South African Health Products
Regulatory Authority
Building A
Loftus Park
Arcadia
Pretoria

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GUIDELINE FOR MANAGEMENT AND DISPOSAL OF NON-NUCLEAR RADIOACTIVE WASTE

This guideline deals with the management and disposal of non-nuclear radioactive waste. The RPO and ARPO of the Authority Holders are also guided in the administrative and legal requirements of which they are subjected to.

Document History

Final Version	Reason for Amendment	Effective Date
1	First issue and published for implementation	April 2005
2	- Content structured on the new SAHPRA Guideline Template - A unique document number SAHPGL-RDN-RN-13 allocated to this Guideline	December 2022

DR BOITUMELO SEMETE-MAKOKOTLELA
CHIEF EXECUTIVE OFFICER

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Glossary

Abbreviation/ Term	Meaning
RPO	Radiation Protection Officer
ARPO	Acting Radiation Protection Officer

1. INTRODUCTION

Radioactive waste generated through the use of radioactive substances in industry, research and medicine (non-nuclear applications) is subject to regulatory control in terms of the Hazardous Substances Act, 1973 (Act 15 of 1973). The body responsible for administering this legislation is SAHPRA.

Radioactive waste consists of a great diversity of products in many physical and chemical forms containing a wide variety of radioactive nuclides at different concentration levels. The characteristics of the different waste types are essential factors which determine the choice of a safe method of waste management. Rules are therefore required for the grouping of waste into different categories depending on the proposed waste management system.

1.1 Purpose

The increasing use of radioactive substances in non-nuclear applications has resulted in a considerable increase in the quantities of radioactive waste produced. This development demands that better and more uniform control procedures be implemented to ensure optimum management of waste. The aim of this code is therefore to ensure that, through optimum waste management, the exposure of workers and members of the public to ionising radiation will be restricted to a minimum.

1.2 Scope

This guideline is intended for all RPOs and ARPOs who deals with the management and disposal of non-nuclear radioactive waste.

2. LEGAL PROVISION

The following are the relevant regulatory documents with necessary provisions:

- Hazardous Substances Act 15 of 1973
- R246, R247 Regulations related to Group IV Hazardous Substances

3. GENERAL PRINCIPLES AND PROCEDURES

The holder of an authority who works with unsealed radioactive material must introduce a waste management procedure which takes cognisance of the following factors:

- the origin of the waste
- the physical and chemical form of the waste
- the activity and the type of radioactive nuclide(s) in the waste

- the activity concentration
- the properties of the radioactive nuclide(s) (e.g. half-life, radiotoxicity, etc.)
- the planned disposal method
- the environment into which the waste will be released
- the ecological transfer mechanisms

3.1 Radiation doses

The holder of an authority must ensure that the handling, packaging, transportation and disposal of radioactive waste is carried out in such a manner that the resultant radiation doses to occupationally exposed workers, critical groups and to the population as a whole are restricted in accordance with SAHPRA's requirements.

For all operations the following three aspects must be taken into consideration:

- occupational exposure during waste handling, packaging, storage and disposal;
- individual doses to persons in critical groups.
- the collective dose resulting from the disposal of the waste;

3.2 Segregation and labelling of unsealed radioactive waste

The waste must be segregated at the point of origin into three categories:

- **Inactive waste**: Laboratory utensils or other materials which have been inside a radioisotope laboratory or which have in some other way been in the vicinity of radioactive materials, but where the risk of contamination has been very small. This type of waste may be disposed of as normal refuse.
- **Low Level waste**: Radioactive waste which does not exceed the activity limits specified in section 6 of this code. This type of waste must be disposed of in the manner specified in Section 4.
- **High Level waste**: Radioactive waste which exceeds the activity limits specified in section 6 of this code. This waste must be stored for decay or disposed of at the Necsa's nuclear waste site at Pelindaba.

To facilitate the management of the waste, further categorisation of low- and high-level radioactive waste should be carried out. Suitable categories are:

- waste containing only short-lived radionuclides which can be stored for decay prior to disposal;

- combustible waste;
- non-combustible waste;
- compactable waste;
- non-compactable waste;
- inorganic liquid waste;
- organic liquid waste;
- biological waste.

All categories may not always be applicable. For example, segregation of combustible and non- combustible waste is relevant only if there are suitable incinerators available for the waste.

At the point of origin of the waste a sufficient number of waste receptacles must be available to facilitate proper waste segregation. Suitable waste receptacles are refuse bins with foot-operated lids, lined with a strong plastic bag.

Immediately after filling a waste package (i.e. before it is removed for interim storage), it must be labelled with the following information:

- Date
- Waste producer (i.e. name of the laboratory, hospital department, etc.)
- Radionuclide content (e.g. x kBq H-3, y kBq C-14 and z kBq Sr-90)
- External surface dose rate
- Waste category or categories
- Person responsible for the waste
- The label must be signed by the person responsible for the operation producing the waste (or by someone else according to an approved local instruction)

3.3 Sealed radioactive sources

Disposal procedures for sealed sources differ from those for unsealed radioactive material. Each time a sealed source is to be disposed of, written permission must be obtained from SAHPRA. Sealed sources are usually disposed of at the Necsa's waste site at Pelindaba or, as is the case with some imported sources, are re-exported to the country of origin. Sealed sources may not be disposed of to incinerators or landfill sites.

