



Fulcrum Series (TLSW/TLWW/TLSWD/TLWWD)

Indirect Fired, Semi-Instantaneous, Steam and Boiler Water Heater

(Vertically or Horizontally Built, Steam-to-Water, or Water-to-Water with Electronic or Pneumatic Controls)

This manual applies to the following models:

- Fulcrum Series
Vertical Construction
Single and Double Wall
- Fulcrum Series
Horizontal Construction
Single and Double Wall



TL Fulcrum SERIES WATER HEATER

CONTRACTOR / FACILITY INFORMATION

NOTE: This user manual must always accompany the specific unit as recorded below:

Model #: _____

Serial #: _____

Install Date: _____

Latest Update: 08/13/2021

DISCLAIMER

The information contained in this document is subject to change without notice from Thermal Leverage, Inc. (TL). TL makes no warranty of any kind in respect to this material, including but not limited to, implied warranties of merchantability and fitness for a particular application. TL is not liable for errors appearing in this document, nor for incidental or consequential damages occurring in connection with the furnishing, performance, or use of these materials.

TABLE OF CONTENTS



TABLE OF CONTENTS:

SECTION 1: GENERAL INFORMATION	4
1.1 INTRODUCTION	4
1.2 DESCRIPTION	5
1.3 FEATURES.....	7
1.4 APPLICATIONS.....	8
1.5 ENERGY SOURCES.....	9
1.6 DESIGN CONDITIONS	10
1.7 CONSTRUCTION.....	11
1.8 SAFETY	12
1.8.1 Operating Precautions.....	12
1.8.2 Storage and Transportation.....	12
1.8.3 Safety Features	12
1.8.4 Safety Notation.....	12
1.8.5 Proper Training.....	13
1.8.6 Safety Precautions.....	13
SECTION 2: INSTALLATION INSTRUCTIONS	15
2.1 RECEIVING, HANDLING, AND STORAGE	16
2.1.1 Examining the Unit	16
2.1.2 Compliance with Codes	16
2.2 SITE PREPARATION	17
2.3 INSTALLATION CLEARANCES AND UNIT DIMENSIONS	18
2.4 PLACEMENT	21
2.5 LOOSE PART INSTALLATION INSTRUCTIONS.....	22
2.5.1 PART 1: DHW Outlet Pressure Relief Valve Installation.....	24
2.5.2 PART 2: Control Valve and Steam Inlet Assembly Installation.....	24
2.5.3 PART 3: Condensate Trap Connection Instructions.....	25
2.6 PIPING INSTALLATION AND UNIT CONNECTIONS	27
2.7 ELECTRICAL CONNECTIONS.....	30
2.8 PNEUMATIC DEVICES INSTALLATION	31
2.9 WATER QUALITY	32
SECTION 3: OPERATION AND CONTROLS	33
3.1 INTRODUCTION	33
3.2 TLSW SERIES FUNCTIONAL DESCRIPTION.....	34
3.3 PREPARATION OF UNIT FOR OPERATION	39
3.4 UNIT STARTUP PROCEDURES	39
3.5 UNIT SHUTDOWN PROCEDURES.....	41
3.6 CONTROLLER INTRODUCTION	42
3.6.1 Control Overview.....	42
3.6.2 PID Controller Overview	44
3.7 CONTROLS STARTUP	46
3.8 PROGRAMMING THE SEQUENCE	48
3.9 DATA COMMUNICATIONS.....	52
3.9.1 Temperature Controller Terminals Layout	52

3.9.2 TL Controller Communication Features.....	53
3.9.3 TL Default Settings Summary for Communication	53
3.9.4 Modbus RTU Communication Wiring.....	54

TABLE OF CONTENTS

TABLE OF CONTENTS:

3.9.5 Modbus/BACnet Data Addresses and Points.....	55
3.9.6 Instructions to Change Communication Settings Manually.....	56
3.10 DRY CONTACTS	63
3.10.1 Contact closure input (enable/disable)	63
3.10.2 Fault Relay Contacts	63
SECTION 4: MAINTENANCE	64
4.1 CIRCULATING PUMP MAINTENANCE.....	65
4.2 POWER CONNECTION REWIRING	66
4.3 PNEUMATIC (INSTRUMENT AIR) CONNECTIONS REFITTING.....	67
4.4 HEAT EXCHANGER BUNDLE & GASKET MAINTENANCE	68
4.5 INLET, OUTLET, AND CONDENSATE / WATER RETURN LINE AND MANUAL SHUTOFF VALVES REPLACEMENT	70
4.6 PRESSURE GAUGE (ENERGY SOURCE) REPLACEMENT.....	71
4.7 PRESSURE OR T&P RELIEF VALVE (SHELL/TANK) REPLACEMENT.....	72
4.8 SOLENOID SAFETY SYSTEM INSPECTION & REPLACEMENT.....	73
4.9 STRAINERS INSPECTION AND REPLACEMENT	75
4.10 CONTROL VALVE INSPECTION AND REPLACEMENT.....	76
4.11 TEMPERATURE CONTROLLER.....	78
4.12 TRAPS (MAIN & AUXILIARY) REPLACEMENT	78
(STEAM SYSTEMS ONLY).....	78
4.13 CLEANING OF HEAT EXCHANGERS AND TANKS.....	79
4.13.1 DISASSEMBLY AND REASSEMBLY	79
4.14 REPLACEABLE PARTS LIST	80
4.15 RECOMMENDED SPARE PARTS	81
4.16 ORDERING INFORMATION	82
4.17 INSPECTION SCHEDULE	83
4.18 PARTS AND ACCESSORIES	85
4.19 STEAM INLET KIT PART NUMBERS (OPTIONAL)	90
4.20 CONTROL BOX PARTS	93
4.21 CONTROL VALVE TECHNICAL INFORMATION.....	96
4.21.1 Siemens Electronic Control Valves	96
4.21.2 Warren Electronic Control Valves.....	96
4.21.3 Warren Pneumatic Control Valves	96
SECTION 5: TROUBLESHOOTING	98
SECTION 6: TECHNICAL DRAWINGS & FORMS	104
6.1 DIMENSIONAL DRAWINGS.....	104
6.2 CLEARANCE DRAWINGS.....	106
6.3 PIPING AND INSTALLATION DRAWINGS	108
6.4 ELECTRICAL WIRING DIAGRAMS/SCHEMATICS	112
6.5 FORMS AND RECORDS	114
6.5.1 TL Water Heater Controller Programming Record Sheet	114
6.5.2 TLSW Series Installation Form	115
6.5.3 TLSW Series Startup Form	119
SECTION 7: WARRANTY	121

SECTION 1: GENERAL INFORMATION**1.1 INTRODUCTION**

The purpose of this manual is to provide an installation, operation, and maintenance procedural guide for the Fulcrum Series Water Heaters, which includes the following unit configurations and models:

- TLSW/TLWW 06,08,10,12
- TLSWD/TLWWD06,08,10,12

These units are either vertically or horizontally constructed, per customer requirement and use - either steam or boiler water to heat domestic water.

1.2 DESCRIPTION

The Thermal Leverage Fulcrum Series semi-instantaneous water heaters are the engineered solutions for facility owners/managers who need high recovery capacity in a small space. They are constructed of stainless-steel pipe and other non-ferrous materials to ensure long leak-free operation. Designed for continuous high-peak loads, the TL Fulcrum Series units are ideal for high-demand applications, such as hospitals and dormitories.

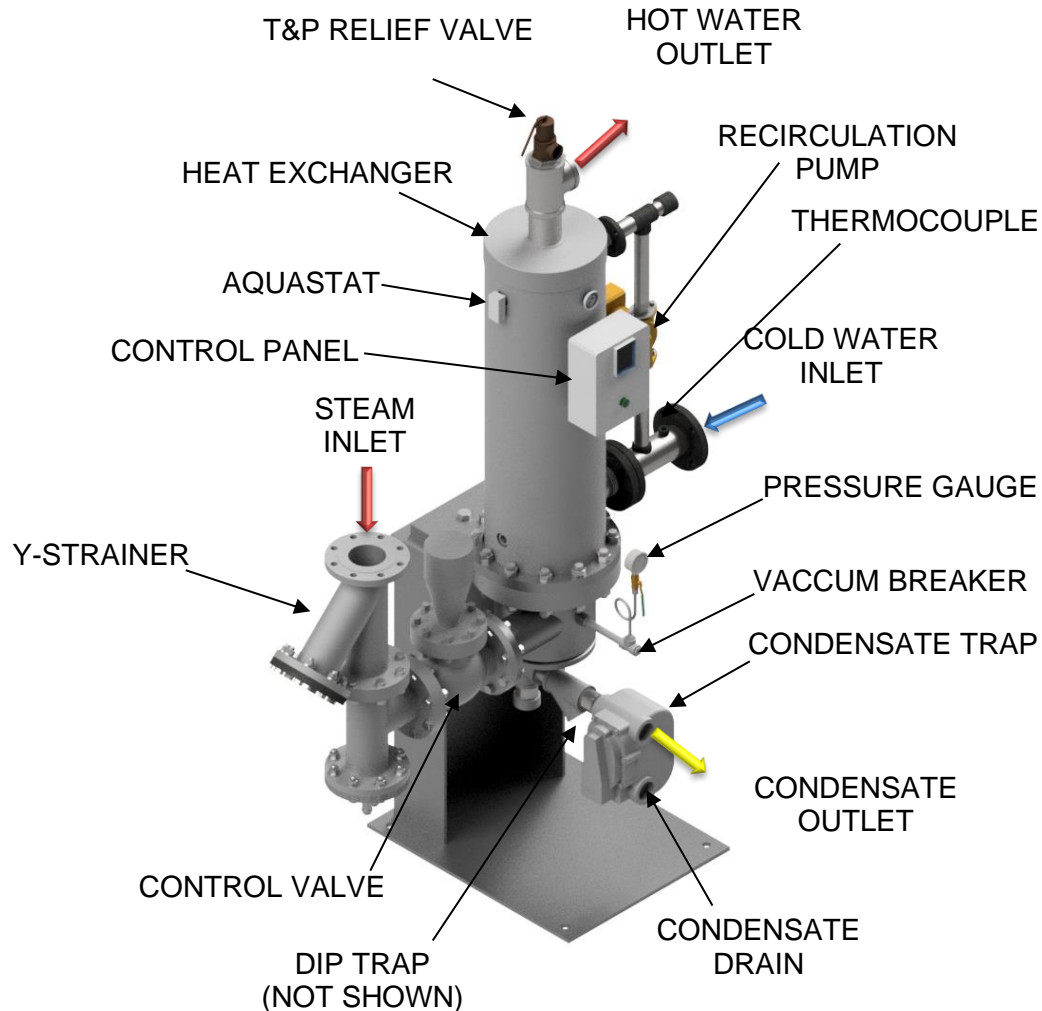


FIG 1.1: Fulcrum Series TLSW/TLWW (Vertical Component and Function Diagram)

SECTION 1: GENERAL INFORMATION

Units are engineered using steam, boiler water, or High Temperature Hot Water (HTHW) as the heating medium. Semi-instantaneous operation provides high output by channeling the incoming cold water directly over the heat exchanger tubes in a controlled manner to maximize the heat transfer rates compared to conventional stratified heat exchanger convection systems. Velocity of water and pressure drop are controlled by changing water flow directly across the heat exchanger, which increases heat transfer and inhibits scale formation.

Perfect for mechanical rooms where space is limited, the water heating systems feature vertical configurations, so they require less than four square feet of floor space. Plus, the tube bundle can be removed straight downward from the bottom of the unit to eliminate the need for overhead space or extra clearances for service or maintenance.

THERMAL LEVERAGE FULCRUM HORIZONTAL WATER HEATER

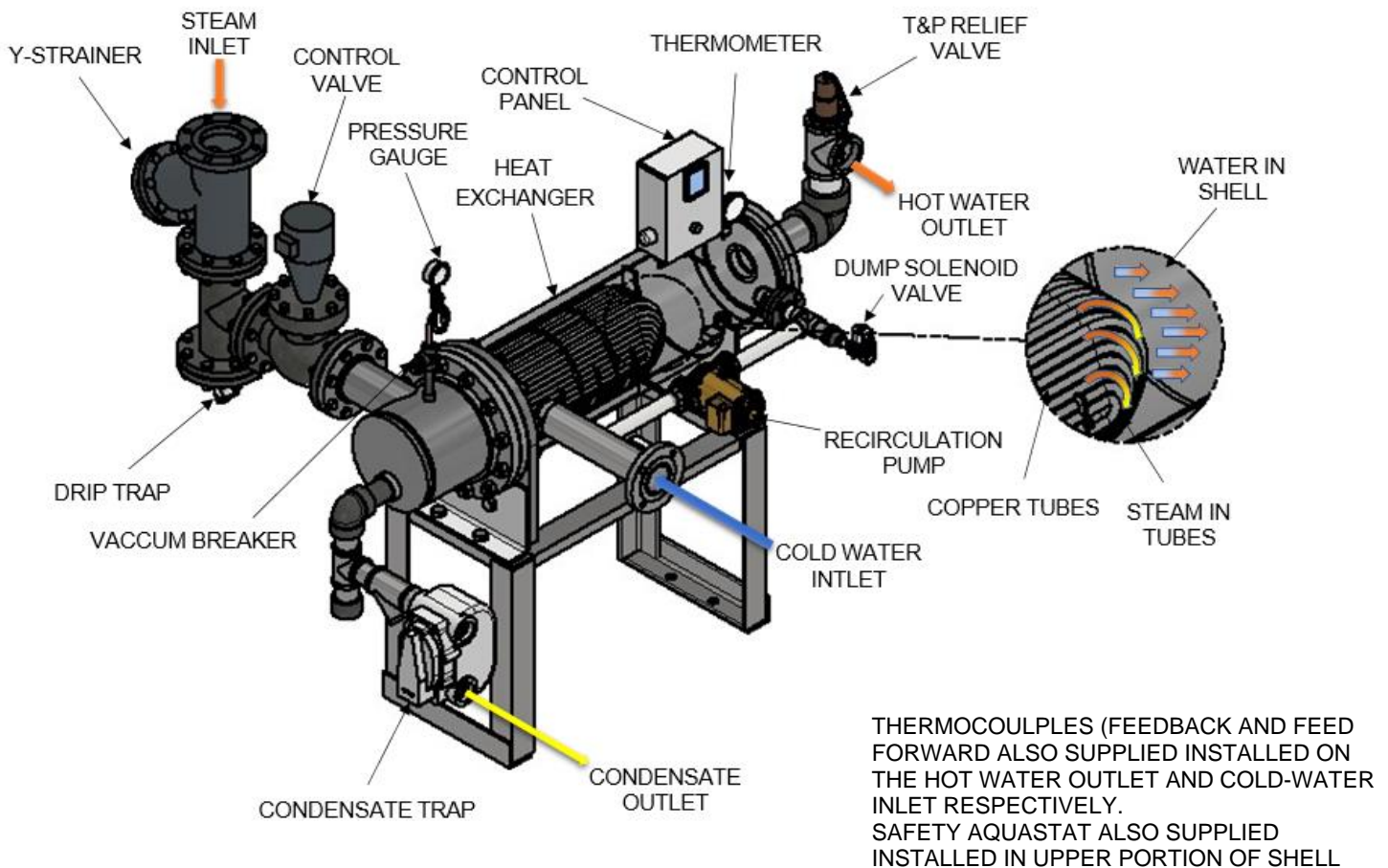
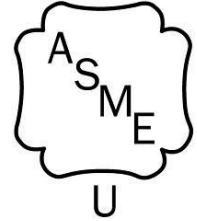


FIG 1.2: Fulcrum Series HS (Horizontal/Steam) Component and Function Diagram

1.3 FEATURES

- Compact design to fit in small mechanical rooms and standard doorways
- Complete packaged system with components engineered to specific application requirements
- Energy efficient
- High recovery
- Stainless alloy construction
- ASME Code Tested & Stamped



1.4 APPLICATIONS

Fulcrum Series units are used in wide range of domestic water heating applications including newconstruction or replacement of existing units. Most common application examples include:

- Apartment complexes
- Prisons/Correctional facilities
- Hospitals/medical centers/nursing homes
- Hotels/casinos/entertainment
- Schools/colleges/universities/dormitories
- Government buildings
- Commercial office buildings
- Factories/industrial facilities
- Fitness centers/health clubs etc.

NOTE:

Contact your TL sales representative or TL factory in case any applications-related information is required.

1.5 ENERGY SOURCES

TL Fulcrum Series Water Heaters are engineered and manufactured to use one the following energysources to produce domestic hot water:

- Steam
- Boiler Water
- HTHW

**This manual includes information for steam to water units with electronic controls and pneumatic controls. Refer to separate manual or additional documentation if hot water as the heating medium or different control options are required.*

1.6 DESIGN CONDITIONS

TL has design, engineering, and manufacturing capabilities to produce products to satisfy a wide range of our customer requirements.

TL standard design conditions for Fulcrum Series units are:

	Shell Side	Tube Side
Design Pressure, PSIG	150/200	150
Design Temperature, °F	250	350

NOTE:

Consult the design specifications for the unit or the name plate attached to the unit and a tag on the T & P Relief valve for maximum pressure for the unit. Higher Design Pressures available

1.7 CONSTRUCTION

All TL Fulcrum Series units are designed and manufactured from superior materials of the highest quality. Each unit meets or exceeds requirements of ASME Section VIII, Div.1 Code. All TL Units are registered with the National Board of Boiler and Pressure Vessels Inspectors and are U-stamped.

Heat exchangers: U-tube heat exchangers are manufactured with stainless steel tube sheet, stainless steel shell, and fabricated carbon steel head. Tubes are available in copper, Cu-Ni 90/10, or stainless-steel options depending upon customer requirement and operating conditions. If it is required the units can be built using double wall, leak protective tubing and double tube sheets. Double wall tubes are available in copper or Cu-Ni 90/10 and steam or tube side tube sheet is available in carbon steel. Shell or water side tube sheet is stainless steel.

