VOLCANIC

INSTALLATION AND OPERATION MANUAL

Hopkins Marine

Horizontal Coil Design

Thermal Fluid Heaters

Serial/ National Board Number _____

Model _____

Volcanic Order _____

Sold To _____

Job Name _____

Date _____

VHPN-IOM-2018-0206

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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
- USCG and ABS (when required)

This manual is provided as a guide to the correct operation and maintenance of your Volcanic 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. Volcanic 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 installersand service personnel. In order to meet Volcanic warranty requirements, this unit must be commissioned by a Volcanic Technician. Trained personnel are responsible for the operation and maintenance of this product, and for the safety assurance of 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.

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 including but not limited to (in the United States) the United States Coast Guard, Title 46 of the Code of Federal Regulations, and/or (in the absence of such requirements), the National Fuel Gas Code ANSI Z223.1/NFPA 54 latest edition (U.S.), and the specific instructions in this manual. Authorities having jurisdiction should be consulted prior to installation.

The 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.

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 Volcanic Product (see Figures 1 and 2, and Table 1) 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 the United States Coast Guard (USCG), 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 heater house specifications and Table 2 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 area 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.
- Heaters are supplied with lifting lugs. 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. Do not allow weight to bear on equipment.

3. Install a 4 inch (102 mm) curb/spill rail 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 and Sides: 36" (1m) or more, depending on burner requirements
- Heater Rear: enough for rear door removal (approximately 48").
- Stack (minimum of 20 inches).

3. Pipes must not be run within 10" (254 mm) of any control cabinets or combustible material.
4. Verify that all clearances adhere to USCG requirements.

Environment, Ventilation and Combustion Air Requirements

Ventilation must be sufficient to maintain a heater house 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 Volcanic equipment (and other equipment) should be considered.*

Adhere to the following to meet ventilation and combustion air requirements, if installed indoors:

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.
3. Ensure the equipment room air supply openings are kept clear at all times.
4. See Table 3 for minimum make-up air required and the recommended area of each opening for each model.
5. If positive forced ventilation is adopted, ensure that there will be no appreciable pressure variation in the equipment room.

⚠ 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 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.

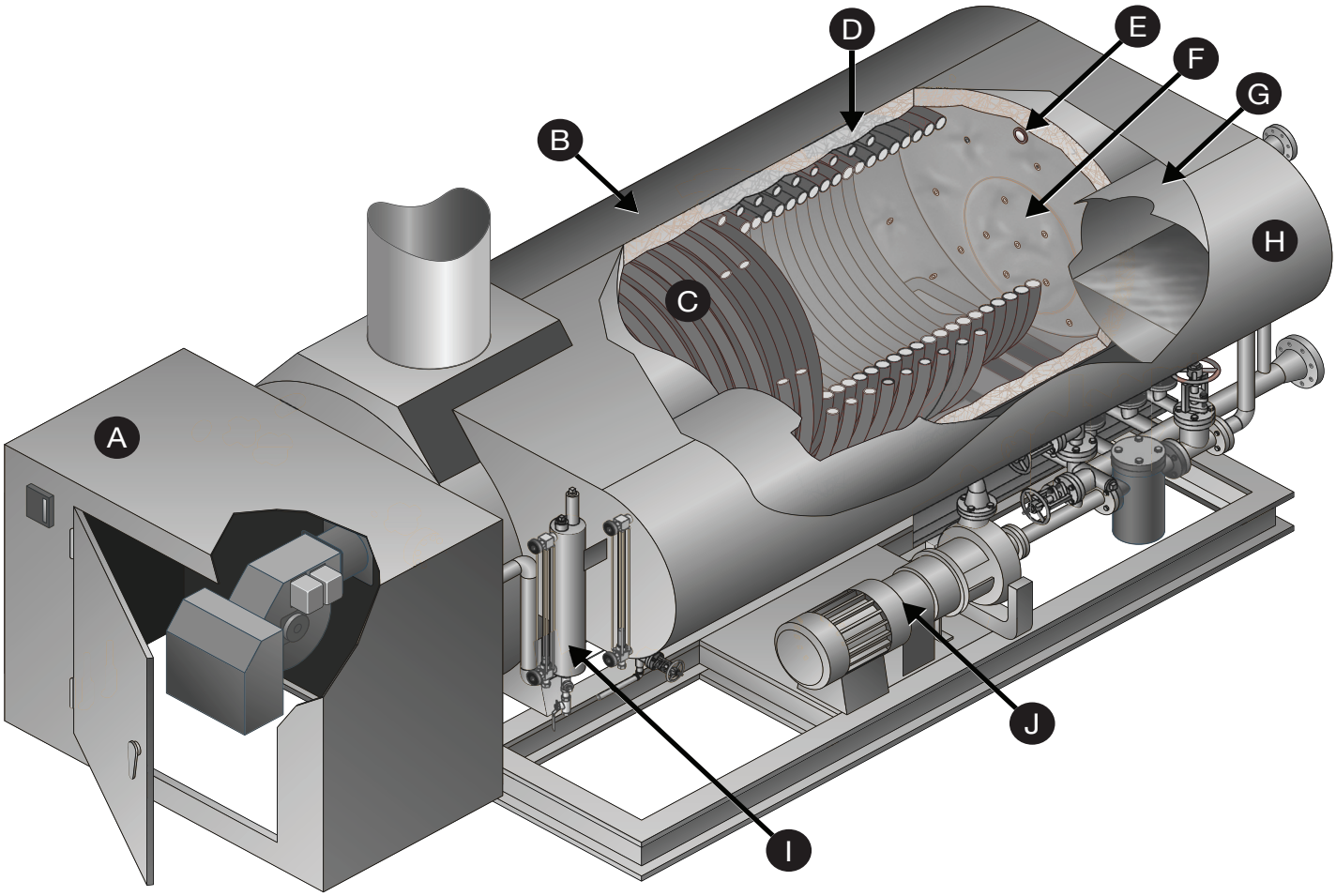

FIGURE 1 - HOPKINS HEATER CUTAWAY

EXPLANATION OF FIGURE 1 CALLOUTS

Letter	Description
A	*Burner and Electrical Control Panel* - Protected by a waterproof housing for on deck usage. Control panel meets NEC and UL codes.
B	*Extra heavy cylindrical steel shell* - Surrounds the helical single or double wound coil. Made from Schedule 40/80 seamless pipe. Spacers separate the coil and shell.
C	*Helical Coil* - Single or double wound; designed by Volcanic.
D	*Ceramic fiber blanket insulation* - A rigidizer is sprayed on the surface to protect against velocity of exiting gases.
E	*Obsevation port* - Allows for checking the flame pattern and flue combustion conditions.
F	*Access door* - Allows for inspection and maintenance tasks.

