Department of Health

LEAK TESTS

CONTENTS

I. REQUIREMENTS FOR AUTHORITY HOLDERS

1. WHAT IS A LEAK TEST?

A leak test (also known as a wipe tests or smear test) is a procedure which involves the following two steps:

1.1 A piece of absorbent material (e.g. tissue paper) is used to wipe the surface of a gauge containing a sealed source. If radioactive material, e.g. Caesium powder) is leaking from the source, some of the radioactive material will adhere to the tissue paper.

1.2 The absorbent material (smear sample) is monitored with a contamination monitor in order to determine whether any radioactive material (contamination) is present.

Measuring radiation levels (exposure rates) directly in the vicinity of a gauge with a radiation monitor is NOT a leak/wipe test. This is a different type of test which checks the integrity of the shielding container and confirms that levels of gamma radiation near the gauge are acceptable. It is not possible to detect contamination(and thus a leaking source) with a radiation monitor in this manner.

2. WHO MUST PERFORM LEAK TESTS

Wherever possible, leak tests should be carried out on a routine basis by the company responsible for servicing the gauge. Where this is not feasible, however, the first step of the leak test, i.e. taking the smear sample, may be performed by the authority holder's radiation protection officer or the acting radiation protection officer, or by someone acting under their instruction.

If the authority holder has access to a suitable contamination monitor, the second step, i.e. the analysis of the smear, may also be performed and recorded by the holder himself.

Usually, however, the authority holder does not have a contamination monitor. In such cases, smear samples may be sent to the supplier of the gauge, or any other institution or company who has the necessary monitoring equipment.

3. HOW MUST THE SMEAR SAMPLES BE SENT?

The smear samples should be sealed in a plastic bag, e.g. bank bags, and can be sent by road, rail or airfreight. Smear samples may NOT be sent by normal post. Freight packages need only be marked "radioactive" on the **inside**, i.e. they should be marked in such a manner that a radiation warning sign is clearly visible upon opening the package. The consignment must be correctly identified in the transport documents, and can be classed as "excepted radioactive material".

4. HOW MUST THE LEAK TEST BE CARRIED OUT?

The leak test should be performed with a piece of absorbent material, such as cotton wool, tissue, or filter paper. The material can be moistened slightly with water or alcohol, or it can be used dry.

The gauge must be turned off before the test is carried out, i.e. the source must be in the fully shielded position within the source container or housing.

Method: Gently wipe the external surface of the source container/housing, and in particular along any joints or external movable parts, where it is more feasible that contamination might occur. Do NOT dismantle any part of the gauge or source container in order to do the leak test.

For certain types of gauges, e.g. some models of fill-level detectors and thickness gauges more thorough internal leak tests can be carried out by trained representatives of the supplier of the gauge during routine maintenance or servicing. These "internal leak tests involve dismantling of the gauge and wiping the source directly, and should thus NOT be carried out by the authority holders themselves.

5. WHAT MUST BE DONE WITH LEAK TEST RESULTS?

The result of the leak test must be recorded on form RN608. This form, as well as any leak test certificates issued to the authority holder, should be safely filed and kept for inspection purposes.

If a source is found to be leaking, the Department must be notified immediately.

6. LEAK TEST FREQUENCIES

The holder of the authority must ensure that leak tests are performed as indicated in Table 1.

