



# Radiation Safety



## RADIATION PROCEDURES MANUAL

### Procedure Cover Sheet

**Procedure Title:** Instrument Calibrations

**Procedure Number:** RS-12 REV 1

**Effective Date:** 11-01-2020

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**Date:** 27-Oct-2020

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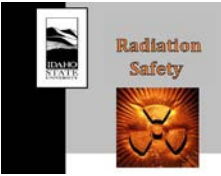
**Date:** 27-Oct-2020



Procedure #: RS-12 REV 1  
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## Table of Contents

<b>1. INTRODUCTION</b> .....	2
<b>2. PURPOSE</b> .....	2
<b>3. SCOPE</b> .....	2
<b>4. ROLES AND RESPONSIBILITIES</b> .....	2
<b>5. REQUIRED MATERIAL(S)</b> .....	3
<b>6. PROCEDURE</b> .....	3
<b>6.2. Calibration of Exposure Rate Instruments</b> .....	3
6.2.1.    Calibration with the Shepherd Source .....	4
<b>6.3. Calibration of Contamination Instruments</b> .....	5
<b>6.4. Calibration of Direct Reading Dosimeters</b> .....	6
<b>6.5. Calibration of Neutron Dose Rate Instruments</b> .....	7
<b>6.6. Recordkeeping</b> .....	7
6.6.1    Quality Assurance Review.....	8
<b>7. REFERENCES</b> .....	8
<b>APPENDIX A – Controller Instructions</b> .....	9



Procedure #: RS-12 REV 1  
Procedure Title: Instrument Calibration  
Approval Date: 10-02-2020  
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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, as required by 10 CFR 20.1501(b). Instruments for measuring exposure and dose rates are calibrated for linearity of response on all useful ranges. 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 meet the regulatory requirements of 10 CFR 20.1501(b).

## **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**

### **4.1. Authorized User**

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

### **4.2. Radiation Safety Personnel**

- Radiation safety personnel are expected to send calibration due notices to the AU one week prior to the instruments calibration due date, perform the calibration 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.

### **4.3. Radiation Safety Staff**

- Review all calibration forms.



Procedure #: RS-12 REV 1  
Procedure Title: Instrument Calibration  
Approval Date: 10-02-2020  
Effective Date: 11-01-2020

## 5. REQUIRED MATERIAL(S)

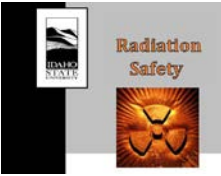
- Instrument User Manual
- Shepherd source room key
- Shepherd source room key code
- Instrument specific calibration form workbook
- Shepherd Calibration Workbook

## 6. PROCEDURE

### 6.1. Pre-Calibration Tasks

1. Check for instrument calibration due dates using HPAssist software
  - a. Log into HPAssist
  - b. Click on the **Instruments** tab.
  - c. Click on **Survey Instrument Menu -> Instruments**.
  - d. Click the **Show All** radial button and sort by **Calib Due**.
  - e. Navigate to the due dates of interest and note the instrument owner, location, type and serial number.
  - f. These instruments should be calibrated by the beginning of the month of Calib Due date but must then be calibrated within 2 months of the beginning of the month listed in the **Calib Due** field.
2. Contact the instrument owner and schedule a pick-up or drop-off time.
3. Upon receipt of the instrument, replace the batteries (located in PS 103 on the shelves on the back wall).
4. Find the appropriate user manual or procedure for the instrument(s) to be calibrated.
  - a. User manuals and procedures are located on the ISU Box server.
  - b. In the event a meter is purchased and no user manual is on file, obtain the manual from the instrument owner and/or the manufacturer.
5. Follow the calibration procedure listed in the user manual.
6. Access the instrument specific calibration form to be electronically filled out during calibration.
7. Login to ISU Box
8. Click on the **Radiation Safety Program -> Calibration and Survey Instrument Info -> Calibration Forms**
9. Select the appropriate form based on the instrument model to be calibrated.

