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WANL - TME - 899

TITLE: ACCEPTANCE TEST SPECIFICATIONS/PROCEDURE FOR
THERMOCOUPLES

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1.0 SCOPE

All thermocouples will be given this acceptance test before they are used for reactor testing. The acceptance test will involve a thermocouple resistance measurement and an insulation resistance measurement. For thermocouples that arrive at WANL, but require further processing before they are used (i.e. gold plating, etc.), the acceptance tests will be performed after the processing work is accomplished.

2.0 PERFORMANCE OF TESTS

- 2.1 The acceptance testing will be performed by the Standards Laboratory and/or Sensor Application Engineering, per the requirements of this specification.
- 2.2 All data taken shall be approved by Quality Control and kept as a permanent record for the thermocouple. The data shall be dated, signed by the technician and three copies forwarded to the responsible Sensor Applicable engineer.
- 2.3 No deletions, changes or omissions of tests covered by this specification shall be made without the consent of the cognizant Sensor Application engineer.

3.0 REFERENCE DOCUMENTS AND/OR SPECIFICATIONS

The following documents and/or specifications per their latest revisions are a reference for this specification. In any conflict between this specification and those documents, this specification shall prevail.

- 3.1 CD-2703; End Sealing of Sheathed Leads in Reactor Assembly
- 3.2 WANL-E-675424; Exposed Junction Thermocouples Copper-Constantan for use in Nuclear Reactors
- 3.3 WANL-E-675360; Thermocouples, Chromel-P-Alumel for use in Nuclear Reactors
- 3.4 WANL-E-675361; Thermocouples, Copper-Constantan for use in Nuclear Reactors

- 3.5 WANL-E-675362; Thermocouples, Tungsten/Tungsten-26% Rhenium
- 3.6 WANL-E-675489; Dual Sheathed Thermocouples, Tungsten/Tungsten-26% Rhenium, for use in Nuclear Reactors

4.0 TEST EQUIPMENT AND MATERIAL REQUIRED

The following is a list of test equipment and material needed to perform these tests. Additional and/or equivalent test equipment can be substituted if necessary.

- 4.1 Resistance Bridge, ($\pm .05\%$), Honeywell Model No. 1071
- 4.2 Megohmmeter, Model No. 1862B
- 4.3 Furnace with capability of 0°F to 500°F
- 4.4 Sheath Strippers; sizes 0.092", 0.065", 0.045" (Equipment Sales Company)
- 4.5 Epoxy, EPY-400
- 4.6 Silicone Fluid, GE SF-99
- 4.7 Vise
- 4.8 Magnifying Glass

5.0 TEST PROCEDURE

The following procedure outline describes the sequence of operations necessary to correctly perform the acceptance testing of all thermocouples. This sequence shall be maintained to minimize errors in insulation and wire resistance.

- 5.1 Record all preliminary data of individual T/C on Instrumentation History Sheet. (i.e. vendor's resistance T/C serial number, etc.)
- 5.2 The outer sheath of the thermocouple shall be visually checked for nicks, scratches, dents or other obvious surface defects. Reject any thermocouple which has anything more than superficial marks (affecting only the surface). Visually check that the junction is intact on exposed junction types.
- 5.3 Carefully straighten the right angle bend, when applicable, at the non-sensing end of thermocouple, then grind or file away the weld-seal using care

to remove a minimum length of lead. Do not attempt to cut the end off with cutting pliers.

