8	36.5	
	90.0	15.4	35.6	87.8	339.7	19.3	273.7	5.2	40.7	9.4	21.7	88.0	350.2	19.5	283.7	5.3	43.5	15.8	36.5	
60	68.0	9.1	21.0	91.5	380.3	20.6	310.0	5.4	49.5	9.3	21.5	91.9	393.6	20.7	322.8	5.6	52.6	15.6	36.0	
	90.0	15.4	35.6	88.7	377.6	19.9	309.7	5.6	49.5	9.3	21.5	88.9	388.9	20.1	320.3	5.7	52.7	15.6	36.0	
70	68.0	9.1	21.0	92.7	418.6	21.2	346.1	5.8	58.3	9.2	21.3	93.2	433.7	21.4	360.6	5.9	61.7	15.5	35.8	
	90.0	15.4	35.6	89.5	415.5	20.5	345.6	5.9	58.3	9.2	21.3	89.8	427.6	20.7	357.0	6.1	61.8	15.5	35.8	
100	20	68.0	9.0	20.8	106.4	210.0	23.1	131.2	2.7	15.5	10.0	23.1	106.5	215.8	23.3	136.2	2.7	16.9	16.6	38.3
		90.0	15.1	34.9	104.8	209.3	22.8	131.5	2.7	15.5	10.0	23.1	104.9	215.3	23.1	136.5	2.7	16.9	16.6	38.3
	30	68.0	9.0	20.8	107.3	241.6	23.7	160.6	3.0	24.5	9.7	22.4	107.5	248.6	24.1	166.3	3.0	26.2	16.2	37.4
		90.0	15.1	34.9	105.5	240.5	23.4	160.6	3.0	24.5	9.7	22.4	105.7	246.0	23.9	166.5	3.0	26.2	16.2	37.4
	40	68.0	9.0	20.8	108.7	288.1	24.5	204.4	3.4	33.1	9.6	22.2	109.0	296.5	24.9	211.6	3.5	35.2	16.0	37.0
		90.0	15.1	34.9	106.6	287.1	24.1	204.9	3.5	33.0	9.6	22.2	106.8	295.5	24.5	211.9	3.5	35.1	16.0	37.0
50	68.0	9.0	20.8	110.1	334.6	25.3	248.1	3.9	41.6	9.4	21.7	110.4	344.4	25.6	256.9	3.9	44.1	15.8	36.5	
	90.0	15.1	34.9	107.6	333.7	24.7	249.3	4.0	41.5	9.4	21.7	107.9	343.0	25.1	257.3	4.0	44.1	15.8	36.5	
60	68.0	9.0	20.8	111.3	371.4	26.1	282.1	4.2	50.4	9.3	21.5	111.6	382.3	26.4	292.2	4.2	53.9	15.6	36.0	
	90.0	15.1	34.9	108.5	370.7	25.4	283.9	4.3	50.3	9.3	21.5	108.7	380.5	25.7	292.8	4.3	53.9	15.6	36.0	
70	68.0	9.0	20.8	112.4	408.2	27.0	316.2	4.4	59.3	9.2	21.3	112.7	420.1	27.2	327.4	4.5	62.5	15.5	35.8	
	90.0	15.1	34.9	109.3	407.6	26.1	318.5	4.6	59.2	9.2	21.3	109.6	418.0	26.3	326.2	4.7	62.5	15.5	35.8	
120	30	68.0	8.9	20.6	127.2	237.9	28.9	139.4	2.4	25.3	9.7	22.4	127.4	244.4	29.5	143.8	2.4	26.7	16.2	37.4
		90.0	14.9	34.4	125.4	236.9	28.6	139.2	2.4	25.3	9.7	22.4	125.6	243.6	29.4	143.2	2.4	26.7	16.2	37.4
	40	68.0	8.9	20.6	128.5	282.6	29.8	180.9	2.8	33.8	9.6	22.2	128.8	289.8	30.3	186.3	2.8	35.7	16.0	37.0
		90.0	14.9	34.4	126.5	282.4	29.4	182.0	2.8	34.0	9.6	22.2	126.6	289.7	30.1	187.1	2.8	35.7	16.0	37.0
	50	68.0	8.9	20.6	129.9	327.3	30.8	222.3	3.1	42.4	9.4	21.7	130.2	335.2	31.2	226.8	3.1	44.8	15.8	36.6
		90.0	14.9	34.4	127.5	327.8	30.2	224.8	3.2	42.3	9.4	21.7	127.7	335.8	30.7	231.0	3.2	44.7	15.8	36.5
60	68.0	8.9	20.6	131.0	362.5	31.7	254.3	3.3	51.3	9.3	21.5	131.2	370.9	32.0	261.5	3.4	54.0	15.6	36.0	
	90.0	14.9	34.4	128.3	363.7	30.9	258.1	3.4	51.2	9.3	21.5	128.5	372.2	31.4	265.2	3.5	53.9	15.6	36.0	
70	68.0	8.9	20.6	132.1	397.7	32.7	286.2	3.6	60.3	9.2	21.3	132.3	406.5	32.9	294.3	3.6	63.3	15.5	35.8	
	90.0	14.9	34.4	129.2	399.6	31.7	291.4	3.7	60.1	9.2	21.3	129.4	406.5	32.0	299.3	3.7	63.1	15.5	35.8	

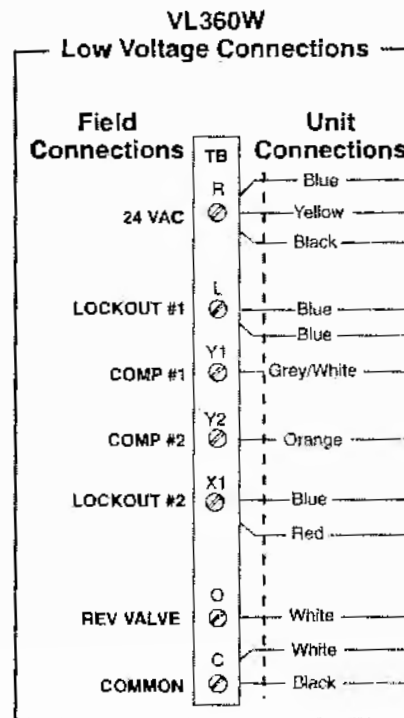
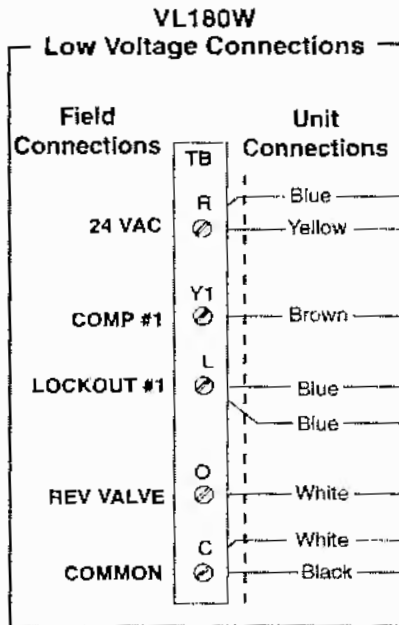
**VL360W Cooling Capacity Data**

