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**Risk Reduction and Environmental Stewardship—
Remediation Services**

Standard Operating Procedure

For

**Subsurface Moisture Measurements
Using a Neutron Probe**

NES Approved

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Revision Log

Revision No.	Effective Date	Prepared By	Description of Changes	Affected Pages
0	8/17/00	John Hopkins	New Procedure	All
1	2/28/01	Dennis Newell	This SOP was revised to reflect current sampling methods and to add a revision log page	All
2	04/05/04	Ken Kisiel	Revise to remove requirement for annual Radiation Work Permit requirement and to meet QP-4.2 format requirements.	All

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List of Acronyms and Abbreviations

LANL	Los Alamos National Laboratory
PPE	personal protective equipment
PTL	project team leader
QP	quality procedure
QPPL	quality program project leader
RPF	records processing facility
RRES-RS	risk reduction and environmental stewardship—remediation services
SOP	standard operating procedure
SSHASP	site-specific health and safety plan

Subsurface Moisture Measurements Using a Neutron Probe

1.0 PURPOSE

This standard operating procedure (SOP) states the responsibilities and describes the process of making subsurface moisture measurements using a neutron probe for the Los Alamos National Laboratory (LANL), Risk Reduction and Environmental Stewardship, Remediation Services (RRES-RS) project.

2.0 SCOPE

- 2.1 All **RRES-RS project participants** shall implement this mandatory SOP.
- 2.2 **Subcontractors** performing work under the RRES-RS project's quality program shall follow this SOP.

OR

- 2.3 **Subcontractors** may use the subcontractor's procedure as long as the substitute meets the requirements prescribed by the RRES-RS project Quality Management Plan, and the RRES-RS Quality Program Project Leader (QPPL) and a RRES-RS project technical staff person approve the procedure before the subcontractor begins the designated activity.

3.0 TRAINING

- 3.1 **RRES-RS project participants** shall train (e.g., read and/or classroom) to and use the current version of this QP; contact the author of this QP if the text is unclear.
- 3.2 **RRES-RS project participants** using this SOP shall document training in accordance with QP-2.2.
- 3.3 The responsible **project team leader (PTL)** shall monitor the proper implementation of this procedure and ensure that the appropriate personnel complete all applicable training assignments.
- 3.4 **RRES-RS project participants** may request any needed assistance with implementation of this procedure from RRES-RS Quality Integration and Improvement (QII).

4.0 DEFINITIONS

- 4.1 *Authorized user (or operator)*—A person who has successfully met the training requirements outlined in this SOP.
- 4.2 *Cable*—The depth-incremented cable that attaches the probe to the surface assembly.

- 4.3 *Casing stick-up*—The distance a borehole casing extends above the ground surface.
- 4.4 *Downhole*—The position of the probe relative to the ground surface or surface casing. When the probe is physically placed into the subsurface, it is said to be downhole.
- 4.5 *Logging technician*—An authorized user who performs subsurface moisture logging using the moisture gauge.
- 4.6 Moisture gauge, moisture probe, instrument, neutron probe—The entire instrument assembly.
- 4.7 *Probe*—The logging tool that contains the radioactive source and detector that is physically placed in the subsurface.
- 4.8 *Site-specific health and safety plan (SSHASP)*—Health and safety plan that is specific to a site or RRES-RS-related field activity that has been approved by an RRES-RS project health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.
- 4.2 *Surface assembly*—The shielded casing that contains the instrument electronics and that houses the probe when not in use.
- 4.10 *Vadose zone*—The unsaturated zone. Portion of the subsurface above the regional water table in which pores are not fully saturated.