### 6.2. Calibration of Exposure Rate Instruments



Procedure #: RS-12 REV 1  
Procedure Title: Instrument Calibration  
Approval Date: 10-02-2020  
Effective Date: 11-01-2020

Exposure rate instruments are calibrated on each useful measurement scale. Continuous digital instruments are calibrated on decade intervals (0-0.5 mR/hr, 0-5 mR/hr, 0-50 mR/hr, 0-500 mR/hr, and 0-5000 mR/hr as applicable). Instruments are calibrated using the two Shepherd sources (1 Ci for scales greater than 0-0.05 mR/hr but less than 0-5000 mR/hr and 20 Ci for the 0-5000 mR/hr scale). Instruments with a 0-50000 mR/hr scale are sent to Qal-Tek for calibration. Instruments with scales lower than 0.25 mR/hr are calibrated with a pulser on the lower scales in conjunction with the 1 Ci Shepherd source.

### 6.2.1. Calibration with the Shepherd Source

**NOTICE: The use of either Shepherd Source is restricted to approved personnel only and must be conducted in accordance with procedure RS-15, Operational Procedure for the Shepherd & Associates Sources.**

#### Preparation

1. Access the Calibration Form workbook and select the tab for the appropriate instrument type. Enter the highest whole value on the instrument scale into the cell under the column Upper Scale Reading.
2. Access the Shepherd Calibration workbook and select the "Low Range Source" worksheet. Enter the dose rates for "As Found" and "Calibration Measurements" from the Calibration Form into the Desired Exposure rate column on the Low Range Source worksheet
3. Print the spreadsheet or note the distances and attenuator combinations planned for the calibration.
4. For the 20 Ci Shepherd source, follow the instructions at the bottom of the High Range Source worksheet to determine the exposure distance using the Excel solver function.
5. Print or note the required distances obtained from the High Range Source worksheet
6. Check the condition of the desiccant in the instrument (if equipped). The desiccant will need to be replaced or revitalized if it is pink. Place the desiccant container in the microwave on the high setting for 20 seconds. The desiccant is ready for use when it has turned blue.
7. Check the instrument's batteries and replace if battery level is less than 50%.
8. Check and record the instruments high voltage, zero, audio function, alarm set points, and physical appearance on the Calibration form worksheet.

#### Instrument Calibration

9. Access the Shepherd room and set the instrument on the sliding platform so that the detector is level and facing the source. All calibrations will be performed in such a manner that the sensitive volume of the detector or chamber is fully encompassed by the beam.
10. Follow the instructions in Appendix A to set the desired distance on the controller. The measurement is made from the front surface of the calibrator to the center of the detector.
11. Adjust the camera so that the meter scale is displayed on the readout in the control room.
12. Place the desired attenuator(s) on the Shepherd.



Procedure #: RS-12 REV 1  
Procedure Title: Instrument Calibration  
Approval Date: 10-02-2020  
Effective Date: 11-01-2020

13. Lift the handle on the Shepherd to start exposure.
14. Use the bolt to prop the handle up.
  - 14.1. Close the door and use the camera to observe the instrument response.
  - 14.2. Record the instrument response on the appropriate form in the Calibration Form workbook.
  - 14.3. The instrument response should be within +/- 10 to 30% (depending on the instrument scale) of the calculated exposure.
15. Repeat the previous steps for each calculated exposure distance in the as found, calibration, and validation check sections.
  - 15.1. Even if the "As Found" readings are within acceptable range the rest of the calibration measurements must be completed
  - 15.2. Follow the adjustment procedure in the user manual if necessary.
16. For instruments that require the 20 Ci Shepherd source, follow the above steps to prepare the form and determine exposure rate distances for placement of the instrument and then use procedure RS-15 to perform the exposure.
17. Complete all sections of the instrument calibration form.
18. Follow the steps in Section 6.6 – Recordkeeping.

#### 6.2.2. Calibration with Pulser

1. Calibration of MicroR dose rate instruments, such as the Ludlum Model-19, are performed with the low-range shepherd source and the Pulser concurrently. These instruments are calibrated following the manufacturer's instructions. Calibration results are recorded on the Model-19 form in the Calibration Form Workbook.
2. Follow the steps in Section 6.6 – Recordkeeping.

