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

TP-051

PREPARING CYLINDRICAL SAMPLES, INCLUDING MEASUREMENT OF DIMENSIONAL AND SHAPE TOLERANCES

Revision 03

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(Reviewer signatures above document the review and resolution of comments.)

REVISION HISTORY

Revision	Description
0	Initial issue
1	Delete reference to Experiment Procedures; general update revision.
2	Revised to incorporate QAIP 20-1 requirements and make other minor improvements.
3	TP-051 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

This procedure applies to the physical preparation and measurement of geologic core samples and other cylindrical samples that will be used in support of work for the Yucca Mountain Project. The tolerance criteria in this Technical Procedure (TP) meet or exceed the dimensional tolerance criteria of the International Society of Rock Mechanics (ISRM) or the American Society for Testing and Materials (ASTM), or both.

The objective of the activity described in this procedure is to prepare and measure cylindrical samples to prescribed dimensions and tolerances. Although primarily intended to support mechanical properties experiments, this procedure may be used to support other efforts if determined applicable after a review of recognized standard methods.

2.0 Prerequisites

Before performing work under this technical procedure, personnel must be trained by the Principal Investigator (PI) and 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

Section 4.1 of this procedure defines documentation requirements that are common to both the grinding and the measuring of samples. Section 4.2 of this procedure contains instructions for the measurement of the samples.

4.0 Operations

4.1 Sample Identification, Custody, and General Documentation Requirements for Machining and Measurement Activities.

4.1.1 Sample Identification (ID)

Sample IDs will appear on the samples, containers and corresponding sample custody forms, and will be used throughout work using this TP. If a sample ID marking becomes illegible, it should be rewritten on a portion of the sample where it would not be removed during subsequent processes. In any case, only one unmarked sample should be outside of its container at any one time.

4.1.2 Reporting Measurements of Ground Samples

The Specimen Preparation Data Sheet (SPDS) (provided at the end of this procedure) will be written in ink that will photocopy well, with units reported

consistently in either inches or millimeters, but not a combination of the two. The completed SPDS forms will contain the following information:

1. The specimen identification.
2. Page # of total page count (e.g., page 1 of 4)
3. Name and organization of the individual performing the machining.
4. The physical location and date(s) of the machining process.
5. Name and organization of the individual performing the measurements.
6. The physical location and date(s) of the measurement process.
7. The number and revision of the governing Test Plan.
8. A brief physical description of the specimen.
9. The types and makes of tools/machines/measurement equipment used.
10. The methods used clamp sample to tool, machine or fixture.
11. A description of the processes used.
12. A listing of the following measured dimensions and tolerances:
    i. diameter,
    ii. length,
    iii. straightness of sides,
    iv. flatness of sample ends,
    v. parallelism of sample ends,
    vi. perpendicularity of sample ends to longitudinal axis.
13. Notation of acceptance, nonconformances and out-of-tolerance measurements, as applicable.
14. Names (printed, signed, and dated) of person(s) who performed the machining and measurement processes.

4.1.3 Environmental Criteria

The use of capping materials or end surface treatments other than machining is not permitted. A small amount (< 5% by volume) of water soluble rust inhibitor may be added to the water used for the coring and/or machining. Lubricants or fluids other than water (distilled or tap water with up to 5% water soluble rust inhibitor) and the sample ID markings are not permitted to contact the samples. Heating of the samples should be minimized. No attempt will be made to control the moisture content of the samples during the work in this procedure.

4.2 Measurement and Acceptance of Samples

If sufficient personnel are available, then the measurements should not to be performed by the same person who performed the machining of the samples.

4.2.1 Measurement Equipment

The equipment will be clean during the measurements defined in this procedure.

A. Measurements described in this procedure may be made with electrical or mechanical (dial) gage indicators.

B. Surface plates, V-blocks and parallel plates used during measurements must be of machinist quality.

4.2.1.1. Calibration of Gages

The critical dimensions of length and diameter will be measured with digital calipers calibrated according to the requirements in AP12.1Q.

