Fulton Electric Thermal Fluid Heaters
(FT-N Models)

Installation, Operation and Maintenance Manual

Serial # _____

Model # _____

Fulton Order # _____

Sold To _____

Job Name _____

Date _____

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Section 1

Section 1 – Safety Warnings & Precautions

Prior to shipment, the following tests are made to assure the customer the highest standards of manufacturing:

a) Material inspections
b) Manufacturing process inspections
c) ASME welding inspection
d) ASME hydrostatic test inspection
e) Electrical components inspection
f) Operating test
g) Final engineering inspection
h) Crating inspection

Rigging your heater into position should be handled by a competent rigger experienced in handling heavy equipment.

The customer should examine the heater for any damage, especially the refractories. **It is the responsibility of the installer to ensure all parts supplied with the heater are fitted in a correct and safe manner.**

Warning

Operating the heater beyond its design limits can damage the heater, it can also be dangerous. Do not operate the heater outside its limits. Do not try to upgrade the heater performance by unapproved modifications. Unapproved modifications can cause injury and damage. Contact your Fulton dealer before modifying the heater.

Warning

A defective heater can injure you or others. Do not operate a heater which is defective or has missing parts. Make sure that all maintenance procedures are completed before using the heater. Do not attempt repairs or any other maintenance work you do not understand. Obtain a Service Manual from Fulton or call a Fulton Service Engineer.

Warning

Thermal Fluid Heaters have high temperature surfaces, that if touched may cause serious burns. Only competent and qualified personnel should work on or in the locality of a thermal fluid heater and ancillary equipment. Always ensure the working area and floor are clear of potential hazards, work slowly and methodically.

WARNING: If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliances.

- <u>WHAT TO DO IF YOU SMELL GAS</u>

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

- Installation and service must be performed by a qualified installer, service agency or the gas supplier.

For Your Safety

The following **WARNINGS**, **CAUTIONS** and **NOTES** appear in various chapters of this manual. They are repeated on these safety summary pages as an example and for emphasis.

- **WARNINGS** must be observed to prevent serious injury or death to personnel.
- **CAUTIONS** must be observed to prevent damage or destruction of equipment or loss of operating effectiveness.
- **NOTES** must be observed for essential and effective operating procedures, conditions, and as a statement to be highlighted.

It is the responsibility and duty of all personnel involved in the operating and maintenance of this equipment to fully understand the **WARNINGS, CAUTIONS** and **NOTES** by which hazards are to be eliminated or reduced. Personnel must become familiar with all aspects of safety and equipment prior to operation or maintenance of the equipment.

Note

Max. room temperature not to exceed 100^{o}F.

Note

In no case should any part of the drive side of the pump be insulated.

Note

Max. operating temperature for air cooled pumps varies by manufacturer. Consult instruction manual to verify.

Note

Non-code tanks cannot be pressurized over 15 psig.

Note

If the tank is located outdoors nitrogen is required.

Warning

High temperature thermal fluid, steam and combustible vapors may be vented through the DA vent connection.

Warning

Once the system has been filled, any modification to the tank or connected piping requires purging of the work area to prevent ignition of potentially flammable vapors. Consult factory prior to beginning work. Consult MSDS for your thermal fluid for flammability limits.

Note

If the circulating pump motor is not supplied by Fulton Thermal Corporation, the motor starter will not be supplied.

Note

Unless the system is pressurized, the inlet to the deaerator section must be higher than or equal to the highest point in the system to prevent pockets of air from collecting in system piping.

Caution

During operation, any leaks are usually detected by a small amount of vapor. Leaks should be attended to as soon as possible because under certain circumstances, such as saturated insulation, thermal fluid can ignite when exposed to air and heat.

Note

Fulton Thermal Corporation cannot be held responsible in the case of accident or damage resulting from the use of inadequate fluid.

Note

Unless specially filtered, compressed air will introduce moisture into the system. Dry air or Nitrogen is recommended.

Note

Some plastics can be dissolved by thermal fluid.

Note

Do not use system circulating pump for system filling.

Note

A pump that has been used for water or a different thermal fluid should not be used prior to extensive cleaning. Thermal fluid can be damaged by contact with moisture or other fluids.

Warning

Pressurizing a drum to force fluid into the system is not recommended. The drum can easily explode, creating a hazard to personnel and equipment.

Note

Tanks are non-code as a standard. Non-code tanks cannot be pressurized over 15psig. Tanks built to ASME code Section VIII Div 1 are available upon request.

Note

Do not run the pump before filling it with fluid.

Caution

1. **Use extreme caution opening plug when system temperature is elevated.**
2. **Wear eye and hand protection.**
3. **Back the plug out slowly to the last two or three threads. Allow any pressure under plug to bleed slowly to prevent a spray of hot oil.**

Note

Flash steam may be generated at any point up to the operating temperature. Watch for gauge fluctuations.

Note

All of the above maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Fulton Service Department at (315) 298-7148 or your local Fulton Thermal Representative.

Product Bulletin

Date: February 22, 2000

Subject: Fulton Electric Thermal Fluid Heaters with SCR Controls

Fulton electric thermal fluid heaters, models FT-0075N through FT-0430N, at 460V or with an amp draw below 160 amps have a contactor in the panel box. The contactor is wired to the temperature limit circuit. The contactor will open under a high temperature and shut down the 3 phase power to the SCR.

All Fulton electric thermal fluid heaters, models FT-0640N through FT-1720N, with an amp draw above 160 amps require a shunt trip breaker. This breaker will be provided by the customer and is wired to the temperature limit on the heater. The breaker will open under a high temperature condition and shut down the 3 phase power to the SCR.

Fulton®

972 Centerville Road
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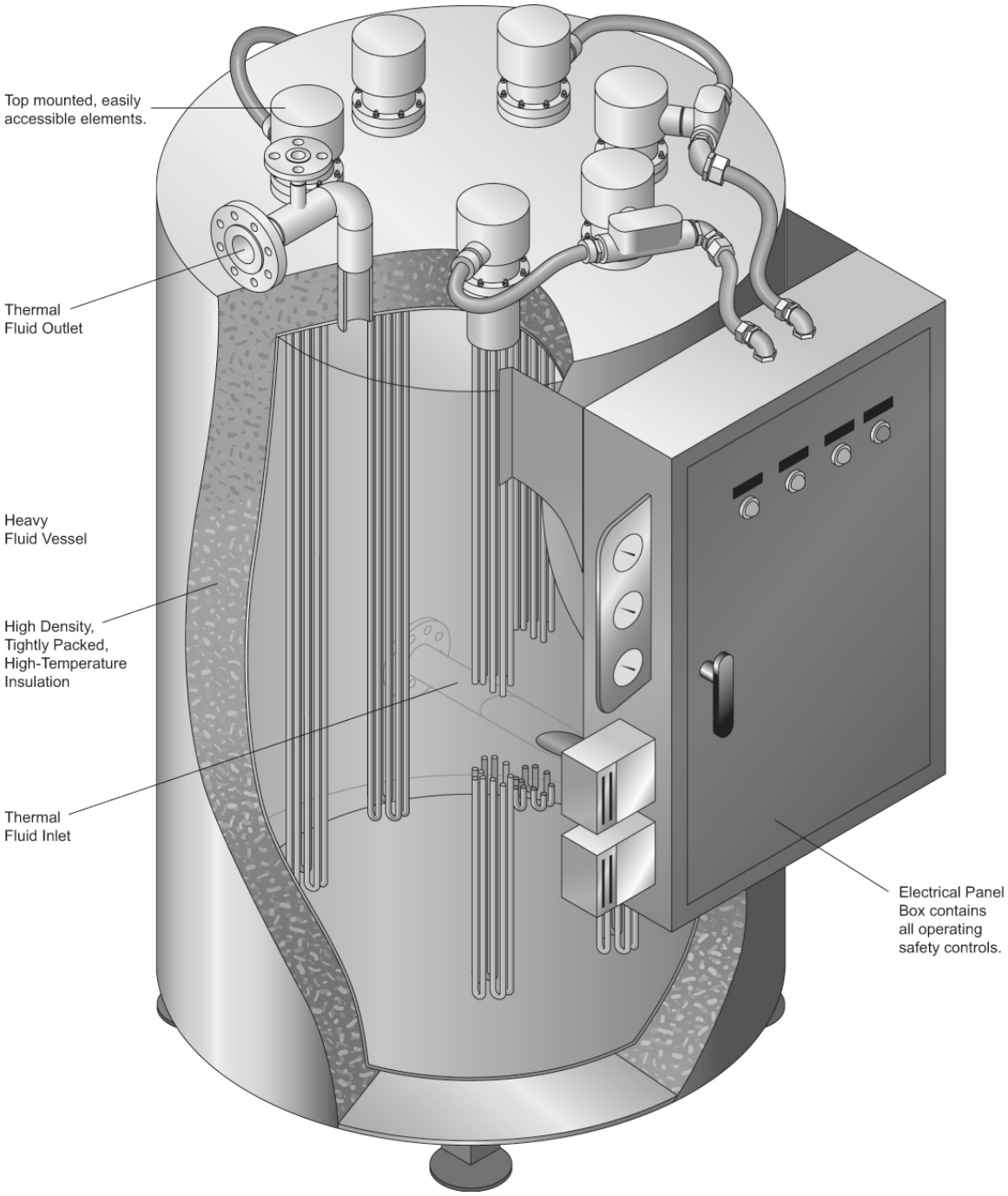
Fulton Thermal Corporation

Product Bulletin
FTC-00-001

Section 2

Section 2 – Installation

1. Component View



2. Placement

a) Proper placement of your Fulton Thermal Fluid Heater is essential. Attention paid to the following points will save a great deal of difficulty in the future. Correct placement is the first step to trouble-free installation, operation and maintenance.

3. Location

a) Authorities with jurisdiction over any national or local codes which might be applicable to thermal fluid applications should be consulted before installations are made.

b) The heater should be located as close as possible to the place where the heat will be used in order to keep pipe work costs to a minimum.

c) A level, hard, non-combustible surface is required for a suitable base for mounting the unit. It is suggested that a four inch curb be installed completely around the unit. In the event of a large spill, this will help contain the fluid.

d) Approximations for the floor loading of each heater are given in the floor loadings table. Check building specifications for permissible floor loading.

e) The heater should be placed in a suitable heater house or well ventilated separate room through which personnel do not normally pass. This is not essential, but the layout should eliminate traffic in potentially hazardous areas. For instance, the service engineer or the operator should not have to pass exposed, hot pipe work to make adjustments to the heater controls.

f) Ventilation must be sufficient to maintain a building temperature of 100°F. or less and the panel box temperature must not exceed 125°F. Natural ventilation should be provided by means of grills at floor and ceiling level.

4. Access

a) Access around the heater should be provided to facilitate maintenance. Appropriate clearances for all sides follow.

b) Place heater with clearances to unprotected combustible materials, including plaster or combustible supports, not less than the following:

Heater Front	36”	(1 m)
Heater Sides	18”	(.5 m)
Heater Rear	18”	(.5 m)
Heater Top (For element removal)	66”	(1.67 m)

5. Approximate Floor Loadings

a) Free standing figures take the weight of the heater alone into consideration. Floor loadings for skid mounted units vary with configuration.

Model	Free-Standing	Skid-Mounted
FT-0075N	400 lbs/ft2	150 lbs/ft2
FT-0150N	300 lbs/ft2	150 lbs/ft2
FT-0225N	300 lbs/ft2	150 lbs/ft2
FT-0300N	300 lbs/ft2	150 lbs/ft2
FT-0375N	300 lbs/ft2	150 lbs/ft2
FT-0430N	300 lbs/ft2	150 lbs/ft2
FT-0640N	300 lbs/ft2	200 lbs/ft2
FT-0860N	300 lbs/ft2	200 lbs/ft2
FT-1070N	200 lbs/ft2	200 lbs/ft2
FT-1290N	200 lbs/ft2	150 lbs/ft2
FT-1500N	200 lbs/ft2	150 lbs/ft2
FT-1720N	200 lbs/ft2	150 lbs/ft2

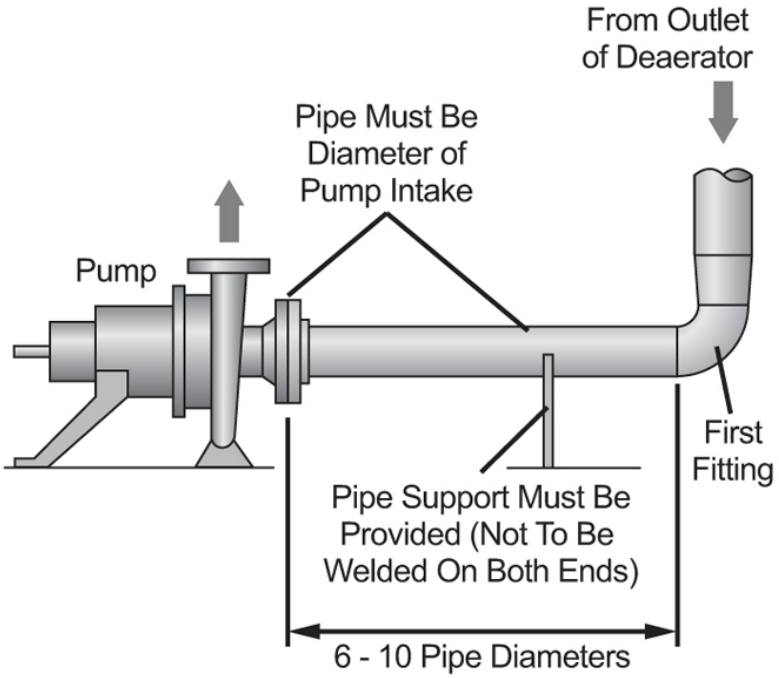
6. Minimum Clearance for Element Removal

Model	Inches	Meters
FT-0075N	46	1.2
FT-0150N	46	1.2
FT-0225N	46	1.2
FT-0300N	46	1.2
FT-0375N	46	1.2
FT-0430N	66	1.7
FT-0640N	66	1.7
FT-0860N	66	1.7
FT-1070N	66	1.7
FT-1290N	66	1.7
FT-1500N	66	1.7
FT-1720N	66	1.7

a) All heaters will also require a minimum clearance overhead for personnel access and element removal. In cases where the available height is insufficient, a roof or ceiling trap might be considered.
b) Pipes should not be run within ten inches of any control cabinets or combustible material.
c) Failure to provide suitable and safe access at the time of commissioning may cause delays, as our Service Engineers are instructed not to commence commissioning if hazardous conditions exist.

7. Circulating Pump

a) Installing the pump in accordance with the manufacturer's specifications and these instructions will prolong the life of the pump and contribute significantly to the successful operation of your Fulton heater system. The pump manufacturer's installation and operation instructions can be found in Section 5 of this manual.



b) Location

1. The pump should be located adjacent to the heater. Its base must be firm, level (preferably concrete), and free from vibration.

c) Connections & Piping

1. The pump should be routed as per the manufacturer's requirements. It should be equipped with flexible connections at the suction and discharge sides. The primary function of these connections are to prevent stresses due to pipe expansion from being placed on the pump and to isolate pump vibrations from the pipe work and the heater. They also allow for expansion and deflection of the pipe work. These connections should be rated for high temperature since they are considered part of the piping system.
2. The suction pipe work must be directly connected to the deaerator section via a vertical run with as few elbows as possible, and should contain the strainer and an isolating valve. The discharge pipe work must be connected directly to the heater inlet, and should contain an isolating

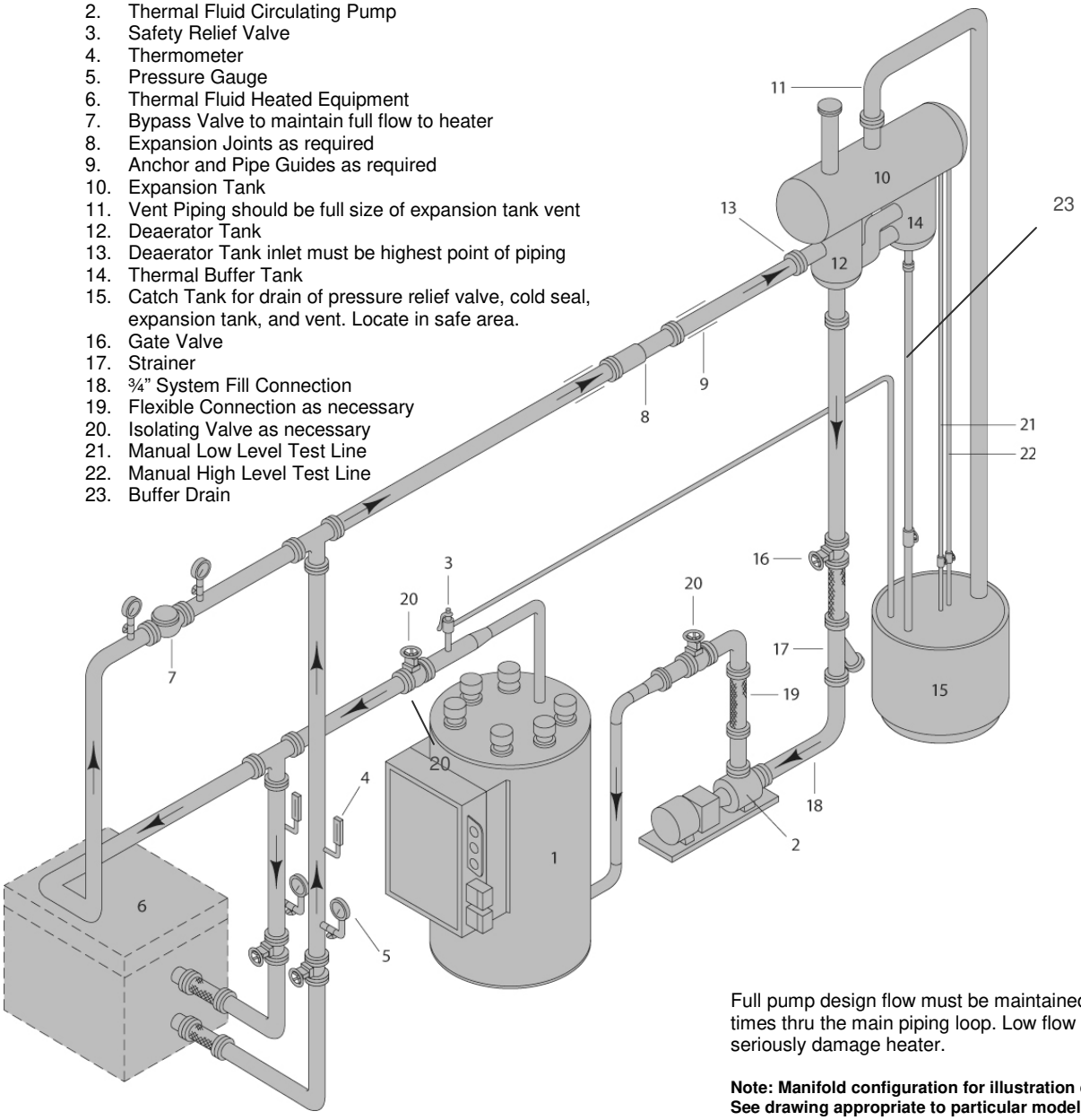
valve. See that pipe work connections match up accurately with pump flanges. Refer to the pump manufacturer's recommendations for the specific pump inlet piping requirements. Typically these requirements are that:

   a. It be a straight run of pipe.
   b. The straight run from the pump inlet to the first fitting, valve, or flex connector be a minimum of 6-10 pipe diameters in length.
   c. The pipe used should be the same size as the inlet of the pump.

3. The piping in the immediate vicinity of the pump must not be supported by the pump. The pump is not designed to bear the weight of the piping, and weight on any part of the pump will throw it out of alignment.

d) Typical Fulton Thermal Piping Schematic

1. Thermal Fluid Heater
2. Thermal Fluid Circulating Pump
3. Safety Relief Valve
4. Thermometer
5. Pressure Gauge
6. Thermal Fluid Heated Equipment
7. Bypass Valve to maintain full flow to heater
8. Expansion Joints as required
9. Anchor and Pipe Guides as required
10. Expansion Tank
11. Vent Piping should be full size of expansion tank vent
12. Deaerator Tank
13. Deaerator Tank inlet must be highest point of piping
14. Thermal Buffer Tank
15. Catch Tank for drain of pressure relief valve, cold seal, expansion tank, and vent. Locate in safe area.
16. Gate Valve
17. Strainer
18. ¾" System Fill Connection
19. Flexible Connection as necessary
20. Isolating Valve as necessary
21. Manual Low Level Test Line
22. Manual High Level Test Line
23. Buffer Drain



Full pump design flow must be maintained at all times thru the main piping loop. Low flow will seriously damage heater.

Note: Manifold configuration for illustration only. See drawing appropriate to particular model.

e) Alignment

1. Proper alignment directly affects bearing, coupling, and seal life expectancy. The pump is properly aligned before it leaves the factory. Because the system expands in operation, pump must be realigned when the system is at operating temperature.
2. The coupling alignment of the pump and driver must be carefully checked for angular and axial alignment. Check pump manufacturers instructions for these specifications. The use of a dial indicator to check the axial and angular alignment is recommended.

f) Lubrication

1. An air cooled pump does not have an oiler. This type of pump has a sleeve bearing which is, like the seals, lubricated by thermal fluid. An air cooled pump has a grease nipple located at the drive end of the pump near the coupling connection. This comes pre-greased, and should be greased at intervals as recommended by the manufacturer.
2. An oiler is shipped with each water cooled pump and it should be filled with a lubricating oil recommended by the manufacturer. The suggested lubricant is usually SAE-30 non-detergent oil. Thermal fluid is not sufficient lubrication for bearings.

