Instrument Calibration and Maintenance

Nuclear Secured / Radiation Safety

NS-RS-PR-401, 0

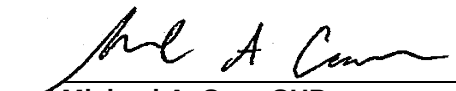
Date Effective: 11 August 2019

History and Approvals

History

Revision	Intent Y/N	Purpose description
0	Y	For Issue (Rebranded CS-FO-PR-002)

Approvals

Preparer: 

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8/5/2019
Date

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8/14/2019
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Table of Contents

Chapter Page

1. Purpose and Scope

1.1. Purpose

The purpose of this procedure is to specify the general requirements and instructions for the calibration and maintenance of portable radiological survey instruments used on Nuclear Secured (NS) field projects. Any project specific calibration and maintenance requirements should be included in the site-specific Work Plans or other project specific documentation.

1.2. Scope

This procedure applies to the calibration and maintenance of following types of instruments used under the NS Radiation Protection Program (RPP):

- Radiation Survey Instruments (dose rate meters)
- Contamination Survey Instruments (friskers)
- Portable and Stationary Scalar Counters
- Personnel Monitoring Devices (TLDs and Self-Reading and Electronic Dosimeters)
- Air Samplers

Calibration and maintenance of survey instrumentation not covered by this procedure, but covered in instrument specific operating procedures or manuals include laboratory analytical and specialized equipment such as:

- Gamma Spectroscopy Equipment
- Alpha or Beta Spectroscopy Equipment
- Liquid Scintillation Counters
- Automated Counters
- Portal Monitors

2. References

2.1. IEEE/ANSI N323AB, *American National Standard for Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments*, 2013

2.2. DOE G 441.1-1C, *Radiation Protection Programs Guide for Use with Title 10, Code of Federal regulations, Part 835, Occupational Radiation Protection*

2.3. NS-RS-PR-102, *Project Records Management*

2.4. NS-RS-PR-300, *Performance of Surveys*

2.5. NS-RS-PF-400, *General Operations of Portable Radiation Survey Instruments*

2.6. NS-RS-PR-402, *QA/QC of Radiation Survey Instruments*

3. General

3.1. Definitions

3.1.1. *Calibration* – Setting the response or reading of an instrument relative to a series of conventionally true values traceable to the National Institute of Standards and Technology (NIST).

3.1.2. *Check Source* – A radioactive source, not necessarily traceable to NIST, which is used to confirm the continuing satisfactory operation of an instrument.

3.1.3. *General Maintenance* – Activities allowable on instruments without requiring recalibration. These include light cleaning, battery and cable change outs, Mylar window replacements and repair, pancake GM tube replacement and other similar activities that do not impact the instruments response.

3.1.4. *Radiological Survey Instrument* – A complete system designed to quantify one or more characteristics of ionizing radiation or radioactive material.

3.1.5. *Range* – All values lying between an upper and lower bound or an indicated limit.

3.2. Responsibilities

Depending on personnel qualifications and the size of the project, project personnel may be assigned multiple roles and/or responsibilities.

3.2.1. NS Radiation Safety Officer

The NS Radiation Safety Officer (RSO) maintains and oversees the implementation of the NS RPP. The RSO shall ensure that radiation safety, radioactive materials management, and radiological operations procedures and programs are kept up to date such that they comply with current regulations and incorporate current and relevant industry practices and regulatory guidance.

3.2.2. Project Manager

The Project Manager (PM) is responsible for ensuring that the proper program procedures and programs are implemented on the project site as required by customer agreements and contracts. The PM is responsible for ensuring that these programs and procedures are properly incorporated into project specific plans and procedures. The PM is responsible for ensuring that the NS RPP and client programs and procedures, as applicable, are available for use by project personnel.

3.2.3. Project Health Physicist

The Project Health Physicist (PHP) is responsible for assisting the RSO in providing health physics support to the PM and Radiation Protection Supervisor (RPS). This includes technical support to ensure procedural and regulatory compliance and to ensure that the project-specific Data Quality Objectives (DQOs) are met.

