



Radiation Safety



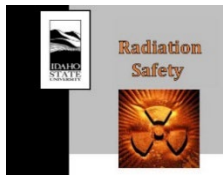
RADIATION PROCEDURES MANUAL

Procedure Cover Sheet

Procedure Title: Instrument Calibration
Procedure Number: RS-12 Rev.2
Effective Date: 10/17/2022

Approved By: Radiation Safety Committee

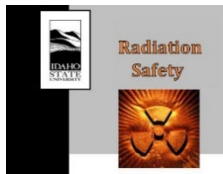
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Revision History

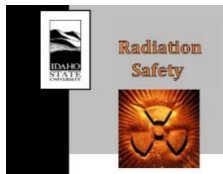
Revision Number	Author Name	Date	Approved by/date
RS 12.0	Mason Jaussi & John Longley	01/23/20	RSO-01/23/20
RS 12.1	Mason Jaussi & John Longley	10/27/20	RSO-10/27/20
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1. INTRODUCTION

Radiation survey instruments used at any of Idaho State University's NRC licensed facilities shall be calibrated annually, or following repair, for the radiation measured, in accordance with Section 16 of the Radiation Safety Manual. Instruments for measuring exposure and dose rates are calibrated for linearity of response on all useful ranges by an independent and accredited calibration facility. Instruments used for contamination surveys are calibrated for detection efficiencies for various radionuclides, as well as for linearity of response.

2. PURPOSE

This procedure specifies instructions for safe and compliant calibration of Idaho State University radiation detection instruments. This procedure and supporting documents ensure that instrument calibrations are performed safely and correctly, while ensuring the regulatory requirements of 10 CFR 20.1501(c) are sufficiently being met.

3. SCOPE

This procedure applies to radiation safety personnel who are trained and approved to perform calibrations of ISU radiation detection instruments.

4. ROLES AND RESPONSIBILITIES

Authorized User

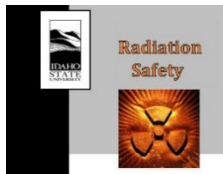
- It is expected that the authorized user will provide a timely response for instrument calibration request, drop-off, and pick-up.

Radiation Safety Personnel

- Radiation safety personnel are expected to send calibration due notices to the AU one week prior to the instrument's calibration due date, perform the calibration or send instrument to an accredited calibration facility within two weeks of receipt of the instrument, and return the instrument to the AU in a timely manner;
- Communicate delays or the need for repairs to the RSO/ARSO and AU;
- Perform the calibration and recordkeeping in accordance with this procedure.

Radiation Safety Staff

- Review all calibration forms and save as a record.



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5. ACRONYMS/DEFINITIONS

ARSO:	Assistant Radiation Safety Officer
AU:	Authorized User
IPL:	Instrument Performance Log
QA:	Quality Assurance
RSO:	Radiation Safety Officer
SN:	Serial number
QA:	Quality Assurance
Audio check:	Verification that the instruments audio feature works.
Battery check:	Verification that all instrument batteries are sufficiently charged. Typically displayed on the meter face (analog or digital).
High voltage check:	Verification that the instruments high voltage is within an acceptable range with a digital readout.
Maximum printed scale value:	The maximum output value that is printed on the analog meter face (no multipliers).
Scale zero-point check:	Verification that the instruments needle rests at zero (Checked with background or on the Pulser with zero counts applied.)
Visual/physical check:	Observation of dents, breaks, cracks, or other forms of damage that may impact functionality.

6. REQUIRED MATERIAL(S)

Located on ISU Box Server

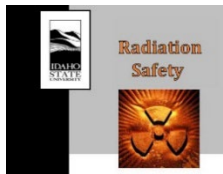
- Instrument Return forms
- 'Calibration Forms_Master_Rev2' Excel Workbook
- 'Avery5660_Calibration Stickers' Word Template
- Instrument User Manual/Calibration Procedure

