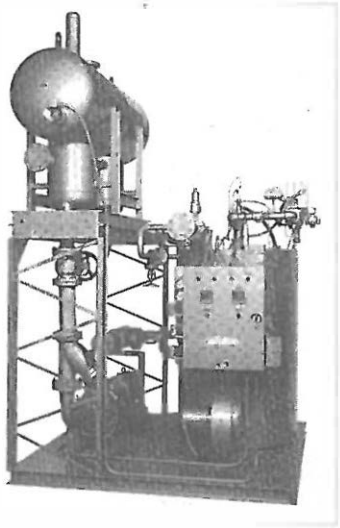
Fulton®

INSTALLATION AND OPERATION MANUAL

Vertical Coil Design

Thermal Fluid Heaters

Models FT-C and FT-S



Serial / National Board Number _____

Model _____

Fulton Order _____

Sold To _____

Job Name _____

Date _____

FTCS-IOM-2013-0227

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Overview

Prior to shipment, the following inspections and tests are made to ensure the highest standards of manufacturing for our customers:

- Material inspections
- Manufacturing process inspections
- American Society of Mechanical Engineers (ASME) welding inspection
- ASME hydrostatic test inspection
- Electrical components inspection
- Operating test
- Final engineering inspection
- Crating inspection

This manual is provided as a guide to the correct operation and maintenance of your Fulton equipment, and should be read in its entirety and be made permanently available to the staff responsible for the operation of the heater. It should not, however, be considered as a complete code of practice, nor should it replace existing codes or standards which may be applicable. Fulton reserves the right to change any part of this installation, operation and maintenance manual.

Installation, start-up, and maintenance of this equipment can be hazardous and requires trained, qualified installers and service personnel. **Trained personnel are responsible for the installation, operation, and maintenance of this product, and for the safety assurance of installation, operation, and maintenance processes. Do not install, operate, service or repair any component of this equipment unless you are qualified and fully understand all requirements and procedures. Trained personnel refers to those who have completed Fulton Service School training specific to this product.**

When working on this equipment, observe all warnings, cautions, and notes in literature, on stickers and labels, and any additional safety precautions that apply. Follow all safety codes and wear appropriate safety protection. Follow all jurisdictional codes and consult any jursidictional authorities prior to installation.

Warnings & Cautions

WARNINGS and CAUTIONS appear in various chapters of this manual. It is critical that all personnel read and adhere to all information contained in WARNINGS and CAUTIONS.

- 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.

All Warnings and Cautions are for reference and guidance purposes, and do not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes or regulations.

Disclaimers and Local Codes

Installation of the equipment shall conform to all the requirements or all national, state and local codes established by the authorities having jurisdiction or, in the absence of such requirements, in the US to the National Fuel Gas Code ANSI Z2231/NFPA 54 latest edition, and the specific instructions in this manual. Authorities having jurisdiction should be consulted prior to installation.

The boiler heat exchanger is manufactured and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section I or Section VIII, Div. 1.

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

Unless otherwise noted, this heater is certified for indoor installation only.

A competent rigger experienced in handling heavy equipment should handle rigging your equipment into position.

The equipment must be installed on a non-combustible surface.

Ensure all labels on the heater are legible. All connections and safety devices, both mechanical and electrical, must be kept clean, with ease of access for inspection, use and maintenance.

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

⚠ CAUTION

Do not allow weight to bear on equipment components to prevent damage.

Placement & Rigging

Proper placement of your Fulton Product (see Figures 1 and 2, and Tables 1 and 2) 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.

Adhere to the following for equipment placement and rigging:

1. Consult authorities with jurisdiction over any national or local codes (including but not limited to National Fire Protection Agency (NFPA), American National Standards Institute (ANSI), Underwriters Laboratories (UL), SCA, and ASME, which might be applicable to heater applications before beginning.
2. Make appropriate determinations for placement, based on the following:

- Check building specifications and Table 3 for permissible floor loading.
- Ensure the equipment is to be placed on a non-combustible level base with adequate clearances from combustible materials. **See Clearances & Serviceability section.**
- Locate heater as close as possible to the place where the heat will be used in order to keep pipe work costs to a minimum.
- Ensure that there is adequate clearance around the unit to provide access for operators and maintenance personnel to all parts of the equipment. Ensure also that clearance provides for component removal for maintenance. **See Clearances & Serviceability section.** The equipment should be placed in a suitable heater house or well ventilated separate room through which personnel do not normally pass. 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.
- Ensure the equipment is to be placed in such a way that the electrical components are protected from exposure to water or excessive humidity.

3. Determine rigging procedure, based on the following:

- Units are shipped upright and crated for forklift transport. Once uncrated, all units can be transported with a forklift with the exception of freestanding models FT-0080C, FT-0120C, FT-0160C and FT-0240C. These four models can only be lifted for unloading and moving by means of lifting lugs at the top of the heaters. All skidded units can be moved with forklifts.
- If means of lifting are not available, place rollers beneath the frame of the equipment for guidance to the position of where it is to be installed.
- Under no circumstances allow weight to bear on the jacket, control panel, burner, fuel train or fan housing of any Fulton heater.

4. Install a 4 inch (102 mm) curb completely around the unit. In the event of a large spill, this will help contain the fluid.

Clearances & Serviceability

Adhere to the following for equipment clearances and serviceability:

1. Ensure appropriate front, back, sides and top clearances are met. This will allow access around the equipment to facilitate maintenance and a safe work environment, and ensure technicians will commission the unit. Technicians will not commence commissioning if hazardous conditions exist.
2. 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" (0.5 m)
- Heater Rear 18" (0.5 m)
- Flue Pipe 18" (0.5 m)
- Minimum clearances for personnel access and burner removal: refer to Table 4.
  - » In cases where the available height is insufficient, a roof or ceiling trap must be considered. Fulton Vertical Coil design units need only sufficient headroom for burner maintenance. Larger models of the vertical coil design unit (FT-0320C and above) require an access ladder/gantry to be provided by the customer to allow clear access to the top of the heater for maintenance purposes. Fulton Thermal Corporation will advise on the suitability of the access provided and will provide assistance that may be required in this respect.
  - » Access provision should avoid possible contact with hot pipework, flues etc.

NOTE: Burners may weigh up to 550 lbs (249 kg) depending on the type and configuration.

NOTE: For UL listed units, see the specification plate on the Fulton Thermal Fluid Heater for these clearances.

3. Pipes must not be run within 10" (254 mm) of any control cabinets or combustible material.
4. Verify that all clearances are acceptable with the local ordinances.

⚠ WARNING

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Crystalline silica may be present in components of this equipment. Exposure to crystalline silica may pose significant health hazards, including but not limited to eye and respiratory system damage. Per the Centers for Disease Control and Prevention (CDC) and Occupational Safety and Health Administration (OSHA), appropriate personal protective equipment must be worn to minimize exposure to hazardous substances. Refer to most current guidelines offered by the CDC and OSHA for more information, including personal protective equipment recommendations.

Failure to provide required and safe access to the equipment could impede commissioning and maintenance. Service technicians are instructed not to commence commissioning if hazardous conditions exist.

Failure to provide proper minimum clearances between equipment and combustible materials may result in fire.

Environment, Ventilation and Combustion Air Requirements

Ventilation must be sufficient to maintain a building temperature of 120°F (49°C) or less. Consistent proper ventilation of the equipment room is essential for good combustion.

➨ *NOTE: When calculating ventilation requirements, heat losses from the Fulton equipment (and other equipment) should be considered.*

Adhere to the following to meet ventilation and combustion air requirements:

1. Install two fresh air openings, one at a low level, 24" (610 mm) from the floor, and one at a higher level on the equipment room wall. This will provide a flow of air to exhaust the hot air from the equipment room.
2. Ensure the burner has an adequate supply of air. Based on NBIC recommendations, unobstructed air openings must be sized on the basis of 0.5 square inch of free area per 1,000 BTU/hr input maximum fuel input of the combined burners in the equipment room or as specified by applicable codes.

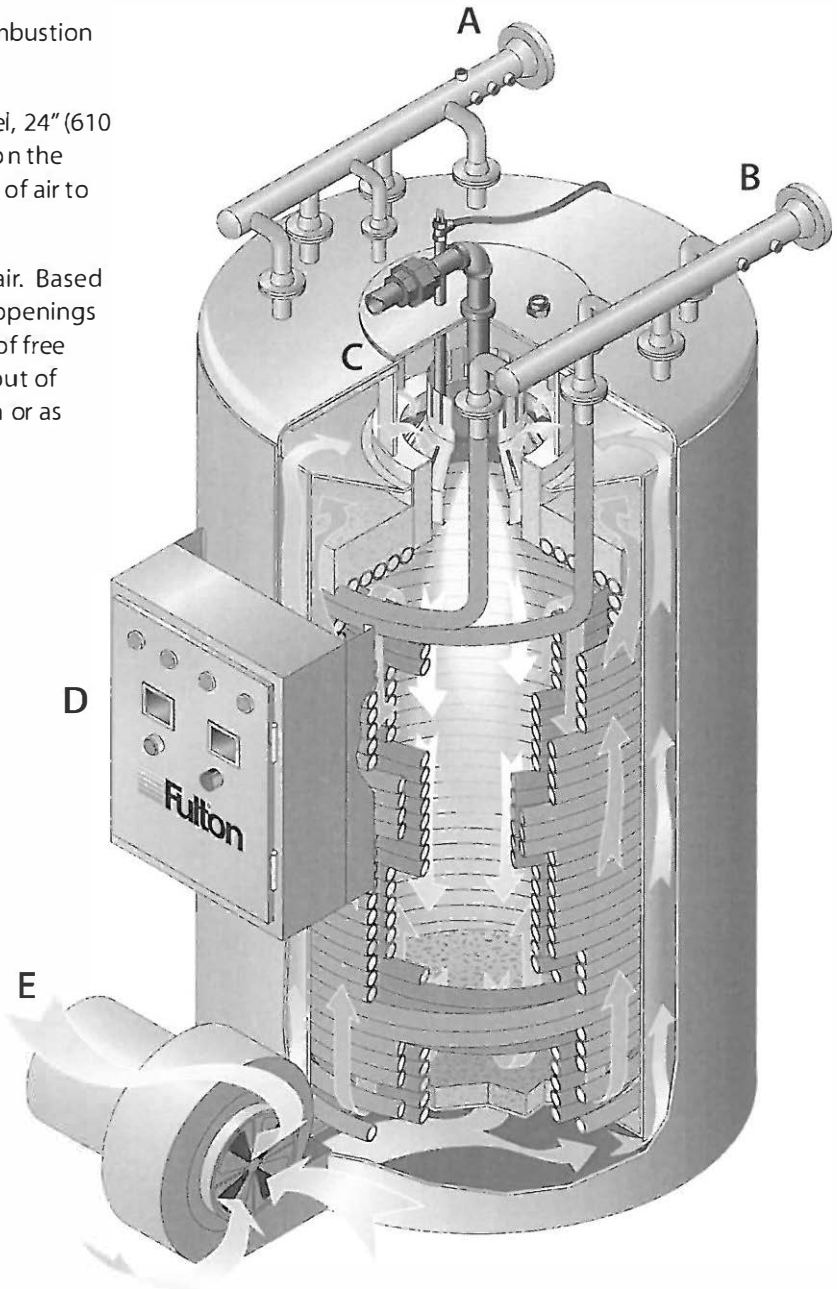

FIGURE 1 -COMPONENT VIEW OF THE FT-C / FT-S THERMAL FLUID HEATER

Legend

A - Fluid Outlet
B - Fluid Inlet
C - Top Mounted Burner
D - Control Panel
E - Fan Inlet

Notes

1. Thermal fluid heater is of four-pass combustion design.
2. First pass (radiant): combustion air enters burner fan and travels upward between inner and outer jacket before it enters top-mounted burner.
3. Second pass (convection): Gases travel back across the inner row of coils.
4. Third pass (convection): Gases continue back down between inner and outer coil.
5. Fourth pass: Upward between the outer coil and inner jacket to the flue outlet.

TABLE 1 - SPECIFICATIONS - COIL DESIGN THERMAL FLUID HEATER

Model FT	0080	0120	0160	0240	0320	0400	0600	0800	1000	1200	1400
Heat Output											
1000 BTU/HR	800	1,200	1,600	2,400	3,200	4,000	6,000	8,000	10,000	12,000	14,000
1000 KCAL/HR	200	300	400	600	800	1,000	1,500	2,000	2,500	3,000	3,500
Thermal Fluid Content											
GAL	10	21	19	31	68	76	132	171	290	383	460
LITERS	38	80	72	116	258	288	498	648	1,097	1,448	1,741
Recommended Flow Rate											
GPM	50	75	100	150	250	250	375	500	615	730	800
M3/HR	11.4	17	22.7	34	56.8	56.8	85.2	113.6	139	167	182
Typical Circulating Pump Motor											
HP	10	10	15	15	20	20	30	40	50	50	60
KW	7.5	7.5	11.2	11.2	14.9	14.9	22.5	29.5	37.3	37.3	45
Typical Burner Motor*											
HP	1.5	3	3	3	5	5	7.5	15	20	20	20
KW	1.1	2.2	2.2	2.2	3.7	3.7	5.6	11.2	15	15	15
Fuel Consumption @ Full Output No.2 Oil											
GPH	7.1	10.7	14.3	21.4	28	35.3	53	69.3	87.1	104.5	122
LITER/HR	27	40.6	54.1	81	108.8	136	201	263.7	329.6	395.5	461.5
Natural Gas											
FT3/HR	998	1,498	1,998	2,999	4,000	4,997	7,498	9,997	12,496	14,998	17,500
M3/HR	38.3	42.4	56.5	84.9	113.2	141.5	212.3	283	353.8	424.6	495.5

*** Std burner, single fuel applications.**

Notes: *Voltage 3 Phase for Burner and Pump - Each unit has an incorporated stepdown transformer. Fuel up to No. 6 Oil Available for Large Units (FT-0600-C and larger). Efficiency up to 80% Minimum Based on High Heating Value of the Fuel (No. 2 Oil @ 140,000 BTU/GHHV; Natural Gas @ 1000 BTU/ft3HHV. Modulation 3 to 1 Turn Down Ratio (5 to 1 for 320). Optional on FT-0080, 0120, and 0160-Standard on all others. Circulating pump motor sizes based on standard pressure (55 PSIG) and viscosity 1 cs, specific gravity 0.7, with 25-37 PSID available head for installation.*

TABLE 2 - DIMENSIONS-COIL DESIGN THERMAL FLUID HEATER (SEE FIGURE 2)

Model FT	0080	0120	0160	0240	0320	0400	0600	0800	1000	1200	1400
Heater Inlet/ Outlet Connections											
IN	1.25	1.5	2	2.5	3	3	4	4	6	6	6
MM	32	38	51	64	76.3	76	102	102	152	152	152
(A) Overall Height											
IN	73.7	80.7	80.6	89.7	100.6	112.4	143.6	143	146.5	146.4	163.1
MM	1,872	2,050	2,046	2,278	2,556	2,856	3,648	3,632	3,721	3,718	4,144
(B) Overall Width											
IN	31.6	34.4	45.9	50.1	49.3	49.3	63.4	70.5	95	108.4	108.4
MM	803	873	1,165	1,273	1,252	1,252	1,611	1,791	2,413	2,753	2,753
(C) Overall Depth											
IN	46.2	60.6	60.6	66.6	80.6	80.6	88.1	107.75	135.1	152.9	152.9
MM	1,173	1,540	1,540	1,691	2,046	2,046	2,237	2,736	3,432	3,882	3,882
(D) Flue Outlet Diameter											
IN	10	10	10	12	14	14	18	20	20	22	22
MM	254	254	254	305	356	356	457	508	508	559	559
Recommended Vertical Stack Diameter											
IN	10	12	12	14	18	18	22	24	24	26	26
MM	254	304	304	356	457	457	558	609	609	661	661
Approximate Dry Weight											
IN	1,500	2,100	2,550	3,400	5,300	5,300	8,250	11,450	19,250	21,700	23,000
MM	700	950	1,150	1,550	2,400	2,400	3.750	5,200	8,750	9,850	10,455

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

A qualified installer, service agency or the gas supplier must perform installation and service on the fuel delivery system.

Do not use matches, candles, flame or other sources of ignition to check for gas leaks.

WHAT TO DO IF YOU SMELL GAS:
Do not try to light the appliance.
Do not touch any electrical switch.
Do not use any phone in the building.
Leave building and contact gas supplier from neighbor's phone. If you cannot reach gas supplier, phone the fire department.

When making gas piping joints, maintain proper ventilation to reduce breathing hazards.

An exhaust fan may draw products of combustion into the work environment creating a possible hazard to personnel.

△ CAUTION

It is essential that only fresh air be allowed to enter the combustion air system. Foreign substances, such as combustible volatiles and lint in the combustion system can create hazardous conditions. If foreign substances can enter the air stream, the combustion air inlet must be piped to an outside location. Failure to do so will void the warranty.

To avoid failures due to poor combustion, ensure make-up air system is properly designed.

3. Ensure the equipment room air supply openings are kept clear at all times.
4. See Table 5 for minimum make-up air required and the recommended area of each opening for each model.

TABLE 3 - APPROXIMATE FLOOR LOADING

Model	Heater Only*
FT-0080C	500
FT-0120C	400
FT-0160C	450
FT-0240C	450
FT-0320C	450
FT-0400C	450
FT-0600C	550
FT-0800C	500
FT-1000C	500
FT-1200C	400
FT-1400C	450
FT-0400S	675
FT-0600S	675
FT-0800S	525

**All weights are lbs/ft²*

TABLE 4 - MINIMUM CLEARANCES FOR COIL REMOVAL

Model	Inches (Meters)
FT-0080C	60 (1.6)
FT-0120C	66 (1.7)
FT-0160C	66 (1.7)
FT-0240C	73 (1.9)
FT-0320C	80 (2.0)
FT-0400C	94 (2.4)
FT-0600C	124 (3.2)
FT-0800C	126 (3.2)
FT-1000C	126 (3.2)
FT-1200C	126 (3.2)
FT-1400C	140 (3.6)
FT-0400S	124 (3.2)
FT-0600S	124 (3.2)
FT-0800S	126 (3.2)

5. If positive forced ventilation is adopted, ensure that there will be no appreciable pressure variation in the equipment room.
6. Avoid ventilation which creates a negative pressure in the building as it will seriously affect combustion and proper operation of the stack. Please note that exhaust fans or similar equipment can create a down draft in the chimney or starve the burner's air supply. Either case may result in poor combustion or nuisance failures.

TABLE 5- MINIMUM MAKE-UP AIR REQUIREMENTS AND RECOMMENDED AREA OF OPENING FOR VENTS

Model	Minimum Make-Up Air(SCFM)*	Opening Area (in2)**Lower Vent	Opening Area (in2) Upper Vent
FT-0080C	200	400	135
FT-0120C	300	600	205
FT-0160C	400	800	270
FT-0240C	600	1200	400
FT-0320C	800	1600	535
FT-0400C	1000	2000	670
FT-0600C	1500	3000	1000
FT-0800C	2000	4000	1335
FT-1000C	2500	5000	1670
FT-1200C	3000	6000	2000
FT-1400C	3500	7000	2335
FT-0400S	1000	2000	670
FT-0600S	1500	3000	1000
FT-0800S	2500	4000	1335

*Minimum make-up air requirements are based on 25% excess air at high fire.
**Opening areas are calculated based input of a single heater and do not account for the ventilation needs of the equipment room. These measurements are subject to state and local regulations.

➨ *NOTE: A properly designed make-up air system in the equipment room will preclude these possibilities and is required to maintain proper combustion.*

7. Eliminate potential for high risk situations for particulate matter to be in the combustion air supply (e.g., as a result of construction and maintenance activities).

Utilities

■ The Gas Supply

Adhere to the following for gas supply installation:

1. Install gas piping in accordance with all applicable codes.
2. Ensure pipe and fittings used are new and free of dirt or other deposits.
3. Ensure piping is of the proper size for adequate gas supply to the gas head assembly. Consult your gas company for specific recommendations.
4. When making gas piping joints, use a sealing compound resistant to the action of liquefied petroleum gases. Do not use Teflon tape on gas line heads.
5. Ensure no piping stresses are transmitted to the equipment. The equipment shall not be used as a pipe anchor.
6. Ensure all vent connections on diaphragms, gas valves, pressure regulators, and pressure switches (gas-fired units) are vented per local code.
7. On gas-fired units with NFPA valve trains, ensure the vent valve is piped to atmosphere per local code. See Figure 4.

Diagram for guidance purposes only. Comprehensive details of dimensions, connections, etc. for each model are given on product dimension data sheets available from Fulton.