3.4 Packaging

Packaging of radioactive waste material for transport must be secure and so designed that the package can be easily handled. The outer layer must be of such material as to avoid, as far as practicable, the collection and retention of water. There must be at least two complete layers of packaging between the radioactive waste material and the exterior of the package, one layer of which must be waterproof.

An acceptable method of handling low level radioactive waste would be to dispose of it initially to a waste receptacle lined with a plastic bag, seal the plastic bag, and then place the whole in a second plastic garbage bag, box or other suitable container (e.g. a drum) in a clean area of the user's premises. The outer containment must also be securely closed.

In the case of syringe needles, pipette tips and any other sharp objects, these must be adequately protected by means of an impenetrable sleeve or container prior to containment to ensure that they do not puncture the packaging material.

High level radioactive waste and sealed sources which are to be disposed of at the Necsa's waste site, are subject to special packaging requirements.

3.5 Transportation

All transportation of radioactive waste must be carried out in accordance with IAEA transport regulations (ref 1).

Consignments of low-level waste can generally be treated as "excepted packages" and radiation warning signs are not required to appear on the vehicle conveying the waste.

High level waste consignments must be assigned to an appropriate transport category (e.g. I- white, II-yellow, etc. See Annexure 1 - fig. 2, 3, 4) and must be labelled and transported in accordance with the relevant IAEA requirements. See Annexure 1 - fig. 5 for correct transport sign to be affixed on vehicles.

3.6 Interim storage

Radioactive waste must be stored under controlled conditions while awaiting disposal.For the interim storage of radioactive waste, the following must be taken into consideration:

- Each holder of an authority generating radioactive waste must have, or have access to, a room or location for interim storage of the waste. The available area must be large enough to store all the

waste in an orderly manner and to keep the different waste categories separate.

- Only waste which is properly labelled must be accepted for interim storage (see Section 3.2).
- The interim storage must be locked to prohibit unauthorized access.
- A radiation warning sign must be posted at the entrance to the interim storage. The telephone number of a person to contact in the event of an emergency must appear on the sign.
- The interim storage must be provided with enough shielding material, either in the walls or as movable shielding material, to ensure that doses to individuals outside the storage area are below prescribed dose limits.
- The storage must be constructed and have such surfaces on floors, benches and walls as to facilitate decontamination.
- Only radioactive waste may be stored in the interim storage room or location.
- Radioactive waste which is inflammable waste, such as certain organic liquids, must be stored in a separate part of the storage provided with special fire-fighting provisions.
- Liquid waste must preferably be absorbed in suitable material (such as vermiculite) before storage.
- When liquid waste is stored it must be placed in a secondary container, or when small volumes are involved, on a tray large enough to contain the liquid if the primary container starts leaking during storage.
- Biological waste, such as animal carcasses, must be protected against decomposing during interim storage. This can be achieved by deep freezing or by storing in jars containing formaldehyde or alcohol or in containers filled with quicklime.
- A record must be kept of waste in storage. A note must be made in the record of the date waste is removed for final disposal and to where it is taken.
- When large quantities of volatile radioactive nuclides such as H-3, I-125, and I-131 are stored, the interim storage area must be equipped with an extraction system, and regular air monitoring must be performed.

4. MECHANISMS FOR DISPOSAL OF LOW-LEVEL WASTE

Low level radioactive waste must be disposed of via one of the following mechanisms to ensure the resulting radiological impact to the environment is acceptable. Such releases must take place in accordance with the requirements and limits specified in sections 4.1 to 4.4 for the particular disposal mechanism. If these requirements and/or limits cannot be met, the waste should be disposed of at the Necsa's waste site at Pelindaba, or SAHPRA consulted with regard to alternative disposal methods.

4.1 Incineration

All incinerators used for the disposal of radioactive waste must be approved by SAHPRA. For radioactive waste under his control, the holder of an authority must at all times ensure that:

(a) Disposal of radioactive waste to incinerators is restricted to suitable waste which includes flammable solid waste (excluding sealed sources), animal carcasses, vials containing organic solvents and bulk solvent;

(b) Glass vials with closed metal caps are not disposed of because of the risk of an explosion and the possibility of radioactive glass residue in the slag; the contents of these should be transferred to plastic containers for incineration. However, glass vials with plastic caps can usually be safely disposed of in limited numbers. Plastic vials containing organic solvents are perfectly acceptable provided the smoke emitted from the incinerator stack does not contravene the standards laid down by air pollution control legislation applicable to the area. The same restriction applies to the incineration of bulk solvents;

(c) The activity per waste package and the total activity disposed of per month does not exceed the limits specified in section 6;

(d) Short-lived materials not meeting the activity and/or surface dose-rate limits for packages are stored until they have decayed to below the specified limits;

(e) Accurate records are kept of the nuclides and total activity disposed of per month to the incinerator;