TABLE 1: LEAK TEST FREQUENCIES

TYPE OF APPLICATION	OTHER NAMES	LEAKTEST FREQUENCY
*Sealed sources used in any aspect of food processing must be leak tested annually		
*All radioactive sources, excluding ^{226}Ra, not being used and only being stored must be leak-tested once every two years. Stored radioactive sources must be leak-tested before being put back into use again.		
AFTERLOADING DEVICE		Annually
ALIGNMENT GAUGE		Every 24 months
ASH MONITOR		Every 24 months
ASPHALT GAUGE		Every 24 months
BELT MASS METER	CONVEYOR SCALE BELT WEIGHER	Every 24 months
BETA LIGHTS	LUMINOUS MARKERS LIGHT SOURCES LUMINOUS EXIT SIGN GUNSIGHTS	Leak tests not required.
BOREHOLE LOGGING	GEOPHYSICAL LOGGING	Annually, unless source is permanently built-in, in which case 2 yearly tests will suffice.
DENSITY GAUGE	DENSITY METER MASS FLOW METER	Every 24 months
DEWPOINT METER		Every 24 months
DUST MONITOR		Usually every 24 months
ELECTRON CAPTURE DETECTOR	GASCHROMATOGRAPH	No leak tests required.
INDUST. RADIOGRAPHY SOURCE	RADIOGRAPHY SOURCE	Every 6 months

TYPE OF APPLICATION	OTHER NAMES	LEAKTEST FREQUENCY
IRRADIATOR	IRRADIATION FACILITY EXPERIMENTAL SOURCE	Every 6 months
LEVEL GAUGE	FILL LEVEL GAUGE LEVEL CONTROL	Every 24 months
MEASURING INSTRUMENT	PHOTOMETER/SPOTMETER URANIUM ORE ANALYSER TRANSFORMER RECTIFIER TUBE SPARK/FUSE GAP MEASURER BONE OR PROFILE SCANNER SULPHUR-IN-OIL ANALYSER	Leak tests must be carried out every 24 months if the source is permanently built into the gauge; else annually.
MOISTURE GAUGE		Gauges with a movable source rod must be leak tested annually. Other, with built-in source only, must be leak tested every 24 months.
PORTABLE LEVEL GAUGE		Annually
PRE-IONISER SOURCE	PLASMA DISPLAY TUBE	Not required
REFERENCE SOURCE	SEALED SOURCE CALIBRATION SOURCE EDUCATIONAL SOURCE FLOOD SOURCE ANATOMIC MARKER	Annually. If sources are not in regular use (in storage) leak tests can be done every 24 months, and before bringing the source back into use.
SCINTILLATION COUNTER	LIQUID SCINTILLATION COUNTER	Source built into LSC's generally need not be leak tested. Loose calibration sources should be leak tested .
SMOKE DETECTORS		Not required
SOIL GAUGE	HIDRODENSIMETER SOIL METER DENSITY/MOISTURE GAUGE	Those soil gauges which have a movable source rod (usually incorporating a Cs-137 source) must be leak tested annually. Other, with built-in source only, must be leak tested every 24 months.
STATIC ELIMINATORS	ANTISTATIC STRIPS	Leak tests not required.
TELETHERAPY UNIT	CANCER THERAPY UNIT	Annually
THERAPY SOURCE	CA CERVIX APPLICATOR LINEAR SOURCE TRAIN RA-NEEDLES STRONTIUM EYE-APPLICATOR	Where appropriate, every 6 months. If sources are stored (not in use) leak tests must be done once a year and before bringing back into use.
THICKNESS GAUGE	SUBSTANCE GAUGE PROFILE SCANNER BASIS WEIGHT METER MASS FLOW METER	Every 24 months, unless the gauge incorporates a gaseous source (e.g. Kr-85, or H-3) in which case no leak test is required.
TRACERS	TRACE SOURCES	Leak tests usually not required, unless tracers are sealed sources.
UNSEALED SOURCE	IN-VIVO/IN-VITRO/RIA	Not required
XRF ANALYSER	METAL ANALYSER MINERAL ANALYSER HILGER & WATTS ANALYSER TEXAS NUCLEAR ANALYSER	Every 24 months - leak tests must be carried out in accordance with the manufacturer's specifications.

II. REQUIREMENTS FOR LEAK-TESTING FACILITIES

1. GENERAL REQUIREMENTS

A. Sealed sources and detector cells shall be tested for leakage and/or contamination at intervals as specified by the regulatory authority (see table 1).