ELT	EST	LGPM	LWPD		SOURCE 68.0 GPM						SWPD		SOURCE 90.0 GPM						SWPD	
			PSI	FT HD	LLT	TC	KW	HR	EER	LST	PSI	FT HD	LLT	TC	KW	HR	EER	LST	PSI	FT HD
30	50	68	9.7	22.4	23.8	205.8	13.92	253.4	14.8	57.7	9.4	21.7	26.2	213.2	13.78	260.2	15.5	54.7	15.8	36.5
		90	16.2	37.4	25.3	206.8	14.12	255.0	14.6	55.8	9.4	21.7	26.0	217.6	13.74	264.4	15.8	54.9	15.8	36.5
	70	68	9.7	22.4	24.2	190.8	17.40	250.0	11.6	57.6	9.2	21.3	26.5	196.8	17.00	255.0	12.2	54.6	15.5	35.8
		90	16.2	37.4	25.5	195.2	17.60	255.2	11.7	55.8	9.2	21.3	26.3	203.0	17.20	261.6	12.5	54.8	15.5	35.8
	90	68	9.7	22.4	24.7	175.6	20.82	246.8	8.4	57.5	9.1	21.0	26.8	180.4	20.36	249.8	8.9	54.5	15.3	35.3
		90	16.2	37.4	25.8	183.6	20.96	255.2	8.8	55.8	9.1	21.0	26.5	188.4	20.60	258.6	9.1	54.8	15.3	35.3
50	30	68	9.4	21.7	40.3	320.8	13.04	365.4	24.6	41.1	9.7	22.4	40.3	321.4	13.36	367.0	24.1	38.4	16.2	37.4
		90	15.8	36.5	42.3	335.4	13.30	381.0	25.2	41.5	9.7	22.4	42.2	340.8	13.32	366.4	25.6	38.9	16.2	37.4
	50	68	9.4	21.7	40.9	299.4	15.62	352.8	19.2	60.7	9.4	21.7	40.9	301.4	15.08	353.0	20.0	58.1	15.8	36.5
		90	15.8	36.5	42.8	312.2	15.86	366.2	19.7	61.1	9.4	21.7	42.7	317.2	15.12	368.8	21.0	58.5	15.8	36.5
	70	68	9.4	21.7	41.6	276.4	19.02	341.4	14.5	80.4	9.2	21.3	41.6	27						

Field Connections



Note: VL180W uses single electrical feed



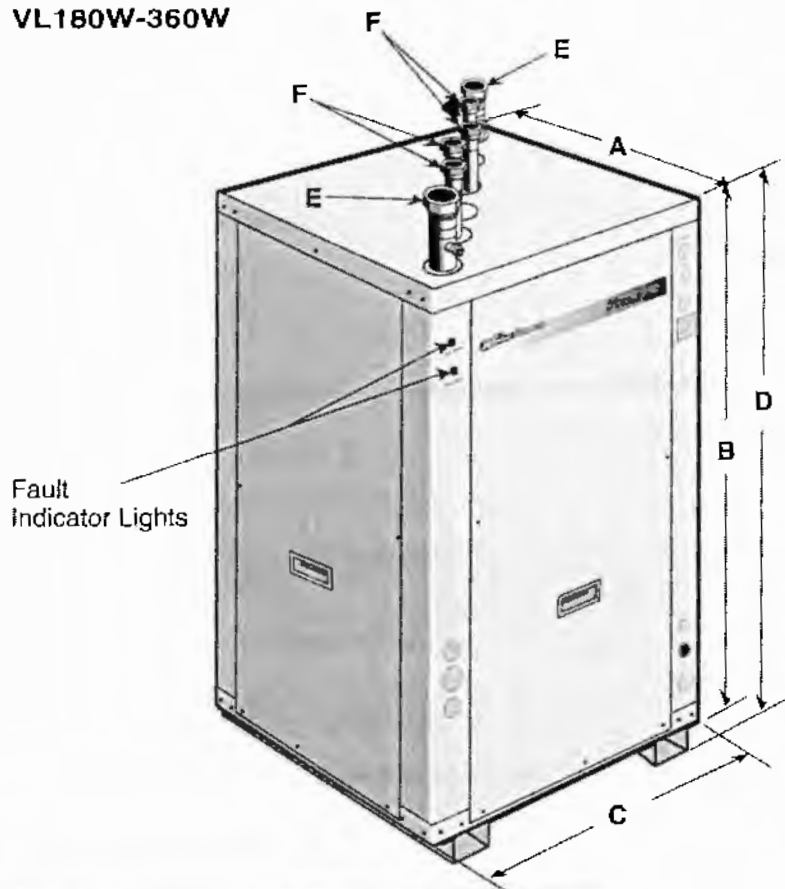
Model	Rated Voltage	Voltage Min/Max	Compressor*			Total Unit FLA	Min Circ Amp	Max Fuse	Max HACR Breaker
			MCC	RLA	LRA				
VL180W	208-230/60/3	197/254	64.0	41.0	350.0	41.0	51.3	90	90
	460/60/3	414/506	34.0	21.8	158.0	21.8	27.2	45	45
	575/60/3	518/633	27.0	17.3	125.0	17.3	21.6	35	35
VL360W	208-230/60/3	197/254	64.0	41.0	350.0	82.0	92.3	125	125
	460/60/3	414/506	34.0	21.8	158.0	43.6	49.0	70	70
	575/60/3	518/633	27.0	17.3	125.0	34.6	38.9	50	50

\*Ratings per each compressor - VL360W unit supplied with two compressors.  
All fuses Class RK-5.

Electrical Dat

**Physical Dimensions**

**VL180W-360W**



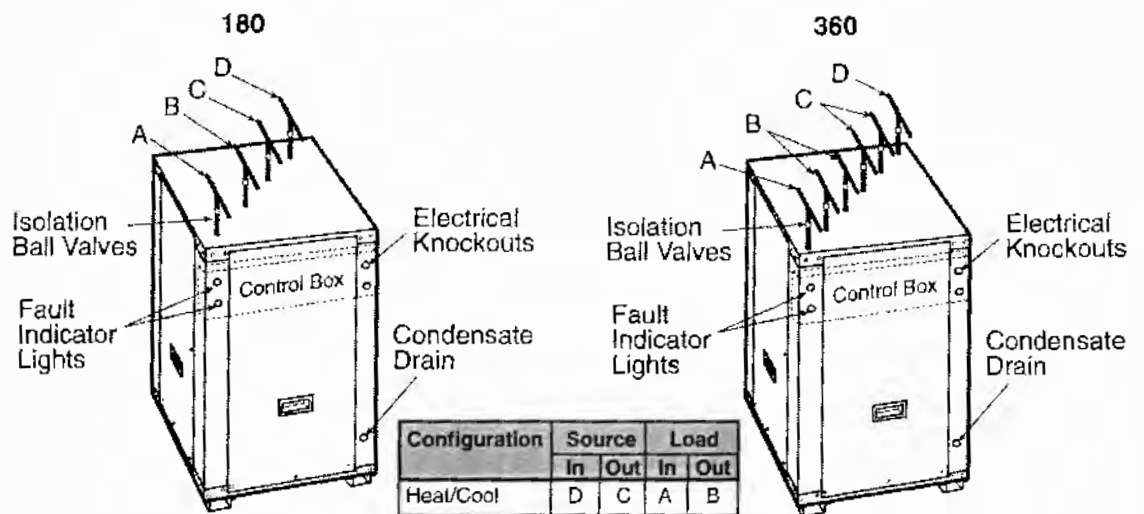
Model	A	B	C	D	E Inlets	F Outlets
180	36.00	58.00	30.00	60.00	1.25 FPT	1.25 FPT
360	36.00	58.00	30.00	60.00	2.0 FPT	1.25 FPT

All dimensions are in inches.

**Physical Data**

Model	VL180W	VL360W
Compressor	Scroll (1)	Scroll (2)
Ref. Charge - R22 (oz.)	130.0	260.0
Unit Weight (lbs.)	563.0	853.0

**Piping Configuration**



## Versatec 15 and 30 Ton Commercial Specifications Catalog

**General** - The liquid source water-to-water heat pump shall be a single packaged, heat only, cool only, or a reverse-cycle heating/cooling unit. The unit shall be listed by a nationally recognized safety-testing laboratory or agency, such as ETL Testing Laboratory or Canadian Standards Association (CSA). Each unit shall be run-tested at the factory. Each unit shall be pallet mounted.

The units shall be warranted by the manufacturer against defects in materials and workmanship for a period of one year.

Optional extended warranties with coverage up to five years shall be available.

The liquid source water-to-water heat pump unit, as manufactured by WaterFurnace International, Fort Wayne, Indiana, shall be designed to operate with source liquid temperature between 20°F and 90°F.

**Casing and Cabinet** - The cabinet shall be fabricated from heavy-gauge, powder coated, galvanized steel (optional stainless steel is available). The interior shall be insulated with 1/2-inch thick, multi-density, coated glass fiber with edges sealed or tucked under flanges. All units shall have 7/8-inch and 1-1/8-inch knockouts for entrance of low and line voltage wiring.

