

SPC-2734 Chromalox Oil Heater System Procurement Specification

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November 2019



The INL is a U.S. Department of Energy National Laboratory
operated by Battelle Energy Alliance

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Specification

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PROCUREMENT SPECIFICATION**

Identifier: SPC-2734

Revision: 0

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PART 1 GENERAL

A thermal energy delivery system (TEDS) is being constructed within the dynamic energy transport and integration laboratory (DETAIL) facility to test heat transfer components, distribution systems, instruments, and controls that can be monitored and controlled for hybrid generation of electrical power and/or non-electrical products. TEDS is designed to operate as a part of an integrated system or independently to demonstrate component operations, to develop and validate thermal energy transport models and control systems, and to study thermal energy inertia and storage. Within the integrated system, TEDS will be connected to the INL Real Time Digital Simulator (RTDS) test platform to develop and demonstrate monitoring and control systems and to investigate real-time, hardware-in-the-loop response characteristics relative to grid operations.

As the basis of the TEDS, Chromalox (the vendor) has been chosen to design and supply a heater, pump, storage tanks, and pressure vessel due to their experience with industrial-scale heat transfer oil systems.

TEDS will use Therminol 66 as the synthetic heat transfer oil. Therminol 66 was chosen over other heat transfer oils such as Dowtherm and Drakeol because of its thermal stability, low vapor pressure, and years of industrial experience under a wide range of operating conditions.

PART 2 WORK INCLUDED

The vendor shall design, fabricate, and supply the following equipment:

- A. Hot oil heater system with hot oil pump
- B. Thermocline tank (ASME pressure vessel)
- C. Expansion tank (ASME pressure vessel)
- D. Two unpressurized oil storage tanks
- E. Oil heater and pump package controls with interface

PART 3 WORK NOT INCLUDED

The vendor shall not be responsible for hardware and labor for fixing and mounting of supplied equipment to experiment skid, power and control wiring to facility or process control cabinet, cabling and glands, and local fees/taxes/import duties.

PART 4 APPLICABLE CODES, PROCEDURES AND REFERENCES

- A. ASME Boiler and Pressure Vessel Code Section VIII – Pressure Vessels
- B. ASME B31.3 – Process Piping
- C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2003
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; 2017
- E. UL-508A – Standard for Industrial Control Panels

PART 5 DESIGN REQUIREMENTS

A. System Design Conditions:

- 1. Pressure 100 psig (690 kPa)
- 2. Temperature 340 °C (644 °F)

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B. System Operating Conditions:

1. Maximum Oil Temperature 325 °C (617 °F)
2. Nominal Hot Oil Supply Temperature 325 °C (617 °F)
3. Nominal Cold Oil Return Temperature 225 °C (437 °F)
4. Nominal Pressure 14 psig (97 MPa)
5. Nominal Mass Flow Rate 0.8 to 1.62 kg/s (1.76 to 3.57 lbm/s)

C. Component Specific Requirements:

1. MOS-650-200P-E182STPDSRGVFCDBHWSGDTPCAEXX (hot oil heater system with main hot oil pump)
 - 200 kW
 - 480 V/3 PH/60 Hz
 - ASME Section VIII certified - MAWP: 100 psig @ 650 °F
 - 33 gpm @ 75'
 - 5 hp inverter duty motor with VFD
 - Analog suction pressure gauge
 - Digital overtemperature protection
 - Pump housing nozzle loading

Nozzle	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
MOS Pump West Outlet (PT=2010)	197	273	105	110	105	329
MOS Pump North Outlet (PT=4080)	172	393	93	30	85	184

- Type K thermocouple overheat/no flow safety
- Type J thermocouple temperature control
- Heater vessel nozzles shall be analyzed to accommodate the following loading

Nozzle	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
MOS Heater Bottom (PT=3870)	517	222	176	196	147	450
MOS Heater Top (PT=460)	394	73	261	561	160	864

- Process control panel with 100% SCR heater control and disconnect
 - Strainer
 - Inlet and outlet gate valves
 - Dedicated fill line and drain/bleed valves
 - See included drawing package for system layout and process inlet and outlet nozzle general locations
 - Additional nozzles shall be included for accessories such as pressure and temperature sensor weld-o-lets – these nozzles shall be connected in the field
 - See included drawing package and system specification for painting requirements
2. Thermocline tank
 - ASME Section VIII certified - MAWP: 100 psig @ 650 °F
 - See included drawing package for nozzle locations and sizes
 - See included drawing package and system specification for painting requirements
 - Thermocline tank nozzles shall be analyzed to accommodate the following loading

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Nozzle	F _x (lb)	F _y (lb)	F _z (lb)	M _x (ft-lb)	M _y (ft-lb)	M _z (ft-lb)
Thermocline Tank Top (PT=110)	53	54	425	178	195	64
Thermocline Tank Bottom (PT=3440)	580	244	364	472	225	643

- A flow distribution baffle and support plate with a 40% void area shall be fabricated to sit in the bottom of the tank on legs (see Figure 1 and Figure 2) per face to face communications with the vendor
- Slots shall be 0.8 inches in width
- A perforated carbon steel sheet with 1/16" round holes on 3/32" staggered centers, of at least 20 gauge thickness, shall be tack welded to the flow distribution baffle in a sufficient number of places to prevent any movement of the perforated sheet
- Baffle and perforated sheet to support 4,800 kg (10,582 pounds) of 1/8" alumina beads
- A similar distribution baffle, with like perforated carbon steel sheet, and spring loaded legs shall be fabricated to sit atop the beads and compress them when the vessel top is installed.
- The baffles and supports shall be fabricated of carbon steel of a specification similar to that of the vessels to ensure like thermal expansion characteristics.