B. In the absence of a certificate from a supplier indicating that a leak test has been made within the time specified for that source (see table 1) prior to the transfer, a sealed source or detector cell received from another person shall not be used until tested.

C. Each sealed source fabricated by the holder of the authority shall be inspected and tested for construction defects, leakage, and contamination prior to any use or transfer as a sealed source.

D. Sealed sources need not be leak tested if:

(i) they contain only hydrogen-3; or
(ii) they contain only a radioactive gas; or
(iii) the half-life of the isotope is 30 days or less; or
(iv) they contain not more than 50 microcuries (1,85 MBq) of beta and/or gamma emitting material or not more than 5 microcuries (185 kBq) of alpha emitting material; or
(v) they are not designed to emit alpha particles, are in storage, and are not being used. However, when they are removed from storage for use or transferred to another person, and have not been tested within the required leak test interval, they shall be tested before use or transfer. No sealed source or detector cell shall be stored for a period of more than 10 years without being tested for leakage and/or contamination.

E The leak testing equipment shall be capable of detecting the presence of 0.5 nanocurie (18,5 Bq) of radioactive material on the test sample. If the test reveals the presence of 5 nanocurie (185 Bq) or more of removable contamination a report shall be filed with this Directorate and the source shall be removed immediately from service and decontaminated, repaired, or disposed of in accordance with regulations. The report shall be filed within 5 days of the date the leak test result is known with this Directorate. The report shall specify the source involved, the test results, and the corrective action taken.

F. The holder of the authority is authorized to collect leak test samples for analysis. Tests for leakage and/or contamination shall be performed by persons specifically accredited by this Directorate to perform such services.

2. TRAINING FOR INDIVIDUALS RESPONSIBLE FOR LEAK TESTING

The following information should be provided about the individual(s) who will be responsible for leak testing:

(i) The person's name
(ii) The person's training:
  (a) Formal training should encompass the following topics:
    - The principles and practices of radiation protection

- Radioactivity measurements, monitoring techniques and the use of instruments
- Mathematics and calculations basic to the use and measurement of radioactivity
- The biological effects of radiation

(b) A minimum of 40 hours of formal course work should be completed by such a person

(c) On-the-job training should encompass hands-on training in leak testing the typical sources and devices specified in your application, including performing independent analysis of leak test samples.

3. FACILITIES AND EQUIPMENT:

Describe such items as:

(i) Laboratory counting rooms and calibration source storage facilities
(ii) Receiving and handling areas where leak test samples are received from customers
(iii) Shielded areas, including auxiliary shielding ("L" blocks, etc.), where bare sources may be actually leak tested
(iv) Storage facilities for sealed sources or devices that may be received by you for leak testing in your facilities
(v) Special tools for handling bare sources or devices and for wiping sealed sources or devices.

Provide this Directorate with a certificate which certifies that the equipment has the required sensitivity (see section II.1(E)).

4. RADIATION SAFETY PROGRAM:

4.1 Personnel Monitoring Equipment

All personnel should wear personnel monitoring devices such as thermoluminescent dosimeters (TLD's) when performing routine leak tests on uncontained/naked sealed sources in the low millicurie activity range and leak tests on multi-millicurie sources contained in devices.
If personnel monitoring will not be used, provide a justification that clearly demonstrates it is unlikely that any individual will receive a radiation dose equal to or greater than that specified in the regulations for non radiation workers (1 mSv a year).

4.2 Radiation Detection Instruments and Instrument Calibration

You should list the radiation detection instruments you will have available for use in performing the leak test services. Your list should specify for each instrument:

(1) the type of instrument
(2) the number of instruments available
(3) the type of radiation detected
(4) the sensitivity range
(5) the specific use.

The instruments listed should have sufficient sensitivity to accurately measure any radioactive contamination on leak test samples obtained from your customer's sources and devices.