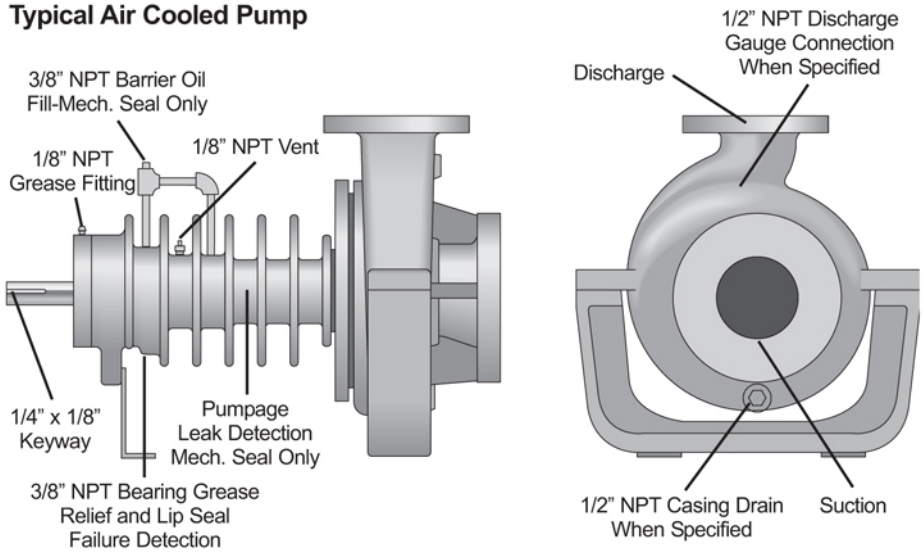
g) Seals

1. All seals on air cooled pumps are lubricated by thermal fluid, therefore the pump must never be run dry, i.e., without thermal fluid in it.
2. Filling a pump equipped with either a Grafoil packed or mechanical seal with thermal fluid will ensure lubrication. However, in order to be certain that all seals on an air cooled pump are coated with thermal fluid, the pump must be bled.
3. Grafoil packings require a run-in procedure. Typically, pumps with these seals are shipped with four or five rings installed and several rings loose. These extra rings must be on hand for the initial run-in procedure. See manufacturer's instruction manual for this procedure.

h) Air Cooling

1. Allow for free air flow around the entire pump casing at all times.
2. Max. room temperature should be 100°F.
3. In no case should any part of the drive side of the pump be insulated.
4. Max. operating temperature for air cooled pumps varies by manufacturer. Consult instruction manual to verify.

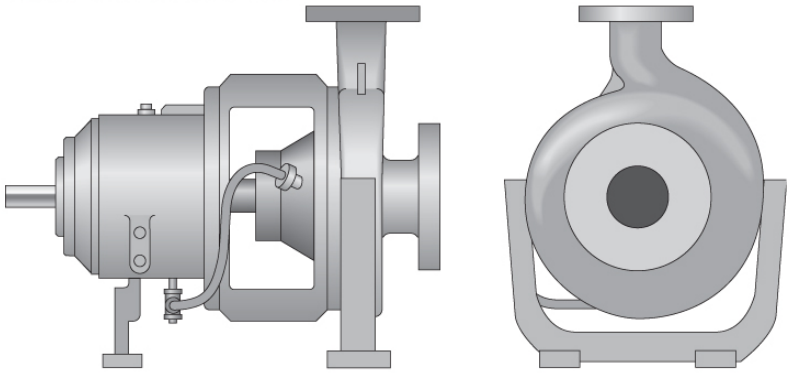
Typical Air Cooled Pump



i) Water Cooling

1. A throttling needle valve should be installed on the inlet side of the water cooling passages and adjusted so that the outlet water is between 120°F. and 160°F. Typically this means a flow rate of 2-5 GPM at 40°F inlet temperature. Consult pump manufacturer's specifications for dimensions of water cooling connection.
2. The throttling valve on a water cooled pump is designed to automatically give the proper flow rate for a 40 PSIG or greater supply.
3. If a minimum of 40 PSIG is not available, consult Fulton Thermal Corporation about resizing the orifice. If the temperature of the cooling water is greater than 55°F to begin with, a correspondingly greater flow rate is required.
4. For automatic operation of water cooling, wire a solenoid valve on the inlet to open whenever the pump motor starter is energized.
5. The outlet flow from the pump must not be restricted in any manner. Therefore, valves are not to be installed on the outlet. Check local codes regarding disposal of hot water.

Typical Water Cooled Pump



8. Combination Expansion/Deaerator/Thermal Buffer Tank

a) Fulton Thermal's efficient design combines the operation of the expansion, deaerator, and thermal buffer tanks. Installation is considerably simplified by virtue of this arrangement.

b) Expansion Section

1. The expansion section is vital to the thermal fluid system. From ambient to operating temperature, the thermal fluid in the system will typically expand in the range of 30%, and a vessel capable of handling this expansion is mandatory. The customer should confirm the expansion rate of the chosen fluid and system volume.

c) Deaerator Section

1. At start up the primary purpose of the deaerator section is to remove all volatiles from the system to avoid pump cavitation. The deaerator section also allows oxygen to be vented from the system on a continuous basis during operation to avoid oxidation of the thermal fluid, and removes other volatile particles generated by the fluid itself during system operation. This section of the tank must be insulated.

d) Thermal Buffer Section

1. A system of interconnecting pipe work in the thermal buffer tank section prevents the movement of any oil that has not cooled sufficiently into the expansion section. This avoids contact of very high thermal fluid temperature with oxygen contained in the atmosphere, which causes fluid breakdown. DO NOT insulate this section.

e) *Sizing The Tank For The System*

1. Expansion tank capacity is the total volume of the tank. It is necessary to have some air space available at the top of the tank to avoid spillage or

overflow. At initial fill (for system volume calculations) the deaerator and cold seal sections must be filled completely and the expansion section must be filled to a level of 4 inches to "make" the liquid level switch.

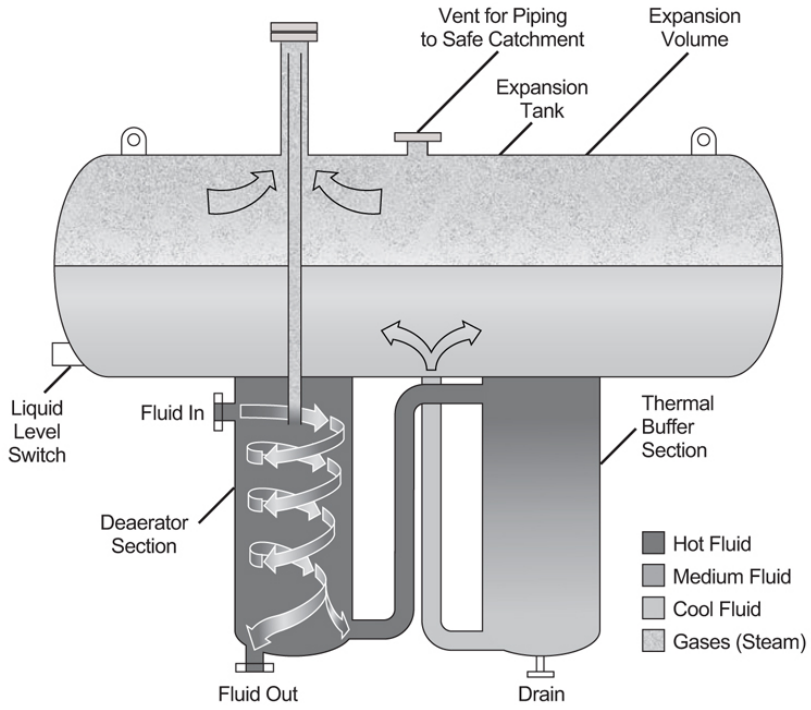
2. The volume between the initial fill level and the safe "full" level is the amount available for expansion. That volume is used to decide which tank is suitable for the system expansion.

f) Sizing Example

1. A system contains 175 gallons, including the heater, but not the tank. You select the FT-200-L, so you add 25 gallons to 175. You must look up the expansion rate for the thermal fluid. (Assume it is 25%). 200 gal. x 1.25 = 250 gallons. 250-200 = 50 gallon expansion. The FT-200-L has only 46 gallons available for expansion, so the correct selection is the FT-500-L.

g) Location

1. The tank must be installed in accordance with Fulton Thermal Corporation's specifications.
2. Unless the system is pressurized, the inlet to the deaerator section must be higher than or equal to the highest point in the system to prevent pockets of air from collecting in system piping.
3. The head required at the circulation pump suction inlet must also be taken into account to avoid the possibility of pump cavitation. In systems operating close to maximum fluid temperature, the tank must be elevated enough, possibly well above the highest point in the system to prevent pump cavitation by increasing the static head. An inert pressurizing blanket may be considered as an alternative. See **Pressurized Systems.**
4. Supports for tank mounting should be provided by the client/contractor. These should be suited for supporting the tank by the side rails. The eyelets fitted to the tank are for lifting only.



Model	Capacity (Gallons)	Initial Fill (Gallons)	Available for Expansion (Gallons)	Max System Volume
FT-200-L	52	25	46	184
FT-500-L	132	40	121	525
FT-1000-L	264	80	232	1000
FT-1500-L	397	90	380	1400
FT-2000-L	528	145	444	1700
FT-3000-L	793	215	717	2600
FT-5000-L	1310	300	1168	4600

9. Pressurized Systems

a) Nitrogen pressurization may be used to advantage where the total system content is very large or in a system operating near or above the vapor pressure of the fluid employed or if the inlet of the DA tank is not the highest point in the piping system.

b) In conjunction with this system, an automatic venting device must be fitted to the system expansion tank. Consult Fulton Thermal Corporation for further details.

c) The location for the liquid level switch is a 2-1/2" NPT connection on the same end of the tank as the inlet. The liquid level switch is supplied and shipped with the unit, and must be installed by the customer and then wired to the control panel.

Note

If the tank is located outdoors nitrogen is required.

10. Connections

a) The vent connection must be made in a manner that will prevent penetration of water or foreign bodies into the tank. This connection must always terminate in a safe, well ventilated area and has to be free of obstruction, open to atmosphere, and arranged in such a manner that, in the event of discharge from the system, thermal fluid could drain into a catch tank without danger to personnel or property.

Note

Non-code tanks cannot be pressurized over 15 psig.

Warning

High temperature thermal fluid, steam and combustible vapors may be vented through this connection.

b) The vent run should be the same size as the tank outlet. It should run pitch down from the outlet of the tank to the catch tank.

c) If nitrogen is used on the system, the vent can be reduced and should be piped with a positive closing valve at the catch tank.

d) The connection between the tank outlet and the horizontal pump inlet run should be as close to a vertical drop as possible. It should not contain an excessive number of bends of length of pipe. These faults could encourage pump cavitation.

e) As noted, the inlet to the deaerator must be higher than or equal to the highest point in the system or a pressurized system must be used.

f) The liquid level switch, supplied and shipped with the unit, must be installed and wired to the control panel by the customer.

g) The high and low level test connections are 1/2" NPT, and are located on the end of the tank opposite the inlet. The low level is on the center line of the expansion tank, the high level is next to it, slightly off center. The high level rises up from the bottom of the tank and ends four inches below the top; the low level rises two inches from the bottom of the tank.

h) Both the high and low level connections should be piped to a safe catchment. Valves should be installed in these lines at the catch tank.

i) Installation of the valves should be accomplished in such a manner that any flow will be visible when the valves are open.

j) Flow from the high level test connection indicates a tank that is too full; no flow from the low level test connection indicates too little fluid.

k) There is a 300 pound, raised face, flanged drain on the bottom of the thermal buffer section, for the purpose of draining the tank when necessary. This should be piped with a valve in the line, to a safe catchment. The valve specifications outlined above apply to this valve as well.

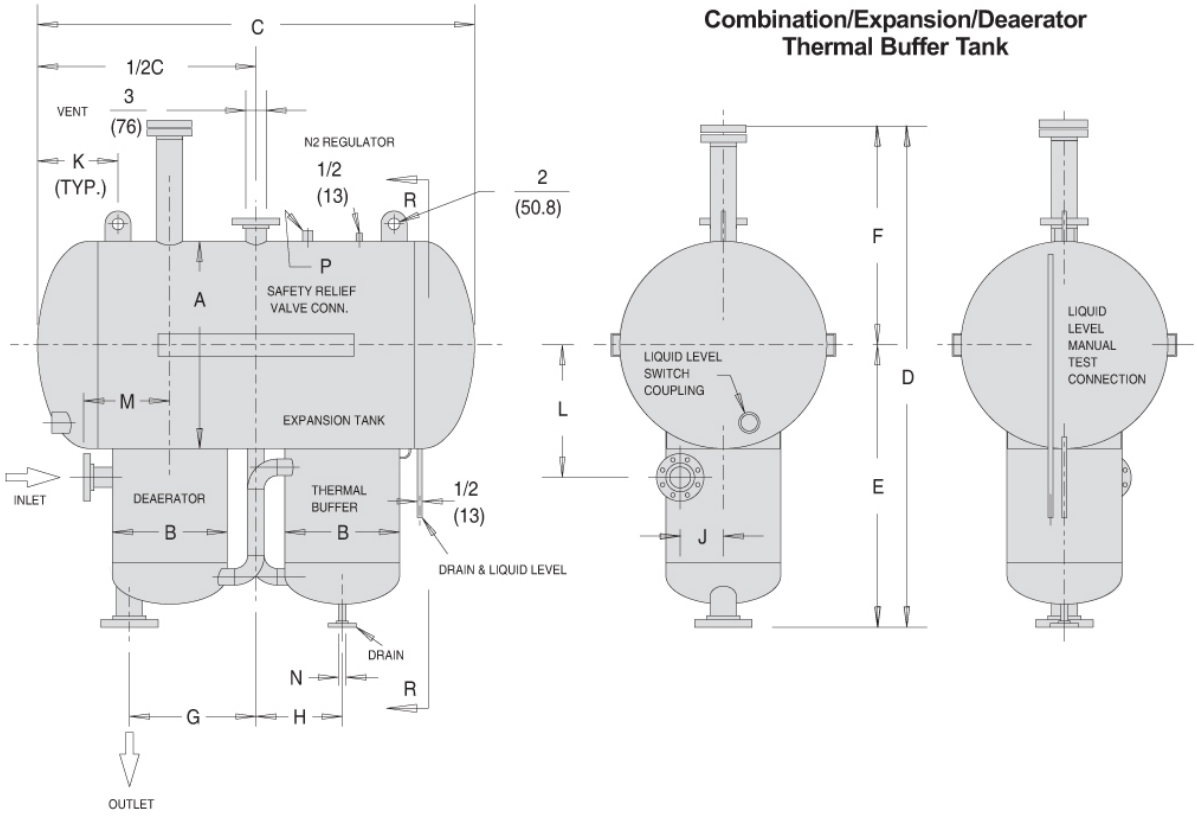
l) An inspection opening is located at the highest point on the tank. Access to this port is recommended but not required.

m) Refer to the maintenance schedule for recommendations on draining the buffer tank. For positioning of all connections on tank, see the diagram labeled Combination/Expansion/Deaerator Thermal Buffer Tank.

Warning

Once the system has been filled, any modification to the tank or connected piping requires purging of the work area to prevent ignition of potentially flammable

vapors. Consult factory prior to beginning work. Consult MSDS for your thermal fluid for flammability limits.



MODEL	A	B	C	D	E	F	G (Ref)	H	J (Ref)	K	L	M	N	P	CAP.	Dry Wt.	Max Full Wt.
FT-0200-L	20 (510)	12¾ (325)	54 (1370)	60⅝ (1540)	34 (865)	26⅝ (676)	16¹¹⁄₁₆ (424)	12 (305)	4½ (115)	4¼ (108)	15 (380)	12¹⁵⁄₁₆ (329)	¾ (20)	¾ (20)	52 (200)	636 (289)	1314 (596)
FT-0500-L	26 (660)	16 (405)	74 (1880)	66⅝ (1692)	37 (940)	29⅝ (752)	19¾ (502)	14 (355)	6 (150)	11½ (290)	18 (460)	14¹⁵⁄₁₆ (379)	¾ (20)	¾ (20)	132 (500)	970 (440)	2450 (1111)
FT-1000-L	36 (915)	20 (510)	76 (1930)	87⅝ (2226)	49 (1245)	38⅝ (981)	22¼ (565)	15 (380)	7¹¹⁄₁₆ (202)	14 (355)	24 (610)	14¹⁵⁄₁₆ (379)	1 (25)	1 (25)	264 (1000)	1350 (612)	4380 (1987)
FT-1500-L	36 (915)	20 (510)	106 (2690)	87 (2210)	49 (1245)	38⅝ (981)	24¾ (629)	17½ (445)	8 (203)	14 (355)	24 (610)	14¹⁵⁄₁₆ (379)	1 (25)	1¼ (32)	397 (1500)	1710 (776)	5875 (2667)
FT-2000-L	42 (1070)	22 (560)	106 (2690)	107⅝ (2734)	62½ (1590)	45⅛ (1146)	31³⁄₁₆ (792)	24 (610)	8½ (216)	15½ (394)	28 (710)	14¹⁵⁄₁₆ (379)	1 (25)	1½ (38)	528 (2000)	2550 (1134)	8230 (3733)
FT-3000-L	42 (1070)	26 (660)	140 (3556)	115⅛ (2924)	70 (1778)	45⅛ (1146)	33³⁄₁₆ (843)	24 (610)	9¹⁵⁄₁₆ (252)	15½ (394)	28 (710)	18⁵⁄₁₆ (481	1 (25)	1½ (38)	793 (3000)	3200 (1451)	11,610 (5265)
FT-5000-L	60 (1524)	26 (660)	130⅜ (3312)	132⅛ (3356)	77½ (1969)	54⅜ (1387)	32⅛ (818)	24 (610)	9⅜ (238)	20⅝ (524)	37 (940)	18⁵⁄₁₆ (481)	1 (25)	1½ (38)	1321 (5000)	5300 (1637)	17,370 (7895)

Inlet and outlet dimensions vary with installation. All dimension are approximate. Specifications subject to change without notice.
Dimensions given in inches and (MM)
Capacities given in gallons and (LITERS)
Weights given in pounds and (KG)

n) Electrical Connections

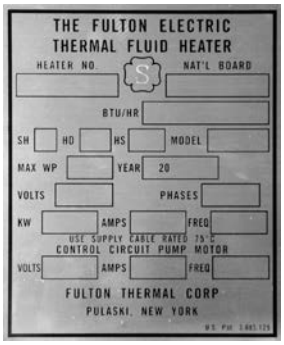
1. A wall-mounted, fused disconnect sized for the unit must be provided and fitted by the client/contractor, if a disconnect is not supplied on the panel.
2. Fuses must be sized according to motor name plates and local electrical codes.
3. Heaters and single skid systems are generally shipped completely prewired. The liquid level switch on the expansion tank, when supplied, will be shipped in the parts box and must be installed in the field. Multiple skid systems may require wiring between the skids.
4. If the unit is not skid-mounted at the factory, the client/contractor is required to wire the circulating pump starter.
5. When using a SCR, a Shunt Trip Breaker is required to be installed by the customer. It will be used to remove power to the panel in the event of an over temperature/pressure condition. The Shunt Trip Coil needs to be wired to the boiler electrical panel as indicated on the electrical drawing.

Note

If the circulating pump motor is not supplied by Fulton Thermal Corporation, the motor starter will not be supplied.

o) Voltage & Frequency

1. Normal supply will be 460 volts, 3 phase, 60 Hz, AC unless otherwise specified.
2. Make sure the information on the electrical drawing corresponds to your voltage and frequency. Check the supply voltage and make sure that there is no over-or under-voltage exceeding 10% of the nominal value.



11. Pipework Systems

a) Certain properties of thermal fluid, including low surface tension, make it necessary to pay particular attention to containing the fluid. Good pipework system design, welded

construction, proper flanging, gaskets, and other appropriate means of eliminating potential leakage must be employed.

12. General

a) All components exposed to thermal fluid flow, including pipe, valves, and screens, must not be made out of copper, copper alloys, aluminum, or cast iron. Cast iron is porous to thermal fluids, and copper and aluminum act as catalysts in the degradation of some thermal fluids. Carbon or stainless steel, or ductile iron, are recommended.
b) For standard applications, all components must be rated to 650°F unless otherwise stipulated.
c) All pipework, valves, and user equipment must be suited to the maximum operating pressure of the heater. The maximum pressure stamped on the heater nameplate is typically 150 psig (690 kPa).
d) If an isolating valve is completely closed, the pressure in the system will rise to the deadhead pressure of the pump. Suitably sized pipe will enable the system to withstand the total head generated by the circulating pump, should this occur. In applications where it is desirable to design to pressures lower than 100 psig, an alternative safeguard is to install appropriately sized safety valves.
e) Where secondary circulating pumps are installed, the system must be suitable for the aggregate head, against a closed valve, of both pumps.
f) During construction of the installation, ensure that no dirt, water, or residue from welding is left in the system.

13. Equipment

a) Heaters that are skid mounted with pumps and tanks are equipped with a y-strainer, a flex connector and a valve in the inlet run between the pump and the combination tank. Piping between the discharge of the pump and the inlet of the heater will include a flex connector and a valve.