Letter	Description
G	*Separation/surge tank* - Velocity of thermal fluid returning from the system is decreased to allow any steam or air in the system to excape into the expansion tank.
H	*Expansion tank* - As the system is brought up to operating temperature, heated thermal liquid expands into the expansion tank from the separation tank. Thermal liquids expand approximately 4% by volume for each 100°F temperature increase. When the system is shut down and the liquid cools, liquid is withdrawn from the expansion tank to maintain a filled circulating loop.
I	*Cold seal tank* - The thermal liquid system is vented to the atmosphere through this tank to expel air and any steam during system start-up.
J	*Circulating pump*

TABLE 1 - SPECIFICATIONS AND DIMENSIONS

Specifications	MODEL	100S	200S	350S	600S	602	800S	802	1000S	1200S
Heat Output	Million BTU/hr	1	2	3.5	6	6	8	8	10	12
Flow Rate-Standard *1	GPM	75	150	265	425	480	600	600	725	900
Circulating Pump Motor - STD	HP	7.5	15	20	30	30	40	40	50	60
Blower Motor	HP	1/3	1	2	7.5	10	10	10	10	5
Light Oil (approx. fuel usage)*3	GPH	8.8	17.5	30.6	52.5	60	80	80	87.5	104.9
Natural Gas (approx. fuel usage)*3	FT3/hr	1,334	2,667	4,667	8,000	8,000	10,667	10,667	13,334	16,000
Pressure Drop - STD	PSI	10	23	11	23		16		13	16
Dimensions	**MODEL**	**100S**	**200S**	**350S**	**600S**		**800S**		**1000S**	**1200S**
(A) Overall Height (w/o Stack)	IN	51	60	62	82		82		105	105
(B) Overall Width	IN	42	50	50	74		93		87	103
(C) Overall Length	IN	115	152	211	231		302		311	360
Inlet/Outlet Connections	IN	2	3	3	4		6		6	8
Thermal Liquid Volume	GAL	45	86	168	426		661		724	853
Approx. Dry Weight	LBS	3,936	6,800	9,052	14,350		18,500		23,100	26,800
Approx. Flooded Weight	LBS	4,310	7,514	10,447	17,886		23,987		29,110	33,880
Floor Loading	LB/FT3	129	143	143	151		123		155	132
Expansion Tank Volume	GAL	71	140	246	602	602	786	802	1167	1379

Note: All dimensions are approximate. Please consult factory for your job specific drawings with dimensions. See Figure 2.

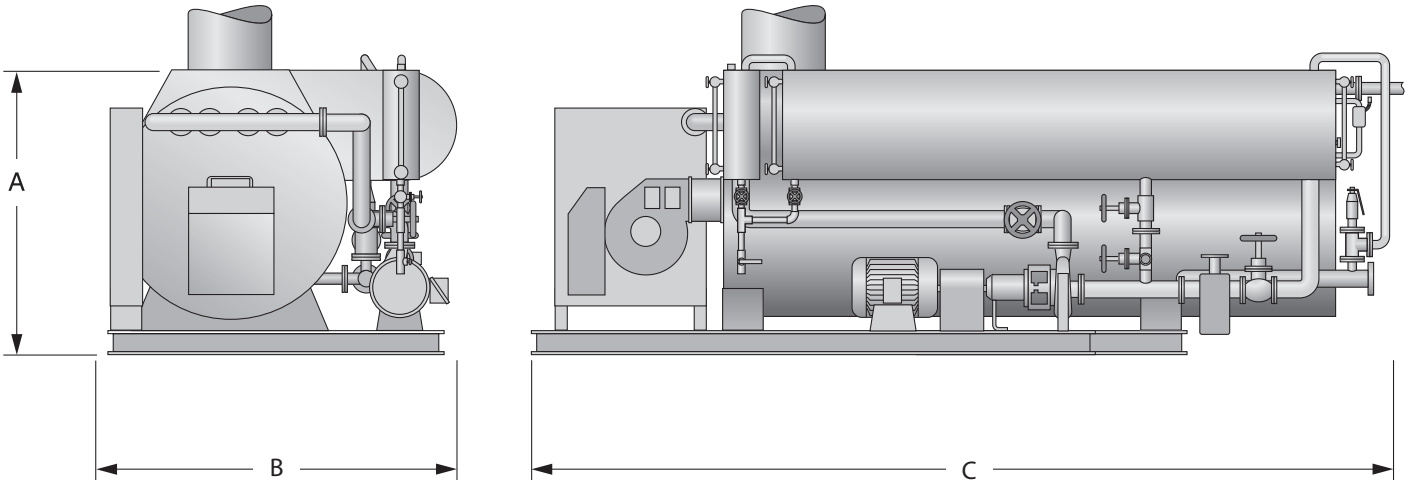

FIGURE 2 - DIMENSIONS

TABLE 2 - APPROXIMATE FLOOR LOADING (BASED ON OPERATING WEIGHT)

Model	Heater Only (lbs/ft2)
100	129
200	143
350	143
600	151
602	
800	123
802	
1000	155
1200	132

TABLE 3- MINIMUM MAKE-UP AIR REQUIREMENTS AND RECOMMENDED AREA OF OPENING FOR VENTS

Model	Minimum Make-Up Air (SCFM)*	Opening Area (in^2)** Lower Vent	Opening Area (in^2) Upper Vent
100	300	600	200
200	600	1200	400
350	1000	2000	667
600	1800	3600	1200
800	2300	4600	1534
1000	2900	5800	1934
1200	3500	7000	2334

* 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.

⚠ WARNING

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

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

⚠ 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.

6. Avoid ventilation which creates a negative pressure in the heater house 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. A properly designed make-up air system in the equipment room will preclude these possibilities and is required to maintain proper combustion.

➨ *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).

Fuel 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 C (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 C (15°C)	less than 0.1.6% 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

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.
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 and/or national requirements. In addition, if a two pipe system is employed, a check valve must be fitted into the return pipe.
4. Do not exceed the 3 psi 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.*

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/breakers 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.*

5. Determine multiple skid systems wiring requirements (between the skids). Volcanic 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 Locate electrical schematic diagram, a copy of which is inside of the panel box. Ensure the information on the electrical drawing corresponds to your voltage and frequency. Check the supply voltage and make sure that there is no over-or under-voltage exceeding 10% of the nominal value.

➨ *NOTE: Normal supply will be 230 or 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 expansion tank 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 Volcanic Thermal Fluid Heater systems, however, your final selection should be made in conjunction with recommendations from Volcanic or the fluid manufacturer.

Consider the following for thermal fluid selection:

1. The Volcanic 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
- 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 product, and verify that the fluid bulk temperature limitation exceeds the expected operating temperature. After a fluid is selected, refer to the manufacturer's recommendations, published in compliance with the Occupational Safety and Health Administration (OSHA).

7. If the fluid expansion volume from 50°F to 450°F (10°C to 232°C) exceeds 20% of the initial fluid volume, consult Volcanic.

■ 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.

Volcanic 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. Volcanic's combination expansion/Surge/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. 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. Volcanic 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. Refer to **Maintenance** section of this manual for troubleshooting activities.

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.

Adhere to the following for piping installation:

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 or Schedule 80 or equal, as required based on the design temperature and pressure of the system.
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).

⚠ 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 CO2 foam or dry chemical. Do not use water.

△ CAUTION

Proper selection of thermal fluid is critical to system performance.

⚠ 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

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

Some plastics can be dissolved by thermal fluid.

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

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. 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. See Figure 3.

11. Ensure heaters that are skid mounted with pumps and tanks are equipped with a 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.

12. 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.

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

14. 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 Tables 4 - 7 and Figure 4 for guidelines.