5.0 RESPONSIBLE PERSONNEL

The following personnel are responsible for activities identified in this procedure:

- Logging technician
- Operator
- PTL
- QPPL
- RRES-RS project participant
- Source custodian
- Subcontractor
- User

6.0 BACKGROUND AND PRECAUTIONS

- 6.1 **RRES-RS project participants** shall use this SOP in conjunction with an approved SSHASP.
- 6.1.1 The neutron probe emits ionizing radiation from a sealed, registerable source. The neutron probe is subject to all source control requirements outlined in LIR402-716-01.1 *Radioactive Sealed Source Accountability/Control*.
- 6.1.2 Exposure should be limited as follows:
- Keep the probe as far away from the body as possible when it is necessary to remove the probe from the housing for any reason.
 - Minimize the length of time the probe spends on the surface when it is unshielded by the surface assembly.
 - Transport the instrument in its case by the handle.
 - Require personnel not involved in the probe's operation to maintain a minimum distance of 10 ft. when the probe is not down-hole.
 - In general, minimize both the number of persons near the probe and the time individuals spend near it.
- 6.1.3 Do not transport or use probes with any observed or suspected damage until the Source Custodian, HSR-1, and HSR-12 verifies the source integrity.
- 6.1.4 In the event of a stuck probe or emergency, contact HSR-1 at 665-4926 and HSR-12 at 665-5298.
- 6.1.5 Only authorized personnel may use the neutron probe. Authorization requires Laboratory radiation worker training (I or II), on-the-job training to this procedure, and an Albedo type dosimeter issued by HSR-4.
- 6.1.6 The moisture probe and cable are designed for use in vertical access holes. As designed, the instrument is placed over a borehole or access tube casing and the probe and cable are deployed directly from the surface assembly into the subsurface. When used in this way, do not remove the probe from the surface assembly or handle directly.
- 6.1.7 The moisture probe may also be used in angle holes and horizontal access holes. Remove the probe from the surface assembly for logging purposes when used in this type of access

hole. The deployment of the probe for logging may be possible using gravity if the access hole has a steep enough angle. However, for shallow angles and horizontal holes, take additional measures to successful probe deployment. These measures may include towing the probe with a cable or rope, deployment with rods, or deployment using positive-pressure, averting membranes.

Note: This procedure does not include instructions for deployment by means other than gravity.

6.1.8 The cable is marked in 1-ft. increments, but the first mark on the cable indicates a depth of 2 ft. This marking assumes the direct deployment of the probe and cable from the surface assembly so takes into account the 1-ft height of the surface assembly itself.

6.1.9 When the probe is not deployed from the surface assembly, this correction to the probe depth is incorrect. The **logging technician** must add 1 ft. to the depth indicated on the cable (e.g., if the cable increment reads 20 ft, record a depth to the probe of 21 ft). Similarly, the use of different cables may require different corrections to derive the correct depth of the probe from the surface.

7.0 EQUIPMENT

7.1 *Neutron probe (CPN 503DR)*—used to measure the subsurface moisture by use of a probe containing a source of high-energy neutrons and a slow neutron detector.

7.2 *Cable*—a depth incremented cable compatible with the CPN 503DR

8.0 PROCEDURE

Make any deviations from this SOP in accordance with QP-5.7 and/or SOP-01.01.

8.1 Perform a Daily Field Standard Count

Note: The standard count serves as an instrument check to ensure that the instrument source, detector, and electronics are operating within the manufacturer's specifications.

8.1.1 The **authorized user** (hereafter referred to as the **operator**) shall perform and document the daily field standard count at the beginning of each day of field measurements. Perform the daily field standard count as follows:

- Place the carrying case on the ground.

- Verify that no other radioactive sources are within 30 ft.
- Verify that no significant sources of hydrogen (e.g., people) are within 10 ft.
- Remove the moisture probe from the carrying case.
- Place the probe on the metal plate located on the lid of the carrying case.
- Attach the cable to the probe.
- Attach the cable to the surface assembly.
- Ensure the display panel on the instrument reads “Ready”; if not, press “Clear.”
- Press “Std” on the instrument keypad; the instrument displays the stored current standard count.
- Press “Step”; the instrument displays the stored previous standard count.
- Press “Step” again; the instrument displays the “Xi” value for the stored standard count.
- Press “Step” again; the instrument displays “NEW STD?.”
- Press “Enter,” which is equivalent to “Yes.”

Caution: Stand back at least 10 ft during the standard count.

- The instrument now collects 32 counts and averages them. This is the standard count. When the count is complete, the instrument displays “S #####,” where “#####” is the standard count.
- Press “Enter” to store the standard count.
- Press “Step”; the previous standard count is displayed.
- Press “Step” again; the current Xi value is displayed, and

If...	Then...
the Xi value is not between 0.75 and 1.25,	repeat the process above.
the Xi value is between 0.75 and 1.25.	proceed to Step 8.1.1.17.

