Instrumentation and Dosimetry Program

I. Purpose

A. To provide the means of monitoring exposure and exposure rates to ensure exposure at or from Western Michigan University is As Low As Reasonably Achievable (ALARA).

B. To ensure instruments used to assess the radiological conditions are reliable, quality controlled, and available to maintain exposure ALARA and protect the public.
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II. Definitions

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<th>'As Found' Data</th>
<th>The readings taken when the instrument is exposed to a known dose rate prior to calibration adjustments.</th>
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<td>Calibration</td>
<td>The determination of variation or accuracy from a standard of a measuring instrument to ascertain necessary correction factors.</td>
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<td>ccpm</td>
<td>Stands for corrected counts per minute. It is derived from subtracted the background reading (cpm) from the sample or survey reading (cpm) when determining loose or fixed contamination levels.</td>
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<td>Conversion rule</td>
<td>Mathematical formula based on calibration data that converts the instrument readings from cpm to dose rate readings in mR/hr.</td>
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<tr>
<td>Declared pregnant women</td>
<td>A woman that has voluntarily informed the RSO, in writing, of her pregnancy and estimated date of conception.</td>
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<td>Dose</td>
<td>A general term that refers to absorbed dose or dose equivalent.</td>
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<tr>
<td>Exposure</td>
<td>The act of being exposed to ionizing radiation or radioactive material.</td>
</tr>
<tr>
<td>Extremities</td>
<td>The parts of the arms from the elbow to the fingertips and the legs from the knees to the toes.</td>
</tr>
<tr>
<td>Multi-purpose instruments</td>
<td>These instruments are built with a meter face that can be read in cpm or mR/hr. The multi-purpose instruments are calibrated in the count rate mode (cpm) on the x 0.1 scale and in the dose rate mode (mR/Hr) for the other scales.</td>
</tr>
<tr>
<td>Occupational exposure</td>
<td>The dose received in the course of employment in which duties involve exposure to ionizing radiation.</td>
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<tr>
<td>Personal monitoring devices</td>
<td>A device such as a film badge or pocket dosimeter designed to be worn or carried by the individual for estimating the dose received.</td>
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<tr>
<td>Pre-operational checks</td>
<td>A series of instrument checks that verify that the instrument can reproduce accurate results from use to use.</td>
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<tr>
<td>REM</td>
<td>The unit of measure of the equivalent absorbed dose in a human.</td>
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<tr>
<td>Whole body</td>
<td>For the purposes of external exposure determinations, include the head, trunk, gonads, legs above the knees, and arms above the elbows.</td>
</tr>
</tbody>
</table>

III. Responsibilities

A. Executive Manager
   1. Support the RSO and AUs in complying with the requirements of this program.

B. Radiation Safety Officer (RSO)
   1. Calibrate or send the instruments for calibration.
   2. Investigate the instrument's use for those instruments that fail the 'As Found' Data check during calibration.
   3. Review the Dose reports.
4. Co-ordinate the Quarterly exchange of personal monitoring devices.
5. Order and distribute personal monitoring devices.
6. Generate and send Individual Dose history as required or requested.
7. Maintain the records and documentation required by this program.

C. All

1. Use the instruments in accordance with procedures and practices.
2. Wear personal monitoring devices as prescribed.
3. Notify the RSO of any problems with the instruments or dosimetry.
4. Update the Pre-operational Checks Sheets for the instruments.

IV. Requirements for Instrumentation

A. Multi-purpose Instruments

1. The Ludlum Model 3 with a G-M detector.
   a. Used in the areas with a need to monitor $\beta-\gamma$ contamination and radiation levels.
   b. The x 0.1 scale is calibrated in cpm mode for contamination monitoring.
   c. Ranges - 0 - 420 cpm and 0 - 200 mR/hr
   d. Conversion rule 100 cpm = 1000 dpm

2. The Ludlum Model 14 C with a G-M detector.
   a. Used in the areas with a need to monitor $\beta-\gamma$ contamination and radiation levels.
   b. The x 0.1 scale is calibrated in cpm mode for contamination monitoring.
   c. The x 1000 scale uses an internal probe.
   d. Ranges - 0 - 660 cpm and 0 - 2000 mR/hr
   e. Conversion rule 100 cpm = 1000 dpm

B. Single-purpose Instruments

   a. Used in the areas with a need to monitor $\beta-\gamma$ radiation levels.
   b. Range - 0 - 2000 mR/hr