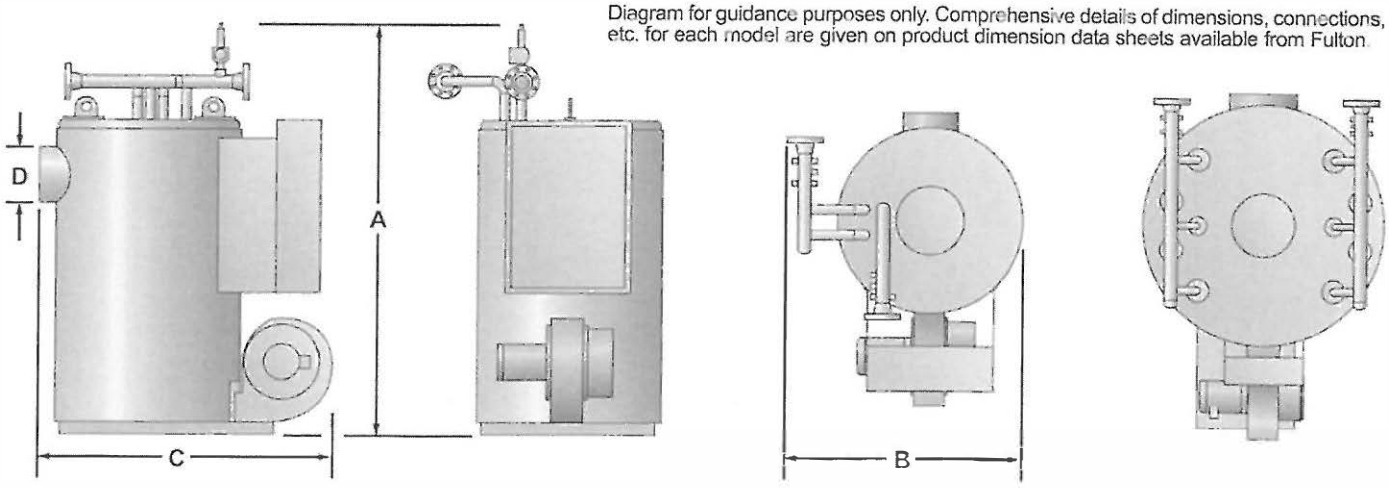

FIGURE 2 - DIMENSIONS (REFER TO TABLE 2)

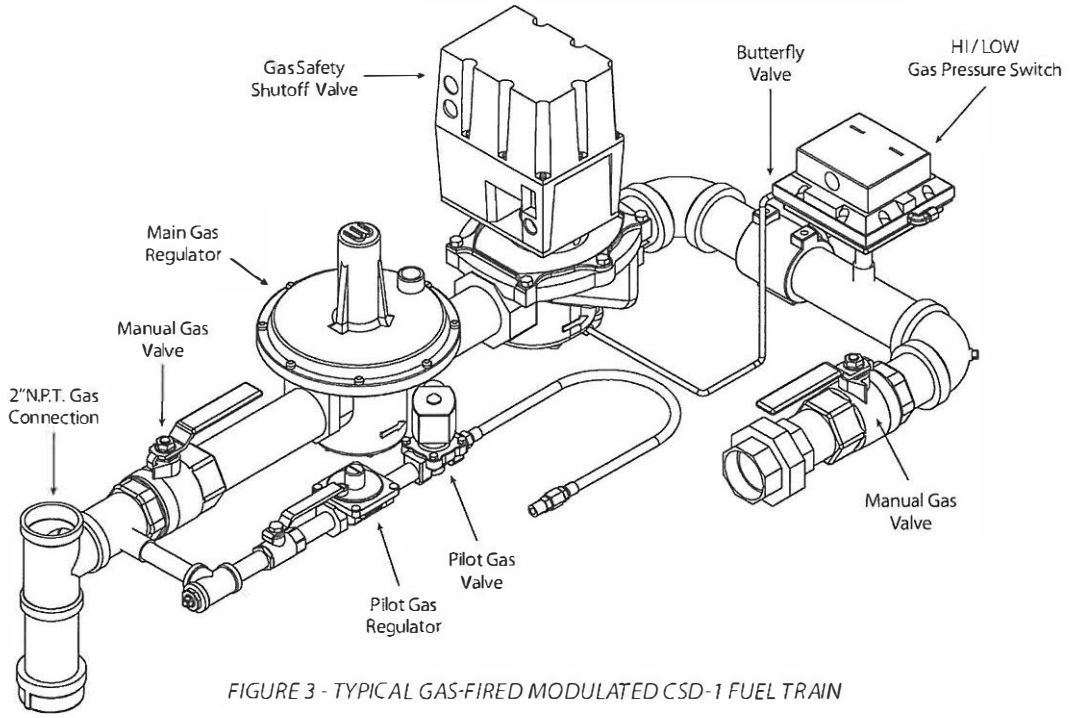

FIGURE 3 - TYPICAL GAS-FIRED MODULATED CSD-1 FUEL TRAIN

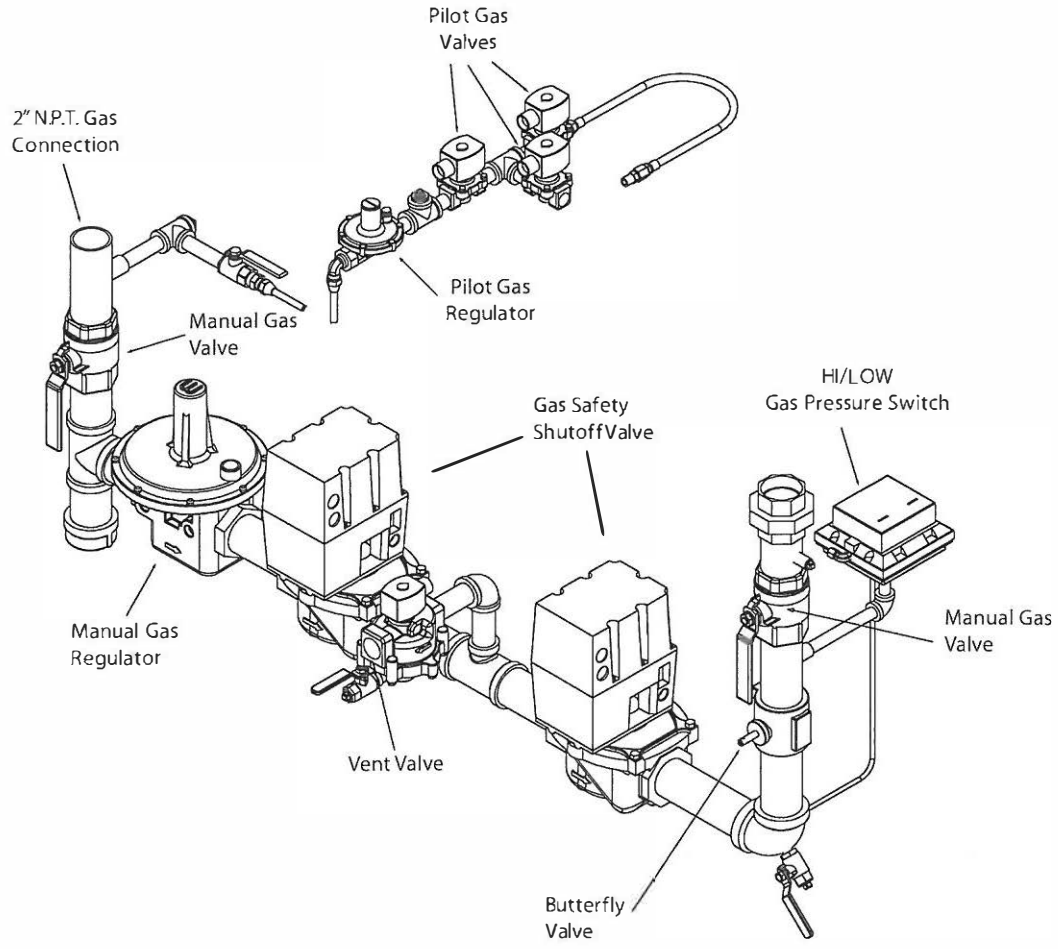

FIGURE 4 - TYPICAL GAS-FIRED MODULATED NFPA FUEL TRAIN

8. During any pressure testing of the system at pressures in excess of 1/2 psig (14 inch W.C.)., disconnect the heater at the heater manual shutoff valve (located at the end of the supplied gas train) from the gas supply piping system.

9. Ensure the supply pressure is regulated by a non-stacking, tight, shut-off regulator.

10. Arrange gas piping so that it does not interfere with any cover or burner, inhibit service or maintenance, or prevent access between unit and walls or another unit.The burner assembly and gas controls terminate at a manual stop valve to which the gas supply should be connected. Piping must be sized for a gas flow consistent with the required BTU/Hr input. Large pressure drops must be avoided. Fulton recommends that the supply piping between the pressure regulator and the inlet to the heater be kept to a minimum. The minimum required gas pressure at the stop valve varies with the model of heater. The requirements for natural gas-fired coil design models are as follows:

   - Models FT-0080-C to FT-0400-C 14"w.c.
   - Models FT-0600-C to FT-0800-C 60"w.c.
   - Models FT-1000-C to FT-1400-C 120"w.c.

NOTE: Note: Low emissions burners for all models require 5 psi.

NOTE: Even when the unit is shut down, the gas supply pressure must never exceed these values.

NOTE: When operating, the supply pressure must not drop below these limits: Not less than 11" w.c. where 14" w.c is required. Not less than 50" w.c. where 60" w.c. is required. Not less than 100" w.c. where 120" w.c. is required.

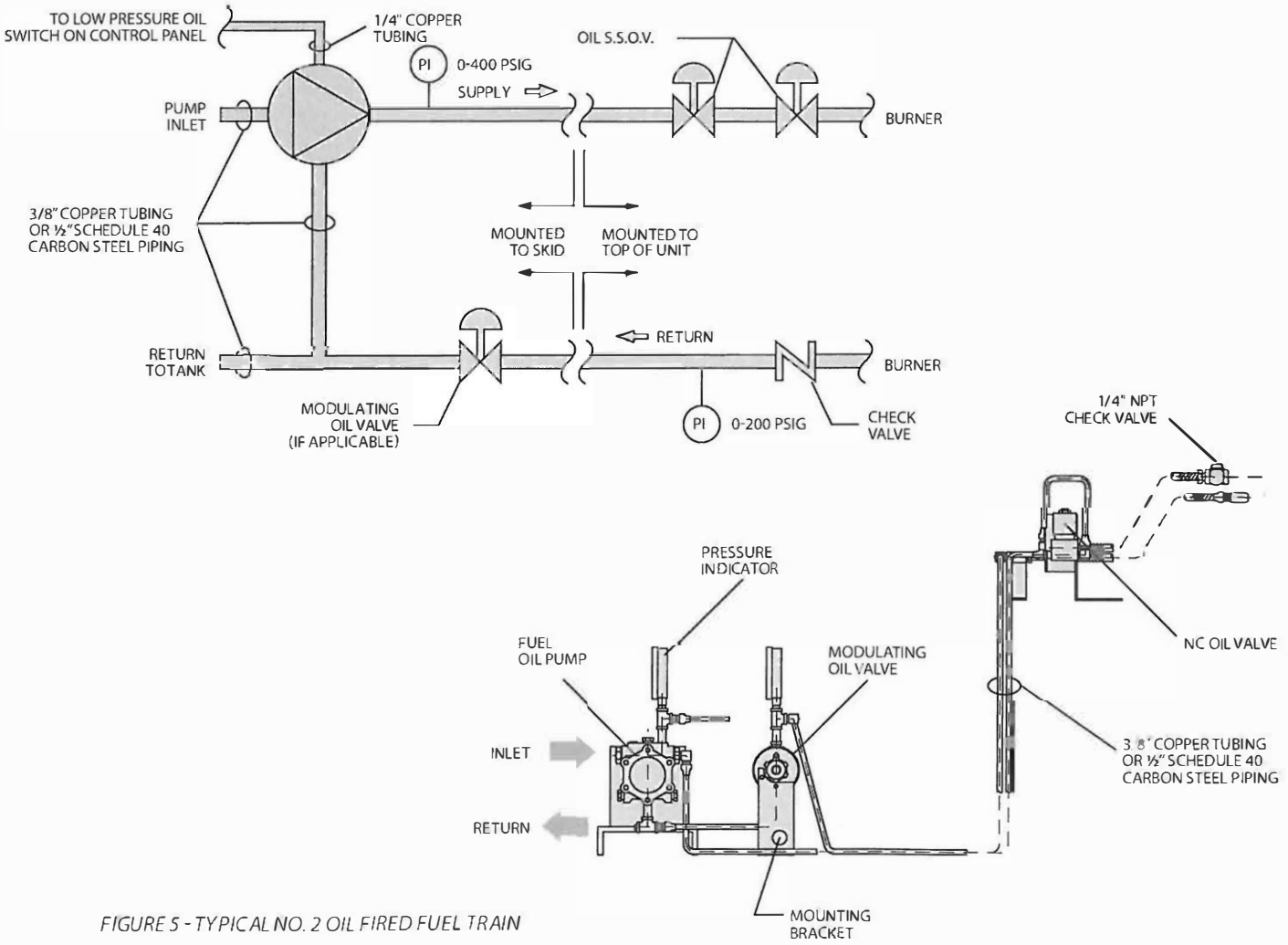

FIGURE 5 - TYPICAL NO. 2 OIL FIRED FUEL TRAIN

⚠ WARNING

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The vent line connection on the gas pressure regulator must be piped to outdoor air by the installer in accordance with National Fuel Gas Code, ANSI Z223-1-1991 or latest addenda. In Canada, gas installations must be in accordance with the current CAN/CGA B149.1 and 2 and/or local codes.

⚠ CAUTION

Some soap used for leak testing is corrosive to certain types of metals. Clean all piping thoroughly after completing the leak check.

11. After gas piping is completed and before wiring installation is started, carefully check all piping connections, (factory and field), for gas leaks. Use a soap and water solution.

■ The Oil Supply

Fuel Oil	Viscosity	Specific Gravity	Sulfur Content
#2	Less than 31.9 Seconds Redwood #1 at 100°F (38°C)	0.824 to 0.852 at 59°F (15°C)	less than 0.40% by weight
#4	Less than 81 Seconds Redwood #1 at 100°F (38°C)	0.90 to 0.93 at 59°F (15°C)	less than 1.6% by weight
#6*	Less than 3000 Seconds Redwood #1 at 100°F (38°C)	0.95 to 0.98 at 59°F (15°C)	less than 2.12% by weight

***Notes:** Propane gas pilot required. Oil must be delivered to the Fulton equipment at 160°F, 3 psi. Fulton equipment will then preheat the oil from 160°F to 230°F. All fuel train components to be rated for the temperature and pressure. Fuel train to be heat traced and insulated.

Adhere to the following for installation:

1. Fuel pipes must be of approved materials and of a diameter suitable for the quantity of oil being delivered to the burner and the static head available. See Figure 5.
2. Make fuel connection in accordance with the details on the enclosed fuel pump cut sheet.
3. Ensure fuel oil piping is in accordance with local/national requirements. In addition, if a two pipe system is employed, a check valve must be fitted into the return pipe.
4. Meet the maximum pressure allowed at the fuel oil pump inlet per the National Fire Protection Association (NFPA).

➨ *NOTE: If for some reason the pressure of the fuel supply will exceed NFPA maximum, fitting a regulator to the fuel line must be considered, e.g. when there is a tank situated with an oil level eight feet (2.4 m) or more above the pump.*

5. On units fitted with NFPA controls, ignition is obtained by means of a gas pilot. A natural gas or LP supply is required for these units. The required gas supply pressure is 7"w.c. If a guaranteed supply of natural gas is not available, then a supply of bottled gas at 11"w.c. is required. For details contact a local liquid propane dealer.

Instrument Air

Instrument air provision for pneumatically actuated control devices should meet the minimum and maximum flow rate and delivery pressures specified by the individual equipment. Additionally, it should be a dry, dust free supply with a dew point of -40°F (-40°C).

Electrical Supply

Adhere to the following for electrical supply installation:

1. Install wiring and ground in equipment in accordance with authority having jurisdiction or in absence of such requirements the National Electrical Code, ANSI/NFPA 70.
2. Provide a wall-mounted, fused disconnect sized for the unit. This must be fitted by the client/contractor if disconnect is not supplied on the panel.
3. Size fuses according to motor name plates and local electrical codes.
4. Connect power to the terminal strip as supplied on the inside of the panel box.

➨ *NOTE: Single skid systems are generally shipped completely prewired.*

➨ *NOTE: The liquid level switch on the expansion tank, when supplied, will be shipped in the parts box and must be installed in the field.*

5. Determine multiple skid systems wiring requirements (between the skids). Fulton will run conduit and wire the devices on each skid. For the devices that have to come down for shipping, the wire will be left at the end of the conduit where possible and wired in the field (by others). When the system has multiple skids that are adjoining, the conduit will be installed to break at the skid joints. The wire for the conduit running between the skids will be shipped loose to prevent damage when the skids are put back together. These wires will need to be run by the installing contractor in the field and wired to proper locations. If there is wiring between skids that are not adjoining, then this will need to be done by qualified personnel.

➨ *NOTE: If the unit is not skid-mounted at the factory, the client/contractor is required to wire the circulating / feed water pump starter.*

➨ *NOTE: If the circulating pump motor is not supplied by Fulton, the motor starter will not be supplied.*

6. Locate electrical schematic diagram, a copy of which is inside of the panel box.
7. Ensure the information on the electrical drawing corresponds to your voltage and frequency. Adhere to the following:

- Typical 120 VAC controls allow for a +10% and -15% voltage fluctuation.
- Motors are designed to operate within the following limits at the motor terminals: AC power supplied is within +/- 10% of the motor rated voltage with the rated frequency applied; or AC power supplied is within +/- 5% of the rated frequency and with the rated voltage; or a combined variation in voltage and frequency of +/- 10% (sum of absolute values) of rated values provided the frequency variation does not exceed +/-5% of rated

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

Assure all electrical connections are powered down prior to attempting replacement or service of electrical components or connections of the equipment.

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

If a fire does occur, extinguish using CO_2, foam or dry chemical. DO NOT USE WATER.

⚠ CAUTION

Some plastics can be dissolved by thermal fluid.

frequency.

- For 3-phase motors, the line to line full load voltage must be balanced within 1% of the rated motor voltage. If the motor is rated 208-230V, the voltage deviations must be calculated from 230V. Operation outside of these limits will degrade motor performance. 575V rated motors cannot be operated at voltages above 600V. Depending on the motor manufacturer, a 208V rated motor may not be able to run below the design voltage.
- Electric elements will have an increase n watt density if the applied voltage is higher than the element design voltage. Therefore, electric elements have a 0% tolerance for operation over design voltage. Electric elements can tolerate a lower than design voltage but the kW must be derated accordingly.
- Normal supply will be 460 volts, 3 phase, 60 Hz, AC unless otherwise specified.

Thermal Fluids

■ Thermal Fluids at Elevated Temperatures

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

Adhere to the following:

1. Be aware that 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.
2. Check that flanged joints are tight during and after the first warming up of the system. Turn Burner and pump off before fittings are tightened. After these checks, exposed hot flanges, pumps, valves and fittings should be fitted with some sort of shield.
3. Remember that there is pressure generated in the system by the circulating pump. Care should be exercised when opening any drain or vent valves in the system. 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.

■ Selecting a Thermal Fluid

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.

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 recommendations from Fulton Thermal Corporation or the fluid manufacturer.

Consider the following for selection:

1. 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.
2. The safe maximum bulk temperature of the fluid must be strictly adhered to. The safe maximum temperature of the fluid varies.
3. 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. It is the BULK fluid temperature and NOT the FILM temperature that is indicated by the instruments.
4. As a general guide, the following list of fluids that have given satisfactory service over many years is provided. This is by no means a complete list. Any fluid specifically designed for heat transfer use may be considered; multipurpose oils are not acceptable.
   - AMOCO Transfer Oil 4199
   - CHEVRON
   - DOW G
   - EXXON 43
   - MOBIL
   - MONSANTO
   - MULTITHERM
   - PARATHERM
   - PETROCANADA T
   - SHELL
   - TEXACO
5. Any fluid specifically designed for heat transfer use must also exhibit these characteristics:
   - Be a stable and homogenous liquid to a temperature of at least 100°F (38°C) over and above the maximum intended temperature of utilization, compatible with metals used in the installation, and tolerating contact with atmospheric air.
   - No solid matter in suspension.
   - Non-toxic in the case of leakage.
   - Sufficient lubricity, i.e. not likely to cause seizure.
6. The thermal fluid manufacturer must guarantee the characteristics of the

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Fulton Companies is not responsible for any injury or damage caused by the use of inadequate fluid.

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⚠ CAUTION

Proper selection of thermal fluid is critical to system performance.

If excessive amounts of thermal fluid are vented from the system, additional thermal fluid may be required in the system. Contact Fulton for further information.

product, and verify that the fluid bulk temperature limitation exceeds the expected operating temperature

7. After a fluid is selected, refer to the manufacturer's recommendations, published in compliance with the Occupational Safety and Health Administration (OSHA).

8. If the fluid expansion volume from 50°F to 600°F (10 C to 316°C) exceeds 20% of the initial fluid volume, consult Fulton Thermal Corporation.

■ Routine Analysis of Heat Transfer Fluid

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.

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.

Fulton Thermal Corporation recommends that the thermal fluid in your system be analyzed within the first two months after startup and annually thereafter.

During the first few months of operation, sampling may be carried out at frequent intervals to confirm that system performance has been predicted correctly.

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.

■ Thermal Fluid Breakdown

The possibilities of thermal fluid breakdown are very slim in a typical closed loop thermal fluid system. Fulton's combination expansion/deaerator/thermal buffer tank creates a "cold seal" of fluid that is slightly above ambient temperature. This prevents oxidation that will otherwise happen when high temperature fluid contacts air.

Oxidation of the fluid 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.

▶ THERMAL FLUID BREAKDOWN PREVENTION

- Multiple pressure switches and a differential pressure switch are used to prevent this condition from occurring. See Figure 6. These safeties must not be bypassed at any time.
- 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.

- A high temperature limit switch is 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 reset button on the flame programmer must also be pressed to reset the unit before it can be restarted. See Figure 7. Refer to **Maintenance** section of this manual for troubleshooting activities.

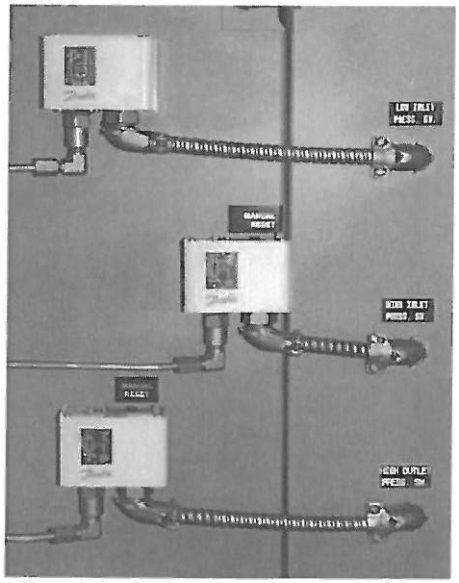

FIGURE 6 - PRESSURE SWITCHES

FIGURE 7 - TEMPERATURE LIMIT DISPLAY

Piping Specifications

For piping, the basic considerations are: the design temperature, the pressure retained by the pipe, the fluid in the pipe, the load resulting from thermal expansion or contraction, impact or shock loads imparted such as water hammer, external loads, wind loads and vibration from equipment.

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CAUTION

The weight of all piping must be properly supported. Failure to support piping may result in equipment damage and/or system leakage.

Piping must take into consideration potential for damage as a result of expansion, contraction, vibration, or other movements.

Dirt, water, and/or other debris in the piping system after welding may result in equipment failure.

Adhere to the following for piping installation (see Figure 8):

1. Ensure the arrangement of the piping and its appurtenances takes into consideration the location of other structures and equipment adjacent to the piping, which may result in freezing interference and/or damage as a result of expansion, contraction, vibration, or other movements.
2. Consider the appropriate location and orientation of valves necessary for safe operation and isolation of the piping. Valves are used in piping systems to stop and start the flow of fluids, to regulate flow, to prevent the back flow, and to relieve excessive pressure build up in the piping.
3. Ensure all piping and piping components are suitable for the design temperatures, pressure and fluid used in the system.
4. Ensure all components exposed to thermal fluid flow, including pipe, valves, and screens, are not copper, copper alloys, bronze, brass, 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.
5. Ensure all pipework is constructed from seamless mild steel pipe, conforming to ASME SA 106B or SA 53B, Schedule 40, Schedule 80, or equal, based on design temperature and pressure of the system.

