System Summary	Self-contained thermal fluid supply, return, and temperature control package for battery testing.

Overview. The proposed Liquid Cooling Thermal Management System is a fully integrated, self-contained package designed to store, supply, and receive temperature-controlled thermal fluid for battery testing applications. The system is housed in a vented enclosure mounted on casters for mobility and is intended for indoor service. The operator interface is provided through a flush-mounted NEMA 4 control cabinet with serial communications via CANopen. All process piping and tubing are 304 stainless steel.

Configuration. The base configuration is a single-stream system equipped with a 3 HP condensing unit. Available options include a 10 HP condensing unit, additional flow streams, and substitution of pressure gauges with indicating pressure transmitters.

Design Basis

Parameter	Value
Fluid	50/50 Ethylene Glycol / Water
Flow Range	10 to 100 LPM
Pressure Range	10 to 80 PSI
Temperature Range	-10 C to +60 C
Base Refrigeration Package	3 HP air-cooled condensing unit
Optional Refrigeration Package	10 HP air-cooled condensing unit

System Description

1. Fluid Storage

Thermal fluid is stored in an insulated stainless steel tank with a nominal volume of approximately 20 gallons. A sight gauge mounted externally on the enclosure provides continuous level indication. A low-level switch prevents operation of both the pump and the tempering circuit when the tank level is below the safe operating threshold.

2. Fluid Transfer

Fluid is circulated by a vertical multistage turbine pump sized to provide the required pressure and flow for the intended application. The pump is driven by a variable-speed motor to maintain efficient operation across a range of flow and pressure conditions. A coarse suction strainer protects the pump, while a 10-micron spin-on filter on the discharge side protects downstream instrumentation and the units under test.

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3. Pressure Control

Primary pressure control is provided by a manually adjusted, self-contained spring-loaded back-pressure regulator. A three-way manual valve in the return circuit allows the operator to configure the system for either supply-pressure control or return-pressure control, depending on the test requirement.

4. Flow Control

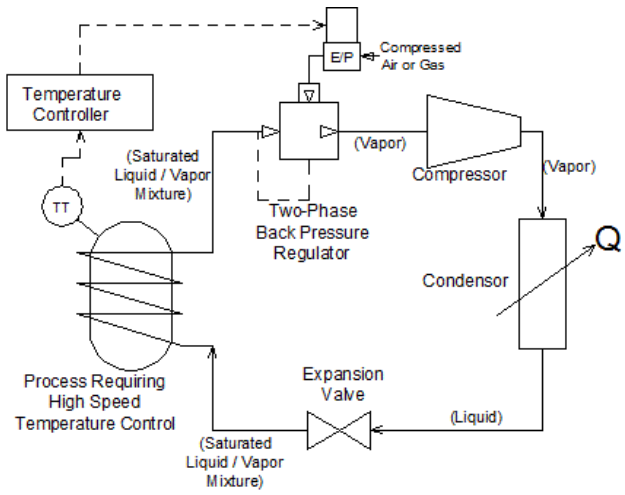
Each outlet stream serving a unit under test is equipped with a flow meter and a manual needle valve for local flow adjustment. The regulated system pressure enables stable and repeatable flow control across the operating range.

5. Tempering Circuit

Return fluid from the test subject may be directed either back to the pump suction or through a refrigerant-cooled flat-plate heat exchanger before re-entering the storage tank. An air-operated mixing valve modulates the proportion of flow sent through the heat exchanger versus bypassed directly to the pump suction. This arrangement supports precise thermal control while also enabling rapid warm-up, since only a small fluid volume is conditioned during startup.

6. Refrigeration Circuit

The base system includes a 3.25 HP air-cooled condensing unit using R-404A refrigerant. Cooling capacity is approximately 19,500 BTU/hr (5.7 kW) at a 10 F (-12.2 C) evaporator temperature and 38,200 BTU/hr (11.2 kW) at a 45 F (7.2 C) evaporator temperature. An optional 10 HP condensing unit increases capacity to approximately 67,500 BTU/hr (19.8 kW) at 10 F (-12.2 C) and 120,000 BTU/hr (35 kW) at 45 F (7.2 C). A high-performance control method is also available in which an electronically actuated back-pressure regulator installed downstream of the evaporator maintains coil temperature directly at the refrigerant saturation temperature corresponding to the controlled fluid pressure, allowing rapid and precise temperature transitions.



Typical Refrigeration Circuit

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7. Tank Heater

The system includes a 3 kW immersion heater sized to raise the stored fluid to the required test temperature and maintain elevated operating temperatures. Tank temperature is controlled independently of the feed circuits by a dedicated microprocessor-based controller. Both the heater and condensing unit are interlocked with pump operation.

8. Instrumentation and Communications

The base system includes panel-mounted pressure gauges at the locations shown on the P&ID, with an option to replace them with indicating pressure transmitters for integration with the customer DAQ system. Temperature is measured using K-type thermocouples wired to individual panel-mounted indicators. Flow meters are turbine type and are wired to panel-mounted flow indicators. Pilot lights are provided to indicate low tank level and excessive strainer or filter differential pressure. All transmitters support Modbus RS485 communications. The system also includes a CANopen gateway for transmission of process data and receipt of setpoints and commands from the customer DAQ system.