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

➨ *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.)*

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

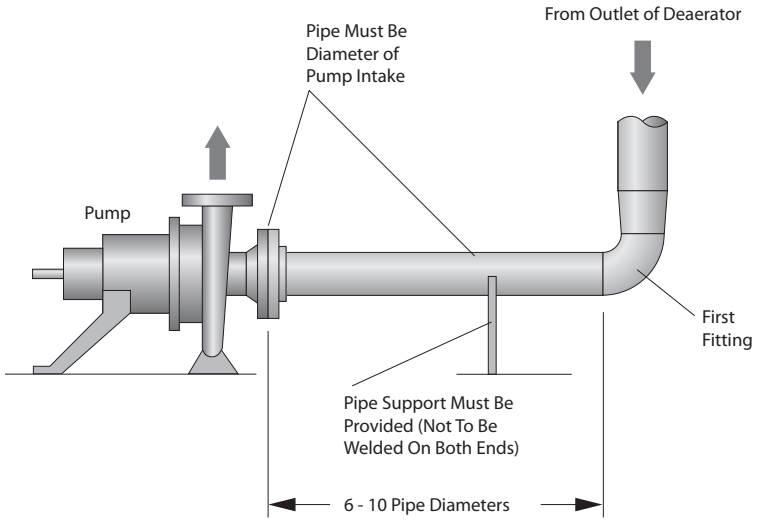

FIGURE 3 - TYPICAL PUMP PIPING

TABLE 4 - RECOMMENDED GASKET LOADS FOR FLEXITALLIC SPIRAL WOUND CLASS 150# GASKETS SAE GRADE 5 BOLTS OR EQUAL

Nominal Flange Size (in.)	Number of Bolts	Diameter of Bolts (in.)	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

⚠ 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.

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

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

⚠ 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 may be dissolved by thermal fluid.

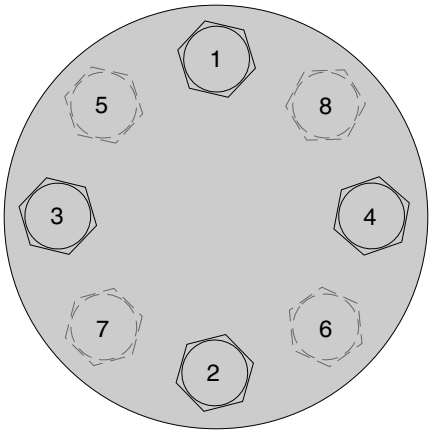

FIGURE 4 - BOLTING SEQUENCE FOR 4 AND 8 BOLT FLANGES

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

Nominal Flange Size (in.)	Number of Bolts	Diameter of Bolts (in.)	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

TABLE 6 - RECOMMENDED LOADS FOR JM CLIPPER ELASTOGRAPH 150# GASKETS SAE GRADE 5 BOLTS OR EQUAL

Nominal Flange Size (in.)	Number of Bolts	Diameter of Bolts (in.)	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 7 - RECOMMENDED LOADS FOR JM CLIPPER ELASTOGRAPH 300# GASKETS SAE GRADE 5 BOLTS OR EQUAL

Nominal Flange Size (in.)	Number of Bolts	Diameter of Bolts (in.)	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.

⚠ 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.

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

△ 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 freezing interference and/or 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.

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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. Do not insulate the expansion and surge 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.
3. 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.

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.

■ 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 Volcanic heater system. The pump manufacturer's installation and operation instructions can be obtained from the manufacturer.

Adhere to the following for pump installation:

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 Surge 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.
- 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 it should be filled with a lubricating oil recommended by the manufacturer. The suggested lubricant is usually SAE-30 non-detergent oil.
- Thermal fluid is not sufficient lubrication for bearings.
- 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.

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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.

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

Non-code tanks cannot be pressurized over 15 psig.

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

⚠ WARNING

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Cements for plastic pipe should be kept away from all sources of ignition. Proper ventilation should be maintained to reduce the hazard and to minimize breathing of cement vapors.

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

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

■ Requirements for Air Cooled Pumps

Adhere to the following for air cooled pumps (See Figure 5):

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.

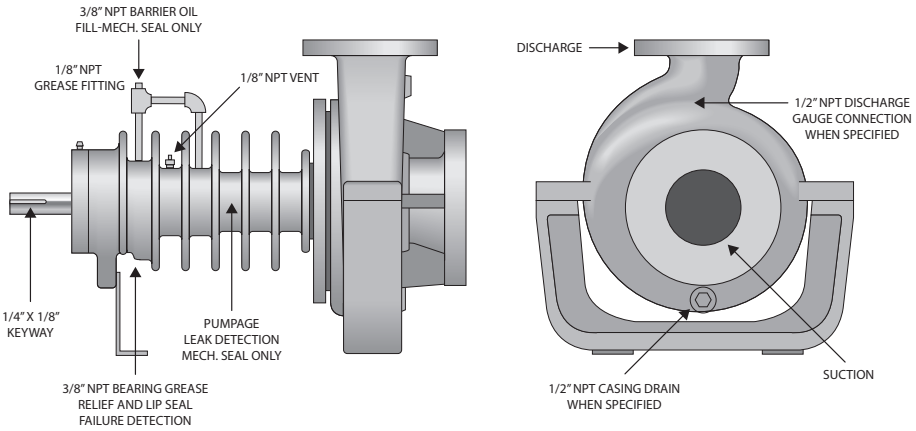

FIGURE 5 - TYPICAL AIR COOLED PUMP

■ Requirements for Water Cooled Pumps

Adhere to the following for water cooled pumps (See Figure 6):

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.

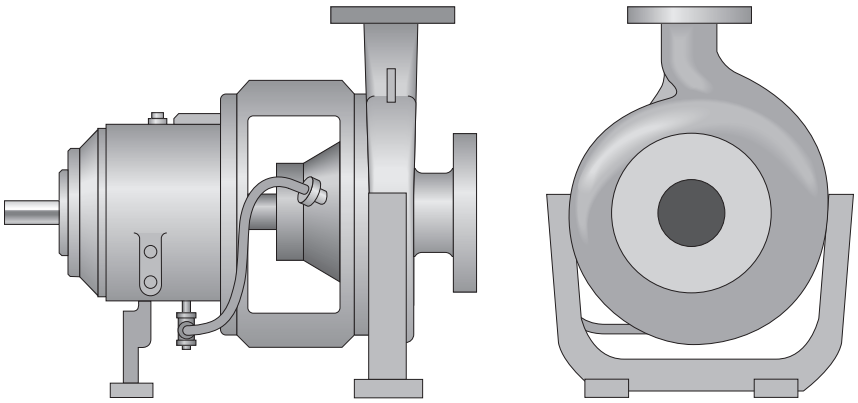

FIGURE 6 - TYPICAL WATER COOLED PUMP

■ Combination Surge/Expansion Tank

Volcanic's efficient design combines the operation of the expansion and surge 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 surge section is to remove all volatiles from the system to avoid pump cavitation. The surge 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.

A system of interconnecting pipe work 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.

Both expansion and surge tanks are equipped with Inferno style sight glasses and valves for easy reading of tank level.

■ 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 surge section 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.

Adhere to the following for installation:

1. Install tank in accordance with Volcanic's specifications.
2. Unless the system is pressurized, the inlet to the cold seal 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.

■ Expansion Tank Bypass Line

This may be used at start-up to remove air and water from the system, and then valved appropriately during operation to provide expansion capacity for the system.

■ 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.

Note: In conjunction with this system, an automatic venting device must be fitted to the system expansion tank. Consult Volcanic for further details.

■ 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 inlet to the cold seal is higher than or equal to the highest point in the system, or a pressurized system must be used.

5. Field-install the liquid level switch (supplied and shipped with the unit). This must be wired to the control panel.

■ Seal and Drain 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 7.