2. The Ludlum Model 12 with a proportional detector.
   a. Used in areas to monitor neutron radiation levels.
   b. Range - 0 - 500,000 cpm
   c. Conversion rule 75 cpm = 1 mREM/hr

3. The Ludlum Model 21 with a ZnS(Ag) probe.
   a. Used to count wipes for $\alpha$ contamination.
   b. Range - 0 - 1,000,000 cpm

4. Packard 1600 TR Scintillation Counter
   a. Used to count prepared samples for $\beta-\gamma$ contamination.
   b. Provides direct dpm results.
   c. Processes low energy $\beta$ at a minimum 60% efficiency, such as H-3 $\beta$. 
5. Packard Cobra Gamma Counter  
   a. Used to count prepared samples for $\gamma$ contamination.  
   b. Provides direct dpm results.

C. Calibration  
1. **Calibrations will be conducted by, either**  
   a. A vendor licensed by the Nuclear Regulatory Commission, or  
   b. Internal procedures reflective of and containing the requirements of the model instrument calibration program specified in Appendix O to NUREG-1556, Vol. 11, "Program-Specific Guidance about Licenses of Broad Scope."

2. **Calibration Frequency**  
   a. Annually.  
   b. Prior to initial use.  
   c. Post maintenance evolutions that may effect the calibration.  
   d. As requested by the RSO to verify proper operation.

3. Calibration failure of 'As found' data  
   a. Investigate the use of the instrument.  
   b. Conduct additional surveys, if possible and necessary, to verify previous instrument readings.  
   c. Document the results of the investigation.

4. Calibration documentation  
   a. Maintain the calibration records and applicable conversion charts for each instrument in accordance with the Administration Program procedures.

D. Pre-operational Checks  
1. Pre-operation checks provide the means to verify the instrument can reproduce accurate results from use to use.  
2. Prior to use all instruments are source checked or verified to have been source checked in accordance with their use procedures.

3. The pre-operational checks include:  
   a. A Calibration sticker verification to ensure the instrument has been and is currently calibrated.  
   b. A battery/power check to ensure the instrument will have adequate voltage supplied to the detector and meter to reproduce readings.  
   c. A source check to verify the instrument will give consistent readings to the same source from use to use and person to person.  
   d. The documentation of the checks will provide validation of previous functionality during an investigation of an instrument failure.

4. The RSO will maintain a list of all instruments and their calibration due dates as a second check to ensure an uncalibrated instrument is not used.

5. Failure of pre-operational checks.  
   a. The instrument is removed from service.  
   b. The instrument is sent for recalibration.
The RSO will investigate the use of the instrument.

i. If the instrument 'As found' data is within the acceptable ranges, close out the investigation.

ii. If the instrument 'As found' data is outside the acceptable ranges, the investigation will be completed under the calibration section.

6. Documentation of pre-operational checks.
   a. Pre-operational check records are kept with the instrument from calibration to calibration.
   b. Completed records are maintained in accordance with the Administration Program procedures.

V. Requirements for Dosimetry

A. Personal Monitoring Devices Shall Be Issued to:
   1. Individuals expected to receive occupational exposure at levels > 10 mREM/month.
   2. Individuals working with millicurie (mCi) quantities of $\eta$, $\beta$, $\gamma$, or X-Ray emitters.
   3. Individuals involved with radioactive material or radiation producing machines, who request to be monitored due to personal concerns.

B. Western Michigan University Will Use A Certified Supplier To Provide Dosimetry Services, Such As:
   1. Calibration of dosimetry,
   2. Routine and investigational readings,
   3. Reports of individual exposure.

C. Devices Worn For Establishing Record Dose Will Be Processed, Read, And Reported:
   1. Quarterly,
   2. As requested by the RSO.

