

RPR 51

LEAK TESTING AND INVENTORY CONTROL OF SEALED SOURCES

PURPOSE

This procedure specifies criteria and methods for performing leak tests and inventory control of sealed sources in accordance with regulatory requirements or license conditions.

POLICY

Sealed sources of radioactive material shall be tested for leakage at regular intervals to verify the integrity of the source containment and, in the unlikely event of failure, to detect the escape of radioactive material before serious contamination of facilities, equipment or personnel occurs. The frequency of leak tests, and the sensitivity of detection of escaping radioactivity, shall comply with the regulations or license conditions specified by the agency authorizing the possession of the source. Leak tests shall be performed only by qualified individuals using procedures approved by the Radiation Safety Officer. Records of sealed source leak tests shall be maintained by the Radiological Health Department.

DEFINITION

Sealed source means radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions which are likely to be encountered in normal use and handling (R313-12-3).

INVENTORY CONTROL

A physical inventory of sealed sources shall be performed at the following frequencies:

1. Every six months - sealed sources used for medical applications including check, calibration and reference use, brachytherapy, and diagnosis, including I-125 sealed sources in devices for bone mineral analysis and in portable imaging devices.
2. Every six months - all foil, plated or sealed sources for non-medical use.

LEAK TESTING

1. Sealed sources containing only radioactive material with a half life of 30 days or less need not be leak tested.
2. Sealed sources containing only tritium or only a gaseous radionuclide need not be leak tested.
3. Sealed sources containing 100 microcuries or less of beta and/or gamma-emitting material or 10 microcuries or less of alpha-emitting material need not be leak tested.
4. Teletherapy and brachytherapy sources must be leak tested every six months even if they are in storage - no exceptions. Other sealed sources containing radioactive material shall be leak tested prior to initial use and at intervals not to exceed six months.

5. Sealed sources designed to emit alpha particles must be leak tested every three months even if they are in storage - no exceptions.

6. Except for teletherapy, brachytherapy, and alpha emitting sealed sources specified in paragraphs 4 and 5 above, sealed sources that are placed in storage need not be leak tested. However, they must be leak tested before use or transfer, and they may not be stored for longer than three years without being leak tested.

7. Sealed sources for which a different frequency for leak testing is specified as a license condition shall be tested in accordance with that condition.

8. Some generally-licensed sources not included in the above categories may also be exempt from leak testing. This exemption must be verified on a case by-case basis.

REQUIRED DETECTION LIMITS

For most sealed sources, leak tests must be capable of detecting 0.005 μCi of removable activity on the outside of the source capsule or the source housing. The basic rationale for this criterion is that a non-leaking source will exhibit only background activity levels on leak tests, whereas a source that is leaking enough to present a health hazard will be easily identified at the required detection level.

PROCEDURES FOR DRY-STORAGE SOURCES

The most common method for detecting radioactivity leaking from a sealed source is to wipe the source capsule or housing with a soft-textured paper and measure the removed activity. If the source activity is in the range of millicuries, the source capsule should be wiped directly, if possible. For sources in the multi-curie range of activity, the wipes should be made on the accessible surfaces of the source housing.

Leak tests of sources containing beta-gamma emitters, e.g. Co-60 or Cs-137, may be evaluated by measuring either beta or gamma emissions. Since proportional or GM detectors offer high detection efficiencies for beta particles, beta counting and comparison with a beta-emitting source is preferred. Leak tests of sources containing nuclides that decay by electron capture, e.g. Co-57 or Ba-133, should be evaluated with gammasensitive instruments, e.g. scintillation detectors. Leak tests of sources containing alpha emitters, e.g. Pu-239, Am-241, Cf-252, etc., should be evaluated by alpha-particle measurements.

The simplest and most direct method for converting instrument count rates to total activity on a sample is to compare the count rate from the sample with that from a known reference source in approximately the same geometry. The reference source should be either the same nuclide as the source to be tested or a relatively long-lived nuclide with comparable emission energy. The reference source activity should be in the order of a few nanocuries (a few thousand dpm) and should be documented appropriately as a standard.

The results of measurements of the activity wiped from the source or its housing, and the measurements of the reference source, are to be recorded on the "SEALED SOURCE LEAK TEST RECORD" (RPR 51A). If the removed activity exceeds 0.005 μCi , the source shall be removed from service and assumed to be defective until proven otherwise. A source that shows evidence of leaking must also be reported to the licensing agency within 5 days.

PROCEDURES FOR SUBMERGED SOURCES

The method used for leak testing sealed sources that are normally stored and used in a large tank of water are based on two reasonable assumptions:

1. Any activity leaking from a source that is continually stored and used under water will be dispersed in the water and will not be readily detectable on a source recently removed from the water.
2. The water in which the source is stored is not used for drinking, although workers are exposed to it by skin contact for brief intervals. The only risk to the public from the storage-tank water would be through a major release. As long as the concentration of radioactivity in water is less than that allowed to be released to the sanitary sewer, there would be no significant risk to anyone, regardless of the amount of activity that may have leaked from the source.