Specifications

Item	Specification
Electrical Power Supply (Base)	480 VAC, 3 Phase, 60 Hz, 3.0 kW
Electrical Power Supply (10 HP Option)	480 VAC, 3 Phase, 60 Hz, 8.0 kW
Instrumentation and Control Power	24 VDC
Ambient Temperature Range	15 C to 55 C

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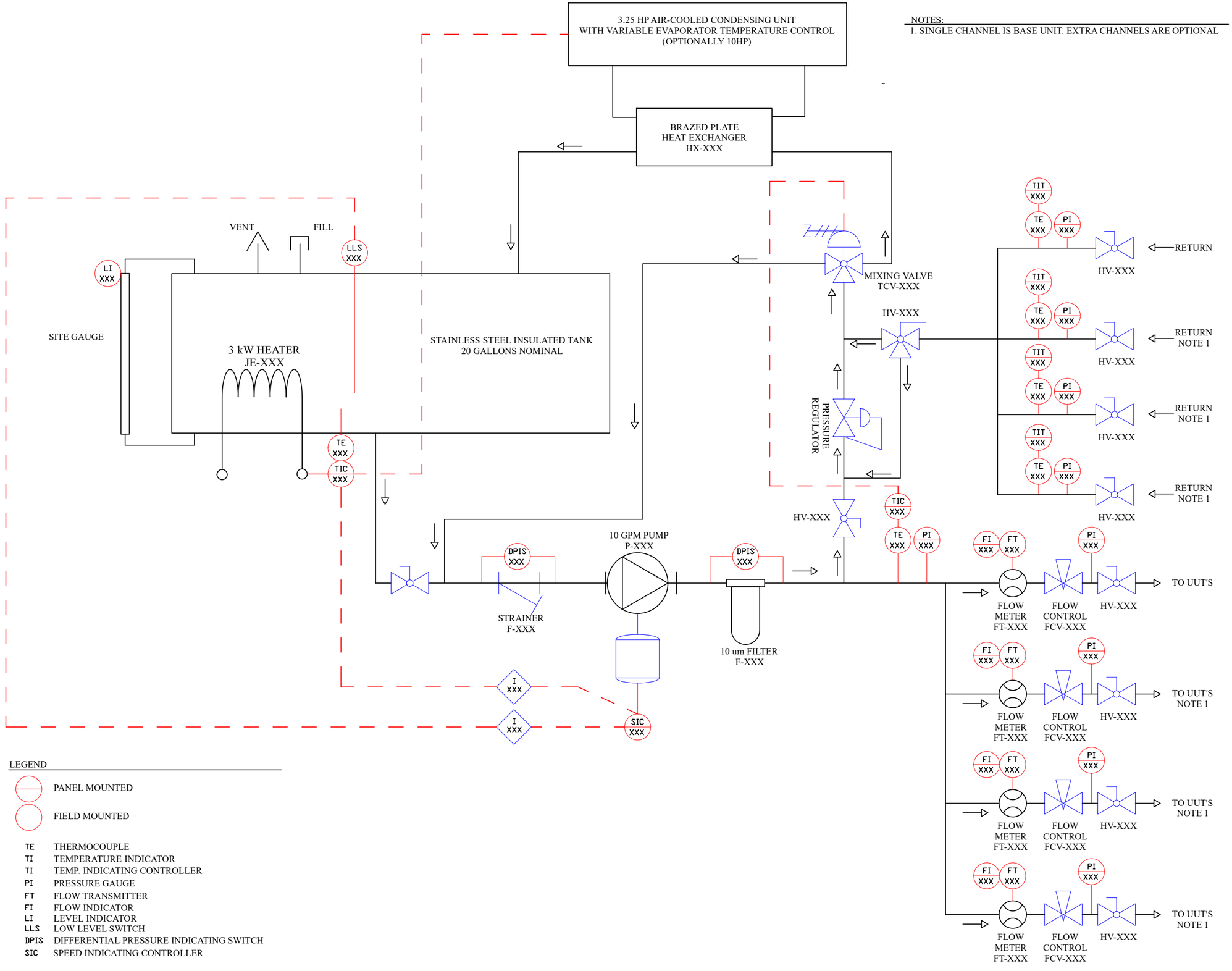

NOTES:

1. SINGLE CHANNEL IS BASE UNIT. EXTRA CHANNELS ARE OPTIONAL

LEGEND

PANEL MOUNTED

FIELD MOUNTED

TE	THERMOCOUPLE
TI	TEMPERATURE INDICATOR
TI	TEMP. INDICATING CONTROLLER
PI	PRESSURE GAUGE
FT	FLOW TRANSMITTER
FI	FLOW INDICATOR
LI	LEVEL INDICATOR
LLS	LOW LEVEL SWITCH
DPIS	DIFFERENTIAL PRESSURE INDICATING SWITCH
SIC	SPEED INDICATING CONTROLLER

TECHNICS

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LTR	DATE	BY	DESCRIPTION
REVISIONS			

ENGINEER APPROVAL BY:		DATE	
DRAWN BY:		DATE	
		DATE	
SCALE	NTS		

CLIENT	
PROJECT TITLE	LIQUID COOLING THERMAL MANAGEMENT SYSTEM
LOCATION	
SHEET TITLE	PROCESS & INSTRUMENTATION DIAGRAM

SIZE	SHEET	NUMBER
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