Controls and trim: TL Fulcrum Series units are equipped with electronically activated control valves. TL Fulcrum Series units are equipped with a control panel that uses a color LCD display, easy adjustable set points, solenoid valve and set points for double safety alarm system. A data port is available for communication with the Building Management System if required.

Standard packages also includes an ASME Temperature and Pressure Relief valve and recirculating water line with circulator.

Steam fired units are equipped with condensate line: F&T steam trap, steam inlet strainer, and drip leg with thermodynamic steam trap.

Insulation and Jacketing: All standard TL Fulcrum Series units contain fiber glass insulation between the heat exchanger and jacket. The jackets are constructed of PVC as standard.

1.8 SAFETY

1.8.1 Operating Precautions

In order to achieve maximum performance from the unit, the precautions and procedures described below must be strictly followed:

- The unit should be installed, operated, and serviced in accordance with the information only in this manual.
- The unit should be installed according to designs prepared by qualified facility engineers, including those of a structural, mechanical, electrical, or other applicable disciplines.
- The unit should not be operated or serviced until a safety training program has been established by the customer.
- The unit should only be operated and serviced by qualified technical personnel in accordance with all applicable codes, laws, and regulations.
 - The unit must be used according to the specification given to TL.
- Pressure and temperatures should not exceed limits indicated on the TL name plate attached to the unit.
- For initial startup refer to all instructions in [Section 3.4: Startup Procedures](#).
 - The heating and heated fluids should be free from any debris.
 - The unit should operate only with fluid that it was designed for.
 - Prevent evaporation of fluid on the shell side. Steam or vapor should only flow through the tubes.
- The system should be designed to prevent the unit from encountering pressure shocks.
 - All strainers installed on the unit should be periodically cleaned as per TL maintenance schedule. (See Recommended Inspections Time Interval).
- Refer to [Section 2.7: Electrical Connections](#) for proper grounding of the unit.

1.8.2 Storage and Transportation

The units should be stored in a clean place away from a corrosive environment or weather elements (e.g. rain, snow), preferably indoor spaces that are maintained between 32°F to 110°F ambient operating temperature. During transportation, ensure that they are not exposed to mechanical damage. Units should not be exposed to cold or hot temperature limits specified by TL.

1.8.3 Safety Features

The customer is responsible for maintenance of the safety features of the Fulcrum Series Water Heaters such as guards, safety labels, safety controls, interlocks, and lockout devices.

1.8.4 Safety Notation

In this manual there will be four levels of important note types that accompany the text of this document. Note headers will appear as shown and described below:

SECTION 1. GENERAL INFORMATION
NOTE:

Important information, but not associated with safety practices.

CAUTION!

Indicates potential safety concerns, possible material damage, and unsafe practices that may lead to damage to property, injury, or death.

WARNING!

Indicates a potential health hazard that *MAY* lead to injury or death.

DANGER!

Indicates an immediate health hazard that *WILL* lead to injury or death.

1.8.5 Proper Training

Proper training is the best protection against accidents. Operating and service personnel must be thoroughly familiar with the basic construction and operation of the Fulcrum Series semi-instantaneous water heater, and all applicable safety precautions. If any of the provisions of this manual are not fully and completely understood, contact TL technical service for advice and information. Please have the serial number of the unit available. The serial number is located on the name plate attached to the front of the unit below the control panel.

1.8.6 Safety Precautions

DANGER!

- ***WATER TEMPERATURES OVER 125°F CAN CAUSE SEVERE BURNS INSTANTLY OR DEATH FROM SCALDS.***



- Children, disabled, and elderly are at the highest risk of being scalded.
- See instruction manual before setting temperature at water heater.
- Feel water before bathing or showering.
- Temperature limiting valves are available. Contact TL technical support at (insert telephone #) for more information.

WARNING!

- Fluids under pressure may cause injury to personnel or damage to equipment when released. Be sure to shut off all incoming and outgoing water shutoff valves. Carefully decrease all trapped pressures to zero before performing maintenance.

SECTION 1: GENERAL INFORMATION

- Before attempting to perform any maintenance on the unit, shut off all electrical power to the unit from an exterior switch.
- Electrical voltages up to 120 VAC may be used in this equipment; therefore the front panel door on the unit's power box must be closed at all times, except during maintenance and servicing.
- A three-pole switch must be installed on the electrical supply line of the unit. The switch must be installed in an easily accessible position to quickly and safely disconnect electrical service. Do not affix switch to any part of the water heater itself.

CAUTION!

DO NOT use this water heater if any part has been under water. Call a qualified technician to inspect and replace any part that has been under water.

SECTION 2: INSTALLATION INSTRUCTIONS**CAUTION!**

In order to maintain the warranty on the Fulcrum Series Water Heater, the startup must be completed within six (6) months of shipment, and the start-up report must be furnished to TL within thirty (30) days of the startup. The warranty may be found in [Section 7](#), and the Startup and Installation forms can be found in [Section 6.5](#).

WARNING!

- **INSTALLER MUST COMPLY WITH STARTUP AND INSTALLATION INSTRUCTIONS TO AVOID A DANGEROUS SITUATION.**
- Startup and installation forms **MUST** be submitted to a TL representative to avoid risking loss of coverage under warranty.
- The inspection log must be maintained and up-to-date and kept in close proximity to the Fulcrum Series unit for inspection of TL personnel.

NOTE:

The startup must be performed by TL factory personnel or a factory authorized representative.

2.1 RECEIVING, HANDLING, AND STORAGE

2.1.1 Examining the Unit

Fulcrum Series Water Heaters are thoroughly inspected and tested prior to shipment. Upon receipt of the Fulcrum Series Water Heater, please carefully inspect the entire unit and its components for any damages during shipping. If any evidence of damage is detected that could affect the safe operation of the unit, contact TL or the authorized sales representative to report the damage and to receive instructions on how to proceed.

After the inspection has been done, we advise that all pressure and control components be checked to assure that they meet design specifications, the name plate, and the specification tags. In case of any discrepancy, contact TL or an authorized sales representative before proceeding with the installation.

2.1.2 Compliance with Codes

The Fulcrum Series semi-instantaneous water heater is constructed and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII – Division 1. Other codes or approvals which apply will be labeled on the Fulcrum Series Water Heater.

The Fulcrum Series Water Heater installation must only be performed by technically qualified persons. The installation must conform to all national, state, provincial, and local code requirements established by the authorities having jurisdiction, as well as to specific instructions in this manual. Authorities having jurisdiction should be consulted before installations are made.

2.2 SITE PREPARATION

- A firm and level foundation are required (6 to 8 inches concrete pad recommended).
- Secure the Fulcrum Series Water Heater to the building floor or mounting pad. For attachment to the foundation, use the four holes in the base.

NOTE:

Seismic anchorage information is available upon request. Contact your TL sales representative for more information.

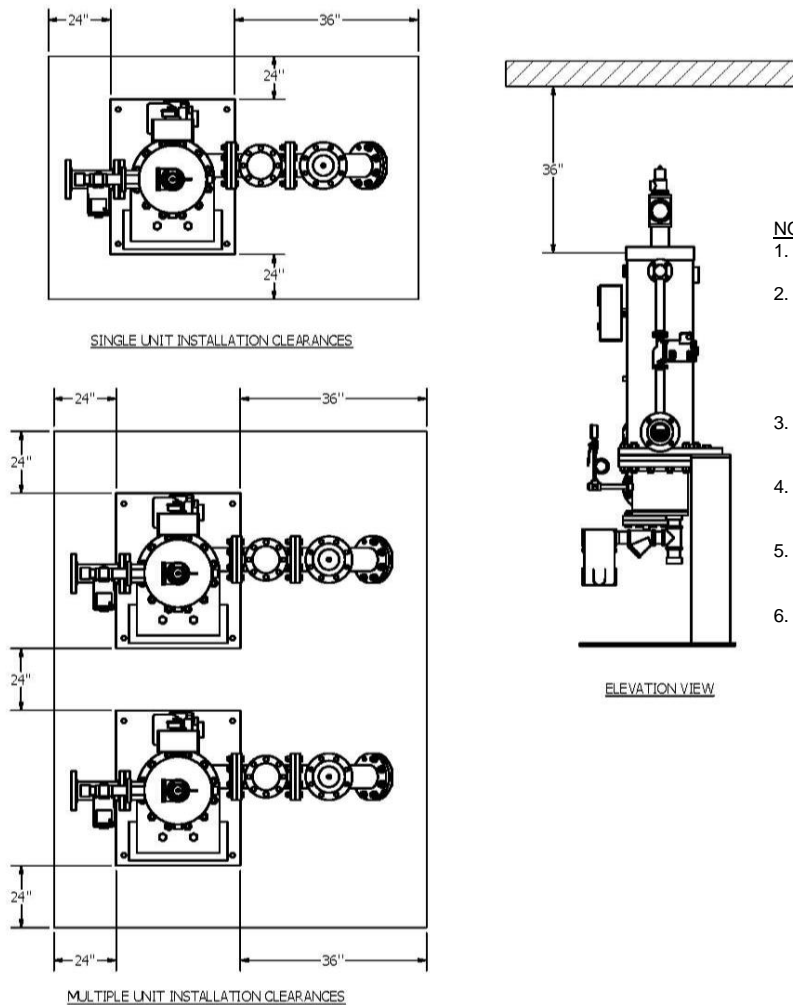
- The Fulcrum Series Water Heater is top-heavy and proper rigging techniques should be followed while moving heavy equipment to avoid injury.
- The Fulcrum Series Water Heater must be plumb and level to function properly.
- The Fulcrum Series Water Heater should be placed with at least 10" headroom above it to permit removal of the relief valve.
- All Fulcrum Series steam water heaters should be placed to permit gravity flow of condensate to the condensate return system (see Sec. 2.6.1.3).

2.3 INSTALLATION CLEARANCES AND UNIT DIMENSIONS

The Fulcrum Series minimum acceptable clearances are shown in Figure 2-1 and dimensions are shown in Figure 2-2. The minimum clearance dimensions are indicated in the drawings. However, if Local Building Codes require additional clearances, these codes shall supersede these requirements.

All steam piping, water piping, and electrical conduit or cable must be arranged so that they do not interfere with the removal of any panels or inhibit service or maintenance of the unit.

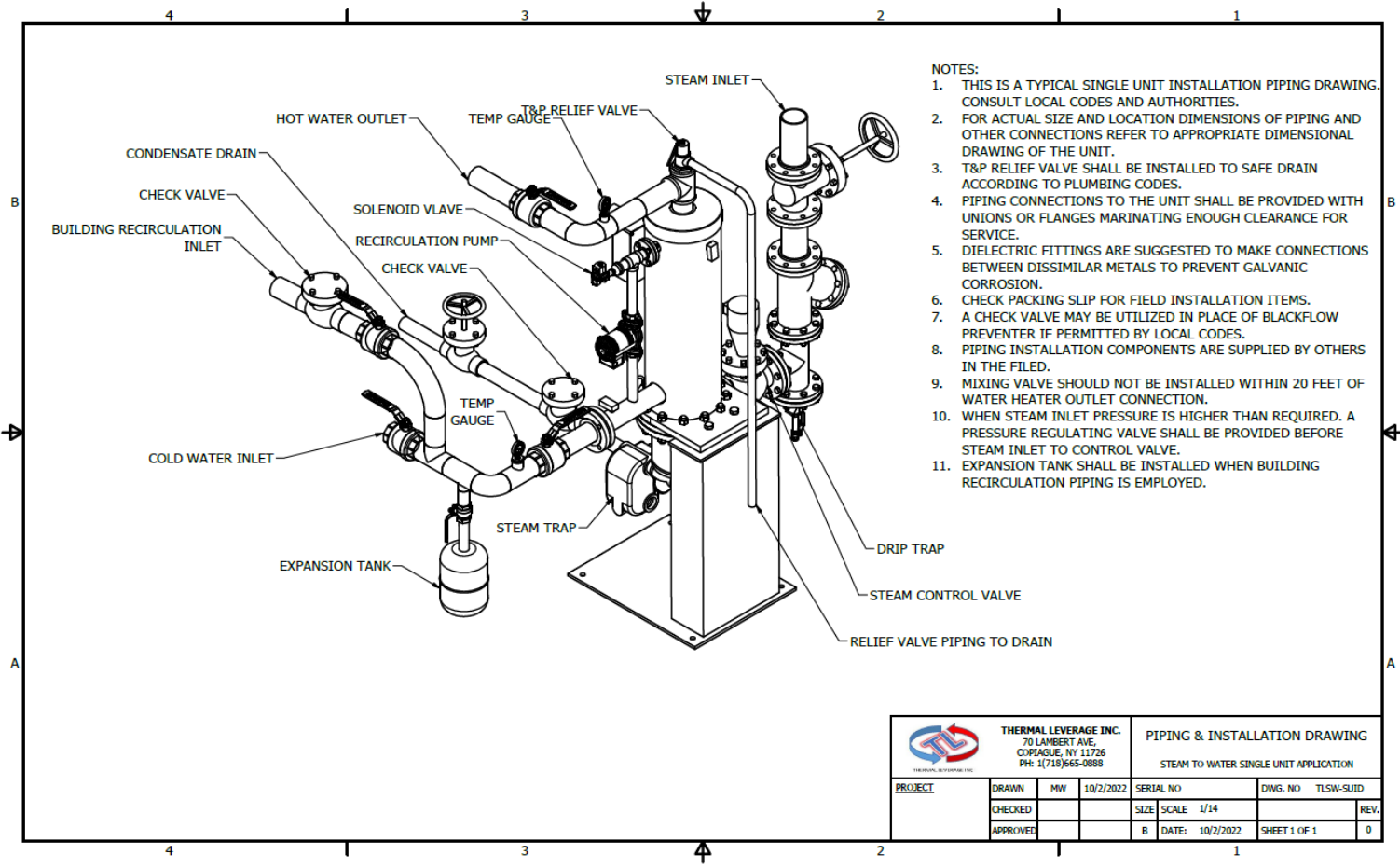
FIG 2-1: FULCRUM SERIES VERTICAL UNIT INSTALLATION CLEARANCE DRAWING



NOTES:

1. ALL DIMENSIONS SHOWN ARE IN INCHES.
2. 54IN MIN. SERVICE CLEARANCE IS REQUIRED ON TOP OF HEAT EXCHANGER SHELL COVER IF RELIEF VALVE AND TEE ARE NOT TO BE DISASSEMBLED IN THE FIELD DURING SERVICE.
3. THIS DRAWING SHOWS MINIMUM RECOMMENDED SERVICE CLEARANCE DIMENSIONS.
4. REFER WATER HEATER DIMENSIONAL DRAWING TO REVIEW OTHER DIMENSIONS.
5. TL RESERVES THE RIGHT TO MODIFY THE DIMENSIONS WITHOUT PRIOR NOTICE.
6. ALSO CONSULT LOCAL CODES AND AUTHORITIES.

SECTION 2: INSTALLATION INSTRUCTIONS




 THERMAL LEVERAGE INC. 70 LAMBERT AVE. COPENHAGEN, NY 11726 PH: 1(718)665-0888		PIPING & INSTALLATION DRAWING STEAM TO WATER SINGLE UNIT APPLICATION				
PROJECT	DRAWN	MW	10/2/2022	SERIAL NO	DWG. NO	TLSW-SUID
	CHECKED			SIZE	SCALE	1/14
	APPROVED	B	DATE: 10/2/2022		SHEET 1 OF 1	REV. 0

FIG 2-2a: FULCRUM SERIES VERTICAL UNIT DIMENSIONAL DRAWING

2.4 PLACEMENT

The unit should be mounted to the suitable floor, concrete pads, or structural construction following TL guidelines and applicable architectural and local code requirements to assure the safe operation of the unit.

NOTES:

1. Proper rigging techniques should be followed while moving heavy equipment.
2. Maintain proper levels in order for the unit to function properly and follow clearance, dimensional, and applicable piping drawings.

CAUTION!

Refer to [Section 2.6: Piping Installation and Unit Connections](#) for **condensate drain piping instructions**. Fulcrum Series units must be installed to permit condensate to drain freely by gravity.

SECTION 2: INSTALLATION INSTRUCTIONS**2.5 LOOSE PART INSTALLATION INSTRUCTIONS**

The pressure relief valve, control valve, optional steam inlet strainer-piping assembly, and condensate trap assembly are included with the Fulcrum Series Water Heater and must first be assembled to the unit before the field piping and electrical installation procedures are performed. See Figure 2-3.

NOTE:

1. Pictures shown may look different than actual component depending upon their size and type. Refer to the latest dimensional drawings to ensure connection details and orientations are up-to-date before proceeding.
2. Under no circumstances should any personnel manually trip the ASME P&T relief valve for any purposes. Otherwise, the warranty will be nullified if it is.

SECTION 2: INSTALLATION INSTRUCTIONS

The following sub-assemblies are packed separately within the unit's shipping container for field installation. Installation instructions follow.