**Refrigerant Circuit** - All units shall contain a sealed refrigerant circuit including one or two hermetic motor-compressor(s), bidirectional thermal expansion valve assembly(s), reversing valve(s) (if applicable), brazed plate water-to-refrigerant heat exchangers, factory-installed high- and low-pressure safety switches and service ports, and liquid line filter-dryer(s).

**Thermostat/Controller (Field Installed)** - A single- or multi-stage 24 VAC thermostat or liquid controller shall be used to turn the heat pump on and off and to switch it from cooling to heating if necessary. Multiple water-to-water heat pumps shall be controlled from one thermostat/controller.

**Solenoid Valve (Field Installed)** - To accommodate the need to stop liquid flow through either side of the water-to-water unit, a 24 VAC solenoid valve (24 VA

Compressor(s) shall be designed for heat pump duty with internal isolation and mounted on rubber vibration isolators. Compressor motors shall have overload protection.

An optional sound attenuation package shall be available, and shall be placed around the compressor(s).

The water-to-refrigerant heat exchangers shall be a brazed plate stainless steel capable of withstanding 450 PSIG working pressure on the refrigerant and water sides. The thermal expansion valve assembly shall provide proper superheat over the liquid temperature range with minimal "hunting." The assembly shall operate bidirectionally without the use of check valves. Externally mounted pressure controlled water regulating flow valves are not acceptable.

**Electrical** - Controls and safety devices will be factory wired and mounted within the unit. Controls shall include compressor contactor(s), 24VAC-75VA transformer with built-in circuit breaker, reversing valve coil(s) (if applicable), and anti short-cycle protection. A terminal block with screw terminals will be provided for field control wiring. To prevent short cycling when the safety controls are activated, the reset relay shall provide a lockout circuit that requires resetting of low voltage supply or main circuit breaker. A lockout indicating signal shall be provided on the low voltage terminal block.

**Piping** - All supply and return water connections shall be FPT copper threaded fittings.

maximum current draw) shall be furnished. Dual solenoid or larger current valves may overload the unit's transformer and may require a separate transformer. It/they shall be wired to the heat pump so as to be energized whenever there is a call for compressor operation. The solenoid valve(s) will be quick opening and spring returned closed. Slow opening valves will be acceptable only if equipped with an end switch to permit compressor operation only after full opening. The body size of the valve(s) shall match the water connection size(s) of the heat pump.

## Engineering Guide Specifications

## Accessories and Other Options



**WaterFurnace.**

9000 Conservation Way  
Fort Wayne, IN 46809-9794

Phone: 1-260-478-5667 or  
1-800-222-5667  
FAX: 1-800-783-5667  
<http://www.waterfurnace.com>



***Versatec***

**Water-To-Water  
Heat Pump  
Specifications Catalog**

WF1063 02/03

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Industrial/Commercial Division  
Fulton Boiler Works, Inc.

## Fulton Electric Hot Water Boilers From 12 to 700 kW (1.2 to 70 HP)

Built/certified in accordance  
to ASME Boiler and Pressure Vessel Code

Entire Boiler is a UL Listed Packaged Boiler.

Vertical designed boilers to meet your  
hot water requirements: Chemical-  
Food-Dairy-Pharmaceutical-Laundry-  
Plastics-Rubber-anywhere heat/hot  
water is needed.



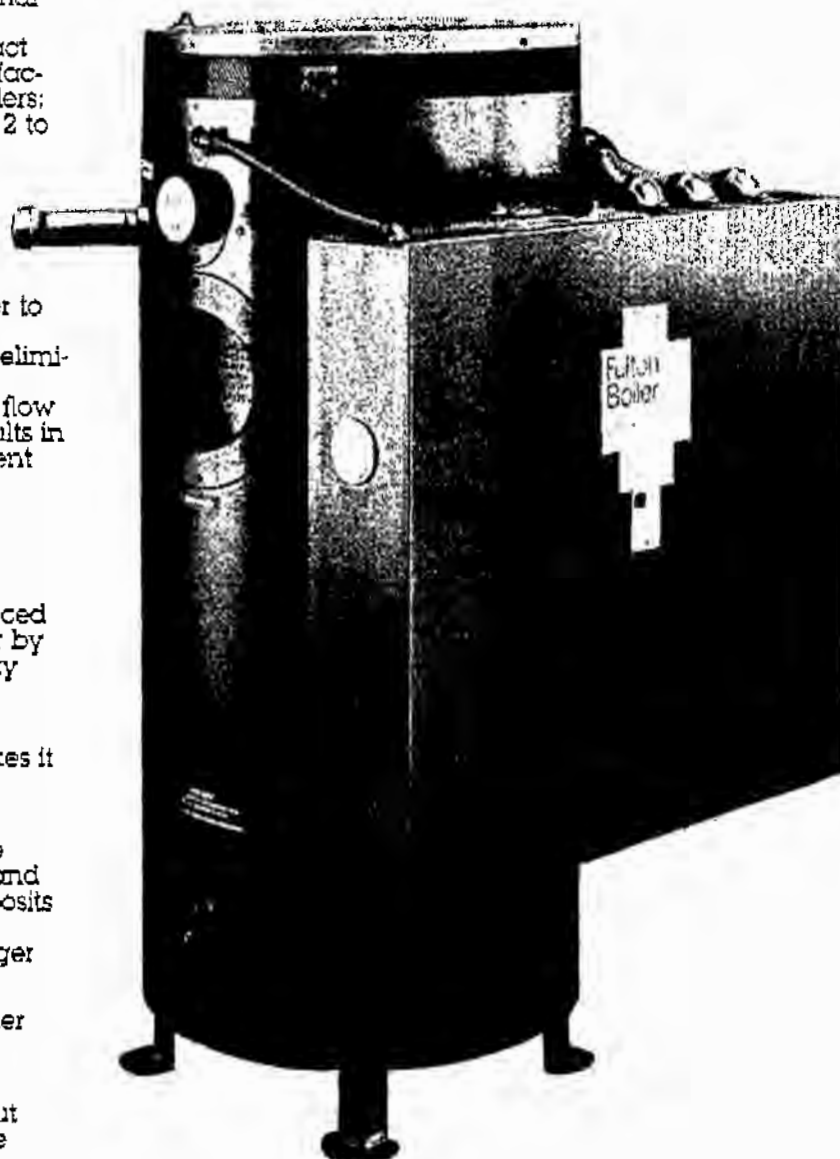
They not only add efficiency, economy,  
and safety to your heating and industrial  
process heat system, they save you  
valuable floor space with their compact  
vertical tubeless design. Fulton manufac-  
tures a complete line of hot water boilers;  
eighteen models from 12 to 700 kW (1.2 to  
70 HP), 60 or 160 PSI design pressure  
standard.

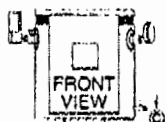
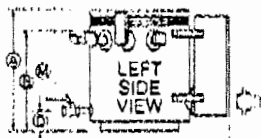
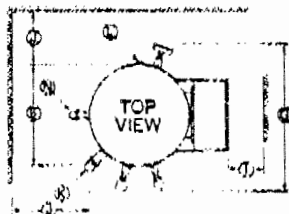
### The Way It Works

Forced even circulation of water is  
achieved by inducing incoming water to  
spin upward within the water vessel.  
The spinning water is evenly heated, elimi-  
nating stratification. This unique  
circulation method achieves an even flow  
of water across the elements. This results in  
low flux temperatures and long element  
life.

