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7. Abstract

This document is the design description for the Rotation Motor Heater System on waste tank 241-SY-101. The description includes the certified vendor (CV) file number, operators instructions, and heater sizing calculations.

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**SYSTEM DESIGN DESCRIPTION
FOR THE HMT
ROTATION MOTOR
HEATER SYSTEM**

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WESTINGHOUSE HANFORD COMPANY
MAY 1995

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ACRONYMS AND ABBREVIATIONS

DACS	Data Acquisition and Control System
HP	Horsepower
HMT	Hydrogen Mitigation Test
SDD	System Design Description
T/C	Thermocouple
SSR	Solid State Relay
vac	Volts Alternating Current

**SYSTEM DESIGN DESCRIPTION
FOR THE HMT
ROTATION MOTOR
HEATER SYSTEM**

1.0 DESCRIPTION

This document describes the design of a heater system and cover hood for the HMT rotation motor and attached gearbox. The rotation motor assembly, during cold weather conditions, has experienced freezing causing the motor not to operate. The motor type is a 440/480 vac, 1 HP squirrel cage induction motor, totally enclosed, and mounted vertically. It is driven by a 5 HP VSD controlled from the DACS. The software program controlling the motor applies a minimum torque to the motor. Therefore, if any resistance from ice or frost is encountered the motor will not turn.

2.0 HARDWARE

A heater system has been designed utilizing 2(two) 400 watt strip heater(s) that keeps the gearbox assembly and rotation motor interface temperature above 50 degrees F. Additionally, a light gauge stainless steel sheet metal hood covers the motor and gearbox assembly from the weather. The heater system is mounted to the gearbox and is controlled via a thermostatically cycled power supply on a maintained circuit. A J-Type thermocouple (T/C) mounted to the gearbox supplies the feedback signal to the self-contained controller. The controller and associated hardware are contained in an environmentally protected, locally mounted, enclosure. This enclosure is mounted on the West end of the HMT hydraulic brake cabinet on the SY-241-101 HMT pump pit. A small strip heater in the enclosure keeps the instrumentation at a temperature, above 50 degrees F, sensed from a second T/C mounted in the inside top of the enclosure.

3.0 OPERATION

The system consists of a maintained circuit, with a POWER ON (S1) and STOP (S2) buttons, supplying 120 vac power to the major components. An Omega temperature controller (WST-TC-3112A) cycles power to the strip heaters via input from the J-Type T/C (WST-TE-3111A) attached to the gearbox. The design allows for only manual starting of the system. This will prevent inadvertent start-up without operator attention. Furthermore, loss of 120vac power or over temperature opens the maintained circuit and causes a manual re-start of the system. The instrumentation enclosure is locally mounted and environmentally protected. Additionally, the front panel of the enclosure features a HEATERS POWER ON (DS1) and HEATERS ON (DS2) lamp indicator(s). Two (2) electrically series-connected high temperature thermostats (WST-TS-3112A;

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Rev 0

WST-TS-3113A), attached to the gearbox in the maintained circuit, protect the gearbox and system from over-temperature. A third high temperature thermostat (WST-TS-3111A), in series with the two thermostats attached to the gearbox, is attached to the instrument enclosure to protect the enclosure heater system from over temperature. The actuation of any one of the three(3) thermostats will cause a shut down and a manual re-start of the system.

When the POWER ON (S1) button is pushed the circuit is energized from a 120 vac, 15 amp circuit breaker(CB-7) located in the I/O #1 cabinet. Reference H-2-140500. A 10 amp fuse (FU-1) protects the circuit. Power is simultaneously applied to the enclosure thermostat (WST-TC-3112A), gearbox temperature controller (WST-TC-3111A), and the two (2) paralleled 400 watt heater assemblies (WST-HTR-3112A; WST-HTR-3113A) in series with a normally open (N.O.) contact of a solid state relay (SSR K2). The SSR K2 is controlled from the Omega temperature controller (WST-TC-3111A) sensing the temperature of the gear box via the J-Type T/C (WST-TE-3111A) input. A HEATER POWER ON (DS1) lamp and a relay (K1) is energized from the initial POWER ON (S1) button. A N.O. contact of K1 maintains the circuit across the series connected STOP (S2) button.

The enclosure heater thermostat (WST-TC-3112A) operates independently. When the T/C mounted in the instrument enclosure senses a temperature lower than 50 degree F, +/- 5 degrees F, the thermostat closes and energizes a 150 watt (WST-HTR-3111A) strip heater mounted to the enclosure. Consequently, the thermostat will de-energize the heater when the enclosure temperature is above 50 degrees F, +/- 5 degrees F.