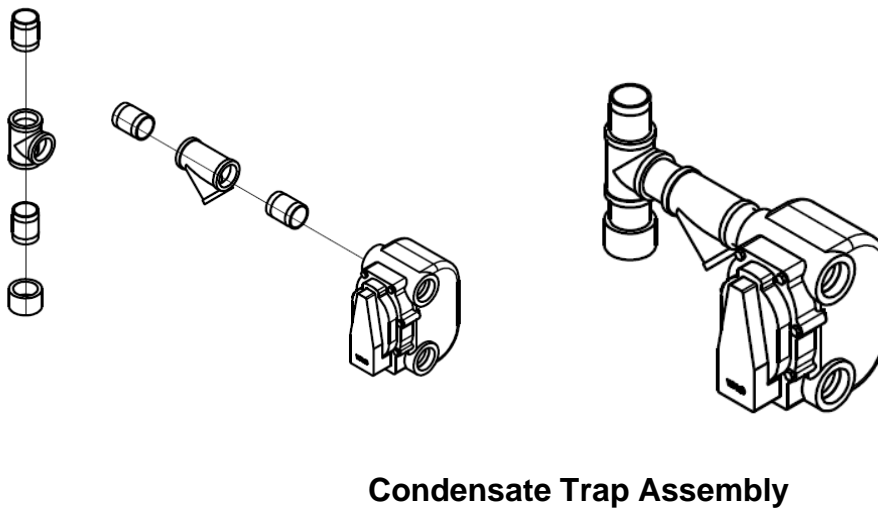
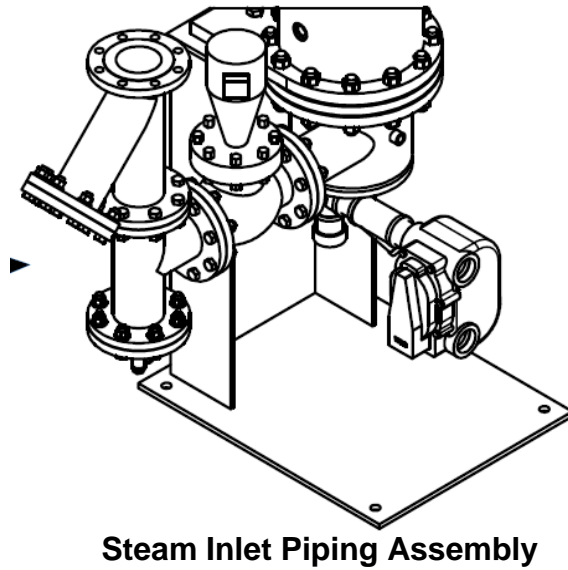
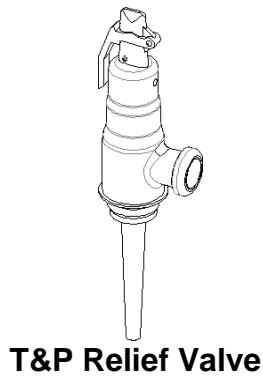


FIG 2-3: FACTORY SUPPLIED LOOSE PART ILLUSTRATIONS

➤ COMPONENT INSTALLATION AND PIPING INSTRUCTIONS

Locate and install the Fulcrum Series Heater in the mechanical room as described in [Section 2.2 \(Site Preparation\)](#) according to local codes. Perform Parts 1 to 3 of the instructions below to install the factory supplied component parts.

2.5.1 PART 1: DHW Outlet Pressure Relief Valve Installation

1. Locate the temperature and pressure relief valve shipped with the unit. See Figure 2-4.
2. After installation of the Fulcrum Series unit in the mechanical room, carefully make the relief valve connection on top of the unit as shown in following pictures:

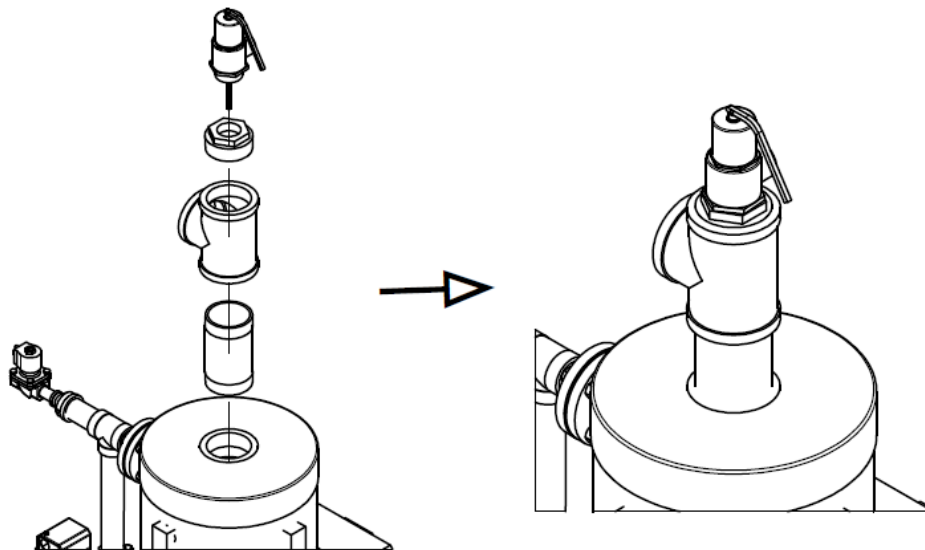


FIG 2-4: DHW OUTLET PRESSURE RELIEF VALVE INSTALLATION DIAGRAM

3. A suitable pipe joint compound for potable water should be used on the threaded connections. Any excess compound should be wiped off.
4. Tighten until sealed and facing proper orientation/direction.

NOTE:

Under no circumstances should any personnel manually trip the ASME P&T relief valve for any purposes. Otherwise, the warranty will be nullified if it is.

2.5.2 PART 2: Control Valve and Steam Inlet Assembly Installation

- 1) After the relief valve is installed per the last instruction, locate the Control Valve and optional Steam Inlet sub-assembly, as shown in Figure 2-5, and install as described below:

SECTION 2: INSTALLATION INSTRUCTIONS

NOTE: It is available in both flange and union connections, depending on the size. Up to two inches (2") is available in union. Larger sizes are available in flanged connections.

- 2) Provide appropriate support below for the steam inlet piping assembly. Unit is not designed to support this additional weight.
- 3) Install control valve on the steam head, and then steam inlet sub-assembly on the control valve of the unit as shown in following pictures:

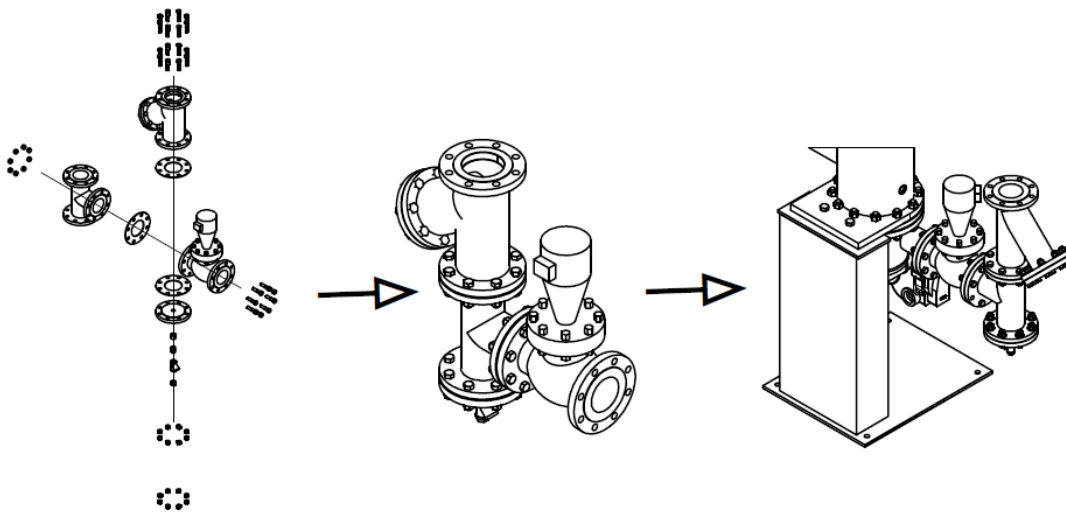


FIG 2-5: STEAM INLET PIPING ASSEMBLY INSTALLATION DIAGRAM

For Thread Connections: a suitable pipe joint compound should be used on the threaded connections. Any excess compound should then be wiped off.

For Flange Connections: required appropriate studs, nuts, and gasket are also packed separately.

- 4) Tighten until sealed and facing proper orientation/direction.

2.5.3 PART 3: Condensate Trap Connection Instructions

After the Steam Inlet Piping Assembly is installed per the last instruction, locate the condensate trap assembly, as shown in Figure 2-6, and install as described below:

- 5) Provide appropriate support below the condensate trap. Unit is not designed to support the weight of the condensate trap outlet assembly.
- 6) Install it on the condensate outlet piping union of the unit as shown in following pictures:

2.6 PIPING INSTALLATION AND UNIT CONNECTIONS

Fulcrum Series units can be installed in various domestic water applications within the rated temperature and pressure conditions. Refer to [Section 6.3](#) for appropriate Piping and Installation drawings per application requirements (single, multiple units, and with or without storage tanks) before making piping connections. CAD drawings are also available on www.thermalleverage.com for layout specification. If any special application help is needed, please call your local TL representative TL factory for specific application information.

NOTE:

Also consult local codes and authorities in addition to TL typical Piping and Installation drawings.

- **Domestic water piping:** the exact location of cold water inlet and hot water outlet ports of the unit, as well as pipe diameters and thread/flange size, can be determined using the drawing supplied with the unit. Properly sized water lines should be connected to the unit. A manual shutoff valve should be installed on the inlet water source as an isolation device. All piping and fittings should be clean and free of debris. It is important that the piping systems are balanced when two or more units are installed parallel to each other in order to achieve the combined capacity and proper temperature control. Refer to typical Piping and Installation Drawings in [Section 6.3](#).

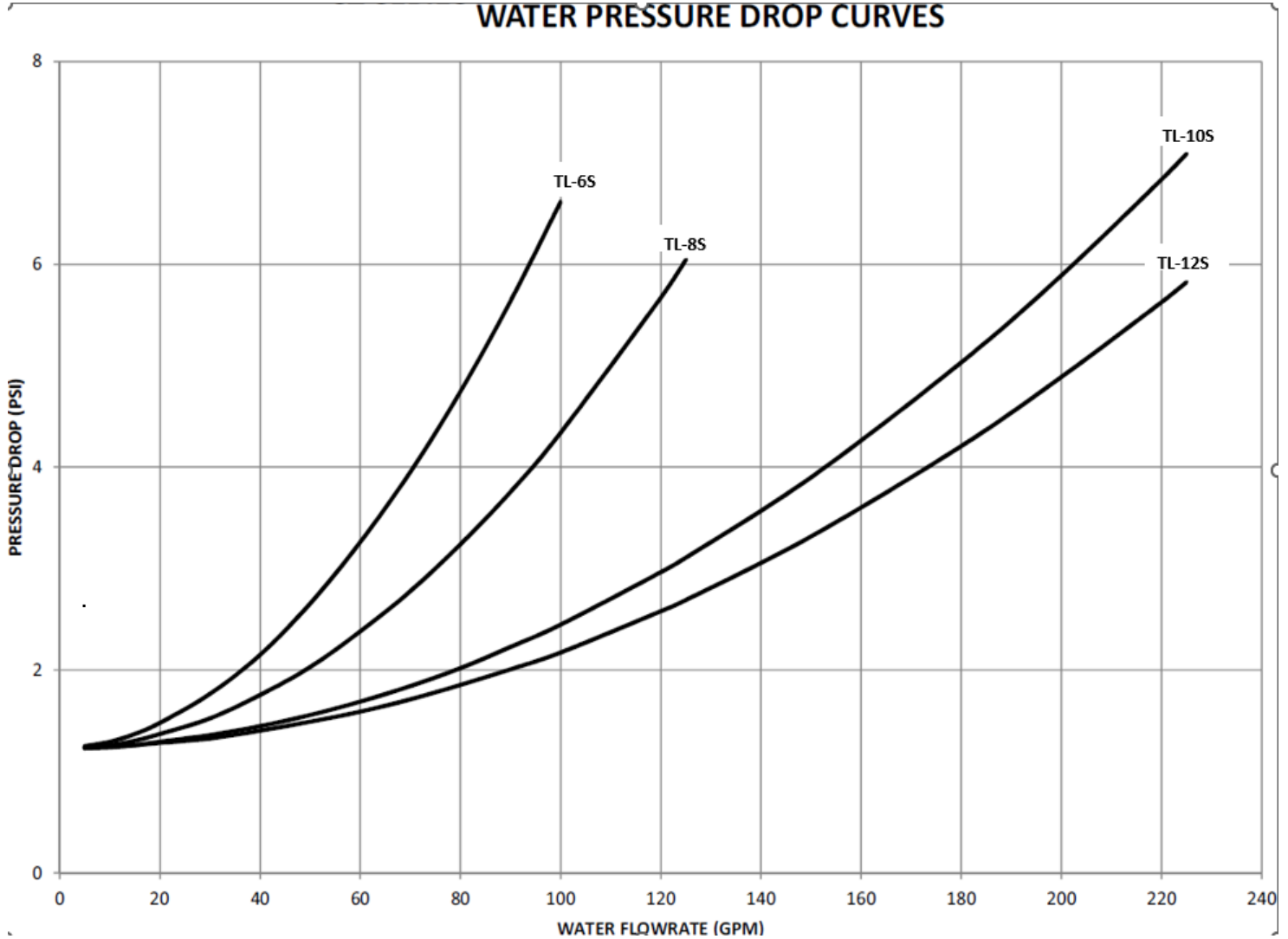
NOTE:

Building recirculation piping shall be properly sized to provide sufficient capacity to dissipate residual heat within the tube bundle of the water heaters during the periods of low demand.

SECTION 2: INSTALLATION INSTRUCTIONS

TABLE 2: WATER PRESSURE DROP CHARTS (SINGLE WALL)

Refer to the following charts in order to determine the domestic water-side pressure drop through the unit:



SECTION 2: INSTALLATION INSTRUCTIONS

- **Steam inlet piping:** Steam inlet piping to be sized per given steam pressure, steam volume, and supply-line pressure drop to deliver correct volume of steam at sufficient pressure to the control valve.

CAUTION!

Steam, boiler water, or high temperature water can present a very dangerous situation because of the high pressures and temperatures. Follow all mandatory and recommended procedures and safety rules to avoid any hazardous situation.

Make sure that a shutoff valve is installed up stream in the steam line and that it works properly. It is recommended to install pressure gauge between shutoff valve and strainer on the steam inlet assembly. All valves on the source line should be closed during the installation process. Connect the energy source to the piping leading to the control valve. Determine the exact location of the inlet connections and piping size using the drawing of the unit. Refer to typical [Piping and Installation Drawings in Section 6.3](#).

- **Main Condensate and drip trap drain piping:** Determine exact location and size of the condensate port shown on the drawings and connect condensate piping to the port and to the system following all applicable codes and rules to avoid creating the excessive back pressure to the unit. Shutoff valve and check valve should be installed on the condensate drain line to allow the unit to be isolated from the system.

SECTION 2: INSTALLATION INSTRUCTIONS

CAUTION!

The condensate drain piping must be arranged to permit condensate to drain freely by gravity from the unit. Failure to do so can cause improper water temperature control and damage to heat exchanger (premature tube bundle failure) and drainage components.

Do not attempt to lift the condensate above the condensate outlet of the trap without a condensate pump. A pumping steam trap may be substituted if condensate drain by gravity is not feasible after referring to manufacturer's instructions.

- **Drain discharge piping:** All TL Fulcrum Series units are equipped with pressure and temperature relief valves, over temperature solenoid valve, and heat exchanger shell drain. They should be piped directly to a safe drain according to appropriate plumbing codes as explained in Piping and Installation drawings in [Section 6.3](#).

WARNING!

Make sure that the pressure & temperature relief valve, solenoid valve, and condensate traps are piped to a proper drain per instructions and codes. Scalding injury and/or water damage can occur from either the manual lifting of the lever or the normal operation of the valve if it is not piped to a proper drain. Ensure that the piping is of the proper material and rating for the temperature and pressure of the system and that it is secured to prevent possible injury. If the valve fails to flow water or reseal, consult the factory.

SECTION 2: INSTALLATION INSTRUCTIONS

2.7 ELECTRICAL CONNECTIONS

All field wiring connections for power and controls are inside the control panel on the front of the Fulcrum Series Water Heater. The wiring label is attached to the inside aluminum door of the control panel. An external electrical disconnect (not supplied with the water heater) with adequate overload protection is required. The water heater must be grounded in accordance with national, state, provincial, and local codes.

Connect the system to the correct voltage. The Fulcrum Series Water Heater requires 120V AC, 15Amp service with ground (H, N, G) supplied from a suitable circuit breaker or fused disconnect. The circulation pump has a 120V constant speed fractional HP motor that operates continuously when the power to the unit is on.

Refer to [Section 6.4](#) for standard electrical wiring drawings/schematics.

CAUTION!

All electrical wiring must be in accordance with all local, state, and national codes that apply. Do not exceed the rated current of the D.C. power supply (100MA) or the form 'C' relay outputs (5A/240VAC resistive).

WARNING!

Hazardous voltages are present within the enclosure. Installation or service should only be carried out by trained personnel.

CAUTION!