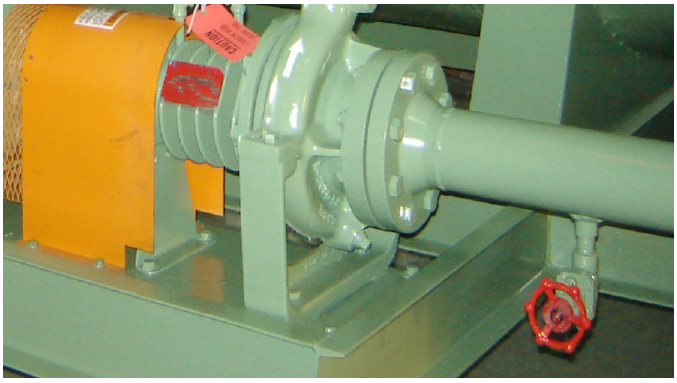

FIGURE 7 - DRAIN AND FILL CONNECTION

■ Pressure Gauges

The range in which readings are expected to fall should comprise mid-scale on the pressure gauge chosen (See Figure 8). Pressure gauges must be able to withstand overpressure equal to the rating of the safety relief valves, normally 100 psig.

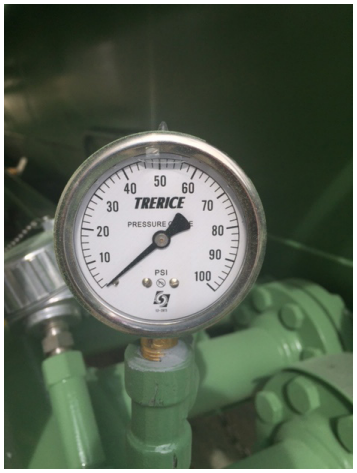

FIGURE 8 - GAUGES

■ Thermometers

Thermometers should read up to 450°F (232°C). For systems with higher operating temperatures, select thermometers 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" or basket type strainer in the fluid return line, between the Surge 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. 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.
7. 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

■ 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 Volcanic.

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:

1. Ensure the stack is at least the same diameter as the flue gas outlet.
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 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.
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 heater house location installations. This will help to maintain the required draft.
10. Insulate the section of the chimney duct within the heater house.
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

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

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.

△ CAUTION

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

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.

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

⚠ 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.

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 requirements, including United States Coast Guard (USCG) guidelines.
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.
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 fuel 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 7 for the drain and fill connection.

2. A drain and fill point (generally a 2" 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.
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 surge tank sight glass, begin slowing down the filling process.
5. Continue to fill until the liquid level switch closes. After fluid appears in the expansion tank, fill to cold start level.
6. 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.
7. Verify to see that the liquid level switch operates freely. To confirm operation of the liquid level switch, manually trip the liquid level switch. Burner should shut down.

■ 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 (see Figure 9) and be sure the switch is functioning properly.
6. Fill the system to the cold start level in expansion tank.
7. 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

⚠ 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-Volcanic 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 fluid should not be used prior to extensive cleaning. Thermal fluid can be damaged by contact with moisture or 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.

Wear eye and hand protection for your safety.

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

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If a fire does occur, extinguish using CO^2 foam or dry chemical. Do not use water.

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.

8. Determine the final nitrogen pressure by measuring the difference between the 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).
9. 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.
10. Adjustment can be made via the regulator mounted on top of the tank.

■ Circulating Pump

Adhere to the following:

1. Read manufacturer's instruction manual thoroughly. If the pump is supplied by Volcanic, 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 there is no fluid flow, discontinue Start-up procedures and contact the Volcanic 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.
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

Make sure 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 Volcanic 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 & Installation Review** and **Fill the System**, including 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

⚠ 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 established, discontinue start-up and contact Volcanic 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 fuel lines have been purged.

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

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 marine personnel with the operation of all Volcanic 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.

■ High Temperature Limit Control

Yokogawa:

1. 0-650˚ range adjustable. Adjustment is made internally and must be made with cover removed.
2. 35' capillary installed in heater outlet header.
3. Normally closed contact installed in series with fuel valves that open when pre-set remperature is reached.
4. When temperature reaches pre-set temperature, fuel valves close and Fireye goes into alarm condition. Alarm horn sounds.
5. Limit control, Fireye must be manually reset to resume nmormal operation.

TEST: Run temperature up to control set temperature.

■ Main Air Blower Starter Auxiliary Contact

Allen-Bradley 509BOD, Size 1:

1. Normally open contact, installed in series with fuel valves, that closes when started is energized.
2. Should starter fail to remain energized during firing cycle, fuel valves close and Fireye will go into alarm condition. Alarm horn sounds.
3. Fireye must be manually reset to resume normal operation.

TEST: Remove one wire from the Main Air Blower Auxiliary contact.

■ Ignition System

Pilot Ignition Transformer - Allanson Cat. #421-655, 120V Promary, 10,000V Secondary. Pilot Oil Solenoids - General Controls S311AFO2V2AC9:

1. Ignition Transformer and Pilot Oil Solenoids are sequenced tjhrough program control, Terminal 5.
2. 10-second trial for ignition.
3. If no ignition after trial for ignition period, Fireye will go into alarm condition. Alarm horn sounds.
4. Manual reset of Fireye required to return to normal operation.
5. Pilot Transformer and Pilot Oil Solenoids de-energize 10 seconds after Terminal 7 energizes and main flame is established.

TEST: Time trial for ignition period.

■ Fluid Flow

1. Main circulating pump - Dean pH2141, 3x4-8 1/2/7-1/2, for 6000 GPM @ 55 PSI
   - Provides 9.72 ft.sec. velocity approximately per coil.
2. By-pass Valve - Dresser Industries Consolidated 1905JC 2" x 3" 150# Flanged set @ 50 PSI.
   - Mounted on discharge line of Heater.
   - Bypass oil flow to pump suction to provide minimum safe fluid flow in the heater coil in case of system dead heading.

TEST: Close heater discharge valve.

■ Non-Recycling Interlock

Low Combustion Air Switch - Cleveland Controls AFS-A

- Normally open contact that closes with correct air pressure.
- If pressure is not correct, burner will shut down and Fireye goes into alarm condition. Alarm horn sounds.
- Requires manual reset of Fireye to resume normal operation.

TEST: Remove vacuum line from air switch and cover intake with hand.

■ Cold Circulation

1. Turn on the main power switches.
2. Check for proper fluid level in the expansion section of tank.
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 full open.
5. Check pump rotation. Operating the pump in reverse rotation may cause extensive damage.

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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 fuel 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 fuel 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 Volcanic 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.

If excessive amounts of thermal fluid are to be vented from the system, additional thermal fluid may be required in the system. Contact Volcanic 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 boilout procedure must be followed as water may have been introduced to the system.

6. Remove the pump coupling located between motor and pump.
7. Turn the main pump switch located on the front of the panel box door to ON.
8. Check for proper alignment. Realign, at temperature.
9. Check that all pressure gauge readings remain stable. Refer to Figure 8. Pressure exceeding 100 PSIG or identical readings at inlet and outlet gauges indicate a closed valve.
10. Check all piping, connections and users for leaks. Repair any leaks immediately.

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. Check for correct fuel feed. All air must be eliminated from fuel lines, preheaters, etc. by proper, approved methods.
2. 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.
3. Check safeties.
4. Disable N2 blanket if equipped and open vent line on expansion tank.