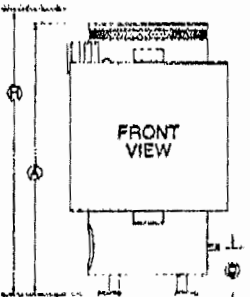
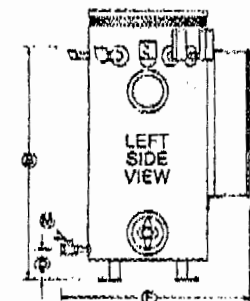
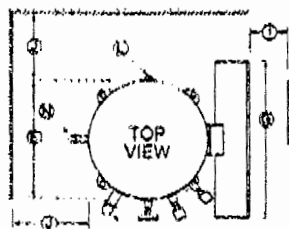
### The Features

- The Fulton Electric Hot Water Boiler is designed for completely controlled forced circulation and even heating of water by multiple stainless steel low watt density elements. Consult factory for specific watt densities.
- Compact vertical tubeless design makes it ideal for skid mounting with ancillary equipment.
- Vertical elements (7-70 HP) discourage buildup because element expansion and contraction cause mineral or lime deposits to flake off and drop to the bottom of the boiler, thus assuring longer element life.
- Controlled circulation through the boiler minimizes thermal shock.
- Designed for ease of installation, operation, and can be serviced without dismantling the system or draining the boiler.
- Complete with all operating and safety controls.





Hot Water Boilers - FB-012-W up to and including FB-030-W



Hot Water Boilers - FB-070-W up to and including FB-700-W

**Dimensions and Weights**

Model FB-W		012	030	070	105	175	280	420	560	700
Unit Size:	kW	12	30	70	105	175	280	420	560	700
	HP	1.2	3.0	7.0	10.5	17.5	28.0	42.0	56.0	70.0

**Height**

(A) Boiler Overall	IN	24	24	55	55	55	55	55	55	55
	MM	610	610	1400	1400	1400	1400	1400	1400	1400
(B) Hot Water Outlet	IN	18.25	18.25	45.5	45.5	45.25	45.25	45	44.75	44.50
	MM	464	464	1156	1156	1149	1149	1143	1137	1130
(C) Return Water Inlet	IN	4	4	9.5	9.5	9.5	9.5	9.5	9.5	9.5
	MM	100	100	241	241	241	241	241	241	241
(D) Drain Outlet	IN	4	4	6	6	6	6	6.5	6.5	7
	MM	100	100	150	150	150	150	165	165	180

**Width & Depth**

(E) Boiler Diameter	IN	20	20	17	24	28	36	40	44	50
	MM	508	508	430	610	710	915	1015	1120	1270
(F) Overall Depth Electric Panel to Drain	IN	49	49	41	41	48	60	.	.	.
	MM	1245	1245	1041	1041	1219	1524	.	.	.
(G) Boiler Width Overall	IN	32	32	40	40	44	68	.	.	.
	MM	813	813	1016	1016	1118	1727	.	.	.

**Minimum Clearances**

(H) Floor to Ceiling to remove elements	IN	NA	NA	95	95	95	95	95	95	95
	MM			2415	2415	2415	2415	2415	2415	2415
(I) Front of Boiler	IN	24	24	32	32	34	36	36	36	36
	MM	610	610	815	815	865	915	915	915	915
(J) Sides & Rear of Boiler	IN	24	24	24	24	24	24	24	24	24
	MM	610	610	610	610	610	610	610	610	610

**Boiler Connection Sizes**

(K) Hot Water Outlet	IN	1.25	1.25	1.50	1.50	2	2	2.50	3	3
	MM	32	32	40	40	50	50	65	75	75
(L) Return Water Inlet	IN	1.25	1.25	1.50	1.50	2	2	2.50	3	3
	MM	32	32	40	40	50	50	65	75	75
(M) Drain Outlet	IN	1	1	1	1	1.25	1.25	1.5	1.5	2
	MM	25	25	25	25	32	32	40	40	50
(N) Safety Valve	IN	1.25	1.25	1.25	1.25	1.25	1.50	2.00	2.00	2.50
	MM	32	32	32	32	32	40	50	50	65

**Weights**

Approximate Ship Weight	LB	420	450	580	950	1225	1380	1850	2150	2300
	KG	191	204	263	386	556	623	839	977	1043

**Specifications**

**Ratings**

Output	1000 BTU/HR	41	101	235	359	585	938	1406	1876	2344
	1000 KCAL/HR	10	25	59	90	147	236	364	472	540
Number of Elements		1	2	2	3	5	4	6	8	10

**Electric Power Requirements (In Amps)\*\***

208V, 50/60 CY, 3 Phase	34	84	194	292	485	780	.	.	.	.
240V, 50/60 CY, 3 Phase	29	73	169	252	420	676	.	.	.	.
480V, 50/60 CY, 3 Phase	15	36	85	127	216	333	505	675	845	

**Water Content**

	GAL	13	13	20	50	66	133	133	180	213
	LTR	49	49	75	189	249	503	503	681	806

\* Consult factory.

NA = Not Applicable

Only selected models are shown: Models FB-015-W, 018-W, 024-W, 036-W, 140-W, 210-W, 350-W, 490-W, and 630-W are also available. Consult factory.

Dimensions are approximate. We reserve the right to change dimensions and/or specifications.

\*\*For other unspecified voltages, consult factory.

Industrial/Commercial Division  
Fulton Boiler Works, Inc.



3981 Port St., Box 257  
Pulaski, New York USA 13142  
Call 315-298-5121  
Fax 315-298-6390

e-mail: info@fulton.com  
web site: www.fulton.com

Fulton Boiler Works, Inc.  
Fulton Thermal Corporation

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0/08 2.5M  
PP-2H20RD  
Printed in USA

**BELL & GOSSETT**

**SUBMITTAL**

C-211  
REVISION 3

Type "OC"  
Heat Exchangers



Straight Tube—Channel Head Design

JOB _____	B & G REPRESENTATIVE _____	
UNIT TAG NO. <u>HE-1</u>	ORDER NO. _____	DATE _____
ENGINEER _____	SUBMITTED BY _____	DATE _____
CONTRACTOR _____	APPROVED BY _____	DATE _____

**DUTY:**

**OPERATING DATA**

1. Type of Service    Condenser \_\_\_\_\_ Evaporator \_\_\_\_\_ Cooler \_\_\_\_\_ Heater OC 8-12-24

	TUBE SIDE	SHELL SIDE
2. Fluid Circulated	<u>COYCOL</u>	<u>WATER</u>
3. Total Flow*	<u>180</u>	<u>90</u>
4. Specific Gravity	<u>1.08</u>	<u>1.00</u>
5. Specific Heat		
6. Latent Heat		
7. Viscosity**	<u>8.89</u>	<u>1.59</u>
8. Thermal Conductivity		
9. Temperature In/Out	<u>258°F/30.5°F</u>	<u>44.5°F/35.5°F</u>
10. Heat Load BTU/hr.	<u>405,291</u>	
11. Openings (Flanged) (Threaded)		
12. Operating Pressure		
13. Design Pressure		
14. Maximum Operating Temperature of Unit		
15. Pressure Drop (Maximum)		
16. Fouling Factor or Percentage of Additional Surface		

\*Expressed in GPM, GPH, SCFM, SCFH, lbs./min. or lbs./hr.  
\*\*Expressed in Proper Units and Temperature such as centipoises @ °F.

**MATERIALS:**

1. Heads <u>FLUORINATED STEEL</u> (Channel)	5. Tube Size O. D. & Gauge. <u>3/4"</u>
2. Shell <u>STEEL</u>	6. Baffles <u>STEEL</u>
3. Tube Sheets <u>STEEL</u>	7. Gaskets <u>COMPRESSED FIBRE</u>
4. Tubes <u>COPPER</u>	CODE: ASME _____ Other _____

**DESCRIPTION**

B&G Type "OC" Heat Exchangers are of the shell and tube type. Tube bundles are removable and tubes are easily cleaned both inside and outside. Tube ends are roller expanded into both the front and rear tube sheets. Floating tube sheet construction within the rear head compensates for expansion or contraction of the entire bundle regardless of temperature variations. Baffles are stamped to close tolerances, minimizing the slippage of liquids or gases between the baffles and shell wall.