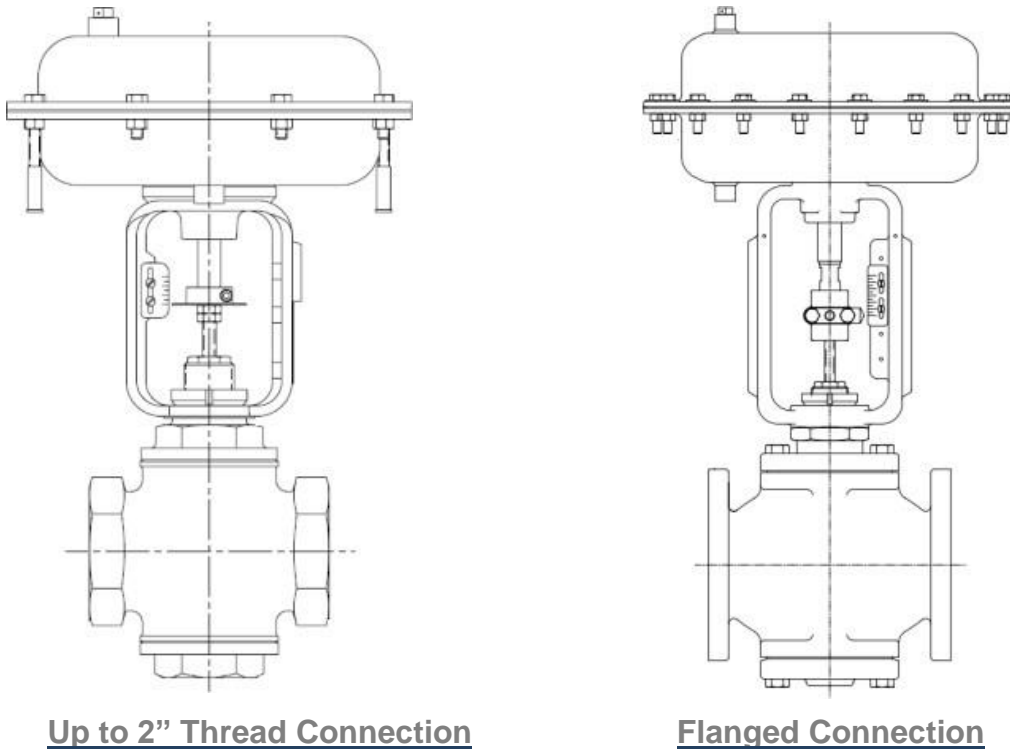
Do not operate the pump without water in the unit! Do not turn on power before filling with water! Failure to do so can cause damage to the pump.

SECTION 2: INSTALLATION INSTRUCTIONS
2.8 PNEUMATIC DEVICES INSTALLATION

TL Fulcrum Series units can be equipped with pneumatically activated control valves. In most cases they require instrument air with pressure ranges from 15 to 30 psi. Consult the supplied drawings and specific installation and operation manuals for each component to determine the requirements for that component.

NOTES:

- 1) Assure that the pneumatic feed has been shut down, and air pressure bled from the system by acceptable methods before attempting any connections.
- 2) For all pneumatic connections, the use and/or type of joint compound or sealer on the joint should be determined by referring to local codes, accepted practices, or the requirements of the installing contractor.



Up to 2" Thread Connection

Flanged Connection

FIG 2-7: PNEUMATIC VALVES (Up to 2" and FLANGED) DIAGRAM

Normally closed, 2-way, pneumatically-activated actuators and globe control valves are available in NPT connections up to 2 inches in size, and flanged connections for larger sizes as shown in above pictures. Follow good piping practices and refer to codes and standards in addition to information supplied by TL. Supply air should be connected to ports or terminals as indicated on the control valve. Final tuning may be required under the actual operating conditions. Refer to section [4.22 Control Valve Technical Information](#) or supplied pneumatic control valve Installation and Operations Manual before making field piping connections and operating the valve.

2.9 WATER QUALITY

- Before piping the unit into the system, the system must be thoroughly flushed to remove sediment, flux, filings, and other foreign matter. The heat exchanger can be damaged by build-up of corrosion due to sediment.
- The manufacturer cannot be held responsible for any damage caused by incorrect use of additives in the system.
- Mineral buildup in the heat exchanger reduces heat transfer, overheats the heat exchanger, and causes failure. Leaks in the heater or piping must be repaired at once. Leakage of steam, boiler water, or HTHW into domestic water side is unsafe and needs to be repaired immediately.
- Air elimination is extremely important from the domestic hot water system. Ensure proper air vents are installed in the piping systems that are prone to trap air pockets.
- Consider using water hammer arrestors or an expansion tank to dampen the spikes in water pressure, since water hammering can lead to premature failure of the tube bundle and baffles.
- **Hardness** – Water hardness contributes to the formation of scaling, which impacts the performance of the heater exchanger and may lead to premature tube bundle failures. Water hardness should not exceed 6 grains per gallon or 100 ppm. Water softening may be required if it exceeds these levels.
- **Artificial Softness** – Do NOT use artificially softened water since artificial softening agents generally use salt, which causes corrosion of the heat exchanger and piping components. Do NOT use deionized water.
- **Chloride** – Elevated chloride levels in water accelerate corrosion of the heat exchanger and piping system materials. Concentrations of chlorides in system water should be less than 100 ppm.
- **PH** – The pH must always be between 6.5 to 9.5. However, it is recommended to keep it higher than 6.8 for copper materials.

NOTES:

1. CuNi or stainless-steel materials can handle wider range of water quality levels as compared to copper. Please consult TL factory if water quality levels exceeds these limits.
2. Consult TL factory before using Fulcrum Series units for any other non-standard

SECTION 3: OPERATION AND CONTROLS

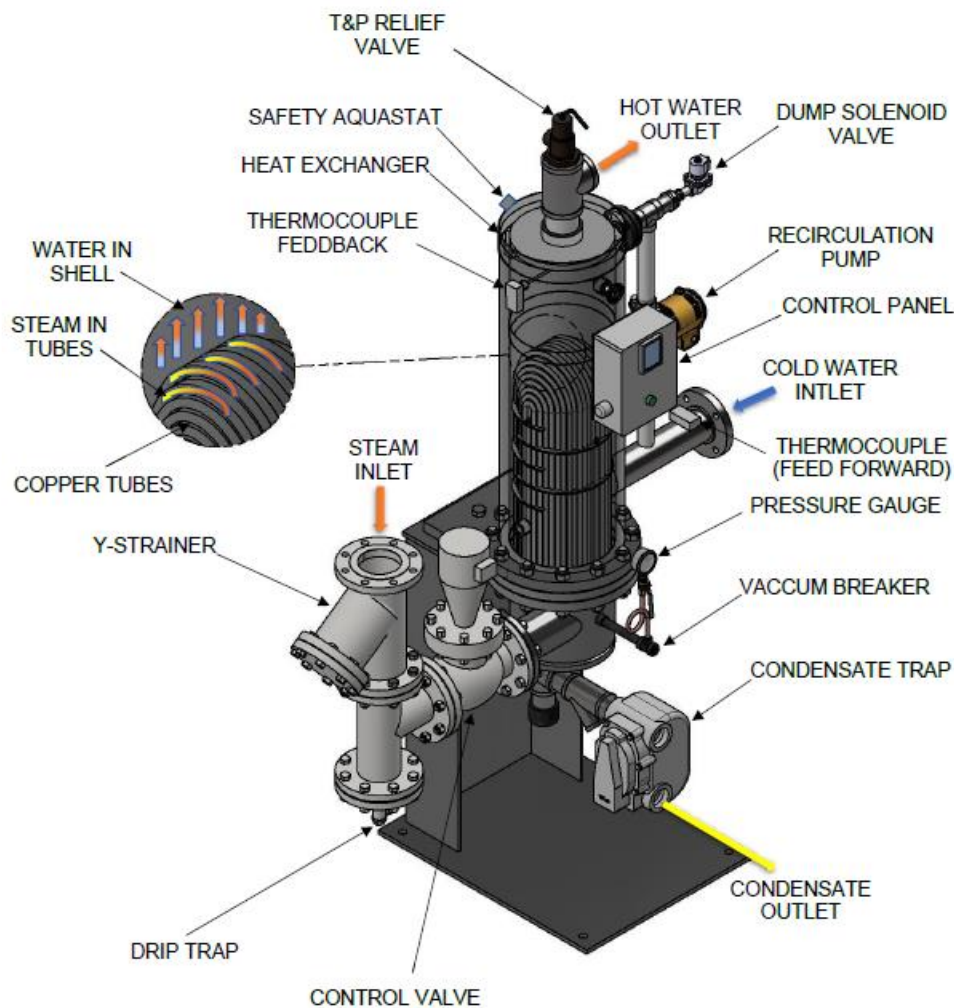
3.1 INTRODUCTION

This chapter provides information and instructions for the following topics:

- Fulcrum Series functional description
- Preparation of unit for operation
- Unit startup procedure instructions
- Unit shutdown procedure instructions
- Controls overview and startup settings
- BAS/BMS communication settings

SECTION 3: OPERATION AND CONTROLS
3.2 TL FULCRUM SERIES FUNCTIONAL DESCRIPTION

TL's Fulcrum Series units are engineered using steam, boiler water, or HTHW as the heating medium. Heat exchanger U-tube bundles are either available in single or double wall configuration, depending upon customer requirement. Heating fluid is on the tube side and the domestic water is on the shell side. Semi-instantaneous operation provides high output by channeling the incoming cold water directly over the heat exchanger tubes in a controlled manner to maximize the heat transfer rates, as compared to conventional stratified heat exchanger convection systems. Velocity of water and pressure drop are controlled by changing water flow directly across the heat exchanger, which increases heat transfer and inhibits scale formation. Domestic hot water temperature is maintained by using either electronic or pneumatic controls.

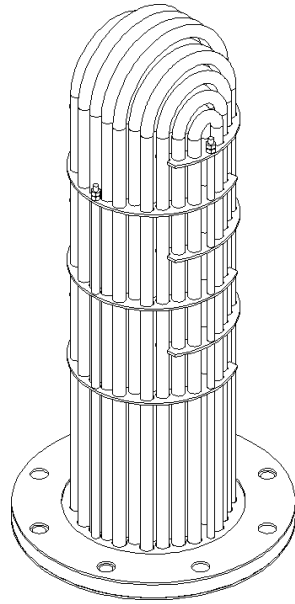

FIG 3-1: FULCRUM SERIES HEAT EXCHANGER FUNCTIONAL DIAGRAM

SECTION 3: OPERATION AND CONTROLS

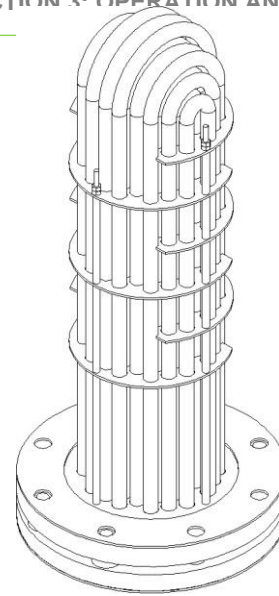
Cold domestic water enters the heat exchanger through the cold water inlet connection (as shown in Figure 3-2). It is distributed over the tubes in the heat exchanger shell and flows upwards. It is heated by steam, boiler water, or HTHW circulating inside the heat exchanger tube bundle. Heated domestic water then exits the heat exchanger from the hot water outlet connection on top of the unit. Unit also includes a constant speed recirculation pump which continuously circulates the heated domestic water through the heat exchanger shell to ensure there is always hot water present in case of demand. Domestic hot water supply temperature is maintained by either electronic or pneumatically operated control valve.

Steam, boiler water, or HTHW enters the heat exchanger coils through the control valve, which is modulated by the 4-20 mA output from the controller based upon the reading from both the feedback temperature sensor on the outlet of the heat exchanger and the feedforward temperature sensor on cold water inlet to heat exchanger. The unit employs a closed-loop feedforward control system to maintain the target temperature set point in tight range. Steam or heating water passes through the first pass, then enters the second pass of the U-tube bundle and finally exits through the outlet connection on the bottom/front head as shown. The flow rate of heating medium is modulated to maintain the desired set point in varying load conditions.

Tube Bundle Options: Fulcrum Series units are available in either single or double wall U-Tube bundle construction, depending upon customer requirement (see Figure 3-3). Double wall construction has inner and outer walls separated by air gap between them. Steam or boiler water flows through the inner walls, and any condensate or water leaking through the inner walls is collected within the air gap that is vented to atmosphere for leak detection. Similarly, if the domestic water leaks through the outer walls, it is collected within the air gap between the tubes and is vented to atmosphere for leak detection.



**SINGLE WALL
U-TUBE BUNDLE**



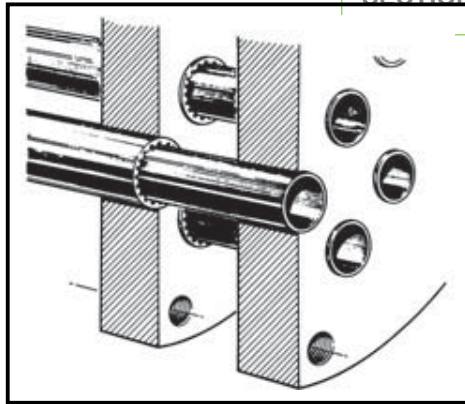
**DOUBLE WALL
U-TUBE BUNDLE**

FIG 3-3: SINGLE AND DOUBLE WALL U-TUBE ILLUSTRATIONS

Double Wall Construction and Protection Performance:

- Prevents cross-contamination.
- Easy inspections and low maintenance.
- Fully visible, 360° vented leak detection between tubesheets as shown.
- Bolting and gaskets for potable water and heating medium are completely independent.
- Individual tube access for easy maintenance.
- Used to upgrade present single wall tube bundles.
- Double wall U-tube bundle construction is available in either Copper or Cu-NI materials.

TL Fulcrum Series Water Heaters' double wall tube bundle construction meets Uniform Plumbing Code requirements for heating potable water. The heat transfer surface is 1/2" O.D. inner wall and 5/8" O.D. outer wall. Both inside and outside surfaces are smooth with no fins or surface irregularities that promote scale formation or corrosion attack. Double wall tubing has a similar overall heating conductivity as a single wall tube of equivalent wall thickness. Each tube has multiple parallel and continuous vent paths. See Figure 3-4.

SECTION 3: OPERATION AND CONTROLS

FIG 3-4: U-TUBE DOUBLE WALL CONSTRUCTION DETAIL ILLUSTRATION

Tube failure can be caused by corrosion, erosion, and vibration, and can result in the contamination of the domestic water system by a heating medium such as steam, hydronic water, or glycol solution. There is no practical way to have the heating medium sterile or free from harmful treatment compounds or corrosion byproducts. A low pressure heating medium circuit does not ensure contamination protection of indirect, single-wall water heaters. Whether they are shell and tube, shell and coil, plate and frame, or any other type, all consist of a relatively thin wall heat transfer surface separating the heating medium from the domestic water system. Therefore, the potential for cross contamination is real, and in some instances contamination has occurred. Several states and cities are now insisting on double-wall vented construction in all indirect type domestic water heaters. Plumbing codes have also been re-written to include double-wall protection. TL has developed the most practical, “state-of-the-art” double tube wall heaters to preclude any possibility of contaminating the domestic water system.

Safety Controls: An automatic over-temperature limit switch is included, which will cut off all electricity supply to the unit and close the normally closed control valve during over-temperature condition. Power supply is restored if unit goes back to normal operation.

Unit includes primary and secondary alarm functionality in the safety controls. Error messages show on the display when the heated domestic water temperature reaches the primary alarm setting, and then the alarm starts sounding. In the next step, power supply to the normally closed control valve is interrupted, causing it to close. If the water temperature continues to rise, it turns the secondary alarm on, which then opens the dump solenoid valve to release high temperature hot water to safe drain in order to protect the unit. When the unit goes back to normal operating temperature conditions, the error message disappears from the home screen, but the siren continues until owner manually presses the switch to turn it off. Power to the control valve is restored and solenoid valve closes. Controls also include separate aquastat safety over the control panel system in case it malfunctions.

In case of pneumatic controls, the air shutoff solenoid valve shuts off or interrupts air supply to the normally closed control valve, causing it to close. Air supply to control valve is restored if unit goes back to normal operation.

SECTION 3: OPERATION AND CONTROLS

Condensate Sub-Cooling Economizer Kit Option: Fulcrum Series Steam-to-Water units are available with optional condensate sub-cooling kit, which includes piping assembly with circulator and a compact brazed plate sub-cooling or shell and tube water to water heat exchanger. This cools down the condensate to safedrain temperatures by recovering waste heat from it. This recovered waste heat energy is used in pre-heating the cold water entering the unit. A portion of cold water is circulated from inlet of the Fulcrum Series unit through counter flow direction inside plate heat exchanger compared to condensate flow, and then back to the inlet of unit. Here, it is heated to required set point using steam. Condensate sub-cooling increases the overall system efficiency above 90%, which requires less steam consumption as compared to a standard unit.

3.3 PREPARATION OF UNIT FOR OPERATION

It is important to make sure that the unit is installed, and all piping and electrical connections are made per instructions in Chapter 2. Also make sure that the connecting piping has been cleaned out before starting up the unit. **NOTE: PUMP WIRING SHOULD BE CONNECTED ONCE WATER HAS BEEN PIPED TO THE UNIT WITH NO LEAKS.**

3.4 UNIT STARTUP PROCEDURES

Follow the instructions below to start up the Fulcrum Series unit:

➤ UNIT STARTUP PROCEDURE INSTRUCTIONS

- 1) Assure that all manual shutoff valves on steam, boiler water/high temperature hot water, domestic water, and pneumatic lines are closed.
- 2) Slowly open the manual shutoff valve on the feed water inlet line, checking to assure that there are no leaks at the valve or any joints.
- 3) Adjust the operating temperature control to the desired temperature. Refer to Section 3.5 for the exact location of the control and detailed adjusting procedure.
- 4) Adjust the high temperature limit per actual operating conditions. It is normally factory set at 160°F, considering 140°F operating supply water temperature.
- 5) Open the steam condensate return valve or steam/boiler water high temperature water return valve.
- 6) Slowly open the manual shutoff valves on the power source inlet.

NOTE:

This procedure is similar for both boiler water and high temperature water energy sources.

CAUTION!

Steam, boiler water and high temperature water present situations that can be very dangerous because of the high temperatures and pressures. Use common sense and follow all accepted and recommended procedures when performing installation, operation, and maintenance procedures to avoid possible injury or death.

- 7) If no leaks are found, slowly continue to open the manual shutoff valves on the power source inlet.
- 8) As the unit is initially heating the water, carefully re-inspect the water/steam inlet, the water outlet, power source inlet (steam, boiler water, or high temperature water), and condensate return lines and joints for signs of leakage.
- 9) As the unit approaches the desired operating temperature, check that the temperature inside the unit is within the desired range. If necessary, readjust the temperature control valve. See the Submittal Documents and the temperature control valve Component Manual included with the unit for the exact location of the valve and detailed adjusting procedures.
- 10) After the unit has reached operating temperature, re-inspect all joints for signs of leakage. In addition, check all gauges and controls to verify that the clean steam and (Cont.) energy source pressures are within design specification.