D. Table of Dose Limits

<table>
<thead>
<tr>
<th></th>
<th>Federal</th>
<th>State</th>
<th>WMU Level 2</th>
<th>WMU Level 1</th>
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<tr>
<td>Whole Body</td>
<td>5,000 mREM/yr</td>
<td>1,250 mREM/qtr</td>
<td>100 mREM/qtr</td>
<td>50 mREM/qtr</td>
</tr>
<tr>
<td>Lens of the Eye</td>
<td>15,000 mREM/yr</td>
<td>1,250 mREM/qtr</td>
<td>1,000 mREM/qtr</td>
<td>500 mREM/qtr</td>
</tr>
<tr>
<td>Skin</td>
<td>50,000 mREM/yr</td>
<td>7,500 mREM/qtr</td>
<td>2,000 mREM/qtr</td>
<td>1,000 mREM/qtr</td>
</tr>
<tr>
<td>Extremities</td>
<td>50,000 mREM/yr</td>
<td>18,750 mREM/qtr</td>
<td>2,000 mREM/qtr</td>
<td>1,000 mREM/qtr</td>
</tr>
<tr>
<td></td>
<td>Federal</td>
<td>State</td>
<td>WMU Level 2</td>
<td>WMU Level 1</td>
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<tr>
<td>Declared Pregnant Woman</td>
<td>500 mREM/gestation</td>
<td>500 mREM/gestation</td>
<td>Same as Above</td>
<td>Same as Above</td>
</tr>
<tr>
<td>Minor (≤ 18 yrs)</td>
<td>10% of limits</td>
<td>10% of limits</td>
<td>75 mREM/qtr</td>
<td>N/A</td>
</tr>
<tr>
<td>Skin and Extremities</td>
<td>10% of limits</td>
<td>10% of limits</td>
<td>100 mREM/qtr</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**NOTE:** For individuals exceeding WMU Level’s, follow the Emergency Plan for an Overexposure.

1. Unplanned exposure to an individual exceeding Level 1 limits
   a. Will be investigated by the RSO to determine the cause AND why the exposure was not reviewed and planned.
   b. The RSO and AU will develop and implement a plan to prevent recurrence.
2. Unplanned exposure to an individual exceeding Level 2 limits.
   a. The RSO will restrict the individual from further exposure until the investigation is completed.
   b. Will be investigated by the RSO to determine the cause AND why the exposure was not reviewed and planned.
   c. The RSO and AU will develop and implement a plan to prevent recurrence.

E. The Quarterly Dosimetry Change Out.
   1. Film badges will be collected at the end of each quarter; Jan, Apr, Jul, Oct.
   2. A new Film Badge will be given ONLY when the previous badge has been returned.
   3. Badges can be obtained from the RSO or a prearranged Department Representative.
   4. The RSO will send expired devices to the vendor for processing.
   5. The RSO will review the vendor reports, make necessary notifications, update the individual records, and maintain the files in accordance with the Administrative Controls Program.

F. Records and Reports
   1. NRC Form 4
   2. NRC Form 5
   3. Quarterly Exposure Report
VI. **Final Conditions**
   
   A. Exposure is being monitored in accordance with the rules and regulations governing the use of radiation and radiation producing machines.

   B. Instruments are calibrated and operational.

   C. All records are maintained in accordance with the Administrative Controls Program.
Appendix A
Ludlum Model 3

The following steps will be performed by all users:

A. Perform the Pre-operational Checks:
   1. Obtain a copy of the Pre-operational Checks Sheet for the instrument.

| NOTE: | If the instrument is out of calibration or fails the second attempt of any check, remove the instrument from service and notify the RSO. |

2. Verify and record if the instrument has a valid calibration and sticker.
   a. If the instrument is out of calibration, remove the instrument from service and notify the RSO.

3. Perform an instrument battery check.
   a. Turn the range selector switch to BATT.
   b. Observe the meter deflection.
   c. Record the check as Sat or Unsat.
      i. Within the test range area, the check is Satisfactory.
         a. Proceed to instrument source check.
      ii. Outside the test range area, the check is Unsatisfactory.
         a. Turn the instrument off.
         b. Locate and remove the battery compartment cover.
         c. Open the cover.
         d. Remove and properly dispose of the batteries.
         e. Inspect the battery compartment for damage or battery acid.
            1) Stop and notify the RSO if damage or acid is noted.
         f. Place new batteries in the compartment.
         g. Close the cover.
         h. Repeat the instrument battery check.

4. Perform an instrument source check.
   a. Turn the range selector switch to the range necessary to obtain the expected source check band.
   b. Place or verify the audible response is on.
   c. Open the check source cover.
   d. Place the detector probe over the check source.
   e. Observe the needle deflection until it stabilizes for 15 seconds.
   f. Record the check as Sat or Unsat.
      i. Within the acceptance band, the check is satisfactory and the instrument is ready for use.
      ii. Outside of the test band, the check is unsatisfactory.
         a. Reposition the probe over the source.
         b. Repeat the instrument source check.
NOTE: The instrument can be used for both contamination and radiation surveys. The lowest range (x 0.1) is calibrated in the counts per minute (cpm) mode and the remaining scales in the dose rate (mR/hr) mode.