Legend

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
8. Expansion Joints
9. Anchor and Pipe Guides
10. Expansion Tank
11. Vent Piping
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, expnasion tank, vent)
16. Valve
17. Strainer
18. 3/4"System Fill Connection
19. Flexible Connection
20. Isolating Valve
21. Manual Low Level Test Line
22. Manual High Level Test Line
23. Buffer Drain

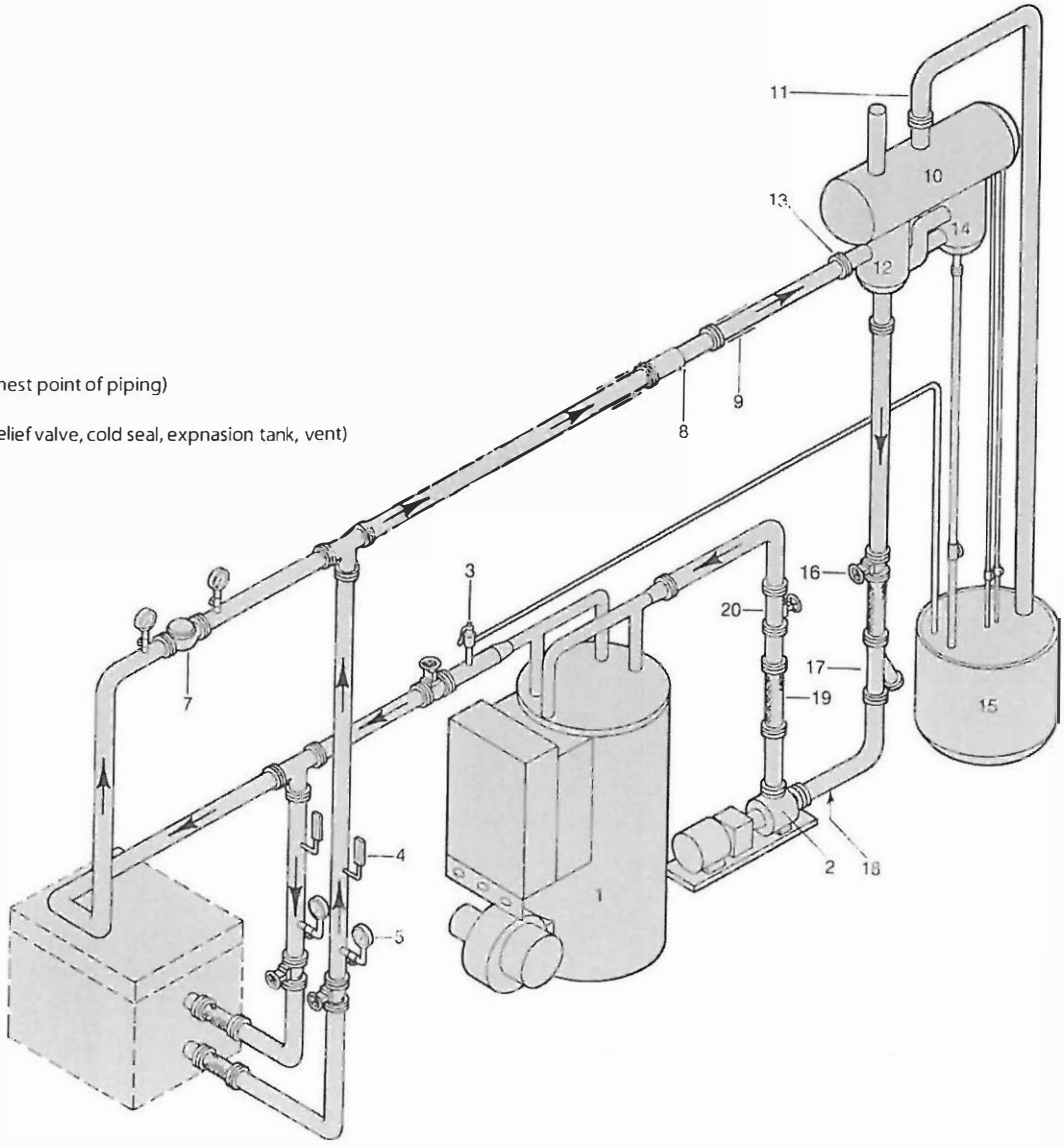

FIGURE 8 - TYPICAL THERMAL PIPING SCHEMATIC

6. 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.

7. Where secondary circulating pumps are installed, ensure the system is suitable for the aggregate head, against a closed valve, of both pumps.

8. During construction of the installation, ensure that no dirt, water, or residue from welding is left in the system.

9. Consider expansion joints or pipe loops to accommodate thermal expansion. Design should be per latest edition of ASHRAE Systems and Equipment Handbook to prevent detrimental forces and stresses at connected equipment. 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 grow axially and can be expected to expand approximately 1"over 100ft @ 100°F temperature rise (1mm per meter over 100 C rise).

10. Provide properly designed supports and anchors for all piping where necessary to prevent undue stress from being imparted on equipment such as pumps, valves and the heater. Care should be taken as end reactions transmitted to rotating equipment, such as pumps, may deform the equipment. Therefore equipment manufacturers' recommendations on allowable forces and movements should be followed. See Figure 9.

11. Ensure all pipe joints are 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. All flanges should be welded to the pipe and not screwed. Depending on the size, flanges should be 150# or 300# raised face flanges, SA105.

12. Ensure 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.

13. If screwed connections have to be made, e.g., to items of control equipment, use a thread sealant suitable for use with fluids at elevated temperature. Teflon tape, standard pipe sealant, or hemp and paste are not acceptable.

14. Cut screw threads carefully and accurately. If possible,

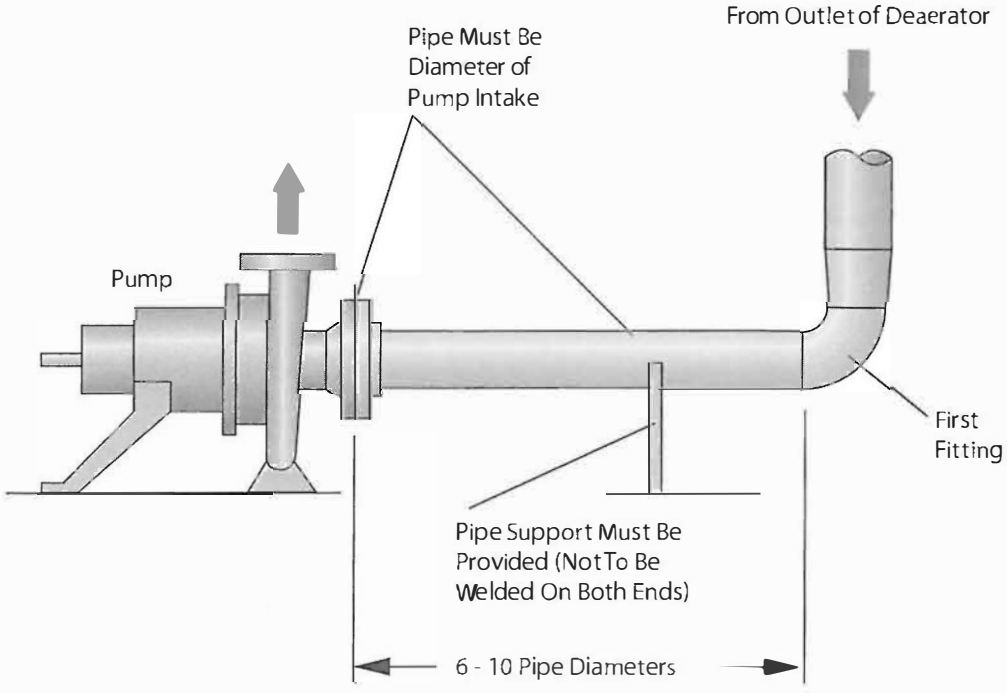

FIGURE 9 - TYPICAL PUMP PIPING

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new tools should be used. Threaded connections larger than 1" are not to be used. It is recommended that GR5 or higher tensile steel bolts be used for all flanged joints.

15. Use gaskets to make all flanged connections. Gasketing material must be suitable for use with the pressure, temperatures and fluids in the system. Flexible graphite gaskets are suited for most applications. Recommended gasket thickness is 1/10 - 1/8 inch. Ensure that all bolts are tightened evenly and to the torque recommended values provided by the gasket manufacturer. Refer to Figure 10 and Tables 6-9 for guidelines.

NOTE: Typical gaskets used by Fulton include JM Clipper Elastograph gaskets and Flexitallic gaskets. Adhere to installation instructions and torque requirements for these gaskets.

16. Install high point bleeds at all high points in the system piping. 1/2"x 12" nipples welded in the top of the piping with ball valves and plugs attached are to be used.

NOTE: It will save a considerable amount of time during the cold filtration if the system piping is cleaned prior to assembly. The mill scale (the results of oxidation) on the inside of the piping as well as construction debris can foul the fluid and cause the need for the filters (strainers) 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.)

17. Install all pipes with a pitch to facilitate draining and venting.

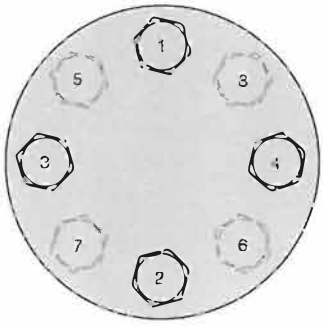

FIGURE 10 - BOLTING SEQUENCE FOR 4 AND 8 BOLT FLANGES

TABLE 6 - RECOMMENDED GASKET LOADS FOR FLEXITALLIC SPIRAL WOUND CLASS 150# GASKETS SAE GRADE 5 BOLTS OR EQUAL

Nominal Flange Size (inches)	Number of Bolts	Diameter of Bolts (inches)	Preferred Torque Req. Per Bolt (ft-lb)
1/2	4	1/2	45
3/4	4	1/2	45
1	4	1/2	45
1 1/4	4	1/2	45
1 1/2	4	1/2	45
2	4	5/8	90
2 1/2	4	5/8	90
3	4	5/8	90
3 1/2	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

TABLE 7 - RECOMMENDED LOADS FOR FLEXITALLIC SPIRAL WOUND CLASS 300# GASKETS SAE GRADE 5 BOLTS OR EQUAL

Nominal Flange Size (inches)	Number of Bolts	Diameter of Bolts (inches)	Preferred Torque Req. Per Bolt (ft-lb)
1/2	4	1/2	45
3/4	4	5/8	90
1	4	5/8	90
1 1/4	4	5/8	90
1 1/2	4	3/4	150
2	8	5/8	90
2 1/2	8	3/4	150
3	8	3/4	150
3 1/2	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

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TABLE 8 - RECOMMENDED LOADS FOR JM CLIPPER ELASTOGRAPH 150# GASKETS SAE GRADE 5 BOLTS OR EQUAL

Nominal Flange Size (inches)	Number of Bolts	Diameter of Bolts (inches)	Preferred Torque Req. Per Bolt (ft-lb)
1/2	4	1/2	30
3/4	4	1/2	30
1	4	1/2	30
1 1/4	4	1/2	30
1 1/2	4	1/2	30
2	4	5/8	60
2 1/2	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

TABLE 9 - RECOMMENDED LOADS FOR JM CLIPPER ELASTOGRAPH 300# GASKETS SAE GRADE 5 BOLTS OR EQUAL

Nominal Flange Size (inches)	Number of Bolts	Diameter of Bolts (inches)	Preferred Torque Req. Per Bolt (ft-lb)
1/2	4	1/2	30
3/4	4	5/8	60
1	4	5/8	60
1 1/4	4	5/8	60
1 1/2	4	3/4	100
2	8	5/8	60
2 1/2	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

Insulation

After the appropriate system tests have been satisfactorily completed (see **Testing** section of this manual), all hot pipework and vessels must be adequately insulated with material suited to the temperature and application to prevent both heat loss and personnel injury.

Adhere to the following for insulation installation:

1. For inspection and maintenance purposes, leave pumps, flanges, valves and fittings uninsulated but suitably shielded for safety.
2. Insulate the deaerator section of the combination tank.
3. Do not insulate the thermal buffer and expansion sections of the combination tank. 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 it is not necessary.
4. Ensure hot oil pipe insulation is a minimum of 2" (51 mm) thick, high temperature, laminated, foamglass cellular glass insulation as manufactured by Pittsburgh Corning Corporation or equal.
5. For heaters equipped with flue gas recirculation (FGR) on the burner, the ducting must be insulated to prevent personnel injury.

System Interfaces

Proper selection and installation of the components in the hot oil system will ensure proper and safe operation of the heater.

■ Heater Connections

Adhere to the following for heater connections:

1. Connect the outlet of the pump directly to the inlet of the heater via an isolating valve (preferably a throttling valve) and pump flexible connector.
2. Pipe heater outlets directly to the system via an isolating valve.
3. 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.

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To maintain a reasonable temperature in the equipment area and ensure safety to personnel, the section of the chimney duct within the building should be insulated.

Due to extremely high operating temperatures of the thermal fluid, all exposed pipework should be insulated, and exposed hot flanges, pump, valve, and fittings should be shielded. Refer to Insulation section of this manual for details.

No shutoff of any kind may be placed between the safety relief valve and the equipment, or in the discharge pipe between such valve and the atmosphere. Doing so may cause accidental explosion from overpressure.

Discharge from safety relief valve must be configured so that there is no danger of scalding personnel or causing equipment damage. Provisions must be made to properly drain safety relief valve discharge piping.

Failure to insulate ducting on equipment with Flue Gas Recirculation on the burner may result in personnel injury.

■ Thermal Fluid Circulating Pump

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 obtained from the manufacturer.

Adhere to the following for pump installation (see Figure 9):

1. Locate pump adjacent to the heater. Its base must be firm, level (preferably concrete), and free from vibration.
2. Route pump 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.
3. Connect suction pipe work directly to the deaerator section via a vertical run with as few elbows as possible. It 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:

- It be a straight run of pipe.
- 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.
- The pipe used should be the same size as the inlet of the pump.
- 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.
- 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.

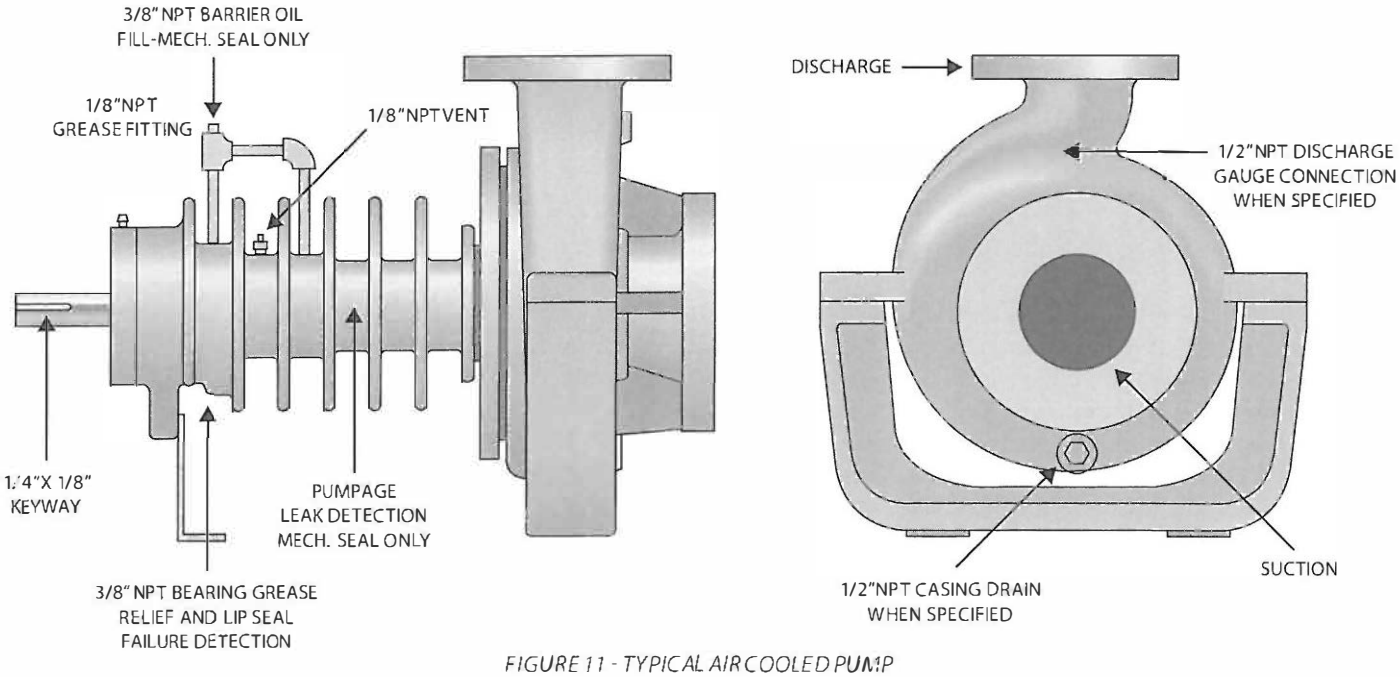

FIGURE 11 - TYPICAL AIR COOLED PUMP

- 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.
- 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.
- An oiler is shipped with each water cooled pump and should be filled with lubricating oil recommended by the manufacturer. The suggested lubricant is usually a SAE-30 non-detergent oil.
- Thermal fluid is not sufficient lubrication for bearings.
- 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.
- 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.
- 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.

■ Requirements for Air Cooled Pumps

Adhere to the following (See Figure 11):

1. Allow for free air flow around the entire pump casing at all times.
2. Maximum room temperature should be 100°F (38°C).
3. In no case should any part of the drive side of the pump be insulated.
4. Maximum operating temperature for air cooled pumps varies by manufacturer. Consult instruction manual to verify.

■ Requirements for Water Cooled Pumps

Adhere to the following for (See Figure 12):

1. Requirements for water cooled pumps will vary with manufacturer. Consult manufacturer's instructions for flow rate and temperature requirements.
2. Check local codes regarding disposal of hot water.

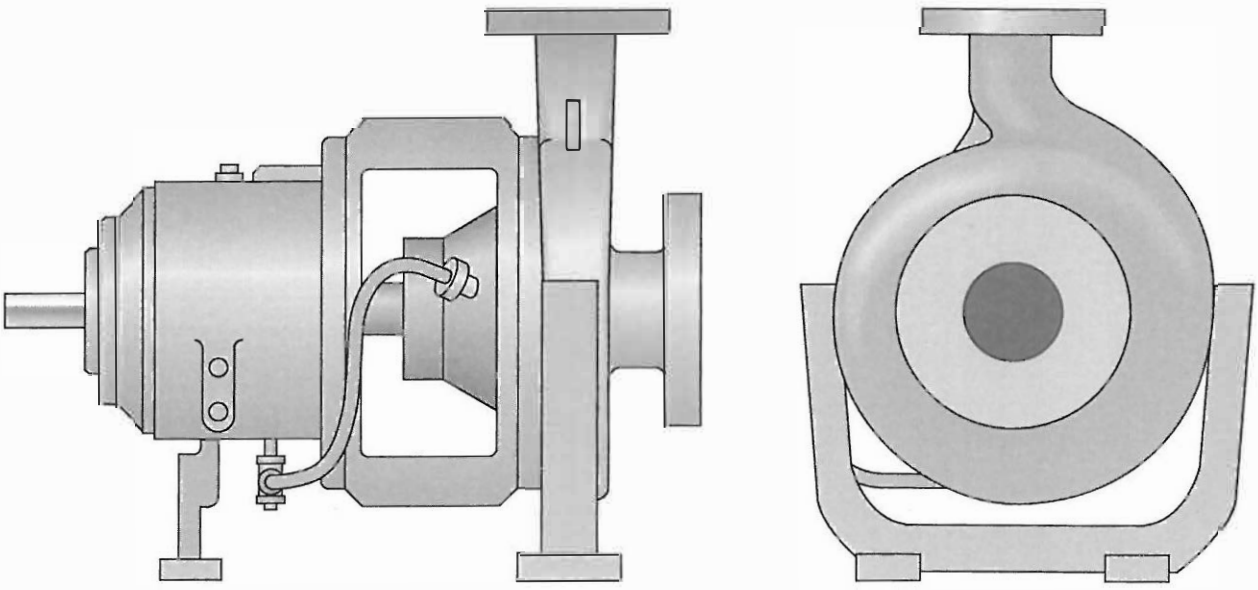

FIGURE 12 - TYPICAL WATER COOLED PUMP

⚠ WARNING

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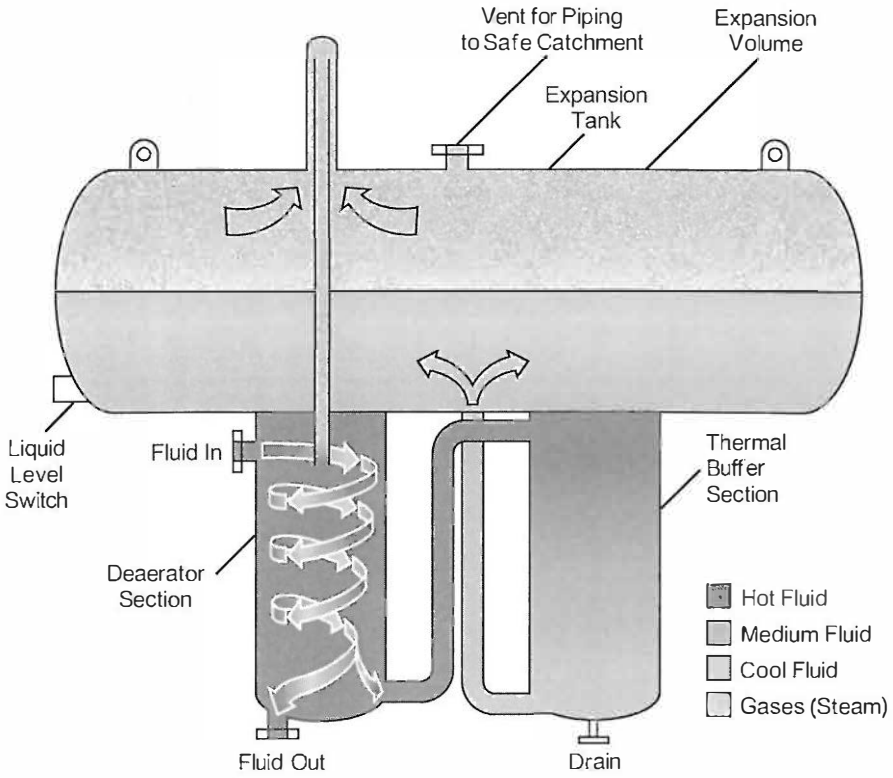
■ Combination Deaerator/Thermal Buffer/Expansion Tank

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.

