Heat Trace Insulation Testing for General Equipment

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CHANGE HISTORY (≤ LAST 5 REV-MODS)

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<td>12/26/2018</td>
<td>Comply with field conditions.</td>
<td>Update Caution statement in section 3.2 and all Caution statements through procedure. Add, edit, and/or removed multiple steps throughout procedure.</td>
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<tr>
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<td>New procedure to support maintenance activities.</td>
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1.0 PURPOSE AND SCOPE

1.1 Purpose

This procedure provides instructions for testing of installed heat trace cables, generally fitted below insulation or below grade.

1.2 Scope

This procedure assures functionality and operability of heating cables.

2.0 INFORMATION

2.1 Terms and Definitions

- “Pipe potential” is any point at which a ground strap can be connected.

2.2 General Information

The insulation resistance (IR) tests are conducted with a megohmmeter (megger) which applies a constant voltage across the insulation. The quality of the insulation can be evaluated based on the level of insulation resistance. These tests are recommended maintenance by the National Fire Protection Association (NFPA).

3.0 PRECAUTIONS AND LIMITATIONS

3.1 Personnel Safety

3.1.1 Failure to confirm no work activities downstream of megger testing may result in work being performed on energized systems and possible personnel injury.

3.1.2 Failure to dissipate any accumulated charge following each test could result in personnel injury.

3.1.3 Comply with DOE–0359, Hanford Site Electrical Safety Procedure.

3.1.4 Comply with DOE-0336, Hanford Site Lockout/Tagout Procedure.

3.1.5 If animal droppings or nests are found, stop work in affected area, and notify Operations.

3.1.6 Contact Industrial Hygiene for sampling plan.
3.2 Equipment Safety

**CAUTION** - During testing, failure to disconnect system components such as thermostats or heat trace controllers could damage them due to the exceedingly high (500VDC and 1000VDC) voltages temporarily applied to the active heating portions of the heat trace cables.

3.3 Radiation and Contamination Control

3.3.1 Work in radiological areas will be performed using a radiological work permit following review by Radiological Control per ALARA Work Planning procedure, TFC-ESHQ-RP_RWP-C-03.
4.0 PREREQUISITES

4.1 Special Tools, Equipment, and Supplies

Special Instruction:

The amount of material taken into contaminated areas is to be minimized to reduce radioactive waste creation and future decontamination needs.

The following supplies may be needed to perform this procedure:

- Voltage rated gloves, within test certification period, and leather protectors for safe to work checks
- Digital volt-ohm meter, accuracy ± 5%
- Calibrated 1000 volt megohmmeter (megger)
- Small clamp-on ammeter
- Freeze spray
- Chemical goggles
- Protective impervious gloves such as neoprene or equivalent
- Other tools, equipment and supplies as identified by FWS/User.

4.2 Performance Documents

The following documents may be needed to perform this procedure:

- DOE-0336, Hanford Site Lockout/Tagout Program
- DOE-0359, Hanford Site Electrical Safety Procedure
- A-6003-876, Tank Operations Contractor Lifted/Landed Lead Record.

4.3 Field Preparation

4.3.1 CONFIRM pipe potential grounding can be connected during work performance.

4.3.2 IF thermal insulation needs to be removed to provide access to grounding locations, CONFIRM it has been identified to Maintenance Management and removed.
5.0 PROCEDURE

5.1 Prepare to Megger Test Heat Trace Insulation

Special Instruction:

Steps or portions of steps in Section 5.1 may be performed in any logical order or not at all depending system conditions and/or configuration.

5.1.1 INSTALL Lock and Tag, or Authorized Worker Lockout/Tagout in accordance with DOE-0336.

CAUTION

During testing, failure to disconnect system components such as thermostats or heat trace controllers could damage them due to the exceedingly high (500VDC and 1000VDC) voltages temporarily applied to the active heating portions of the heat trace cables.

Disconnecting Heat Trace Wiring at Terminal Box/Boxes:

5.1.2 IF the heat trace circuit has a single heat trace terminal box with a single end point (see Figure 3), DISCONNECT heat trace bus wires from power source at heat trace terminal box AND

IF there is a shield wire, DISCONNECT from ground terminal.

5.1.2.1 IF the recording of the leads lifted is required RECORD leads lifted on Lifted/Landed Lead Record (A-6003-876) AND

GO TO Section 5.2.
5.1 Prepare to Megger Test Heat Trace Insulation (Cont.)

5.1.3 IF the heat trace circuit has multiple terminal boxes with a single end point (see Figure 4), PERFORM the following:

5.1.3.1 DISCONNECT heat trace bus wires from power source at the first heat trace terminal box downstream from the power source AND

IF there is a shield wire, DISCONNECT from ground terminal.