The gearbox Omega temperature controller (WST-TC-3111A) also operates independently. When the J-Type T/C (WST-TE-3111A) mounted on the gearbox senses a temperature lower than 50 degrees F, +/- 5 degrees F, the controller outputs a signal to the SSR K2 causing the two (2) paralleled 400 watt heaters (WST-HTR-3112A; WST-HTR-3113A) to energize. In parallel with the heaters is the HEATERS ON (DS2) lamp that energizes with the heaters. Since the power to the heaters is pulsed rather than continuous, a flashing of the lamp will be noticed.

If the STOP (S2) button is pushed or any of the three thermostats (WST-TS-3111A; WST-TS-3112A; WST-TS-3113A) open on over-temperature power is lost to the maintained circuit and the POWER ON (S1) button must be manually operated to re-start the system. However, this assumes that the system(s) are not in an over-temperature condition and that power can be applied to K1 and maintained.

In normal operation, after the POWER ON (S1) is depressed, the HEATER POWER ON (DS1) lamp will energize and stay lit. The HEATERS ON (DS2) lamp will light only when a low temperature is sensed by the controller.

4.0 HOOD ASSEMBLY

The entire rotation motor and gearbox assembly are enclosed in a sheet metal hood fabricated from 16 gage 304 stainless steel. The hood is manufactured in five sections; main body, side panel, rear panel, front upper panel, and front lower panel. The hood mounts from the front, i.e., the hood front faces East and attaches to the side of plates, facing North and South, that supports the rotation motor gearbox. The rotation motor gearbox mounts between these plates via 3/8" stainless steel studs that replace the 3/8" socket head cap screws that previously attached the gearbox to the plates. The socket head cap screws are removed one at a time and replaced with the stainless steel studs. The hood is attached to the studs with nut(s) and washer(s).

The hood is installed on the rotation motor and gearbox in sections to accommodate the encoder and motor cabling. The main body hood is installed first. This section is located on the studs that have been previously installed. The encoder and rotation motor cabling are then located in their respective slots. The remaining panels are then screwed in place.

The hood assembly contains two(2) clear lexan windows for visual inspection of the motor and gearbox without removal of the hood. The inside surfaces of the hood assembly are insulated with 1/2" foam to minimize the thermal losses.

5.0 CALIBRATION

The following components have been initially factory calibrated and requires no further calibration during their lifetime:

1. The enclosure thermostat (WST-TC-3112A), and attached T/C, has been verified to operate at the manually adjusted setpoint in degrees F +/- 5 degrees F.
2. The rotation motor gearbox temperature controller (WST-TC-3111A) and T/C (WST-TE-3111A) has been verified to output the + Vdc at the programmed degrees F.
3. The three thermostats (WST-TS-3111A, WST-TS-3112A, WST-TS-3113A) have been verified to open on a rising temperature of 100 degrees F.

6.0 MAINTENANCE

No maintenance is required on the system. However, if 120 vac power is lost to the system, for any reason, it must be manually restarted from the JBX - 3111 instrumentation enclosure by depressing of the POWER ON (S1) button. If the HEATER POWER ON (DS1) lamp does not latch and stay energized, after the

depression of POWER ON (S1) then an abnormal state exists in the system and it should be investigated for a malfunction.

7.0 CERTIFIED VENDOR FILE

The Certified Vendor Information file (CVI) is 21924, Supplemental III. This is the CVI file for the 241-SY-101 HMT mixer pump.

8.0 OPERATORS INSTRUCTIONS

These instructions are the operators' steps to place the HMT rotation motor gearbox heater system in operation. These instructions assume the installation of the heater system is complete.

1. Verify the circuit breaker CB-7 in I/O #1 cabinet is open.
2. Open the heater control box JBX-3111. Perform a zero energy check on the system across both end of fuse FU-1 to TB2-3. Verify that the dial on the box heater thermostat (WST-TC-3112A) is set to 50 degrees F. Visually inspect the enclosure to ensure that the unit is safe to energize. If the box looks safe and all conditions look normal close the box in preparation to energize.
3. Close circuit breaker CB-7 in I/O #1 cabinet.
4. Depress momentary pushbutton POWER ON to energize the system. Observe the HEATER POWER ON light energizes and latches.
5. The digital displays on the front panel mounted temperature controller, Omega CN8500, will energize and display the Process Variable (PV) on the top display and the Setpoint Variable (SV) on the lower display. The PV will be the actual temperature of the system. The SV will be the temperature that the controller is set to maintain. The SV should be reading 50. If the PV temperature is less than 50 degrees F, the HEATERS ON light will begin flashing. This is an indication that the heaters are being energized to bring the system up to the setpoint temperature.
6. The system is now functioning normally.