3.2.4. Radiation Protection Supervisor

The Radiation Protection Supervisor (RPS) is responsible for implementing the NS RPP at the project location. The RPS manages and oversees the use of radiological survey instrumentation and reports directly to both the PM and the RSO.

3.2.5. Radiation Protection Technicians

Radiation Protection Technicians (RPTs) are responsible for the proper use and control of radiological survey instrumentation in accordance with the NS RPP procedures.

3.3. Precautions and Limitations

3.3.1. Efficiency calibrations should simulate field conditions as closely as possible including:

- Types and energies of radiation expected (i.e., radioisotopes of concern)
- Cable length
- Detector to source distance
- Special geometry requirements

3.3.2. Environmental conditions such as significant changes in temperature or changes in elevation may affect the performance of field instruments. An evaluation should be performed by the RPS to assess the potential impact of environmental conditions.

3.3.3. Ensure the proper detector cable length is used as indicated on the instrument calibration paperwork.

3.3.4. Ensure any quench gasses used for gas flow proportional detectors is certified laboratory grade with a certificate of analysis to minimize any impurities that may impact the performance of the detectors.

4. Pre-Requisites / Requirements

4.1. Instrument calibration shall be performed using NIST traceable sources and Measurement and Test Equipment (M&TE).

4.2. All instrument calibrations shall be performed by the original equipment manufacturer, by a qualified vendor, or under the direct supervision of the RPS following approved protocols and/or procedures which shall include the determination and documentation of the “as found” conditions.

4.3. Only NS health physics personnel or personnel under the direction of NS health physics personnel may operate radiological instruments.

4.4. Repairs that may affect the instrument performance are considered an instrument modification and will invalidate any current calibration.

4.5. Instrument modifications may only be made with RSO or PHP approval.

5. Procedure

5.1. Instrument Calibration

5.1.1. Prior to instrument set-up, the RPS and/or PHP should evaluate the site specific conditions to determine if calibration adjustments are required based on environmental factors such as extreme temperature changes or significant changes in elevation or whether on-site calibration should be performed, specifically, instrument plateau tests to set the proper high voltages for the instruments in accordance with Section 5.2.

5.1.2. All Instruments used for radiological surveys shall be calibrated at least annually, when in use, and after any major instrument repair.

5.1.3. Certain Agreement States or clients may require instrument calibration every six (6) months. Calibration frequencies other than annually shall be documented in project-specific documents.

5.1.4. If using an off-site vendor for calibration, the RPS and/or PHP should specify the calibration requirements. This will include the identification of the radioisotopes and special geometry requirements.

5.1.5. As needed, the calibration due date may be extended up to 30 days on written authorization by the RSO following a review of the current calibration and instrument response test records provided the routine checks remain stable over a long period of time.

5.1.6. Air Samplers shall be calibrated by a qualified vendor or on-site using a primary standard or a calibrated secondary standard.

5.1.7. The RPS shall maintain copies of calibration certificates at the project. The RPS shall confirm that the certificate of calibration and the calibration sticker attached to the radiation survey instrument agree and are up to date.

5.2. Calibration Field Adjustments

5.2.1. Any on-site calibration adjustments shall be performed using approved calibration procedures or the instruments operating manual under the guidance and review of the RPS and/or PHP.

5.2.2. Field calibration adjustments shall be limited to the following:

- HV Plateau testing and HV settings
- Chi-Square testing and efficiency determination

5.2.3. As directed by the PHP and/or RSO, perform a high voltage (HV) plateau test on the instrument, Attachment 7.1.

5.2.3.1. Determine the HV range over which the plateau will be evaluated. This will depend on the types of emissions being measured (e.g., alpha or beta). Consult the RPS and/or PHP to establish the range.

5.2.3.2. Set the HV to the bottom of the range and perform a 1-minute background and a 1-minute source count.

5.2.3.3. Adjust the HV in increments (e.g., 50 volts) and re-perform the background and source checks.

5.2.3.4. Repeat over the HV range to be evaluated.

5.2.3.5. Plot the net source count results against the high voltage. There should be a plateau or range of voltages where the net instrument response is relatively uniform.