B. Operation of the instrument.
   1. Fixed contamination (frisking) monitoring.
      a. Set the meter to the x 0.1 scale for readings in cpm and turn on the audible response, if the meter has one.
      b. Determine the background levels.

NOTE: The probe should be held within 1/4 to 1/2 inch of the surface being monitored. Contact with the surface being monitored should be minimized to prevent the spread of contamination. However, it has been demonstrated that occasional contact will not contaminate the probe or another area.

c. Slowly (1" - 2" per second) move across the surface.

d. Listen to the audible response of the meter.

e. If the frequency of the audible response quickens:
   i. Stop.
   ii. Monitor the meter reading until it stabilizes for 15 seconds.

   f. Record the reading, if necessary.

2. Loose contamination (wipes) monitoring.
   a. Set the meter to the x 0.1 scale for readings in cpm and turn on the audible response.

   b. Determine the background levels in cpm.

   c. Place the wipe ¼ - ½ inch from the probe face.

   d. Note the meter reading after it has stabilized for 15 seconds.

   e. Determine the activity of the wipe in dpm.

   \[ dpm = (\text{Meter Reading (cpm)} - \text{Background reading (cpm)}) \times 10 \]

   f. Record the activity in dpm of the wipe.

3. Radiation (dose rate) level monitoring.
   a. Set the meter to the highest scale that corresponds to the expected dose and turn on the audible response, if the meter has one.

   b. General Area Radiation Survey
      i. Hold the probe about waist high and ≥ 30 cm from an object.
      ii. Slowly move about the area.
      iii. Listen to the audible response of the meter
      iv. If the frequency of the audible response quickens
a. Stop.
b. Monitor the meter reading until it stabilizes for 15 seconds.
c. Record the reading, if necessary.
v. Continue the process until a representative survey of the condition of the room has been obtained.
vi. Record the General Area readings.

c. Contact Radiation Survey
i. Hold the probe ¼ - ½ inch from the surface.
ii. Slowly (1" - 2" per second) move across the surface.
iii. Listen to the audible response of the meter
   1) Watch the meter reading if the meter does not have an audible response.
iv. If the frequency of the audible response quickens:
   a. Stop.
   b. Monitor the meter reading until it stabilizes for 15 seconds.
   c. Record the reading, if necessary.
v. Continue the process until a representative survey of the condition of the room has been obtained.
vi. Record the contact readings.
Appendix B
Ludlum Model 14 C

The following steps will be performed by all users:

A. Perform the Pre-operational Checks:
   1. Obtain a copy of the Pre-operational Checks Sheet for the instrument.

   **NOTE:** If the instrument is out of calibration or fails the second attempt of any check, remove the instrument from service and notify the RSO.

2. Verify and record if the instrument has a valid calibration and sticker.
   a. If the instrument is out of calibration, remove the instrument from service and notify the RSO.

3. Perform an instrument battery check.
   a. Turn the range selector switch to a low multiplier.
   b. Depress the battery check button
   c. Observe the meter deflection.
   d. Record the check as Sat or Unsat.
      i. Within the test range area, Record the results.
         a. Proceed to instrument source check.
      ii. Outside the test range area, the check is unsatisfactory
         a. Turn the instrument off.
         b. Locate and remove the battery compartment cover.
         c. Open the cover.
         d. Remove and properly dispose of the batteries.
         e. Inspect the battery compartment for damage or battery acid.
            1) Stop and notify the RSO if damage or acid is noted.
         f. Place new batteries in the compartment.
         g. Close the cover.
         h. Repeat the instrument battery check.

4. Perform an instrument source check.
   a. Turn the range selector switch to the range necessary to obtain the expected source check band.
   b. Place or verify the audible response is on.
   c. Open the check source cover.
   d. Place the detector probe over the check source.
   e. Observe the needle deflection until it stabilizes for 15 seconds.
   f. Record the check as Sat or Unsat.
      i. Within the acceptance band, the check is satisfactory and the instrument is ready for use.
      ii. Outside of the test band, the check is unsatisfactory.
         a. Reposition the probe over the source.
         b. Repeat the instrument source check.
**NOTE:** The instrument can be used for both contamination and radiation surveys. The lowest range (x 0.1) is calibrated in the counts per minute (cpm) mode and the remaining scales in the dose rate (mR/hr) mode.