14. Piping

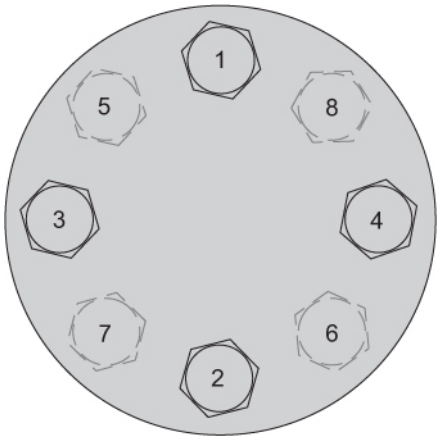
a) All pipework should be constructed from seamless mild steel pipe, conforming to ASME SA 106B or SA 53B, Schedule 40 or equal.
b) Expansion joints or properly designed and sited loops should be provided to accommodate thermal expansion. Thermal expansion should be calculated using the maximum possible utilization fluid temperature, regardless of whether the pipe considered is in the feed or return circuit. Steel pipe will expand approximately 1 “ per 100’ over a 100° F. temperature rise (1 mm. per meter over 100°C. rise).

c) Supports and anchors must be provided for all pipes where necessary to prevent undue stresses from being placed on items of equipment, including pumps, valves, and the heater. Supports and anchors which will not interfere with thermal expansion should be chosen.
d) All pipe joints should be of either welded or flanged construction. Screwed joints must be avoided where possible. In no instance should screwed joints be used in the flow circuit.
e) All flanges should be welded to the pipe and not screwed. Flanges should be 150# or 300# raised face flanges, SA105.
f) Gasketing material suitable for use with thermal fluids at high temperatures should be used to make all flanged joints. Flexible graphite gaskets are suited for most thermal fluids. Recommended gasket thickness is 1/10 - 1/8 inch.
g) Ensure that all bolts are tightened evenly and to the torque recommended values provided by the gasket manufacturer.

15. Gasket Installation Instructions

a) Lubricate nuts, bolts and washers with a graphite/oil mixture.
b) Assure that the flange surfaces are clean and free from damage.
c) Center gasket properly over flange. In retrofit, use pry bar to spread flange apart enough that the gasket will not be damaged when sliding in place.
d) Install all flange nuts and bolts.
e) Hand tighten.
f) Utilizing a torque wrench, tighten all bolts to 20% final torque specification following a “star” pattern. (This means do not tighten bolts in order as a clock. This will result in a poor seat between 12 o’clock and 1 o’clock.)
g) Tighten all bolts to 40% final torque specification following a “star” pattern.
h) Tighten all bolts to 60% final torque specification following a “star” pattern.
i) Tighten all bolts to 80% final torque specification following a “star” pattern.
j) Tighten all bolts to 100% final torque specification following a “star” pattern.
k) Following a sequential pattern, ensure that all bolts are tightened to 100% final torque specification.
l) It is important that all bolts are checked and re-torqued after flanges have been heated and cooled down for the first time.

Bolting Sequence for 4 and 8 Bolt Flanges



Standard gaskets supplied by Fulton are JM Clipper Elastograph for operating temperatures up to 650°F.

Recommended Loads for JM Clipper elastograph 150# Gaskets
SAE Grade 5 Bolts (typical) or Equal

Nominal Flange Size Inches	Number of Bolts	Diameter of Bolts Inches	Preferred Torque Required per Bolt Ft-Lbs.
1/2	4	1/2	30
3/4	4	1/2	30
1	4	1/2	30
1 ¼	4	1/2	30
1 ½	4	1/2	30
2	4	5/8	60
2 ½	4	5/8	60
3	4	5/8	60
4	8	5/8	60
5	8	3/4	100
6	8	3/4	100
8	8	3/4	100
10	12	7/8	160

Recommended Loads for JM Clipper elastograph 300# Gaskets
SAE Grade 5 Bolts (typical) or Equal

Nominal Flange Size Inches	Number of Bolts	Diameter of Bolts Inches	Preferred Torque Required per Bolt Ft-Lbs.
1/2	4	1/2	30
3/4	4	5/8	60
1	4	5/8	60
1 ¼	4	5/8	60
1 ½	4	3/4	100
2	8	5/8	60
2 ½	8	3/4	100
3	8	3/4	100
4	8	3/4	100
5	8	3/4	100
6	12	3/4	160
8	12	7/8	245
10	16	1	160

16. Piping

a) High point bleeds are to be installed at all high points in the system piping. 1/2" x 12" nipples welded in the top of the piping with ball valves & plugs attached are to be used.

b) It will save a considerable amount of time during the cold filtration if the thermal system piping is cleaned prior to assembly.

c) The mill scale (the results of oxidation) on the inside of the piping as well as construction debris can foul the oil and cause the need for the filters to be cleaned more than need be. This can range from simply using a rag to ordering pickled pipe. ("Pickling" is a process

where the piping is first soaked in an acid bath, then soaked in a neutralizing bath, then given a protective oil coating.)

d) All pipes should be installed with a pitch to facilitate draining and venting.

Note

Inspect the system daily for leaking joints. Shut the system down and tighten any leaking flanges or connects immediately.

17. System Connections

a) If screwed connections have to be made, e.g. to items of control equipment, then a thread sealant suitable for use with fluids at elevated temperature must be used. Teflon tape, standard pipe dope, or hemp and paste are not acceptable. Screw threads must be carefully and accurately cut. If possible, new tools should be used. Threaded connections larger than 1" are not to be used. It is recommended that GR5 or better tensile steel bolts be used for all flanged joints.

Standard gaskets supplied by Fulton for operating temperatures above 650°F are Flexitallic Spiral Wound.

Recommended Loads for Flexitallic Spiral Wound Class 150# Gaskets

SAE Grade 5 Bolts (typical) or Equal

Nominal Flange Size Inches	Number of Bolts	Diameter of Bolts Inches	Preferred Torque Required per Bolt Ft-Lbs.
1/2	4	1/2	45
3/4	4	1/2	45
1	4	1/2	45
1 ¼	4	1/2	45
1 ½	4	1/2	45
2	4	5/8	90
2 ½	4	5/8	90
3	4	5/8	90
3 ½	8	5/8	90
4	8	5/8	90
5	8	3/4	150
6	8	3/4	150
8	8	3/4	150
10	12	7/8	240

Recommended Loads for Flexitallic Spiral Wound Class 300# Gaskets

SAE Grade 5 Bolts (typical) or Equal

Nominal Flange Size Inches	Number of Bolts	Diameter of Bolts Inches	Preferred Torque Required per Bolt Ft-Lbs.
1/2	4	1/2	45
3/4	4	5/8	90
1	4	5/8	90
1 ¼	4	5/8	90
1 ½	4	3/4	150
2	8	5/8	90
2 ½	8	3/4	150
3	8	3/4	150
3 ½	8	3/4	150
4	8	3/4	150
5	8	3/4	150
6	12	3/4	150
8	12	7/8	240
10	16	1	368

Note

The system pump is not to be used to fill the system.

The system is usually filled from the lowest point, with the aid of a pump. On skid-mounted units, a drain and fill connection is provided in the inlet piping to the pump.

Drain and Fill Connection

18. Heater Connections

a) The outlet of the pump should connect directly to the inlet of the heater via an isolating valve and pump flexible connector.

b) The heater outlet should be piped directly to the system, via an isolating valve.

c) A safety relief valve may be shipped in the parts box accompanying the fuel-fired heater, and must be installed in the outlet manifold. On all units, the outlet must be piped to a safe discharge area. The piping from the outlet of the safety valve must be piped to a catch tank. The discharge flow must not be restricted, i.e. no valve should be installed. The weight of the piping must be properly supported in order to prevent damage to the safety valve. If the valve body becomes warped, leakage may result.

19. Gauges

a) The range in which readings are expected to fall should comprise mid-scale on the pressure gauge chosen. Pressure gauges must be able to withstand overpressure equal to the rating of the safety relief valves, normally 100 psig.

b) Thermometers should read up to 650°F.

20. Valves

a) Vent and drain valves should normally be 1/2” or 3/4” with internal seals made from materials suited to use with thermal fluids. They may be of the screw type if installed on stalks not less than 12” long.

b) Gasketing material specifically suited to the task must be used.

c) Drain valves should be fitted at all low points in the pipework system and ventilating valves should be fitted at all high points in the installation.

d) Valves must be fitted with either the conventional packed stuffing box seal or a bellows seal as required. Where the stuffing box is specified, it should be as deep as possible

and packed with Grafoil packing or equal. The valves should have a back seating to allow re-packing without draining the system. In all units, a “Y” type strainer should be installed in the fluid return line, between the deaerator tank and the circulating pump.

e) As previously stated, this strainer is provided on all skid-mounted units. Valves must be provided (unless the heater has been skid-mounted with the tank) so that the strainer can be isolated for cleaning of the element. The strainer element should be 60 mesh and must remain in place during normal operation of the system.

f) The pump suction pressure should be checked periodically, under similar operating conditions. A vacuum reading on the suction gauge indicates that the screen must be cleaned. For isolating purposes, globe, wedge, gate, ball, or other shut-off valves should be used. When there is a likelihood that some manual balancing will be required, a ball or globe valve should be used.

g) Manual control and isolating valves should be the flanged or weld type, manufactured from cast or forged steel or ductile iron, with internals and gland seals made from materials suitable for use with high temperature fluids.

h) When ordering valves, the maximum possible service temperature and type of fluid must be indicated on the order.

i) A partial list of manufacturers known to market valves of acceptable quality follows:

1. Jenkins Brothers
2. Lunkenheimer Company
3. Nibco Incorporated
4. Stockham Valves and Fittings Company
5. Velan
6. Vogt Machine Company
7. Worcester Valve Company

j) Automatic Fluid Control Valves

1. Because of the widely varied processes Fulton Thermal Fluid Heaters are used in, it is not possible to set down specific rules for the selection of automatic fluid control valves. Generally, these valves must satisfy the materials and construction requirements described above.
2. The type of operation and design of porting are governed by the degree of control required as well as the particular application.

k) Bypass Valves

1. When process flow requirements do not match heater flow requirements, a by-pass valve must be installed.

2. If the process flow will vary with the system load, a suitable bypass system can be recommended by Fulton Thermal Corporation.

21. Testing

a) Upon completion of the installation, a pneumatic test not exceeding 15 psig should be conducted. Soap tests should be made at all welds and joints to ensure that the system is free from leaks.
b) Under no circumstances should the system be filled with water. Make sure that the air supply is as free from moisture as possible.
c) The most satisfactory method of testing is to introduce bottled nitrogen through a pressure control valve. Check pressure ratings on all the equipment in the system to make sure that it is capable of withstanding the pressure involved.
d) The time needed to be spent during boilout directly corresponds to the amount of moisture in the system. Boilout can take anywhere from two to three days to complete. Pressure testing on the system should be done by means of an inert gas, such as nitrogen, or by an air compressor producing dry air (air with a dewpoint of 50^{o} F or less). Never perform a hydrostatic test on the system.

22. Insulation

a) After the appropriate system tests have been satisfactorily completed, all hot pipework, including manifolds on the heater, must be adequately insulated with material suited to the temperature and application to prevent both heat loss and personnel injury.
b) The deaerator section of the combination tank must be insulated. The expansion section of the combination tank must not be insulated, nor should the thermal buffer section.
c) On units operated with inert gas blankets above the fluid in the expansion tank, the entire combination tank, including the expansion and thermal buffer sections, may be insulated, but is not necessary.
d) It is recommended that for inspection and maintenance, pumps, flanges, valves, and fittings be left un-insulated but suitably shielded for safety.
e) Hot oil pipe insulation should be a minimum of 2” thick, high temperature, laminated, foamglass cellular glass insulation as manufactured by Pittsburgh Corning Corporation, or equal.

23. Thermal Fluids

Thermal Fluids at Elevated Temperatures

a) Plant engineers must be familiar with the nature of potential hazards when working with thermal fluids at operating temperatures.
b) Unlike steam or high-pressure water systems, thermal fluid attains extremely high temperatures without a corresponding increase in pressure. While this lack of high

pressure in the system yields many advantages, a false sense of security should not be allowed to develop on account of this alone.

c) Certain types of thermal fluid may have operating temperatures reaching 650°F (345°C) and above, so all exposed pipework is hazardous and should be insulated, as indicated in the preceding sections.

d) Flanged joints must be checked for tightness during and after the first warming up of the system. After these checks, exposed hot flanges, pumps, valves and fittings should be fitted with some sort of shield.

e) It is important to remember that there is pressure generated in the system by the circulating pump. Great care should be exercised when opening any drain or vent valves in the system.

f) This is especially important during commissioning, when any air trapped in the system is vented at high points, and when water, which will flash into steam, is either expelled from the deaerator vent or drained off at low points.

Caution

During operation, any leaks are usually detected by a small amount of vapor. Leaks should be attended to as soon as possible because under certain circumstances, such as saturated insulation, thermal fluid can ignite when exposed to air and heat.

g) If a fire does occur, extinguish using CO2, foam or dry chemical. DO NOT USE WATER.

h) Selecting a Thermal Fluid

1. The selection of the thermal fluid most suited to your application is very important. Factors to be considered include efficiency, thermal stability, adaptability to various systems, and physical properties, including vapor pressure, freezing point, and flash and fire points.
2. Heat transfer fluids of both mineral and synthetic origin have been specially developed to give thermal stability over a very wide range of temperature. A wide variety of thermal fluids have been used successfully in Fulton Thermal Fluid Heater systems, however, your final selection should be made in conjunction with Fulton Thermal Corporation or the fluid manufacturer.
3. The Fulton coil design heater is a fired heat exchanger and the safe control and monitoring of the thermal fluid temperature is of paramount importance.
4. The safe maximum bulk temperature of the fluid must be strictly adhered to. The safe maximum temperature of the fluid varies, but a typical maximum for many types of mineral oil based fluids is 600°F (320°C).

5. Special care must be taken when consulting fluid manufacturers' literature, as maximum fluid temperatures quoted are the actual limit to which any of the fluids may be subjected. It is important to remember that in any fired heater there exists a "film temperature" which is higher than the temperature of the "bulk" of the fluid.
6. It is the BULK fluid temperature and NOT the FILM temperature that is indicated by the instruments.
7. As a general guide, the following list of fluids that have given satisfactory service over many years is provided.
8. This is by no means a complete list. Any fluid specifically designed for heat transfer use may be considered; multipurpose oils are not acceptable.

a.	AMOCO	Transfer Oil 4199
b.	CHEVRON	Teknifax
c.	DOW	Dowtherm A or G
d.	EXXON	Caloria HT 43
e.	MOBIL	Mobiltherm 603 or 605
f.	MONSANTO	Therminol
g.	MULTITHERM	PG1, IG4, IG1
h.	PARATHERM	Paratherm NF or HE
i.	PETROCANADA	CalFlo, AF, Purity FG, CalFlo LT
j.	SHELL	Thermia 23
k.	TEXACO	Texatherm

9. Any fluid specifically designed for heat transfer use must also exhibit these characteristics:
    a. Be a stable and homogenous liquid to a temperature of at least 100°F over and above the maximum intended temperature of utilization, compatible with metals used in the installation, and tolerating contact with atmospheric air.
    b. The absence of any solid matter in suspension.
    c. Non-toxic in the case of leakage.
    d. Sufficient lubricity, i.e. not likely to cause seizure.
10. The thermal fluid manufacturer must guarantee the characteristics of the product, and verify that the fluid bulk temperature limitation exceeds the expected operating temperature.
11. After a fluid is selected, refer to the manufacturer's recommendations, published in compliance with OSHA.
12. If the fluid expansion volume from 50° F to 600°F exceeds 20% of the initial fluid volume, consult Fulton Thermal Corporation.

Note

Fulton Thermal Corporation cannot be held responsible in the case of accident or damage resulting from the use of inadequate fluid.

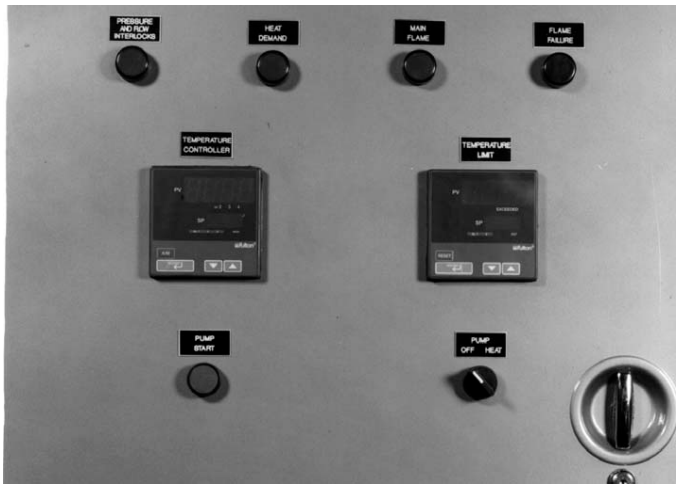
i) Routine Analysis of Heat Transfer Fluid

1. Nearly all leading manufacturers of heat transfer fluids provide an after sales service to monitor the condition of the fluid in operation and make recommendations when replacement becomes necessary.
2. Each fluid manufacturer has procedures for regular testing and analysis of the fluid. These usually allow for a sample to be taken and analyzed at least once a year, although actual frequency will depend on operating temperature, number of hours operated weekly, and the results of tests made during the first weeks of system operation.
3. Fulton Thermal Corporation recommends that the thermal fluid in your system be analyzed within the first two months after start-up.
4. During the first few months of operation, sampling may be carried out at frequent intervals to confirm that system performance has been predicted correctly.
5. If the supplier of your thermal fluid does not contact you within four weeks of commissioning, contact the supplier and make certain that the “fill” is registered for routine analysis.

j) Thermal Fluid Breakdown

1. The possibilities of thermal fluid breakdown are very slim in a typical closed loop thermal fluid system. Fulton’s D/A tank creates a “cold seal” of fluid that is slightly above ambient temperature. This prevents oxidation that will happen when high temperature fluid contacts air.
2. This will also occur when hot thermal fluid contacts air at a leak in the system piping. Oxidized thermal fluid becomes acidic and will damage the thermal fluid system. Thermal fluid breakdown can occur in sections of piping where there is a low flow
   condition. A low flow rate through the heater will result in high film temperatures leading to breakdown of the thermal fluid.
3. Multiple pressure switches and a differential pressure switch are used to prevent this condition from occurring. These safeties must not be bypassed at any time.

4. Exceeding the maximum operating temperature of the thermal fluid will also result in thermal fluid breakdown. Fulton heaters are equipped with a temperature limit switch (located on the front of the panel box) to prevent this from occurring.



Section 3

Section 3 – Operation

1. Start-Up Preparation & Installation Review

a) Check with local authorities where approval for start-up is required. In some localities, final inspection of services may be required.

b) Review the installation section of this manual carefully. Confirm accordance with installation guidelines, including:

1. In general, ensure that the heater area is in conformance with established heater room requirements. Review national and local codes.

2. Preparation

a) Check for total absence of water in pipework and fluid. To help the system, open all drains; blow air nitrogen if available into a high point bleed through a pressure regulating valve.

Note

Unless specially filtered, compressed air will introduce moisture into the system. Dry air or Nitrogen is recommended.

b) Make sure that there are no obstructions left in the thermal fluid circuit from pressure leak testing such as blanking plates in flanged joints.

c) Check that pipework is free to expand naturally when hot. Open all valves to user circuits including air bleed valves at high points and drains at low points in the piping system, and the liquid level test connections in the expansion section of the combination tank.

3. Filling the System

a) The viscosity of thermal fluid is generally very high (500 cS) at ambient temperature. Below 50°F (10°C) some fluids become very thick. Fluid should be in a pumpable liquid form prior to filling the system.

b) Filling must be carried out from the lowest point in the system in order to prevent air pockets from forming.

c) A drain and fill point (generally a 3/4” threaded coupling) is provided on the inlet to the pump suction on skid-mounted units. Typically a portable, high velocity pump, such as the type used for chemical transfer, is appropriate for filling the system. Where only one or two drums of fluid are required, a handheld pump may be practical.

Note

Some plastics can be dissolved by thermal fluid.

Note

Do not use system circulating pump for system filling.

Note

A pump that has been used for water or a different thermal fluid should not be used prior to extensive cleaning. Thermal fluid can be damaged by contact with moisture or other fluids.

Warning

Pressurizing a drum to force fluid into the system is not recommended. The drum can easily explode, creating a hazard to personnel and equipment.

Drain and Fill Connection

d) Filling Procedure

1. Fill the system slowly, closing all opened bleed and drain valves as fluid reaches them.
2. When the fluid reaches and flows from the expansion tank low level manual test connection, begin slowing down the filling process.
3. Close the low level connection and continue to fill until the liquid level switch closes. After fluid appears in the low level connection, only a small amount of additional fluid should be required.
4. If fluid is observed coming from the expansion section high level manual test connection, drain fluid from the tank until the level is between the liquid level switch and the high level connection.
5. Filling is complete when the fluid has reached the lowest level in the expansion tank required to actuate the liquid level switch. Check to see that the liquid level switch operates freely. To confirm operation of the

liquid level switch, manually trip the liquid level switch. Unit should shut down; pump will stop.