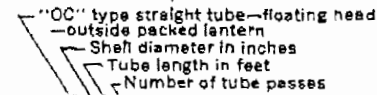
**CONSTRUCTION MATERIALS**

B&G "OC" Heat Exchangers are constructed according to ASME requirements for pressures and temperature. A Manufacturer's Data Report for Pressure Vessels, Form No. U-1 as required by the provisions of the ASME Code Rules is furnished with each unit upon request. This form is signed by an authorized inspector, holding a National Board Commission, and who is employed by an authorized inspection agency, certifying that construction conforms to the latest ASME Code for pressure vessels. The ASME "U" symbol is stamped on each vessel. In addition, each unit is registered with the National Board of Boiler and Pressure Vessel Inspectors.

**BELL & GOSSETT ITT**  
FLUID HANDLING DIVISION

# TYPE "OC" HEAT EXCHANGERS (Straight Tube—Channel Head Design)

## DIMENSIONS



Complete sales number consists of example: OC-86\*

UNIT NUMBER	HEAD CONN. 150# ANSI FLANGES		SHELL CONN. 150# ANSI FLANGES		OVERALL LENGTH (INCHES)		DIMENSIONS IN INCHES												
	1 & 2 PASS	1 PASS	2 PASS	SMALL	LARGE	1 PASS	2 PASS	A <sub>s</sub>	A <sub>L</sub>	B <sub>s</sub>	B <sub>L</sub>	C	D	E	F Max.	G <sub>s</sub>	G <sub>L</sub>	H	J
OC-62-*	3	2-N.P.T.	2½	3	47	38¾	14¼	13¼	9¾	10	5¼	6¾	10½	7¾	12½	12¾	19	7	17
OC-63-*	3	2-N.P.T.	2½	3	59	50¾	26¼	25¼	9¾	10	5¼	6¾	10½	7¾	12½	12¾	19	19	29
OC-64-*	3	2-N.P.T.	2½	3	71	62¾	38¼	37¼	9¾	10	5¼	6¾	10½	7¾	12½	12¾	19	31	41
OC-65-*	3	2-N.P.T.	2½	3	83	74¾	50¼	49¼	9¾	10	5¼	6¾	10½	7¾	12½	12¾	19	43	53
OC-66-*	3	2-N.P.T.	2½	3	95	86¾	62¼	61¼	9¾	10	5¼	6¾	10½	7¾	12½	12¾	19	55	65
OC-67-*	3	2-N.P.T.	2½	3	107	98¾	74¼	73¼	9¾	10	5¼	6¾	10½	7¾	12½	12¾	19	67	77
OC-68-*	3	2-N.P.T.	2½	3	119	110¾	86¼	85¼	9¾	10	5¼	6¾	10½	7¾	12½	12¾	19	79	89
OC-69-*	3	2-N.P.T.	2½	3	131	122¾	98¼	97¼	9¾	10	5¼	6¾	10½	7¾	12½	12¾	19	91	101
OC-610-*	3	2-N.P.T.	2½	3	143	134¾	110¼	109¼	9¾	10	5¼	6¾	10½	7¾	12½	12¾	19	103	113
OC-83-*	4	2½	3	4	61¾	52½	25¼	24¼	10¾	11¾	5¾	8¾	12½	8¾	13¼	14	21	16	28
OC-84-*	4	2½	3	4	73¾	64½	37¼	36¼	10¾	11¾	5¾	8¾	12½	8¾	13¼	14	21	28	40
OC-85-*	4	2½	3	4	85¾	76½	49¼	48¼	10¾	11¾	5¾	8¾	12½	8¾	13¼	14	21	40	52
OC-86-*	4	2½	3	4	97¾	88½	61¼	60¼	10¾	11¾	5¾	8¾	12½	8¾	13¼	14	21	52	64
OC-87-*	4	2½	3	4	109¾	100½	73¼	72¼	10¾	11¾	5¾	8¾	12½	8¾	13¼	14	21	64	76
OC-88-*	4	2½	3	4	121¾	112½	85¼	84¼	10¾	11¾	5¾	8¾	12½	8¾	13¼	14	21	76	88
OC-89-*	4	2½	3	4	133¾	124½	97¼	96¼	10¾	11¾	5¾	8¾	12½	8¾	13¼	14	21	88	100
OC-810-*	4	2½	3	4	145¾	136½	109¼	108¼	10¾	11¾	5¾	8¾	12½	8¾	13¼	14	21	100	112
OC-811-*	4	2½	3	4	157¾	148½	121¼	120¼	10¾	11¾	5¾	8¾	12½	8¾	13¼	14	21	112	124
OC-812-*	4	2½	3	4	169¾	160½	133¼	132¼	10¾	11¾	5¾	8¾	12½	8¾	13¼	14	21	124	136
OC-104-*	6	4	4	6	78¾	67¾	35¼	33¼	12¾	13¾	7¼	10¼	14¾	9¾	15½	16½	26	24	38
OC-105-*	6	4	4	6	90¾	79¾	47¼	45¼	12¾	13¾	7¼	10¼	14¾	9¾	15½	16½	26	36	50
OC-106-*	6	4	4	6	102¾	91¾	59¼	57¼	12¾	13¾	7¼	10¼	14¾	9¾	15½	16½	26	48	62
OC-107-*	6	4	4	6	114¾	103¾	71¼	69¼	12¾	13¾	7¼	10¼	14¾	9¾	15½	16½	26	60	74
OC-108-*	6	4	4	6	126¾	115¾	83¼	81¼	12¾	13¾	7¼	10¼	14¾	9¾	15½	16½	26	72	86
OC-109-*	6	4	4	6	138¾	127¾	95¼	93¼	12¾	13¾	7¼	10¼	14¾	9¾	15½	16½	26	84	98
OC-1010-*	6	4	4	6	150¾	139¾	107¼	105¼	12¾	13¾	7¼	10¼	14¾	9¾	15½	16½	26	96	110
OC-1011-*	6	4	4	6	162¾	151¾	119¼	117¼	12¾	13¾	7¼	10¼	14¾	9¾	15½	16½	26	108	122
OC-1012-*	6	4	4	6	174¾	163¾	131¼	129¼	12¾	13¾	7¼	10¼	14¾	9¾	15½	16½	26	120	134
OC-1013-*	6	4	4	6	186¾	175¾	143¼	141¼	12¾	13¾	7¼	10¼	14¾	9¾	15½	16½	26	132	146
OC-1014-*	6	4	4	6	198¾	187¾	155¼	153¼	12¾	13¾	7¼	10¼	14¾	9¾	15½	16½	26	144	158
OC-126-*	6	4	4	6	104¼	92¾	59¼	57¼	13¾	14¾	7¼	12¼	16¾	10¾	16	17	28	47	62
OC-127-*	6	4	4	6	116¼	104¾	71¼	69¼	13¾	14¾	7¼	12¼	16¾	10¾	16	17	28	59	74
OC-128-*	6	4	4	6	128¼	116¾	83¼	81¼	13¾	14¾	7¼	12¼	16¾	10¾	16	17	28	71	86
OC-129-*	6	4	4	6	140¼	128¾	95¼	93¼	13¾	14¾	7¼	12¼	16¾	10¾	16	17	28	83	98
OC-1210-*	6	4	4	6	152¼	140¾	107¼	105¼	13¾	14¾	7¼	12¼	16¾	10¾	16	17	28	95	110
OC-1211-*	6	4	4	6	164¼	152¾	119¼	117¼	13¾	14¾	7¼	12¼	16¾	10¾	16	17	28	107	122

NOTES: Bolt holes straddle center lines on flanged openings. Legs available at extra cost. Removable bundle. Removable heads. Channel covers removable. Dimensions are subject to change. If exact dimensions are needed for layout, write for certified drawings. See front page for flange connection sizes and construction materials.

IMPORTANT: Designate 1 or 2 pass where asterisk appears. A<sub>s</sub>, B<sub>s</sub>, G<sub>s</sub> with smaller listed shell openings. A<sub>L</sub>, B<sub>L</sub>, G<sub>L</sub> with larger listed shell openings.

Different size Shell Connections available to suit flow requirement.

B<sub>s</sub>, B<sub>L</sub>, C and overall length dimensions are based upon one-pass head connections.