B. Operation of the instrument.
   1. Fixed contamination (frisking) monitoring.
      a. Set the meter to the x 0.1 scale for readings in cpm and turn on the audible response, if the meter has one.
      b. Determine the background levels.

**NOTE:** The probe should be held within 1/4 to 1/2 inch of the surface being monitored. Contact with the surface being monitored should be minimized to prevent the spread of contamination. However, it has been demonstrated that occasional contact will not contaminate the probe or another area.

   c. Slowly (1" - 2" per second) move across the surface.
   d. Listen to the audible response of the meter
   e. If the frequency of the audible response quickens:
      i. Stop.
      ii. Monitor the meter reading until it stabilizes for 15 seconds.
   f. Record the reading, if necessary.

2. Loose contamination (wipes) monitoring.
   a. Set the meter to the x 0.1 scale for readings in cpm and turn on the audible response.
   
   **Note:** If the background level is > 200 cpm, relocate to an area of lower background.
   
   **Note:** If the activity requires use of a scale > x 0.1, record the reading in mR/hr/100 cm². Background, if it was < 200 cpm, will be negligible.

   b. Determine the background levels in cpm.
   c. Place the wipe ¼ - ½ inch from the probe face.
   d. Note the meter reading after it has stabilized for 15 seconds.
   e. Determine the activity of the wipe in dpm.

   \[ \text{dpm} = \left( \text{Meter Reading (cpm)} - \text{Background reading (cpm)} \right) \times 10 \]

   f. Record the activity in dpm of the wipe.

3. Radiation (dose rate) level monitoring.
   a. Set the meter to the highest scale that corresponds to the expected dose and turn on the audible response, if the meter has one.
   b. General Area Radiation Survey
      i. Hold the probe about waist high and ≥ 30 cm from an object.
      ii. Slowly move about the area.
      iii. Listen to the audible response of the meter
      iv. If the frequency of the audible response quickens
a. Stop.
  b. Monitor the meter reading until it stabilizes for 15
     seconds.
  c. Record the reading, if necessary.

v. Continue the process until a representative survey of the
   condition of the room has been obtained.

vi. Record the General Area readings.

c. Contact Radiation Survey
  i. Hold the probe ¼ - ½ inch from the surface.
  ii. Slowly (1" - 2" per second) move across the surface.
  iii. Listen to the audible response of the meter
       a. Watch the meter reading if the meter does not have an
          audible response.
  iv. If the frequency of the audible response quickens:
       a. Stop.
       b. Monitor the meter reading until it stabilizes for 15
          seconds.
       c. Record the reading, if necessary.
  v. Continue the process until a representative survey of the
     condition of the room has been obtained.
  vi. Record the contact readings.
Appendix C
Ludlum Model 14 B

The following steps will be performed by all users:

A. Perform the Pre-operational Checks:
   1. Obtain a copy of the Pre-operational Checks Sheet for the instrument.

   **NOTE:** If the instrument is out of calibration or fails the second attempt of any check, remove the instrument from service and notify the RSO.

   2. Verify and record if the instrument has a valid calibration and sticker.
      a. If the instrument is out of calibration, remove the instrument from service and notify the RSO.

   3. Perform an instrument battery check.
      a. Turn the range selector switch to a low multiplier.
      b. Depress the battery check button
      c. Observe the meter deflection.
      d. Record the check as Sat or Unsat.
         i. Within the test range area, Record the results.
            a. Proceed to instrument source check.
         ii. Outside the test range area, the check is unsatisfactory
            a. Turn the instrument off.
            b. Locate and remove the battery compartment cover.
            c. Open the cover.
            d. Remove and properly dispose of the batteries.
            e. Inspect the battery compartment for damage or battery acid.
               1) Stop and notify the RSO if damage or acid is noted.
            f. Place new batteries in the compartment.
            g. Close the cover.
            h. Repeat the instrument battery check.

   4. Perform an instrument source check.
      a. Turn the range selector switch to the range necessary to obtain the expected source check band.
      b. Place or verify the speaker is plugged in.
      c. Open the check source cover.
      d. Place the detector probe over the check source.
      e. Observe the needle deflection until it stabilizes for 15 seconds.
      f. Record the check as Sat or Unsat.
         i. Within the acceptance band, the check is satisfactory and the instrument is ready for use.
         ii. Outside of the test band, the check is unsatisfactory.
            a. Reposition the probe over the source.
            b. Repeat the instrument source check.
NOTE: The instrument can be used only for radiation surveys.