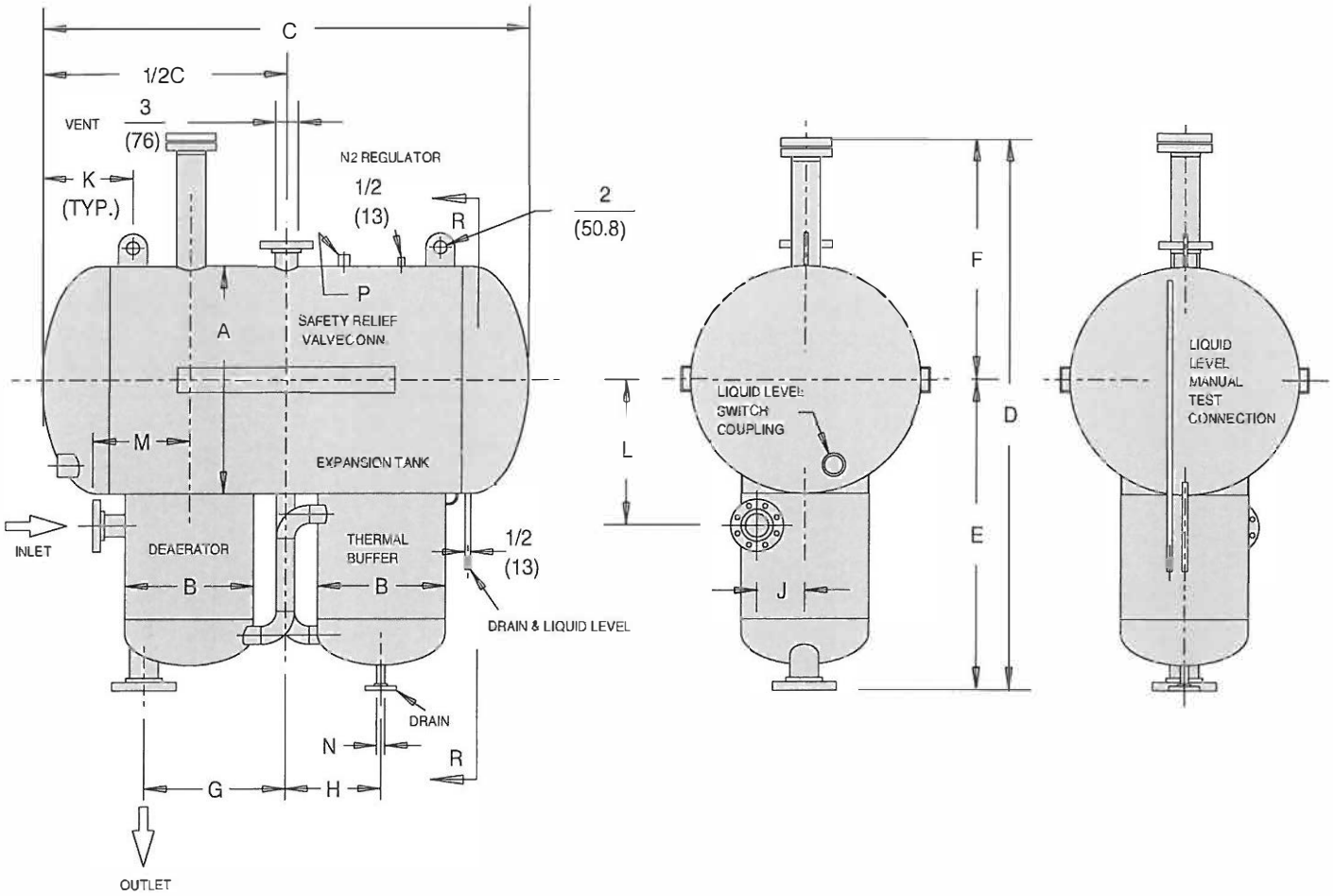
The expansion section is vital to the thermal fluid system. From ambient to operating temperature, the thermal fluid in the system will typically expand in the range of 25% to 50%, and a vessel capable of handling this expansion is mandatory. The customer should confirm the expansion rate of the chosen fluid and system volume.

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 air 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.



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

FIGURE 13 - EXPANSION TANK DETAILS



Model	A	B	C	D	E	F	G	H	J	K	L	M	N	P	CAP	Dry Wt.	Max Full Wt.
FT-0200-L	20 (510)	12 3/4 (325)	54 (1370)	60 5/8 (1540)	34 (865)	26 5/8 (676)	16 11/16 (424)	12 (305)	4 1/2 (115)	4 1/4 (108)	15 (380)	12 15/16 (329)	3/4 (20)	3/4 (20)	52 (200)	636 (289)	1314 (596)
FT-0500-L	26 (660)	16 (405)	74 (1880)	66 5/8 (1692)	37 (940)	29 5/8 (752)	19 3/4 (502)	14 (355)	6 (150)	11 1/2 (290)	18 (460)	14 15/16 (379)	3/4 (20)	3/4 (20)	132 (500)	970 (440)	2450 (1111)
FT-1000-L	36 (915)	20 (510)	76 (1930)	87 5/8 (2226)	49 (1245)	38 5/8 (981)	22 1/4 (565)	15 (380)	7 11/16 (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)	38 5/8 (981)	24 3/4 (629)	17 1/2 (445)	8 (203)	14 (355)	24 (610)	14 15/16 (379)	1 (25)	1 1/4 (32)	397 (1500)	1710 (776)	5875 (2667)
FT-2000-L	42 (1070)	22 (560)	106 (2690)	107 5/8 (2734)	62 1/2 (1590)	45 1/8 (1146)	31 3/16 (792)	24 (610)	8 1/2 (216)	15 1/2 (394)	28 (710)	14 15/16 (379)	1 (25)	1 1/2 (38)	528 (2000)	2550 (1134)	8230 (3733)
FT-3000-L	42 (1070)	26 (660)	140 (3556)	115 1/8 (2924)	70 (1778)	45 1/8 (1146)	33 3/16 (843)	24 (610)	9 15/16 (252)	15 1/2 (394)	28 (710)	18 15/16 (481)	1 (25)	1 1/2 (38)	793 (3000)	3200 (1451)	11,610 (5265)
FT-5000-L	60 (1524)	26 (660)	130 3/8 (3312)	132 1/8 (3356)	77 1/2 (1969)	54 5/8 (1387)	32 3/16 (818)	24 (610)	9 3/8 (238)	20 5/8 (524)	37 (940)	18 15/16 (481)	1 (25)	1 1/2 (38)	1321 (5000)	5300 (1637)	17,370 (7895)

Inlet and outlet dimensions vary with installation. All dimensions are approximate. Specifications are subject to change without notice. Dimensions are in inches (mm). Capacities are in gallons (liters). Weights are in pounds (kg).

FIGURE 14- COMBINATION/EXPANSION/DEAERATOR THERMAL BUFFER TANK

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

High temperature thermal fluid, steam, and combustible vapors may be vented through the vent connection on the combination deaerator/thermal buffer/expansion tank.

⚠ CAUTION

Non-code tanks cannot be pressurized over 15 psig.

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.

■ Sizing The Expansion 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 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 (102 mm) to "make" the liquid 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.

▶ SIZING 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 for a total of 200 gallons.

You look up the expansion rate for the thermal fluid. (Assuming 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.

Adhere to the following for installation:

1. Install tank 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. Take into account the head required at the circulation pump suction inlet to avoid the possibility of pump cavitation.
4. In systems operating close to maximum fluid temperature, ensure the tank is 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** section of this manual.
5. Provide supports for tank mounting. These should be suited for supporting the tank by the side rails. The eyelets fitted to the tank are for lifting only.

■ Pressurized Systems

Nitrogen pressurization may be used if 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, or at any time to further protect the fluid from oxidation.

In conjunction with this system, adhere to the following:

1. An automatic venting device must be fitted to the system expansion tank. Consult Fulton Thermal Corporation for further details.
2. The location for the liquid level switch (Figure 15) 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.
3. If the tank is located outdoors, nitrogen is required.

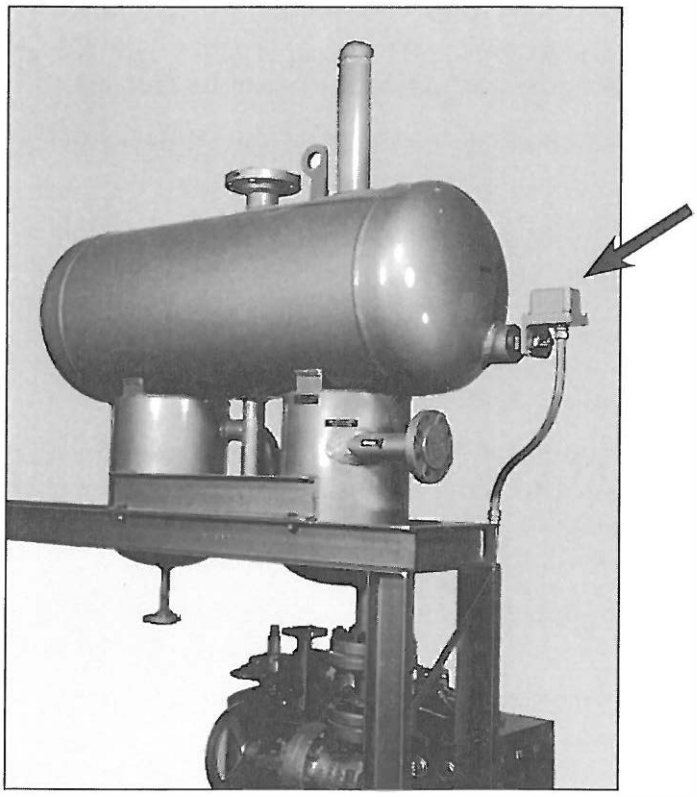


FIGURE 15 - LIQUID LEVEL SWITCH LOCATION

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

Failure to ensure vent connections terminate into a well-ventilated area with catch tank may create an environmental hazard.

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

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 Material Safety Data Sheet (MSDS) for your thermal fluid for flammability limits.

⚠ CAUTION

If the deaerator/thermal buffer/ expansion tank is located outdoors, a nitrogen blanket is required.

■ Vent Connections

Adhere to the following for vent connections:

1. Make vent connection 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.
2. Make the vent run the same size as the tank outlet. It should run pitch down from the outlet of the tank to the catch tank.
3. If nitrogen is used on the system, the vent can be reduced to 2" (51 mm) and should be piped with a positive closing valve at the catch tank.
4. Ensure the connection between the tank outlet and the horizontal pump inlet is as close to a vertical drop as possible. It should have the minimum bends and length of pipe.
5. Ensure the inlet to the deaerator is higher than or equal to the highest point in the system, or a pressurized system must be used.
6. Field-install the liquid level switch (supplied and shipped with the unit). This must be wired to the control panel.
7. Ensure test connections are accurate. 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 4" (102 mm) below the top; the low level rises 2" (51 mm) from the bottom of the tank.
8. 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. Installation of the valves should be accomplished in such a manner that any flow will be visible when the valves are open.
9. 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.
10. There is a 300 #, 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.
11. An inspection opening is located at the highest point on the tank. Access to this port is recommended but not required.
12. Refer to the maintenance schedule for recommendations on draining the buffer tank. For positioning of all connections on tank, see Figure 14.

■ Catch Tank

Adhere to the following for the catch tank:

1. Ensure the heater safety relief valve outlet and connections on the DA tank are piped to a safe catch tank. The catch tank must be appropriately sized based on the system volume and configuration.
2. Under normal operating conditions, the catch tank should be empty. Fluid that is expelled into the tank should not be reintroduced into the system.
3. Ensure the vent from the catch tank is located and installed in such a manner as to protect personnel and property from discharge of steam, water, and thermal fluid. Vent outlet should be positioned in a safe location outside of heater room.

■ Drain/Fill Connection

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. See Figure 16.

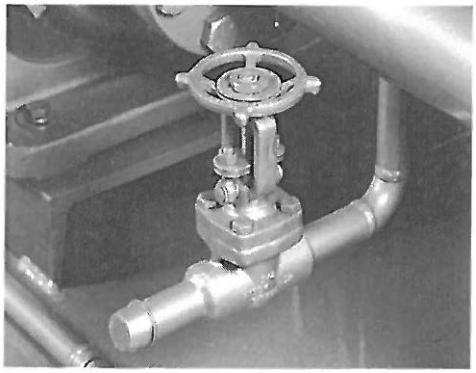


FIGURE 16 - DRAIN AND FILL CONNECTION

■ Pressure Gauges

The range in which readings are expected to fall should comprise mid-scale on the pressure gauge chosen (See Figure 17). Pressure gauges must be able to

FIGURE 17 - GAUGES

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

Failure to properly locate and install vent connections may cause personnel and property damage.

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

withstand overpressure equal to the rating of the safety relief valves (normally 100 psig).

■ Thermometers

Thermometers should read up to 650°F (343°C). For systems with higher operating temperatures, thermometers should be selected accordingly.

■ Valves

Adhere to the following for valve installation:

1. Use vent and drain valves that normally are 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" (30.5 cm) long.
2. Use gasketing material specifically suited to the task.
3. Fit drain valves at all low points in the pipework system and ventilating valves at all high points in the installation. Valves must be fitted with either the conventional packed stuffing box seal or a bellows seal as required.
4. 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 backseating to allow re-packing without draining the system.
5. In all units, install a "Y" type strainer in the fluid return line, between the deaerator tank and the circulating pump. 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.
6. Check the pump suction pressure 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.
7. Ensure manual control and isolating valves are of 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.
8. When ordering valves, obtain the maximum possible service temperature and type of fluid. A partial list of manufacturers known to market valves of acceptable quality follows:
   - Stockham Valves and Fittings Company
   - Velan
   - Vogt Machine Company
   - Worcester Valve Company

■ Automatic Fluid Control Valves

Because of the widely varied processes in which Fulton Thermal Fluid Heaters are used, it is not possible to provide specific rules for the selection of automatic fluid control valves. Generally, these valves must satisfy the specific materials and construction requirements.

The type of operation and design of porting are governed by the degree of control required as well as the particular application.

■ By-Pass Valves

When process flow requirements do not match heater flow requirements, a by-pass valve must be installed. If the process flow will vary with the system load, a suitable bypass system can be recommended by Fulton Thermal Corporation.

Assembly of Fulton Multi-Skid Engineered Systems

Adhere to the following for multi-skid engineered systems:

1. Refer to the Fulton mechanical/electrical drawings during assembly.
2. Ensure that equipment orientation allows for operation interface and maintenance.
3. Align the skids as shown on the drawings ensuring that skid fasteners (skid joint angles) are matched. The skid joint angles are a matched set and the edges of the fasteners should be exactly aligned.

✏ *NOTE: Do not bolt the skids to the housekeeping pad/floor until all of the piping has been reassembled and tightened.*

4. Ensure the skids are level and flat before fastening the skids together with the supplied bolts. The skids should be leveled front to back, side to side and corner to corner. Failure to properly level the skids will result in piping misalignment. A level or laser level should be used to verify skid alignment (when a standard level is used, the length should be appropriate for the skid). If assembling multi-component support stands, attach sections using the supplied bolts through the tank frame mounting plates. These should be hand tight until all of the piping is assembled. Note: skids are leveled at the factory using a laser level.
5. Connect the piping between the skids by matching the union connections and/or flange stamps and tightening. Refer to the mechanical drawing as necessary to confirm location of spool pieces etc. as the flange stamps are shown on the drawing in hexagonal callouts. The flange stamps should matched and aligned (the flange stamps should be directly across from one another. Rotating a flange will result in piping misalignment). Bolts should be hand tight until all of the piping is assembled. Refer to the appropriate instructions to tighten the flanges to the required torque specifications. Support pipe runs as required.
6. Ensure that a low point drain is installed in the piping.

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

For reasons of safety, the hot exhaust gas duct and chimney must be insulated or shielded within the locality of the heater in compliance with local codes and regulations.

⚠ CAUTION

The stack arrangement and draft conditions should be in accordance with the information in this manual for proper performance of the equipment.

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

Do not attempt to start the equipment for any testing prior to filling and purging the vessel. A dry fire will seriously damage the equipment and may result in property damage or personnel injury and is not covered by warranty. In case of a dry firing event, shut off the fuel supply and allow the vessel to cool to room temperature before fluid is reintroduced to the pressure vessel.

Failure to insulate ducting on equipment with Flue Gas Recirculation on the burner may result in personnel injury.

△ CAUTION

Avoid flue corrosion and other negative impacts ensuring properly-sized stack and flue.

In order to meet warranty conditions, ensure appropriate tests and operational safety activities are performed.

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

7. Connect the conduit runs between the skids and tighten conduit connectors.
8. Locate the supplied wiring for the equipment and pull wiring through the appropriate conduit runs. Electrical wires are labeled for easy landing. Connect all wiring per the Fulton supplied electrical drawings.
9. If a header is supplied, mount the header as shown in the mechanical drawing.

➨ *NOTE: For piping supplied in sections, make up and connect hand tight until all sections are in place to ensure sections align properly. Sections are match marked for reassembly.*

10. Tighten all connections.
11. Pneumatically test the piping (at 15 psig maximum) prior to filling the systems.
12. Check bolts and connections for tightness after the first heat up cycle. Retorquing may be required.

Stack and Flue

An appropriately sized stack should be connected to the flue gas outlet at the heater. The proper flue size and draft control is most important for proper burner operation. The flue must be as large or larger than the outlet on the vessel. Avoid flue piping and elbows by placing the equipment as close as possible to the chimney.

Adhere to the following for stack and flue installation (see Figure 18):

1. Ensure the stack is the same diameter as the flue gas outlet for an FT-0080C, and at least one size larger for the coil design models FT-0120C and larger.
2. Ensure the stack rises continuously to the connection at the chimney and contains no more than two bends at 45 degree angles or less. If required, as a result of space limitations, one 90 degree elbow (or tee) can be fitted at the back of the vessel.
3. Ensure 2 feet (0.6 m) of straight, horizontal flue before any change in direction, fitting or draft regulator. This is to prevent potential pilot or main flame failures due to back pressure build up during ignition. Any alternative stack arrangement must supply negative 0.02 to 0.04"wc.
4. Ensure the run in the total distance of stack ducting, as measured in a straight line from the outlet of the heater to the outlet of the stack, does not exceed 70% of the rise. With the exception of the duct run previously described, horizontal sections of ducting must be avoided and should not exceed 4 feet (1.2 m) total. See Figure 18.
5. Ensure the stack, chimney, and any components associated with the stack, such as heat reclaimers or assist fans, are constructed from material that is

rated for a 1200°F (649°C) operating temperature.

6. Ensure the stack and chimney material complies with all applicable codes.
7. Make adequate provisions for the support of the weight of the chimney and stack to avoid having a load imparted to the outlet connection of the equipment.
8. Ensure the draft, when firing, is negative and constant. A reading of -0.02 to -0.04"wc when the unit and stack are cold usually indicates sufficient draft. When the unit is running and the stack is hot, the draft should read 0.04 to 0.08 "wc negative.
9. The installation of a draft regulator by the client/ contractor is recommended at all installations. This will help to maintain the required draft. The placement of the draft regulator should be as shown in Figure 19.
10. Insulate the section of the chimney duct within the building. For heaters equipped with Flue Gas