5.1.3.2 At the second and any subsequent terminal boxes DISCONNECT heat trace wires from the upstream terminal box; DO NOT disconnect wiring leading downstream to the next terminal box or end point.

5.1.3.3 IF the recording of the leads lifted is required RECORD leads lifted on Lifted/Landed Lead Record (A-6003-876) AND GO TO Section 5.2.

5.1.4 IF the heat trace circuit has a single heat trace terminal box with multiple end points (see Figure 5), PERFORM the following:

5.1.4.1 DISCONNECT heat trace bus wires from power source at heat trace terminal box AND

IF there is a shield wire, DISCONNECT from ground terminal.

5.1.4.2 DISCONNECT all circuits at heat trace terminal box leading to end points.

5.1.4.3 IF the recording of the leads lifted is required RECORD leads lifted on Lifted/Landed Lead Record (A-6003-876) AND GO TO Section 5.2.
5.2 Test Heat Trace Leads to Shield (Test A)

5.2.1 IF system conditions and/or configuration allow; CONCURRENTLY PERFORM visual inspection per Section 5.5 during performance of this Section AND RECORD any deficiencies found on Data Sheet.

5.2.2 IF desired, REFER to Figure 1 during performance of this section.

5.2.3 CONNECT negative (-) lead to the heat trace cable metallic braid (shield).

5.2.4 IF heat trace cable is of the type that does not have a metallic braid (shield), CONNECT the negative (-) lead to pipe potential or a connected component such as a pipe flange.

5.2.5 CONNECT positive (+) lead to both heat trace cable bus wires.

5.2.6 TURN ON megohmmeter AND SET voltage to 500VDC.

5.2.7 APPLY voltage at 500VDC for approximately 1 minute AND PERFORM the following:

5.2.7.1 RECORD insulation resistance value on Data Sheet.

5.2.7.2 IF heat trace failed test at 500VDC ($\leq 20$ MegOhms), PERFORM the following:

a. RECORD “FAIL” on Data Sheet.

b. NOTIFY the Electrical Engineer or FWS.

c. GO TO Step 5.2.9.

5.2.7.3 IF heat trace passed test at 500VDC (> 20 MegOhms), RECORD “PASS” on Data Sheet AND SET voltage to 1000VDC.
5.2 Test Heat Trace Leads to Shield (Test A) (Cont.)

5.2.8 APPLY voltage at 1000VDC for approximately 1 minute AND PERFORM the following:

5.2.8.1 RECORD insulation resistance value on Data Sheet.

5.2.8.2 IF heat trace failed test at 1000VDC (≤ 20 MegOhms), PERFORM the following:

   a. RECORD “FAIL” on Data Sheet.
   b. NOTIFY the Electrical Engineer or FWS.
   c. GO TO Step 5.2.9.

5.2.8.3 IF heat trace passed test at 1000VDC (> 20 MegOhms), RECORD “PASS” on Data Sheet.

5.2.9 DISCHARGE any capacitive charge accumulated while applying test voltage for no less than 1 minute (the time the test voltage was applied).

5.2.10 IF circuit failed Test A, CONTINUE testing any other remaining circuits by returning to Step 5.2.1.

5.2.11 IF circuit passed Test A, GO TO Section 5.3.

OR

IF heat trace cable is of the type that does not have a metallic braid (shield), GO TO Section 5.4.
5.3 Test Heat Trace Shield to Ground (Test B)

5.3.1 IF desired, REFER to Figure 2 during performance of this section.

NOTE - “Pipe potential” is any point at which a ground strap can be connected.

5.3.2 CONNECT negative (-) lead to pipe potential or a connected component such as a pipe flange.

5.3.3 CONNECT positive (+) lead to the heat trace cable metallic braid (shield).

5.3.4 TURN ON megohmmeter AND SET voltage to 500 VDC.

5.3.5 APPLY voltage at 500VDC for approximately 1 minute AND PERFORM the following:

5.3.5.1 RECORD insulation resistance value on Data Sheet.

5.3.5.2 RECORD insulation resistance value on Data Sheet.

5.3.5.3 IF heat trace failed test at 500VDC ($\leq$ 20 MegOhms), PERFORM the following:

a. RECORD “FAIL” on Data Sheet.

b. NOTIFY the Electrical Engineer or FWS.

c. GO TO Step 5.3.7.

5.3.5.4 IF heat trace passed test at 500VDC (> 20 MegOhms), RECORD “PASS” on Data Sheet AND SET voltage to 1000VDC.
5.3 Test Heat Trace Shield to Ground (Test B) (Cont.)