# BELL & GOSSETT

**SUBMITTAL**

C-221A



## Straight Tube-Bonnet Head Design Type "OC" Heat Exchangers

JOB _____	B & G REPRESENTATIVE _____	
UNIT TAG NO. <u>HEX-2</u>	ORDER NO. _____	DATE _____
ENGINEER _____	SUBMITTED BY _____	DATE _____
CONTRACTOR _____	APPROVED BY _____	DATE _____

### OPERATING DATA

**DUTY:**

1 Exchanger Model Number QOC B-10-23  
 Type of Service: Condenser \_\_\_\_\_ Evaporator \_\_\_\_\_ Cooler \_\_\_\_\_ Heater \_\_\_\_\_

	TUBE SIDE		SHELL SIDE
	WATER	WATER	APPROVALS
2. Fluid Circulated			
3. Total Flow**	<u>456 GPM</u>	<u>63</u>	
4. Specific Gravity	<u>1.0</u>	<u>1.0</u>	
5. Specific Heat	<u>1.0</u>	<u>1.0</u>	
6. Latent Heat			
7. Viscosity**	<u>CENTIPOISE</u>	<u>1.31</u>	
8. Temperature In/Out	<u>67°F / 57°F</u>	<u>35.5°F / 57°F</u>	
9. Transfer BTU/hr.	<u>677,429</u>		
10. Openings (Flanged) (Threaded)			
11. Operating Pressure			
12. Design Pressure			
13. Maximum Operating Temperature of Unit			
14. Pressure Drop (Maximum)			
15. Fouling Factor or Percentage of Additional Surface			

\*Expressed in GPM, GPH, CFM, CFH, lbs./min. or lbs./hr.  
 \*\*Expressed in Proper Units and Temperature such as centipoises @ °F

**MATERIALS:**

- 1. Heads (Bonnet) CAST IRON
  - 2. Shell STEEL
  - 3. Tube Sheets STEEL
  - 4. Tubes COPPER
  - 5. Tube Size O. D. & Gauge 5/8" OD 20 BWG
  - 6. Baffles STEEL
  - 7. Gaskets COMPRESSED FIBRE
- CODE: ASME \_\_\_\_\_ Other \_\_\_\_\_

**DESCRIPTION**

B&G Type "OC" Heat Exchangers are of the shell and tube type. Tube bundles are removable and tubes are easily cleaned both inside and outside. Tube ends are roller expanded into both the front and rear tube sheets. Floating tube sheet construction within the rear head compensates for expansion or contraction of the entire bundle regardless of temperature variations. Baffles are stamped to close tolerances, minimizing the slippage of liquids or vapors between the baffles and shell wall.

**CONSTRUCTION MATERIALS**

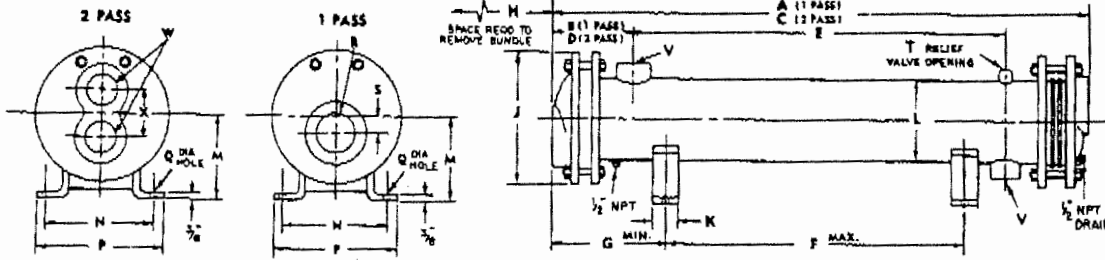
B&G "OC" Heat Exchangers are constructed according to ASME requirements for pressures and temperatures. A Manufacturers' Data Report for Pressure Vessels, Form No. U-1 as required by the provisions of the ASME Code Rules is furnished with each unit when requested. In addition, each unit is registered with the National Board of Boiler and Pressure Vessel Inspectors.

This form is signed by an authorized inspector, holding a National Board Commission, and who is employed by an authorized inspection agency, certifying that construction conforms to the latest ASME Code for pressure vessels. The ASME "U" symbol is stamped on each vessel.

# TYPE "OC" HEAT EXCHANGERS (Straight Tube—Bonnet Head Design)

## DIMENSIONS FOR OC-62 through OC-1214

NOTES: Bolt holes straddle center lines on flanged openings. Legs available at extra cost. Removable bundle. Removable heads. Dimensions are subject to change. If exact dimensions are needed for layout, write for certified drawings.



"OC" type straight tube—floating tube sheet  
 —outside packed lantern  
 Shell diameter in inches  
 Tube length in feet  
 Number of tube passes