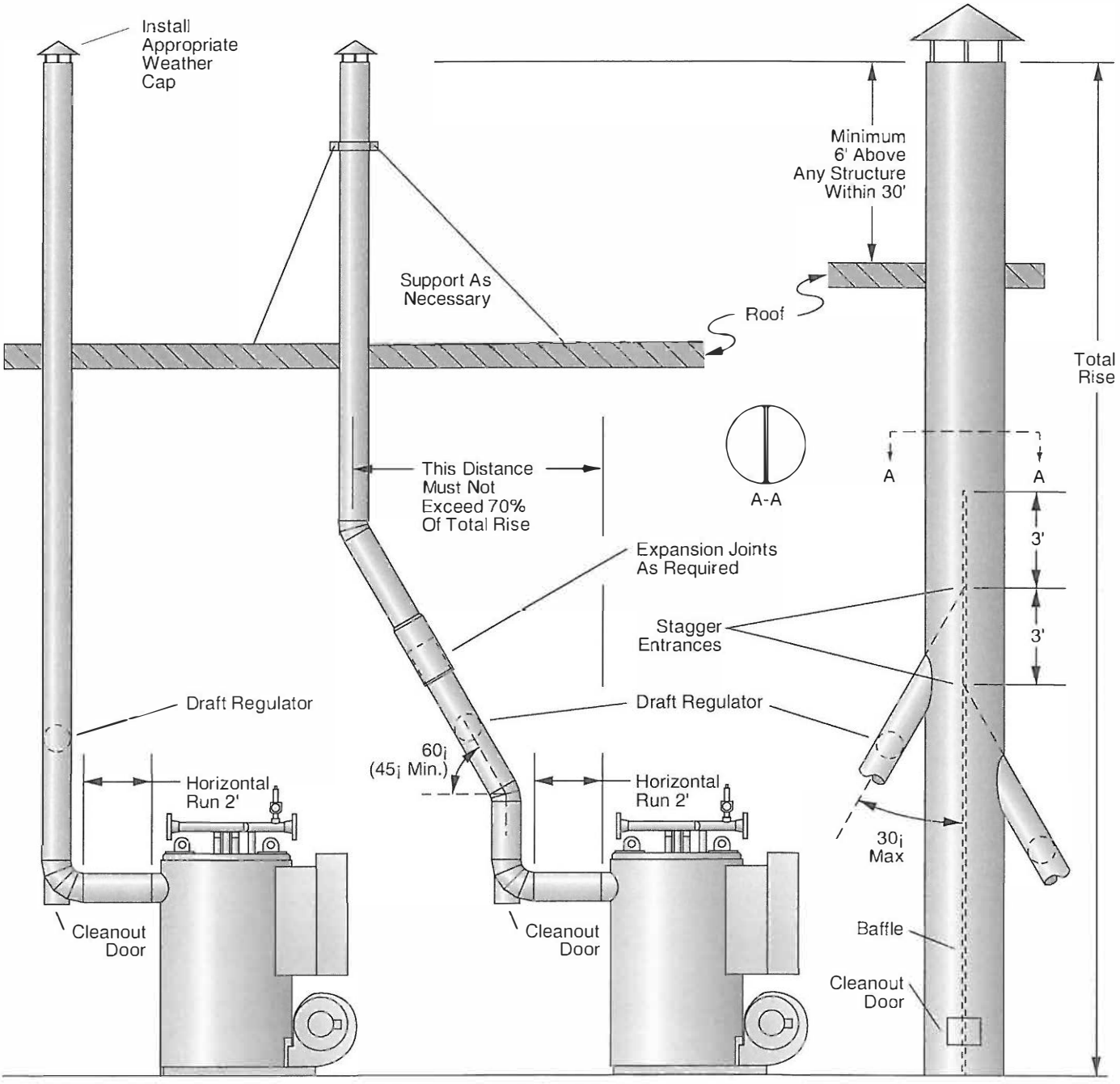


FIGURE 18 - TYPICAL STACK AND FLUE INSTALLATION

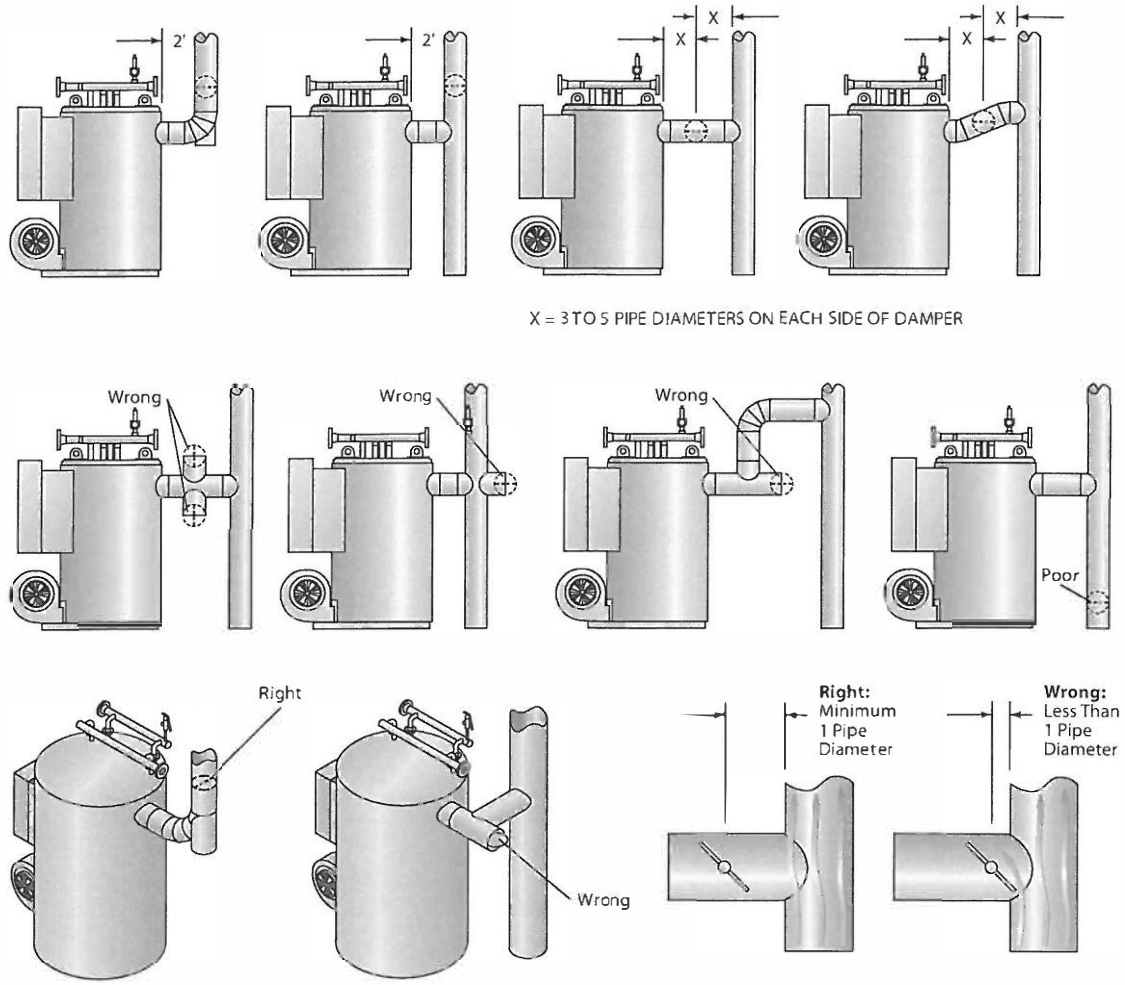


FIGURE 19 - BAROMETRIC DAMPER INSTALLATION

Recirculation (FGR), ducting must be insulated to prevent personnel injury.

11. Concentration levels of only a few ppm of chlorine containing compounds in combustion air can produce serious corrosion of the flue over long periods of time. High chlorine containing compounds such as carbon tetrachloride or perchloroethylene would be prime suspects.

Testing

Upon completion of the installation, perform the following testing:

1. A pneumatic test of thermal fluid piping not exceeding 15 psig.

2. Soap tests at all welds and joints to ensure that the system is free from leaks.

- *NOTE: Under no circumstances should the system be filled with water. Make sure that the air supply is as free from moisture as possible.*

3. Boil-out. The time needed for adequate boilout directly corresponds to the volume of the system and the amount of moisture and debris in the system. Boilout typically takes anywhere from one 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°F [10°C] or less). Never perform a hydrostatic test on the system. The boilout procedure is described in the **Operation** section of this manual.

4. The most satisfactory method of testing is to introduce bottled nitrogen through a pressure control valve. Check pressure ratings on all equipment in the system to ensure that it is capable of withstanding the pressure involved.

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

Do not operate, or allow others to operate, service or repair this equipment unless you (they) fully understand all applicable sections of this manual and are qualified to operate/maintain the equipment.

Defective or improperly installed equipment is hazardous. Do not operate equipment which is defective or improperly installed.

Never leave an opened manual air vent unattended. In the event an opened vent is left unattended, water or fluid damage could occur. The exception to this warning is a feed water deaerator manual vent cracked open may be left unattended.

Defective equipment can injure you or others. Do not operate equipment which is defective or has missing parts. Make sure all repairs or maintenance procedures are completed before using the equipment. Do not attempt repairs or any other maintenance work you do not understand.

⚠ CAUTION

Installation in accordance with the guidelines within the manual should be fully completed before performing the initial start-up, and start-up must be complete prior to putting the unit into service. Starting a unit without the proper piping, venting or electrical systems can be dangerous and may void the product warranty.

"Factory Trained Personnel" refers to someone who has attended a Fulton Service School specifically for the equipment covered in this manual.

Start-Up Preparation & Installation Review

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

1. You have read and followed all safety information.
2. The equipment area is in conformance with established boiler room requirements. Review national and local codes.
3. There is total absence of water in pipework and fluid. To help the system, open all drains; blow dry air or nitrogen if available into a high point bleed through a pressure regulating valve.
4. There are no obstructions left in the fluid circuit from pressure leak testing such as blanking plates in flanged joints.
5. 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.
6. Heater is located with the proper clearances as shown in **Installation** section of this manual.
7. Relief valves have been properly piped to a safe catchment.
8. Flue gas from the heater is properly vented.
9. Combustion air openings are not obstructed in any way and have adequate capacity.
10. There are no flammable liquids, materials or hazardous fumes present in the environment.
11. Nothing was damaged or knocked loose during shipment and installation. Inspect the main gas train and trim assembly to be sure they were not damaged during shipment or installation.
12. Local authorities where approval for start-up is required have been notified. In some localities, final inspection of services may be required.
13. Installation checklist is complete.

Fill the System

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. Refer to the thermal fluid manufacturer's recommendations.

Adhere to the following when filling the system:

1. Refer to Figure 17 for the drain and fill connection.

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

2. A drain and fill point (generally a 3/4" threaded coupling) is provided on the inlet to the pump suction on skid-mounted units.

3. 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.

■ Filling Procedure for Systems Open to Atmosphere

Adhere to the following:

1. Follow the instructions in **Fill The System** section of this manual.
2. 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.
3. Fill the system slowly, closing all opened bleed and drain valves as fluid reaches them.
4. When the fluid reaches and flows from the expansion tank low level manual test connection, begin slowing down the filling process.
5. 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.
6. 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.
7. Filling is complete when the fluid has reached the lowest level in the expansion tank required to actuate the liquid level switch.
8. As oil reaches a 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 in **Initial Start-Up: Cold Circulation** section of this manual. Leave the fill equipment connected as cleaning the strainer may create the need for more oil in the system.
9. Verify 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.

⚠ WARNING

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

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.

⚠ CAUTION

Do not use this equipment if any part has been under water (or subjected to heavy rains/water if the equipment does not have NEMA 4 wiring, controls and instrumentation). Immediately call a qualified service technician to inspect the equipment and to replace any part of the control system and/or gas control(s) which have been under water.

Commissioning/Start up by a non-Fulton authorized person will void the product warranty.

Please read these instructions and post in an appropriate place near the equipment. Maintain in good legible condition.

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

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

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

Crystalline silica may be present in components of this equipment. Exposure to crystalline silica may pose significant health hazards, including but not limited to eye and respiratory system damage. Per the Centers for Disease Control and Prevention (CDC) and Occupational Safety and Health Administration (OSHA), appropriate personal protective equipment must be worn to minimize exposure to hazardous substances. Refer to most current guidelines offered by the CDC and OSHA for more information, including personal protective equipment recommendations.

Use extreme caution when opening circulating pump plug if system temperature is elevated.

Non-Fulton product information is for referencepurposes only. No Fulton document may substitute for full review of documentation available from the component manufacturer.

If a fire does occur, extinguish using CO_2, foam or dry chemical. DO NOT USE WATER.

■ Filling Procedure for Systems Equipped with Inert Blankets

Adhere to the following:

1. Follow the instructions in **Fill The System** section of this manual.
2. Inspect the system to be sure all valves are open and all drains are closed.
3. Open all high point air vents.
4. Do not pressurize the system with nitrogen at this point.
5. Inspect the liquid level switch (Figure 16) and be sure the switch is functioning properly.
6. Begin filling the system.
7. Fill the system until the liquid level switch indicates there is oil in the expansion tank.
8. 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.
9. 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 in **Initial Start-Up: Cold Circulation** section of this manual. Leave the fill equipment connected as cleaning the strainer may create the need for more oil in the system.
10. Determine the final nitrogen pressure 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).
11. If the tank is located outdoors and the inlet to the tank is the highest point in the system, then 1-2 psig of nitrogen is sufficient.
12. Adjustment can be made via the regulator mounted on top of the D.A. tank.

✏ ***NOTE: If you are using a fluid above its boiling point, the system must be pressurized to overcome the vapor pressure of the fluid. Consult the factory for assistance.***

Circulating Pump

Adhere to the following:

1. Read manufacturer's instruction manual thoroughly. If the pump is supplied by Fulton Thermal Corporation, manufacturer's literature is included with this manual.
2. Never run the pump 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.
3. 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.

■ Pump With Mechanical/Air Cooled Seal

Adhere to the following:

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.

➨ ***NOTE: If at 150°F (65.5°C) there is still no fluid flow, discontinue start-up and contact Fulton Service Department immediately.***

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.

⚠ WARNING

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⚠ CAUTION

Operation of the circulating pump for any amount of time without first bleeding will result in equipment damage.

If fluid temperature exceeds 150°F during start-up and no flow has been induced, discontinue start-up and contact Fulton Service Department. Failure to do so may cause equipment damage.

⚠ WARNING

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Never attempt to operate equipment that has failed to pass all safety checks.

This heater is equipped with an ignition device which automatically lights the burner. Do not try to light burner by hand.

Operating this equipment beyond its design limits can damage the equipment and can be dangerous. Do not operate the equipment outside of its limits. Do not try to upgrade the equipment performance through unapproved modifications. Unapproved modifications may cause injury, equipment damage, and will void the warranty.

Before commissioning the unit, verify with proper authorities that gas lines have been purged.

Check daily that the equipment area is free and clear of any combustible materials, including flammable vapors and liquids.

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. 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.
11. Carefully check the coupling alignment of the pump and driver 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.
12. Realign at operating temperature, if necessary.
13. Make sure that the pump is properly greased or oiled.

■ Pump with Packed Seal

Adhere to the following: Make certain that the gland is finger tight before filling the system.

Start-Up Service

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 three weeks before a Fulton service engineer is required on site.

Consider the following in preparation for your on-site visit:

1. All procedures covered in manual sections **Start-Up Preparation** and **Fill the System**, including installation review, air testing of piping, pump alignment (where applicable), and filling the system must be completed before the service person's arrival.
2. Depending on the size of the system and the amount of service time contracted, start-up service includes firing the heater, checking, verifying and adjusting all safety settings.
3. 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.
4. 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.
5. 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.

Initial Start-Up

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 manual section **Routine Operation.**

■ Cold Circulation

1. Turn on the main power switches.
2. Check for proper fluid level in the expansion section of tank. See Figure 13 and 14.
3. A centrifugal pump cannot be operated with the discharge valve closed without heating up dangerously.
4. The pump should be started with the suction valve full open and the discharge valve open a slight amount.
5. Check pump rotation. Operating the pump in reverse rotation may cause extensive damage.
6. Turn the three position switch located on the front of the panel box door to "Pump".
7. 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. If the rotation direction is incorrect, turn the three position switch back to "Off" immediately. Change the wiring connections and recheck.
8. Check for proper alignment. Realign, at temperature.
9. 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.
10. 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.
11. Check that all pressure gauge readings remain stable. Refer to Figure 18. Pressure exceeding 100 PSIG or identical readings at inlet and outlet gauges indicate a closed valve.
12. 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.
13. Check all piping, connections and users for leaks. Repair any leaks immediately.

⚠ WARNING

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⚠ CAUTION

Do not use this equipment if any part has been under water (or subjected to heavy rains/water if the equipment does not have NEMA 4 wiring, controls and instrumentation). Immediately call a qualified service technician to inspect the equipment and to replace any part of the control system and/or gas control(s) which have been under water.

*A temperature exceeding 120°F** in the boiler room may cause premature failure of electrical components. Provisions should be made to maintain an ambient temperature of 120°F** or less (the panel box interior should not exceed 125°F**).*

***Pumps, PLC or ModSync panels may require lower ambient temperatures or additional cooling.**

⚠ WARNING

Before commissioning the equipment, verify with authorized personnel that the gas lines have been purged.

Never attempt to operate a heater that has failed to pass all the safety checks.

After checking controls by manual adjustment, make sure they are always reset to their proper settings. Contact your Fulton dealer before modifying the equipment.

If any "Manual Reset" limit device trips DO NOT reset without determining and correcting the cause. (Manual Reset Limits may include: flame safeguard, high or low gas pressure, high temperature limit, high pressure limit)

Never tamper with low water (liquid level) cutoff sensors or circuitry.

WHAT TO DO IF YOU SMELL GAS:
Do not use matches, candles, flame or other sources of ignition to check for gas leaks. Do not try to light the 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.

If excessive amounts of thermal fluid are to be vented from the system, additional thermal fluid may be required in the system. Contact Fulton for further information.

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

If fluid or piping is added to the system, the boil out procedure is required, as water may have been introduced to the system.

■ Filtering the System

1. Initially, readings on the 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.
2. 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.
3. In some cases, a positive pressure can be measured at the pump suction gauge (due to the use of a nitrogen blanket or large positive head). This should be noted and if the reading decreases by several inches or pressure, check the strainer to ensure it clean.
4. 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.
5. 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.
6. 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.

■ Boilout

1. Ensure adequate ventilation.
2. Check for correct fuel feed. All air must be eliminated from fuel lines, gas piping, preheaters, etc. by approved methods.

✏ ***NOTE: As the system is being boiled out, the piping must be checked for leaks as the temperature of the thermal fluid is increased. If a leak is detected, refer to*** *Thermal Fluids at Elevated Temperatures* ***section in*** *Installation* ***section of this manual.***

3. Open all manual valves in the fuel oil supply line. Do not run the fuel pump dry or without fuel lines connected to fuel source. Do not allow the fuel oil pump to pull a vacuum.
4. Check safeties.
5. Disable N2 blanket if equipped and open vent line on DA tank.
6. Set control switch to "Heat". The burner will begin the call for heat if oil temperature is below setpoint.
7. With burner firing and pump running, keep checking the gauges indicating pump and circuit pressures. Make sure they remain stable.
8. In case of pressure fluctuations, stop the burner, but allow the pump to

continue to circulate fluid.

9. When pressures have stabilized, start burner again.
10. 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 steam, indicating the presence of water. If this occurs, burner should be shut down.
11. If steam is forcing thermal fluid out of the expansion tank vent, turn the heater off, but leave the pump on. This is to circulate the hot fluid through the piping without flushing the steam too quickly. Once steam and thermal fluid stop leaving the expansion tank unit, the heater can be turned on. Increase the temperature very slowly to prevent fluid from being forced out of the tank.
12. 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.
13. 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.
14. After fifty hours of operation at operating temperature, check all flanges and connections for tightness.

■ Combustion

Before firing the heater familiarize yourself on the use of the controls, lighting, and shutdown procedures.

▶ SEQUENCE OF OPERATION FOR GAS FIRED BURNERS

The burner is of forced design. The sequence of operation is as follows:

1. The flame programmer opens the main gas valve once stable pilot flame is established.
2. Pressure regulators on both the pilot and main gas supply, supply pressure to the proper level.

➨ ***NOTE: Note the maximum inlet pressure rating of each regulator and supply a step-down regulator if required.***

3. Combustion air is delivered by a centrifugal blower fan. An air switch monitors the pressure and is part of the flame programmer safety interlock circuit.
4. The flame programmer monitors the safe operation of the burner. Functions include pre-purge of the combustion chamber, provision of ignition via the ignition transformer and electrode, opening the pilot gas valve, monitoring the pilot flame signal via the flame sensor, opening main gas valves and

⚠ WARNING

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A qualified installer, service agency or the gas supplier must perform installation and service on the fuel delivery system.

During system boilout, it is imperative that all system legs or paths are open to ensure flow throughout the system. Never open a cool or unheated user leg of a system when the rest of the system is above 210°F (99°C).

Do not attempt to start the equipment for any testing prior to filling and purging the vessel. A dry fire will seriously damage the equipment and may result in property damage or personnel injury and is not covered by warranty. ***In case of a dry firing event, shut off the fuel supply and allow the vessel to cool to room temperature before fluid is reintroduced to the pressure vessel.***

When opening any drains on the equipment or piping system, steps should be taken to avoid scalding/ burning of personnel due to hot fluids. Whenever possible, the system should be cooled prior to opening any drains.

Use only your hand to turn valve handles. Never use tools. If the handle will not turn by hand, don't try to repair. Forced or attempted repair may result in fire or explosion.

⚠ WARNING

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Should overheating occur or the gas supply fails to shut off, manually shut off the gas supply external to the equipment.

providing post-purge of the combustion chamber.

5. The flame is monitored by a flame sensor. In the event of insufficient, unstable, or non existent pilot or main flame, the flame sensor will cause a safety lockout of the flame programmer. Safety lockout can also be caused if the flame sensor is improperly positioned or grounded. After fault has been corrected, reset by pressing the reset button on the casing of the burner control box.

▶ SEQUENCE OF OPERATION FOR ON/OFF BURNER

The sequence of operation for the on/off burner is as follows:

1. Beginning with power on, limit switch closed, fuel valves closed, and temperature controller calling for heat, the flame programmer starts the cycle and the blower motor starts prepurge.
2. The air proving switch must be closed now. Air dampers remain in maximum position.
3. ***(Gas Pilot)*** Provided all safety interlocks are proven, ignition and pilot are energized and a timed trial for pilot ignition begins. After the pilot flame is proven, the main fuel valve is energized. Ignition is turned off when flame is registered and the main gas valves open.
4. ***(Spark Ignition)*** At the end of purge time, provided all safety interlocks are proven, the spark is on and oil valves are opened. When the flame is proven, the spark is shut off.
5. When the fluid temperature reaches the off setting (typically the setpoint plus 2 to 5 degrees) of the operating temperature controller, all fuel valves are closed.

The burner motor stops and the entire system is ready for restart on demand.

▶ MODULATING BURNER

The function of the flame programmer must be greatly extended in a modulated system. Along with limit controls, operating controls and interlock devices, the programmer automatically controls the operation of the burner, blower motor, ignition, main fuel valves and modulating motor (or servo motors).

The sequence of operation is as follows:

1. Beginning with power on, limit switch closed, fuel valves closed, and modulating limit controller closed and calling for heat, the flame programmer begins its cycle and the blower motor starts prepurge. The modulating circuit closes, driving the air dampers to maximum for prepurge.
2. The air flow proving switch must be closed now. After timed prepurge, the modulating motor (servo motor) drives the air damper to its low fire position. All start interlocks must be proven or the flame programmer will lockout.
3. ***(Units with Gas Pilot)*** Ignition and pilot are energized and a timed trial for pilot ignition begins. After the pilot flame is proven, ignition turns off and the main fuel valve is energized. Pilot fuel is turned off and the modulating motor

(servo motor) is released to automatic.

4. ***(Units with Spark Ignition)*** The spark and oil valves are energized and a timed trial for ignition begins. With the flame proven, the control advances through its main light off sequence, and the ignition shuts off. At this time, with the flame proven, the modulating motor (servo motor) is released to automatic.

5. When the modulating motor (servo motor) is released to automatic, it receives its signal from the modulating temperature controller. The modulating motor (servo motor) then drives the modulating fuel valve and air damper in proportion to the heat demand.

6. During the initial call for heat, the modulating fuel valve and air damper will drive to their full-fire position. As the temperature set point is approached, the modulating motor (servo motor) will continue to reduce the input until low-fire position is reached. Input automatically increases and decreases according to load demand.

7. When the fluid temperature reaches the set point of the temperature controller or of the optional operating limit controller, all fuel valves will close and the flame programmer will advance to the post purge cycle. When the postpurge cycle begins, the modulating motor will be in the low fire position. At the end of postpurge, the burner motor stops and the entire system is ready for restart on demand.

▸ OIL FIRED BURNER

The following refers to the design and operation of the on/off burner utilizing fuel oil which requires no preheating. This burner is of high pressure, mechanical atomization design.