5.3.6 APPLY voltage at 1000VDC for approximately 1 minute AND PERFORM the following:

5.3.6.1 RECORD insulation resistance value on Data Sheet.

5.3.6.2 IF heat trace failed test at 1000VDC (±20 MegOhms), PERFORM the following:
   a. RECORD “Fail” on Data Sheet.
   b. NOTIFY the Electrical Engineer or FWS
   c. GO TO Step 5.3.7.

5.3.6.3 IF heat trace passed test at 1000VDC (> 20 MegOhms), RECORD “PASS” on Data Sheet.

5.3.7 DISCHARGE any capacitive charge accumulated while applying test voltage for no less than 1 minute (the time the test voltage was applied).

5.3.8 ENSURE all Lifted Leads are Re-Landed.

5.3.9 IF circuit failed Test B, CONTINUE testing any remaining circuits by returning to Step 5.3.1.

5.3.10 AFTER all circuits have been tested, PERFORM the following:

5.3.10.1 IF circuit passed both Test A and Test B REMOVE Lock and Tag, or Authorized Worker Lockout/Tagout AND GO TO Section 5.4.

5.3.10.2 IF circuit failed either Test A or Test B, CONTACT FWS for resolution AND RECORD any verbal direction in the work package.

5.3.10.3 RECORD any deficiencies found on data sheet.
5.4 **Perform Heat Trace Function Test**

**NOTE** - In most cases the function and design of the heat trace system is to operate during cold weather conditions. By design, these systems will not function in a manner that will allow functional testing during warm weather conditions.

- The intent of this section is to check the current for circuits that have passed Test A and Test B, if applicable. Data Sheets will designate heat trace circuits to be tested.

5.4.1 **TEST** each circuit that passed testing per Sections 5.2 and 5.3 in accordance with this section.

5.4.2 **IF** the circuit being tested has multiple terminal boxes or multiple end points, **INSTALL** test equipment at a convenient location between the temperature switch and the first downstream terminal box.

**Perform Function Test of Heat Trace**

5.4.3 **PERFORM** heat trace testing as follows:

5.4.3.1 **CLOSE** heat trace circuit breaker.

5.4.3.2 **IF** the use of freeze spray is required **DON** chemical goggles and neoprene or equivalent gloves.

5.4.3.3 **IF** temperature contacts are open, **SPRAY** Freeze Spray on capillary tube as long as needed to keep temperatures switch contacts closed until testing is complete.

5.4.3.4 **AFTER** heat trace breaker has been closed for 1 minute, **RECORD** heat trace amps on Data Sheet.
5.5 **Perform Visual Inspection**

**Special Instruction:**

Steps or portions of steps in Section 5.5 may be performed in any logical order or not at all depending on system conditions and/or configuration. (The following is a list of examples for not performing inspections (this list is not intended to be all-inclusive); portions of the heat trace system are below grade or under portable exhauster skids and are not reasonably accessible. Also visual inspections cannot be performed inside controllers or terminal boxes not opened as part of testing.

5.5.1 **CHECK** for damaged or wet thermal insulation.

5.5.2 **CHECK** lagging and/or weather-proofing for:
- Damage
- Missing pieces
- Cracks.

5.5.3 **CHECK** control and monitoring system and field equipment for the following:
- Moisture
- Corrosion
- Set point
- Switch operation
- Capillary damage.
5.6 Restoration

5.6.1 **ENSURE** all test equipment has been disconnected and removed.

5.6.2 **RESTORE** maintained equipment to original configuration as documented in Outage Procedure, Work Package, or Data Sheet.

5.7 Review

5.7.1 **INFORM** Operations Management that maintenance is completed.

5.7.2 **IF** a Lifted/Landed Lead Record(s) (A-6003-876) was utilized **PLACE** the filled out form in the Work Package.

5.7.3 **PROVIDE** completed data sheets (originals or a copy) to Electrical Engineer for review upon completion of the task.

5.7.4 **RECORD** in the Comment/Remarks Section of Data Sheet, work request number(s) of work documents generated as a result of these instructions, if applicable.

5.7.5 **IF** discrepancies are noted, **ENSURE** engineering has updated the Data Sheets upon close-out.

5.8 Records

This procedure is performed within a work package, as such, the procedure in its entirety will be maintained as a record per the Work Control process.

The record custodian identified in the Company Level Record Inventory and Disposition Schedule (RIDS), is responsible for record retention in accordance with TFC-BSM-IRM_DC-C-02.
Figure 1 - Heat Trace Leads to Shield
Figure 2 - Heat Trace Shield to Ground

TEST B

Terminal Box

Pipe Potential (Metal hose clamp)

PIPE

+ -

+ -

[Diagram showing Heat Trace Shield to Ground with connections and terminals]
Figure 3 - Single Heat Trace Box with a Single End
Figure 4 - Multiple Heat Trace Boxes with a Single End
Figure 5 - Single Heat Trace Box with Multiple Ends