4. For Systems Equipped with Inert Blankets

a) Follow the instructions listed under “Filling The System”.
b) Pay close attention to notes and warnings.
c) Inspect the system to be sure all valves are open and all drains are closed.
d) Open all high point air vents.
e) Do not pressurize the system with nitrogen at this point.
f) Inspect the liquid level switch and be sure the switch is functioning properly.
g) Begin filling the system.
h) Fill the system until the liquid level switch indicates there is oil in the expansion tank.
i) Pressurize the system slightly with nitrogen. Leave the high point vent connections open, as the nitrogen should be isolated from the vents by the oil in the system. The pressure required in the system at this point is only 2-3 psi. If too much pressure is applied, the nitrogen will bubble through the oil and vent to atmosphere. If this happens, reduce the pressure.
j) Continue filling the system. If liquid level switch is made, be sure to observe the high point vents as oil is now entering the elevated portion of the pipe work. As oil reaches the vent, close it. After all vents have been closed, and you believe the system to be full, stop filling. Start the circulating pump as described under “Cold Circulation.” Leave the fill equipment connected as cleaning the strainer may create the need for more oil in the system.
k) The final nitrogen pressure is determined by measuring the difference between the D.A. Tank inlet and the highest point in the system. Divide that number by 2.31 (this will indicate the nitrogen pressure the system should be set for). Adjustment can be made via the regulator mounted on top of the D.A. tank.

Note

Tanks are non-code as a standard. Non-code tanks cannot be pressurized over 15psig. Tanks built to ASME code Section VIII Div 1 are available upon request.

5. Circulating Pump

a) Read manufacturer’s instruction manual thoroughly. If the pump is supplied by Fulton Thermal Corporation, manufacturer’s literature is included in this manual.

Note

Do not run the pump before filling it with fluid.

b) The pump should never be run without fluid in the casing. For pumps equipped with mechanical or air-cooled seals, air must be bled out of the stuffing box area to ensure that thermal fluid has lubricated all seal and bearing areas. Operation of the pump even a short time without bleeding first will damage the pump.

c) Also use the thermal fluid as a barrier fluid. Remove the 3/8” plug at the barrier fluid fill port. Fill the cavity with thermal fluid until it comes out of the overflow tube. Replace the 3/8” plug.

d) Mechanical/Air Cooled Seal

1. Open the air bleed connection located directly over the pump shaft. Replace plug when a steady stream of thermal fluid, free of entrained air, flows from the port.
2. If flow has not started after two to five minutes, remove the coupling guard and rotate the pump shaft by hand in the proper direction. This should help move the cold viscous fluid through close tolerance seal areas. Replace plug when flow is steady.
3. If this fails to induce flow, introduce fluid through the bleed port and rotate the shaft by hand to work the fluid around the seal area. Continue to add fluid and rotate the shaft until no more fluid can be added.
4. Replace the plug and run pump for five to ten seconds. Stop the pump, remove the plug and wait for flow to start. If after two minutes flow has not started, add more fluid as described above and run the pump for five minutes.
5. Constantly check the bearing area (located immediately behind the casing) for overheating. Remove the plug and check for flow.
6. If flow has not started at this point, the fluid may be too viscous to move through the seal area. Start the system normally by selecting heat on the control panel, and raise the temperature 50°F. Continue to raise the system temperature by 50°F increments. Keep checking the pump until flow starts.

Caution

1. **Use extreme caution opening plug when system temperature is elevated.**
2. **Wear eye and hand protection.**
3. **Back the plug out slowly to the last two or three threads. Allow any pressure under plug to bleed slowly to prevent a spray of hot oil.**

7. The pump should not be subjected to thermal or pressure shock. The thermal fluid should, therefore, be allowed to flow into the casing slowly.
8. Check field work and make sure that all connections have been made in the proper places. Check electrical connections to the motor.
9. Rotate the pump shaft by hand to be sure there is no binding or rubbing within the pump or driver. Correct any problems immediately.
10. Check to see that pump is properly aligned while cold.
11. The pump is properly aligned before it leaves the factory. Because the system expands in operation, the pump must be realigned when the system is at operating temperature.
12. The coupling alignment of the pump and driver must be carefully checked for angular and axial alignment. Check pump manufacturers instructions for these specifications. The use of a dial indicator to check the axial and angular alignment is recommended.
13. Realign at operating temperature, if necessary.
14. Make sure that the pump is properly greased or oiled.

e) Pumps with Packed Seals

1. Make sure that the gland is finger tight before filling the system.

6. Initial Start-Up

a) These instructions are for use when the unit is being started up for the first time, or after prolonged shutdown. They are to be used in conjunction with the specific procedure information in titled section, “Routine Operation.”

7. Start-Up Service

a) If start-up service has been included in the order, the factory should be contacted after the installation has been successfully completed and approved by the client’s representative or engineers. Where possible, contact the factory at least one week before a Fulton service engineer is required on site.

b) All procedures covered in Operating Instruction sections “Start-Up Preparation” and Filling the System,” including installation review, air testing of piping, pump alignment, and filling the system must be completed before the service person’s arrival.

c) Depending on the size of the system and the amount of service time contracted for, start-up service includes firing the heater, boiling out the system, checking, verifying and adjusting all safety settings.

d) Careful preparation can expedite the commissioning of your heater. Most delays can be avoided by following the instructions in this manual. Failure to complete required procedures properly can result in the need for further service time, at extra cost to the customer.

e) Service people will not commence start-up if there are obvious system deficiencies. However, start-up service in no way constitutes a system design check or approval of the installation.

f) In addition to commissioning the heater, the service person will also familiarize heater room personnel with the operation of all Fulton equipment. Personnel must be qualified to understand the basic operation and function of controls.

8. Cold Circulation

a) Turn on the main power switches.

b) Check for proper fluid level in the expansion section of tank.

c) A centrifugal pump cannot be operated with the discharge valve closed without heating up dangerously.

d) The pump should be started with the suction valve full open and the discharge valve open a slight amount.

e) Check pump rotation. Operating the pump in reverse rotation may cause extensive damage.

f) Turn the three position switch located on the front of the panel box door to “Pump”.

g) Jog the green pump motor starting button and observe the direction of rotation. Rotation should be in the direction of the arrow shown on pump casing.

h) If the rotation direction is incorrect, turn the three position switch back to “Off” immediately. Change the wiring connections and recheck.

i) Check for proper alignment. Realign, at temperature.

j) With the control switch set to “Pump” push and hold the pump start button, check all manual resets on pressuretrols. The circulating pump will run, but the burner will not fire.

k) If the pump stops when the button is released, check for proper flow in the system, and review settings of high and low fluid pressure switches and differential pressure switch. Check liquid level switch.

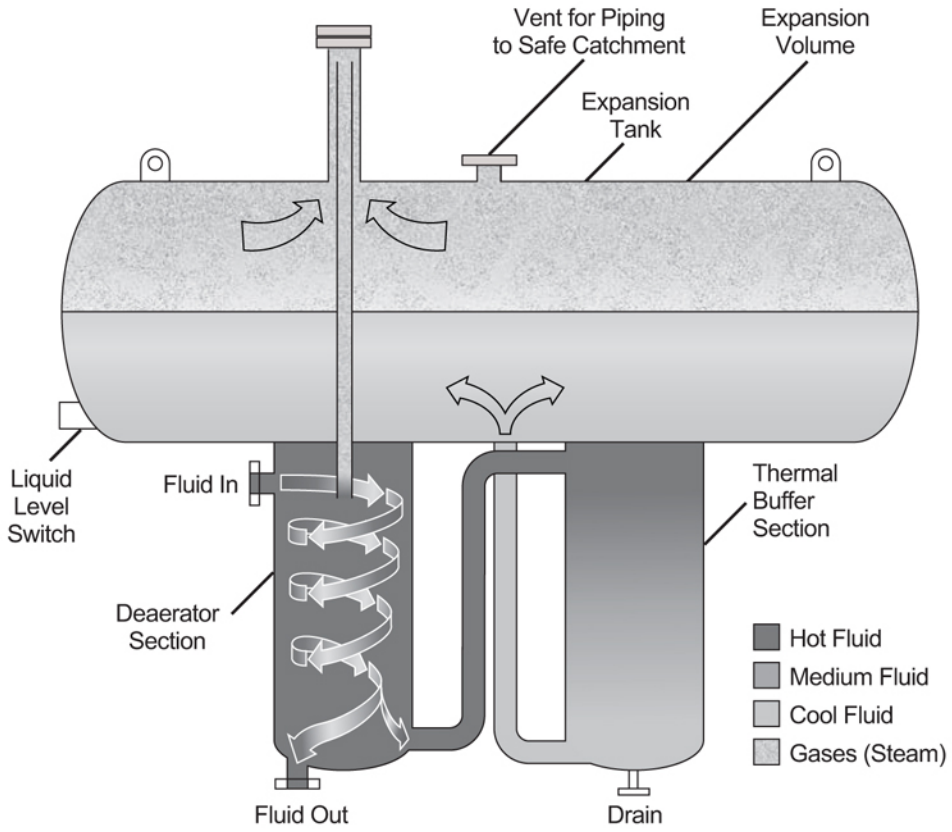
l) Check that all pressure gauge readings remain stable. Pressure exceeding 100 PSIG or identical readings at inlet and outlet gauges indicate a closed valve.

m) If an extremely high vacuum (i.e.15” Hg or more) is indicated on the compound gauge, the valve between the circulating pump and the combination tank may have been left closed. In this case, little or no pressure will be indicated by other gauges.

9. Filtering the System

a) Initially, readings on the compound gauge will indicate zero or slightly positive pressure. During the first few moments of flow, this reading will go towards vacuum, indicating that the strainer is becoming plugged.
b) Typically, a reading of 3” Hg or greater vacuum on the pump suction gauge indicates that the strainer must be cleaned. The strainer screen should be back flushed or pulled, cleaned and replaced.
c) Strainers should be cleaned by means of compressed air. A rag will merely force the smaller particles into the mesh of the strainer. It is recommended to place a lint free rag in the center of the strainer and blow air from the outside, trapping the debris in the rag.
d) Allow the pump to run again for several minutes and repeat the filtering process until pump suction pressure remains steady after cleaning. The amount of time which must be allotted for filtering varies with the system.
e) When the system is initially brought up to temperature, additional pipe scale and welding slag will loosen and enter the fluid stream. This will be trapped in the strainer causing vacuum at the pump suction. This procedure must be followed as necessary in the course of heater operation.

Illustration indicates proper fluid level in the expansion section of the deaerator tank.



10. Energizing the Elements

Pressure Gauges

a) When the system is initially brought up to temperature, additional pipe scale and welding slag will loosen and enter the fluid stream. This will be trapped in the strainer causing vacuum at the pump suction. This procedure must be followed as necessary in the course of heater operation.
b) Check safeties.
c) Place three position switch in Position “2”. Elements will begin to cycle on.
d) Check gauges indicating pump and circuit pressures. Make sure readings remain stable. In case of pressure fluctuations, turn three position switch to Position “1”, elements will cycle off but pump continues to circulate fluid. When pressures have stabilized, switch to Position “2”.
e) Continue in this manner up to the maximum operating temperature. Throughout the initial warm-up, the expansion tank and its overflow pipe must be watched to detect the formation of froth, indicating the presence of water.
f) Water in the fluid can provide the ejection of a certain amount of fluid as soon as a temperature of 212°F (100°C) is reached. If this occurs, a temperature of 212°F must not be exceeded until frothing and fluid ejection have completely ceased.

Note

Flash steam may be generated at any point up to the operating temperature. Watch for gauge fluctuations.

g) Continue bringing unit up to temperature slowly, with a temperature rise not exceeding 100°F (38°C) per hour. Do not exceed specified maximum outlet temperature. In the absence of specific information, consult the factory before proceeding.

h) If no liquid level switch is provided on the expansion tank, open the low level manual test connection regularly while brining the unit up to temperature. If a permanent flow of fluid does not result when this valve is opened, stop the heater and the pump and add more thermal fluid to the system. Use only the exact same brand and type of fluid initially used to fill the system.

i) Once up to temperature, check the fluid level in the expansion section by opening the high level manual test connection. If a permanent flow of fluid results when this valve is opened, and if all previous precautions have been followed, the expansion tank is too small for the capacity of the fluid in the installation. A larger tank must be installed.

j) After fifty hours of operation at operating temperature, check all flanges and connections for tightness.

11. Procedure for First Shutdown

a) The heater system should be shut down after no more than 24 hours of operation at full operating temperature. At this time, the following maintenance items will need to be completed to meet warranty conditions.

b) While pump is still at operating temperature, align circulating pump(s) to pump manufacturer's specifications. This should be done by means of a dial indicator.

c) Isolate Y-strainer(s) in system and clean regardless of pump suction pressure. Make sure that the temperature is low enough to handle safely or provision has been made to handle materials at high temperature. Generally, temperatures below 150°F are acceptable to perform operation with regular work gloves.

d) With piping system cooled to ambient temperature, torque all bolts on skid and throughout system to gasket manufacturer's specifications using proper flange torquing practices such as incremental torque increases, star pattern, etc. Refer to Installation Section.

e) Visually inspect all thread fittings and valve packings. Repair leaks and tighten valve packings to the point of stopping leak.

f) Upon putting unit back into operation, check all gauge readings and compare to values given to you by the start-up technician. Note any discrepancies and contact Fulton.

12. Required Pressure Drop Across the Heater

a) The thermal fluid pressure drop across your heater is critical. This should be recorded at the completion of start-up. The pressure drop value is obtained by subtracting the heater outlet pressure from the heater inlet pressure when the thermal fluid is at normal operating temperature.

b) At the recommended standard flow rates, and .7 sp gr, the pressure drop across the heater should be as shown in the chart on the following page.

c) In the event of an abnormal reading, contact Fulton Service immediately. Failure to take immediate action in the event of reduced fluid flow may result in rapid and serious degradation of the fluid, with possible damage to the heater.

13. Required Flow Through The Heater

a) Maintenance of sufficient flow through the thermal fluid heater and system at all times of operation is critical. See table for recommended standard flow rates.

b) Note pressure gauge readings at start-up. Record readings in a log book and contact Fulton service immediately in the event of abnormal readings. Failure to take action when fluid flow is reduced may result in serious and rapid degradation of the fluid with possible damage to the heater.

Model	Recommended GPM	Differential Pressure (PSI)
FT-0075N	50	7
FT-0150N	50	7
FT-0225N	50	7
FT-0300N	90	10
FT-0375N	90	10
FT-0430N	125	10
FT-0640N	125	10
FT-0860N	150	12
FT-1070N	150	12
FT-1290N	175	12
FT-1500N	200	12
FT-1720N	200	15

14. Operating Controls

a) The following specifications, data, equipment and operating descriptions apply to typical Coil Design units. These sections are provided for general information purposes only, and do not necessarily reflect the specific details of individual systems.

b) Liquid Level Switch-When Combination Tank is Supplied

1. In the event of system fluid loss, the level in the expansion section of the combination tank will drop, and the liquid level switch will shut the unit down. Control power will be lost to the panel.
2. To confirm operation, manually trip the liquid level switch. Unit should shut down; pump will stop.

c) Differential Pressure Switch

1. The heater is dependent on proper flow for operation; therefore, a differential pressure switch is used to sense the pressure drop across the

heater. The differential pressure switch will shut the unit down in the event of loss of flow.

2. The differential pressure switch can be tested while only the pump is running. Remove the metal cover on top of the switch and increase the setpoint until the pump shuts down. Next, decrease the setpoint back to its initial value and depress the pump start button to verify the pump will re-start.

d) Pump Motor Starter

1. While firing, actuate the manual trip button on the pump motor starter. Pump and burner will shut down. The blower should continue to run for approximately thirty seconds. Attempt to restart pump by setting the selector switch to “Pump” and depressing the pump start push button. The pump should not start. Reset starter and start pump.

e) High and Low Fluid Pressure Switches

1. The only pressure required in the thermal fluid system is the pressure required to maintain the proper flow. Pressure changes are monitored with these switches, which will shut the unit down in case of a change in the fluid flow.
2. With three position switch set to “Pump”, remove the cover from the pressure switch and manually activate. Pump should shut down.
3. Repeat for each switch; replace covers. Note, if the burner was on, it would also stop.
4. To set the low fluid pressure cutout switch, raise the setpoint with the fluid at operating temperature and pump running, until the pump shuts down. Note the setpoint and lower by 10 PSI, then re-start pump. The setpoint at cutout should correspond to the reading on the output pressure gauge.
5. With the unit cold and pump running, lower the high fluid pressure cutout switch until the pump shuts down. Note the setpoint and raise by 10 PSI, then re-start pump. The setpoint at cutout should correspond to the inlet gauge reading.

f) Operating Temperature Controls

1. The safe maximum temperature of the fluid must be strictly adhered to.
2. When consulting fluid manufacturer’s literature for the safe maximum fluid temperature, note that the temperatures quoted are the actual limit to which any of the fluids may be subjected. It is important to remember that in any fired heater there exists a “film” temperature which is higher than the temperature of the bulk of the fluid.

3. Temperature controllers measure the bulk temperature and not the film temperature. This must be taken into consideration when setting the temperature controls.
4. These approximate guidelines for temperature settings are not to override the system design parameters.
5. These instructions should be used with information from the system designer. Manufacturer's literature on the temperature controller is provided in the last section of this manual.
6. Standard primary temperature control sensing point location for On/Off and Modulating heaters is on the heater outlet.
7. When optional inlet location of the primary controls is specified. the following instructions may still be used with some modification. For instance when primary controls are located on the inlet, the dead band range will be much narrower than on heaters with outlet control. In addition, temperature changes will not be as immediately apparent.
8. An indicating temperature controller is used to regulate the thermal fluid temperature. Typically the indicating control is a thermocouple.
9. The thermocouple is directly immersed in the thermal fluid in the heater manifold. The setpoint of the controller is regulated by the keypad.

g) High Temperature Limit Switches Safety (All units)

1. All units are fitted with high temperature limit controllers which monitor the fluid temperature at the heater outlet. This limit controller provides over temperature protection. A high temperature limit switch acts as an over temperature safety device. If the high temperature limit shuts down the unit, the manual reset button on the limit switch must be pressed. The red button on the flame programmer must also be pressed to reset the unit before it can be restarted. The high temperature limit controller is factory set to 0°F. This must be set to the lowest of the following:
    a. Maximum operating temperature of the fluid.
    b. Maximum operating temperature of the equipment.
    c. 15°F over maximum system operating temperature.
2. Do not set this controller too close to the normal outlet temperature in order to avoid nuisance lockouts due to small transient over temperatures.
3. Several consecutive lockouts caused by the high temperature limit controller indicate the need for immediate installation review, beginning with fluid level in the expansion tank, firing rate, and circulating pump performance.

h) Operating Limit Controller

1. The limit controller is mounted in the panel box door. This limit controller senses temperature in the outlet manifold. The temperature setpoint in the controller can be adjusted following instructions in the component data sheet section of this manual.

i) Pressure Gauges

1. All units have two pressure gauges measuring the thermal fluid pressure at the inlet of the heater and at the outlet of the heater. The difference between the readings of the two gauges indicates the pressure loss across the heater. The difference must not fall below the recommended value. Recommendations are based on heater size and are listed in Section Two.
2. The gauge indicating the pressure of the fluid at the inlet is labeled “Inlet“. The “Outlet” gauge indicates the pressure at the outlet, and in effect indicates the resistance of the external pipework circuit. The pressure gauge indicating pressure at the inlet of the pump is labeled “Suction .”

j) Flow Proving Device

1. The heater is dependent on proper flow for operation; therefore, three pressure switches and a differential pressure switch are used to sense flow across the heater. Any one of these switches will shut the unit down in the event of loss of flow.

15. Daily Start-Up

a) Check positioning of all system valves to ensure flow is not dead-headed.
b) Visually check relative position of minimum level float switch in the combination tank.
c) Turn on power supply switches.
d) Where applicable, open water cooling valve and check that water flows correctly. (For water cooled pumps only.)
e) Open fuel valves.
f) Set three position switch to “Pump”. Push and hold manual pump start button, monitoring pressure gauges on heater.
g) Push reset on high fluid pressure switch located on the side of the control panel. Release pump start switch. Pump should continue to run.
h) When ready to begin heating, move three position switch from “Pump” to “Heat”. After a short delay resulting from the purge period, the burner will ignite. Make sure that the temperature setpoint is as desired.
i) On gas units, pilot valve activation will be indicated after pre-purge cycle has completed, followed by main flame activation. Check the presence of the flame by observing flame

signal strength from flame programmer or testing device. Operator attendance during warm-up is a recommended precaution.

j) Start-up is considered complete when the unit begins to throttle back or shutdown on target temperature.

16. Daily Shutdown

a) Set control switch to “Pump” pump running, burner off.

b) Allow the fluid to circulate for approximately 20-30 minutes and then set the control switch to the “Off” position.

c) When using fluid cooled pump, continue to circulate cooling water to pumps for 30 minutes after stopping circulation.

d) Open power supply switches.

e) Units switched off by an automatic time switch should have an extra relay fitted to allow 20-30 minutes of fluid circulation after stoppage in order to prevent localized over heating of fluid .

f) Close fuel valves if required. Closing of system valves is not generally necessary unless maintenance of components requires a partial draining of the system.

g) Because of the high temperatures usually applied, leaks are not expected to occur when cool down is achieved, provided pipework is free to contract naturally when cold.