Located in the Radiation Safety Office - Campus

- Replacement Batteries
- Pulser & Cables
- Applicable Sources & Probe Jig

7. REQUIRED TRAINING(S)

- ISU Radiation Safety Training



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8. PROCEDURE

8.1. Pre-Calibration Tasks

8.1.1. Check for instrument calibration due dates using the HPAssist software.

- Log into HPAssist
- Click on the 'Equipment' tab.
- In the 'Meters' menu > Click on 'Meters'.
- Single click the 'Calibration Due' column header once.
 - A single click will display instruments marked as out of service first, followed by instruments next due for calibration in descending order.
 - A second click will display the most recently calibrated instruments first, followed by out of service instruments in descending order.
 - A third click will remove column sorting order filters
- Navigate to the calibration dates due in the current month, or over due in the last two months, and note:
 - Instrument model & serial number
 - Probe model & serial number (if applicable)
 - Authorized User & instrument location

8.1.2. Instruments due for calibration should be collected and calibrated in the same month in which they are due, but must be calibrated within two months after the month they were originally due.

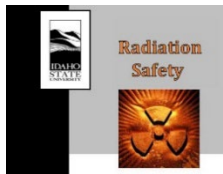
NOTE: Instruments that are more than two months overdue are not to be used for any radiation safety related measurements.

8.1.3. Collect all instruments due for calibration.

- Ensure replacement instruments are provided for all actively used instruments, and any emergency back-up instruments, ensuring the Instrument Performance Log is set up according to RS-24, Instrument Response Checks.
- Replace instrument batteries.

8.1.4. Mark the instruments as "out-of-service" in HPAssist with the date it was collected for calibration or as the date it was delivered/shipped.

- If applicable, include a comment stating which accredited calibration facility the instrument was sent to and the reason (e.g., @Qal-Tek for calibration or @Ludlum for repair).



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8.2. Calibration of Exposure Rate Instruments & Direct Reading Dosimeters

Calibrations of exposure rate instruments and direct reading dosimeters are performed by an accredited calibration facility. There are two types of direct reading dosimeters used at ISU, electronic dosimeters and fiber electroscope dosimeters. Fiber electrometer dosimeters measure cumulative exposure and electronic dosimeters measure both exposure rate and cumulative exposure. Both dosimeter types are calibrated at the frequency discussed in Section 1 and Section 8.1.2.

- 8.2.1. Complete the appropriate service form (Ludlum, Qal-Tek, etc.) and make a copy as a temporary record.
- 8.2.2. Drop-off or ship the instruments to the calibration facility with the included service form.
- 8.2.3. When the instruments return from the calibration facility, upload the calibration certificate as specified in Section 8.5
- 8.2.4. Update HPAssist as specified in Section 8.5
- 8.2.5. Create a new Instrument Performance Log for the calibrated instruments as outlined in RS-24 Instrument Response Checks.
- 8.2.6. Return the instruments to the Authorized User.

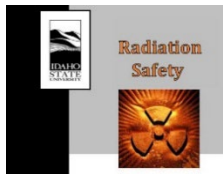
8.3. Calibration of Count Rate Instruments

Count rate instruments are calibrated using a Pulser to verify linearity of response and various sources to determine detection efficiency. General sources used for alpha and beta radioactivity are Am-241 and Tc-99, respectively. Tc-99 is used because it gives a conservatively low efficiency, this is ideal for ensuring the detection of other higher energy beta-emitters that are used at ISU. I-129 is used to determine the detection efficiency for instruments used for low energy photon detection from I-125 operations, such as the Ludlum 44-3.

- 8.3.1. Obtain the instrument user manual or manufacturer calibration to use as a reference through the calibration process.

NOTE: Instrument user manuals and calibration procedures are located on the ISU Box server. In the event a meter is purchased and no user manual is on file, obtain the manual from the instrument Authorized User or the manufacturer.

- 8.3.2. Access the form to be electronically filled out during calibration.
 - Login to ISU Box
 - Click on 'Radiation Safety Program' > 'Calibration and Survey Instrument Info' > 'Calibration Forms'