SECTION 3: OPERATION AND CONTROLS

11) The unit is now ready for normal operation. Proceed to [Section 3.6](#) for setting the temperature and other initial startup parameters using the controller.

3.5 UNIT SHUTDOWN PROCEDURES

All maintenance procedures require the water heater to be properly shutdown. Follow the instructions below in order to shut down the Fulcrum Series unit:

➤ UNIT SHUTDOWN PROCEDURE INSTRUCTIONS

1. Close all valves in the energy source inlet line (steam, boiler water, or high temperature water).
2. Turn off all power to the electric control, if so equipped.
3. Turn off the pneumatic (instrument air) source. Only applicable for pneumatic controls.
4. When possible, relieve the pressure from energy source line (steam, boiler water, or high temperature water) between the shutoff valve and the unit.
5. Wait 5 minutes or until the dial thermometer starts dropping. Close all remaining valves in the system in this order.
 - a) Hot water outlet line.
 - b) Cold water inlet line; and
 - c) Condensate return line (or boiler/high temperature water return line).
6. After the system has cooled, drain the unit by opening the heat exchanger drain valve and holding the pressure relief valve in the open position. This will prevent the formation of a vacuum and increase the drainage flow.
7. Proceed with the required maintenance or repairs.
8. After performing the required maintenance or repairs, return the unit to operation by following the described above startup procedures in [Section 3.4](#).

3.6 CONTROLLER INTRODUCTION

The TL Water Heater Controller is a microprocessor-based, state-of-the-art device offering unmatched PI performance for water heating applications.

It is used with type 'J' thermocouple sensor.

Menu-based programming, all parameters, and set points are user configurable via menu prompts. The preconfigured screens and 'pull-down' sub menus with English prompts assure rapid setup and commissioning.

Process indication is displayed on the front-colored display, as shown below on Home Screen. All aspects of the unit are user configurable through the 'plain English' menus and combinations of menus.. Standard communication is through MODBUS RTU protocol.

Utilizes 1/4 DIN advanced programmable PI temperature controller, factory configured for the full range of math, logic, totalizer, and specialized functions required for single loop process and temperature control of water heating applications.

MODBUS RTU®: RS485Network allows single or multiple units to be connected for distributed applications and remote monitoring SCADA applications (optional).

MODBUS TCP/IP and **BACnet UDP/IP:** Ethernet Network allows single or multiple units to be connected for distributed applications and remote monitoring SCADA applications (optional). Ethernet port is available on the rear side of the temperature controller.

Optional building automation communication gateway is also available for connections with other protocols.

3.6.1 PI Overview

This section shows the description of the main display on the front screen, and menu functions of the controller of touchscreen user interface.



NOTE:

USB memory drive kit is available as an accessory with the unit. Contact your TL sales representative or TL factory if it is required.

3.6 CONTROLLER INTRODUCTION

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SECTION 3: OPERATION AND CONTROLS

- **Page+Raise:** Scroll back the list headers (with auto-repeat).
- **Scroll:** Select parameters in turn, returning to the first parameter in the list or to a list header if Level 3 or Configuration level is selected. If the button is held down, the list will auto-repeat. In levels 1 and 2 this button also scrolls through promoted parameters when the HOME screen is selected.
- **Scroll+Raise:** Scroll back through parameters from bottom to top (with auto-repeat).
- **Page+Scroll - all variants:** Jump directly to the "HOME page." The current operating level remains unchanged. If the HOME page is already selected, these buttons will perform the custom function. The default is Alarm Acknowledge.
- **Raise+Lower (Run/Hold):** If a programmer option is enabled and a program is configured, a momentary press of these keys toggles between Run and Hold modes.
- **Raise+Lower (hold for >3 seconds - Mode):** If a programmer option is enabled, and a configured program is running, holding these buttons will abort the program. If the HOME page is selected, and the Programmer is not running, holding these buttons will invoke the 'Mode' display where the Loop Mode parameter will allow selection of Auto or Manual mode.
- **F1 and F2:** the functionality of these buttons is set by the Instrument function block. The default settings are:
 - F1: Auto/Man
 - F2: Run/Hold

NOTE:

A time-out applies to all displays. If no button presses are detected within a timeout period (default is 30 min.), the display will revert back to the "HOME screen."

3.7 CONTROLS STARTUP

Location of controls main touchscreen display is shown below.



TL FULCRUM SERIES CONTROL PANEL FRONT

NOTE:

The set point shown in this section is for information purposes only. User has to manually adjust the number, depending upon required application operating conditions following the programming sequence in [Section 3.8](#).

➤ SYSTEM DIAGNOSTICS

14. During startup or in normal operation, unit performs the self-diagnostics for a few seconds to check for any system errors. If an error condition is detected, it displays error message(s) on the home screen as shown below. These which require corrective action.

Domestic outlet temperature sensor fails

Domestic inlet temperature sensor fails

Remote Disable activated via Dry Contact

Remote Disable activated via Digital BAS

NOTES:

- Sometimes loose wiring connections can also cause these error conditions, which can be easily cleared by making proper connections.
- If error condition still exists, contact sales representative or TL technical support for more information.

3.9 DATA COMMUNICATIONS

The TL Fulcrum Series Water Heater control system allows the controller to communicate with the external Building Automation System (BAS) or Energy Management System (EMS). It is compatible with standard Modbus RTU or TCP/IP and BACnet UDP/IP multi-protocols. Optional gateway is also available for communications with other protocols.

- Communication between HMI and Temperature controller is standard Modbus RTU.
- Use RJ45 port to connect PC or network computer system with PID controller.

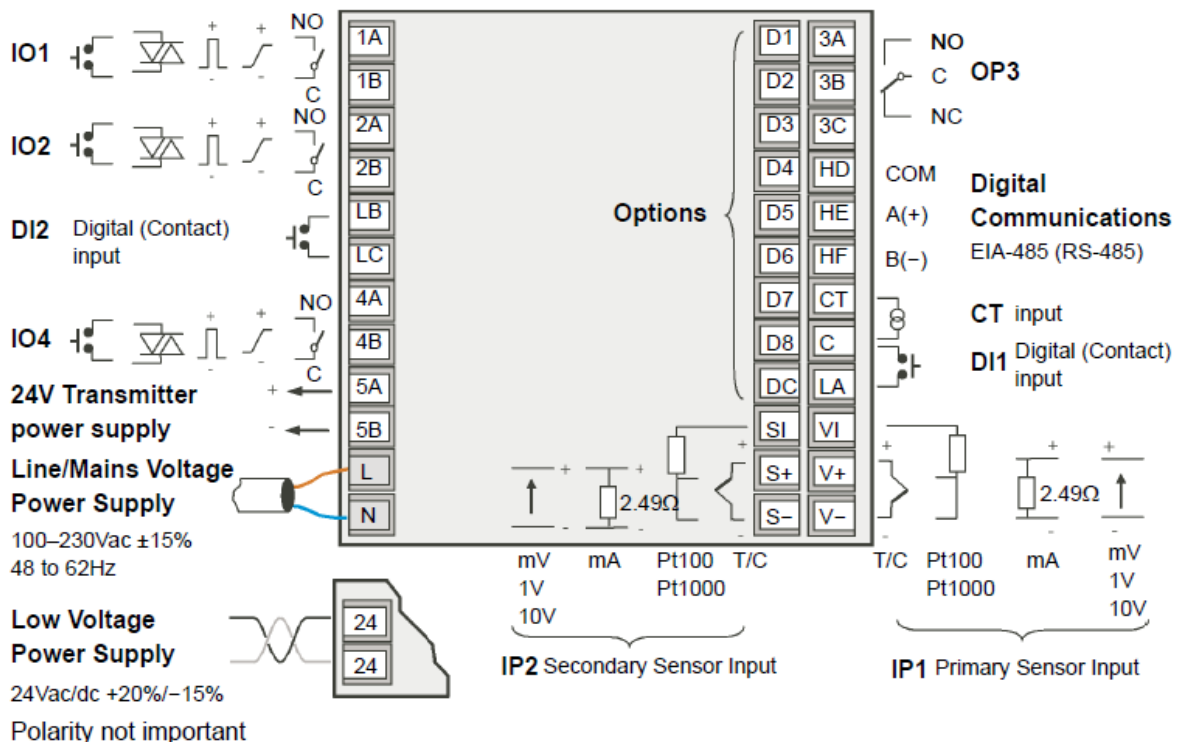
WARNING!

- Maximum communication cable lengths without repeater
 RS485 Network – 4,000 feet
 Ethernet Network – 328 feet
- Communications and power wiring should never be routed together inside same conduit because it can cause nuisance-related issues on communications side.

NOTES:

- To help prevent ground loops, the cable shield should be grounded at one point only.
- Use twisted, shielded-pair communication wiring.
- Modbus serial (RS485) communication port is utilized to communicate with HMI. RJ 45 (Ethernet) port is available to communicate with building automation system.

3.9.1 Temperature Controller Terminals Layout

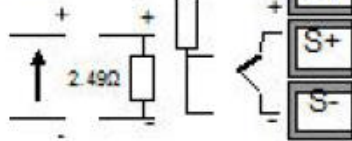


SECTION 3: OPERATION AND CONTROLS

Digital I/O

D1 - D8
Voltage input
On (1) >4V, <35V
Off (0) >-1V, <+1V
Contact input On <100Ω
Off >28KΩ

Secondary
Sensor Input

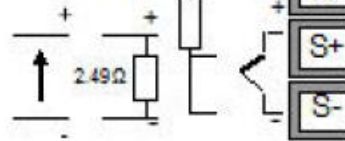


Option I8
PV Input
8 × Digital I/O

Digital I/O

D1 - D4
Voltage input
On (1) >4V, <35V
Off (0) >-1V, <+1V
Contact input
On <100Ω
Off >28KΩ

Secondary
Sensor Input



Option IE
PV Input
Ethernet
4 × Digital I/O

Operator Levels

What is in this Chapter?

This chapter describes the different operator levels:

- Operator Level 1.
- Operator Level 2.
- Introduction to Operator Level 3.
- Return from a higher level to a lower level of operation.

Overview

There are 5 levels of operation:-

1. **LEU1** - Level 1 has no password, the control is active and only the home list is accessible.
2. **LEU2** - Level 2. The control is active and an extended home list is accessible.
3. **LEU3** - Level 3. The control is active and the complete operator parameter set is shown and modifiable; the complete Configuration parameter set is shown, (read only); the user calibration (two point cal) facility is available.
4. **ConF** - Configuration level is used to setup the whole controller; the configuration parameters are accessible; the operator parameters are available, without the need to switch to operator mode. The instrument calibration parameters are also available in this mode. See "User Calibration" on page 369.

Levels 2, 3 and Configuration can be restricted by passwords.

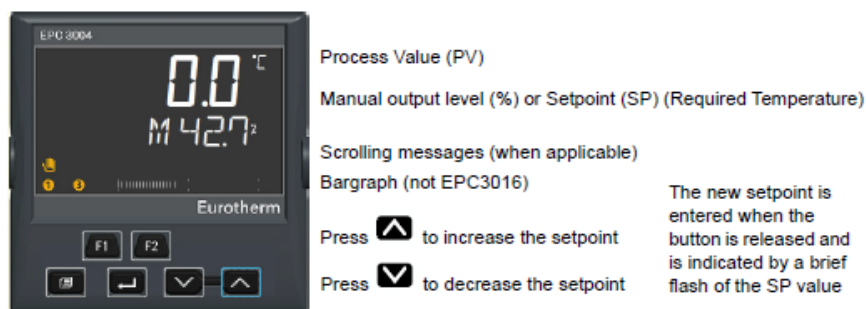
5. In addition the Quick Start Mode (See "Start Up—New Unconfigured Controller" on page 67) is provided to allow users to configure the product in the minimum number of operations. It is only available at power up after the instrument is cold started or by holding the Page key during power up.

Operator Level 1

Operator Level 1 is entered:

1. After the Quick Code has been entered for those controllers supplied unconfigured.
2. After power up when the controller has been configured.

The display shown below is for a typical temperature controller.



In general the current value of the process is shown in the upper display.

By default the controller will start in 'Manual' Mode. This is shown by 'M' in the display, the 'Hand' symbol, the value of the output (in %) and the bargraph (if available).

In 'Auto' mode, the required value (Setpoint) is shown in the lower display.





Additional scrolling messages are shown, for example, when operator parameters are selected (see section "Level 1 Operator Parameters" on page 81). These may be standard descriptions of the parameter currently selected or they may be user specific messages which have been set up using iTools. (See "Parameter Promotion" on page 233).

Auto/Manual Mode

In Manual mode the value of the output is increased or decreased directly by the operator using the Up and Down buttons.



In Auto mode the process is adjusted automatically by the controller in response to differences between the setpoint and the actual measured value.

In Operator Level 1 the controller may be placed into manual operation as follows:

- By default in EPC3008 and EPC3004 controllers, Auto/Manual may be selected by the user by toggling the F1 button.
- By default in EPC3016 controller Auto/Manual may be selected by the user by pressing and holding the  and  buttons for longer than 3 seconds. This will show the A-M (Auto-manual select) parameter. Then press  or  to toggle between auto and manual.







Manual is indicated in the HMI by showing the 'Hand' symbol and the character 'M'.


The current level of the output demand is shown as a percentage. This may be increased or decreased by pressing the  or  buttons respectively.



Note: Alternative ways to select Auto/Manual may be configured and will be explained in subsequent chapters of this manual.

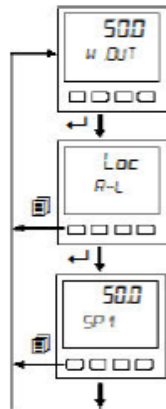
Level 1 Operator Parameters

A minimal list of parameters is available in Operator Level 1 which is designed for day to day use. Access to these parameters is not restricted by a password.

Press  to step through the list of available parameters. The mnemonic of the parameter is shown in the lower display. Alternatively, press and hold  then press  to scroll forward through parameters and  to scroll back.

Press  to return to the Home display.

The value of the parameter is shown in the upper display. If the value is read/write press  or  to adjust. If no key is pressed for 60 seconds the controller returns to the HOME display. The navigation is shown diagrammatically for the first two parameters in the example below:










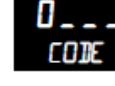


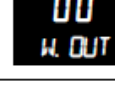
The parameters that appear depend upon the functions configured. The list can also be customized using iTools by adding or removing parameters. The table below shows an example of the list of parameters in Level 1. Parameters may be added to or deleted from this list, see "Parameter Promotion" on page 233.

Parameter Mnemonic	Scrolling name	Description	Further information
WOUT	WORKING OUTPUT	The output demand – 0% to 100% or –100% to +100%.	
R-L	REMOTE-LOCAL SELECT	Selects the Remote or Local setpoint source.	"Loop - Main Sub-list" on page 117.
SP1	SETPOINT 1	The value which the process is required to attain as set by setpoint 1.	
SP2	SETPOINT 2	The value which the process is required to attain as set by setpoint 2 if selected.	
RI1PV	PV	The current value of the process (read only) read by the primary input IP1.	
RI2PV	PV	The current value of the process (read only) read by the secondary input IP2.	If the secondary input is used.
LII	CT LOAD CURRENT	The current being supplied to the heater as measured by the CT.	If the CT is being used.

Operator Level 2



To Select Operator Level 2



Operator level 2 is normally restricted by a password. By default the password is 0002 in a new controller. Enter Level 2 as follows:

Operation	Action	Display	Notes
Select Level 2	<ol style="list-style-type: none"> 1. Press and hold  until GOTO is shown. 2. Press  to choose LEu 2 (Level 2). 3. Press  to enter. 		
Enter the password	<ol style="list-style-type: none"> 4. Press  or  to enter the correct digit value of the password. 5. Press  to accept the value and move to the next digit. 6. The controller will now show the top of the HOME list in Level 2. 		<p>Press  to move to the next digit.</p> <p>The default password for level 2 is '0002'.</p> <p>A special case exists if a security code has been configured as '0000'. If this has been done it is not necessary to enter a code and the controller will enter the chosen level immediately.</p> <p>If an incorrect code is entered the display will return to HOME. After three wrong attempts the password entry system will lock out for a time set by the 'password Lockout Time' set in the "Security Sub-List (SEC)" on page 197.</p>
Select Level 2 parameters	<ol style="list-style-type: none"> 7. Repeatedly press . 		The list of available parameters is given in the table in the next section.

Level 2 Operator Parameters

Parameters available in level 1 are also available in level 2, but level 2 includes additional parameters for commissioning purposes and for more detailed operation.

Press  to step through the list of available parameters. The mnemonic of the parameter is shown in the lower display. Press  to return to the previous parameter.

The value of the parameter is shown in the upper display. If the value is read/write press  or  to adjust. If no key is pressed for 60 seconds the controller returns to the top of the HOME list.

By default the following table lists all possible parameters available in both Levels 1 and 2. Parameters associated with a particular feature will only be shown if that feature is configured.