5. Set burner switch to "ON". The burner will begin the call for heat if oil temperature is below setpoint.
6. With burner firing and pump running, keep checking the gauges indicating pump and circuit pressures. Make sure they remain stable.
7. In case of pressure fluctuations, stop the burner, but allow the pump to continue to circulate fluid.
8. When pressures have stabilized, start burner again.
9. 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.
10. 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.
11. 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.
12. 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.
13. After fifty hours of operation at operating temperature, check all flanges and connections for tightness.

■ Combustion: Oil Fired

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

▶ 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.

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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.

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

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.

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.
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.

▸ S.T. JOHNSON OR POWER FLAME #2 OIL FULL MODULATION BURNER

Checklist for safe starting:

1. Check all oil piping for leaks.
2. Check all linkages, especially for damage incurred in shipment.
3. If not installed, mount oil pressure and temperature gauges.
4. There should be NO shut off valve installed in fuel return line.
5. Check electrode spark gap as specified in burner manual.
6. Once properly authorized service personnel have set burner linkage, it is advisable to permanently mark the linkage settings for future reference.

Flame Programmers

■ Fireye Linkage Modulation, YB110/E110

The Fireye Linkage Controls come complete and wired from the factory, with no programming necessary. Please refer to the Fireye cut sheet for specific programmer information. Units come with an IR Scanner and amplifier module as standard.

▸ YZ300/E300 ANNUNCIATOR

Most Volcanic units come with the YZ300/E300 expansion module with panel-mounted display. This display will read first out annunciation of any recycled or safety limits wired into the Fireye module.

Both annunciators come pre-programmed from Volcanic with application specific display messages. Please refer to Fireye cut sheet or contact Volcanic for assistance with annunciator programming.

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 Volcanic Service Department with any questions regarding the proper operation, set points and verification procedures for these controls.

■ Liquid Level Switch

Adhere to the following:

1. Locate the liquid level switch (See Figures 9A and 9B) installed on the surge tank prior to operation of the equipment. The liquid level switch is wired to the main heater panel.

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⚠ CAUTION

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

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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 burner down.

3. To confirm operation, manually trip the liquid level switch by pressing the button shown at the tip of the arrow in Figure 9B. Unit should shut down.

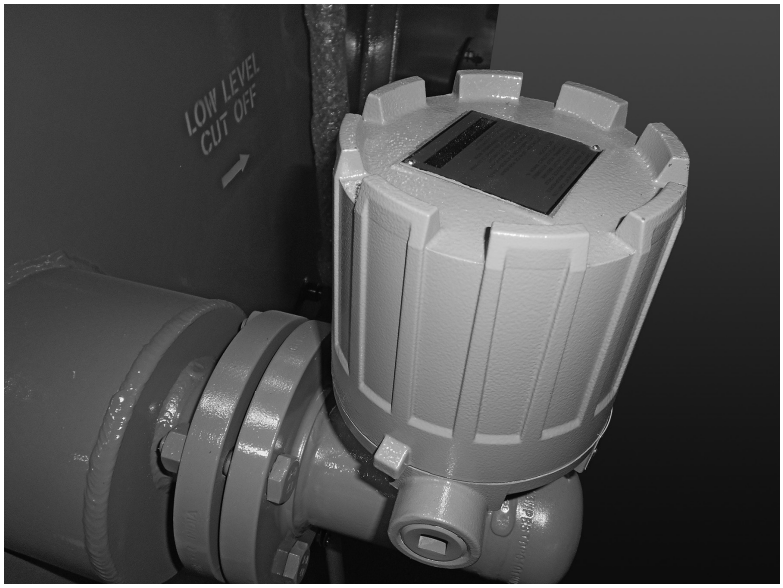

FIGURE 9A - LIQUID LEVEL SWITCH LOCATION

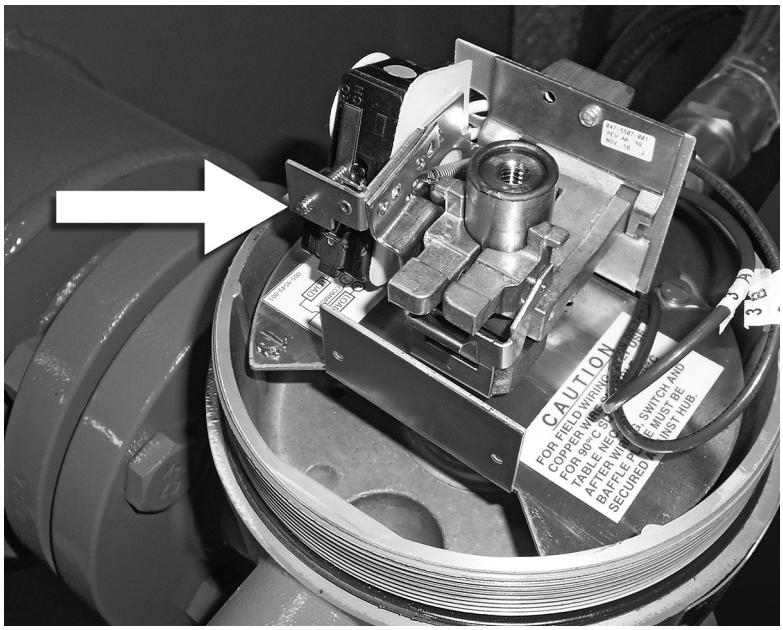

FIGURE 9B- MANUAL TRIP FOR LIQUID LEVEL SWITCH

■ Air Safety Switch

1. The air safety switch is installed on the burner 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 Fireye control 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.
2. Reset motor starter; blower should start and purge cycle will begin.
3. Lockout of Fireye control 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 seconds.
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 10) 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.*

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. Remove the metal cover on top of the switch and increase the

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setpoint until the pump shuts down. Next, decrease the setpoint back to its initial value and depress the pump start button to verify the pump will re-start.

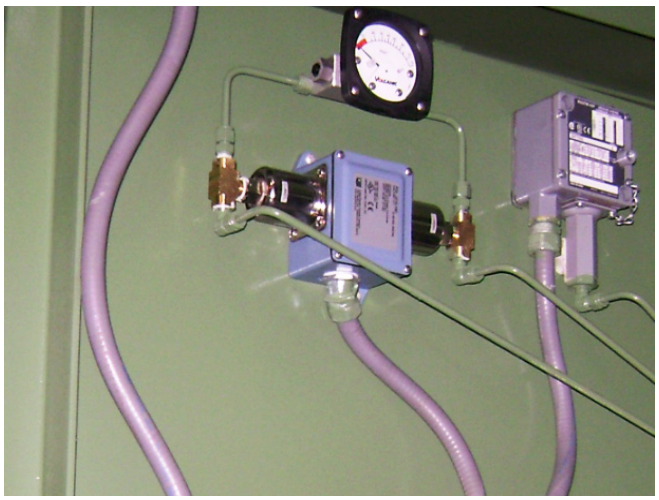

FIGURE 10 - DIFFERENTIAL PRESSURE SWITCH

■ Operating Temperature Controls

The operating temperature control is located above the heater panel and regulates 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 and Low Fluid Pressure Switches

The heater is equipped with a low inlet, high inlet and high outlet pressure switch. See Figure 11. 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.

FIGURE 11- HIGH AND LOW FLUID PRESSURE SWITCH

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 the circulating pump running, 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 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,

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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 the safety valve set pressure*.

■ 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.

■ Modulating Controls

All coil models are standard-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. 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.

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.Volcanic-heater.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."