4.2.1 Survey Meters

Survey meters must be calibrated at least once every 12 months and after any servicing of the instrument (other than a simple battery exchange). You have three options for calibration, as follows:

1. The instruments will be returned to the manufacturer for calibration,
2. If the survey instruments will be contracted out for calibration, state the name and address of the firm.
3. If the instruments will be calibrated in-house, provide the following additional information:
   (i) The name of the manufacturer and model number of each radiation source to be used,
   (ii) The nuclide and quantity of radioactive material contained in each source,
   (iii) The accuracy of each source and the traceability of the source to a primary radiation standard,
   (iv) The step-by-step procedures, including associated radiation safety procedures, you will use in calibrating, and,
   (v) The name and experience and training in instrument calibration of each individual who will perform the calibrations.

4.2.2 Wipe-Sample Counting Equipment

Quantitative measuring instruments used to perform analytic measurements on leak test samples should be calibrated before use with standard sources having an accuracy better than or equal to 5 % of the stated value. Standard sources should be traceable to a primary radiation standard such as those maintained by the National Bureau of Standards. You should supply the following information on the calibration of the listed instruments you will use to perform measurements on leak test samples:

(i) List the standard sources to be used with each listed wipe-sample counting instrument by nuclide and quantity of radioactive material contained in each of the sources.
(ii) Provide a statement of the accuracy of each standard source (information usually available from the source manufacturer). At a minimum, you should state that the accuracy of the standard will be +- 5 % of the stated value and traceable to a primary radiation standard such as those maintained by the National Bureau of Standards.
(iii) Provide an example of a calculation for converting leak test sample counting results to bequerels or nanocuries.

4.3 Operating Procedures

The following elements should be included in your operating and emergency procedures, if applicable:

(i) Instructions for performing the wipe tests, including materials to use and methods of handling samples to prevent or minimize exposure to personnel.
(ii) Surveys to be performed, such as those around the housing to be sure the device is in the "safe", "store" or "off" position before wipe samples are taken from designated areas of the device.
(iii) Surveys to be performed on wipe- or leak test samples to check for gross contamination before removal from the site.
(iv) Any specific instructions provided by source and device manufacturers on recommended methods and areas to be wiped.

(v) Instructions on what to do in case of emergencies, for example, if sources or devices are found to be leaking or excessive radiation levels are found around devices. These instructions should include procedures for proper notification to customer personnel, means of preventing and controlling the spread of contamination, and means of obtaining professional assistance, if needed.

4.4 Commercial Leak Test Kits

If you plan to manufacture and distribute commercial leak test kits for your customers' use, provide samples of each type of kit you intend to distribute. Commercial leak test kits are designed to be used by your customers to wipe specific sources or to wipe sources in specific devices; the wipes are then returned to you for analysis. Each type of kit you wish to distribute should be identified by a separate model number and clearly labeled as to the type and strength of the source or device it is designed to test.

Each kit should contain all necessary components for use:

(1) the swabs, wipes, absorbent-tipped sticks, etc., that are to be used to make the wipes on the specified sources or devices

(2) instructions for safe use of the particular kit (including the type and strength of the source the kit is designed for), step-by-step procedures for making the wipes or smears, and procedures for returning the wipes to you for analysis

(3) a label for the customer to fill out that identifies the customer's name, authority number, source or device (by manufacturer, model number, and activity) wiped, and the name of the individual who made the wipes.

You must have appropriate sample analysis equipment to properly evaluate the customers' wipes for each type of kit you wish to distribute.

4.5 Records

You should include copies or descriptions of the types of records you will maintain on leak test samples as part of the documentation of your radiation protection program.

These records should include:

(i) Identification of each source or device (manufacturer, model number, serial number, isotope, quantity)

(ii) Identification of each customer (name, address, person to contact)

(iii) Radiation survey measurements, as appropriate

(iv) Date of test and date of next scheduled test

(v) Information on test methods used (e.g., type of wipe such as dry filter paper or wet cloth swipe and areas wiped)

(vi) Leak test results expressed in bequerels or nanocuries of alpha, beta, or gamma radiation for each area wiped, and identification of the individual who performed the test.