Parameter Mnemonic	Scrolling name	Description	Further information
WOUT	WORKING OUTPUT	The output current demand – 0% to 100% or -100% to +100%.	Level 1 & 2
R-L	LOOP REMOTE/LOCAL	Selects the Remote or Local setpoint source.	Level 1 & 2
SPHI	SETPOINT HIGH	Maximum value allowed for the local setpoints (SP1 and SP2).	
SPLO	SETPOINT LOW	Minimum value allowed for the local setpoints (SP1 and SP2).	
SP1	SETPOINT 1	The value which the process is required to attain as set by setpoint 1	Level 1 & 2
SP2	SETPOINT 2	The value which the process is required to attain as set by setpoint 2 if selected.	Level 1 & 2
SPUP	SETPOINT RATE UP	Limits the maximum rate at which the working setpoint can change in an increasing (upwards) direction. Setpoint rate limiting is often used to prevent rapid bumps in controller output that may damage equipment or product, or cause upset to downstream processes.	
SPDN	SETPOINT RATE DOWN	Limits the maximum rate at which the working setpoint can change in an increasing (downwards) direction.	
RI1PV	PV	The current value of the process (read only) read by the primary input IP1.	Level 1 & 2
RI2PV	PV	The current value of the process (read only) read by the secondary input IP2.	Level 1 & 2
TUNE	AUTOTUNE ENABLE	Starts an autotune.	"Autotuning" on page 309
P1H	CH1 PROPORTIONAL BAND	Channel 1 (heat) proportional band.	
P1C	CH2 PROPORTIONAL BAND	Channel 2 (cool) proportional band.	
TI	INTEGRAL TIME	Integral time.	
TD	DERIVATIVE TIME	Derivative time.	
C1H	CUTBACK HIGH THRESHOLD	High cutback.	
C1L	CUTBACK LOW THRESHOLD	Low cutback.	

3.9.2 TL Controller Communication Features

1. TL controller auto-detect the protocol of Modbus TCP/IP and BACnet UDP/IP.
 - a. The two protocols share the same IP addresses, Subnet masks, and default gateways.
 - b. Auto-Discovery Mode – known as Zero-configuration networking (zeroconf)
 - i. Utilized Bonjour Service released by Apple under a terms-of-limited-use license.
 - ii. It is intended to use with itools (Eurotherm), not third party applications
 - iii. The Bonjour™ service is enabled by default, which makes it easier for a malicious user to discover and access the controller via the network.
 - c. DHCP Mode
 - i. Default: OFF
 - ii. Enabling DHCP will auto-configure IP address, Subnet Masks, and default gateway.
 - iii. Dynamic IP addressing.
 - d. Static Mode
 - i. Default: ON
 - ii. User can manually set up IP address, Subnet Masks, and default gateway.

SECTION 3: OPERATION AND CONTROLS

2. Ability to connect through Modbus RTU protocol.

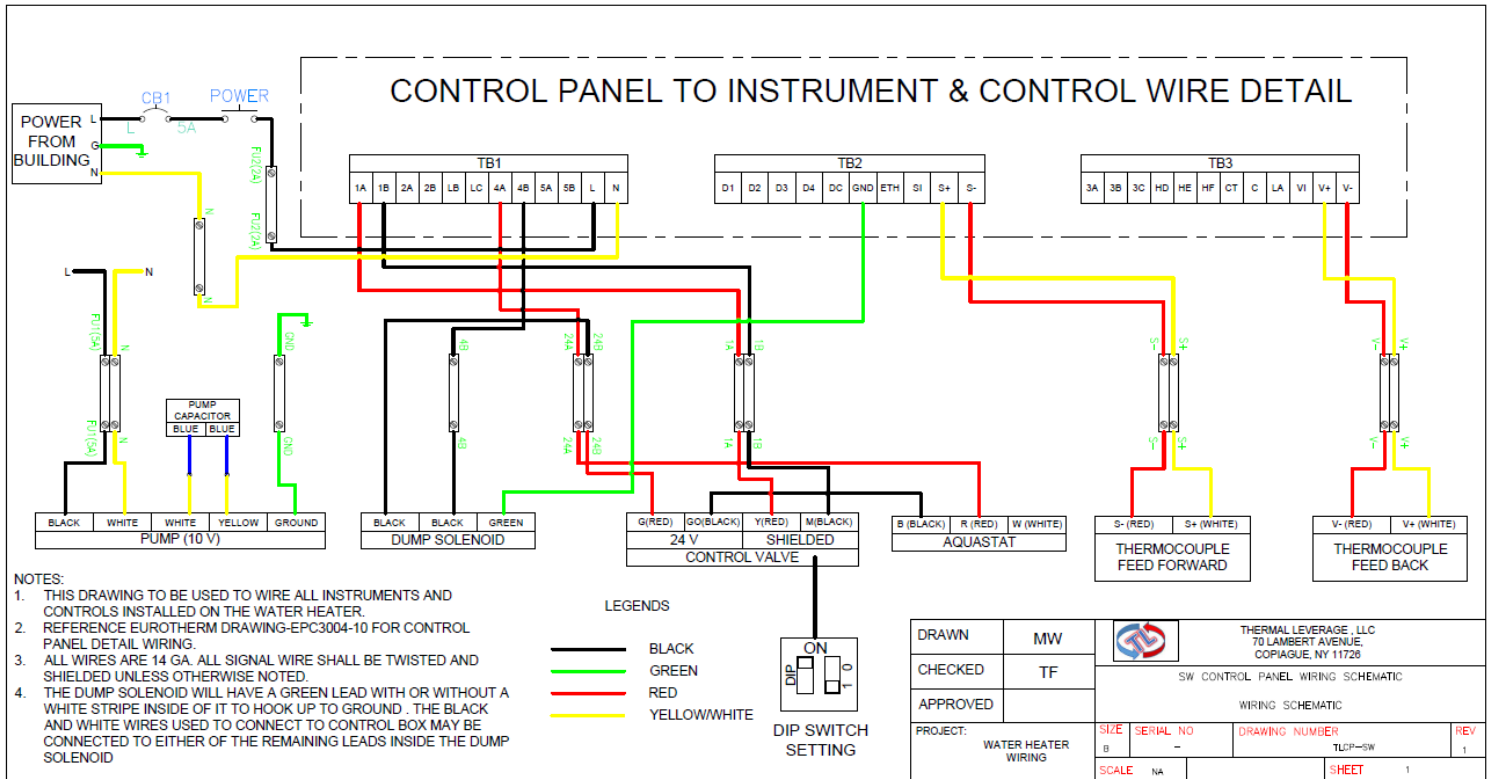
WARNING!

Auto-discovery is on as the default option for simple and quick field setup. However, it makes it easier for a malicious user to discover and access the controller via the network.

3.9.3 TL Default Settings Summary for Communication

1. Auto-detection of Modbus TCP/IP and BACnet UDP/IP protocols when connecting RJ45 port on the controller.
 - a. Default Mode: Static (Need to manually set parameters)
 - b. Default IP: 192.168.111.222
 - c. Default Mask: 255.255.255.0
 - d. Default Gateway: 0.0.0.0
 - e. Mac is read-only (Introduced in the instruction)
2. Ability to connect to Modbus RTU when wiring to HD (COM), HE (A+), HF (B-)
 - a. Default Baud Rate:19200
 - b. Default Parity: None
 - c. Default Data Length: 8
 - d. Default Stop Bits: 1
 - e. Default Slave ID: 1

SECTION 3: OPERATION AND CONTROLS

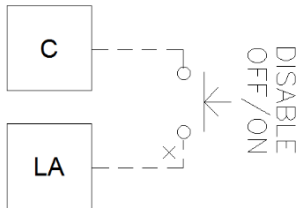


3.10 DRY CONTACTS

The following two types of contacts are available for remote monitoring of unit:

3.10.1 Contact closure input (enable/disable)

Dry Contacts C and LA are available on the PID temperature controller to remotely start/stop the unit if required.

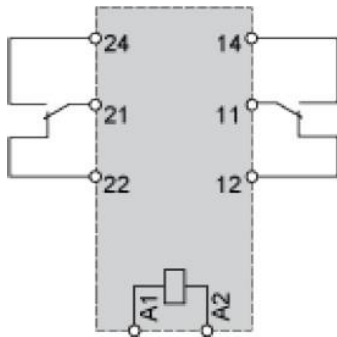


This input is supplied with the current transformer. Contact closure on the remote switch enable (start) the unit.

3.10.2 Fault Relay Contacts

Fault relay R1 terminals 11 & 14 shown below (also shown in Section 6.4) available on the terminal block inside the control panel box for remote alarm indication purposes. This relay is a Double Pole Double Throw (DPDT) type, which energizes when fault condition occurs. Fault can be cleared by pressing the Alarm Silence button.

It has one set each of normally open contacts (between contacts 11 & 14 and 21 & 24) and normally closed contacts (between contacts 11 & 12 and 21 & 22). Normally open (NO) contacts are rated for 8 amps, and maximum switching voltage is 400 VAC.



SECTION 4: MAINTENANCE

This section covers the service and maintenance actions for TL Series Water Heaters and provides step by step instructions for the inspection and replacement of critical parts and components.

Any questions concerning maintenance procedures should be directed to TL support at (Enter telephone #). Please be prepared with model and serial number of the unit(s) prior to contacting TL.

CAUTION!

All service on the Fulcrum Series Water Heaters must be performed by trained and experienced technicians from appropriate service agencies.

NOTE:

Taking the unit offline is required for many of the maintenance procedures in this section, so all technicians performing maintenance should be familiar with the procedures necessary for unit shutdown ([Section 3.5](#)) and unit startup ([Section 3.4](#)).

Carefully examine any component(s) directly connected or linked to the part(s) being replaced before maintenance procedures are started. Consider them for replacement at same time if any of the associated component(s) show signs of wear or improper operation.

4.1 CIRCULATING PUMP MAINTENANCE

TL Fulcrum Series Water Heaters are equipped with a circulating pump to assist in even heating of the water. The following instructions describe the procedure for testing the pump or replacing it should that be required.

➤ CIRCULATING PUMP INSPECTION AND REPLACEMENT INSTRUCTIONS

- 1) Before performing this maintenance procedure, follow Steps 1 through 5 of the shutdown procedure in [Section 3.5](#) to take the unit off-line.

WARNING!

TURN OFF/DISCONNECT ALL ELECTRIC POWER BEFORE ATTEMPTING ANY MAINTENANCE PROCEDURE.

- 2) Test the pump according to manufacturer's instructions supplied with the unit. If found to be defective or worn, replace the pump per the following steps:
 - a) After assuring that the power has been turned off, disconnect the electric leads to the circulating pump.
 - b) Drain the shell by removing the plug on the shell drain connection as shown in Figure 4-1B, item 17.
 - c) Break the flanged joint between the pump and the inlet and outlet piping.
 - d) Remove the pump.
 - e) Reconnect the pump to the inlet and outlet piping. Follow recommendations contained in the manufacturer's documentation, local codes, or accepted contractor practices as to the use and/or type of joint compounds or sealer at the connections.
 - f) Reconnect the electric leads to the pump (reference wiring diagram provided with the unit to assure proper wiring).
 - g) Follow the startup procedure in [Section 3.4](#) to return the unit to operation. Check for signs of leakage at all connections.

SECTION 4: MAINTENANCE

4.2 POWER CONNECTION REWIRING

If any of the power connections must be rewired at the electrically activated controls or junction boxes, follow the steps listed below.

➤ POWER CONNECTION REWIRING INSTRUCTIONS

- 1) Before performing this maintenance procedure, follow Steps 1 through 5 of the shutdown procedure in [Section 3.5](#) to take the unit off-line.

WARNING!

TURN OFF/DISCONNECT ALL ELECTRIC POWER BEFORE ATTEMPTING ANY MAINTENANCE PROCEDURE.

- 2) Ensure that electrical power has been turned off, then disconnect and rewire the electrical connection as required.
- 3) Turn the power on to check that the component that has been rewired is functioning properly.
- 4) Follow the startup procedure in [Section 3.4](#) to return the unit to operation.

SECTION 4: MAINTENANCE

4.3 PNEUMATIC (INSTRUMENT AIR) CONNECTIONS REFITTING

If any of the pneumatic (instrument air) connections must be refit at the pneumatically activated controls, follow the steps listed below. Instrument air, at pressures as high as 150 psi, can be required for pneumatically activated controls. Air pressure at this level can pose a very dangerous situation. Assure that the air source has been shut down and that the line pressure has been bled before breaking any pneumatic connection.

➤ PNEUMATIC CONNECTIONS REFITTING INSTRUCTIONS

- 1) Before performing ANY maintenance procedure, follow Steps 1 through 6 of the shutdown procedure in [Section 3.5](#) to take the unit off-line.
- 2) After assuring the air source has been turned off, break and redo the pneumatic connections in questions.
- 3) Turn the air supply on and check that the component that has been reconnected is functioning properly.
- 4) Follow the startup procedure in [Section 3.4](#) to return the unit to operation.

SECTION 4: MAINTENANCE

4.4 HEAT EXCHANGER BUNDLE & GASKET MAINTENANCE

The “U-Bend” heat exchanger bundle is the heart of TL water heaters. Every two years this coil should be removed from the unit and inspected for wear or damage. There is one (1) gasket located between the coil tube face and the flange welded to the shell/tank, and one (1) gasket with a divider so that it will fit between the tubesheet and the head.

➤ HX COIL/GASKET INSPECTION/REPLACEMENT INSTRUCTIONS

- 1) Before performing this maintenance procedure, follow the steps for the shutdown procedure in [Section 3.5](#) to take the unit off-line.

WARNING!

- Boiler steam and high temperature water can be **very dangerous** and can lead to possible injury or death if caution is not exercised. Use all recommended procedures in this manual, as well as general safety and acceptable practices when performing any of these maintenance procedures.
- **TURN OFF/DISCONNECT ALL ELECTRIC POWER BEFORE ATTEMPTING ANY MAINTENANCE PROCEDURE.**

- 2) Shut OFF the energy source, water inlet and outlet, and condensate/water return line AND make sure that the pressure has been bled from both the water line and energy source systems, that the shell/tank has been completely drained, and that the steam, water, surface, and all other components have cooled.
- 3) Using care, break the joint between the coil head of the heat exchanger and the small line leading to the energy source pressure gauge.
- 4) Using care, break the connections between heat exchanger coil head and the energy source inlet and outlet lines.

NOTE: If you are required to make the necessary break at a second location and to rotate the lines to allow heat exchanger coil clearance, ensure the action does not damage the in-line components.

- 5) Remove the studs and nuts that secure the heat exchanger coil head to the shell and remove all studs from the unit.
- 6) Carefully separate the heat exchanger coil head from the mounting flange and remove the coil assembly from the tank.
- 7) Be careful, as residual steam condensate (or boiler or high temperature water) can leak out from the coil after it is removed, and this could present a scalding danger.
- 8) There may still be residual steam condensate (or boiler / high temperature water) in the coil that can run out during removal of the coil from the tank. If sufficient time has not been allowed for cooling, this residual condensate/ water could present a danger of injury.
- 9) Inspect the heat exchanger coil for buildup of scale and evidence of leakage. If there is no leakage, use care and clean the excess scale from the coils to prepare the heat exchanger coil for re-installation. If leakage is found between the water in the tank and the coils, either repair or replace the heat exchanger coil with a new one.

SECTION 4: MAINTENANCE

- 10) Completely remove the old gaskets, then entirely clean the mating surfaces. Install one of two new gaskets between the coil tube face and the flange welded to the tank, and the gasket (with a divider) between the tubesheet and the head.
- 11) Insert the heat exchanger coil carefully into the tank, oriented with the divider in the head properly lined up with the coil.
- 12) Assure that the heat exchanger unit is aligned properly, then clamp the flanges together and follow the torque procedures below:

NOTE: Studs used to secure the heat exchanger in TL water heaters are A193 B7 grade.

- a) Lubricate the stud threads and the nut faces with a suitable lubricant.
- b) Insert the studs through the flanges, then start and finger tighten the nuts.
- c) Number all bolts so that torquing requirements can be followed.

NOTE: Refer to [Section 4.18](#) for drawing location and part number information of studs and nuts. Reference the applicable drawing for the unit model being serviced.

- d) Apply torque in fifty percent (50%) increments of the final torque value around 140-150 FT-LBS until sealed, before proceeding to the next step.
 - e) Tighten bolts in the applicable sequential order (0°-180°, 90°-270°, 45°-225°, 135°-315°) at each step until final target torque is reached.
 - f) Use rotational tightening until all bolts are stable at final torque level. Two (2) completetimes around is usually required.
- 13) Reconnect the steam/ energy source inlet to the heat exchanger coil. If these lines have been broken at a secondary location for coil removal, ensure these connections are also tightened.

NOTE: Use and type of joint sealer should be determined from local codes or the specifications of the installing contractor.

- 14) Reconnect the small line leading to the energy source pressure gauge.
- 15) Follow the startup procedure in [Section 3.4](#) to return the unit to operation. Check for signs of leakage at all connections.

4.5 INLET, OUTLET, AND CONDENSATE / WATER RETURN LINE AND MANUAL SHUTOFF VALVES REPLACEMENT

If any of the inlet, outlet, return lines, or shutoff valves are damaged and must be replaced, follow the steps outlined below.

➤ INLET, OUTLET, AND CONDENSATE/WATER RETURN LINE AND MANUAL SHUTOFF VALVES REPLACEMENT INSTRUCTIONS

- 1) Before performing this maintenance procedure, follow Steps 1 through 5 of the shutdown procedure in [Section 3.5](#) to take the unit off-line.

WARNING!

TURN OFF/DISCONNECT ALL ELECTRIC POWER BEFORE ATTEMPTING ANY MAINTENANCE PROCEDURE.

CAUTION!

It is **NOT** advised to replace the inlet, outlet, condensate/water return line, and shutoff valves without a complete shutdown of the unit. In the absence of a complete shutdown and removal of electrical power, failure of a manual shutoff valve during the maintenance procedure could result in a dangerous situation.

- 2) Shut OFF the energy source, condensate/water return line, and feed water inlet and outlet AND ensure that both the water lines and energy source systems have been bled of pressure. Ensure that the shell/tank has been drained completely and that all surfaces and components have cooled.
- 3) Use care and break the joint between the line or valve to be replaced and the unit.
- 4) Remove the valve or section of line to be replaced.
- 5) Replace the damaged valve or section of line.
- 6) Reconnect the valve or line to the unit.