Complete sales number consists of example: OC-86\*

UNIT NUMBER	HEAD DIMENSIONS IN INCHES								DIMENSIONS IN INCHES													Heating Surface (Sq. Ft.)
	1 PASS		2 PASS		1 PASS		2 PASS		E	F	G	H	J	K	L	M	N	P	Q	T	V	
	R	S	W	X	A	B	C	D														
OC-62*	2 1/2 NPT	1 3/8	2 NPT	3 3/4	32 1/2	8 1/4	31	7 3/8	13 3/4	7	11	25	10 1/2	2 1/2	6 3/4	6 1 1/8	6 3/4	8 1/8	3/4	1 NPT	2 NPT	12.9
OC-63*	2 1/2 NPT	1 3/8	2 NPT	3 3/4	44 1/2	8 1/4	43	7 3/8	25 3/4	19	11	37	10 1/2	2 1/2	6 3/4	6 1 1/8	6 3/4	8 1/8	3/4	1 NPT	2 NPT	19.4
OC-64*	2 1/2 NPT	1 3/8	2 NPT	3 3/4	56 1/4	8 1/4	55	7 3/8	37 3/4	31	11	49	10 1/2	2 1/2	6 3/4	6 1 1/8	6 3/4	8 1/8	3/4	1 NPT	2 NPT	26.0
OC-65*	2 1/2 NPT	1 3/8	2 NPT	3 3/4	68 1/2	8 1/4	67	7 3/8	49 3/4	43	11	61	10 1/2	2 1/2	6 3/4	6 1 1/8	6 3/4	8 1/8	3/4	1 NPT	2 NPT	32.6
OC-66*	2 1/2 NPT	1 3/8	2 NPT	3 3/4	80 1/2	8 1/4	79	7 3/8	61 3/4	55	11	73	10 1/2	2 1/2	6 3/4	6 1 1/8	6 3/4	8 1/8	3/4	1 NPT	2 NPT	39.1
OC-67*	2 1/2 NPT	1 3/8	2 NPT	3 3/4	92 1/2	8 1/4	91	7 3/8	73 3/4	67	11	85	10 1/2	2 1/2	6 3/4	6 1 1/8	6 3/4	8 1/8	3/4	1 NPT	2 NPT	45.7
OC-68*	2 1/2 NPT	1 3/8	2 NPT	3 3/4	104 1/2	8 1/4	103	7 3/8	85 3/4	79	11	97	10 1/2	2 1/2	6 3/4	6 1 1/8	6 3/4	8 1/8	3/4	1 NPT	2 NPT	52.2
OC-69*	2 1/2 NPT	1 3/8	2 NPT	3 3/4	116 1/2	8 1/4	115	7 3/8	97 3/4	91	11	109	10 1/2	2 1/2	6 3/4	6 1 1/8	6 3/4	8 1/8	3/4	1 NPT	2 NPT	58.8
OC-610*	2 1/2 NPT	1 3/8	2 NPT	3 3/4	128 1/2	8 1/4	127	7 3/8	109 3/4	103	11	121	10 1/2	2 1/2	6 3/4	6 1 1/8	6 3/4	8 1/8	3/4	1 NPT	2 NPT	65.3
OC-82*	4 NPT	1 1/2	3 NPT	5	33 3/4	9 1/4	32 1/2	8 3/4	13 3/4	7	12	24	12 1/2	2 1/2	8 3/4	7	9	10 3/4	3/4	1 1/4 NPT	2 1/2 NPT	24.6
OC-83*	4 NPT	1 1/2	3 NPT	5	45 3/4	9 1/4	44 3/4	8 3/4	25 3/4	19	12	36	12 1/2	2 1/2	8 3/4	7	9	10 3/4	3/4	1 1/4 NPT	2 1/2 NPT	37.1
OC-84*	4 NPT	1 1/2	3 NPT	5	57 3/4	9 1/4	56 3/4	8 3/4	37 3/4	31	12	48	12 1/2	2 1/2	8 3/4	7	9	10 3/4	3/4	1 1/4 NPT	2 1/2 NPT	49.5
OC-85*	4 NPT	1 1/2	3 NPT	5	69 3/4	9 1/4	68 3/4	8 3/4	49 3/4	43	12	60	12 1/2	2 1/2	8 3/4	7	9	10 3/4	3/4	1 1/4 NPT	2 1/2 NPT	61.9
OC-86*	4 NPT	1 1/2	3 NPT	5	81 3/4	9 1/4	80 3/4	8 3/4	61 3/4	55	12	72	12 1/2	2 1/2	8 3/4	7	9	10 3/4	3/4	1 1/4 NPT	2 1/2 NPT	74.4
OC-87*	4 NPT	1 1/2	3 NPT	5	93 3/4	9 1/4	92 3/4	8 3/4	73 3/4	67	12	84	12 1/2	2 1/2	8 3/4	7	9	10 3/4	3/4	1 1/4 NPT	2 1/2 NPT	86.8
OC-88*	4 NPT	1 1/2	3 NPT	5	105 3/4	9 1/4	104 3/4	8 3/4	85 3/4	79	12	96	12 1/2	2 1/2	8 3/4	7	9	10 3/4	3/4	1 1/4 NPT	2 1/2 NPT	99.2
OC-89*	4 NPT	1 1/2	3 NPT	5	117 3/4	9 1/4	116 3/4	8 3/4	97 3/4	91	12	108	12 1/2	2 1/2	8 3/4	7	9	10 3/4	3/4	1 1/4 NPT	2 1/2 NPT	111.6
OC-810*	4 NPT	1 1/2	3 NPT	5	129 3/4	9 1/4	128 3/4	8 3/4	109 3/4	103	12	120	12 1/2	2 1/2	8 3/4	7	9	10 3/4	3/4	1 1/4 NPT	2 1/2 NPT	124.1
OC-811*	4 NPT	1 1/2	3 NPT	5	141 3/4	9 1/4	140 3/4	8 3/4	121 3/4	115	12	132	12 1/2	2 1/2	8 3/4	7	9	10 3/4	3/4	1 1/4 NPT	2 1/2 NPT	136.5
OC-812*	4 NPT	1 1/2	3 NPT	5	153 3/4	9 1/4	152 3/4	8 3/4	133 3/4	127	12	144	12 1/2	2 1/2	8 3/4	7	9	10 3/4	3/4	1 1/4 NPT	2 1/2 NPT	148.9
OC-104*	4 NPT	1 1/2	4 NPT	5 3/8	58	9 3/4	56 1/2	9	36 3/4	29	13	50	14 3/4	2 1/2	10 3/4	9 3/4	9 3/4	11 1/4	3/8	1 1/2 NPT	3 NPT	87
OC-105*	4 NPT	1 1/2	4 NPT	5 3/8	70	9 3/4	68 1/2	9	48 3/4	41	13	62	14 3/4	2 1/2	10 3/4	9 3/4	9 3/4	11 1/4	3/8	1 1/2 NPT	3 NPT	109
OC-106*	4 NPT	1 1/2	4 NPT	5 3/8	82	9 3/4	80 1/2	9	60 3/4	53	13	74	14 3/4	2 1/2	10 3/4	9 3/4	9 3/4	11 1/4	3/8	1 1/2 NPT	3 NPT	131
OC-107*	4 NPT	1 1/2	4 NPT	5 3/8	94	9 3/4	92 1/2	9	72 3/4	65	13	86	14 3/4	2 1/2	10 3/4	9 3/4	9 3/4	11 1/4	3/8	1 1/2 NPT	3 NPT	153
OC-108*	4 NPT	1 1/2	4 NPT	5 3/8	106	9 3/4	104 1/2	9	84 3/4	77	13	98	14 3/4	2 1/2	10 3/4	9 3/4	9 3/4	11 1/4	3/8	1 1/2 NPT	3 NPT	175
OC-109*	4 NPT	1 1/2	4 NPT	5 3/8	118	9 3/4	116 1/2	9	96 3/4	89	13	110	14 3/4	2 1/2	10 3/4	9 3/4	9 3/4	11 1/4	3/8	1 1/2 NPT	3 NPT	197
OC-1010*	4 NPT	1 1/2	4 NPT	5 3/8	130	9 3/4	128 1/2	9	108 3/4	101	13	122	14 3/4	2 1/2	10 3/4	9 3/4	9 3/4	11 1/4	3/8	1 1/2 NPT	3 NPT	219
OC-1011*	4 NPT	1 1/2	4 NPT	5 3/8	142	9 3/4	140 1/2	9	120 3/4	113	13	134	14 3/4	2 1/2	10 3/4	9 3/4	9 3/4	11 1/4	3/8	1 1/2 NPT	3 NPT	241
OC-1012*	4 NPT	1 1/2	4 NPT	5 3/8	154	9 3/4	152 1/2	9	132 3/4	125	13	146	14 3/4	2 1/2	10 3/4	9 3/4	9 3/4	11 1/4	3/8	1 1/2 NPT	3 NPT	263
OC-1013*	4 NPT	1 1/2	4 NPT	5 3/8	166	9 3/4	164 1/2	9	144 3/4	137	13	158	14 3/4	2 1/2	10 3/4	9 3/4	9 3/4	11 1/4	3/8	1 1/2 NPT	3 NPT	284
OC-1014*	4 NPT	1 1/2	4 NPT	5 3/8	178	9 3/4	176 1/2	9	156 3/4	149	13	170	14 3/4	2 1/2	10 3/4	9 3/4	9 3/4	11 1/4	3/8	1 1/2 NPT	3 NPT	306



# TYPE "OC" HEAT EXCHANGERS

## Straight tube design

The "OC" heat exchanger is designed for applications where high fouling fluids are circulated on the tubeside and/or single pass construction is required.

- Replaceable tubes.
- Easily cleaned without removing bundle.
- Removable bundle.
- Constructed, tested and stamped to ASME code rules, Section VIII, Division I.

### Design pressures and temperatures

Standard Construction	Design Pressure (PSI)	Test Pressure (PSI)	Design Temperature°F	
			Cast Iron Head	Brass Tubesheet
Tubeside	125	250	375°F	300°F
	150	300	375°F	300°F
Shellside	125	250	375°F	300°F
	150	300	375°F	300°F

Exchangers available on special order with design tubeside and shellside pressures up to 300 PSI at 400°F.

TEMA Class B, C, & R Construction also available.

Part of the

**ESI PLUS**  
Equipment Selection Program

### SHELL

Diameters 3" through 32"  
Carbon Steel  
304 SS  
316 SS

With a wide variety  
of nozzle configurations  
(refer pages 6 & 7)



### TUBESHEET

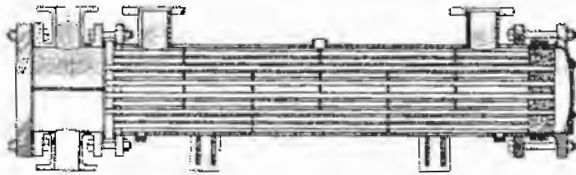
Carbon Steel  
304 SS  
316 SS  
Naval Brass  
90/10 Cupro Nickel

### SUPPORT LEGS

Cast Iron  
Adjustable Steel

### TUBES

Copper  
Carbon Steel  
304 SS  
316 SS  
Admiralty  
90/10 Cupro Nickel



### TIE-ROD SPACERS

Carbon Steel  
Naval Brass  
304 SS  
316 SS

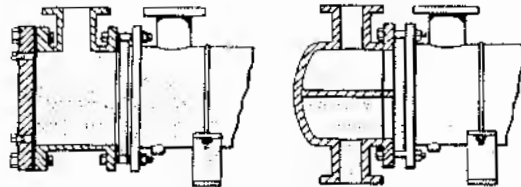
### BAFFLES

Carbon Steel  
Naval Brass  
304 SS  
316 SS

Stamped to close  
tolerances to provide  
positive cross flow for  
maximum heat transfer

### BOLTING

Carbon Steel  
304 SS  
316 SS



Single-pass channel head. Two-pass bonnet head.