5.2.3.6. Select the HV setting slightly above the knee (i.e., bottom end of the plateau). Typically, the HV will be selected 50 to 100 volts above the knee depending on how wide the plateau is. Consult the RPS and/or PHP for the proper HV setting.

5.2.3.7. Set the instrument HV to the selected voltage.

5.2.4. Following any HV adjustments or as directed by the RPS and/or PHP, perform a Chi-Square test in accordance with NS-RS-PR-402, *QA/QC of Radiation Survey Instruments* and calculate a new instrument efficiency.

5.2.5. Document any HV plateau tests and Chi-Square test with the instruments calibration paperwork.

5.3. General Maintenance

5.3.1. General maintenance may be performed in the field on survey instruments and equipment provided it will not affect the instrument calibration. This includes general cleaning, gas and hose change-out, and cable and battery exchange. For cable replacement, the cable must be approximately the same length as used during calibration (i.e., within 12 inches).

5.3.2. The exchange of probes may be permitted as approved by the RPS and or PHP. This is typically performed for GM tubes such as pancake friskers which may have popped.

5.3.3. Mylar windows may be replaced or patched to repair pin holes, tears, and light leaks. If the Mylar window is replaced, ensure that the new window is of the same Mylar thickness as when calibrated.

5.3.4. If replacing the Mylar window on a scintillation detector, it should be replaced in a dark area since the detector is very sensitive to light and may take up to 24 hours before a scintillation detector is acceptable for re-use following window replacement.

5.3.5. Care should be taken not to touch the electrode wires inside gas flow proportional detector when changing detector mylar as these are very fine and fragile.

5.3.6. Ensure that gas flow proportional detectors are properly purged following detector window maintenance and gas bottle exchange. To ensure the detector is purged, perform a purge test to make sure the detector response has reached a steady rate.

5.3.6.1. Place the gas flow proportional detector such that the gas exhaust is elevated. P-10 gas is heavier than air and the detector will purge quicker by displacing the air in the detector.

5.3.6.2. Increase the gas flow rate to approximately 100 cc/min.

5.3.6.3. Allow the detector to purge a minimum of 20 minutes.

5.3.6.4. Perform a 1-minute source count, wait 5 to 10 minutes and perform a second count.

5.3.6.5. If the second count is with +/- 10% of the prior count, the detector has been purged and is ready for use.

5.3.6.6. Reduce the gas flow rate to the operational rate depending on the detector.

5.3.7. Instrument decontamination may also be performed as necessary. During decontamination, care should be taken not to damage the detector window.

5.3.8. Following field instrument repair, perform an instrument response test to ensure it falls within the range of acceptable values as established during the baseline

evaluation. Notify the RPS if the instrument does not fall within the acceptable range of values. The RPS shall determine if the instrument will be taken out of service for further repair and recalibration or perform a field calibration adjustment following Section 5.2 and have a new baseline field evaluation performed in accordance with NS-RS-PR-402, *QA/QC of Radiation Survey Instruments*.

5.3.9. Complete the instrument maintenance log, Attachment 7.2, and document any field repairs that were performed to track the maintenance history of the instrument.

5.3.10. If the instrument cannot be repaired in the field, the instrument shall be removed from service and clearly labeled “Do Not Use” or “Out of Service” until it is shipped for repair and recalibration.

6. Records

6.1. Instrument calibrations

6.2. Instrument inventory

6.3. Instrument QA/QC records (Set-up and daily source check)

6.4. Instrument maintenance logs

7. Appendices and Forms

7.1. High Voltage Evaluation (Example)

7.2. Instrument Maintenance Log (Example)

Attachment 7.1 **High Voltage Evaluation (Example)**

Instrument:		**Serial Number:**	
Detector:		**Serial Number:**	
High Voltage Range:		**High Voltage Increment:**	
High Voltage	**Background**	**Source Count**	**Net Count**
High Voltage Setting			
Performed By:			
Reviewed By:			

Attachment 7.2 **Instrument Maintenance Log (Example)**

Instrument / Serial Number:		Detector / Serial Number:	
Date	**Maintenance Performed**	**Notes**	**Performed By**