The sequence of operation is as follows:

1. An oil pump is used to obtain necessary atomizing pressure before the fuel oil reaches the nozzle. The fuel oil is divided into fine particles in the nozzle and imparted with a rotating motion before escaping from the nozzle as a cone of finely atomized oil.

2. Combustion air is supplied by a centrifugal fan. A damper provides throttling of the inlet opening. The air from the fan reaches the burner head after going through a turbulator, accomplishing correct distribution and mixture of air and atomized fuel oil.

3. An electric spark between two electrodes provides ignition of the atomized mixture, except where code requires a gas pilot. This spark is produced by a high voltage transformer.

4. The flame programmer circuit controls normal operation of the burner. The sequence includes purging of the combustion area for a set period, ignition and opening of magnetic valves on the oil circuit; post-purge of combustion area and return to re-start position.

5. A scanner mounted on the burner casing and facing the light of the flame monitors the flame.

⚠ WARNING

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⚠ CAUTION

Unburned oil, unlike gas, does not leave the combustion chamber during purge.

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6. Safety lock out occurs within a preset minimum time in the event of insufficient, unstable or non-existent flame. After fault has been corrected, reset programmer by depressing the reset button on the casing of the burner control box.

7. Proper fuel pressure at the burner nozzle is essential. The correct firing rate is obtained by setting the fuel oil pump to give the design pressure for each unit. This is done at the factory. Pressure is measured by connecting a 0-400 PSI (0-25 bar) test pressure gauge to the gauge connection on the fuel pump. The fuel pressure gauge indicates the pressure of the fuel at the burner nozzle.

8. Typical pressures range between 160-350 PSI (12-22 bar). Note the correct setting upon commissioning. Modulating units should have a second pressure gauge monitoring the pressure in the return pipe from the burner. This gauge will indicate the variation of oil flow caused by modulation of the burner. Gauge readings should be recorded at start-up and checked periodically.

▶ DUAL FUEL BURNER - CHANGING FUEL

The following instructions apply only to units supplied with dual fuel burners. These procedures should be performed only when the fluid is cold, unless sufficient safeguards are provided to prevent contact with hot fluid piping in the vicinity of the burner.

1. Set the fuel switch to "Off" and the heat selector switch to either "Pump" or "Off."

Gas to Oil

1. Turn off the manual gas cocks in the gas train.
2. Remove the gas nozzle orifice assembly from the burner.
3. Install the oil nozzle assembly (see Figure 20) and attach the oil whips to the assembly.
4. Open all oil manual shutoff valves.
5. Set the fuel selector switch to the proper fuel. Restart unit normally

Oil to Gas

1. Turn off all oil manual shutoff valves.
2. Detach the oil whips and remove the oil nozzle assembly.
3. Install the gas nozzle orifice assembly (see Figure 21) and open the gas cocks in the gas train.
4. Reset the hi/low gas pressure switch.
5. Refer to Figure 22 for complete dual fuel assembly.
6. Set the fuel selector switch to the proper fuel. Restart unit normally.

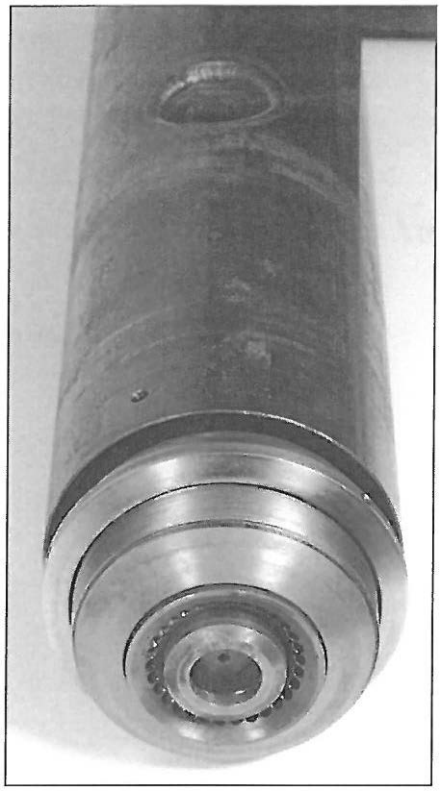

FIGURE 20
OIL NOZZLE DUAL FUEL BURNER
(MODELS FT-0400-C THROUGH FT-1400-C)

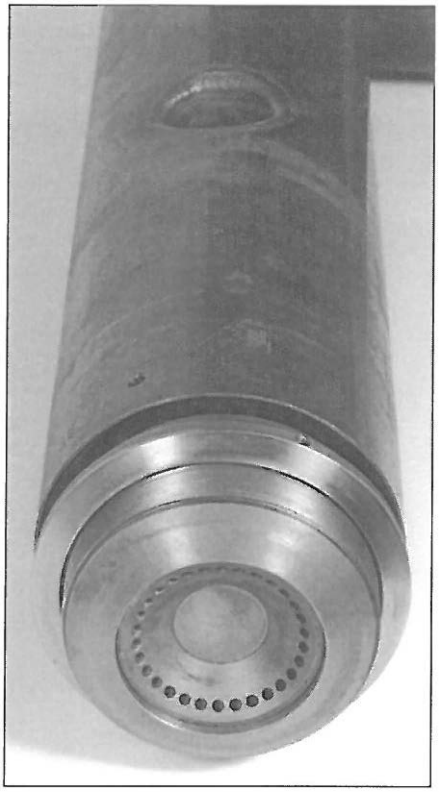

FIGURE 21
GAS NOZZLE WITH ORIFICE
DUAL FUEL BURNER
(MODELS FT-0400-C THROUGH FT-1400-C)

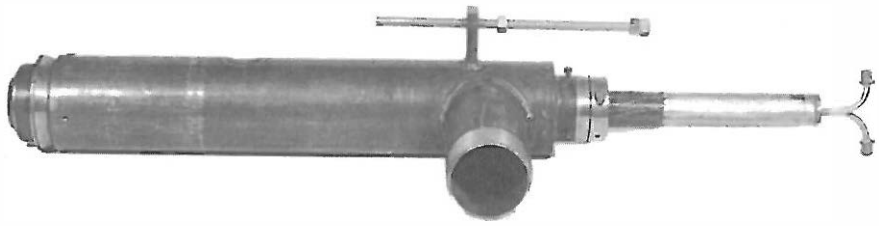

FIGURE 22 - COMPLETE DUAL FUEL ASSEMBLY

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⚠ CAUTION

Do NOT leave unit unattended in Manual Operation, in this mode the LMV51 will ignore its internal Set Point.

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Flame Programmers

■ Siemens Linkageless Modulation, LMV 51

➨ *NOTE: Refer to cut sheets for any non-Siemens programmers.*

▶ SETTING PILOT

1. Verify the main burner switch is in the **OFF** position.
2. Supply power to the heater. The AZL will display **"system test"** and then move to the main menu.
3. Select **PWLogin**, press **Enter**. Select **AccessServ.** Press **Enter**. (This type of step will be shown as **PWLogin > AccessServ** for the remainder of this section. Enter the service passwords using the arrow key. The password is case sensitive. The case of a letter can be changed by pressing the other arrow key. (For example, if you used the right arrow key to get to the letter A, press the left arrow key to get a). After you have pressed Enter on the last character of the password, press Enter once more to accept the password. If you do not have the password, contact your Fulton Authorized Representative to perform the changes. Service=NB# or OEM=AAAA (Enter after each A).
4. Select **Params&Display.** Press **Enter.** Select **Ratio Control**. Press **Enter**. Select **ProgramStop**. Press **Enter**. Change the **Program Stop** to **44 Interv1** by using the arrow keys. Confirm the change by pressing **Enter**. This will set the burner management system to a '**pilot hold**' setting.
5. Verify that the current value "**curr**" changes to **44 Interv 1**.
6. The full listing of program stops are:
   - » 24: Air damper in the prepurge position
   - » 32: Traveling to the FGR position
   - » 36: Ignition position (before pilot ignition)
   - » 44: Ignition position (after pilot ignition)
   - » 52: Ignition position (after main burner ignition)
   - » 72: Air damper in the postpurge position
   - » 76: Traveling to the FGR position
7. Press **Escape** 4 times to get back to the main menu.
8. Under **ManualOperation > Setload**, change the load to 0% by using the arrow keys. Press **Enter** and verify the 0% has been acknowledged in the "**curr**" field.
9. Press **Escape** once to get back to the **ManualOperation** menu.

10. Under **Auto/Manual/Off,** change the operation to **Burner On** by using the arrow keys. Press enter and verify that "**Burner On**" is acknowledged in the current field.
11. Press **Escape** twice to get back to the main menu.
12. Turn the main burner switch **Local** or **On** position.
13. Increase the set point. Under **operation-Heater set point** go to **setpoint W1** using the arrow key then press **Enter**. Change the set point under **new**, using the arrows and press **Enter**. The new set point should appear under **actual** and displayed in degrees.
14. After several seconds the burner control will start its pre-ignition phase and the blower will start.
15. You can observe the status of the burner by going to the main menu (by pressing **Escape**) then selecting **Operational Stat > Normal Operation**.
16. The unit will purge then drive to the ignition position and the pilot should light.
17. The burner control will stay at this pilot hold stage so you can inspect and adjust the pilot as needed.
18. The pilot gas pressure should match the test fire sheet.
19. The flame signal should be greater than 90% when viewed from the top menu of the Siemens AZL display.
20. Once the pilot is adjusted properly and you are ready to light the main burner, press **Escape** to the main menu.

▶ SETTING MAIN BURNER IGNITION

1. Under **Params&Display >RatioControl >ProgramStop**, change the **Program Stop** to **52 Interv2**. This is the main burner ignition position. Press Enter and confirm that **52 Interv2** is acknowledged in the current field. This change moves the control to the main burner ignition point in the burner sequence.
2. This will allow the main burner to ignite. Should the burner not light, the gas and air servo motors are not synchronized to produce a combustible mix.
3. Turn the **ON/OFF** switch on the panel box to **OFF**.
4. To reset the alarm: Press **Escape** on the AZL once. Press **Enter** on the AZL to reset the control. The red light should go out.
5. To change the setting, return to the front menu by pressing **Escape** until you are to the main menu. Then select **Params&Display >RatioControl >GasSettings >SpecialPositions > IgnitionPos**, adjust the gas servo position by using the arrow key to move down to Gas servo if needed. Press **Enter** to select the servo. Move the gas servo to its new position with the arrow keys. Press **Enter** to confirm the new value. Use the down arrow to move to the air servo setting if needed. Press **Enter** to select the servo, use the arrow keys to set the new value. Press **Enter** to confirm this.

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6. Switch the **ON/OFF** switch back to **ON**. The heater will re-start.
7. **The light off point for main flame can be set at a higher input than low fire.**
8. Press **Escape** 6 times to get back to the main menu.
9. You can observe the status of the burner by going to **OperationalStat > NormalOperation.**
10. Verify that the flame signal on the display is great than 90% and check combustion. Adjust the burner to match the test fire sheet for main burner ignition. The procedure described in Setting Main Burner Ignition is used.
11. Once the ignition position has been adjusted properly, you are ready to check the burner throughout its modulation range. Press **Escape** twice to get back to the main menu.

SETTING MAIN RUN MODULATION

1. Upon releasing the heater to main run modulation, the heater will drive to low fire.
2. It is necessary to set/check combustion through the entire range of modulation first to enable high fire to be reached. Once high fire is achieved, the incoming gas pressure can be set (if required). Fine-tuning of the servo setting throughout the range should be performed only once high fire settings are confirmed.
3. Note: If the burner loses flame while driving to a point then:
   - » Turn the main ON/OFF switch to OFF.
   - » Reset the loss of flame fault.
   - » Press **Escape** on the AZL once.
   - » Press **Enter** on the AZL to reset the control. The red light on the panel box door should go out. Adjust the air and gas servos for that point while the burner is off.
   - » Follow steps below.
   - » Turn the main ON/OFF switch to ON.
4. Under **Params&Display >RatioControl >GasSettings >ProgramStop,** change the program stop to deactivated by using the arrow keys. Confirm that 'deactivated' is acknowledged in the current field.
5. This change will allow the burner to modulate. The burner will now drive to low fire. Remember, it is only important at this stage to set low fire to be stable and with clean combustion. Exact setting is to be performed once high fire is confirmed.
6. Press **Escape** 5 times to get back to the main menu.
7. You can observe the status of the burner By going to **OperationalStat/ NormalOperation.**

8. Verify the flame signal on the display, measure input if gas meter is available. If not, match last elbow pressures and combustion for test fire sheet. Adjust the burner as needed.

SETTING LOW FIRE

NOTE: As soon as a servo position is altered, the servo will move to that position. Only change servo settings by a maximum of 0.5° at a time before verifying combustion.

1. Go to **Params&Display >RatioControl >GasSettings>CurveParams.**
2. Wait for the spinning line on the left to disappear. Press **Enter.** The number 1 should appear to the right of the cursor, this is the Point Number.
3. Press **Enter** once. Select **ChangePoint** by pressing the arrow keys to highlight and then press **Enter** to select. This will cause the servo motors to move to this low fire point.
4. Check combustion and adjust the servo motors as required. To adjust a servo motor, arrow to it and press **Enter**. Then adjust the setting as required and press **Enter.** You can now adjust another servo motor if needed.
5. When combustion is properly set for that point, press **Escape**. If it asks you to store the point, press **Enter.** Note the AZL will only ask to save if either servo value has been altered.
6. Low fire is now set and stored.

SETTING THE COMPLETE RANGE

1. Remember it is only necessary to approximate the setting through the modulation range until high fire conditions are established.
2. Press **Enter** once more to have access to the point number field. Increase the point number by one and press **Enter**. Select **ChangePoint** and press **Enter**. The servos will now move to that point.
3. Verify combustion is satisfactory.
4. Measure input or monitor last elbow pressure. Verify that these points are in general correspondence with the test fire sheet. Repeat step 2 until the point position has a load value of 100%.
5. You are now at high fire. Verify combustion is per test fire sheet.
6. Once at high fire, adjust the incoming gas pressure at the main gas regulator to match the test fire report. Adjust the gas servo motor to change the last elbow pressure to match the test fire report.
7. Adjust the air servo motor to adjust the emissions as needed.
8. Repeat step 2 but start at the high fire point number. Continually decrease the point number after combustion has been verified at each point.

⚠ WARNING

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⚠ WARNING

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9. Once all the points have been verified, press **Escape** until you are back to the main menu.
10. You can observe the status of the burner by going to **OperationalStat >NormalOperation**.
11. Turn the main **ON/OFF** switch to **OFF**. The control will now postpurge. Verify ignition using steps from Setting Main Burner Ignition with the new gas pressures.
12. Turn the main burner switch to **OFF.** The control will now post purge.
13. Under **Manual Operation > Auto/Manual/Off**, change the operation to **Automatic** and press **Enter** and confirm **Automatic** is entered in the current field.
14. Press **Escape** twice to get back to the main menu.
15. Under **Updating >ParamBackup**, select **LMV51 – AZL.** This will store all of the adjustments that have been made in the LMV base module to the display. If the base module fails in the future, the display can be used to download all of the parameters into a new base module.
16. The heater is now ready to run. Adjust your setpoint on the temperature control to the desired temperature and turn the main ON/OFF switch to **ON** for the burner to operate.

▸ CHANGING SET POINT ON THE AZL

1. Hit **Escape** to Select **Operation** than hit **Enter** and scroll to **Heater Set** point, hit **Enter** to Set point **W1** hit **Enter** and enter new set point with Select buttons.
2. When accomplished hit **Enter** than **Escape** 3 times to **Operational Stats** hit **Enter** to **Normal Operation**, hit **Enter** to get to the main screen.

▸ FOR MANUAL OPERATION

1. Hit **Escape** and scroll to Manual, hit **Enter** to **Auto / Manual / Off,** change to **Manual** and hit **Escape** to **Set Load**, change to **0** or desired load range with the select buttons.
2. When in **Manual** it will allow you to go to any load range to verify combustion.
3. When done hit **Escape** and scroll to **Operational Stats**, hit **Enter** to **Normal Operation**, hit **Enter** to main screen.
4. To return back to **Auto** operation repeat step 1 & 2.
5. Please refer to this manual's addendum for information on specific LMV 51 control parameters.

✒ ***NOTE: DO NOT leave unit unattended in Manual Operation, in this mode the LMV 51 will ignore its internal Set Point.***

Operating Controls

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

At commissioning, the operation of all safeties and interlocks should be verified. Setpoints of all pressure and temperature switches as well as the programs for all programmable controls (temperature controls, temperature limits, operating controls, servo motors etc.) should be recorded for future reference. Contact the Fulton Service Department with any questions regarding the proper operation, set points and verification procedures for these controls.

The procedures below are used to verify functionality of the safeties and the interlocks.

■ Liquid Level Switch - When Combination Tank is Supplied

Adhere to the following:

1. Locate the liquid level switch (ships in the parts box, see Figures 15 and 16) and install prior to operation of the equipment. The liquid level switch is wired to the main heater panel. Failure to "make" this switch will result in lack of power at the panel.
2. 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.
3. To confirm operation, manually trip the liquid level switch. Unit should shut down; pump will stop. Refer to Figure 16.

■ Air Safety Switch

1. The air safety switch is installed in the heater panel and is connected by tubing to the blower outlet. This switch requires that the blower fan deliver combustion air before energizing any fuel valves.
2. While firing, disconnect the copper line from the fitting in the top cover of the air switch. The burner should shut down. Attempt to restart the unit by resetting the flame programmer.
3. Blower motor will start, but firing sequence should not begin.
4. Lockout of LMV will occur.

■ Blower Motor Starter

➨ ***NOTE: For units equipped with manual trip test button or motor starter.***

1. While firing, actuate the manual trip button on blower motor starter. Unit should lock out. Attempt re-start by resetting the flame programmer. Purge cycle will not begin.

⚠ WARNING

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⚠ WARNING

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2. Reset motor starter; blower should start and purge cycle will begin.
3. Lockout of LMV will occur.

■ Pump Motor Starter

If a pump starter is supplied the pump motor starter will be located in the heater panel or pump skid. When the pump start button is pushed, the pump motor starter will engage the pump.

1. While firing, actuate the manual trip button on the pump motor starter.
2. Pump and burner will shut down.
3. The blower should continue to run for approximately 30 secods.
4. Attempt to restart pump by depressing the pump start push button.
5. The pump should not start. Reset starter and start pump.

■ Differential Pressure Switch

The differential pressure switch (Figure 23) is mounted to the heater panel. Sensing lines connect this switch to both the inlet and outlet manifold of the heater. This switch is critical and ensures proper flow through the heater at all times.

1. Proper setpoint is 2 psi below the published differential pressure of the heater.

➨ ***NOTE: The differential pressure will vary with heater model.***

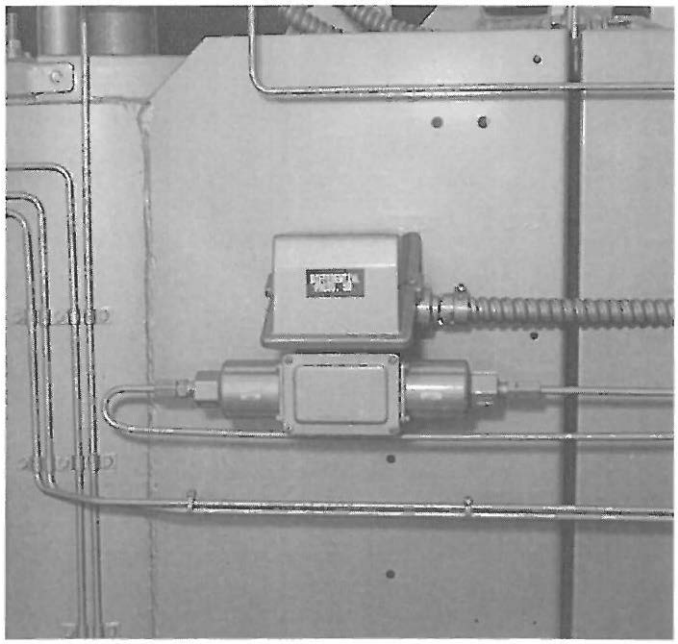

FIGURE 23 - DIFFERENTIAL PRESSURE SWITCH

2. 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.

3. The differential pressure switch can be tested while only the pump is running at operating temperature. Remove the metal cover on top of the switch and increase the setpoint until the pump shuts down. This value should be greater than the DP of the gauges. Next, decrease the setpoint back to its initial value and depress the pump start button to verify the pump will re-start.

■ High and Low Fluid Pressure Switches

The heater is equipped with a low inlet, high inlet and high outlet pressure switch. See Figure 6. The switches are located on the side of heater panel with tubing connections to the respective heater inlet and outlet manifolds. The switches are used to ensure proper flow through the heater (no restrictions in the piping system). The switches must be set at startup and the setpoints are based on the system design/performance.

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.

▸ TO TEST THE SWITCHES

1. With three position switch set to "Pump", remove the cover from the pressure switch and manually trip the switch. Pump should shut down.

2. Repeat for each switch; replace covers. Note, if the burner was on, it would also stop.

3. To set the inlet low fluid pressure cutout switch, raise the setpoint with the fluid at operating temperature and pump running, until the pump

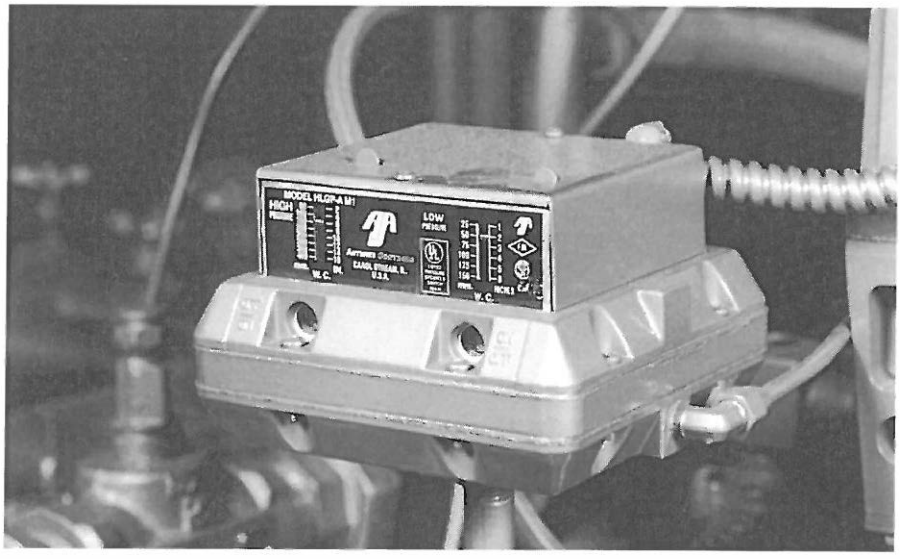

FIGURE 24 - HIGH/LOW GAS PRESSURE SWITCH

⚠ WARNING

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WARNING

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shuts down. Note the setpoint and lower by 10 PSI, then restart pump. The setpoint at cutout should correspond to the reading on the inlet pressure gauge.