4.2.1.2 System Checks

Gage blocks (with measurements of length and flatness made by, or traceable to NIST, the National Institute of Standards and Technology) may be provided with the samples for measurement. If provided, their length and flatness will be measured and reported with the results of the other samples.

4.2.2 Measurement Criteria and Methodology

4.2.2.1 Determination of Deviation from the Nominal Sample Diameter

A. Tolerance: The average sample diameter will be within $\pm$ 0.005 in (0.13 mm) of the defined nominal diameter.

B. Measurement Method: Determine the diameter of the sample to the nearest 0.001 in (0.025 mm) by averaging two diameters measured at right angles to each other at about midheight of the sample and near both ends (6 measurements). If the sample length is $\leq$ 0.75 in (19 mm), measurements at sample ends may be omitted.

4.2.2.2 Determination of Deviation from the Nominal Sample Length

A. Tolerance: The sample length will be within $\pm$ 0.005 in (0.13 mm) of the defined nominal length.

B. Measurement Method: Determine the length of the sample to the nearest 0.001 in (0.025 mm) at the centers of the end faces.

4.2.2.3 Determination of Deviation from Straightness of the Sample Sides

A. Tolerance: The sides of the sample will be generally smooth and free of abrupt irregularities, with all elements straight to within 0.010 in (0.25 mm) over the full length of the sample.

B. Measurement Method:

1. Place the cylindrical surface of the sample on a V-block that is laid on a surface plate.

2. Place a parallel plate (to provide smooth and continuous travel of the dial indicator support) between the dial indicator support and the V-block. Position the dial indicator, with its support on the surface plate, over the sample so that the contact is on the top of the sample.

3. While maintaining an axial-parallel path, slide the dial indicator support along the surface plate, and record the maximum and minimum readings from the indicating gage and calculate and record the difference. If the indicating gage traverses a natural cavity in the rock, the readings in this region should not be used. Repeat the operation two additional times by rotating the sample about its own cylindrical axis approximately 120^{o}, obtaining the max-min at approximately 120^{o} and 240^{o}.

4.2.2.4 Determination of Deviation from Flatness of the Sample Ends

A. Tolerance: The end surfaces of the sample will be flat to within 0.001 in (0.025 mm) over the end profile.

B. Measurement Method:

1. Use the same setup as that for straightness, except the dial gage shall be mounted near the end of the V-block so as to traverse the end of the sample. The sample must be clamped to prevent movement during gage movement.

2. Position the V-block, with respect to the parallel plate (held in a fixed position), so as to remove any contribution of non-perpendicularity of the end to this measurement.

3. Move the indicator support horizontally, along the parallel plate, so the dial gage runs across a diameter of the sample end surface. (Make sure the support maintains contact with the fixed position parallel plate) Record the maximum and minimum readings.

4. Repeat Step 3 twice, after rotating the sample 120^{o} between measurements.

5. Repeat entire procedure for the other end of the sample.

4.2.2.5 Determination of Deviation of the Sample End Perpendicularity to the Longitudinal Axis of the Sample.

A. Tolerance: The ends of the sample will not depart from perpendicularity to its longitudinal axis by more than 0.001 in for each inch of sample length (0.025 mm for each 25 mm of sample length).

B. Measurement Method: Use the same setup, and method as that for the flatness measurement, except position the parallel plate tightly to the end of the V-block. Deviations indicated by the dial indicator will include elements of flatness and perpendicularity, with the overall edge-to-edge variability being the essential perpendicularity check.

4.2.2.6 Determination of Deviation from Parallelism of the Sample Ends

A. Tolerance: The ends of the sample will be parallel to each other within 0.001 in for each in of sample diameter (i.e. 0.001 in/in or mm/mm).

B. Measurement Method:

1. Support the dial indicator so as to maintain the contact point in a fixed position over a surface plate.

2. Stand the sample with either end on the surface plate (with its longitudinal axis perpendicular to the surface plate).

3. While maintaining full contact with the surface plate, slide the sample past the indicating gage along a diameter of the upper end of the sample. Record the maximum and minimum readings of the indicating gage.