■ 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.

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 8. Please contact Volcanic for your specific order to verify your flow rate.
3. In the event of an abnormal reading, contact Volcanic 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 8 - REQUIRED PRESSURE DROP ACROSS THE HEATER

Model	Recommended GPM (schedule 40)	Pressure Drop PSI
100S	75	10
200S	150	23
350S	265	11
600S	425	16
602	480	
800S	600	16
802	600	
1000S	800	13
1200S	900	16

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.

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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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2. Isolate Y-strainer(s) or baskets 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 4 - 7.
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 Volcanic.

Daily Operational Procedures

The following procedures must be performed by trained and qualified personnel only.

■ Check Out

Take a visual check of heater for the following:

- Surge tank – full or above low level cutoff.
- Expansion tank – 2" to 6" heating oil in sight glass.
- Cold seal tank – 2" to 6" heating oil in sight glass.
- Both cold seal and expansion tanks should be drained of water or sludge before starting or shutting down heater.
- Supply and return hot oil valves should be in proper position.
- Check lube oil in main pump. The dean ra series pumps do not require lubricating oil.
- All fuel supply & return valves should be in open to and from the fuel supply tank.
- No fuel leaks near or around burner.
- All switches on control panel should be in the "off" position.
- Partlow or yokogawa operating temperature control should be set to desired temperature (385 on asphalt and 225-300 on #6 oil).
- All pressure gauges and visual controls in zero (0) or normal position.

■ Start-Up

Start generator after its "check out" (refer to generator manufacturers procedure).

1. Allow time for engine to warm up.

2. Close main breaker (puts power to control panel).
3. Set voltage and cycles to proper settings (60 cycles and_____[1] volts).

CONTROL POWER

1. Turn control power switch to the "on" position.
2. Allow one minute for the fireye flame program controller to warm up.

MAIN PUMP

1. Turn main pump switch to the "on" position.
2. Recheck levels in surge and expansion tanks (2"-6" minimum when cold).
3. Check differential pressure gauge – must be a minimum of _____[1] PSI.
4. Recheck voltage and cycles at generator panel (low voltage or cycles will damage gen and/or hot oil heater).

FUEL SUPPLY PUMP SWITCH (IF PRESENT)

1. Re-check fuel supply and return valves to make sure they are open to and from the fuel supply tank. Make sure the fuel pressure gauge reads zero. Damage will occur if either valve is closed.
2. Turn fuel supply pump switch to the "on" position if present.

➨ *NOTE: Push in low level and low flow reset buttons if they are present.*

BURNER SWITCH

1. Turn burner switch to the "on" position.
2. Pre-purge will be initiated and blower motor and fuel pump motor will start. Damper doors will move to the high fire position in 30 seconds. (on model 800 heaters and larger, damper doors will stay in high fire position for 30 seconds.)
3. Damper doors will drop to low fire position in 30 seconds.
4. Burner will fire in low fire position. Green light will illuminate and fuel valves will open.
5. If calling for heat, the burner will modulate into the high fire position after 30 seconds.
6. Check vacuum gauge at the fuel filter (should be no more than 15-18" vacuum) if vacuum is over 18". change fuel filter elements. Use 30 micron filters only.

When the heater is running in the high fire position, you must have 300 PSI of fuel supply pressure, less than 18" vacuum at fuel filters, and approximately _____[1] PSI fuel return bypass pressure.

[1] Note: These values are to be filled in by Volcanic, as they can vary depending on model of heater and specific customer needs.

⚠ WARNING

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

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After the heater has been running for at least two hours in the high fire position, there should be a 50 degree temperature differential between the oil coming into and leaving the heater. The burner will start to modulate into the low fire position approximately 15 degrees before the set point on the Partlow or Yokogawa. It will be in the low fire position at set point. The burner will turn off at approximately 10 degrees past the set point, and re-light automatically when the temperature falls back below the set point.

⚠ **WARNING**

Be sure to turn the burner switch to the "off" position before servicing fuel filters. Severe damage or personal injury could occur if trying to service filter assemblies while burner is running.

■ Shut Down

1. Turn burner switch to the OFF position.
2. Turn fuel supply pump switch to the OFF position if present.
3. Allow thermal liquid in system to cool down to 225 deg. F or run pump for 1 hour, which ever comes first before shutting down main circulating pump.
4. Drain cold seal & expansion tank of water & sludge.
5. Turn main circulating pump switch to the OFF position.
6. Turn control power switch to the OFF position.
7. Open main breaker on generator panel.
8. Shut down generator (refer to generator manufacturers procedure).

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

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.

Prior to any maintenance concerning electrical components of this equipment, ensure electrical 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.

Be sure to turner the burner and the fuel supply pump switches to OFF position before servicing fuel filters. Failure to comply may result in personal injury and/or equipment damage.

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) or basket 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 Volcanic Service Department, at the end of this section of this manual, and on *www.volcanic-heater.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 contact Volcanic Heater Service Department.

5. Drain water from cold seal tank and expansion tank.
6. Check all linkage components for tightness. (Figure 12).
7. In systems utilizing a Dean pH style or Goulds circulating pump, check level of lubricating oil in self-leveling reservoir. See Figure 13.

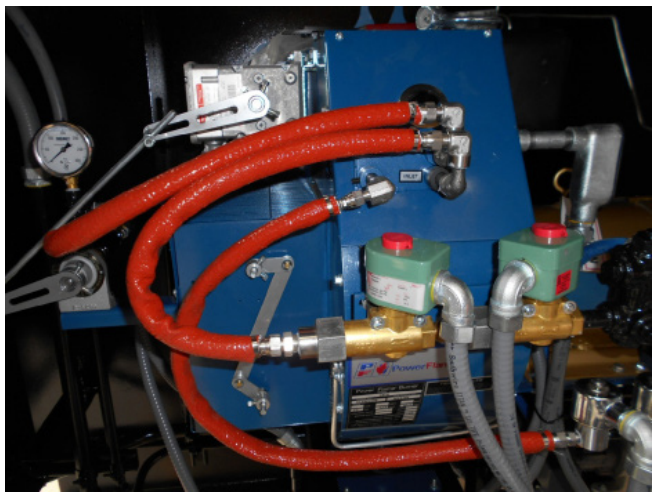

FIGURE 12- LINKAGE COMPONENTS

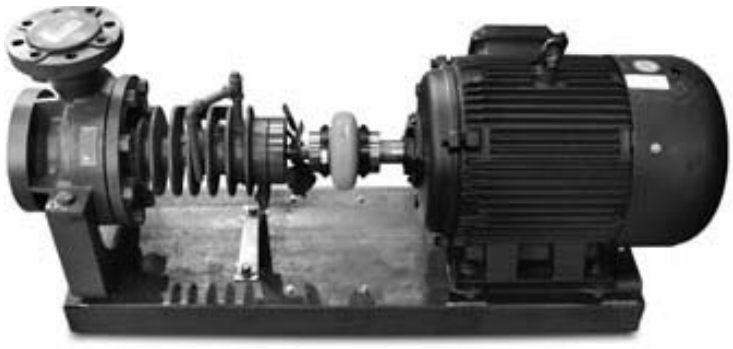

FIGURE 13- AIR-COOLED THERMAL FLUID CIRCULATING PUMP

Monthly Maintenance Schedule

1. Change 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. Lubricate linkage on burner.

⚠ WARNING

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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 fuel leaks.

⚠ CAUTION

All maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Volcanic Service Department.