4. 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.

5. With the unit running at operating temperature, lower the high outlet pressure switch until the pump shuts down. Note the setpoint and raise by 10 psi, then restart the pump. The setpoint of this switch should correspond to the outlet pressure gauge reading.

➨ ***NOTE: Switch settings shall never exceed teh safety valve set pressure.***

■ Gas Pressure Switch

➨ ***NOTE: Gas Fired Units Only***

The high and low gas pressure switches are located on the gas train See Figure 24. The switches are used to ensure that the incoming gas pressure and gas pressure to the burner are within the appropriate range.

1. While firing, shut the main gas ball valve closest to the burner.
2. Unit will lock out on high gas pressure.
3. Attempt restart by resetting flame programmer.
4. Unit will start purge and lock out.
5. Open the gas valve closest to the burner and reset flame programmer.
6. Reset high side of switch, unit will start purge and fire.
7. To test the low gas pressure switch, close the incoming manual valve.
8. Allow the control to sequence.
9. When the gas valves energize, the heater should lock out.
10. Reset the low side of the switch/reset flame programmer and open the upstream manual valve.
11. The unit will start purge and fire.

■ Operating Temperature Controls

The operating temperature control (Siemens, Fireye, Honeywell) are located in the heater panel and regulate the cycling of the heater. On systems with linkageless modulation, the operating temperature control and operating control (flame programmer) are the same device.

1. The Coil Design unit is a fired heat exchanger and the safe control and

monitoring of the thermal fluid temperature is of vital importance. 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. Temperature controllers measure the bulk temperature and not the film temperature. This must be taken into consideration when setting the temperature controls.
3. Approximate guidelines for temperature settings are not to override the system design parameters.
4. These instructions should be used in conjunction with information from the system designer. Consult manufacturer's literature.
5. Standard primary temperature control sensing point location for On/Off and Modulating heaters is on the heater outlet. For systems with multiple heaters manifolded together, the sensing point is on the heater inlet.
6. 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.
7. An indicating temperature controller is used to regulate the thermal fluid temperature. Typically the indicating control is a thermocouple.
8. The thermocouple is directly immersed in the thermal fluid in the heater manifold. The setpoint of the controller is regulated by the keypad.

■ High Temperature Limit Switches Safety

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.

1. If the high temperature limit shuts down the unit, the manual reset button on the limit switch must be pressed after determining and resolving issue. The red button on the flame programmer (or door reset) must also be pressed to reset the unit before it can be restarted.
2. The high temperature limit controller is factory set to 0 F. This must be set to the lowest of the following:
    - » Maximum operating temperature of the fluid.
    - » Maximum operating temperature of the equipment.
    - » 15°F (9°C) over maximum system operating temperature.
3. Do not set this controller too close to the normal outlet temperature in order to avoid nuisance lockouts due to small transient over temperatures.

⚠ WARNING

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⚠ WARNING

To ensure that your Fulton equipment is kept operating safely and efficiently, follow the maintenance procedures set forth in this manual.

The end user of the heater must maintain all labels on the heater in clean, legible condition. All connections and safety devices, both mechanical and electrical, must be kept clean, with ease of access for inspection, use and maintenance.

4. Several consecutive lockouts caused by the high temperature limit controller indicate the need for immediate installation review.

■ Operating Limit Controller

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 may be adjusted per manufacturer's instructions.

■ On/Off Controls

Typically one controller is provided to sense the temperature on the heater outlet. This controls the operation of the heater by switching it on and off.

1. An adjustable two point differential between shut off and start up is built into the controller. This prevents frequent cycling of the burner. The controller is set to provide the desired outlet fluid temperature. Due to the temperature rise through the unit, this may be considerably higher than the inlet temperature.

2. If the unit is equipped with an on/off controller, it will be located on the face of the electrical cabinet. The temperature setpoint in the controller can be adjusted following the manufacturer's instructions.

■ Modulating Controls

All coil models are standardly equipped with modulating controls.

1. The modulating temperature controller continuously regulates the outlet fluid temperature between the minimum firing rate and high fire. When the unit is on low fire and the temperature continues to climb past the setpoint, the heater will shut down. It will typically re-start when the process temperature drops 7°F below setpoint.

2. Minimum load depends on the degree of modulation provided. Typically 3:1 or 5:1 modulation is provided, depending on the fuel selection and heater size. In this case minimum load is one third of full firing rate.

3. The modulating temperature controller is set to maintain the desired fluid outlet temperature. Due to the temperature rise across the heater, this may be considerably higher than the inlet temperature.

4. If the unit is equipped with a modulating controller, it will be located on the face of the electrical cabinet. The temperature setpoint in the controller can be adjusted following the instructions in the component data sheet section of this manual.

■ Pressure Gauges

All units have two pressure gauges measuring the thermal fluid pressure at the inlet of the heater and at the outlet of the heater. A third gauge measures the pump suction pressure.

1. 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 manual and on the product data submittals on www.fulton.com.

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."

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■ Test of Ignition Safety System Shutoff

Test the ignition system safety shutoff as follows:

1. Shut the pilot ball valve.
2. Close the last gas valve between the inlet to the burner and the butterfly valve.
3. With the main gas cock (inlet manual gas valve) open, the burner should be cycled on. After all the safety limits such as gas pressure and temperature are satisfied, the blower will run and pre-purge the heater.
4. Once the purge is complete (30 seconds), the ignition transformer will be energized. There will be a 4 second trial for ignition period. During this period, indicator lights on the flame safeguard (pilot and main).
5. With no flame established, the flame safeguard will not receive a flame signal from the scanner.
6. After 4 seconds, the flame safeguard programmer will assume a "Flame Failure" condition and go to a "lockout" mode. Lockout will require manual reset of the flame safeguard.
7. After completing this test, open the gas valve.

■ Cycle Testing

The heater should be cycled tested and automatically allowed to go through its normal starting sequence several times to verify that all components are functioning properly. This will also verify that combustion is set properly so that heater light off has a smooth transition from ignition to main flame.

A minimum of 10 cycles should be met without any flame failures, with combustion readings comparable to the factory test fire sheet and no interlocks causing the heater to shutdown.

⚠ WARNING

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Required Pressure Drop Across the Heater

The thermal fluid pressure drop across your heater is critical. This should be recorded at the completion of start-up, as follows:

1. 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.
2. At the recommended standard flow rates, and .7 sp gr, the pressure drop cross the heater should be as shown in Table 10.
3. 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.

TABLE 10 - REQUIRED PRESSURE DROP ACROSS THE HEATER

Model	Recommended GPM (schedule 80)	Recommended GPM (schedule 40)	Pressure Drop PSI
FT-0080-C	44	50	25
FT-0120-C	66	75	27
FT-0160-C	88	100	20
FT-0240-C	132	150	30
FT-0320-C	NA	250	25
FT-0400-C	220	250	25
FT-0600-C	330	375	26
FT-0800-C	440	500	26
FT-1000-C	550	615	18
FT-1200-C	660	730	27
FT-1400-C	NA	800	27
FT-0400-S	NA	400	18
FT-0600-S	NA	600	16
FT-0800-S	NA	800	19

Procedure for First Shutdown

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.

1. 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.
2. 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 (65.5°C) are acceptable to perform operation with regular work gloves.
3. 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 torque specifications in Tables 6 - 9.
4. Visually inspect all thread fittings and valve packings. Repair leaks and tighten valve packings to the point of stopping leak.
5. Upon putting unit back into operation, check all gauge readings. Note any discrepancies and contact Fulton.

Daily Start-Up

1. Check positioning of all system valves to ensure flow is not dead-headed.
2. Visually check relative position of minimum level float switch in the combination tank.
3. Turn on power supply switches.
4. Where applicable, open water cooling valve and check that water flows correctly. (For water cooled pumps only.)
5. Set three position switch to "Pump". Push and hold manual pump start button, monitoring pressure gauges on heater.
6. 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.
7. 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.
8. Start-up is considered complete when the unit begins to throttle back or shutdown on target temperature.

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Daily Shutdown

1. Set control switch to "Pump" pump running, burner off.
2. Allow the fluid to circulate for approximately 20-30 minutes and then set the control switch to the "Off" position.
3. When using fluid cooled pump, continue to circulate cooling water to pumps for 30 minutes after stopping circulation.
4. Open power supply switches.
5. 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.
6. Close fuel valves if required. Closing of system valves is not generally necessary unless maintenance of components requires a partial draining of the system.
7. 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.

Before Leaving the Installation

1. Check all controls to insure they are operating properly. Cycle the heater several times by raising and lowering operating temperature on the thermostat.
2. Make sure the installation complies with all applicable codes.

⚠ WARNING

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Crystalline silica may be present in components of this equipment. Exposure to crystalline silica may pose significant health hazards, including but not limited to eye and respiratory system damage. Per the Centers for Disease Control and Prevention (CDC) and Occupational Safety and Health Administration (OSHA), appropriate personal protective equipment must be worn to minimize exposure to hazardous substances. Refer to most current guidelines offered by the CDC and OSHA for more information, including personal protective equipment recommendations.

Prior to any maintenance concerning electrical components of this equipment, ensure eletrical supply to the equipment is disconnected. Label all wires prior to disconnection; wiring errors may cause improper and hazardous operation.

Follow all proper lockout/tagout procedures for service.

Before beginning any maintenance, ensure area is free of any combustible materials and other dangers.

What to do if you smell gas:
Do not try to light the appliance.
Do not touch any electrical switch.
Do not use any phone in the building.
Leave building and contact gas supplier from neighbor's phone. If you cannot reach gas supplier, phone the fire department.

Required Equipment

The following minimum equipment is necessary to start and maintain fuel-fired thermal fluid heaters:

- Digital Multimeter
- Combustion Analysis Equipment
- Draft Gauge

Required Maintenance at First Shutdown

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.

1. 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.
2. 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 (65.5 C) are acceptable to perform operation with regular work gloves.
3. 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..
4. Visually inspect all thread fittings and valve packings. Repair leaks and tighten valve packings to the point of stopping leak.
5. 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.

Daily Maintenance Schedule

1. Complete the log sheet 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, at the end of this section of this manual, and on www.fulton.com.
2. Make visual inspection of the entire system for leaks. Make repairs as soon as possible.
3. Note any failures on the flame programmer noting fault number, fault code, fault annunciation, fault hour, fault cycle and fault time.
4. Check the exhaust for the presence of smoke. If smoke is present, contact Fulton Companies at (315) 298-5121 or contact your local Fulton Representative.

5. In systems utilizing linkage, check all linkage components for tightness. (Figure 25)

6. 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. See Figure 26.

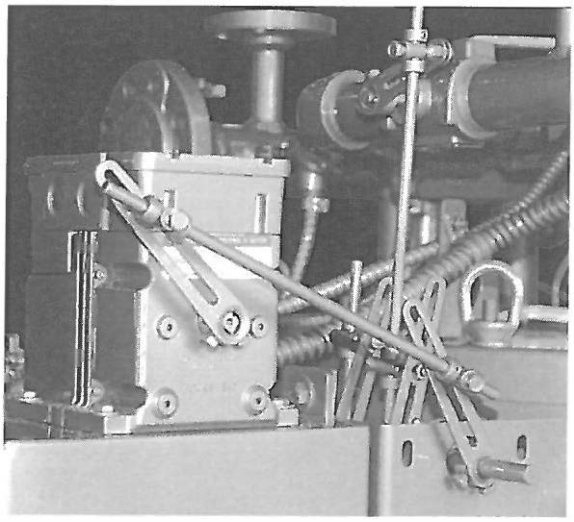

FIGURE 25- LINKAGE COMPONENTS

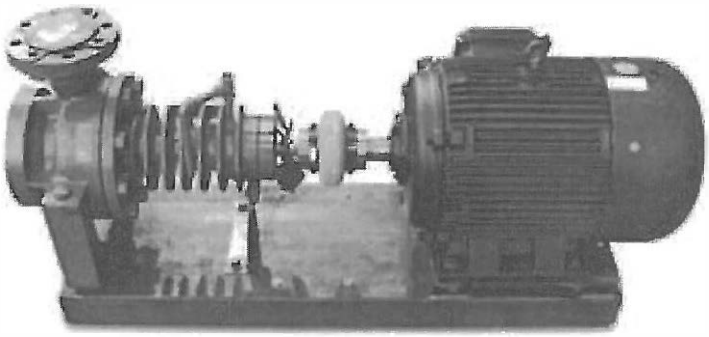

FIGURE 26 - WATER-COOLED THERMAL FLUID CIRCULATING PUMP

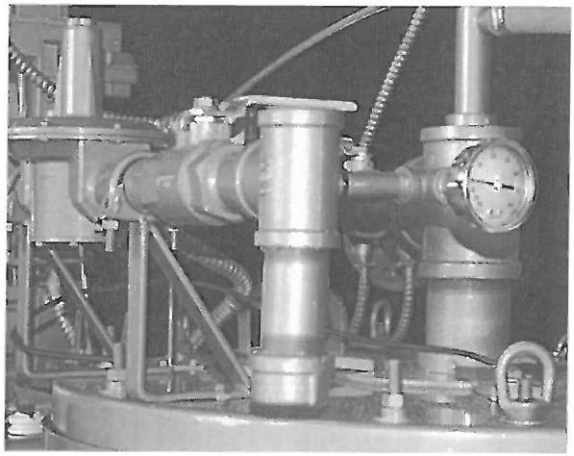

FIGURE 27- GAS TRAIN

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

Fluids under pressure are hazardous and may cause injury to personnel, or equipment damage, when released. Shut off all incoming and outgoing fluid shutoff valves and carefully decrease all trapped pressures to zero before performing any maintenance.

Never use open flame or other sources of ignition to check for gas leaks.

⚠ CAUTION

All maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Fulton Service Department at (315) 298-5121 or your local Fulton Thermal Representative.

In order to meet warranty conditions, ensure all appropriate maintenance activities are performed.

Use caution when using any cleaning solutions. Refer to local regulations for proper cleaning solution disposal.

All maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Fulton Service Department at (315) 298-5121 or your local Fulton Thermal Representative.

In order to meet warranty conditions, ensure all appropriate maintenance activities are performed.

⚠ CAUTION

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All maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Fulton Service Department at (315) 298-5121 or your local Fulton Thermal Representative.

In order to meet warranty conditions, ensure all appropriate maintenance activities are performed.

Weekly Maintenance Schedule

1. Check inlet gas pressure at the beginning of the gas train. This should be accomplished by the installation of an appropriately scaled gauge. See Figure 27.
2. Check manifold gas pressure at high and low fire and compare to Thermal Combustion Checklist filled out by start up technician. This should be accomplished by the installation of an appropriately scaled gauge. Readings should be with .02" w.c. of Thermal Combustion Checklist.

Monthly Maintenance Schedule

1. Clean fuel filters.
2. Check burner blower. Clean if necessary.
3. Clean or change air filter if applicable.
4. 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.
5. Check operation of all safeties. Refer to the instructions at the end of this section.
6. With the burner running, remove or disconnect the flame detection device. The flame programmer should lockout within 3 seconds.
7. Review daily log sheets noting any deviations from the norm.
8. Check the tightness of all couplings, including the fuel oil pump drive (oil-fired units), fan impeller, circulating pump, etc. See Figure 28.

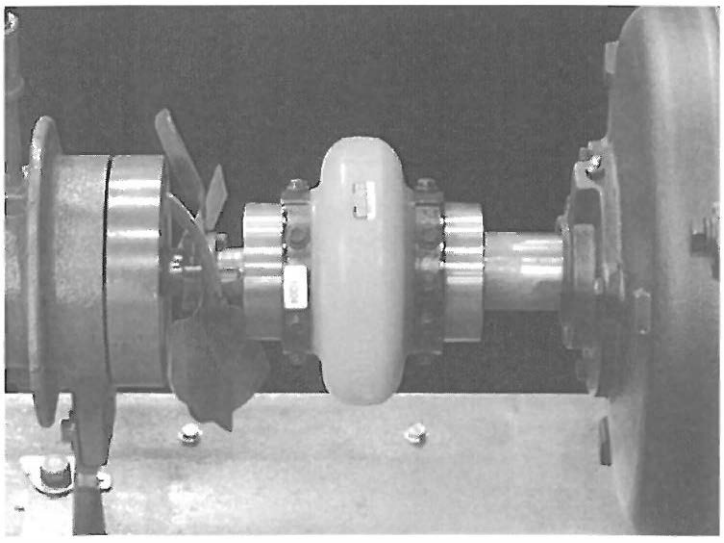

FIGURE 28 - PUMP COUPLING

Semi-Annual Maintenance Schedule

1. Pull burner and inspect for heat stress or soot. Clean or replace as necessary.
2. Inspect pilot tube assembly and ignition electrode. Clean or replace if necessary. Reset ignition settings to manual specifications.
3. Inspect internal surfaces of the heater. Inspect refractory for cracks. Cracks larger than ¼" wide will require repair or replacement of the refractory. Inspect coil for sooting. If soot is present, it can be removed by utilizing a brush or compressed air for light sooting. See **Soot Cleaning** section of this manual.
4. Have combustion checked for efficiency.
5. Review daily log sheets noting any deviations from the norm.

Annual Maintenance Schedule

1. Replace the ignition electrode(s).
2. If the unit utilizes a flame rod, replace.
3. Clean all strainers in the thermal fluid system.
4. Take a one quart sample of thermal fluid and return to the thermal fluid manufacturer for analysis.
5. Schedule local Fulton representative or factory service technician to perform an annual preventative maintenance.

General Maintenance Procedures

■ Lubrication

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

1. When developing your lubrication schedule, consider the thermal fluid pump and all system pumps.
2. If you have a thermal fluid circulating pump with a packed seal, the condition of the pump packing should be checed regularly. If fluid leakage increases, tighten the packing ¼ turn daily.

⚠ WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

⚠ CAUTION

Use extreme caution when using any cleaning solution. Refer to local regulations for disposal requirements.

All maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Fulton Service Department at (315) 298-5121 or your local Fulton Thermal Representative.

In order to meet warranty conditions, ensure all appropriate maintenance activities are performed.

⚠ WARNING

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■ Soot Cleaning

If your vessel inspection indicates severe sooting, the following procedure should be followed:

3. Remove the burner and lower access doors.
4. Remove the top plate, then remove gasket.
5. Wire brush flue passages and use compressed air where accessible.
6. Vacuum loose soot where accessible.
7. Reinstall the burner and all access doors.
8. Fire the heater and set combustion.

Safety Check Procedures

Perform the following safety checks as needed:

■ Liquid Level Switch

Manually turn liquid level switch cam counterclockwise. See Figure 15. Micro-switch will open contacts and control voltage will be lost. Release cam and micro-switch will make and control voltage will be restored.

■ Stack Limit

The limit manufacturer presets the stack limit. Testing can be performed by removing switch from stack and applying heat over that of the switch set point for several seconds. The switch can then be reset and re-installed. See Figure 29.

FIGURE 29 - STACK LIMIT SWITCH

■ Differential Pressure Switch

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. See Figure 30.

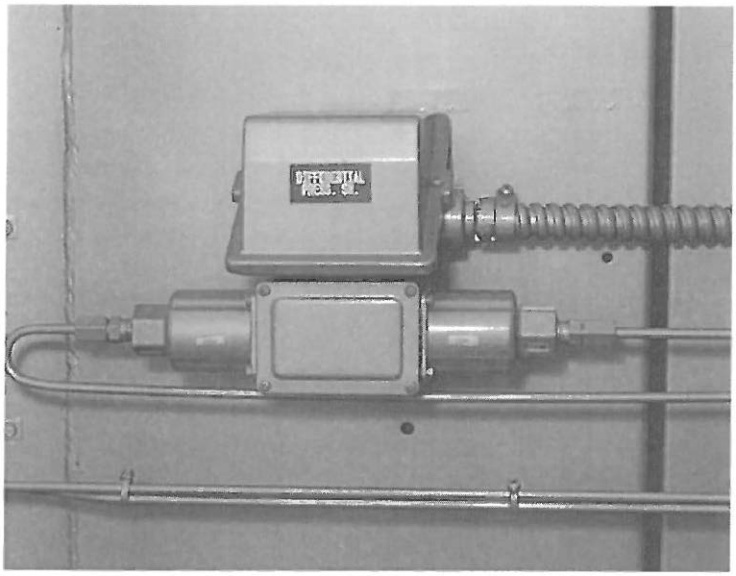

FIGURE 30 - DIFFERENTIAL PRESSURE SWITCH

■ Low Inlet Pressure Switch

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. See Figure 18.

■ High Inlet Pressure Switch

Note the original setting of the switch an0d turn adjustment screw counterclockwise while observing heater inlet 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

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. See Figure 17.

■ Air Switch

Remove the ¼" copper tubing from the bottom of the air switch with the fan

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running. Air switch should trip the interlock circuit. Re-attach copper tubing and reset flame programmer.

■ Air Filter Box Switch

With heater running at high fire, block opening to air filter box by 50%. Slowly close off further until switch trips. Air filter switch should trip at just over 50% blockage. Monitor combustion valves during this procedure.

■ Temperature Limit(s)

Adjust set point(s) of temperature limit(s) down to a point lower than the process variable (PV). PV 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.

■ High/Low Gas Pressure Switch

Shut off the main gas valve prior to the gas train and attempt to light the unit. After the gas valves open during the ignition trial, the low gas pressure switch will trip. Reset the low gas pressure switch and flame programmer. Open main gas valve prior to gas train and close gas valve between last actuated gas valve and burner. Attempt to light the unit. After the gas valves open, the high gas pressure switch will trip. Reset the high gas pressure switch and the flame programmer.

Troubleshooting

■ Flow Circuit/ Circulating Pump(s)

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. 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.

▶ LOW INLET PRESSURE SWITCH

All C-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.

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 indicated in Table 10-A are true. Refer to Table 10-A for a tripped Low Inlet Pressure Switch.

HIGH OUTLET PRESSURE SWITCH

All C-Model heaters have a High Outlet Pressure Switch. This is a normally closed switch that opens with excessive heater outlet pressure.