Section 4

Section 4 – Maintenance

Minimum equipment necessary to start and maintain fuel-fired thermal fluid heaters:

- Digital Multimeter

1. Required Maintenance at First Shutdown

a) The thermal fluid system should be shut down after no more than 24 hours of operation at operating temperature. At this time, the following maintenance items will need to be completed to meet the condition of warranty.

b) While pump is still at operating temperature, align circulating pump(s) to pump manufacturer specifications. This should be done by means of a dial indicator.

c) Isolate Y-strainer(s) in system and clean regardless of pump suction pressure. Make sure that the temperature is low enough to handle safely or provision has been made to handle materials at high temperature. Generally, temperatures below 150°F are acceptable to perform operation with regular work gloves.

d) With piping system at ambient temperature, torque all bolts on skid and throughout system to gasket manufacturer specification using proper flange torquing practices (incremental torque increases, star-pattern, etc). These values are available in the installation section of the manual..

e) Visually inspect all thread fittings and valve packings. Repair leaks and tighten valve packings to the point of stopping leak.

f) Upon putting unit back in operation, check all gauge readings and compare to values given to you by the start up technician. Note any discrepancies and contact manufacturer.

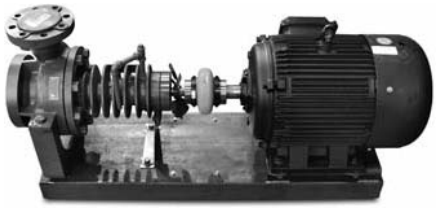
2. General Maintenance Schedule

Daily

a) Complete the log sheet attached at the end of this section at least once per day as a minimum. It is recommended that the log sheet be filled out twice per shift of operation. The log sheet is available from the Fulton Service Department or www.fulton.com

b) Make visual inspection of the entire system for leaks. Make repairs as soon as possible.

c) In systems utilizing a water cooled thermal fluid circulating pump, check level of lubricating oil in self-leveling reservoir and check cooling water circulation loop for proper operation.



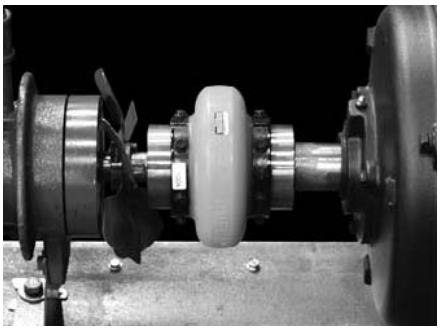
Monthly

a) Manually check fluid level in the expansion tank. Drain ½ gallon of thermal fluid from the expansion tank. If water is present, continue to drain ½ gallon until no water is present.

b) Check operation of all safeties. Refer to the instructions at the end of this section.

c) Review daily log sheets noting any deviations from the norm.

d) Check the tightness of all couplings, including the fuel oil pump drive (oil-fired units), fan impeller, circulating pump, etc.

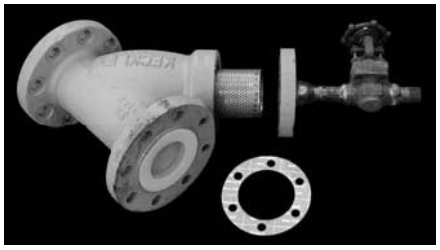


Semi-Annually

a) Review daily log sheets noting any deviations from the norm.

Annually

a) Clean all strainers in the thermal fluid system.



b) Take a one quart sample of thermal fluid and return to the thermal fluid manufacturer for analysis.

c) Schedule to local Fulton representative or factory service technician to perform an annual preventative maintenance.

3. Maintenance Procedures

Lubrication

a) Different motor manufacturers recommend various intervals for lubrication schedules. Load variations will dictate the frequency and amount of lubrication required.

b) When developing your lubrication schedule, consider the thermal fluid pump and all system pumps.

c) If you have a thermal fluid circulating pump with a packed seal, the condition of the pump packing should be checked regularly. If fluid leakage increases, tighten the packing ¼ turn daily.

4. Safety Check Procedures

Liquid Level Switch

a) Manually turn liquid level switch cam counterclockwise. Micro-switch will open contacts and control voltage will be lost. Release cam and micro-switch will make and control voltage will be restored.

Differential Pressure Switch

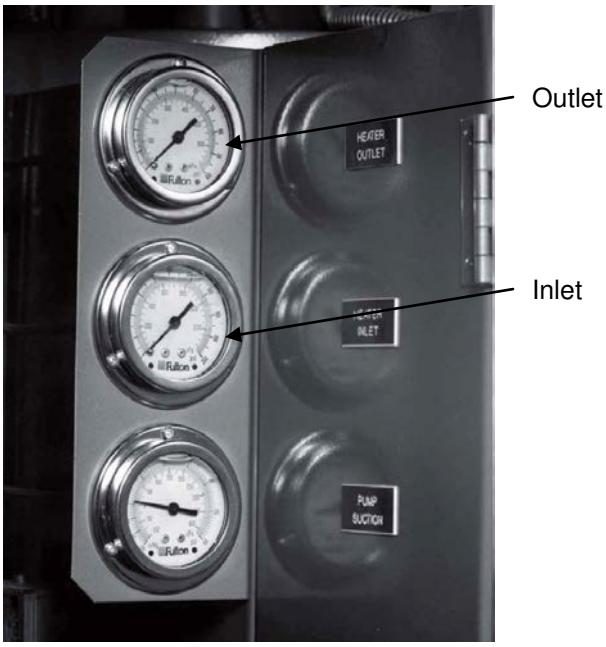
a) With the circulating pump running, observe the difference in pressure between the heater outlet gauge and the heater inlet gauge. Remove the top cover of the differential pressure switch. Note the original setting of the switch and turn adjustment knob clockwise until switch trips. The pointer on the switch should be within 2 psi of the observed pressure difference. Reset switch to the original set point.

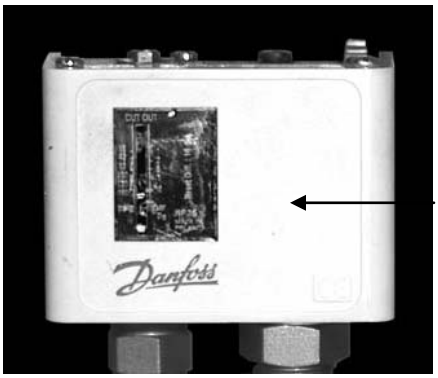
Low Inlet Pressure Switch

a) Slowly close the valve on outlet of main circulating pump observing heater inlet pressure gauge. Note the pressure at which the switch trips. This pressure should be roughly the set point of the switch minus any differential that is set.

High Outlet Pressure Switch

a) Note the original setting of the switch and turn adjustment screw counterclockwise while observing heater outlet pressure gauge until switch trips. The pointer on the switch should be within 2 psi of the observed pressure. Reset switch to the original set point.





High Outlet
Pressure Switch

Temperature Limit(s)

a) Adjust set point(s) of temperature limit(s) down to a point lower than the PV (process variable is typically the current fluid temperature at the heater outlet). Solid-state controls will deactivate a control relay powering a set of n.c. contacts in the interlock circuit. Analog controls will open their contacts in the interlock circuit. Trip temperature should be within 5 degrees of PV temperature. Reset temperature limit if reset exists and reset flame programmer.

5. Recommended Maintenance Schedule (See log sheet)

Daily

a) Complete log-sheet at least once per day. Twice per shift of operation is recommended. (Log sheet is available from the Fulton Service Department or on the web at www.fulton.com)

b) Make visual inspection of entire system for leaks. Repair as soon as possible.

Monthly

a) Manually check fluid level in expansion tank.

b) Check operation of all safeties. Contact Fulton service department for instructions.

c) Review log sheets and note any deviations from the norm.

d) Drain ½ gal. of oil from thermal buffer section of DA tank.

Semi-Annually

a) Review log sheets and note any deviations from the norm.

Annually

a) Clean all the strainers in the thermal fluid system.
b) Take a quart sample of thermal fluid and have it analyzed per fluid manufacturers instructions.
c) Schedule the local representative or factory technician to perform preventative maintenance on the system.

Note

All of the above maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Fulton Service Department at (315) 298-7148 or your local Fulton Thermal Representative.

6. Troubleshooting

Flow Circuit/Circulating Pump(s)

a) The flow circuit is the electrical circuit that enables the circulating pump(s). Your thermal fluid pump(s) will remain on until the flow circuit opens to disable the pump starter or the Off / Pump / Heat switch is turned to the "Off" position.
b) Items in the flow circuit may include paddle type flow switches, a high inlet pressure switch, a low inlet pressure switch, a high outlet pressure switch and a differential pressure switch.
c) Low Inlet Pressure Switch
    1. All N-Model heaters have a Low Inlet Pressure Switch. This is a normally open switch that closes with proper heater inlet pressure. This switch is generally a mercury bulb type switch. Mercury will rest towards the green cap of the mercury bulb in a "made" condition.
    2. The purpose of the Low Inlet Pressure Switch is primarily to protect the heater from a low flow condition. The Low Inlet Pressure Switch should be set at 5 psi below normal heater inlet pressure as read at operating temperature assuming that none of the conditions mentioned below are true. A tripped Low Inlet Pressure Switch is an indication of one of the following.
    3. If your Low Inlet Pressure Switch is not making, check the following items:

d) Plugged circulation pump strainer basket
    1. A plugged strainer will result in a decrease of flow through the heater. High vacuums developed from plugged strainers can also stress the seals of the pump causing the pump to fail.

2. A "Pump Suction" gauge is provided on Fulton Thermal skids to help determine when a strainer needs cleaning. Generally this point is between 0 and -5" Hg.
3. If the strainer is plugged, isolate the strainer and drain that section of piping being mindful of the temperature of the thermal fluid.
4. Remove the strainer and clean with compressed air, high-pressure water or a cleaning solution. Replace and observe new pump suction pressure.

e) *Failed circulation pump coupling*

1. A failed coupling will result in a decreased or no flow condition through the heater. The coupling can be checked by removing the coupling guard between the pump and pump motor.
2. The coupling should not be torn or misshapen. If the coupling needs to be replaced, it is recommended to re-align the circulating pump first at ambient temperature and again when it's at operating temperature. Alignment should be within pump manufacturers' specifications.

f) *Cavitation of the circulating pump*

1. Cavitation occurs when a pump experiences a loss of head or if any low heater flashes to gas at the impeller. During this time, the pump impeller spins without actually circulating any thermal fluid.
2. If Fulton Thermal Corporation provided the heater skid, loss of head to the pump is extremely unlikely with proper fluid level in the combination tank.
3. The most common low heater in a thermal piping system is water, which needs to be boiled out at startup or anytime new piping or fluid is added to the thermal oil system.
4. Once the system has been brought up to full operating temperature, assuming that the entire system has seen flow, there should be no further occurrence of low heater contamination apart from possible heat exchanger failure.

g) *System is Open*

1. Lack of back-pressure. If control valving is improper or pressure drop across the system is too low, the resulting minimal back-pressure may not provide enough resistance for the flow to make the pressure switch. Check the thermal fluid system for proper operation of control valves.

h) *Blocked sensing line on pressure switch*

1. A blocked sensing line will give an inaccurate pressure reading to the pressure switch. A blocked line will need to be replaced or cleaned. Most

installations have block valves at the heater to facilitate safe isolation and cleaning of the sensing line.

i) Improper switch setting

1. The Low Inlet Pressure Switch should be set at 5 psi less than the pressure read on the heater inlet pressure gauge at full operating temperature of the system.

j) Faulty Switch

1. If pressure is verified and reads correctly above set point on switch and the sensing line to the pressure switch is open, the pressure switch is faulty. Replace switch, set for desired set point and test for proper operation.

k) High Outlet Pressure Switch

1. All N-Model heaters have a High Outlet Pressure Switch. This is a normally closed switch that opens with excessive heater outlet pressure.
2. The purpose of the High Outlet Pressure Switch is primarily to protect the heater from building too much pressure. Typical coil model heaters have a maximum working pressure of 150 psi with 100 psi safety valve(s) on the heater outlet manifold.
3. The High Outlet Pressure Switch should be set at 5 psi over the heater outlet pressure as read at ambient temperature assuming that none of the conditions mentioned below are true.
4. A tripped High Outlet Pressure Switch is an indication of one of the following and will require the manual reset button on the switch to be pushed:

l) An obstruction downstream of the heater

1. Any obstruction downstream of the heater will increase the pressure that the heater outlet sees. This obstruction will generally result from an improper valve setting.
2. Observe heater outlet pressure at temperature with all users / heat exchangers calling for heat (100% user). Observe heater outlet pressure at temperature with all users / heat exchangers not calling for heat (100% bypass). Bypass regulating valve(s) should be adjusted to equal flow condition through users.
3. Call or e-mail Fulton for further details. It may be possible that an automatic control valve has failed. If this is the case, the valve actuator should be inspected and possibly replaced.

m) Improper switch setting

1. The High Outlet Pressure Switch should be set at 5 psi over than the maximum pressure read on the heater outlet pressure gauge during proper operation at the coldest ambient temperature expected.

n) Faulty Switch

1. If pressure is verified and reads correctly below set point on switch and the sensing line to the pressure switch is open, the pressure switch is faulty. Replace switch, set for desired set point and test for proper operation.

o) Flow Switches

1. Units older than mid-1993 have Flow Switches on the inlet of the heater. These are normally open switches that close, making a micro-switch, upon flow establishment.
2. The purpose of the Flow Switch(es) is to protect the heater from too high of a temperature and to protect the thermal fluid from exceeding its maximum film temperature.

Flow Switches Not Making

a) An obstruction downstream of the Flow Switch(es)

1. Any obstruction downstream of the flow switch(es) will increase the pressure that the heater outlet sees. Any increase in outlet pressure will result in diminished flow. This obstruction will generally result from an improper valve setting.
2. Observe heater outlet pressure at temperature with all users / heat exchangers calling for heat (100% user). Observe heater outlet pressure at temperature with all users / heat exchangers not calling for heat (100% bypass).
3. Bypass regulating valve(s) should be adjusted to equal flow condition through users. Call or e-mail Fulton for further details.
4. It may be possible that an automatic control valve has failed. If this is the case, the valve should be replaced.

b) Plugged circulation pump strainer basket

1. A plugged strainer will result in a decrease in flow through the heater. High vacuums developed from plugged strainers can also stress the seals of the pump causing the pump to fail.
2. A "Pump Suction" gauge is provided on Fulton Thermal skids to help determine when a strainer needs cleaning. Generally this point is -2 psi (5 in. Hg).
3. If the strainer is plugged, isolate the strainer and drain being mindful of the temperature of the thermal fluid. Remove the strainer and clean with

compressed air, high-pressure water or a cleaning solution. Replace and observe new heater inlet pressure.

c) *Failed circulation pump coupling*

1. A failed coupling will result in a decreased or no flow condition through the heater. The coupling can be checked by removing the coupling guard between the pump and pump motor. The coupling should not be torn or misshapen. If the coupling needs to be replaced, it will be necessary to re-align the circulating pump first at ambient temperature and again when it's at operating temperature.

d) *Cavitation of the circulating pump*

1. Cavitation occurs when a partial vacuum presents itself at the eye of the pump impeller due to loss of head or if any low heater flashes to gas at the impeller.
2. During this time, the pump impeller spins without actually circulating any thermal fluid. If Fulton Thermal Corporation provided the heater skid, loss of head to the pump is extremely unlikely with proper fluid level in the tank.
3. The most common low heater in a thermal piping system is water, which needs to be boiled out at startup.
4. Once the system has been brought up to full operating temperature, assuming that the entire system has seen flow, there should be no further occurrence of low heater contamination apart from heat exchanger failure.

e) *High inlet pressure switch*

1. Units newer than mid-1993 have a High Inlet Pressure Switch. This is a normally closed switch that opens with improper heater inlet pressure.
2. The purpose of the High Inlet Pressure Switch is to protect the heater from building too high of a pressure.
3. Typical electric heaters have a maximum working pressure of 150 psi with 100 psi safety valve(s) on the heater outlet manifold. The High Outlet Pressure Switch should be set at 5 psi over the heater outlet pressure as read at ambient temperature assuming that none of the conditions mentioned below are true.

Tripped High Outlet Pressure Switch

a) *An obstruction downstream of the heater*

1. Any obstruction downstream of the heater will increase the pressure that the heater outlet sees. This obstruction will generally result from an improper valve setting.

2. Observe heater outlet pressure at temperature with all users / heat exchangers calling for heat (100% user). Observe heater outlet pressure at temperature with all users / heat exchangers not calling for heat (100% bypass).
3. Bypass regulating valve(s) should be adjusted to equal flow condition through users. Call or e-mail Fulton for further details.
4. It may be possible that an automatic control valve has failed. If this is the case, the valve should be replaced.

b) Improper switch setting

1. The High Inlet Pressure Switch should be set at ambient temperature. The setting should be 5 psi over than the maximum pressure read on the heater outlet pressure gauge during proper operation.

c) Differential Pressure Switch

1. Units newer than mid-1993 have a Differential Pressure Switch. This is a normally open diaphragm switch that closes with a proper heater differential pressure between the heater inlet and outlet.
2. The purpose of the Differential Pressure Switch is to protect the heater coil from too high of a temperature and to protect the thermal fluid from exceeding its maximum film temperature. Each heater model number has a specific minimum differential pressure.
3. See Section 1 if you do not know this pressure. This pressure is the difference in pressure between the heater inlet pressure gauge and the heater outlet pressure gauge.

Differential Pressure Switch Break

a) An obstruction downstream of the heater outlet

1. Any obstruction downstream of the flow switch(es) will increase the pressure that the heater outlet sees. Any increase in outlet pressure will result in diminished flow. This obstruction will generally result from an improper valve setting.
2. Observe heater outlet pressure at temperature with all users / heat exchangers calling for heat (100% user). Observe heater outlet pressure at temperature with all users / heat exchangers not calling for heat (100% bypass).
3. Bypass regulating valve(s) should be adjusted to equal flow condition through users. Call or e-mail Fulton for further details.
4. It may be possible that an automatic control valve has failed. If this is the case, the valve should be replaced.

b) *Plugged circulation pump strainer basket*

1. A plugged strainer will result in a decrease in flow through the heater. High vacuums developed from plugged strainers can also stress the seals of the pump causing the pump to fail.
2. A "Pump Suction" gauge is provided on Fulton Thermal skids to help determine when a strainer needs cleaning. Generally this point is 5-10 psi (10-20 in. Hg).
3. If the strainer is plugged, isolate the strainer and drain being mindful of the temperature of the thermal fluid. Remove the strainer and clean with compressed air, high-pressure water or a cleaning solution. Replace and observe new heater inlet pressure.

c) *Failed circulation pump coupling*

1. A failed coupling will result in a decreased or no flow condition through the heater. The coupling can be checked by removing the coupling guard between the pump and pump motor. The coupling should not be torn or misshapen. If the coupling needs to be replaced, it will be necessary to re-align the circulating pump first at ambient temperature and again when it's at operating temperature.

d) *Cavitation of the circulating pump*

1. Cavitation occurs when a partial vacuum presents itself at the eye of the pump impeller due to loss of head or if any low heater flashes to gas at the impeller. During this time, the pump impeller spins without actually circulating any thermal fluid.
2. If Fulton Thermal Corporation provided the heater skid, loss of head to the pump is extremely unlikely with proper fluid level in the tank. The most common low heater in a thermal piping system is water, which needs to be boiled out at startup.
3. Once the system has been brought up to full operating temperature, assuming that the entire system has seen flow, there should be no further occurrence of low heater contamination apart from heat exchanger failure.

e) *Improper switch setting*

1. The Differential Pressure Switch should be set at operating temperature. The setting should be 2 psi below the minimum differential pressure for that particular heater model number. If the minimum required pressure is not known, compare model of heater to chart on page 1-x of this manual.

Call For Heat

a) The call for heat circuit is the circuit that enables burner operation. Fulton Thermal Corporation has used a variety of Temperature Controllers to act as the Call for Heat.

b) Generally these controls work in combination with a control relay. When the Temperature Controller calls for heat, a signal is sent to the coil of a control relay that closes a normally open set of contacts in series with the burner circuit.

c) When the call for heat is met, the signal is removed and the contacts return to their open state. Situations that may interfere with the Call for Heat circuit include the following:

    1. Programming problem
        a. Fulton has a general program for each of the temperature controllers we have used over the years. Compare your current temperature controller program to Fulton's general program.
        b. See the back of this section for general programming sheets for standard Fulton heaters.
        c. Make changes as necessary. Contact Fulton service department with any questions.
    2. Temperature controller failure
        a. If the temperature controller is calling for heat but is not putting power on the output to the control relay, the relay will not close the normally open contacts and the heater will remain disabled. If this is the case, some controllers have separate sets of contacts that may be utilized in replacement of the damaged contacts. Some rewiring and/or reprogramming will be needed. Contact Fulton service department if necessary.
    3. Temperature sensor failure
        a. Different temperature controllers use different types of temperature sensors. These may be Type J thermocouples, mercury bulbs, RTDs or another type of sensor. It is possible for these sensors to malfunction. To verify proper sensor operation, use an alternate source of temperature detection such as an infra-red temperature sensor to sense temperature at the same point.
    4. Control relay may have failed
        a. Many temperature controllers energize a relay with a call for heat that in turn closes a normally open set of contacts to energize the burner circuit.
        b. If your temperature controller is sending an output signal to the control relay but the burner does is not initiated, check resistance across coil of the relay. An open reading indicates that the relay

needs to be replaced.

If the coil shows resistance, energize coil and check contacts. With coil energized, normally open contacts should close resulting in a reading of control voltage on both the common and normally open contact.

c. If voltage exists on common but not on normally open contact either switch contacts if another set of normally open contacts are available or replace relay.