You should include a copy of the leak test certificate you will supply to customers.

5. LEAK TEST METHODS

(This part is included for informative purposes and as a guide to promote uniformity of practice to meet the objectives of the standard.)

5.1 General

Maintenance of its integrity after testing of the sealed source is the criterion for determining that a source meets the specifications of a particular class for a given test. In the case of any test that depends on the measurement of radioactive material associated with a test source as an indicator of source capsule integrity, a comparison of activity removed from the source before and after a performance test must be the criterion. The amount of activity removed from a source following a performance test, unless related to the removable activity on the source before the test, is not a measure of leakage from the test source interior or necessarily an indication of a breach in capsule integrity.

Several methods of leak testing (integrity testing) are acceptable to determine whether sealed sources meets or fails the specifications of a test. Not all the listed leak test methods are applicable to all sources. The test, or tests, most applicable to all particular source configurations should be chosen. In the case of multiple encapsulations, different leak test methods may be appropriate for each encapsulation.

Leak Test Methods

A1. Screening measurement:
A screening measurement should be done to determine if any contamination is present. The swab should be counted for an optimised time to determine if the reading is out of the range $x \pm 2{,}58\ b$, where x is the average background and b the standard deviation of the background reading. If the measurement lies within this range there is a 99 % certainty that the reading is only background. If the value lies out of this range a quantitative analyses shall be done on the swab.

5.2 Acceptable Leak Test Methods

5.2.1 General

For the tests by radioactive means, it is assumed that the source has been cleaned and is free from radioactive surface contamination before the performance test is initiated.

5.2.2 Wipe (Smear) Test

Wipe all external surfaces of the sealed source thoroughly with a piece of filter paper or other suitable material of high wet strength and absorbent capacity, moistened with a solvent which will not attack the material of which the outer surfaces of the source are made and which, under conditions of this test, has been demonstrated to be effective in removing the radioactive substance involved. Measure the activity on the wiping material. If the activity is less than 5 nCi (185 Bq) the source is considered to be leak free.

5.2.3 Dry Wipe Test

Wipe all external surfaces of the source thoroughly with a piece of dry filter paper. Measure the activity on the filter paper. If the activity is less than 5 nCi (185 Bq), the source is considered to be leak free.

5.2.4 Immersion with Boiling Test

Immerse the sealed source in a solvent which will not attack the material of which the outer surfaces of the source are made and which, under the conditions of this test, has been demonstrated to be effective in removing the radionuclide involved. Boil for 10 minutes, remove the source (retaining the solvent) and allow to cool, then rinse the source using fresh solvent. Repeat these operations twice, for a total of three tests, using the original solvent for the boiling. Measure the total activity in the solvent. If the activity is less than 5 nCi (185 Bq) the source is considered leak free.

5.2.5 Gaseous Emanation Test (for Radium-226 Sources)

Put the sealed source to be tested into an appropriate small gas-tight container together with activated carbon or two cotton filters and leave it there for 24 hours. Take out the source and shut the container again. Measure immediately the activity of the absorber. If the activity corresponds to less than 1 nCi (37 Bq) of Radon or daughter products, the source is considered leak free.

5.2.6 Kr-85 Test

Place the cleaned sealed source in a suitable pressure chamber. Evacuate the chamber and introduce a known amount of Kr-85. Pressurize the chamber with argon to a pressure of at least 0.4 MN/m^2 (60 lb/in^2) for at least 10 minutes. Vent the chamber and place the source in a clean test chamber. Purge the chamber with argon at atmospheric pressure and allow the system to stand for at least 5 minutes. Draw a fraction of the chamber atmosphere into an evacuated, calibrated Kr-85 counting chamber. Calculate the leak rate from the counting rate. If the leak rate is less than 1×10^{-8} standard cubic centimeter per second, the source is considered leak free.