NOTE: Use and type of joint sealer should be determined from local codes or the specifications of the installing contractor.

- 7) Perform the startup procedure, as described in [Section 3.4](#), to put the unit back online. Check for evidence of leakage at all connections.

SECTION 4: MAINTENANCE

4.6 PRESSURE GAUGE (ENERGY SOURCE) REPLACEMENT

If the pressure gauge for the energy source does not function correctly and must be replaced, follow the procedures outlined below.

➤ PRESSURE GAUGE (ENERGY SOURCE) REPLACEMENT INSTRUCTIONS

- 1) Before performing this maintenance procedure, follow Steps 1 through 7 of the shutdown procedure in [Section 3.5](#) to take the unit off-line.

WARNING!

TURN OFF/DISCONNECT ALL ELECTRIC POWER BEFORE ATTEMPTING ANY MAINTENANCE PROCEDURE.

- 2) Carefully disconnect the small line connecting the pressure gauge with the heat exchanger coil head from both the head and the gauge.
- 3) Remove the gauge from its mounting.
- 4) Mount the new gauge.
- 5) Reconnect the small line to both the heat exchanger coil head and the gauge.
- 6) Follow recommendations contained in the manufacturer's documentation, local codes, or accepted contractor practices as to the use and/or type of joint compound or sealer at the connections.
- 7) Follow the startup procedures outlined in [Section 3.4](#) to put the unit back on-line. Carefully check all connections for any sign of leakage.

SECTION 4: MAINTENANCE

4.7 PRESSURE OR T&P RELIEF VALVE (SHELL/TANK) REPLACEMENT

If the water pressure or T&P relief valve mounted on the tank is not functioning correctly and must be replaced, follow the procedures outlined below.

➤ PRESSURE/T&P RELIEF VALVE REPLACEMENT INSTRUCTIONS

- 1) Before performing this maintenance procedure, follow the shutdown procedure in [Section 3.5](#) to take the unit off-line.

WARNING!

TURN OFF/DISCONNECT ALL ELECTRIC POWER BEFORE ATTEMPTING ANY MAINTENANCE PROCEDURE.

- 2) Carefully disconnect the drain line from the relief valve to the drain.
- 3) Unscrew and remove the relief valve from its mounting location on top of the unit.
- 4) Install the new relief valve in place. Tighten until sealed and facing proper orientation.

NOTE: Use and type of joint sealer should be determined from local codes or the specifications of the installing contractor.

- 5) Reconnect the drain line from the relief valve to the drain, per local codes.
- 6) If any were disconnected, reconnect all electric and pneumatic lines and restore power and instrument air to the system.
- 7) Reference the manufacturer's documentation for the relief that was supplied with your unit for additional installation / setup instructions.
- 8) Follow the startup procedures outlined in [Section 3.4](#) to put the unit back on-line. Carefully check all connections for any sign of leakage.

SECTION 4: MAINTENANCE

4.7 PRESSURE OR T&P RELIEF VALVE (SHELL/TANK) REPLACEMENT

The Solenoid Safety System acts as a fail-safe for TL Fulcrum Series Water Heaters. If it is mandatory that the unit remain in operation during power failures, it should be wired into the building's emergency power system. **Before this is done, it is the duty of the installer/operator to check local codes and requirements to assure that this is an acceptable configuration.**

When power is supplied to the Solenoid Safety System, the system allows the electrically operated controls to supply energy to the unit. The temperature controller monitors the heated hot water supply temperature to make sure it does not exceed the primary over temperature alarm set point. The system cuts off power supply to the steam/boiler water control valve when this over temperature condition occurs. This causes it to "fail close" upon loss of electrical power, and the solenoid valve is energized to start dumping hot water to safe drain in order to relieve the excessive temperature buildup inside the heat exchanger. When the unit goes back to normal operating temperature condition, power to the control valve is restored and the solenoid valve remains closed.

A semi-annual inspection is recommended, but manufacturer recommendations should be followed for frequency of inspection, testing, and maintenance. If it is necessary to replace a malfunctioning system, follow the instructions below.

NOTE: Location of the Solenoid Safety System may vary from unit to unit. Refer to the drawing supplied with the submittal for the exact location and configuration of the Solenoid Safety System in your unit.

➤ SOLENOID SAFETY SYSTEM INSPECTION & REPLACEMENT INSTRUCTIONS

- 1) Before performing this maintenance procedure, follow Steps 1 through 7 of the shutdown procedure in [Section 3.5](#) to take the unit off-line.

WARNING!

TURN OFF/DISCONNECT ALL ELECTRIC POWER BEFORE ATTEMPTING ANY MAINTENANCE PROCEDURE.

- 2) Carefully disconnect the line connecting the Solenoid Safety System to the control panel.
- 3) Carefully disconnect electric leads from the solenoid valve safety system.
- 4) If the system is pneumatically activated, turn off the instrument air source and disconnect the pneumatic lines from the Solenoid Safety System. Also, disconnect any electric lines connecting pneumatic control valve in this case (similar to step 2 and 3 above).
- 5) Remove the solenoid safety valve from its mounting.
- 6) Mount the new solenoid valve.
- 7) Reconnect the line from the control panel to the solenoid valve safety system on both sides.

NOTE: Use and type of joint sealer should be determined from local codes or the specifications of the installing contractor.

- 8) Reconnect the small line from the energy source control valve to the safety system.
- 9) If any were disconnected, reconnect all electric and pneumatic lines and restore power and

SECTION 4: MAINTENANCE

instrument air to the system.

- 10) Reference the manufacturer's documentation for the solenoid safety valve that was supplied with your unit for additional installation / setup instructions.
- 11) Follow the startup procedure in [Section 3.4](#) to return the unit to operation. Check for signs of leakage at all connections.

SECTION 4: MAINTENANCE

4.9 STRAINERS INSPECTION AND REPLACEMENT

The strainers are installed upstream of the energy source shutoff valve for both the coil and the main traps. These strainers must be flushed periodically (approximately every three [3] to six [6] months) to prevent the buildup of any sediment.

➤ STRAINERS INSPECTION AND REPLACEMENT INSTRUCTIONS

- 1) Before performing this maintenance procedure, follow Steps 1 through 7 of the shutdown procedure in [Section 3.5](#) to take the unit off-line.

WARNING!

TURN OFF/DISCONNECT ALL ELECTRIC POWER BEFORE ATTEMPTING ANY MAINTENANCE PROCEDURE.

- 2) Location of the strainers may differ between units. Refer to the drawing that accompanies the submittal sheet for the exact location.
- 3) Break the line connections on the INLET side of both strainers, then break the line connection on the OUTLET side of the strainers.
- 4) Remove and inspect the strainers for wear or damage.
- 5) Clean out any sediment found in the strainers. Replace the strainers if cleaning does not adequately restore function.
- 6) Replace the strainers in the system, back-in-line.
- 7) Reinstall the inlet and outlet lines to both strainers following the manufacturer recommendations, while adhering to local codes, as well as proper safety and accepted practices.
- 8) Follow the startup procedure in [Section 3.4](#) to return the unit to operation. Check for signs of leakage at all connections.

4.10 CONTROL VALVE INSPECTION AND REPLACEMENT

The temperature control valve is installed upstream of the heat exchanger coil and **must be interlocked** with the high temperature cut off solenoid. The manufacturer documentation included with the unit gives specifics for operation and maintenance of the control valve. The location of the temperature control valve and its interlocks with other components can be found in the drawing accompanying the submittal sheet for the unit, and should be referred to before performing this maintenance procedure.

➤ CONTROL VALVE INSPECTION AND REPLACEMENT INSTRUCTIONS

- 1) Before performing this maintenance procedure, follow Steps 1 through 7 of the shutdown procedure in [Section 3.5](#) to take the unit off-line.

WARNING!

- Boiler steam and high temperature water can be **very dangerous** and can lead to possible injury or death if caution is not exercised. Use all recommended procedures in this manual, as well as general safety and acceptable practices when performing any of these maintenance procedures.
- **TURN OFF/DISCONNECT ALL ELECTRIC POWER BEFORE ATTEMPTING ANY MAINTENANCE PROCEDURE.**

- 2) Assure that the energy source, condensate/water return line, and water inlet and outlet have been shut off, that the pressure has been bled from both the steam and energy source systems, that the shell/tank has been completely drained, and that all components and surfaces have cooled.
- 3) For electrically activated control valves, turn off the power and disconnect the leads to the valve.
- 4) For pneumatically activated control valves, turn off the instrument air source, bleed the pressure from the line, and disconnect the lines to the valve.
- 5) Break the joints between the pressure control valve and feed water valve, solenoid safety unit, and auxiliary trap line.
- 6) Break the connections between the energy source inlet line and the heat exchanger coil.

NOTE: If you are required to make the necessary break at a second location and to rotate the lines to allow heat exchanger coil clearance, ensure the action does not damage the in-line components.

- 7) Remove the control valve from the system.
- 8) Follow the supplied manufacturer instructions for inspecting the valve. If found to be malfunctioning, replace the valve.
- 9) Reinstall the control valve by reconnecting it to the heat exchanger coil outlet line and the energy source inlet line. Reconnect the small line from the shell/tank outlet line to the safety system.

SECTION 4: MAINTENANCE

NOTE: Use and type of joint sealer should be determined from local codes or the specifications of the installing contractor.

- 10) Place the valve in the same orientation as it was when removed and tighten the connections. If lines were also broken in a secondary location, ensure those connections are also tightened
- 11) Reconnect the solenoid safety unit and the auxiliary trap line to the control valve.
- 12) Follow the startup procedure in [Section 3.4](#) to return the unit to operation. Check for signs of leakage at all connections.

4.11 TEMPERATURE CONTROLLER

The temperature controller is a digital solid-state device, which requires no periodic maintenance. Occasional physical checks of the unit should be carried out for physical and mechanical security of mounting, terminal blocks, and electrical wiring.

4.12 TRAPS (MAIN & AUXILIARY) REPLACEMENT (STEAM SYSTEMS ONLY)

On units that use a steam energy source, the main and auxiliary traps are installed upstream of the condensate shutoff valve. The flow of condensate is controlled by the rise and fall of a float in the body of the trap. To replace a malfunctioning condensate trap, follow the instructions below.

➤ TRAPS (MAIN & AUXILIARY) REPLACEMENT INSTRUCTIONS

- 1) Before performing this maintenance procedure, follow Steps 1 through 7 of the shutdown procedure in [Section 3.5](#) to take the unit off-line.

WARNING!

TURN OFF/DISCONNECT ALL ELECTRIC POWER BEFORE ATTEMPTING ANY MAINTENANCE PROCEDURE.

- 2) The trap location may differ between units. Refer to the drawing that accompanies the submittal sheet for the exact location of the trap.
- 3) Break the joint on the INLET side of both traps, then break the joint on the OUTLET side of both traps.
- 4) Remove and inspect the traps for wear or damage.
- 5) Replace traps if they are malfunctioning.
- 6) Install the traps back in the system, in-line.
- 7) Reconnect the all inlet and outlet lines to both traps.

NOTE: Use and type of joint sealer should be determined from local codes or the specifications of the installing contractor.

- 8) Follow the startup procedure in [Section 3.4](#) to return the unit to operation. Check for signs of leakage at all connections.

SECTION 4: MAINTENANCE

4.13 CLEANING OF HEAT EXCHANGERS AND TANKS

Heat exchangers and tanks are cleansed by flushing the units with fluids, which do not react with materials of the units. Dirt deposited in the heat exchanger/tank will result in an increase in pressure drop, lower temperature difference in the heated medium, or a higher exit temperature on heating medium side. It is recommended to clean heat exchangers and tanks twice a year.

4.13.1 DISASSEMBLY AND REASSEMBLY

This heat exchanger is designed to function in various domestic water heating applications. It is required to disassemble and reassemble the heat exchanger after checking for tube leaks or regular cleaning etc. TL units are designed to easily remove the tube bundle from bottom of the unit when installed at their location. It requires tooling, including wrenches, torque wrenches, and sealing compounds.

CAUTION!

Proper caution must be taken during disassembly and reassembly of the heat exchanger in order to prevent any damage to the components and/or injury.

4.14 REPLACEABLE PARTS LIST

The following is a list of parts that are generally replaceable by trained/certified personnel on TL water heaters. Replaceable parts may vary to some degree, depending on model and specific design configuration. Refer to the original design specifications or contact TL, Inc. with any questions regarding replaceable parts.

Please have the unit's model and serial number available when contacting TL, Inc.

NOTE: Replaceable parts may vary depending on design specification of the unit.

- Control Valve
- Gaskets
- Heat Exchanger Tube Bundle
- Pressure Gauge
- T&P Relief Valve
- Solenoid Valve
- Auxiliary Trap
- Main Condensate Trap
- PID Controller
- Recirculation Pump
- Thermocouples
- Aquastat
- Vacuum Breaker
- Control Panel Parts
- Other Piping Components

NOTE: Refer to [Section 4.18 Parts and Accessories](#) for complete list and part number information.

SECTION 4: MAINTENANCE
4.15 RECOMMENDED SPARE PARTS:

TABLE 4-3: RECOMMENDED SPARE PARTS			
REFERENCE	ITEM NO.	QUANTITY PER UNIT	PART NAME
FIG. 4-1A	4	1	GASKET
FIG. 4-1A	5	1	GASKET W/ RIB
FIG. 4-1B	19a	1	PRESSURE GAUGE
FIG. 4-1B	13	2	THERMOCOUPLES
FIG. 4-1C	16	1	AQUASTAT
FIG. 4-1C	14	1	SOLENOID VALVE
FIG. 4-1B	20a	1	VACUUM BREAKER
FIG. 4-2	25 & 28	SEE TABLE 4-11	GASKETS (STEAM INLET)

For the replacement heat exchanger tube bundle model and serial number, refer to the nameplate mounted on the jacket of the unit.

SECTION 4: MAINTENANCE

4.16 ORDERING INFORMATION

All replacement parts for TL Fulcrum Series units can be ordered directly from your local authorized sales representative/agent. Visit Rep Locator page on the TL website to find your local sales representative's contact information.

NOTE:

If sales representative is not available, please contact TL Sales.

Please include the model and serial number of the unit for which the parts are being ordered. If ordering by phone, please have this information readily available. All orders must be submitted via PO and sent to (insert sales email).

SECTION 4: MAINTENANCE
4.17 INSPECTION SCHEDULE

Table 4-4, below, summarizes the recommended time intervals for inspection of the water heater, components, inlet and outlet water and energy source lines (steam, boiler water, or high temperature water), and power connections.

TABLE 4-4: RECOMMENDED INSPECTIONS TIME INTERVAL TABLE						
TO BE INSPECTED	PER MANUFACTURE SPECS.	WEEKLY	MONTHLY	3 MONTHS	6 MONTHS	1 YEAR
Recirculation Pump	X					
Control Valve	X					
Temperature & Pressure Gauges				X		
Heat Exchanger Tube Bundle & Gaskets			X			
Inlet, Outlet & Return Connections				X		
Pneumatic Connections				X		
Power & Ground Connections				X		
Relief Valves	X					
Isolation Valves		X				
Solenoid & Aquastat Safety System				X		
Strainers				X		
Traps- Main & Auxiliary					X	
PID Controller & Thermocouple					X	
Vacuum Breaker			X			

SECTION 4: MAINTENANCE

NOTE:

It is mandatory to keep maintenance/inspections logs and applicable federal, state, and local regulations near the unit following TL Installation, Operation, and Maintenance (IOM). Failing to do so will void TL warranty.

SECTION 4: MAINTENANCE

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SECTION 5: TROUBLESHOOTING

The following table shows issues that a TL Fulcrum Series Water Heating Unit may encounter during its operation, and the procedures to remedy those problems. The left-hand column lists the symptoms. The remaining columns are suggested procedures or “remedies” that should be followed to identify and correct the problem.