B. Operation of the instrument.
   1. Radiation (dose rate) level monitoring.
      a. Set the meter to the highest scale that corresponds to the expected dose and turn on the audible response, if the meter has one.
      b. General Area Radiation Survey
         i. Hold the probe about waist high and > 30 cm from an object.
         ii. Slowly move about the area.
         iii. Listen to the audible response of the meter
         iv. If the frequency of the audible response quickens
            a. Stop.
            b. Monitor the meter reading until it stabilizes for 15 seconds.
            c. Record the reading, if necessary.
         v. Continue the process until a representative survey of the condition of the room has been obtained.
         vi. Record the General Area readings.
      c. Contact Radiation Survey
         i. Hold the probe ¼ - ½ inch from the surface.
         ii. Slowly move across the surface.
         iii. Listen to the audible response of the meter
            a. Watch the meter reading if the meter does not have an audible response.
         iv. If the frequency of the audible response quickens:
            a. Stop.
            b. Monitor the meter reading until it stabilizes for 15 seconds.
            c. Record the reading, if necessary.
         v. Continue the process until a representative survey of the condition of the room has been obtained.
         vi. Record the contact readings.
Appendix D
Ludlum Model 12
Neutron Monitor

The following steps will be performed by all users:
A. Perform the Pre-operational Checks:
   1. Obtain a copy of the Pre-operational Checks Sheet for the instrument.

   **NOTE:** If the instrument is out of calibration or fails the second attempt at its any check, remove the instrument from service and notify the RSO.

2. Verify and record if the instrument has a valid calibration and sticker.
   a. If the instrument is out of calibration, remove the instrument from service and notify the RSO.

3. Perform an instrument battery check.
   a. Turn the range selector switch to a low multiplier.
   b. Depress the battery check button
   c. Observe the meter deflection.
   d. Record the check as Sat or Unsat.
      i. Within the test range area, the check is satisfactory.
         a. Proceed to instrument source check.
      ii. Outside the test range area, the check is unsatisfactory
         a. Turn the instrument off.
         b. Locate and remove the battery compartment cover.
         c. Open the cover.
         d. Remove and properly dispose of the batteries.
         e. Inspect the battery compartment for damage or battery acid.
            1) Stop and notify the RSO if damage or acid is noted.
         f. Place new batteries in the compartment.
         g. Close the cover.
         h. Repeat the instrument battery check.

4. Perform an instrument source check.
   a. Turn the range selector switch to the range necessary to obtain the expected source check band.
   b. Center the detector probe on the neutron source shield lid.
   c. Observe the needle deflection until it stabilizes for 15 seconds.
   d. Record the check as Sat or Unsat.
      i. Within the acceptance band, the check is satisfactory and the instrument is ready for use.
      ii. Outside of the test band, the check is unsatisfactory.
         a. Reposition the probe over the source.
         b. Repeat the instrument source check.
B. Operation of the instrument.
   1. Radiation (dose rate) level monitoring.
      a. Set the meter to the highest scale that corresponds to the expected
dose and turn on the audible response, if the meter has one.
      b. General Area Radiation Survey
         i. Hold the probe about waist high and ≥ 30 cm from an object.
         ii. Slowly move about the area.
         iii. Monitor the response of the meter.
         iv. If the meter needle jumps or accelerates:
            a. Stop.
            b. Monitor the meter reading until it stabilizes for 15
               seconds.
            c. Record the reading, if necessary.
         v. Continue the process until a representative survey of the
            condition of the room has been obtained.
         vi. Record the General Area readings.
      c. Contact Radiation Survey
         i. Hold the probe ¼ - ½ inch from the surface.
         ii. Monitor the response of the meter.
         iii. If the meter needle jumps or accelerates:
            a. Stop.
            b. Monitor the meter reading until it stabilizes for 15
               seconds.
            c. Record the reading, if necessary.
         iv. Continue the process until a representative survey of the
            condition of the room has been obtained.
         v. Record the contact readings.
Appendix E
Ludlum Model 21 with a ZnS(Ag) Probe
Alpha Counter

The following steps will be performed by all users:

A. Perform the Pre-operational Checks for the meter operating in the count rate mode:
   1. Obtain a copy of the Pre-operational Checks Sheet for the instrument.