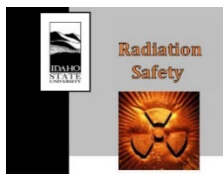


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- 8.3.3. Open 'Calibration Forms Master' Excel workbook. Go to the appropriate tab based on the instrument model to be calibrated.
- 8.3.4. Fill in the following instrument specific information found at the top of the worksheet:
 - Date (MM/DD/YYYY)
 - Authorized User
 - Instrument Serial Number (S/N)
 - Probe Model Number (Probe Type)
 - Probe S/N
- 8.3.5. Turn the instrument on and perform the following operational checks:
 - Battery check*
 - Scale zero-point check*
 - Audio check*
 - Visual/physical check*
 - Maximum printed scale value
 - Average background
 - High voltage* (Section 8.3.9)
- 8.3.6. Record the information from the operational checks in the 'As Found Checks' section of the worksheet. Checks with a * must pass in order for calibration to continue. Please notify a Radiation Safety Staff member if an instrument fails these * operational checks.
- 8.3.7. Disconnect the probe cable from the instrument by twisting the instrument-to-cable connector counter clockwise and pulling gently.
- 8.3.8. Connect the instrument to the Pulser with the appropriate double ended cable by gently pushing and twisting clockwise until it locks into place.
- 8.3.9. Turn the Pulser on and record the displayed high voltage reading in the 'As Found Checks'. Refer to the instruments' calibration procedure to ensure the high voltage is in the prescribed range.
- 8.3.10. If the value is not within range, then an adjustment is necessary. This is accomplished by accessing the instruments' calibration panel to alter the instruments outputs.

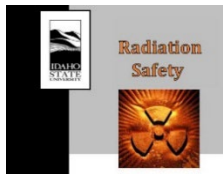
NOTE: To access the calibration panel:

- Remove the two screws from the calibration panel, typically located on the face of the instrument.



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- Use a small flat head screw driver to slowly adjust the corresponding potentiometer until the value displayed is within range.
 - The potentiometer for the high voltage will change the output voltage displayed on the Pulser.
 - Each of the multiplier potentiometers will affect the needle position and output reading displayed on the instrument (Scale specific).
 - Several potentiometers may need adjusted throughout the calibration. Replace the cover and screws once calibration on the Pulser is complete. No adjustments are necessary once the instruments' probe is reconnected.
- 8.3.12. Set the instrument to the smallest multiplier. Set the Pulser to the x1 multiplier. Using the course and fine adjustment dials set the pulse rate to the first '50% of Scale' value under the 'As Found Checks' section.
- 8.3.13. Record the instruments' displayed output count rate in the 'Instrument Response' column of the calibration form on the row corresponding to the current scale. Verify that the rates 'Pass' or are within the 'Acceptance Range'.
- 8.3.14. If the value is not within the 'Acceptance Range', then an adjustment is necessary. This is accomplished by accessing the instruments' calibration panel to alter the instruments outputs. See step 8.3.10.
- NOTE: Ensure all readings are made on the slow response setting. Adjustments and scale increases may be done on the fast response
- 8.3.15. Increase the instruments scale to the next multiplier, then do the same for the Pulser.
- 8.3.16. Repeat Steps 8.3.13 - 8.3.15. for each of the instruments' scale multipliers.
- 8.3.17. Set the instrument back to the smallest multiplier. Set the Pulser back to the x1 multiplier. Using the course and fine adjustment dials set the pulse rate to the first '20% of Scale' value under the 'Calibration' section.
- 8.3.18. Repeat Steps 8.3.13 - 8.3.15 for each of the instruments' scale multipliers.
- 8.3.19. Set the instrument back to the smallest multiplier. Set the Pulser back to the x1 multiplier. Using the course and fine adjustment dials set the pulse rate to the first '80% of Scale' value under the 'Calibration' section.
- 8.3.20. Repeat Steps 8.3.13 - 8.3.15 for each of the instruments' scale multipliers.
- NOTE: Adjustments can affect other scales after they have already been checked, the 'Performance Validation' section is a final verification that each of the scales remain within the 'Acceptable Range'.
- 8.3.21. Set the instrument back to the smallest multiplier. Set the Pulser back to the x1 multiplier. Using the course and fine adjustment dials set the pulse rate to the first '50% of Scale' value under the 'Performance Validation' section.