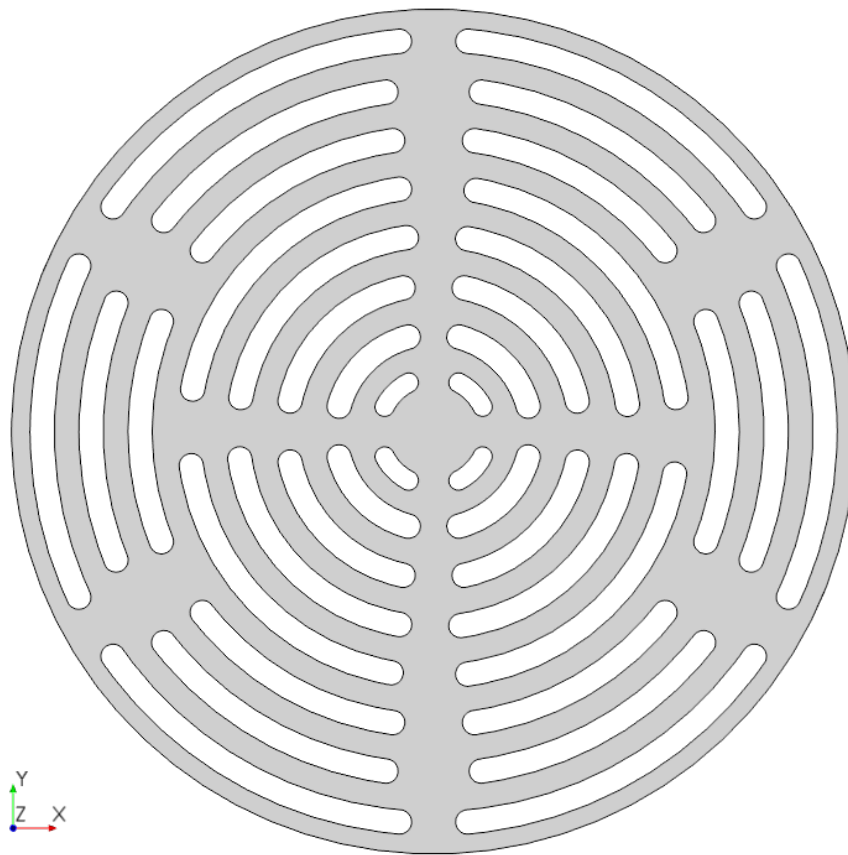


Figure 1 Conceptual Support and Baffle Plan View

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Figure 2 Conceptual Support and Baffle Isometric View

3. 300-gallon expansion tank

- ASME Section VIII certified - MAWP: 100 psig @ 650 °F
- Tank shall be equipped with nitrogen regulator and back-pressure regulator (shipped loose), magnetic indicating liquid level transmitter, and a port for a safety relief valve (relief valve by others)
- See included drawing package for process inlet/outlet nozzle locations and sizes
- Additional nozzles, e.g., level indication or thermowell nozzles, shall be connected by field routed piping
- See included drawing package and system specification for painting requirements
- Expansion tank nozzles shall be analyzed to accommodate the following loading

Nozzle	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
Expansion Tank West Outlet (PT=2410)	21	40	24	86	51	9
Expansion Tank East Outlet (PT=2950)	22	43	27	100	62	2

4. 500-gallon, unpressurized storage tanks

- See included drawing package for system layout and process inlet and outlet nozzle general locations and sizes
- Additional nozzles, e.g., level indication or thermowell nozzles, shall be connected by field routed piping
- See included drawing package and system specification for painting requirements
- Thermocline tank nozzles shall be analyzed to accommodate the following loading

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Nozzle	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
North Storage Tank (PT=3050)	218	191	141	106	31	190
South Storage Tank (PT=3150)	247	83	26	30	5	207

D. Electrical Requirements

1. All electrical components and assemblies (motors, heaters, wiring, etc) shall be NRTL listed and labeled
2. All electrical components and assemblies shall be installed in accordance with the applicable requirements of the NEC (NFPA 70-2017)
3. Control panel shall be listed and labeled to UL 508A standards

E. Controls

1. Control panel shall be equipped with Modbus TCP/Ethernet and shall allow monitoring of process variables, hot oil temperature setpoint adjustment, and alarm monitoring from a National Instruments LabView program (by others)
2. Start, stop, and frequency adjustment shall be available from National Instruments LabView program (by others)

PART 6 SUBMITTALS

Vendor data, including tank dimension drawings, pump curves, and installation, operation, and maintenance manuals shall be submitted to INL by electronic distribution.

- A. Tank dimension drawings submitted for design review prior to tank fabrication
- B. Operation & Maintenance Manual: O&M Manuals shall be the standard publication issued for the product by the manufacturer submitted upon system delivery
- C. ASME Certificate of Accreditation submitted upon system delivery
- D. Component drawings submitted upon system delivery
- E. Completed U-1A forms for ASME stamped pressure vessels delivered upon system delivery

PART 7 DELIVERY, STORAGE, AND HANDLING

System component delivery shall be coordinated with installing sub-contractor. Storage and handling shall be in accordance with vendor's instructions. Equipment shall be inspected upon arrival.