This switch is generally a mercury bulb type switch. Mercury will rest towards the green cap in a "made" condition.

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.

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 in Table 10-B are true.

Refer to Table 10-B for a tripped High Outlet Pressure Switch, which will require the manual reset button on the switch to be pushed.

FLOW SWITCHES

Units older than mid-1993 have Flow Switches on the inlet of each pipe in the coil. These are normally open switches that close, making a micro-switch, upon flow establishment.

The purpose of the Flow Switch(es) 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 flow switch is wired in series requiring flow through each pipe in the coil. Refer to Table 10-C for flow switch troubleshooting.

HIGH INLET PRESSURE SWITCH

Units newer than mid-1993 have a High Inlet Pressure Switch. This is a normally closed switch that opens with improper heater inlet pressure.

This switch is generally a mercury bulb type switch. Mercury will rest towards the green cap in a "made" condition. The purpose of the High Inlet Pressure Switch is to protect the heater from building too high of a pressure.

Typical coil model 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 in Table 10-D are true.

DIFFERENTIAL PRESSURE SWITCH

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.

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.

This pressure is the difference in pressure between the heater inlet pressure gauge and the heater outlet pressure gauge. See Table 10-E for troubleshooting.

CALL FOR HEAT/BURNER INTERLOCK

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. 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.

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 are in Table 10-F. The burner interlock is the electrical circuit that enables the flame programmer. Your thermal heater needs to have the items in the burner interlock 'made' before ignition can occur. Items in the burner interlock may include an air switch, air filter switch, auxiliary blower motor starter contacts, high temperature limit(s), high gas pressure switch, low gas pressure switch, and / or low oil pressure switch.

AIR SWITCH

All C-model heaters have an Air Switch. This is a normally open switch that closes with proper burner fan outlet pressure. This switch is generally a diaphragm type switch.

The Air Switch is a safety device that proves that there is an adequate pressure and volume of make up air for proper combustion and mixing. There is no manual reset on the air switch itself to indicate a trip. The most likely time of an air switch trip is at low fire purge or low fire. If this switch trips, it is generally one of the issues indicated in Table 10-G.

AIR FILTER SWITCH

C-model heaters with an air filter box or ducted supply air have an Air Filter Switch. This is a normally closed switch that opens on too high of a suction pressure at the burner fan inlet. This switch is generally a diaphragm type switch.

The Air Filter Switch is a safety device that proves that there is not too negative of a pressure at the combustion blower inlet. This switch is only used on units that have a built in air box for use as a duct connection or air filtering device.

There is no manual reset on the air filter switch itself to indicate a trip. The most likely time of an air filter switch trip is at high fire purge or high fire. If this switch trips, it is generally one of the issues indicated in Table 10-H.

AUX. BLOWER MOTOR STARTER

All C-model heaters use an auxiliary set of contacts on their blower motor starter to prove that the burner motor is latched on. This is a normally open set of contacts mounted on or built in to the blower motor starter. The Auxiliary Blower Motor Contacts are a safety device that proves that the blower motor starter is latched in. These contacts work in redundancy to the air switch to prove that there is proper makeup air. There is no manual reset on the auxiliary contacts themselves to indicate a trip. If the contacts do not make, it is generally one of the issues indicated in Table 10-I.

HIGH TEMPERATURE LIMIT

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.

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.

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 issues indicated in Table 10-J.

HIGH GAS PRESSURE SWITCH

All gas-fired modulating or NFPA rated thermal fluid heaters have a High Gas Pressure Switch. This is a normally closed diaphragm switch that opens on a pressure increase over set point. The High Gas Pressure Switch is a safety device that protects the burner from receiving too high of a gas pressure. The switch senses this pressure downstream of the last gas valve, upstream of the modulation valve on units that modulate.

This switch is most likely to trip at low fire. If this switch trips, it is generally one of the issues indicated in Table 10-K.

LOW GAS PRESSURE SWITCH

All gas-fired modulating or NFPA rated thermal fluid heaters have a Low Gas Pressure Switch. This is a normally closed diaphragm switch that opens on a pressure decrease below set point.

The Low Gas Pressure Switch is a safety device that protects the burner from receiving too low of a gas pressure. The switch senses this pressure just downstream of the gas regulator. This switch will most likely trip at high fire. If this switch trips, it is generally one of the issues indicated in Table 10-L.

LOW OIL PRESSURE SWITCH

All oil fired modulating thermal fluid heaters have a Low Oil Pressure Switch. This is a normally closed diaphragm switch that opens on a pressure decrease below set point. The Low Oil Pressure Switch is a safety device that protects the burner from receiving too low of an oil pressure. The switch senses this pressure just downstream of the gas pump. If this switch trips, it is generally one of the issues indicated in Table 10-M.

PILOT FLAME (FAILURE)

A Pilot Flame Failure is a flame failure that occurs when the unit is trying to establish an adequate flame signal. Solid-state controllers indicate a Pilot Flame Failure by showing as a fault code either Fault 28 for Honeywell 7800 series controllers. Flame Failure PTFI on Fireye E110 series controllers or Fault 9 on Fireye Nexus controls. For electro-mechanical controls, you need to witness when the failure occurs. A Pilot Flame Failure indicates that either a strong enough pilot flame was not generated or the means of sensing the pilot flame strength has failed. All gas fired units have a gas pilot. Oil fired units may be 2-stage, in which the 1st stage to light would be considered the pilot, or may have a gas pilot. In either case, during the pilot proving period, the flame programmer must sense a strong enough flame to initiate the opening of the main valves.

▶ MAIN FLAME (FAILURE)

Main Flame Failure is a flame failure that occurs while the unit is trying to establish an adequate flame signal during the Main Flame Trial for Ignition.

Solid state controllers indicate a Main Flame Failure by showing as a fault code of either Fault 19 for Honeywell 7800 series controllers, Flame Failure MTFI on Fireye E110 series controllers, or a Fault 09 for Fireye Nexus controls. For electro-mechanical controls, you need to witness when the failure occurs.

A Main Flame Failure indicates that either a strong enough main flame was not generated or the means of sensing the main flame strength has failed. During the main flame proving period, the flame programmer must sense a strong enough flame to hold the main valves open. If you are experiencing Main Flame Failures, check the items indicated in Table 10-O.

TABLE 10-A - LOW INLET PRESSURE SWITCH TROUBLESHOOTING

Problem	Potential Remedy
Plugged circulation pump strainer basket	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. 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. If the strainer is plugged, isolate the strainer and drain that section of piping 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 pump suction pressure.
Failed Circulation Pump Coupling	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 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
Cavitation of the circulating pump	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. 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. 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. 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.
System is open	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.
Blocked Sensing Line on Pressure Switch	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. Do not attempt when system is hot.
Improper Switch Setting	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.
Switch is faulty	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.

TABLE 10-B - HIGH OUTLET PRESSURE SWITCH TROUBLESHOOTING	
Problem	**Potential Remedy**
An obstruction downstream of the heater	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. 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. 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.
Improper Switch Setting	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.
Faulty Switch	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.

TABLE 10-C - FLOW SWITCHES TROUBLESHOOTING	
Problem	**Potential Remedy**
An obstruction downstream of the Flow Switch(es)	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. 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. 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 should be replaced.
Plugged circulation pump strainer basket	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. 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). 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.
Failed circulation pump coupling	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.
Cavitation of the circulating pump	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. 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. 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.
Plugged coil pipe(s)	If too low of a flow condition has occurred for too long a period of time or if the maximum operating temperature of the oil has been exceeded, it is possible, however unlikely, that a pipe or pipes in the coil could plug with solids. If this occurs, it will be necessary to shut down the system and clean the coil. Fulton Thermal Corporation should be consulted in this matter.

TABLE 10-D - HIGH INLET PRESSURE SWITCH TROUBLESHOOTING	
Problem	**Potential Remedy**
An obstruction downstream of the heater	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. 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. 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 should be replaced.
Plugged Coil Pipes	If too low of a flow condition has occurred for too long a period of time or if the maximum operating temperature of the oil has been exceeded, it is possible, however unlikely, that a pipe or pipes in the coil could plug with solids. If this occurs, it will be necessary to shut down the system and clean the coil. Fulton Thermal Corporation should be consulted in this matter.
Improper Switch Setting	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.

TABLE 10-E - DIFFERENTIAL PRESSURE SWITCH BREAK TROUBLESHOOTING	
Problem	**Potential Remedy**
An obstruction downstream of the heater outlet	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. 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. 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 should be replaced.

TABLE 10-F - CALL FOR HEAT CIRCUIT TROUBLESHOOTING	
Problem	**Potential Remedy**
Programming Problem	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. See the back of this section for general programming sheets for standard Fulton heaters. Make changes as necessary. Contact Fulton service department with any questions.
Temperature Controller Failure	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.
Temperature Sensor Failure	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.
Control Relay May Have Failed	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. If your temperature controller is sending an output signal to the control relay but the burner 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. 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.

TABLE 10-G - AIR SWITCH TROUBLESHOOTING	
Problem	**Potential Remedy**
Combustion Blower Fan is Dirty	If the cups of the squirrel cage type fan become dirty, less air will be moved by the fan. If the fans are dirty enough, there will not be enough air flow for the air switch to prove. You should assure that the combustion blower fan is clean, reset the flame programmer and try to light unit again
The sensing line is plugged, crimped or pointing in the wrong area	If the sensing line to the air switch is crimped or blocked, the switch will not sense the proper pressure. Ensure that the sensing line is clear and not crimped by removing both sides of the sensing line and using compressed air to blow through the line. Also ensure that the elbow acting as an air scoop is pointing directly into the air stream. Reset the flame programmer and try to light the unit again.
The Switch setting is improper	The adjustment screw for the air switch is located opposite the electrical connections. A gray cap covers the screw. Turn the screw clockwise to increase setting, counter-clockwise to decrease setting. To set switch, run unit at low fire. Increase setting 1/2 turn every 5 seconds until unit trips on interlock. Decrease setting by 2 full turns. Reset unit.

TABLE 10-H - AIR FILTER SWITCH TROUBLESHOOTING	
Problem	**Potential Remedy**
The air filter is dirty	If the air filter becomes dirty, the fan will generate greater suction. Too much suction will result in not enough airflow for proper combustion and mixing and will cause air switch to trip. You should regularly change filters on a schedule dependent on how dirty the makeup air is. After checking or changing air filter, reset the flame programmer and try to light unit again.
There is an obstruction in the make-up air ducting	Units that have make-up air ducting need to assure that blockage to the ducting does not occur. Check outside termination and any bends in the ducting for blockage. Clear blockage, reset flame programmer and try to light unit again.
The sensing line is pointing in the wrong direction	The sensing line for the air filter switch is supposed to provide the static pressure of the air box. The termination of the sensing line should be pointing in the direction that limits its contact with moving air. If the sensing line is pointed perpendicularly to enetering air stream, the switch will not sense the proper pressure and could give a false indication of air box suction. Reset the flame programmer and try to light the unit again.
Switch setting is improper	The adjustment screw for the air switch is located opposite the electrical connections. A gray cap covers the screw. Turn the screw clockwise to increase setting, counter-clockwise to decrease setting. The switch setting should be set in such a way that with 50 % of the the air box opening blocked, the switch will trip. Reset switch setting, reset the flame programmer, and try to light the unit again.

TABLE 10-I - AUXILIARY BLOWER MOTOR STARTER TROUBLESHOOTING	
Problem	**Potential Remedy**
The blower motor starter coil is bad	If this is the case, the blower starter will not latch in. Check for voltage to the coil. If proper voltage is present and the starter does not pull in, that proves the coil is bad. Replace the starter, reset the flame programmer and try to light unit again.
The auxiliary contacts are burned or pitted	Visibly inspect contacts. With power off, attempt to clean or replace starter if damaged. Reset flame programmer and try to light unit again.

TABLE 10-J - HIGH TEMPERATURE LIMIT TROUBLESHOOTING	
Problem	**Potential Remedy**
Flow rate is too low	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. It is important to make sure that the minimum flow rate as specified by Fulton for that specific model is maintained 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.
Heater is over-fired	If the heater has more fuel input than design, it is probable that the heat transfer rate will increase beyond design. Check input to heater at high fire for modulated heaters or at the standard rate for on / off units. This can be done by either using a corrected gas meter reading or measuring gas pressure supplied to the burner compared to factory test-fire settings. If input is improper, inspect burner as described below. If burner is not damaged or have improper components, adjust fuel input and combustion to specification.
Gas-fired burner is damaged	Pull and inspect the burner. Primary areas of concern for gas-fired units are the orifice plate, pilot assembly seating and orifice plate gap. If the orifice plate is warped or burned through, pilot assembly is not seated or gap between orifice plate and gas tube is improper, more fuel than designed for will enter the furnace. This will cause the heater to have more fuel input than designed for. The design flow rate will then be too low causing the fluid to heat up higher than it should.

TABLE 10-K - HIGH GAS PRESSURE SWITCH TROUBLESHOOTING	
Problem	**Potential Remedy**
Gas pressure setting on the main regulator is too high	With unit running at high fire, make sure that the modulated gas valve is at full open. Since unit lights at low fire, it may be necessary to increase high gas pressure setting or jumper contacts to allow unit to modulate to where modulation gas valve back pressure is lessened. Check net last elbow gas pressure and compare to factory test fire sheet. Net gas pressure is running gas pressure minus p urge pressure. Make sure net pressure reading is within .2"w.c. of factory reading. If there is a difference, adjust main regulator. Adjust for proper combustion throughout range.
Low fire gas valve setting is too low	Because the sensing point of the High Gas Pressure Switch is upstream of the modulating gas valve, the highest pressure read will occur during low fire. Check net last elbow gas pressure and compare to factory test fire sheet. Net gas pressure is running gas pressure minus purge pressure. Make sure net pressure reading is within .1"w.c. of factory reading. If there is a difference, adjust modulating gas valve linkage. Adjust for proper combustion throughout range.
Gas pressure switch setting is improper	If above two items are proper, check the pressure that the high gas pressure switch is sensing by way of a tee installed in the line. Hold unit at low fire and check pressure. Setting on switch should be 10% over pressure read. Call Fulton if you have any questions.
Gas regulator has failed open	This is highly unlikely. Regulators will usually fail safe in the closed position. The gas regulator can be checked by checking upstream pressure and comparing to downstream pressure. Make sure that the upstream pressure is not above the rating of the regulator. Make sure that the downstream pressure does not exceed the range of the spring. If regulator has failed, replace, reset input and adjust input throughout the range.

TABLE 10-L - LOW GAS PRESSURE SWITCH TROUBLESHOOTING	
Problem	**Potential Remedy**
Gas pressure setting on the main regulator is too low	At high fire, the modulating gas valve is full open resulting in the least amount of back pressure in the gas train. With unit running at high fire, check net last elbow gas pressure and compare to factory test fire sheet. Net gas pressure is running gas pressure minus purge pressure. Make sure net pressure reading is within .2"w.c. of factory reading. If there is a difference, adjust main regulator. Adjust for proper combustion throughout range.
Gas orifice plate is damaged	If the orifice plate is damaged, it may be holding back less gas creating a lower pressure on the sensing switch. Pull burner and inspect gas orifice plate. Plate should in no way be warped or degraded. If it is, replace. After reinstallation, recheck input and adjust combustion throughout range.
Gas regulator has failed closed	Regulators will usually fail safe in the closed position. The gas regulator can be checked by checking upstream pressure and comparing to downstream pressure. Make sure that the upstream pressure is not above the rating of the regulator. If regulator has failed, replace, reset input and adjust input throughout the range.

TABLE 10-M - LOW OIL PRESSURE SWITCH TROUBLESHOOTING	
Problem	**Potential Remedy**
Oil pressure setting on the back pressure valve is too low	At low fire, the modulating oil valve is at its most open position resulting in the least amount of back pressure in the fuel train. With unit running at low fire, check oil pressure and compare to factory test fire sheet. Make sure oil pressure reading is within 10 psi of factory reading. If there is a difference, adjust back pressure regulator. Adjust for proper combustion throughout range.
Fuel oil pump may have lost its prime	An air bubble in the pump will result in a momentary loss of prime that will be enough to cause the Low Oil Pressure Switch to trip. Ensure that oil pump is primed properly and all connections are tight. Check the pump seal. A blown seal will allow air in the pump housing.
Fuel oil pump motor may have failed	Check the pump motor for proper voltage. If voltage is proper but motor does not turn, replace or rebuild motor. If there is no voltage, check motor starter for input signal and incoming 3-phase power.
Fuel oil pump coupling may have failed	A failed coupling will result in the pump not turning. Check coupling. Replace if necessary..

TABLE 10-N - PILOT FLAME FAILURE TROUBLESHOOTING	
Problem	**Potential Remedy**
Pilot flame strength is inadequate	Cycle the unit. During the pilot trial for ignition, carefully observe the pilot flame strength. On Honeywell controllers, the pilot flame strength must be between 1.25 to 5.0 VDC. On Fireye controllers, the pilot flame strength must be greaterthan 10 VDC. Current controls are supplied with a test switch that can hold the programmer in the pilot trial for ignition stage. If a pilot signal greater that 0.0 but less than the minimum required is detected, look through the sight hole provided on the burner plate of the heater to visibly detect flame. If flame is seen, make small adjustments to increase pilot gas and air to provide larger flame.
Pilot sensing device does not work properly	Cycle the unit. If a pilot signal of 0.0 is detected, look through the sight hole provided on the burner plate of the heater to visibly detect flame. Iffiame is seen, your flame detection device or amplifier may be faulty. If the unit has a flame rod, lockout and tag heater's electrical circuit and fuel supply. Pull pilot assembly out of unit. Inspect the flame rod. If the flame rod is corroded, shows isgns of heat impingement, has been burdned off or has cracks in the porcelain, replace with a new flame rod. Reinstall and cycle unit. If the unit has a U.V. scanner, lockout and tag heater's fuel supply. Remove U.V. scanner from U.V. sight tube. Make sure that the lens of the scanner is clean. Use a lighter or match and make a flame in front of the scanner eye. Lens should flicker. If unti does not flicker, change U.V. scanner. If this change does not work, change U.V. amplifier. Reinstall and cycle unit.
Room air pressure is different from outside air pressure	Check room air pressure relative to outside air pressure. Heater room pressure should equal outside air pressure. Significant differences in pressure will result in an erratic flame, which will not deliver a strong flame signal.

TABLE 10-O - MAIN FLAME FAILURE TROUBLESHOOTING	
Problem	**Potential Remedy**
Main flame strength is inadequate	Cycle the unit. During the main flame proving period , carefully observe the pilot flame strength. Current controls are supplied with a test switch that can hold the programmer in the main flame proving period. If a main signal is greater than 0.0 but less than the minimum required is detected, look through the observation port to try to visibly see flame. A combustion change may be necessary to establish main. If observed flame is blue, slightly decrease the air damper setting and recycle. If flame is red or orange, slightly increase air damper setting and recycle. Once adequate flame signal is established, reset input and combustion throughout range of modulation.
Flame sensing device does not work properly	Cycle the unit. If a signal of 0.0 is detected, look through the sight hole provided on the burner plate of the heater to visibly detect flame. If flame is seen, your flame detection device or amplifier may be faulty. If the unit has a flame rod, lockout and tag heater's electrical circuit and fuel supply. Pull pilot assembly out of unit. Inspect the flame rod. If the flame rod is corroded, shows signs of heat impingement, has been burned off or has cracks in the porcelain, replace with a new flame rod. Reinstall and cycle unit. If the unit has a U.V. scanner, lockout and tag heater's fuel supply. Remove U.V. scanner from U.V. sight tube Make sure that the lens of the scanner is clean. Use a lighter or match and make a flame in front of the scanner eye. Lens should flicker. If unit does not flicker, change U.V. scanner. If this change does not work, change U.V. amplifier. Reinstall and cycle unit.
Room air pressure is different from outside air pressure	Check room air pressure relative to outside air pressure. Heater room pressure should equal outside air pressure. Significant differences in pressure will result in an erratic flame, which will not deliver a strong flame signal.
Unit is experiencing too great of a restriction	At the breaching of the heater, take a draft reading. Draft should read between -.02"w.c. and -.04"w.c. with the heater off and between -.04"w.c. and -.08"w.c. with the unit on. A restrictive draft would be a draft that was positive. A restrictive draft is usually the result a stack that is undersized, a stack with too many elbows or a stack whose cap or piping is warped and damaged. Another source of restriction results from broken refractory. If the unit's refractory breaks, large enough pieces could block the flue passes. The burner should be pulled for refractory inspection. A broken refractory should be cleaned out and replaced.

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	PilotFlame Signal	Run Flame Signal	Stack Temperature
Date	*Time*	*On or Off*	*On or Off*	*psi*	*psi*	*or greater*	*psi*	*F*	*F*	*psi*			

⚠ WARNING

Use of non-factory authorized replacement parts is not recommended for this equipment. Use of non-factory authorized parts may jeopardize safety and system performance, and voids the product warranty.

Parts

Spare and replacement parts may be ordered from your local representative or through the Fulton Companies. When ordering replacement parts, please have the model number and serial number of your Fulton boiler ready. Factory-direct replacement parts must be used to ensure proper equipment operation and adherance with warranty requirements. Contact Fulton Companies at (315) 298-5121 for further information.

Standard Warranty for Fulton Thermal Fluid Heaters

WARRANTY VALID FOR MODELS FT-A, FT-C, FT-S, FT-N, FT-HC

ONE (1) YEAR (12 MONTH) MATERIAL AND WORKMANSHIP WARRANTY

The pressure vessel is covered 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 equipment, as defined above, provided this equipment has been installed, operated and maintained by the buyer in accordance with approved practices and recommendations made by Fulton. The commissioning agency must also successfully complete and return the equipment Installation and Operation Checklists to Fulton's Quality Assurance department. This warranty covers any failure caused defective material or workmanship.

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.

PARTS 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 and the commissioning agency has successfully completed and returned the equipment Installation and Operation Checklists to Fulton's Quality Assurance department.

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 boiler and peripheral components and equipment. Warranties valid only if installed, operated, and maintained as outlined in the Fulton Installation and Operation Manual.

No Sales Manager or other representative of Fulton other than the Quality 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 Quality 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.

To activate the warranty for this product, the appropriate commissioning sheets must be completed and returned to the Fulton Quality Assurance department for review and approval.

Fulton®

Effective: 08.04.2011

Fulton Boiler Works, Inc., Fulton Heating Solutions, Inc. & Fulton Thermal Corporation are part of the Fulton Group of Companies, a global manufacturer of steam, hot water and thermal fluid heat transfer systems.

Fulton® The heat transfer innovators.

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