Safety Interlock

a) High temperature limit

1. All thermal fluid heaters have at least one High Temperature Limit. The high temperature limit(s) is/are normally closed switch(es) that break on a temperature rise over set point.
2. The switch may be either a solid state controller or a bulb and capillary type switch. The High Temperature Limit is a safety device that protects the thermal fluid and heat transfer coil from excessively high temperatures.
3. Solid-state high temperature limits will have a manual reset. Bulb and capillary type limits will not have a manual reset. If this/these switch(es) trips, it is generally one of the following issues.

b) Flow rate is too low

1. Too low of a flow rate will result in a higher rate of heat transfer to the thermal fluid and heat transfer coils. This will result in a higher temperature difference between inlet temperature and outlet temperature.
2. It is important to make sure that the minimum flow rate as specified by Fulton for that specific model is maintained.
3. Check inlet and outlet pressures of the heater to determine differential pressure and flow rate. Ensure that this flow rate meets or exceeds minimums specified by Fulton (see chart). Also check differential pressure switch for proper operation and setting.

7. Fulton Thermal Fluid Heater Log Sheet

Fulton Thermal Fluid Heater Log Sheet

Date	Time	Pump Status	Heater Status	Heater Inlet Pressure	Heater Outlet Pressure	Differential Pressure	Pump Suction Pressure	Setpoint Temperature	Current Temperature	Nitrogen Level	Pilot Flame Signal	Run Flame Signal	Stack Temperature
Date	*Time*	*On or Off*	*On or Off*	*psi*	*psi*	*or greater*	*psi*	*F*	*F*	*psi*			

Section 5

Section 5 – Parts & Warranty

Part Number	Description	Approx. lbs.	Weight kgs.	Lead Time
CONTROLS				
Differential/Flow Switches				
2-30-000454	UE H105K14727 Differential Pressure Switch	4.0	1.82	Stock
2-30-000448	UE H105K456 Differential Pressure Switch-2-20-psi	4.0	1.82	Stock
2-30-000453	1/4” Needle Valve (block valve)	1.0	0.46	Stock
2-35-000330	Swedgelock-straight	0.025		Stock
2-35-000329	Swedgelock-90deg.	0.025		Stock
2-35-000526	Steel Tubing Union			
2-10-000211	1/4 OD Steel Tubing			
2-30-000813	Flow Switch “O” Ring-Shaft	0.001	0.0	Stock
2-30-000814	Flow Switch “O” Ring-Casing	0.001	0.0	Stock
Pressure Switches & Transducers				
2-40-003040	Danfoss Pressure Switch w/manual reset 150psi			
2-40-003041	Danfoss Pressure Switch w/auto reset 6-50psi			
2-40-000662	6NNK54FIA SOR Pressuretrol-NEMA 4	1.62	0.73	Stock
2-40-000661	6R3-D5 SOR Pressuretrol-M/R-NEMA 4	2.1	0.95	Stock
2-40-000999	Pressure Transducer -0-100psi			Stock
2-40-000994	Pressure Transducer -0-200psi			Stock
2-40-000998	Pressure Transducer -0-15psi			Stock
Temperature Controls/Limits/Thermocouples				
2-40-000861	UT 350 Yokogawa	1.2	0.55	Stock
2-40-000862	UT 350L Yokogawa	1.16	0.55	Stock
2-40-000867	UT 550-04(RSP) Yokogawa	1.16	0.55	Stock
2-30-000900	Yokogawa Window Kit-NEMA 4			Stock
2-40-000909	FUJI PYZ4-RAY-1-4V	0.5	0.23	Stock
2-40-000311	EZ Relay			Stock
2-40-000816	UE E54 Temp. Limit- A,N models	1.66	0.75	Stock
2-40-000631	Watlow Temp. Control 146E1602	3.0	1.37	Stock
2-40-000800	2 X 8 Thermocouple -FT-0080C	0.16	0.07	Stock
2-40-000801	4 X 12 Thermocouple N & A models	0.2	0.09	Stock
2-40-000802	2 X 12 Thermocouple - C models	0.2	0.09	Stock
2-40-000802	1/2” NPT Spring Loaded Thermocouple			Stock
2-40-000830	Thermocouple Wire	0.2/ft.	0.1/ft.	Stock
2-40-000798	Thermocouple Splice Kit	0.1	0.05	Stock
2-40-000799	Thermocouple Splice Kit	0.1	0.05	Stock
2-40-001000	6” Probe 150-750°F Adj. Thermometer			

Deaerator Tank Parts				
2-30-000551	Liquid Level HG34	4.3	1.95	Stock
2-30-000552	NEMA 4 Liquid Level HW34	10.32	4.69	Stock
2-30-000553	Explosion Proof HR34	10.36	4.71	Stock
2-40-000730	Liquid Level Switch L4 High & Explosion Proof	4.22	1.92	Stock
2-30-000554	Magnetrol Level Switch			
4-30-000200	2-Way Nitrogen Kit (SV not included)			2 Weeks
2-30-000138	Fairchild N2 Reg-#66162-2-150#	2.94	1.34	Stock
2-30-000869	3/4" Gate Valve - Fill			
2-30-000214	3/4" 15# Series 19 V-Stamped brass Safety Valve	2	0.9	Stock
2-30-000215	1" 15# Series 19 V-Stamped brass Safety Valve	4.3	1.95	Stock
2-30-000216	1-1/4" 15# Series 19 V-Stamped brass Safety Valve	6.75	3.1	Stock
2-30-000016	1-1/2" 15# Series 19 V-Stamped brass Safety Valve	12.4	5.63	Stock
2-30-000217	2" 15# Series 19 V-Stamped brass Safety Valve	14.85	6.75	Stock
Electric Heater Parts-"N" Model				
2-40-000910	Main Frame for Athena Sequencer	2.2	1.0	Stock
2-40-000911	Step Card (White)	0.1	0.05	Stock
2-40-000912	Step Delay (Yellow)	0.1	0.05	Stock
2-40-000913	Signal Card (Green)	0.1	0.05	Stock
2-40-000914	Starter Card (Black)	0.1	0.05	Stock
2-40-000105	Honeywell 5-Step Sequencer	10.2	4.64	Stock
2-40-000107	Honeywell 10-Step Sequencer	11.0	5.0	Stock
2-40-000904	120V/240V 10 Step Solitec Sequencer Note: above replaces 5 Step Solitec Sequencer 120V/240V	1.82	0.83	Stock
2-40-000025	600V 60Amp Contactor-120V	2.5	1.14	Stock
2-40-000024	300V 60Amp Contactor-120V	2.3	1.05	Stock
2-40-000022	600V 60Amp Contactor-220V	2.5	1.14	Stock
2-40-000852	21KW 230V Element-nema 4&7	15.14	6.88	2-4 Weeks
2-40-000850	21KW 380V Element-nema 4&7	15.14	6.88	2-4 Weeks
2-40-000847	21KW415V Element-nema 4&7	15.14	6.88	2-4 Weeks
2-40-000851	21KW 460V Element-nema 4&7	15.14	6.88	2-4 Weeks
2-40-000848	21KW 575V Element-nema 4&7	15.14	6.88	2-4 Weeks
2-40-000854	11KW 208V Element-nema 4&7	11.0	5.0	2-4 Weeks
2-40-000845	11KW 230V Element-nema 4&7	11.0	5.0	2-4 Weeks
2-40-000846	11KW 380V Element-nema 4&7	11.0	5.0	2-4 Weeks
2-40-000853	11KW 460V Element-nema 4&7	11.0	5.0	2-4 Weeks
2-40-000849	11KW 575V Element-nema 4&7	11.0	5.0	2-4 Weeks
2-12-000068	Element Gaskets -11KW	0.04	0.01	1 Week
2-12-000069	Element Gaskets -21KW	0.04	0.01	1 Week
2-22-000173	2-1/2" Element Bolt-all thread	0.04	0.01	Stock
2-35-000348	Nut 5/16"	0.04	0.01	Stock

2-22-000046	Lockwasher-5/16”	0.03	0.01	Stock
Fuses				
2-45-000368	KTKR2 Amp			Stock
2-45-000366	KTKR4 Amp			Stock
2-45-000367	KTKR5 Amp			Stock
2-45-000365	KTKR8 Amp			Stock
2-45-000380	KTKR10 Amp			Stock
2-45-000465	KTKR12 Amp			Stock
2-45-000466	KTKR15 Amp			Stock
2-45-000464	KTKR20 Amp			Stock
2-45-000268	KTKR25 Amp			Stock
2-45-000249	KTKR30 Amp			Stock
2-45-000152	JKS30 Amp			Stock
2-45-000010	JKS35 Amp			Stock
2-45-000011	JKS40 Amp			Stock
2-45-000012	JKS50 Amp			Stock
2-45-000013	JKS60 Amp			Stock
2-45-000214	LPJ 1-6/10 Amp			Stock
2-45-000151	LPJ 2 Amp			Stock
2-45-000360	LPJ 3 Amp			Stock
2-45-000361	LPJ 4 Amp			Stock
2-45-000250	LPJ 5 Amp			Stock
2-45-000363	LPJ 7 Amp			Stock
2-45-000267	LPJ 10 Amp			Stock
2-45-000266	LPJ 15 Amp			Stock
2-45-000265	LPJ 20 Amp			Stock
2-45-000278	LPJ 25 Amp			Stock
2-45-000264	LPJ 30 Amp			Stock
2-45-000263	LPJ 35 Amp			Stock
2-45-000262	LPJ 40 Amp			Stock
2-45-000261	LPJ 50 Amp			Stock
2-45-000260	LPJ 60 Amp			Stock
2-45-000382	LPJ 70 Amp			Stock
2-45-000343	LPJ 80 Amp			Stock
2-45-000374	LPJ 100 Amp			Stock
2-45-000270	LPJ 125 Amp			Stock
2-45-000270	LPJ 150 Amp			Stock
2-45-001000	FNQ2 Amp			Stock
2-45-000381	FNQ3 Amp			Stock
2-45-000998	FNQ4 Amp			Stock
2-45-000995	FNQ5 Amp			Stock
2-45-000272	200 Amp Fuse Block			Stock

2-45-000244	Fuse Block J600-603C			Stock
2-45-000344	Fuse Block J60100-3CR			Stock
2-45-000006	SC-40 Fuse (240V)	0.1	0.05	Stock
2-45-000007	SC-50 Fuse (240V)	0.1	0.05	Stock
2-45-000008	SC-60 Fuse (240V)	0.1	0.05	Stock
2-45-000276	16 Amp Disconnect			Stock
2-45-001050	25 Amp Disconnect			Stock
2-45-001051	40 Amp Disconnect			Stock
2-45-001052	60 Amp Disconnect			Stock
Gaskets & Material				
2-60-000114	Silicone Sealant - red - 10 oz.	0.82	0.37	Stock
2-60-000111	Silicone Sealant - clear - 10 oz.	0.82	0.37	Stock
2-12-000010	Anti-Seize #76764	1.0	0.5	Stock
2-60-000007	Turbo 50 -4oz	0.4	0.16	Stock
2-12-000052	Graphoil Packing	0.5	0.23	Stock
2-12-000060	Kast-o-lite 30 55# per bag (by the pound)	55.0	25.0	Stock
2-12-000210	1/4” Rope Gasket			Stock
2-12-000051	1/4” Rope Gasket			Stock
2-12-000003	1/2” Rope Gasket			Stock
2-12-000049	1” Thermal Bar Gasket-for burner plate			Stock
2-12-000150	Dresser Plate Gasket Material-Omni light			Stock
2-12-000140	Omnilight 8” OD Gasket			Stock
2-12-000141	Omnilight 10” OD Gasket			Stock
2-12-000142	Omnilight 12” OD Gasket			Stock
2-12-000143	Omnilight 4”x9” Gasket			Stock
2-12-000144	Omnilight 4”x14” Gasket			Stock
2-12-000145	Omnilight 6”x12” Gasket			Stock
Elastagraph ring gaskets for flanges				
2-12-000400	1/2” 150# Gasket	0.5	0.22	Stock
2-12-000402	3/4” 150# Gasket	0.8	0.44	Stock
2-12-000404	1” 150# Gasket	0.1	0.05	Stock
2-12-000406	1-1/4” 150# Gasket	0.1	0.05	Stock
2-12-000408	1-1/2” 150# Gasket	0.12	0.05	Stock
2-12-000410	2” 150# Gasket	0.18	0.08	Stock
2-12-000412	2-1/2” 150# Gasket	0.22	0.1	Stock
2-12-000414	3” 150# Gasket	0.14	0.06	Stock
2-12-000416	4” 150# Gasket	0.32	0.15	Stock
2-12-000418	5” 150# Gasket	0.4	0.18	Stock
2-12-000420	6” 150# Gasket	0.42	0.19	Stock
2-12-000422	8” 150# Gasket	0.45	0.2	Stock
2-12-000401	1/2” 300# Gasket	0.08	0.4	Stock

2-12-000403	3/4” 300# Gasket	0.1	0.05	Stock
2-12-000405	1” 300# Gasket	0.12	0.05	Stock
2-12-000407	1-1/4” 300# Gasket	0.14	0.06	Stock
2-12-000409	1-1/2” 300# Gasket	0.18	0.08	Stock
2-12-000411	2” 300# Gasket	0.18	0.08	Stock
2-12-000413	2-1/2” 300# Gasket	0.26	0.12	Stock
2-12-000415	3” 300# Gasket	0.3	0.14	Stock
2-12-000417	4” 300# Gasket	0.44	0.2	Stock
2-12-000419	5” 300# Gasket	0.54	0.25	Stock
2-12-000421	6” 300# Gasket	0.6	0.27	Stock
2-12-000423	8” 300# Gasket	0.65	0.3	Stock
Ignition Transformer				
2-40-000082	6kv 120V/60hz Ignition Transformer	8.62	3.92	Stock
2-40-000084	6kv 110V/50hz Ignition Transformer	8.62	3.92	Stock
2-40-000086	10kv 120V/60hz Ignition Transformer	8.62	3.92	Stock
2-40-000088	10kv 110V/50hz Ignition Transformer	8.62	3.92	Stock
Lights/Switches/Buttons/Relays				
2-40-000131	General Purpose Relay (Ice Cube)700HA32A1 120V-AB	0.8		Stock
2-40-000135	General Purpose Relay (Ice Cube)700HA32A2 220V-AB	0.8		Stock
2-40-000096	Base for Ice Cube Relay	0.1		Stock
2-40-000843	4 Pole Relay 120V-AB			
2-40-000842	4 Pole Relay Bast			
2-40-000993	PS5-RA24 Power Supply	0.4	0.2	Stock
2-45-000050	PS5-RA24 Power Supply	0.34	0.15	Stock
2-45-000091	SPST Switch- mod lock	0.05	0.02	Stock
2-45-000212	3 Position Switch- SqD	0.14	0.06	Stock
2-45-000300	NO Contacts for switch	0.04	0.02	Stock
2-45-000269	NC Contacts for switch	0.04	0.02	Stock
2-40-000791	Push Button Start- SqD-green	0.1	0.05	Stock
2-40-000793	Push Button Stop-SqD-red	0.1	0.05	Stock
2-45-000412	Green Light- SqD-120v	0.08	0.03	Stock
2-45-000411	Red Light-SqD-120v	0.08	0.03	Stock
2-40-000841	700HR Time Delay Relay for Circulating Pump	0.85	0.34	Stock
2-40-000134	Time Delay Relay Base			Stock
2-45-000309	Primary/Stand-by Switch- 2 pos.	0.14	0.06	Stock
2-40-000151	Time Delay 10 sec. adjustable			
2-45-000203	Bulb S & S	0.02	0.01	*
2-45-000205	Green Lens only S & S	0.02	0.01	*
2-45-000206	Red Lens only S & S	0.02	0.01	*
*** Consult Factory for Lead Time**				

Motor Contactors-3 Phase/120V coil-Siemens				
2-40-000878	3RT1015-1AK6 Contactor-7amp	0.8	0.36	Stock
2-40-000567	3RT1016-1AK6 Contactor-9amp	0.8	0.36	Stock
2-40-000642	3RT1017-1AK6 Contactor-12amp	0.8	0.36	Stock
2-40-000643	3RT1025-2QB0 Contactor-17amp	0.8	0.36	Stock
2-40-000644	3RT1026-1AK6 Contactor-25amp	0.8	0.36	Stock
2-40-000646	3RT1035-1AK6 Contactor-40amp	0.8	0.36	Stock
2-40-000825	3RT1036-1AK6 Contactor-50amp	0.8	0.36	Stock
2-40-000647	3RT1044-1AK6 Contactor-65amp	0.8	0.36	Stock
2-40-000645	3RT1033-1AK6 Contactor-28amp			Stock
2-40-000631	3RT1046-1AK6 Contactor-95amp			Stock
2-40-000637	3RT1046-1AK6 Contactor			Stock
2-40-000879	3RH1921-1LA11 Aux. Contactor			Stock
2-40-000648	3BR1015-2PB0 Overload-1.5-6amp	0.45	0.2	Stock
2-40-000566	3RB1015-2NB0 Overload-.4-1.6amp	0.45	0.2	Stock
2-40-000573	3RB1015-2SB0 Overload-3-12amp	0.45	0.2	Stock
2-40-000651	3RB1025-2QB0 Overload-6-25amp	0.45	0.2	Stock
2-40-000716	3RB1035-2UB0 Overload-13-50amp	0.45	0.2	Stock
2-40-000656	3RB1045-2EB0 Overload-23-75amp	0.45	0.2	Stock
2-40-000822	3RB1045-2EB0 Overload-25-100amp			Stock
Panel Box Air Conditioner & Parts				
2-40-000997	Panel Box Air Conditioner	49.6	22.6	1 Week
2-45-000468	5 Minute Time Delay Relay for A/C	0.5	0.3	Stock
2-45-000469	Relay Base for 2-45-000468	0.2	0.1	Stock
Stepdown Transformer				
2-40-000441	.75KVA Stepdown Transformer-480/120-50/60hz	12	5.46	1 Week
2-40-000443	1.5KVA Stepdown Transformer-480/120	12	5.46	1 Week
2-40-000445	1KVA Stepdown Transformer-480/120-50/60hz	12	5.46	Stock
2-40-000440	1KVA Stepdown Transformer-208/120			
Pressure Gauges & Accessories				
2-30-000529	0-100 PSI Panel Pressure Gauge - heater outlet	0.44	0.2	Stock
2-30-000530	0-200 PSI Panel Pressure Gauge - heater inlet	0.44	0.2	Stock
2-30-000531	30-0-60 PSI Panel Pressure Gauge - pump suction	0.38	0.17	Stock
2-30-000342	0-200 PSI Liquid Filled Gauge	0.56	0.25	Stock
2-30-000343	0-400 PSI Liquid Filled Gauge	0.56	0.25	Stock
5-21-000274	Single Gauge Panel	0.5	0.3	Stock
5-21-000273	Dual Gauge Panel	0.9	0.4	Stock
5-21-000272	Triple Gauge Panel	0.8	0.4	Stock
2-40-001003	Stack Thermometer 9” Probe 1/2” NPT			

PUMPS				
Allweiler Unmounted Pumps				
2-30-001680	NTT 32-160 w/ Mechanical Seal			*
2-30-001041	NTT 32-200 w/ Mechanical Seal			*
2-30-001681	NTT 40-160 w/ Mechanical Seal			*
2-30-001020	NTT 40-200 w/ Mechanical Seal			*
2-30-001021	NTT 50-160 w/ Mechanical Seal			*
2-30-001684	NTT 50-200 w/ Mechanical Seal			*
2-30-001022	NTT 50-250 w/ Mechanical Seal			*
2-30-001685	NTT 65-160 w/ Mechanical Seal			*
2-30-001036	NTT 65-200 w/ Mechanical Seal			*
2-30-001035	NTT 65-250 w/ Mechanical Seal			*
2-30-001034	NTT 80-160 w/ Mechanical Seal			*
2-30-001031	NTT 80-200 w/ Mechanical Seal			*
2-30-001033	NTT 80-250 w/ Mechanical Seal			*
2-30-001032	NTT 100-200 w/ Mechanical Seal			*
2-30-001040	NTT 100-250 w/ Mechanical Seal			*
Allweiler Full Size Impellers				
2-30-001051	NTT 32/160 Impeller 170mm	4.8	2.18	*□
2-30-001120	NTT 40/160 Impeller 170mm	4.98	2.26	*
2-30-001122	NTT 65/160 Impeller 170mm	4.62	2.1	*
2-30-001123	NTT 80/160 Impeller 180mm			*
2-30-001126	NTT 40/200 Impeller 205mm	6.62	3.01	*□
***Long Lead Time-check with factory for delivery & impeller trim size**				
Allweiler Spare Parts List				
Common parts for: NTT-25-200; 32-1 60; 40-1 60; 4200; 4250; 50-1 60; 50-200; 32-200; 50-250; 65-1 60; and 80-160, 65-200				
4-30-000106	Seal Kit	1.58	0.72	Stock
4-30-000126	Rebuild Kit - Includes Seal Kit	3.12	1.42	Stock
2-30-001030	400.1 Casing Gasket-206 x 217.5 x .5mm	0.01	0.0	Stock
2-30-001043	400.2 Gasket 257 x 269 x .5	0.01	0.0	Stock
2-30-001044	400.13 Gasket-72.5 x 88 x .5mm	0.01	0.0	Stock
2-30-001045	321.4 & 321.3 Ball Bearing	0.4	0.18	Stock
2-30-001048	461.1 Set of Packing	0.1	0.05	Stock
2-30-001049	433.2 Mechanical Seal	0.26	0.12	Stock
2-30-001050	210.1 Shaft	4.46	2.03	Stock
2-30-001055	Complete 360 Bearing Frame	30.52	13.87	Stock
2-30-001055	EP #2 Grease	10.14	4.61	Stock
Common parts for: NTT-65-250; 80-200; 80-250; 100-200; 100-250; and 125-250				
2-30-001029	400.2 Casing Gasket	0.01	0.0	Stock
2-30-001205	400.8 Gasket	0.01	0.0	Stock
2-30-001203	461.1 Set of Packing	0.01	0.0	Stock