### 6.3. Calibration of Contamination Instruments

Contamination detectors 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  $^{241}\text{Am}$  and  $^{99}\text{Tc}$  which gives a conservative (low) efficiency for beta-emitters used at ISU.  $^{129}\text{I}$  is used to determine detection efficiency for Ludlum 44-3 instruments used for low energy photon detection from  $^{125}\text{I}$  operations.

1. Using the pulser apply the pulse rate at the 50% level for each scale and record the output count rate on the as found section of the calibration form.
2. Using the pulser apply the pulse rate at the 20% and 80% level for each scale and record the output count rate on the calibration sections of the calibration form. Verify that the rates are within



Procedure #: RS-12 REV 1  
Procedure Title: Instrument Calibration  
Approval Date: 10-02-2020  
Effective Date: 11-01-2020

appropriate tolerance range of the expected value. If not repeat the measurement and make adjustments per the manufacturer's recommendations.

3. Using the pulser apply the pulse rate at the 50% level for each scale and record the output count rate on the validation section of the calibration form.
4. Place the probe and the appropriate alpha and beta sources (located in the source cabinet in room 103) in the source jig and record these readings.
  - Beta:  $^{99}\text{Tc}$  (SN 7182-11)
  - Alpha:  $^{241}\text{Am}$  (SN AN-8954)
5. Record the gross count rate from the source on the calibration form. The calibration form workbook will compute the net count rate.
6. The calibration form workbook computes the efficiency as the ratio of the net count rate to the decay corrected source activity and record on the calibration sheet.
7. Record the detection efficiencies and the probe number on the efficiency sticker and place it on the detector. Ensure the previous efficiency sticker is removed.
8. Complete the remainder of the calibration sheet.
9. Follow the steps in Section 6.6 – Recordkeeping.

#### 6.4. Calibration of Direct Reading Dosimeters

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.

##### Fiber Electrometer Dosimeters (Pen Dosimeters):

1. Reset the DRD to a zero reading.
  - 1.1. Resetting a DRD is accomplished by pressing it to the terminal of the yellow "gun" charger in the EHS Lab or the Idaho Accelerator Center's charger and adjusting the hairline to zero.
2. Expose the DRD to 50% of full scale (typically 100 mrem) in 30 minutes using the Shepherd source.
  - 2.1. This is done by placing the DRD at a specified distance away from the Shepherd to obtain the desired exposure rate.
  - 2.2. Expose the DRD for 30 minutes to achieve the desired total exposure.
  - 2.3. Typically this is done by exposing the DRD for 30 minutes at 200 mrem/hr to achieve a total exposure of 100 mrem.
3. Read and record this measurement on the instrument calibration form.
  - 3.1. Verify that the DRD reading is within +/- 20% of the exposure value.



Procedure #: RS-12 REV 1  
Procedure Title: Instrument Calibration  
Approval Date: 10-02-2020  
Effective Date: 11-01-2020

4. Observe the reading 24 hours later to verify that the reading has not varied more than +/- 5%. Record the variance in the “Drift” column on the instrument calibration form.
5. If the reading has varied outside of the +/- 5% acceptable range, repeat the previous steps and observe the variance again.
6. If the variance is once again out of the acceptable range, follow the instrument’s user manual or contact the manufacturer’s customer service for assistance or take the dosimeter out of service.
7. Follow the steps in Section 6.6 – Recordkeeping.

#### Electronic Dosimeters

1. Expose the dosimeter to 200 mR/hr for 0.5 hr.
2. Record the exposure rate and integrated exposure on the calibration form.
3. Ensure both values are within 20% of the true value.
4. Complete the remainder of the calibration form.
5. Follow the steps in Section 6.6 – Recordkeeping.

