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**SANDIA NATIONAL LABORATORIES
CIVILIAN RADIOACTIVE WASTE MANAGEMENT
TECHNICAL PROCEDURE (TP)**

TP-095

THERMOCOUPLE CALIBRATION AT NEW ENGLAND RESEARCH, INC.

Revision 01

Effective Date: 10-09-03

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10/03/03
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10/03/03
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10/06/03
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(Reviewer signatures above document the review and resolution of comments.)

REVISION HISTORY

<u>Revision</u>	<u>Description</u>
0	Initial issue
1	TP-095 was deactivated during Audit BSC-ARC-01-010. It is now reactivated for additional work to be performed. No major technical revisions were required from the previous revision, only references to current procedures and other minor editorial revisions.

1.0 Scope and Objective

The objective of this Technical Procedure (TP) is to define the process for New England Research, Inc. (NER) to calibrate the thermocouples for use in mechanical properties experiments. This procedure is intended for implementation in a laboratory environment, in conjunction with work for the Yucca Mountain Project (YMP).

2.0 Prerequisites

Before performing work under this technical procedure, personnel must be trained by the author and/or the Principal Investigator (PI), and they must demonstrate their proficiency in performing the work in this procedure. The PI has the responsibility for generating a record of the personnel proficiency training, as well as the responsibility that work is performed and documented in accordance with this procedure.

The personnel using this procedure are responsible for ensuring that a controlled copy of this procedure is available and used for performing the work in this procedure.

3.0 Description of Activity

Thermocouples are used to monitor the temperature of the specimen and the displacement transducers, to provide temperature data to the data acquisition system (DAS), and as the feedback mechanism for the temperature controllers.

The thermocouples to be used in these activities are Omega Type J. They are capable of measuring temperatures accurately to $\pm 2^{\circ}\text{C}$ over a range of at least 20° to 275°C .

At least annual calibrations of the active thermocouples against a laboratory standard thermocouple/digital thermometer system with a certified calibration traceable to the National Institute of Standards and Technology (NIST), will ensure the correct values of temperature are being measured during experiments. A laboratory standard thermocouple/digital thermometer will be calibrated on an annual basis by an independent calibration facility.

4.0 Activity Process

The calibrations are carried out on all subject thermocouples electrically configured as they are during an experiment so that calibrations are carried out in an "as used" condition. A scaling factor is calculated for each thermocouple based on the output voltages acquired by the DAS.

All calibration information will be recorded on the Thermocouple Calibration Data Sheet (TCDS) in accordance to the requirements specified in AP-12.1Q.

1. Document the unique identification of each thermocouple on the TCDS (Appendix A).
2. Insert the fully instrumented subject thermocouple and laboratory standard thermocouple into the laboratory oven. The oven should be off and at room temperature. Position the tips of all of the thermocouples near the center of the

oven, supported by a multiholed ceramic thermocouple tube. Place four inches of fiberglass insulation around the thermocouple at the oven opening to close the opening.

3. Read the temperature (in °C) displayed by the laboratory standard digital thermometer and the voltage on the DAS for the thermocouple being calibrated. Record the values on the TCDS.
4. Turn the laboratory oven on and heat it to approximately 50°C as indicated by the laboratory standard. Allow the temperature to equilibrate for a minimum of five (5) minutes.
5. Record the values displayed at the digital thermometer and the DAS as per Step 3.
6. Continue to increase the oven temperature in increments of approximately 25°C to a maximum of 150°C. At each incremental rise in temperature, record the temperature data as per Step 3.
7. Turn off the oven and allow it to cool to ambient temperature.
8. Repeat Steps 3 through 7, then go on to Step 9.
9. Plot the calibration test results utilizing standard software. Plot the temperature measured with the standard thermocouple as a function of the output voltage of the thermocouple being calibrated. The mean slope of the least-squares fit lines to the increasing temperature portion of these two sets of data is the scale factor (in °C/V) for the subject thermocouple. Evaluate the results of the calibration in terms of accuracy, nonlinearity, and reproducibility.
 - a) Accuracy: The mean deviation between the temperature values measured by the standard thermocouple and those calculated for the subject thermocouple using the new scale factor. This quantity is expressed as a percentage of the full-scale output of the subject thermocouple.
 - b) Nonlinearity: The maximum difference in voltage between the calibration data and the linear fit to the data at a given temperature. This quantity is expressed as a percentage of the full-scale output of the subject thermocouple.
 - c) Reproducibility: The difference in the scaling factors determined during succeeding calibration runs. This quantity is expressed as a percentage of the previous scaling factor.
10. The calibrated thermocouple must meet, or exceed, the tolerances given below:
 - a) Accuracy: $\pm 2^{\circ}\text{C}$
 - b) Nonlinearity: $\pm 2\%$

- c) Reproducibility: $\pm 2\%$

If the calibration results do not meet the specifications, the problem must be solved and an acceptable calibration performed prior to using the load cell in further experiments.

5.0 Safety

There are no special safety hazards, only the normal hazards of the equipment. Operations will be in accordance with safety requirements of the facility where the work is being performed and that of the employer of person(s) performing the work.

6.0 Nonconformances, Deviations, and Corrective Actions

Any nonconformances or deviations must be reported to the PI as soon as possible. Deviations, deficiencies and corrective actions must be determined and documented in accordance with AP-16.1Q, *Condition Reporting and Resolution*.

7.0 QA Records

QA records, and any corrections or changes thereto, generated as a result of implementing this procedure will be prepared and submitted as inclusionary QA records (QA:QA) by the PI in accordance with AP-17.1Q, *Records Management*.

The QA records include:

- Proficiency training records (Section 2.0)
- Calibration records
- Thermocouple Calibration Data Sheets (TCDS) (Appendix A)

8.0 References

AP-12.1Q, *Control of Measuring and Test Equipment and Calibration Standards*

AP-16.1Q, *Condition Reporting and Resolution*

AP-17.1Q, *Records Management*

Appendix A

THERMOCOUPLE CALIBRATION DATA SHEET (TCDS)

Unique identifier of thermocouple to be calibrated _____

Date of calibration _____ Date of last calibration _____

Calibration Procedure Number and Revision _____

Unique identifier of standard thermocouple _____

Date of last calibration of standard thermocouple _____

First Cycle					Second Cycle			
Heating		Cooling			Heating		Cooling	
TC	Standard	TC	Standard		TC	Standard	TC	Standard

Note: TC = thermocouple

Calibration Results

Accuracy: _____% Combined Error: _____% Reproducibility _____%

Based on the evaluation of the accuracy, combined error and reproducibility of the data, the thermocouple is (check one): In Specification _____ Out of Specification _____

Note: If "In Specification", the thermocouple calibration is completed. If "Out of Specification", then note suspected problem(s) below, rerun the calibration and take appropriate steps to mark data collected with this thermocouple since previous calibration.

Comments: _____

Work performed by: _____
 Printed Signed Date

Company/Division: _____

Location of Work: _____