2-30-001200	433.2 Mechanical Seal	0.4	0.18	Stock
2-30-001038	210.1 Shaft	3.0	1.36	Stock
2-30-001204	321.3 & 321.4 Ball Bearing	1.42	0.65	Stock
2-30-001058	Complete 470 Bearing Frame	53.84	24.47	Stock
2-60-000153	EP #2 Grease	10.14	4.61	Stock
Dean's –Unmounted Pump-includes impeller (truck ship only-call for impeller trim size)				
2-30-002000	RA3000 1-1/2x3x8-1/2	260.0	118.0	Stock
2-30-002002	RA3000 2x3x8-1/2	260.0	118.0	Stock
2-30-002004	RA3000 3x4x8-1/2	344.0	156.0	Stock
2-30-002006	RA3000 4x6x8-1/2	390.0	177.0	Stock
MISC Part	RA3000 1.5x3x10			Stock
5-20-000400	Small Pump Guard			Stock
5-20-000402	Large Pump Guard			Stock
2-30-002218	#4 Impeller Key	0.02	0.01	Stock
2-30-002219	#12 Impeller Bolt	0.04	0.02	Stock
2-30-002220	#12A Impeller Washer	0.14	0.07	Stock
2-30-002221	#13 Mech Seal Gland	1.8	0.9	Stock
2-30-002222	#25A Thrust Bearing	1.5	0.7	Stock
2-30-002223	#28 Bearing End Cover	5.7	2.6	Stock
2-30-002224	#29 Pump Shaft	9.5	4.4	Stock
2-30-002225	#31 Thrust Bearing Locknut	0.3	0.2	Stock
2-30-002226	#31A Thrust Bearing Washer	0.1	0.05	Stock
2-30-002227	#75 Snap Ring	0.02	0.01	Stock
2-30-002228	#76 Grease Seat- front	0.1	0.05	Stock
2-30-002229	#76A Grease Seat- rear	0.1	0.05	Stock
2-30-002230	#77B Bearing End Cover Gasket			Stock
2-30-002231	#95 A/B Mech Seal	0.5	0.23	Stock
2-30-002232	#180 Radial Bearing Cartridge	3.8	1.8	Stock
2-30-002233	#325 Seal Gland Gasket			Stock
2-30-002257	Seal Gland			1 Week
2-30-002258	**Lip Seal**			1 Week
2-30-002259	Gland Gasket			1 Week
2-30-002256	Collar & Set Screws			1 Week
2-30-002252	#6A Casing Ring 1x3x8 1/2 & 1 1/2x3x8 1/2			Consult Factory
2-30-002253	#6A Casing Ring 2x3x8 1/2			Consult Factory
2-30-002254	#6A Casing Ring 3x4x8 1/2			Consult Factory
2-30-002255	#6A Casing Ring 4x6x8 1/2			Consult Factory
2-30-002234	#325A Seal Gland Gasket			Stock
2-30-002242	#365 Mech Seal Retainer	0.2	0.1	Stock
2-30-002251	#3 Impeller 1x3x8 1/2			1 Week

2-30-002235	#3 Impeller - 1-1/2x3x8-1/2	8.7	4.0	Stock
2-30-002236	#3 Impeller - 2x3x 8-1/2	10.3	4.7	Stock
2-30-002237	#3 Impeller - 3x4x8-1/2	11.1	5.1	Stock
2-30-002238	#3 Impeller - 4x6x 8-1/2	12.6	5.8	Stock
MISC Part	#3 Impeller - 1.5x3x10			Stock
2-30-002239	#77 Casing Gasket	0.04	0.02	Stock
2-30-002240	6322595 Grease	0.2	0.1	Stock
8-00-000046	Shaft Sleeve Guide	1.0	0.05	Stock
8-00-000047	Carbon Sleeve Removal Tool	1.6	0.8	Stock
Dean's –Kits				
4-30-000130	Start-up Kit for Deans RA3000 Series Pumps			Stock
4-30-000140	1 Year Service Kit for Deans RA3000 1.5x3x8.5			Stock
4-30-000141	1 Year Service Kit for Deans RA3000 2x3x8.5			Stock
4-30-000142	1 Year Service Kit for Deans RA3000 3x4x8.5			Stock
4-30-000143	1 Year Service Kit for Deans RA3000 4x6x8.5			Stock
4-30-000150	2 Year Service Kit for Deans RA3000 1.5x3x8.5			Stock
4-30-000151	2 Year Service Kit for Deans RA3000 2x3x8.5			Stock
4-30-000152	2 Year Service Kit for Deans RA3000 3x4x8.5			Stock
4-30-000153	2 Year Service Kit for Deans RA3000 4x6x8.5			Stock
SIHI Unmounted Pumps-includes impeller (call for impeller trim size)				
2-30-001000	ZTN 3216 w/mech seal	58.0	26.36	Consult Factory
2-30-001002	ZTN 3220 w/mech seal	84.0	38.18	Consult Factory
2-30-001004	ZTN 4016 w/mech seal	73.0	33.18	Consult Factory
2-30-001006	ZTN 4020 w/mech seal	84.0	38.18	Consult Factory
2-30-001007	ZTN 5013 w/mech seal	90.0	40.91	Consult Factory
2-30-001008	ZTN 5016 w/mech seal	90.0	40.91	Consult Factory
2-30-001010	ZTN 5020 w/mech seal	95.0	43.18	Consult Factory
2-30-001012	ZTN 6516 w/mech seal	92.0	41.82	Consult Factory
2-30-001014	ZTN 6520 w/mech seal	89.0	40.45	Consult Factory
2-30-001016	ZTN 8016 w/mech seal	107.0	48.64	Consult Factory
2-30-001018	ZTN 8020 w/mech seal	115.0	52.27	Consult Factory
2-30-001019	ZTN 10020 w/mech seal	152.0	69.09	Consult Factory
SIHI Impellers				
2-30-000589	8020-30 Impeller 210 mm	8.08	3.67	Consult Factory
2-30-000590	5016-30 Impeller 170 mm	3.56	1.62	Consult Factory
2-30-000591	3220-30 & 4020 Impeller 210 mm	5.52	2.51	Consult

				Factory
2-30-000693	5020-30 Impeller 210 mm	6.14	2.79	Consult Factory
2-30-000694	4016-30 Impeller 170 mm	3.94	1.79	Consult Factory
Miscpart	10020 Impeller Pump serial number must be given to factory to verify availability & pricing.			Consult Factory
Common Parts for the Following Models: 3213; 3216; 3220; 4013; 4016; 4020; 5013; 5016; 5020; 6513; 6516; 6520 and 8016				
4-30-000108	Mech Seal Kit (3213 to 8016)	1.7	0.8	Stock
4-30-000110	Pump Repair Kit w/mech seal (3213 to 8016)	2.0	1.0	Stock
4-30-000100	Radial Seal Kit (3213 to 8016)	1.34	0.61	Stock
4-30-000120	Pump Rebuild Kit w/rad seals(3213 to 8016)	2.32	1.05	Stock
2-30-001013	Item 500-Mechanical Seal	2.0	1.1	Stock
2-30-000580	Item 241-Sleeve Bearing	0.44	0.2	Stock
2-30-000583	Item 200-Shaft (includes-#256,257,260,286,292)	2.94	1.34	Stock
2-30-000585	Item 426-Rad Seal -7 required	0.1	0.05	Stock
2-30-000451	Item 140-Gasket	0.01	0.0	Stock
2-30-000588	Item 81-'O' Ring	0.01	0.0	Stock
2-30-000594	Item 221-Ball Bearing Cover	0.5	0.23	Stock
2-30-000597	Item 230-Ball Bearing	0.5	0.23	Stock
2-30-000598	Item 292 Lockwasher	0.01	0.0	Stock
2-20-000190	Item 266-Spacer	0.01	0.0	Stock
2-12-000067	Item 80-13 Series Casing Gasket	0.12	0.05	Stock
2-12-000098	Item 80-16 Series Casing Gasket	0.18	0.08	Stock
2-12-000099	Item 80-20 Series Casing Gasket			Stock
2-60-000153	EP #2 Grease	10.14	4.61	Stock
Common Parts for the 8020 and 10020 Models				
4-30-000112	Seal Kit w/ mech seal	1.7	0.8	Stock
4-30-000113	Pump Repair Kit w/mech seal	4.1	1.9	Stock
2-30-001015	Item 500-Mechanical Seal	0.4	0.2	Stock
4-30-000102	8020 Seal Kit w/radial seals	1.38	0.63	Stock
4-30-000122	8020 Rebuild Kit w/radial seals	3.8	1.73	Stock
2-30-000451	Item 140-Gasket	0.1	0.0	Stock
2-30-000581	Item 230-Ball Bearing	0.98	0.45	Stock
2-30-000593	Item 221-Bearing Cover	0.1	0.05	Stock
2-30-000582	Item 200-Shaft	7.5	3.41	Stock
2-30-000584	Item 426 - Rad Seal - 7 required	0.1	0.05	Stock
2-30-000592	Item 241-Sleeve Bearing	0.66	0.3	Stock
2-12-000099	Item 80-Casing Gasket	0.0		Stock
2-12-000116	Item 80-Casing Gasket for ZTN 10020	0.02	0.01	Stock
2-30-000599	Item 81-'O' Ring	0.0		Stock

2-60-000153	EP #2 Grease	10.14	4.61	Stock
Pump/Motor Coupling Parts				
2-30-000707	E4 24mm Rexnord Hub	1.8	0.82	Stock
2-30-000705	E4 1-1/8” Rexnord Hub	1.45	0.66	Stock
2-30-000706	E4 1-3/8” Rexnord Hub	1.22	0.55	Stock
2-30-000710	E4 1-5/8” Rexnord Hub	0.96	0.44	Stock
2-30-000708	E4 Elastomer Element	1.36	0.62	Stock
2-30-000704	E5 24mm Rexnord Hub	2.84	1.29	Stock
2-30-001072	E5 32mm Rexnord Hub	2.4	1.09	Stock
2-30-000712	E5 1-1/8” Rexnord Hub	2.52	1.15	Stock
2-30-000703	E5 1-3/8” Rexnord Hub	2.5	1.14	Stock
2-30-000702	E5 1-5/8” Rexnord Hub	2.14	0.97	Stock
2-30-000713	E5 1-7/8” Rexnord Hub	1.64	0.75	Stock
2-30-000714	E5 Elastomer Element	2.14	0.97	Stock
2-30-000716	E10 24mm Rexnord Hub	4.08	1.85	Stock
2-30-001073	E10 32mm Rexnord Hub	5.0	2.27	Stock
2-30-000718	E10 1-5/8” Rexnord Hub	3.4	1.55	Stock
2-30-000717	E10 1-7/8” Rexnord Hub	3.04	1.38	Stock
2-30-000711	E10 2-1/8” Rexnord Hub	3.5	1.59	Stock
2-30-000715	E10 Elastomer Element	2.86	1.3	Stock
2-30-000752	E20 1 1/8” Rexnord Hub			Stock
2-30-000821	E20 32mm Rexnord Hub	7.86	3.57	Stock
2-30-000823	E20 1-7/8” Rexnord Hub	7.86	3.57	Stock
2-30-000824	E20 2-1/8” Rexnard Hub	7.86	3.57	Stock
2-30-000822	E20 Elastomer Element	2.86	1.3	Stock
Pump Bases				
5-30-005000	12”x40” Base			Stock
5-30-005002	15”x48” Base			Stock
5-30-005004	18”x48” Base			Stock
Safety Relief Valves **Thermal Fluid Safety Valves (threaded)**				
2-30-000544	Kunkle Safety Valve 3/4” 100 psi-920	3.92	1.78	Stock
2-30-000545	Safety Valve 1” 100psi -920	5.72	2.6	Stock
2-30-000546	Safety Valve 1-1/4” 100psi -920	8.6	3.91	Stock
2-30-000547	Safety Valve 1-1/2” 100psi -920	15.04	6.84	Stock
2-30-000548	Safety Valve 2” 100psi -920			Stock
Thermal Fluid Safety Valves (flanged)				
2-30-000609	Kunkle Safety Valve 3/4” 100 psi-920--300#flanged	11.3	5.2	Stock
2-30-000610	Kunkle Safety Valve 1” 100 psi-920--300#flanged	14.6	6.7	Stock
2-30-000611	Kunkle Safety Valve 1-1/4” 100 psi-920--300#flanged	23.5	10.7	Stock

2-30-000612	Kunkle Safety Valve 1-1/2" 100 psi-920--300#flanged	34.0	15.5	Stock
2-30-000613	Kunkle Safety Valve 2" 100 psi-920--300#flanged Above used on heater #3117C & UP (2001)	45.0	20.5	Stock
Kunkle N2 Safety Valves-Expansion Tank				
2-30-000637	1" SRV 15 PSI			
2-30-000636	3/4" SRV 15 PSI			
2-30-000639	1 1/2" SRV 15 PSI			
2-30-000638	1 1/4" SRV 15 PSI			
Skid Components **Worchester Valves**				
2-30-000534	1/4" Threaded Ball valve	1.54	0.07	Consult Factory
2-30-000536	3/4" Ball Valve- Two Way	1.98	0.9	Consult Factory
2-30-000537	1" Ball Valve- Two Way	3.82	1.74	Consult Factory
2-30-000538	1-1/4" Ball Valve- Two Way	5.1	2.32	Consult Factory
2-30-000539	1-1/2" Ball Valve- Two Way	7.46	3.39	Consult Factory
2-30-000540	2" Ball Valve - Two Way	10.1	4.59	Consult Factory
2-30-000897	1/2" Ball Valve w/Actuator	7.08	3.22	Consult Factory
2-30-000896	1" Ball Valve w/Actuator	14.2	6.45	Consult Factory
2-30-000899	1-1/2" 3-Way Diverting Valve w/Actuator	22.14	10.06	Consult Factory
2-30-000898	2" 3-Way Diverting Valve w/Actuator	25.84	11.75	Consult Factory
2-30-001300	1-1/4" Valve Repair Kit	0.16	0.07	Consult Factory
2-30-001301	1-1/2" Valve Repair Kit	0.2	0.09	Consult Factory
2-30-001303	1039 Actuator Repair Kit	0.18	0.08	Consult Factory
2-30-001304	2039 Actuator Repair Kit	0.18	0.08	Consult Factory
2-30-001305	Series 1039 Actuator (1" and smaller)	0.1	0.05	Consult Factory
2-30-001313	1-1/4" S Ring	0.06	0.03	Consult Factory
2-30-001314	1-1/2" S Ring	0.02	0.01	Consult Factory
2-30-001315	2" S Ring	0.02	0.01	Consult Factory
Dezurik Valves				
2-30-000885	1.5" Dezurik Valve w/EI-O-Matic Actuator and Positioner			Consult Factory
2-30-000820	2" Dezurik Valve w/EI-O-Matic Actuator and Positioner			Consult Factory
2-30-000886	3" Dezurik Valve w/EI-O-Matic Actuator and Positioner			Consult Factory
2-30-000882	3" Dezurik Valve Repair Kit			Consult Factory
2-30-000880	2" Dezurik Valve Repair Kit			Consult

				Factory
2-30-000883	1.5” Dezurik Valve Repair Kit	0.2	0.1	Consult Factory
2-30-001261	ES10 Actuator Rebuild Kit	0.2	0.1	Consult Factory
2-30-001260	ES20 Actuator Rebuild Kit	0.16	0.07	Consult Factory
2-30-001276	1” Valve Actuator ES10-6			Consult Factory
SteamPac Components				
2-40-000420	Fulton Pump Relay - 120V	0.5	0.23	Stock
2-40-000422	Base for Fulton Pump Relay (8 pin)	0.25	0.11	Stock
2-40-000403	IDIDO Relay	2.0	0.91	Stock
2-40-000202	Motor Starter R4243 - 30amp	0.52	0.24	Stock
2-40-000421	120V Water Level Relay			Stock
2-40-000423	Base for 120V Water Level Relay (11 pin)			
2-40-000229	Pressuretrol L404A1396	2.0	0.91	Stock
2-12-000004	Handhole Gasket	0.04	0.02	Stock
2-12-000007	5/8” X 9 -1/4” Gauge Glass	0.2	0.09	Stock
2-12-000019	5/8” Rubber Gasket	0.004	0.0	Stock
2-12-000020	5/8” Brass Gasket	0.002	0.0	Stock
2-30-000149	1/2” Water Gauge Valve w/ball checks	1.5	0.68	Stock
2-30-000047	1/2” Tri-cock	0.42	0.19	Stock
2-20-000017	Low Water Cut Off Probe -17-1/8”-cut to any length	0.5	0.23	Stock
2-20-000010	Low Water Probe	0.5	0.23	Stock
2-20-000012	High Water Probe	0.5	0.23	Stock
2-30-000029	1/2” Float Valve	0.72	0.33	Stock
2-30-000028	3/4” Float Valve	0.76	0.35	Stock
2-30-000124	4 1/2” Float Ball Only	0.6	0.27	Stock
2-12-000534	1/2” Float Valve Disc	0.01	0	Stock
2-12-000535	3/4” Float Valve Disc	0.01	0	Stock
2-30-000332	300# Steam Gauge	0.5	0.23	Stock
Strainer Parts				
2-30-000870	60 Mesh Strainer Basket - 2” Keckley	0.4	0.18	Stock
2-30-000871	60 Mesh Strainer Basket - 2-1/2” Keckley	0.38	0.17	Stock
2-30-000872	60 Mesh Strainer Basket - 3” Keckley	0.66	0.3	Stock
2-30-000873	60 Mesh Strainer Basket - 4” Keckley	0.75	0.34	Stock
2-30-000847	60 Mesh Strainer Basket - 6” Keckley	0.75	0.34	Stock
2-30-000829	60 Mesh Strainer Basket - 8” Keckley	0.8	0.37	Stock
2-12-000120	Gasket for 2” Keckley Strainer	0.04	0.02	Stock
2-12-000121	Gasket for 2-1/2” Keckley Strainer	0.04	0.02	Stock
2-12-000122	Gasket for 3” Keckley Strainer	0.04	0.02	Stock
2-12-000123	Gasket for 4” Keckley Strainer	0.14	0.06	Stock
2-30-000878	Gasket for 6” Keckley Stainer	0.14	0.06	Stock

2-30-000830	Gasket for 8” Keckley Stainer	0.14	0.06	Stock
2-30-000627	Strainer -4” Keckley 150# Flanged	62.2	28.3	Stock
2-30-000874	Strainer -5” Keckley 150# Flanged			Stock
2-30-000875	Strainer -6” Keckley 150# Flanged	68.5	34.3	Stock
2-30-000828	Strainer -8” Keckley 150# Flanged	999.0	454.0	Stock
2-30-000808	Strainer - 2 1/2” Titan			
2-30-000809	Strainer - 3” Titan			
2-30-000810	Strainer - 4” Titan			
2-12-000135	Gasket for 2 1/2” Titan Strainer			
2-12-000136	Gasket for 3” Titan Strainer			
2-12-000137	Gasket for 4” Titan Strainer			
Notes: SIHI & Allweiler pump flanges use 150# - 4 bolt, Deans pump flanges use 300#				

Standard Warranty for Fulton
Warranty Valid for Model FT-N

Vessel Warranty: One (1) Year (12 Month) Material and Workmanship Warranty
The pressure vessel carries warranty coverage against defective material or workmanship for a period of one (1) year from the date of shipment from the factory. Fulton will repair or replace F.O.B. factory any part of the vessel, provided this equipment has been installed, operated and maintained by the buyer in accordance with approved practices and recommendations made by Fulton per the Installation and Operation Manual.

Parts and Other Components Warranty
Fulton will repair or replace F.O.B. factory any part of the equipment of our manufacture that is found to be defective in workmanship or material within one (1) year of shipment from the factory provided this equipment has been installed, operated and maintained by the buyer in accordance with approved practices and recommendations made by both Fulton and the component manufacturers.

Thermal fluid system piping and valves are painted at the factory to protect from corrosion prior to installation and operation. These painted surfaces are not covered under warranty.

General
Fulton shall be notified in writing as soon as any defect becomes apparent. This warranty does not include freight, handling or labor charges of any kind. These warranties are contingent upon the proper sizing, installation, operation and maintenance of the heater and peripheral components and equipment. These warranties are valid only if installed, operated, and maintained as outlined in the Fulton Installation and Operation Manual. All Installation and Operation Checklists as noted in the manual must be submitted to Fulton's Quality Assurance department. Startup (commissioning) by a Fulton Factory Technician is required, and start-up of the heater by anyone other than a Fulton Service Solutions Service Technician will void the warranty on the equipment supplied. To activate the warranty for this product, a Fulton factory technician is required to start up the heater and the appropriate Installation and Operation Checklists as noted in the manual must be submitted to Fulton's Quality Assurance department for review and approval. Annual Preventative Maintenance reports must also be submitted to Fulton. No Sales Manager or other representative of Fulton other than the Warranty Manager or an officer of the company has warranty authority. Fulton will not pay any charges unless they were pre-approved, in writing, by the Fulton Warranty Manager. This warranty is exclusive and in lieu of all other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Fulton shall in no event be liable for any consequential or incidental damages arising in any way, including but not limited to any loss of profits or business, even if the Fulton Companies has been advised of the possibility of such damages. Fulton's liability shall never exceed the amount paid for the original equipment found to be defective.