<table>
<thead>
<tr>
<th>NOTE:</th>
<th>If the instrument is out of calibration or fails the second attempt of any check, remove the instrument from service and notify the RSO.</th>
</tr>
</thead>
</table>

   2. Verify and record if the instrument has a valid calibration and sticker.
   3. Ensure the instrument has power to it.
      a. Connect or verify the instrument is connected to a power source.
      b. Look at the power light.
   4. Perform an instrument source check.
      a. Turn the range selector switch to the range necessary to obtain the expected source check band.
      b. Place the check source under the detector probe.
      c. Observe the needle deflection until it stabilizes for 1 minute.
      d. Record the check as Sat or Unsat.
         i. Within the acceptance band, the check is satisfactory and the instrument is ready for use.
         ii. Outside of the test band, the check is unsatisfactory.
            a. Reposition the probe over the source.
            b. Repeat the instrument source check.

B. Operation of the instrument in the count rate mode
   1. Loose contamination (wipes) monitoring.
      a. Set the meter to the appropriate scale for readings in cpm

<table>
<thead>
<tr>
<th>Note:</th>
<th>If the background level is &gt; 200 cpm, relocate to an area of lower background.</th>
</tr>
</thead>
</table>

   b. Determine the background levels in cpm.
   c. Place the wipe ¼ - ½ inch from the probe face.
   d. Note the meter reading after it has stabilized for 1 minute.
   e. Determine the activity of the wipe in dpm.

   \[
   \text{dpm} = (\text{Meter Reading (cpm)} - \text{Background reading (cpm)}) \times 30
   \]
   f. Record the activity in dpm of the wipe.
C. Perform the Pre-operational Checks for the meter operating with a scaler.
   1. Obtain a copy of the Pre-operational Checks Sheet for the instrument.

   **NOTE:** If the instrument is out of calibration or fails the second attempt at its any check, remove the instrument from service and notify the RSO.

   2. Verify the instrument has a valid calibration and sticker, record the results
   3. Verify or connect the instrument to the scaler.
      a. Attach the cable to the connector to the back of Model 21
      b. Attach the other end on the cable to the scaler.
   4. Ensure the instrument has power to it.
      a. Connect or verify the instrument is connected to a power source.
      b. Look at the power light.
   5. Perform an instrument source check.
      a. Set the collection time for the background check, usually 10 minutes.
      b. Place an empty tray or sample container beneath the probe.
      c. Start the count collection.
      d. Determine the count rate by dividing the number of counts by the count time.
      e. Record the background level.
      f. Place the check source under the detector probe.
      g. Set the collection time for the sample count, usually 5 minutes.
      h. Determine the count rate by dividing the number of counts by the count time.
      i. Determine the check count rate by dividing the number of counts by the count time.
      j. Subtract the background count rate from the check count rate.
         \[ \text{Source (cpm)} - \text{Bkg (cpm)} = \text{Check count rate (ccpm)} \]
      k. Record the check as Sat or Unsat.
         i. Within the acceptance band, the check is satisfactory and the instrument is ready for use.
         ii. Outside of the test band, the check is unsatisfactory.
            a. Reposition the probe over the source.
            b. Repeat the instrument source check.

D. Operation of the instrument with a scaler.
   1. Verify the instrument has had a background check completed with 24 hours.
   2. Place the sample under the detector probe.
   3. Set the collection time for the sample count, usually 5 minutes.
   4. Determine the count rate by dividing the number of counts by the count time.
   5. Subtract the background count rate from the sample count rate.
      \[ \text{Sample (cpm)} - \text{Bkg (cpm)} = \text{Sample count rate (ccpm)} \]
NOTE: Notify the RSO of samples with an alpha (α) activity $\geq 20$ dpm.

6. Determine the activity in dpm.
   \[ \text{dpm} = \text{Sample ccppm} \times \text{instrument efficiency from the calibration data} \]

7. Record the sample activity.

8. Clean the area.

9. Dispose of samples.
   a. $< 20$ dpm α in normal trash
   b. $> 20$ dpm α in trash marked as radioactive.
Appendix F
Packard Liquid Scintillation Counter

**NOTE:** The machine must be energized for a minimum of 24 hours prior to calibrating or using the instrument.

**NOTE:** Avoid touching the viewing surfaces of the vial with your hands/fingers. The oil residue may affect the results by absorbing or refracting the light pulses emitted in the sample.