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.

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 Volcanic Service Department.

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

7. With the burner running, remove or disconnect the flame detection device. The flame programmer should lockout within 3 seconds.
8. Review daily log sheets noting any deviations from the norm.
9. Check the tightness of all couplings, including the fuel oil pump drive (oil-fired units), fan impeller, circulating pump, etc. See Figure 14.

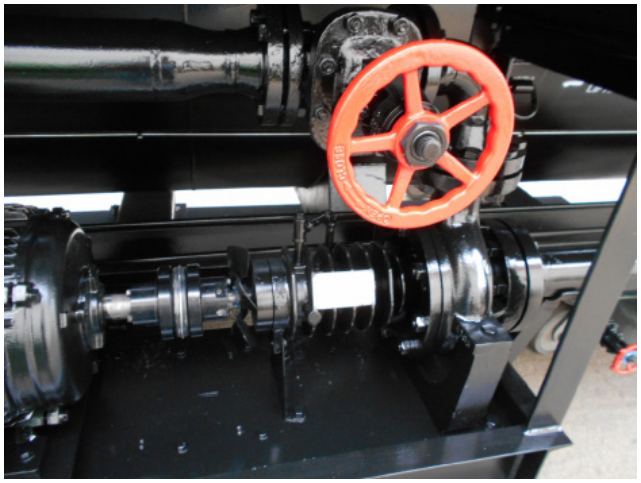

FIGURE 14 - PUMP COUPLING

Semi-Annual Maintenance Schedule

1. Pull burner gun 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. Clean or replace fuel nozzle.
4. Inspect internal surfaces of the heater. Inspect refractory for loose insulation. 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.
5. Have combustion checked for efficiency.
6. Review daily log sheets noting any deviations from the norm.
7. Clean sight glasses and grease all motors.

Annual Maintenance Schedule

1. Replace the ignition electrode(s).
2. Clean all strainers in the thermal fluid system.

3. Take a one quart sample of thermal fluid and return to the thermal fluid manufacturer for analysis.
4. Schedule Volcanic 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.

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

■ Soot Cleaning

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

1. Make sure the heater is off and fluid is ambient temperature.
2. Remove the burner and lower access doors.
3. Wire brush coils and use compressed air where accessible.
4. Vacuum loose soot where accessible.
5. Reinstall the burner and lower access doors.
6. Fire the heater and set combustion.

Safety Check Procedures

Perform the following safety checks as needed:

■ Liquid Level Switch

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

⚠ WARNING

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⚠ 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 Volcanic Service Department.

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

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All maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Volcanic Service Department.

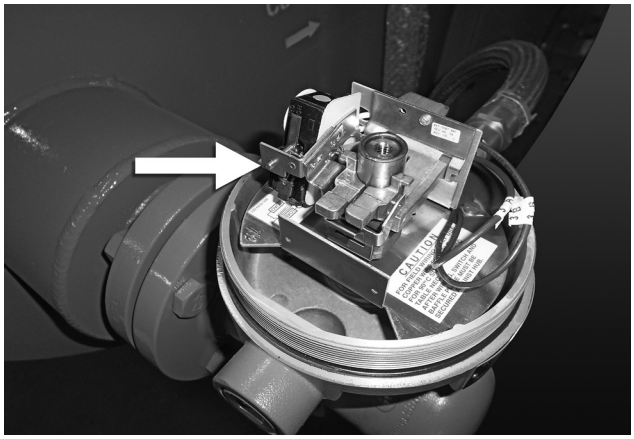

FIGURE 15 - DIFFERENTIAL PRESSURE SWITCH

■ Stack Limit (if applicable)

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 16.

FIGURE 16 - 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. The setpoint should be 2 - 3 psi below the published differential pressure of the heater (this will vary by heater model, refer to Product Data Submittals). See Figure 17.

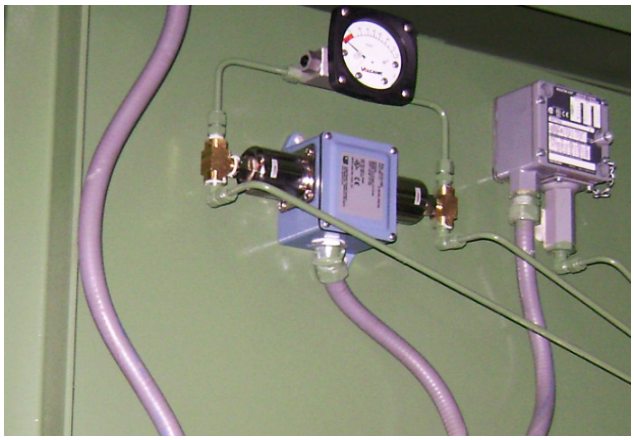

FIGURE 17 - DIFFERENTIAL PRESSURE SWITCH

■ Low Inlet Pressure Switch (if applicable)

Slowly close the valve on outlet of main circulating pump observing heater inlet pressure gauge. Note the pressure at which the switch trips. The setpoint should be 10 psi lower than the heater inlet pressure when the system is at operating temperature (or 50 psig, whichever is less).

■ Air Switch

Remove the ¼" copper tubing from the bottom of the air switch with the fan running. Air switch should trip the interlock circuit. Re-attach copper tubing and reset flame programmer.

■ 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.

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 main pump 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.

⚠ WARNING

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At no time should the high inlet pressure switch be set above the safety relief valve set pressure.

△ CAUTION

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⚠ CAUTION

All maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Volcanic Service Department.

DIFFERENTIAL PRESSURE SWITCH

Units 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. The setpoint should be 2 - 3 psi below the published differential pressure of the heater (this will vary by heater model).

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. Volcanic 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, auxiliary blower motor starter contacts, high temperature limit(s), and / or low oil pressure switch.

AIR SWITCH

All 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.

AUX. BLOWER MOTOR STARTER

All 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.

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 fuel 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 Flame Failure PTFI on Fireye controllers. 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-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 Volcanic 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	Volcanic has a general program for each of the temperature controllers we have used over the years. Compare your current temperature controller program to Volcanic's general program. See the back of this section for general programming sheets for standard Volcanic heaters. Make changes as necessary. Contact Volcanic 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 Volcanic service department if necessary.
Temperature Sensor Failure	Different temperature controllers use different types of temperature sensors. These may be Type J thermocouples, 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-I - 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 Volcanic 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 Volcanic (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.

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 greater than 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. 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 turned 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.

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 10.0 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 U.V. scanner, lockout and tag heater's fuel supply. Remove the scanner from 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 scanner. If this change does not work, change 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.

⚠ 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 through Volcanic Heater, Inc. When ordering replacement parts, please have the model number and serial number of your Volcanic Heater ready. Factory-direct replacement parts must be used to ensure proper equipment operation and adherance with warranty requirements. Visit www.volcanic-heater.com for further information.

Standard Warranty for Volcanic Hopkins Thermal Fluid Heaters

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. Volcanic Heater, Inc. 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 Volcanic Heater, Inc. All Installation and Operation Checklists must be submitted to Volcanic Heater, Inc.'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

Volcanic Heater, Inc. 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 Volcanic Heater, Inc. and the component manufacturers. All Installation and Operation Checklists must be submitted to Volcanic Heater, Inc.'s Quality Assurance department.

GENERAL

Volcanic Heater, Inc. 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 Volcanic Heater Installation and Operation Manual.