NOTE: IF THE CN 8500 DOES NOT INDICATE 50 IN THE SV DISPLAY, AFTER INITIAL POWER ON, REFER TO THE CN8500 OPERATORS' MANUAL FOR PROGRAMMING. IF THE SYSTEM DOES NOT OPERATE, AS DESCRIBED IN STEPS 1-6 ABOVE, DEPRESS THE STOP BUTTON. OPEN CIRCUIT BREAKER CB-7 IN I/O #1 CABINET. NOTIFY THE OPERATIONS SHIFT MANAGER THAT THE UNIT REQUIRES MAINTENANCE.

9.0 REFERENCES

1. Development Control Drawing H-14-100164, Rev 0., Sheet 1, "HMT PUMP ROTATION SYS INSULATED HOOD ASSY INSTALLATION DRAWING".
2. Development Control Drawing H-14-100165, Rev 0., Sheet 1, "HMT PUMP ROTATION SYS INSULATED HOOD ASSEMBLY".
3. Development Control Drawing H-14-100165, Rev 0., Sheet 2, "HMT ROTATION SYS INSULATED HOOD ASSY VIEWS AND DETAILS".
4. Drawing H-2-815007, Rev. 2, Sheet 1, "HMT MIXER PUMP CONDUIT ARRANGEMENT" (Reference Only).
5. Development Control Drawing H-14-100162, Rev 0., Sheet 1, "TANK SY-101 HMT WST-JBX-3111 ASSEMBLY".
6. Development Control Drawing H-14-100162, Rev 0., Sheet 2, "TANK SY-101 HMT WST-JBX-3111 ASSEMBLY DETAILS".
7. Development Control Drawing H-14-100162, Rev 0., Sheet 3, "TANK SY-101 HMT WST-JBX-3111 ELEM / WIRING DIAG".
8. "WORK PLAN FOR THE HYDROGEN MITIGATION TEST (HMT) ROTATION MOTOR HEATER SYSTEM", WHC-SD-WM-WP-296, Rev 0, Westinghouse Hanford Company, February 1995.
9. "STANDARD ENGINEERING PRACTICES", WHC-CM-6-1, Westinghouse Hanford Company.
10. "NATIONAL ELECTRICAL CODE HANDBOOK 1993", National Fire Protection Association, Batterymarch Park, Quincy, MA.

10.0 APPENDIX
ANALYTICAL CALCULATIONS

Subject SY-101 MIXER PUMP ROTATION MOTOR GEARBOX HEATER
Originator A.F. Vampr. Date 1/13/95
Checker J.P. Strickland Date 5/9/95

REQUIREMENTS : KEEP GEARBOX TEMPERATURE AT 50°F FROM -20°F TO 50°F

HEAT REQUIREMENTS TO INCLUDE:

1. HEAT REQUIRED FOR PROCESS START-UP
2. HEAT REQUIRED TO MAINTAIN PROCESS

$$POWER_{IN} = POWER_{OUT} + LOSSES$$

$$P_o = P_{IN} - (C_{dL} + C_{vL} + C_{rL})$$

$$P_o = POWER_{OUT}$$

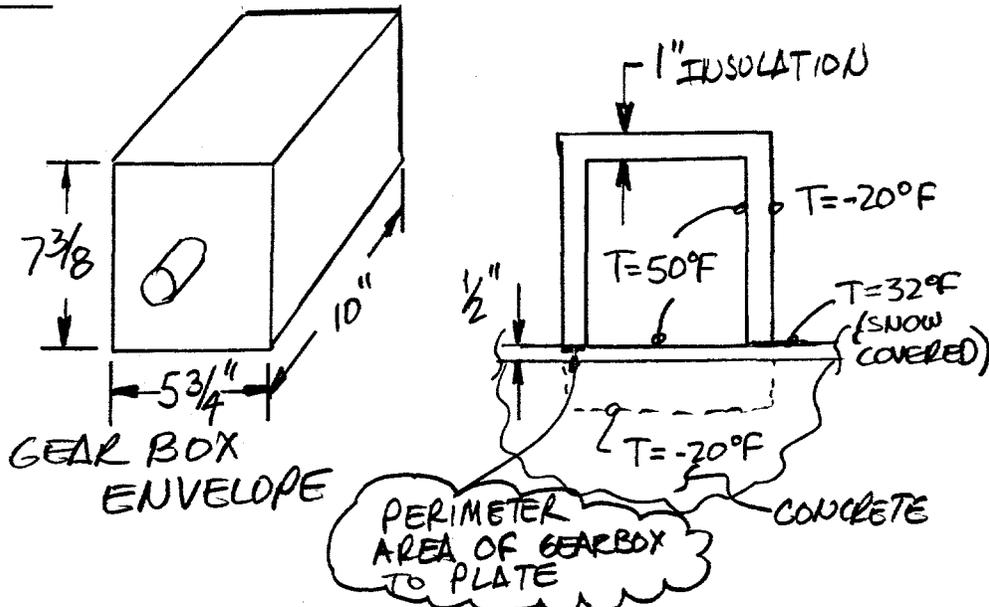
$$P_{IN} = POWER_{IN}$$

$$C_{dL} = \text{HEAT LOSS DUE TO CONDUCTION}$$

$$C_{vL} = \text{HEAT LOSS DUE TO CONVECTION}$$

$$C_{rL} = \text{HEAT LOSS DUE TO RADIATION}$$

CONFIGURATION:



ASSUMPTIONS:

ASSUME GEAR BOX IS AT 50°F & IS COVERED WITH 1" OF INSULATION WITH A SURFACE AT -20°F. THERMAL CONDUCTIVITY OF CONCRETE EQUIVALENT TO 1" INSULATION WITH OUTSIDE SURFACE @ -20°F.

ANALYTICAL CALCULATIONS

Page 2 of 3Subject SY-101 MIXER PUMP ROTATION MOTOR GEARBOX HEATEROriginator G.F. VmgolDate 1/13/95Checker J.P. SheltonDate 5/9/95ASSUMPTIONS (CONT)

ALSO ASSUME THAT 1/2" BASE PLATE EXTENDS ACROSS THE 1" INSULATION AT THE BOTTOM OF THE GEAR BOX AROUND THE PERIMETER OF THE INSULATION. ASSUME THE BASE PLATE IS COVERED WITH SNOW AND AT 32°F ON THE OUTSIDE SURFACE OF THE INSULATION & 50°F JUST INSIDE THE INSULATION.

$$L_1 = 5.75''$$

$$L_2 = 10.0''$$

$$L_3 = 7.375''$$

$$T_a = -20^\circ\text{F}$$

$$T_s = 50^\circ\text{F}$$

$$C_p (\text{STEEL}) = .12 \text{ BTU/LB } ^\circ\text{F}$$

AREA OF SHAFT & BASE PLATE

(PERIMETER AREA OF GEAR BOX INTERFACE TO 1/2" PLATE)

$$A = (L_1 + 1 + L_2 + 1) \cdot 2.5$$

$$A = (5.75'' + 1 + 10.0'' + 1) \cdot 2.5$$

$$A = 17.75 \text{ IN}^2$$

HEAT LOSS THROUGH METAL

$$L = 1.0''$$

$$K = 30 \frac{\text{BTU}}{\text{HR} \cdot \text{FT} \cdot ^\circ\text{F}}$$

$$Q_m = K \cdot \left(\frac{A}{L} \right) \cdot (T_s - 32) \cdot \left(\frac{1}{3.412} \right)$$

$$Q_m = 234.1 \text{ WATT}$$

ANALYTICAL CALCULATIONS

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Subject ST-101 MIXER PUMP ROTATION MOTOR GEARBOX HEATER
 Originator A.F. Vangoly Date 1/13/95
 Checker J.P. Stroh Date 5/9/95

HEAT LOSS THROUGH INSULATION

$$L = 1.0''$$

$$A = (L_1 \cdot L_2 + L_2 \cdot L_3 + L_1 \cdot L_3) \cdot 2$$

$$A = 347.313 \text{ IN}^2$$

$$K = \frac{.02 \text{ BTU}}{\text{HR} \cdot \text{FT} \cdot ^\circ\text{F}}$$

$$Q_i = k \frac{\left(\frac{A}{144}\right) \cdot (T_s - T_a) \cdot \frac{1}{\left(\frac{L}{12}\right)}}{3.412}$$

$$Q_i = 11.876 \text{ WATT}$$

TOTAL HEAT LOSS

$$Q_T = Q_m + Q_i$$

$$Q_T = 245.976 \text{ WATT}$$

FOR REDUNDANCY PURPOSES SYSTEM WILL UTILIZE 2 (TWO) 400 WATT STRIP HEATERS MOUNTED ON EACH SIDE OF THE HMT GEARBOX ASSEMBLY. THIS WILL ALSO SHORTEN HEAT-UP TIME AND INCREASE STRIP HEATER LIFETIME.