The following steps will be performed by all users:

A. Perform the Weekly Pre-operational Checks:
   1. Record your name and the date in the Weekly Pre-operational Checks Log.

**NOTE:** If the instrument is out of calibration or fails the second attempt at its any check, remove the instrument from service and notify the RSO.

      a. Obtain a large rack for the source vials.
      b. Insert the SNC flag into the rack.
      c. Place the Carbon - 14 (C-14) source vial into the 1st position.
      d. Place the Hydrogen - 3 (H-3) source vial into the 2nd position.
      e. Place the Background Standard vial into the 3rd position.
      f. Ensure the flag is extended.
      g. Place the rack into the counter with the flag on the left side of the track.

**NOTE:** [ ** ] Indicates operator action to press the key on the computer 's keyboard.

   h. [ F2 ] - to initiate the counting process.
   i. Review the computer printout when the machine completes the counting.
      i. System normalized.
      ii. C14 IPA Data Processed and efficiency.
      iii. H3 IPA Data Processed and efficiency.
      iv. BKG IPA Data Processed.
   j. If necessary, obtain the instrument efficiencies from the IPA computer files.
      i. [ F10 ] - etc.
      ii. [ F4 ] - IPA

**NOTE:** Ensure you do not change any parameters other than the IPA information parameters.

   iii. [ ↑ ] or [ ↓ ] as necessary to change the IPA parameter to C-14 or H-3.
v. Scroll to the IPA operation.
vi. [F2] - Display table.
vii. [F1] - IPA page
viii. Repeat A. 2. k.iii. – A. 2. k.viii. for the second parameter; 
     H-3 or C-14.
ix. [F1] - Status page
j. Record the results, including any abnormalities.
   i. Notify the RSO of any abnormalities noted on the printout.
l. Compare the efficiency values with the acceptance criteria,
   C-14 acceptable efficiency $\geq$ 91%
   H-3 acceptable efficiency $\geq$ 60%
i. If acceptable continue.
ii. If Unacceptable,
   a. Mark the instrument 'Out of Specification - Do Not Use'
   b. Notify the RSO
   c. Continue through the remainder of the Weekly Quality
      Control checks.
m. Return the standards to their storage place under the lid.
n. Return the rack to its storage.

B. Operation

<table>
<thead>
<tr>
<th>NOTE:</th>
<th>Indicates operator action to press the key on the computer 's keyboard.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Verifying that the Weekly Pre-operational Checks have been completed.</td>
<td>a. If the Weekly Pre-operational Checks have not been completed, Perform Section A. of this procedure.</td>
</tr>
<tr>
<td>2. Place the sample in the scintillation vial.</td>
<td></td>
</tr>
<tr>
<td>3. Add enough scintillation fluid to fill the sample vial three quarters full.</td>
<td></td>
</tr>
<tr>
<td>4. Cap the vial.</td>
<td></td>
</tr>
<tr>
<td>5. Obtain an appropriate size sample rack for the sample vials.</td>
<td></td>
</tr>
<tr>
<td>6. Choose the counting protocol flag.</td>
<td></td>
</tr>
<tr>
<td>7. Insert the flag into the rack.</td>
<td></td>
</tr>
<tr>
<td>8. Place the samples into the rack.</td>
<td></td>
</tr>
<tr>
<td>9. Ensure the flag is extended.</td>
<td></td>
</tr>
<tr>
<td>10. Place the rack into the counter with the flag on the left side of the rack.</td>
<td></td>
</tr>
<tr>
<td>11. Count the prepared samples in the Liquid Scintillation Counter.</td>
<td>a. [F2] - to initiate the counting process.</td>
</tr>
<tr>
<td>12. Record the activity of the samples from the computer printout.</td>
<td></td>
</tr>
<tr>
<td>13. Inform the RSO of any abnormalities with the counting system or results.</td>
<td>Clean the counting area.</td>
</tr>
<tr>
<td>Clean the counting area.</td>
<td>a. Discard samples with an activity of &lt; 1000 dpm/100 cm$^2$ as normal trash.</td>
</tr>
<tr>
<td>a. Discard samples with an activity of &gt; 1000 dpm/100 cm$^2$ as radioactive trash.</td>
<td></td>
</tr>
</tbody>
</table>