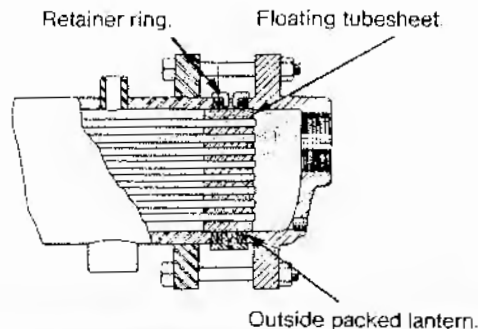
Single or two-pass construction.

### HEAD

Fabricated	Cast
Carbon Steel	Iron
304 SS	Ductile Iron
316 SS	Brass
90/10 Cupro Nickel	316 SS

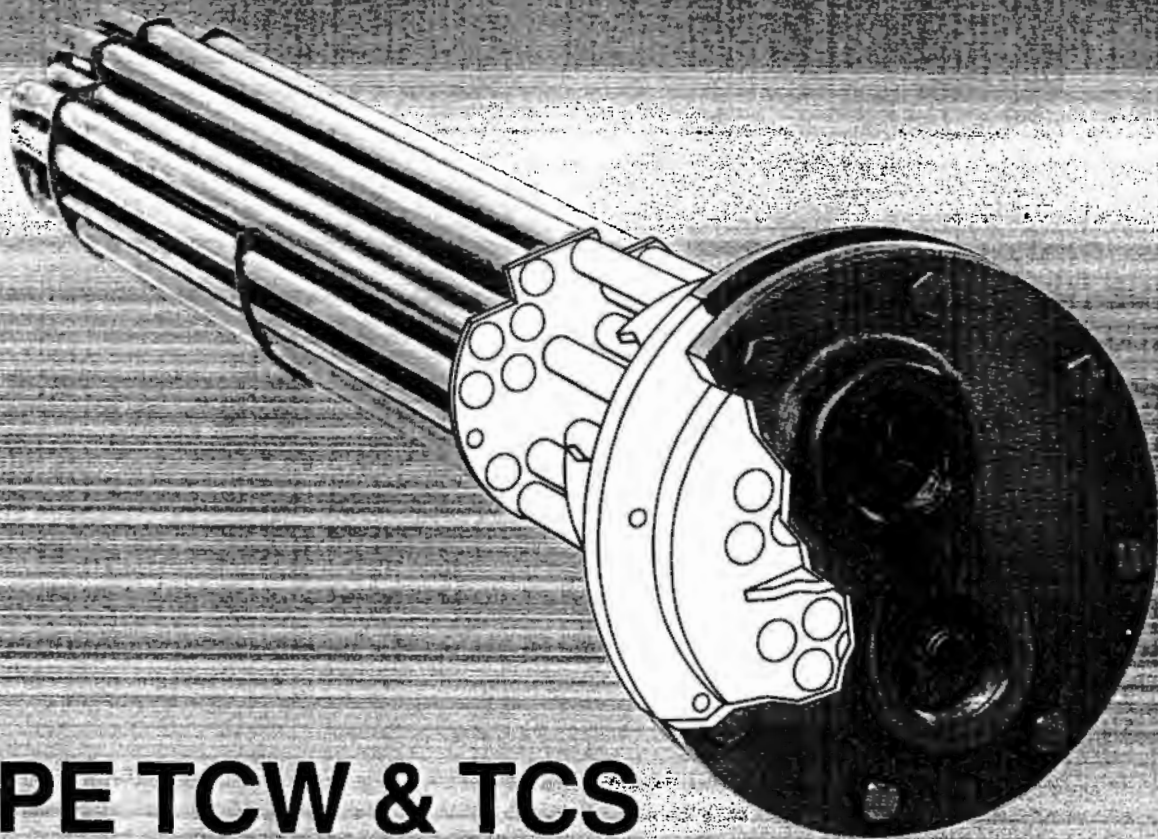
Refer to pages 6-7 for configuration

### FLOATING TUBESHEET CONSTRUCTION



Floating tubesheet construction within the rear head  
compensates for expansion or contraction of the entire  
tube bundle

Separate gaskets, externally vented, between shell and  
tube fluids prevent intermixing of fluids.



# TYPE TCW & TCS TANK HEATERS "U" tube design

Tank Heaters are designed for heating a fluid through natural convection in a tank by circulating fluid or steam in the heater tubes.

The "U" bend design with the tube ends roller expanded into a stationary tubesheet, permits ample expansion or contraction for wide temperature variation.

Model TCW is designed for use with liquid in the heater tubes.

Model TCS is designed for steam in the heater tubes.

- Removable tube bundle.
- Replaceable tubes.
- Constructed to ASME code rules, Section VIII, Division I.

## Design Pressures and Temperatures

Standard Design	Design Pressure (PSI)	Test Pressure (PSI)	Design Temperature °F	
			Cast Iron Head	Brass Tubesheet
Tubeside	125	250	375°F	300°F
	150	300	375°F	300°F

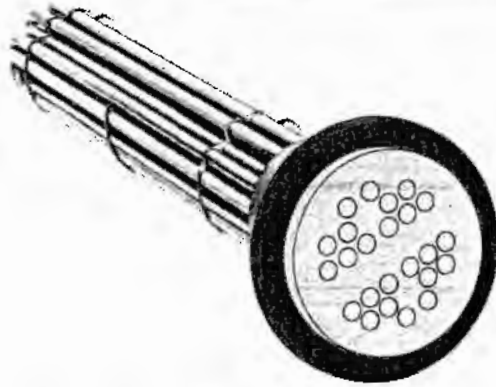
Exchangers available on special order with design tubeside pressures up to 1500 PSI and 650°F depending on the shell diameter and materials of construction.

TEMA Class B, C, & R Construction also available.

Special construction available for epoxy or cement lined tanks.

### WELDING COLLAR

Carbon Steel  
304 SS  
316 SS



### TUBESHEET

Carbon Steel  
Naval Brass  
304 SS  
316 SS  
90/10 cupro nickel

Tube bundle diameter  
4" through 30"

### TUBES

Copper  
Carbon Steel  
304 SS  
316 SS  
Admiralty  
90/10 cupro nickel



### TIE-ROD SPACERS

Carbon Steel  
Brass  
304 SS  
316 SS

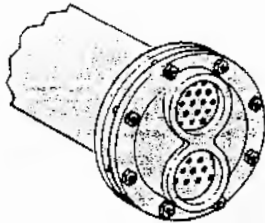
### TUBE SUPPORTS

Carbon Steel  
Brass  
304 SS  
316 SS

### Two-pass bonnet.

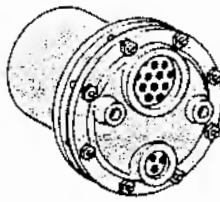
### BOLTING

Carbon Steel  
304 SS  
316 SS



"TCW"  
(liquid)

Two, four-pass construction.



"TCS"  
(steam)

Two-pass construction.

### HEAD

Fabricated	Cast
Carbon Steel 304 SS 316 SS	Iron Brass 316 SS

Refer pages 6-7 for configuration

Heads are furnished with tappings for steam, condensate, vacuum breaker and vent connections.

### TANK AND HEATER ASSEMBLY



The Bell & Gossett Tank and Heater offers many advantages, as it both heats and stores the liquid in the same unit. It can be operated by passing either steam or hot water through the coil and is an excellent heater for hard water territories. Large capacity in small space makes this heater particularly suitable for boiler rooms with low head room.