The sources that fall into this category are the 5-curie ^{239}Pu -Be neutron start-up source used in the TRIGA reactor and 3 ^{252}Cf neutron sources used for sample irradiation. Both of these nuclides are alpha emitters, with concentration limits for release to the sanitary sewer of 0.2 and 0.7 pCi/mL, respectively.

As long as the sources remain in the water tanks, the 6-month leak test will consist of measurement of the alpha activity in the tank water. A concentration exceeding 0.2 pCi/mL (0.4 dpm/mL) will be used as a threshold for further action. If the measured concentration exceeds 0.4 dpm/mL, the sources will be removed from the tank, wiped immediately and placed in dry storage. If removed from the water tank for any other reason, the source(s) will also be wiped immediately and placed in dry storage. After 72 hours of dry storage, the source will be wiped again (dry). If either the immediate (wet) or the follow-up (dry) wipe exhibits more than 0.005 μCi (11,000 dpm), the source will be removed from service for further evaluation.

RECORDING AND REPORTING RESULTS

Leak test data shall be recorded on the "SEALED SOURCE LEAK TEST RECORD" (RPR 51A) or equivalent. (A spreadsheet format is available for recording and reporting results for tests of immersed sources.) If the results of the leak test are negative, i.e. $<0.005 \mu\text{Ci}$ removable activity from the source or its housing, the leak test record shall be filed with the previous survey records for that responsible user or device. The date of completion of the leak test shall be entered in the computer database to maintain scheduling for future tests. In the event that a leaking source is detected, i.e. the test results exceed the detection criterion, the RSO shall be notified immediately and a written report must be submitted to the licensing agency within 5 days. The report must include a description of the equipment used to perform the leak tests, the results obtained, and the corrective action taken.

REFERENCES

American National Standards Institute, Inc., 1973. *American National Standard for Leak-Testing Radioactive Brachytherapy Sources*, ANSI N44.2-1973, New York, NY.

National Council on Radiation Protection and Measurements, 1972. *Protection Against Radiation from Brachytherapy Sources*, NCRP Report No. 40, Washington, D.C.

U.S. Nuclear Regulatory Commission, 1974. *Leak Testing Radioactive Brachytherapy Sources*, Regulatory Guide 6.1, Washington, D.C.

Utah Department of Environmental Quality, Division of Radiation Control, *Utah Radiation Control Rules*: R313-12, "General Provisions"; R313-15, "Standards for Protection Against Radiation" and R313-32, "Medical Use of Radioactive Material."

Radioactive Materials License No. UT1800001 issued to the University of Utah by the Utah Department of Environmental Quality.

RPR 51A. SEALED SOURCE LEAK TEST RECORD

Responsible User: _____ Group #: _____ Location: _____
Source description: _____ Device/Inventory #: _____ Task #: _____
Manufacturer: _____ Serial _____ No.: _____
Nuclide: _____ Activity: _____ μCi mCi Ci (Circle one)

☐ Analysis of liquid in which immersed. Sample volume, $V =$ _____ mL
Counted as a liquid ☐ or as an evaporated solid ☐
Acceptance criterion for immersion liquid = 0.2 pCi/L = 0.4 net alpha dpm/mL.

☐ Direct wipe of source capsule or ☐ accessible surface of housing
Acceptance criterion = 0.005 μCi on wipe.

Counting instrument:

Model: _____ Ser. No.: _____ Cal. date: _____
Reference source identification: _____
Nuclide: _____ Activity, $A_r =$ _____ μCi (preferably $<0.005 \mu\text{Ci}$ or 10,000 dpm)

Background obtained from tap water ☐ or from instrument only ☐

RESULT:	Background	Reference	Sample
Total counts recorded:	$C_b =$ _____	$C_r =$ _____	$C_s =$ _____
Total count time (minutes):	$T_b =$ _____	$T_r =$ _____	$T_s =$ _____
Count rate (counts/minute):	$R_b =$ _____	$R_r =$ _____	$R_s =$ _____

Efficiency, $E = (R_r - R_b)/A_r =$ _____ net cpm/ μCi , or _____ cpm/dpm

Activity on wipe, $A_s = (R_s - R_b)/E =$ _____ μCi , or

Concentration in liquid, $A_s = (R_s - R_b)/(E \times V) =$ _____ $\mu\text{Ci/mL}$

If the result is less than the acceptance criterion, the source is acceptable for use. If the result exceeds the acceptance criterion, the source is assumed to be leaking and must be repaired or disposed of as radioactive waste.

Any sealed source that shows evidence of leaking must be reported in writing to the licensing agency (NRC or state) within 5 days.

Tested by: _____ Date: _____