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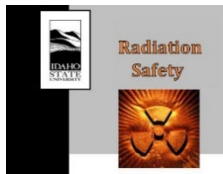
- 8.3.22. Repeat Steps 8.3.13 - 8.3.15 for each of the instruments' scale multipliers.
- 8.3.23. Turn off the Pulser and disconnect the instrument.
- 8.3.24. Replace the probe on the instrument.
- 8.3.25. Obtain all sources listed in the 'Source Information' section. Sources are located in the campus source cabinet. Sources may change for different model tabs.
- 8.3.26. Place the source jig onto the probe. Be sure to include a comment if the jig cannot be used.
- 8.3.27. Place a source into the jig and record the 'Observed Count Rate' under the 'Detection Efficiency' section on the source on the calibration form. Commonly used sources are listed below.
 - Beta: ^{99}Tc (SN: 7182-11)
 - Alpha: ^{241}Am (SN: AN-8954)
- 8.3.28. Complete the remainder of the calibration sheet and upload the calibration certificate as specified in Section 8.5
- 8.3.29. Record the detection efficiencies and the probe number on the efficiency sticker and place it on the instrument. Ensure the previous efficiency sticker is removed.
- 8.3.30. Record the calibration date and calibration due date (month and year one year from the calibration date) on the calibration sticker and place it on the instrument. Ensure the previous calibration sticker is removed.
- 8.3.31. After QA approval (Section 8.6), Update HPAssist as specified in Section 8.5
- 8.3.32. Create a new Instrument Performance Log for the calibrated instruments as outlined in RS-24, Instrument Response Checks.
- 8.3.33. Return the instruments to the Authorized User.

8.4. Calibration of Neutron Dose Rate Instruments

Neutron meters are not calibrated by the Radiation Safety Office. These instruments are sent to Ludlum Measurements to be calibrated.

NOTE: Instruments containing an internal source (i.e. ^{244}Cm) must be shipped in accordance with Procedure RS-08, Transport of Radioactive Material. Contact the RSO or ARSO for approval and further instructions.

- 8.4.1. Fill out a Ludlum Instrument Return Form. Specify which instrument is being returned and what it is being returned for (calibration or repair). If the instrument needs repair, be sure to include a brief description explain what is wrong with the instrument. Make and retain copies of the Instrument Return Form.

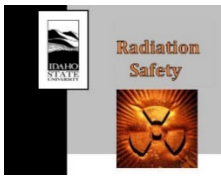


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- 8.4.2. Obtain the cardboard box that contains the correct Styrofoam molding for the corresponding neutron meter to be sent in for calibration.
- 8.4.3. Place the instrument and a copy of the Instrument Return Form in the box and tape the box shut.
- 8.4.4. Contact ISU receiving at x4047 for shipping forms. Take or arrange pick-up of the package to the ISU Shipping and Receiving department.
- 8.4.5. When the instrument is returned from Ludlum, upload the calibration certificate as specified in Section 8.5
- 8.4.6. Update HPAssist as specified in Section 8.5
- 8.4.7. Create a new Instrument Performance Log for the calibrated instruments as outlined in RS-24, Instrument Response Checks.
- 8.4.8. Return the instruments to the Authorized User.

- 8.5. Recordkeeping
 - 8.5.1. Upload the instruments calibration form for QA Review.
 - Login to ISU Box
 - Click on 'Radiation Safety Program' > 'Records' > 'Radiation Instruments' > 'Calibrations (50-1)' > Current Year
 - Save the document using the following title format 'SNXX' Where the XX is replaced with the instruments full serial number.
 - 8.5.2. Update instrument tracking information.
 - Login to the HPAssist
 - Un-check the instruments as 'out-of-service'
 - Update the 'Last Calibration' date.
 - Ensure the Calibration Frequency in the top right corner is set to 12 months.
 - Click Save and close HPAssist.

- 8.6. Quality Assurance Review
 - 8.6.1. A Radiation Safety Department staff member will perform a quality assurance review of each calibration performed at ISU.
 - 8.6.2. Upon successful review, the senior staff member will electronically sign the calibration form and move it into the appropriate Records folder.



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- 8.6.3. The instrument will be returned to the authorized user following a successful QA review, and completion of a new Instrument Performance Log.

9. LIST OF FORMS

N/A – See Required Materials Section 6

10. REFERENCES

10 CFR 20

NUREG-1556, Vol. 11

11. CHANGE HISTORY

Revision 1 – Revised the preparation of calibration forms and added QA section.

Revision 2 – Reformatted in accordance with RS-27. Removed references to calibrations performed with the Shepard source and expanded upon steps relating to calibrations performed on the Pulser.

12. APPENDICES

None.