Fulton

Effective: **12/02/2016**

Section 6

Section 6 – Product Specs & Data

Fulton Thermal Fluid Electric Heat Transfer Systems

1. General Description

a) Contractor shall furnish and install a _____KW BTU/Hr. electric thermal fluid heat transfer system per plans. The system shall be "Fulton" as manufactured by Fulton Thermal Corporation, Pulaski, New York.

b) The system shall be a complete package including a vertical jacket type heater; combination expansion deaerator thermal buffer tank to allow for expansion of thermal fluid during heat up to operating temperature and to prevent oxidation of the thermal fluid during operation, even when tank is vented to atmosphere; for operating temperatures up to 650°F complete with instrumentation and controls.

2. Heater Size & Operating Temperature

a) The heater shall produce a minimum of _____ BTU/Hr. output as measured at the thermal fluid outlet. The heater shall _____ KW and be supplied complete with control panel and all required safety devices for a maximum operating temperature of _____°F (standard 650°F max). It shall have a flow rate of _____GPM and an element voltage of _____ with a control voltage of _____.

3. Heater Design

a) The heater shall be of a vertical, annular shell type and the pressure vessel construction shall be carbon steel ASME SA-53B/106B, SA-285C and SA-516 GR 70 with a design pressure of 150 PSI (trimmed at 100 PSI) standard at 700°F. Test pressure will be per ASME Code Section I and the heater shall bear the ASME stamp. The heater shall be insulated with 4” of high temperature glass fiber insulation wrapped by a neatly finished stainless steel jacket. It shall be completely factory piped, wired and tested. Thermal efficiency shall be 96% minimum.

b) The following instrumentation/controls/safety devices shall be supplied as a minimum requirement:

1. High temperature Indicator/Controller - Yokogawa
2. High temperature safely switch for shutdown - United Electric
3. Heater operation interlock with circulation pump.
4. High system pressure switch for complete shutdown – Danfoss
5. Low system pressure switch for complete shutdown – Danfoss
6. Expansion tank low level switch for shutdown - Square D
7. Heater inlet pressure gauge – Fulton
8. Pump supply (Vacuum) gauge – Fulton

9. Heater outlet pressure gauge – Fulton
10. ASME Certified safety relief valve - Kunkle Model 920
11. Fused magnetic contactors for electric elements
12. Magnetic starter for thermal fluid circulation pump
13. Step controller for sequential control of elements - Solitec Note: an SCR is an available option
14. Three Position Selector Switch: Off/Pump On/Heater On
15. Four Indicating Lights:
    1. Power
    2. Pressure & Flow
    3. Heat Demand
    4. Alarm
16. Low flow interlock
17. Non-fused disconnect
18. Single source power connection

4. Combination Expansion/Deaerator Thermal Buffer Tank Size

a) The combination expansion/deaerator thermal buffer tank shall have _____gallon capacity and be supplied complete with liquid level switch. It shall be suitable for a maximum total system fluid content of _____ gallons, including heater and expansion/deaerator tank capacities (based on a _____% expansion rate of the hot oil – to be verified by the client).

5. Combination Expansion/Deaerator Thermal Buffer Tank Design

a) The combination expansion/deaerator thermal buffer tank will be constructed of carbon steel. It shall be supplied with expansion tank liquid level switch and 300# ANSI flanged connections. The tank may be built to ASME Code Section VIII Division I upon request.

6. Thermal Fluid Circulating Pump Size

a) The thermal fluid circulating pump shall be air cooled with mechanical seal design for 650°F maximum operating temperature, _____GPM at _____PSI, _____HP motor, RPM motor, complete with motor starter, _____voltage.

7. Thermal Fluid Circulating Pump Design

a) The thermal fluid circulating pump shall be of centrifugal design, with a mechanical seal air cooled for temperatures up to 650°F or water cooled for operating temperatures above

650°F and shall be supplied complete with motor starter for proper motor HP, voltage and cycles.

8. Tests

a) Shall include a hydrostatic test of the pressure vessel in the presence of an inspector having a National Board Commission. He shall certify a Data Report which shall be delivered with the heater as evidence of ASME Code compliance. In addition to ASME symbol, the heater shall bear a National Board Registration Number.

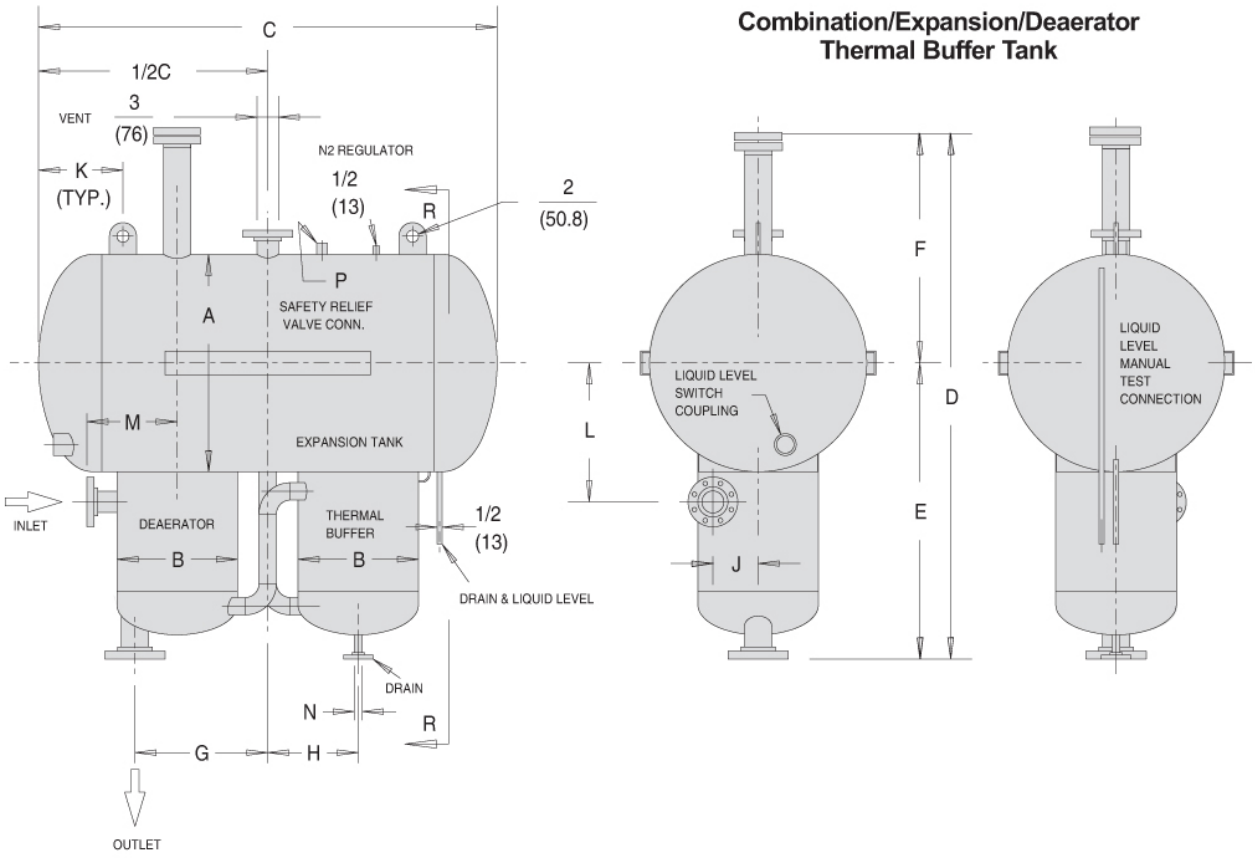
b) Full electrical checks will be performed including testing of all controls and circuitry.

9. Operating Manual

a) Instructions for installation, operation, and maintenance of the heat transfer system shall be contained in a manual provided with each unit.

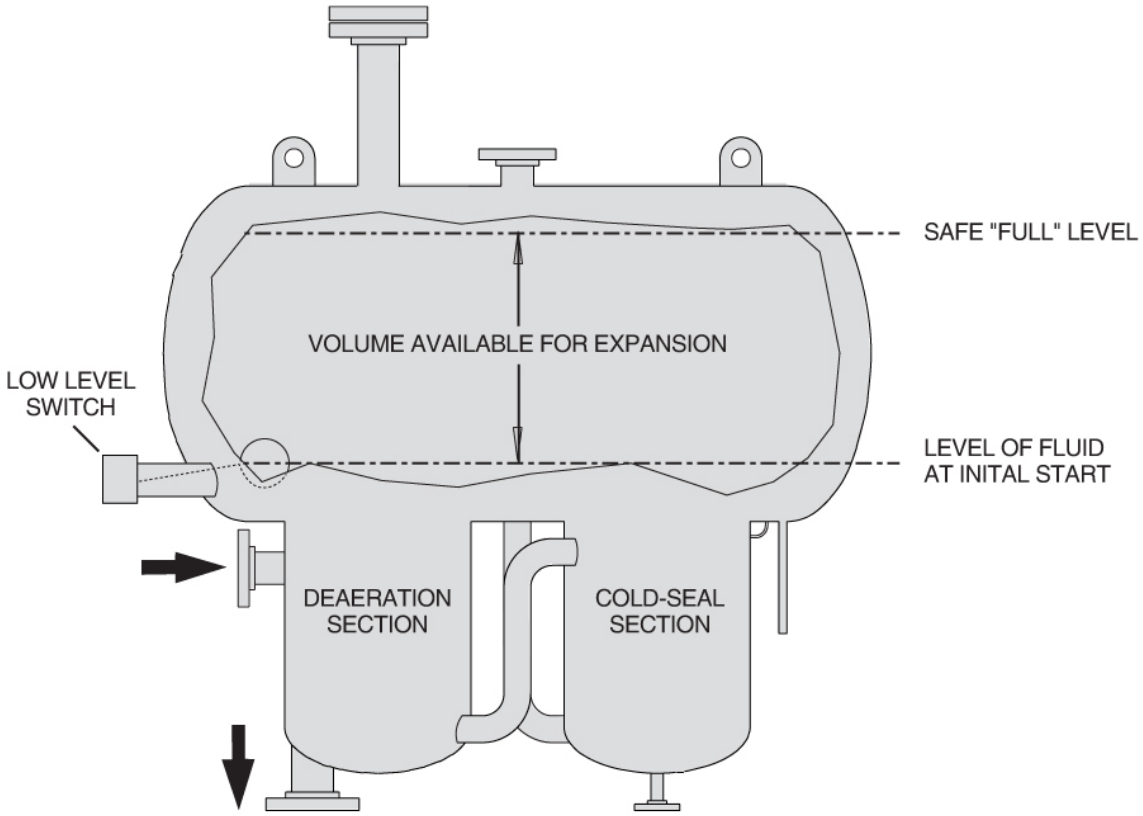
b) A complete wiring diagram, corresponding to the equipment supplied, shall be part of the manual and one shall also be affixed to the inside of the heater's panel box.

Dimensions and Sizing Instructions of the Fulton Combination Expansion/Deaerator/Thermal Buffer Tank Models FT-200-L to FT-5000-L



MODEL	A	B	C	D	E	F	G (Ref)	H	J (Ref)	K	L	M	N	P	CAP.	Dry Wt.	Max Full Wt.
FT-0200-L	20 (510)	12¾ (325)	54 (1370)	60⅝ (1540)	34 (865)	26⅝ (676)	16 1/16 (424)	12 (305)	4½ (115)	4¼ (108)	15 (380)	12 15/16 (329)	¾ (20)	¾ (20)	52 (200)	636 (289)	1314 (596)
FT-0500-L	26 (660)	16 (405)	74 (1880)	66⅝ (1692)	37 (940)	29⅝ (752)	19¾ (502)	14 (355)	6 (150)	11½ (290)	18 (460)	14 15/16 (379)	¾ (20)	¾ (20)	132 (500)	970 (440)	2450 (1111)
FT-1000-L	36 (915)	20 (510)	76 (1930)	87⅝ (2226)	49 (1245)	38⅝ (981)	22¼ (565)	15 (380)	7 1/16 (202)	14 (355)	24 (610)	14 15/16 (379)	1 (25)	1 (25)	264 (1000)	1350 (612)	4380 (1987)
FT-1500-L	36 (915)	20 (510)	106 (2690)	87 (2210)	49 (1245)	38⅝ (981)	24¾ (629)	17½ (445)	8 (203)	14 (355)	24 (610)	14 15/16 (379)	1 (25)	1¼ (32)	397 (1500)	1710 (776)	5875 (2667)
FT-2000-L	42 (1070)	22 (560)	106 (2690)	107⅝ (2734)	62½ (1590)	45⅛ (1146)	31⅛ (792)	24 (610)	8½ (216)	15½ (394)	28 (710)	14 15/16 (379)	1 (25)	1½ (38)	528 (2000)	2550 (1134)	8230 (3733)
FT-3000-L	42 (1070)	26 (660)	140 (3556)	115⅛ (2924)	70 (1778)	45⅛ (1146)	33⅜6 (843)	24 (610)	9 15/16 (252)	15½ (394)	28 (710)	18 15/16 (481	1 (25)	1½ (38)	793 (3000)	3200 (1451)	11,610 (5265)
FT-5000-L	60 (1524)	26 (660)	130⅜ (3312)	132⅛ (3356)	77½ (1969)	54⅝ (1387)	32 1/16 (818)	24 (610)	9⅜ (238)	20⅝ (524)	37 (940)	18 15/16 (481)	1 (25)	1½ (38)	1321 (5000)	5300 (1637)	17,370 (7895)

Inlet and outlet dimensions vary with installation. All dimension are approximate. Specifications subject to change without notice.
Dimensions given in inches and (MM)
Capacities given in gallons and (LITERS)
Weights given in pounds and (KG)



Developed specifically for thermal fluid system use, the Fulton Combination/Deaerator/Expansion/Thermal Buffer Tank is a patented design. The unique combination of the operation of these three vessels in one results in numerous advantages including: pipework simplification, protection of thermal fluid from oxidation, ease of installation, and continuous deaeration of fluid, avoiding pump cavitation.

Expansion Section:

The expansion section is vital to the thermal fluid system. From ambient to operating temperature, the thermal fluid in the system will typically expand in the range of 30%, and a vessel capable of handling this expansion is mandatory. Additional expansion section features include a liquid level switch and manual fluid levels test connections. In the event of system fluid loss, the level in the expansion section of the combination tank will drop, and the liquid level switch will shut the unit down. Manual low and high fluid level test connections are always provided.

Deaerator Section:

At start up the primary purpose of the deaerator section is to remove all volatiles from the system to avoid pump cavitation. The deaerator section also allows oxygen to be vented from the system on a continuous basis during operation to avoid oxidation of the thermal fluid, and removes other volatile particles generated by the fluid itself during system operation.

Thermal Buffer Section:

A system of interconnecting pipework in the thermal buffer tank section prevents the movement of any oil, that has not cooled sufficiently, into the expansion section. This avoids contact of very high thermal fluid temperature with oxygen contained in the atmosphere.

Sizing the Tank for the System:

Expansion tank capacity is the total volume of the tank. It is necessary to have some air space available at the tope of the tank to avoid spillage or overflow.

At initial fill (for system volume calculations) the deaerator and cold seal sections must be filled completely, and the expansion section must be filled to a level of 4" to "make" the low level switch.

The volume between the initial fill level and the safe "full" level is the amount available for expansion. That volume is used to decide which tank is suitable for the system expansion.

Model	Capacity (Gallons)	Initial Fill (Gallons)	Available for Expansion (Gallons)	Max System Volume
FT-100-L	35	9	25	100
FT-200-L	52	25	46	184
FT-1000-L	264	80	232	1000
FT-1500-L	397	90	380	1400
FT-2000-L	528	145	444	1700
FT-3000-L	793	215	717	2600
FT-5000-L	1310	300	1168	4600

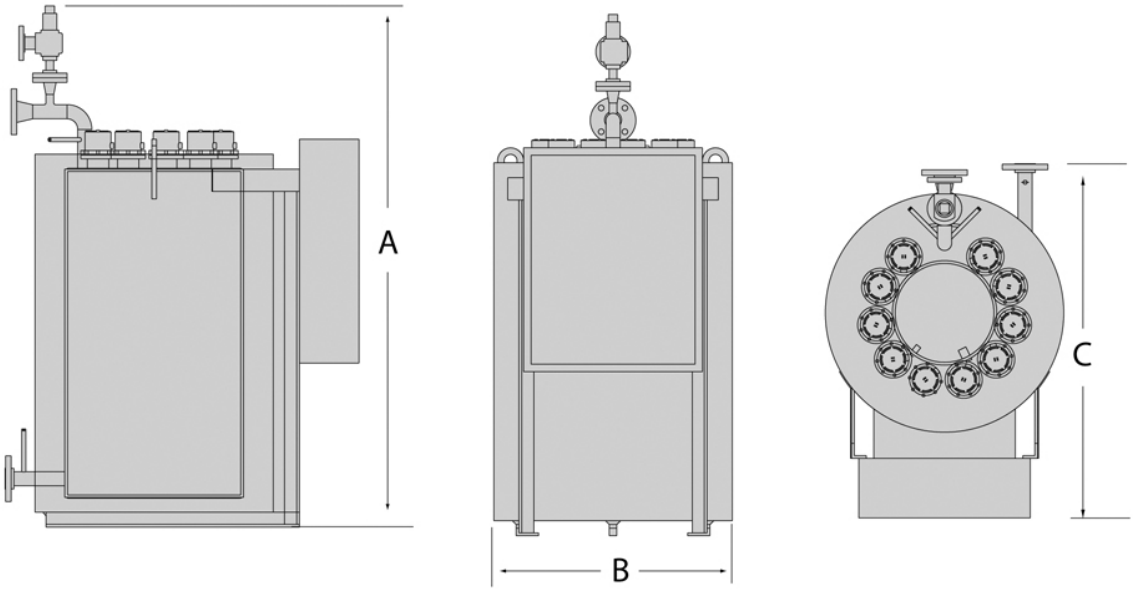
Example: A System contains 175 gallons, including the heater, but not the tank. You select the FT-200-L, so you add 25 gallons to 175. You must look up the expansion rate for the thermal fluid. (Assume it's 25%). 200 gal. x 1.25=250 gal. 250-200=50 gal. expansion. The FT-200-L has only 46 gal. available for expansion, so the correct selection is FT-500-L.

Specifications-Vertical Electric Thermal Fluid Heater

Model FT-N	0075	0150	0225	0300	0375	0430	0640	0860	1070	1290	1500	1720
KW	22	44	66	88	110	126	189	252	315	378	441	504
Heat Input												
1000 BTU/HR	75	150	225	300	375	429	644	859	1074	1289	1504	1719
1000 KCAL/HR	18.9	37.8	56.7	75.6	94.5	108	162	216	271	325	379	434
Heat Output												
1000 BTU/HR	74	148	222	294	368	420	631	842	1053	1263	1474	1685
1000 KCAL/HR	18.6	37.3	59.9	74.1	92.7	105.8	159	212.2	265.4	318.3	371.4	424.6
Thermal Fluid Content												
GAL	18	36	42	54	63	79	79	102	127	152	168	185
LITERS	68	136	159	204	238	299	299	386	480	575	636	700
Recommended Flow Rate												
GPM	50	50	50	90	90	125	125	150	150	175	200	200
M^3/HR	11.4	11.4	11.4	20.5	20.5	28.4	28.4	34	34	39.8	45.5	45.5
Typical Circulating Pump Motor												
HP	7.5	7.5	7.5	10	10	15	15	15	15	15	20	20
KW	5.6	5.6	5.6	7.5	7.5	11.2	11.2	11.2	11.2	11.2	14.9	14.9
Amps												
208V	61	122	183	245	306	350	525	700	875	1050	1224	1399
240V	53	106	159	212	265	303	455	607	758	910	1061	1212
480V	26	53	79	106	132	151	228	303	379	455	531	606

Dimensions-Vertical Electric Thermal Fluid Heater

Model FT-N	0075	0150	0225	0300	0375	0430	0640	0860	1070	1290	1500	1720
Heater Inlet/Outlet Connections												
IN	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2	2.5	2.5
MM	38	38	38	38	38	51	51	51	51	51	63.5	63.5
(A) Overall Height												
IN	70	70	70.5	70	70	90.5	90.4	90.8	89.8	91.2	93	93
MM	1778	1778	1791	1778	1778	2299	2296	2306	2281	2317	2362	2362
(B) Heater Width												
IN												
MM	20	26	28	32	32	32	32	38	44	50	54	58
	508	660	711	813	813	813	813	965	1118	1270	1372	1473
(C) Overall Depth												
IN	37.5	43	43.5	47.5	47.5	47.5	49.5	53.75	58.4	65.7	71.75	75.7
MM	953	1092	1105	1207	1207	1207	1257	1365	1257	1669	1823	1993
Approximate Dry Weight												
LBS	1060	1220	1400	1540	1660	2040	2200	2370	2650	2950	2950	3600
KG	481	555	636	700	756	927	1000	1077	1205	1341	1341	1636



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