If...	Then...
the instrument consistently returns Xi values outside of the acceptable range.	Do not use the instrument; the instrument requires servicing by the manufacturer.

Table 1 Standard Count Function Check

- Record the standard count, the previous standard count, and the Xi value in the logbook (see Section 8.3.1).

Note: Pressing “Clear” at any time during the standard counts aborts the standard count. Use “Clear” to clear the instrument display and return to the “Ready” mode.

Note: A small black dot in a corner of the display panel indicates a low battery; recharge the moisture probe overnight before use.

8.2 Prepare Instrument for Field Measurements

This procedure assumes the **operator** shall collect raw counts.

8.2.1 The **operator** shall calculate moisture content in spreadsheets, which employ the applicable calibration.

8.2.2 The operator shall set the instrument to return raw counts as follows:

- Press “Units” on the instrument keypad.
- Press “Step” until the display reads “CNT.”
- Press “Enter” on the instrument keypad; the instrument returns to the “Ready” mode.

8.3 Take a Field Measurement

The **operator** shall take a field measurement in the following manner.

8.3.1 Lower the probe through the surface assembly with the cable to the desired depth.

8.3.2 Press “Start” on the instrument keypad; the instrument counts for 16 seconds.

8.3.3 At the “beep”, the instrument displays the value for that depth. Record the measurement in the logbook (see action step 6.1.4). and

8.3.4 Repeat steps 8.3.1 through 8.3.3 until all of the required measurements are complete.

8.4 Document the Results of the Field Measurement

8.4.1 The **PTL** shall ensure that all field personnel who are assigned field notebooks read and implemented the requirements listed in QP-5.7 before documenting assigned tasks in any technical notebooks.

8.4.2 The **operator** shall record the data in a field logbook; at a minimum, the logbook shall contain the following information:

- field technician
- date
- location ID
- standard count
- previous standard count
- Xi value
- surface casing stick-up (if any)
- access hole diameter
- casing type (e.g., PVC)
- casing depth
- access hole total depth (below top of casing)
- data with units identified (i.e., raw counts) versus depth below top of casing

8.4.3 When the operator “closed out” the logbook, the **PTL** shall submit it to the Records Processing Facility (RPF) in accordance with QP-4.4.

9.0 LESSONS LEARNED

9.1 Before performing work described in this SOP, **RRES-RS project participants** should go to the Department of Energy Lessons Learned Information Services home page, located at <http://www.tis.eh.doe.gov/II/II.html>, and/or to the LANL Lessons Learned Resources web page, located at http://www.lanl.gov/projects/lessons_learned/, and search for applicable lessons.

9.2 During work performance and/or after the completion of work activities, **RRES-RS project participants**, as appropriate, shall identify, document, and submit lessons learned in accordance with the LANL, Lessons Learned System located at http://www.lanl.gov/projects/lessons_learned/.

10.0 RECORDS

The **PTL** shall submit the following records to the Records Processing Facility, in accordance with QP-4.4:

- completed field logbook forms

11.0 REFERENCES

To properly implement this SOP, **RRES-RS project participants** should become familiar with the contents of the following documents, located at http://erinternal.lanl.gov/home_links/Library_proc.shtml:

- RRES-RS Quality Management Plan
- QP-2.2, Personnel Orientation and Training
- QP-4.4, Record Transmittal to the Records Processing Facility
- QP-5.7, Notebook Documentation for Environmental Restoration Technical Activities
- SOP-01.01, General Instructions for Field Investigations
- LIR402-716-01.1, Radioactive Sealed Source Accountability/Control
- VM-6.00, CPN 503DR Hydro probe Moisture Gauge Operating Manual

12.0 ATTACHMENTS

The **user** of this SOP may locate all forms associated with this procedure at <http://erinternal.lanl.gov/Quality/user/forms.asp>.

Attachment A: Field Logbook Entry Form (1 page)

[Using a token card, click here to record "self-study" training to this procedure.](#)

If you do not possess a token card or encounter problems, contact the RRES-ECR training specialist.