4. Rotate the sample 90^{o} about its longitudinal axis and repeat Step 3.

4.2.3 Exemption from Tolerances

Surface features attributable to naturally occurring cavities in rock samples are exempt from the tolerance requirements.

5.0 Safety

There should be no safety hazards other than the normal hazards of the equipment. Operations will be in accordance with safety requirements of the facility where the work is being performed and those of the employer of person(s) performing the work.

6.0 Nonconformance, 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*. These records include:

- Proficiency training records (Section 2.0)
- Sample custody forms
- Specimen Preparation Data Sheet (SPDS) (Section 4.1.2)
- Calibration records (if applicable)

8.0 References

American Society for Testing and Materials (ASTM) D4543-85, “Standard Practice for Preparing Core Specimens and Determining Dimensional and Shape Tolerances,” published January 1986.

International Society for Rock Mechanics (ISRM) Commission on Standardization of Laboratory and Field Tests, “Suggested Methods of Determining the Strength of Rock Materials in Triaxial Compression: Revised Version,” 1983.

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

AP-16.1Q, *Condition Reporting and Resolution*

AP-17.1Q, *Records Management*

QAIP 20-03, *Sample Control*

SPECIMEN PREPARATION DATA SHEET – Page ____ of ____

Block 1: General Information

Specimen Identification: _____

Specimen prepared by (name/organization): _____/_____

Specimen preparation performed at: _____

Date(s) of preparation: _____

Specimen measured by (name/organization): _____/_____

Specimen measurements performed at: _____

Date(s) of measurements: _____

Specimen prepared under Test Plan Number: _____ Revision _____

Rock type/description (e.g., vugginess, fissures, irregularities, texture, color, etc.):

_____

_____

_____

Block 2: Description of Processes:

Type and make of tools/machines/measurement equipment used (note unique identifiers):

_____

_____

_____

Methods used to clamp sample to machine, tool or fixture:

_____

_____

_____

Description of processes used (written in order in which they were performed):

_____

_____

_____

SPECIMEN PREPARATION DATA SHEET – Page ____ of ____

Block 3: Specimen Dimensions and Tolerances **Specimen Identification:** _____

Diameter (in or mm)	Length (in or mm)	Straightness (in or mm)
upper end 1:_____		
upper end 2:_____	Center to Center:_____	0^o max_____ min_____
midheight 1:_____		120^o max_____ min_____
midheight 2:_____		240^o max_____ min_____
lower end 1:_____		
lower end 2:_____		
Average:_____		
Nominal:_____	Nominal:_____	
Difference:_____	Difference:_____	Maximum Difference:_____

Flatness of Ends (in or mm)	Parallelism (in or mm)	Perpendicularity (in or mm)
End 1	Diameter 1:	End 1
0^o max_____min_____dif_____	max_____	0^o max_____min_____dif_____
120^o max_____min_____dif_____	min_____	120^o max_____min_____dif_____
240^o max_____min_____dif_____	dif_____	240^o max_____min_____dif_____
End 2	Diameter 2:	End 2
0^o max_____min_____dif_____	max_____	0^o max_____min_____dif_____
120^o max_____min_____dif_____	min_____	120^o max_____min_____dif_____
240^o max_____min_____dif_____	dif_____	240^o max_____min_____dif_____
Maximum Difference:_____	Maximum Difference:_____	Maximum Difference:_____

Block 4: Acceptance and Signatures:

Acceptance criteria are:

- Average diameter within ± 0.005 in (0.13 mm) of defined nominal
- Length within ± 0.005 in (0.13 mm) of defined nominal
- Straightness within ± 0.010 in (0.25 mm) over full length of sample
- Flatness to within ± 0.001 in (0.025 mm) over end profile
- Parallelism within ± 0.001 in (0.025 mm) per in (mm) of sample diameter
- Perpendicularity within ± 0.001 in (0.025 mm) per in (mm) of sample length

Are all acceptance criteria met: (Y/N) _____, if the answer is no, then discuss below.

Comments (e.g., discuss measurement problems)/other information (e.g., specimen mass):

_____

_____

	Specimen Preparation By	Measurements By
Print Name	_____	_____
Sign/Date	_____	_____