### **6.5. Calibration of Neutron Dose Rate Instruments**

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

**NOTE: Instruments containing an internal source (i.e., <sup>244</sup>Cm) must be shipped in accordance with Procedure RS-19-08, Transport of Radioactive Material. Contact the RSO or ARSO for approval and further instructions.**

1. Obtain the cardboard box that contains the correct Styrofoam molding for the corresponding neutron meter to be sent in for calibration.
2. Place the instrument in the box and fill out the “Instrument Return Form” located on the ISU Box server (under the title “Ludlum Calibration”) or on Ludlum’s website
  - 2.1. Specify that the instrument is being returned for calibration or repair on the form.
3. Contact ISU receiving at x4047 for shipping forms
4. Make and retain copies of the “Instrument Return Form”
5. Put the original “Instrument Return Form” form in the box with the instrument and the letter and tape the box shut.
6. Take or arrange pick-up of the package to the ISU Shipping and Receiving department.
7. When the instrument is returned from Ludlum, follow Section 6.6 – Recordkeeping.

### **6.6. Recordkeeping**





Procedure #: RS-12 REV 1  
Procedure Title: Instrument Calibration  
Approval Date: 10-02-2020  
Effective Date: 11-01-2020

1. Place the ISU calibration sticker on the instrument and record the calibration date and calibration due date (month and year one year from the calibration date). Remove any previous calibration or efficiency stickers.
2. Upload the calibration form to the ISU Box server: **Radiation Safety Program -> Records -> Radiation Instruments -> Calibrations -> Current Year > To Be Reviewed** and save the document using the following title format "Serial # 111111 Month Day Year (Note: for dosimeter forms with multiple serial numbers under the same Authorized User, enter the instrument owner in place of the serial number in the title).
3. Login to the HPAssist, open the instrument list (**Instrument -> Survey Instrument Menu -> Instruments**)
4. Select the instrument that was calibrated and update the Last Calibration date. Ensure the Calibration Frequency in the top right corner is set to 12 months.
5. Click **Save** and close HPAssist.

#### 6.6.1 Quality Assurance Review

1. A Radiation Safety Department staff member will perform a quality assurance review of each calibration performed at ISU.
2. Upon successful review, the senior staff member will electronically sign the calibration form and move it into the Current Year folder.
3. The instrument will be returned to the authorized user following a successful QA review.

## 7. REFERENCES

10 CFR 20  
NUREG-1556, Vol. 11



Procedure #: RS-12 REV 1  
Procedure Title: Instrument Calibration  
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Effective Date: 11-01-2020

## **APPENDIX A – Controller Instructions**



Procedure #: RS-12 REV 1  
Procedure Title: Instrument Calibration  
Approval Date: 10-02-2020  
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# Shepherd Motor Control Instructions

This device allows precise, hands free manipulation of the Shepherd source carriage. The user will need to calculate the distance from the source to attain desired dose rate and also ensure the correct attenuators are installed.

Limits on the carriage's range of travel are as follows (distances are from source opening to black line on Styrofoam)

**Minimum distance 11.5 in**

**Maximum distance: 108 in**

This device has two (2) power cables that must be plugged in, one powers the microcontroller and the other powers the motor. When powered on the display will read "Enter Distance".

This message indicates that the controller is waiting for user input. The user may then use the keypad to **enter a distance in inches.**

**NOTE:** The asterisk (\*) is used as a decimal point  
The pound key (#) is used to confirm and submit the input distance

**EX.** Entering 78\*12# will move the black line on the carriage to 78.12 inches from the source opening

**Prior to use, this controller must be zeroed out by following these steps. Failure to zero will result in distances being off by 11.5 inches and potential damage to device**

1. Plug in **both** power supplies for the device
2. Disengage carriage from the lead screw by lifting the bar where the carriage connects to the screw
3. Slide carriage to the forward most position (closest to the source)
4. Enter a distance "0" on the control pad and allow the motor to run (if the motor does not run then the device is already zeroed or the motor is not plugged in)
5. Re-engage carriage

Further information is available on the ISU box server

(All Files>Radiation Safety Program>Calibration and Survey Instrument Info>Shepherd>Shepherd Control Info)