III Companies accredited by the Department of Health to analyse leak test samples

Eastern Cape

1. Outeniqua Oncology Unit, PO Box 10376, George.
   Contact: Mr W v/d Merwe, ✆: 044-884086; @: woesie.vandermerwe@cancercare.co.za

Free State

2. Biophysics Dept, Medical Faculty, UFS, Rm 444, Block E, DF Malherbe Ave, Bloemfontein.
   Contact: Prof MG Lotter, ✆: 051-405 3156/7/8.

Gauteng

3. CSIR, National Metrology Laboratory, Bldg 6, Meiring Naude Rd, Brummeria, Pretoria.
   Contact: Dr J Mostert, ✆: 012-841 3139; @: nml@csir.co.za

4. Nuclear Energy Corporation of SA, Dept. of Occupational Safety, Building P1500, Pelindaba.
   Contact: Mr Leon Genis, Tel.: 012-3053428 or
   Mr Piet Lourens, ✆: 012-3053445; @: isotopes@aec.co.za

5. SABS, Radiation Physics, Dr Lategan Rd, Groenkloof, Pretoria.
   Contact: Mr Charles Kros, ✆: 012-428 6690.

6. ChemRad Services cc, P6 Pinelands, Modderfontein, PO Box 169, Modderfontein, 1645
   Contact: Mr MJ Lalkhan, ✆: 011-606 2301; @: isotope@iafrica.com

7. Ramsey Technology, PO Box 137, Isando.
   Contact: Mr W Sturzenegger, ✆: 011-609 3101; @: willi@ramsey.co.za

8. Secony Industrial Pty Ltd, PO Box 2468, Florida, 1710
   Contact: Ms Elmarie du Toit, ✆: 011-472 0987, @: secony@freemail.absa.co.za

9. Tracerco Africa Corporation, PO Box 4852, Rivonia, 2128
   Contact: Mr Bram Beinart, ✆: 011-706 2592, @: bram@tracerco.co.za

10. Process Automation (Pty) Ltd, PO Box 1905, Randburg, 2125
    Contact: Mr Marius Venter, ✆: 011-793 1258

11. Mecosa (Pty) Ltd, PO Box 239, Bergvlei, 2012
    Contact: Mr Erich Springer, ✆: 011-887 4622; 083 675 0326

12. V.I. Instruments, 77 Smits Street, Industries West, Germiston.
    Contact: Mr Dave Pendrill, ✆: 011 878 2600; 🖷: 011 872 0650

KwaZulu-Natal

13. V.I. instruments, 12 Halifax Road, Pinetown
    Contact: Mr Grant Merchant, ✆: 031 717 6400; 🖷: 031 709 1928

Western Cape Province

14. Koeberg Nuclear Power Station, Health Physics, Melkbosstrand, Cape.
    Contact: Mr James Muller, ✆: 021-550 4911

15. Radiation Dosimetry and Protection, PO Box 678, Bellville, 7535
    Contact: Mr HF Kotzé, ✆: 073-171 5960; @: RDP01@absamail.co.za

16. Dr PR le Roux, 24 Intermezzo St, Legato, Sonstraal Hights, Durbanville, 7550
    Contact: Dr PR le Roux, ✆: 028-435 6709; 082 785 7767

17. Radiation Shielding & Protection Consultants CC, PO Box 5276, Helderberg, 7135
    Contact: Mr J van Rooyen, ✆: 082 829 8734

18. iThemba LABS, PO Box 722, Somerset West, 7129
    Contact: Mr T Modisane, ✆: 021-843 1044, @: tiro@tlabs.ac.za; 🖷: 021-843 3999

19. V.I. Instruments, Cnr. Van Riebeeck Drive & Jan Smuts Avenue, Beaconvale, Parow
    Contact: Mr Deon Quintao, ✆: 021 932 0568; 🖷: 021 932 3006

Please note that leak test samples may <u>NOT</u> be sent via ordinary mail.