No Sales Manager or other representative of Volcanic Heater, Inc. other than the Quality Manager or an officer of the company has warranty authority. Volcanic Heater, Inc. will not pay any charges unless they were pre-approved, in writing, by the Volcanic Heater 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. Volcanic Heater, Inc. 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 Volcanic Heater, Inc. has been advised of the possibility of such damages. Volcanic Heater, Inc.'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 Volcanic Heater Quality Assurance department for review and approval.

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Effective: 07.15.2016

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U.S. COST GUARD TEST PROCEDURES A

Burner Controls

PROGRAMMING CONTROL - FIREYE YB110, YP100 PROGRAMMER, BLV512 DISPLAY, 60-2874-1 BASE & YZ300 EXPANSION MODULE.

1. Operating Control Circuit must be closed to start. Operating Control circuit consists of Operating Temperature Control, Main Circulating Pump Starter Auxiliary Contact, and Burner Switch.
2. Limit Control Circuit must then be closed to start operating cycle. Limit Circuit consists of Low Level Control, Low Flow Control, Low Fuel Oil Pressure Switch, High Temperature Control, (2) Flow Switches & Low Combustion Air Switch
3. Modulator sent to high fire position, blower motor energized, pre-purge period minimum of 30 seconds.
4. Modulator sent to low fire position, when low fire start switch closes Ignition Transformer and pilot fuel valves simultaneously energized. 10-second trial for ignition period.
5. After pilot flame is detected during this 10-second period, the main fuel valves are energized and the main flame trial for ignition sequence will start.
6. Modulator released for automatic control by Operating Temperature/Burner Modulating Control upon demand for heat.
7. When operating control circuit opens, fuel valves de-energize, modulator driven to close dampers, 15-second post-purge, blower motor de-energized.

TEST:

8. Observe for proper operation.
9. Time purge and post-purge periods.

FLAME SAFEGUARD - FIREYE TYPE 48PT2 INFRARED FLAME SCANNER AND PROGRAMMING CONTROL.

1. De-energize fuel valves within 4 seconds of flame failure, control will safety lockout. Alarm horn will sound off. Control requires manual reset.

TEST: Disconnect one scanner wire at junction box on Burner. Time fuel valve shutoff.

Operating Circuit Controls

OPERATING TEMPERATURE/BURNER MODULATING CONTROL- YOKOGAWA UT152

1. 0-650° adjustable range.
2. Thermo couple installed in Heater Outlet Header.
3. 15° F adjustable override shutoff above set point (OTC).
4. Operating Temperature Control normally closed switch installed in Operating Control Circuit.
5. Shuts down burner at temperature limit with automatic re-start on cool-down of fluid temperature.
6. In conjunction with Programming Control properly modulates air-fuel ratio throughout the range of firing rates.

TEST: Start heater and run outlet temperature to set point temperature.

MAIN CIRCULATING PUMP STARTER AUXILIARY CONTACT-ALLEN-BRADLEY 509-DOD, SZ. 3 (500F-DOD930)

1. Normally open contact installed in operating control circuit that closes when starter is energized.
2. Prevents start of burner without oil circulation.

TEST: Remove one wire from Main Circulating Pump Auxiliary Contact.

BURNER SWITCH, LIMIT CONTROL - ALLEN-BRADLEY 800T-H2A WITH OFF/ON PLATE.

1. Normally open contact installed in Operating Control circuit that is manually closed with maintained position.
2. Shuts down burner when manually turned to off position.

TEST: Verify proper operation.

Limit Control

LOW LEVEL CONTROL (SURGE TANK FLUID LEVEL) – MAGNETROL T-62

1. Normally open switch installed in limit circuit, which closes with proper fluid level.
2. When fluid level drops, switch opens and burner shuts down. Alarm sounds.
3. Manual reset of Fireye required, with automatic start when reset corrected.

TEST: Trip Float Switch manually.

LOW FLOW CONTROL - UNITED ELECTRIC TYPE J21K, MODEL 150, STOCK #9538

1. Normally open switch installed in limit circuit, which closes with proper flow and differential adjustment, pressure drop from inlet to outlet of heater coil.
2. When fluid flow changes or drops to switch setting, switch opens and burner shuts down. Alarm sounds.
3. Manual reset of Fireye required, with automatic restart when reset corrected.

TEST: Close heater discharge valve.

LOW FUEL OIL PRESSURE SWITCH - ALLEN-BRADLEY 836T-T255J, 0-450 PSI RANGE

1. Normally open switch installed in limit circuit that closes with proper pressure from fuel oil supply pump.
2. When pressure drops to set pressure during firing cycle, fuel valves close and Fireye control goes into alarm condition. Alarm horn sounds.
3. Fuel conditions must be corrected. Fireye must be manually reset to resume normal operation.

TEST: Close off supply valve to switch and bleed pressure off.

HIGH TEMPERATURE LIMIT CONTROL - YOKOGAWA UT150L

1. 0-650˚ range, adjustable. Adjustment made internally and must be made with cover removed.
2. Thermo coupler installed in Heater Outlet Header.
3. Normally closed contact installed in limit circuit that opens when pre-set temperature is reached.
4. When temperature reaches pre-set temperature fuel valves close and Fireye goes into alarm condition. Alarm horn sounds.
5. Limit Control and Fireye must be manually reset to resume normal operation.

TEST: Run temperature up to control set temperature.

LOW COMBUSTION AIR SWITCH - CLEVELAND CONTROLS AFS-A

1. Normally open contact that closes with correct air pressure.
2. If pressure is not correct, burner will shut down and Fireye goes into alarm condition. Alarm horn sounds.

3. Requires manual reset of Fireye to resume normal operation.

TEST: Remove vacuum line from air switch and cover intake with hand.

Fuel Supply Control System

MAIN AIR BLOWER STARTER AUXILIARY CONTACT - ALLEN-BRADLEY 509-BOD, SIZE 1 (500F-BOD930)

1. Normally open contact installed in series with fuel valves that closes when starter is energized.
2. Should starter fail to remain energized during firing cycle, fuel valves close and Fireye will go into alarm condition. Alarm horn sounds.
3. Fireye must be manually reset to resume normal operation.

TEST: Remove one wire from Main Air Blower Auxiliary Contact.

Ignition System

PILOT IGNITION TRANSFORMER – ALLANSON 421-655, 120V PRIMARY, 10,000V SECONDARY. PILOT OIL SOLENOIDS - ASCO 8262H096 - 1/8"

1. Ignition Transformer and Pilot Oil Solenoids are sequenced through Program Control, Terminal 5.
2. 10-second trial for ignition.
3. If no ignition after trial for ignition period, Fireye will go into alarm condition. Alarm horn sounds.
4. Manual reset of Fireye required to return to normal operation.
5. Pilot Transformer and Pilot Oil Solenoids de-energize 10 seconds after Terminal 7 energizes and main flame established.

TEST: Time trial for ignition period.

Fluid Flow

MAIN CIRCULATING PUMP – DEAN BROS. PH 3X4-8-1/2 FOR 600 GPM @ 50 PSI

Provides 10.37 ft./sec. velocity approximately, per coil.

BY-PASS VALVE - DRESSER INDUSTRIES CONSOLIDATED 1905JC 2" X 3" 150# FLANGED @ 50 PSI

1. Mounted on discharge line of Heater.
2. Bypass oil flow to pump suction to provide minimum safe fluid flow in the heater coil in case of system dead heading.

TEST: Close heater discharge valve.

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