- 5.4 The sheath must be removed for approximately one-half inch (1/2"), to expose the thermocouple wires on the non-sensing end, as follows:
 - 5.4.1 Clamp the sheath firmly in a vise, being careful not to crush same, with approximately three quarter inch (3/4") protruding.
 - 5.4.2 Select a stripping tool of the proper diameter and insert it over the end of the sheath. Turn clockwise, pressing moderately to pare away the sheath in a continuous ribbon until the tool bottoms against the end at the vise.
 - 5.4.3 Remove the tool and any remaining insulation around wires, being extremely careful of the wires since they are relatively brittle. If a wire is broken during the stripping operation, the depth of the cutting tool should be checked, adjusted and/or replaced. If necessary, begin again at 5.4.
 - 5.4.4 Any loss in length of thermocouple wires must be included in calculating "% Difference" in 5.7 and 5.7.1 below.
- 5.5 Immediately apply a small but sufficient amount of epoxy, EPY-400 to temporarily moisture-seal this exposed area. (Do not heat-cure epoxy.)
- 5.6 Using a resistance-bridge, measure the resistance wire to wire and each wire to sheath and record on the individually assigned Instrumentation History Sheet. On open junction type thermocouples, the junction end must be shorted together before measuring. The measured value of resistance should agree within $\pm 3\%$ with that supplied by the vendor for the specific probe being tested, after correcting for temperature and any length which has been removed. There should be no temperature gradient along the length of the thermocouple. (For grounded junction thermocouples, the wire resistance from each wire to sheath must be measured from the sensing end of the sheath to each wire.)

- 5.6.1 Resistance measurements of copper-constantan and chromel-alumel thermocouples must be temperature corrected using the formula below if the temperature of measurement is more than $\pm 5^{\circ}\text{F}$ from 70°F .

$$R_s = R_m [1 + K (530 - T_m)]$$

Where R_s = resistance at 70°F , R_m = measured resistance

T_m = measured temperature ($^{\circ}\text{R}$)

$K = 0.818 \times 10^{-4}$ ohm/ohm/ $^{\circ}\text{R}$ at 530°R , for C/C

$K = 4.33 \times 10^{-4}$ ohm/ohm/ $^{\circ}\text{R}$ at 530°R , for C/A

- 5.6.2 Record R_s on Instrumentation History Sheet opposite "T/C Resistance Before Sample Removed".

- 5.6.3 For tungsten/tungsten-26% rhenium thermocouples, the resistance should be measured at a temperature within $\pm 5^{\circ}$ of the vendors measurement. Enter the resistance on Instrumentation History Sheet opposite "T/C Resistance Before Sample Removed".

- 5.7 Calculate % Difference of thermocouple and record on Instrumentation History Sheet.

$$5.7.1 \quad \% \text{ Difference} = \frac{\text{Vendor Resistance} - \text{T/C Res.}}{\text{Vendor Resistance}} \times 100$$

- 5.8 Using a 50 volt megohmmeter, perform one of the following insulation resistance measurements. An insulation resistance reading of 50 megohms minimum is acceptable. Record this reading on the Instrumentation History Sheet opposite Insulation Resistance.

- (a) For exposed and open junction type thermocouples, measure the insulation resistance between the thermocouple wires and sheath. If this resistance is below minimum, remove a six inch (6") test piece from the non-sensing end and repeat operations 5.4 through 5.8 (a). Reject thermocouple if insulation resistance is still below minimum. Seal exposed non-sensing end of thermocouple, per CD-2703.

- (b) For grounded junction type thermocouples, cut off a six inch (6") test piece from the non-sensing end. Immediately apply a small but sufficient amount of EPY-400 epoxy to temporarily moisture-seal the exposed areas of the thermocouple lead and test piece. (Do not heat-cure epoxy) Measure the insulation resistance of the test piece, between wires and between each wire and sheath.
 - (c) If insulation resistance measures below minimum, repeat 5.8 (b).
Reject thermocouple if insulation resistance is still below minimum.
Seal exposed non-sensing end of thermocouple, per CD-2703.
- 5.9 Place a temporary three inch (3") piece of steel tubing over exposed leads as a protective jacket and tape in place.
- 5.10 Have Quality Control verify completed operation on Instrumentation History Sheet.
- 5.11 Initial and date thermocouple Instrumentation History Sheet where applicable.
- 5.12(a) Return accepted thermocouples to appropriate store room for disposition.
 - (b) Deliver rejected thermocouples to Engineering Review Board for disposition.