SYMPTOM	PROBABLE CAUSE(S)	REMEDY
<p>Water heater is not able to maintain the required temperature at the rated capacity.</p>	<ol style="list-style-type: none"> 1. Inlet steam/energy source pressure is too low. 2. Inlet steam/energy source pressure control valve is not opening properly. 3. The condensate drain/water return piping has not been installed properly to allow the condensate to drain freely (by gravity)/water return circulation; the condensate drain/water return line is restricted; or the condensate/water return check valve is leaking or has failed. 4. The water heater temperature control system/valve is not operating properly. 5. There is a leakage in the heat exchanger coil. 	<ol style="list-style-type: none"> 1. Check the steam/energy source pressure gauge. Adjust the inlet pressure to meet the design requirements if the reading is low. If there is a restriction in the primary energy source line, the gauge reading will drop drastically when the heat exchanger calls for full energy, even though the pressure seems to be normal during light demand. If the incoming energy source pressure is correct, its pressure gauge reading should reach design pressure as the hot water supply temperature approaches set point. 2. See the adjustment and testing instructions contained in the supplied Installation/Operations Manual for the specific temperature control valve installed on the unit. Replace the valve if necessary. Refer to Section 4.21 Control Valve Technical Information if hard copy is not available. 3. Rearrange the condensate drain/water return piping and inspect the valve for proper drainage. Also check to make sure there is no restriction in the condensate drain/water return line. Replace the check valve if it is leaking or has failed. Inspect F&T trap and drip line. If condensate drain/water return line is restricted due to trap, contact the local TL representative for the required trap size. Also inspect vacuum breaker for any malfunctioning. 4. See the adjustment and testing instructions contained in Section 3.6 for the specific temperature control system installed on the unit. Also, check to ensure that the thermocouple is installed and functioning correctly. Repair or replace it if needed. Replace the control valve and/or actuator if necessary. 5. Shut off the primary energy source to unit and break connection in the condensate/water return line to verify the presence of leakage. Steam condensate or boiler / high temperature water will drain from the coil in the beginning, but the flow should stop after a short

SECTION 5: TROUBLESHOOTING

	<ol style="list-style-type: none"> 6. The heat exchanger coil is heavily scaled or damaged. 7. Water heater and control valve being used at higher than rated design capacity. 8. Recirculating pump malfunctions/failed. 	<p>period of time. If the flow continues and water is leaking from shell into the coil; disassemble, inspect, repair (if possible), or replace the heat exchanger coil and reassemble the unit.</p> <ol style="list-style-type: none"> 6. Call TL or your authorized representative for instructions on repair or replacement. Refer to the nameplate for the model and serial numbers of the unit and heat exchanger coil. Include these numbers in all correspondence. 7. Call TL or your authorized representative. Refer to the nameplate for the model and serial numbers of the unit and heat exchanger coil. Include these numbers in all correspondence. 8. Recirculation piping temperature should be same as the hot water outlet temperature when recirculation pump is operating properly. Check the power supply or repair/replace the pump if needed.
DHW supply temperature is too high	<ol style="list-style-type: none"> 1. The water heater temperature control system/valve is not operating properly. 2. The temperature controller or thermometer indicates wrong value. 3. Incoming water is preheated too much. 	<ol style="list-style-type: none"> 1. See the adjustment and testing instructions contained in Section 3.6 for the specific temperature control system installed on the unit. Also, check to ensure that the thermocouple is installed and functioning correctly. Repair or replace it if needed. Replace the control valve and/or actuator if necessary. Refer to Section 4.21 Control Valve Technical Information if hard copy is not available. 2. Inspect and replace the temperature controller, thermocouple and/or thermometer if any of them are not functioning properly. 3. Maintain incoming cold water at least 10°F below the hot water supply temperature.
DHW supply outlet temperature fluctuates significantly	<ol style="list-style-type: none"> 1. Inlet steam/energy source control valve does not open/close properly. 2. Inlet steam/energy source pressure is too low. 	<ol style="list-style-type: none"> 1. See the adjustment and testing instructions contained in the supplied manual for the specific temperature control valve installed on the unit. Replace the control valve and/or actuator if necessary. Refer to Section 4.22 Control Valve Technical Information if hard copy is not available. 2. Check the steam/energy source pressure gauge. Adjust the inlet pressure to meet the design requirements if the reading is low. If there is any restriction in the steam/energy source line, the gauge reading will drop extremely when the heat exchanger calls for full energy, even though the pressure seems to be normal during light demand. If the incoming energy source pressure is correct, its pressure gauge reading should reach design pressure as the pressure in the heat exchanger as hot water supply temperature approaches set point.

SECTION 5: TROUBLESHOOTING

	<ol style="list-style-type: none"> 3. Water heater and control valve being used at higher than rated design capacity. 4. There is a water leakage in the heat exchanger coil. 5. The condensate drain/water return piping has not been installed properly to allow the condensate to drain freely (by gravity)/water return circulation; the condensate drain/water return line is restricted; or the condensate/water return check valve is leaking or has failed. 6. Recirculating pump malfunctions/failed. 7. Ground wiring connection is loose or disconnected. 8. The water heater temperature control system is not operating properly 	<ol style="list-style-type: none"> 3. Call TL or your authorized representative. Refer to the nameplate for the model and serial numbers of the unit and heat exchanger coil. Include these numbers in all correspondence. 4. Shut off the primary energy source to unit and break connection in the condensate/water return line to verify the presence of leakage. Steam condensate or boiler / high temperature water will drain from the coil in the beginning, but the flow should stop after a short period of time. If the flow continues and water is leaking from shell into the coil; disassemble, inspect, repair (if possible), or replace the heat exchanger coil and reassemble the unit. 5. Rearrange the condensate drain/water return piping and inspect the valve for proper drainage. Also check to make sure there is no restriction in the condensate drain/water return line. Replace the check valve if it is leaking or has failed. Inspect F&T trap and drip line. If condensate drain/water return line is restricted due to trap, contact the local TL representative for the required trap size. Also inspect vacuum breaker for any malfunctioning. 6. Recirculation piping temperature should be same as the hot water outlet temperature when recirculation pump is operating properly. Check the power supply or repair/replace the pump if needed. Also check building recirculation pump aquastat settings if being used. 7. Check the ground connection to make sure it is not loose, which can cause electrical nuisance for temperature control (building stray voltage). 8. Refer to the PID settings adjustment and testing instructions contained in Section 3.6 for the specific temperature control system installed on the unit. Also, check to ensure that the thermocouple is installed and functioning correctly. Repair or replace it if needed.
<p>Excessive or insufficient condensate (steam, boiler water, or high temperature hot water) being returned from the unit.</p>	<ol style="list-style-type: none"> 1. The condensate drain/water return piping has not been installed properly to allow the condensate drain freely (by gravity)/water return circulation; the condensate drain/water return line is restricted; or the condensate/water return check valve is leaking or has failed. 	<ol style="list-style-type: none"> 1. Rearrange the condensate drain/water return piping and inspect the valve for proper drainage. Also check to make sure there is no restriction in the condensate drain/water return line. Replace the check valve if it is leaking or has failed. Inspect F&T trap and drip line. If condensate drain/water return line is restricted due to trap, contact the local TL representative for the required trap size. Also inspect vacuum breaker for any malfunctioning.

SECTION 5: TROUBLESHOOTING

	<ol style="list-style-type: none"> There is a water leakage in the heat exchanger coils. 	<ol style="list-style-type: none"> Shut off the primary energy source to unit and break connection in the condensate/water return line to verify the presence of leakage. Steam condensate or boiler / high temperature water will drain from the coil in the beginning, but the flow should stop after a short period of time. If the flow continues and water is leaking from shell into the coil; disassemble, inspect, repair (if possible), or replace the heat exchanger coil and reassemble the unit.
<p>Steam is discharged into the condensate drain</p>	<ol style="list-style-type: none"> The heat exchanger coil is heavily scaled or damaged. Undersized or faulty condensate trap(s). 	<ol style="list-style-type: none"> Call TL or your authorized representative, for instructions on repair or replacement. Refer to the nameplate for the model and serial numbers of the unit and heat exchanger coil. Include these numbers in all correspondence. Contact the local TL representative for the required trap size if it is faulty.
<p>Temperature and Pressure or pressure only relief valve "pops".</p>	<ol style="list-style-type: none"> Inlet steam/energy source control valve does not close properly. Incoming water is preheated too much. Improperly sized or disconnected expansion tank in closed loop piping system. Inadequate water hammer arrestors. System/incoming water pressure is too high. Relief valve is faulty. Aquastat/over temperature settings in PID controller or solenoid valve not properly set or defective. 	<ol style="list-style-type: none"> See the adjustment and testing instructions contained in Section 3.6 for the specific temperature control system installed on the unit. Also, check to ensure that the thermocouple is installed and functioning correctly. Repair or replace it if needed. Replace the control valve if necessary. Refer to Section 4.22 Control Valve Technical Information if hard copy is not available. Maintain incoming cold water at least 10°F below the hot water supply temperature. Install the properly sized expansion tank in the closed loop piping system as shown in Installation and Piping drawings in Section 6.3. In order to avoid any shock waves, install water hammer arrestors/shock absorbers in the hot and cold water systems as needed. Bring the system water pressure below the relief valve setting. Inspect and adjust or replace the relief valve if it has failed. Contact DHT representative for replacement. Check and readjust as necessary. Replace the defective parts as necessary. Refer to adjustment instructions contained in Section 3.6.
<p>Water heater shuts down at or too close to (above or below) the</p>	<ol style="list-style-type: none"> Over temperature limit settings not properly set or defective. 	<ol style="list-style-type: none"> Refer to adjustment instructions contained in Section 3.6. Replace the defective parts as necessary.

SECTION 5: TROUBLESHOOTING

design outlet water temperature.		
A loud banging in the water heater, primary piping, or condensate/water return piping (not to be confused with a normal clicking noise made during operation).	<ol style="list-style-type: none"> 1. The condensate drain/water return piping has not been installed properly to allow the condensate to drain freely (by gravity)/water return circulation; the condensate drain/water return line is restricted; or the condensate/water return check valve is leaking or has failed. 2. Primary/inlet steam line is not properly trapped (steam as energy source only). 3. Vacuum breaker is faulty. 4. Improperly sized or disconnected expansion tank in closed loop piping system. 5. Inadequate water hammer arrestors. 	<ol style="list-style-type: none"> 1. Rearrange the condensate drain/water return piping and inspect the valve for proper drainage. Also check to make sure there is no restriction in the condensate drain/water return line. Replace the check valve if it is leaking or has failed. Inspect F&T trap and drip line. If condensate drain/water return line is restricted due to trap, contact the local TL representative for the required trap size. Also inspect vacuum breaker for any malfunctioning. 2. Reconfigure the primary/inlet steam line to allow main and auxiliary (drip) traps to function properly. 3. Check and replace the vacuum breaker if faulty. 4. Install the properly sized expansion tank in the closed loop piping system as shown in Installation and Piping drawings in Section 6.3. 5. In order to avoid any shock waves, install water hammer arrestors/shock absorbers in the hot and cold water systems as needed. Also check for any trapped air in the domestic water system.
Over-temperature sound alarm occurs frequently.	<ol style="list-style-type: none"> 1. Automatic over temperature settings not properly set or defective parts. 	<ol style="list-style-type: none"> 1. Check and readjust the over-temperature setting as necessary. Refer to adjustment instructions contained in Section 3.6. Replace the defective parts or thermocouple if defective.
Unable to clear over-temperature sound alarm condition	<ol style="list-style-type: none"> 1. Automatic over temperature settings not properly set or defective parts. 2. Defective thermocouple. 3. Over-temperature solenoid valve leaks/open. 4. Recirculating pump malfunctions/failed. Flow is stagnant through the heat exchanger. 	<ol style="list-style-type: none"> 1. Check and readjust the over-temperature setting as necessary. Refer to adjustment instructions contained in Section 3.6. Replace the defective parts. 2. Replace the thermocouple if shorted. 3. Readjust or replace the solenoid valve if defective. 4. Check to make sure pump is functioning properly. Also, check for any blockage in the piping to ensure proper flow through heat exchanger.
Solenoid Valve does not open and DHW supply temperature is higher than the secondary alarm limit.	<ol style="list-style-type: none"> 1. Solenoid valve is defective or disconnected. 	<ol style="list-style-type: none"> 1. Check to make sure solenoid valve wiring is done correctly and not loose. Also, check to make sure voltage is present. Replace the solenoid valve if defective.

SECTION 5: TROUBLESHOOTING

	2. Automatic over temperature settings not properly set, loose wiring or defective parts.	2. Check and readjust the over-temperature setting as necessary. Refer to adjustment instructions contained in Section 3.6. Replace the defective parts.
Controller unit 'Locks Up'	1. Controller 'Locks Up'	1. Recycle power to the unit by removing AC power, waiting 10 seconds, and reconnecting power. DANGER! This should be done by using the user-provided circuit breaker or fuse, not by removing the power wires at the terminal block. Serious injury or death can occur if contact is made with the incoming AC power.
HMI and/or Controller display remains at zero or shows no change	1. Display remains at zero or shows no change but the process is changing.	1. Recycle power to the unit by removing AC power, waiting 10 seconds, and reconnecting power. If the problem persists, contact the local TL representative.
Entire System is OFF	2. External 120V AC power disconnected or ON/OFF switch on control panel failed/OFF.	2. Check to make sure external circuit breaker is ON and there is power supply available. Replace the ON/OFF switch on the control panel if faulty.

NOTE:

Use of non-TL thermocouple on unit may lead to temperature controls issues. See 4.19 for TL thermocouple part number details.

SECTION 6: WARRANTY

SECTION 6: WARRANTY

FULCRUM SERIES WATER HEATER PRODUCT SPECIFIC LIMITED WARRANTY

Subject to the terms and conditions herein and the Terms and Conditions of Sale (as defined herein), Thermal Leverage, Inc. (TL) (“Seller”) provides to the purchaser of the product (“Buyer”) a non-prorated warranty for the following components of the Fulcrum Series Water Heater. The Fulcrum Series Water Heater must be operated in accordance with the conditions stated herein, against the indicated failures. The Fulcrum Series Warranty commences on the date of shipment or if a start-up report is furnished to Seller, on the start-up date shown on the report furnished to Seller (the “Warranty Period”). The startup must be completed within six (6) months of shipment, and the start-up report must be furnished to Seller within thirty (30) days of the startup.

- **TUBE BUNDLE** shall carry a non-prorated (10) year warranty against failure due to thermal shock, mechanical failure, manufacturing, or material defect. The tube bundle shall not be warranted from failure due to scaling, liming, corrosion, or erosion due to water or installation conditions.
- **Heat Exchanger SHELL & Feed Forward system** shall carry a non-prorated (20)year warranty.
- **ALL OTHER COMPONENTS** shall carry a non-prorated (1) year warranty.

CONDITIONS OF WARRANTY:

This Specific Product Limited Warranty is transferrable to the owner that utilizes the product(s) purchased hereunder for its intended use at the original installation site (the “Original Owner”). This Specific Product Limited Warranty is non-transferable to anyone who subsequently receives or purchases products from the Original Owner. If the Original Owner did not purchase the product directly from Seller, the Original Owner should contact the reseller from whom it purchased the product for a copy of the Terms and Conditions of Sale, which can be also found on (input TL website).

Seller’s obligations under this Specific Limited Warranty is limited to modify, repair, or exchange the defective item which after examination shall, to Seller’s own satisfaction, be determined to have been defective at the time it was shipped. In the event that a replacement is provided by Seller, the defective item will become the property of Seller. Any claims relating to this product shall be limited to the list price of the product at the time of sale. Transportation to Seller’s facility or other designated facility for repairs of any products or party alleged defective shall, in all events, be at Buyer’s sole risk and cost.

This warranty applies only if the Seller receives, within the Warranty Period, an immediate written notice, providing a detailed description of all claimed defects, upon discovery of such defects together with proof of purchase (invoice or Order Acknowledgment) and a copy of the start-up report for the affected product (Attention: Thermal Leverage, Inc., 70 Lambert Avenue, Copiague, NY 11726).

Seller may seek reimbursement of any costs incurred by Seller where the product is found to be in good working order, or when it has been determined that this Specific Product Limited Warranty does not apply as per the exclusions set forth below. The remedies available to Buyer set forth herein are exclusive remedies, and all other remedies, statutory or otherwise, including but not limited to the right of legal action, are waived by Buyer. Buyer shall indemnify and hold Seller harmless against, any claim due to any injury or death to any person or damage to any property resulting in whole or in part from any modification or alteration Buyer makes to any product sold hereunder.

EXCLUSIONS:

To the full extent permitted by law, Seller shall have no liability for and the warranties do not cover:

- A. Any product which has been altered or repaired by other than Seller’s personnel;
- B. Deterioration or failure of any product due to:
 - a. abrasion, corrosion, erosion, or fouling,
 - b. misuse,
 - c. modification not authorized by Seller in writing
 - d. improper installation, lack of or improper maintenance or operation;

SECTION 6: WARRANTY

- C. Equipment not furnished by Seller, either mounted or unmounted, or when contracted for by a party or parties other than Seller to be installed or handled;
- D. The suitability of any product for any particular application;
- E. The design or operation of owner's plant or equipment or of any facility or system of which any product may be made a part;
- F. Any damage to the product due to abrasion, erosion, corrosion, deterioration, abnormal temperatures, or the influence of foreign matter or energy;
- G. The performance of any product under conditions varying materially from those under which such product is usually tested under industry standards at the time of shipment;
- H. Leakage or other malfunction caused by:
 - a. defective installations in general and specifically, any installation which is made
 - i. in violation of applicable state or local plumbing, housing or building codes or
 - ii. contrary to the written instructions furnished with the product,
 - b. adverse local conditions in general and, specifically, sediment or lime precipitation in the tubes, headers and/or shells or corrosive elements in the water, heating medium or atmosphere, or
 - c. misuse in general and, specifically, operation and maintenance contrary to the written instructions furnished with the unit, disconnection, alteration, or addition of components or apparatus not approved by Seller, operation with heating media, fuels, or settings other than those set forth on the rating plate, or accidental or exterior damage;
 - I. Discoloration or rusty water caused by piping, fittings, valves, pumps, or other sources outside of the Fulcrum Series Water Heater;
 - J. INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES, SUCH AS LOSS OF THE USE OF PRODUCTS, FACILITIES OR PRODUCTION, INCONVENIENCE, LOSS OF TIME OR LABOR EXPENSE INVOLVED IN REPAIRING OR REPLACING THE ALLEGED DEFECTIVE PRODUCT;
 - K. Damage to surrounding area or property caused by leakage or malfunction;
 - L. Costs associated with the replacement and/or repair of the unit including: any freight, shipping or delivery charges, any removal, installation or reinstallation charges, any material and/or permits required for installation, reinstallation or repair, charges to return the Fulcrum Series Water Heater or components;
 - M. Any claim due to any injury or death to any person or damage to any property resulting in whole or in part from any modification or alteration Buyer makes to any product sold hereunder; and
 - N. Design defects where Seller has complied with Buyer's design specifications.

No salesman or other representative of the seller has any authority to expand warranties beyond the face of the said warranty and purchaser shall not rely on any oral statement except as stated in the said warranty. An Officer of the Seller must do any modifications to this warranty in writing.

WARRANTY CLAIMS:

Warranty claims should be presented through prompt telephone notification to TL at 973 650-1711 or email to (input TL's email). In order to process a warranty claim a formal purchase order number is required prior to shipment of any warranty item. In addition, the returned item must include a Returned Goods Authorization (RGA) label, attached to the shipping carton, which identifies the item's return address, register number and factory authorized RGA number.

This warranty applies only to units sold to customers in North America. All other geographical areas carry a standard warranty of 18 months from date of shipment or 12 months from startup, whichever comes first.

-END-

SECTION 6: WARRANTY

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