(f) When disposing of radioactive waste at an incinerator, the holder of the authority or his agent shall liaise with incinerator operators to develop mutually convenient procedures for the receipt and disposal of the waste, which will minimise health hazards;

(g) When a package is sent to an incinerator it carries the following markings:

- the warning sign for ionizing radiation,
- information as to the sender,
- information regarding the mechanism of disposal (i.e. "for incineration"),
- information as to the radionuclide content and activity,

- a statement that the surface dose rate does not exceed 5 microsievert per hour (0.5 mR per hour),
- a statement that the waste package can be disposed of as low level waste;

4.2 Disposal to a sewer

For radioactive waste under his control, the holder of an authority must at all times ensure that:

(a) Radioactive waste for disposal to the sewer is restricted to aqueous solutions of radioactive materials and macerated biological material where this is acceptable to the wastewater authorities;

(b) The activity per release and the total activity per month does not exceed the limits specified in section 6 of this code;

(c) Accurate records are kept of the nuclides and total activity disposed of per month via the sewer;

(d) Release of radioactive waste is confined to one release point for each laboratory;

(e) At each release point there shall be a visible sign stating that radioactive waste may be released into the sewage system;

(f) Water to dilute the discharge is flushed before and for at least one minute after the discharge;

(g) Plumbing personnel are warned of the possible hazard prior to performing maintenance;

(h) Liquid scintillation counting vials containing chemically toxic organic compounds (e.g. toluene, xylene, etc.) are not disposed of via the sewer.

4.3 Release to the atmosphere

The holder of an authority must at all times ensure that:

(a) Discharges to the atmosphere do not create a health hazard;

(b) Effluent systems remain leak-free so that radioactive gases cannot escape into working areas;

(c) The activity per release and the total activity per month is kept as low as is reasonably achievable;

(d) Accurate records are kept of the nuclides and total activity disposed of;

(e) Filters, if required, are checked and replaced at regular intervals.

5. RESPONSIBILITIES

5.1 General responsibilities of the authority holder

In addition to the above-mentioned specific responsibilities, an authority holder who generates radioactive waste is responsible for:

(a) Obtaining SAHPRA's approval before disposing of any radioactive waste to an incinerator and providing SAHPRA with details of the proposed disposal facility, together with activities, volumes and types of radionuclides likely to be disposed of per month;

(b) Obtaining SAHPRA's approval before disposing of any liquid waste to the sewerage system and providing SAHPRA with details of the proposed discharge(s) (i.e. activities, volumes and types of radionuclides likely to be discharged per month);

(c) Obtaining SAHPRA's approval before disposing of any gaseous products into the atmosphere, and providing SAHPRA with details of:

- the design of the proposed discharge system,
- the activities, volume and types of radionuclides likely to be discharged,
- the expected frequency of discharge,
- the distribution of members of the public in the discharge area,
- proximity of air-conditioning/ventilation inlet ducts to the discharge point,
- the meteorology of the area, especially with regard to prevailing wind direction and speed,
- and providing SAHPRA with any other details as may be required;

(d) Maintaining good management procedures and keeping accurate records of the purchase, use and disposal of radioactive materials;

(e) Providing the necessary equipment for the safe handling and disposal of radioactive waste;

(f) Ensuring that all radioactive waste being transported from the premises to the place of disposal or storage is packed and transported so that in an event of an accident there will be negligible risk to the public;

(g) Ensuring that any agent transporting radioactive waste from the premises of the user and disposing of it or storing it on behalf of the user is fully informed of and understands his

responsibilities.

5.2 Responsibilities of incinerator operators

In general, they must:

(a) Obtain SAHPRA's approval before receiving any radioactive waste at an incinerator and provide the SAHPRA with details of such facilities as may be required;

(b) Familiarise themselves with the requirements of SAHPRA for the disposal of radioactive waste;

(c) Liaise with the user to develop mutually convenient procedures for the receipt and disposal of the waste, which will minimise health hazards;

(d) Only accept radioactive waste which is packaged and labelled according to SAHPRA's requirements;

(e) Maintain good management procedures and keep accurate records of the radioactive materials received and disposed of;

(f) Advise SAHPRA of any irregularities in disposal procedures which might give rise to a health hazard.

5.2.1 Incinerator operators

Incinerator operators must;

(a) Carry out such tests as may be required by SAHPRA to ensure that the incinerator may be safely used for the disposal of radioactive waste;

(b) Supply samples of slag or fly ash as may be requested by SAHPRA and/or allow officers of SAHPRA to sample them;

(c) Ensure that the maximum activity of gaseous products released to the atmosphere complies with the emission standards specified by SAHPRA;

(d) Seek approval from SAHPRA before making changes in the design or operation of the incinerator.

6. ACTIVITY LIMITS FOR LOW-LEVEL WASTE

6.1 Liquid waste

The total activity released into the sewage system may not exceed 10 ALI_{min} per month per laboratory or corresponding entity (see Annexure 2) for an explanation of the concept of ALI_{min}.) On each occasion on which a release is made, the activity may not exceed 1 ALI_{min} and must not exceed 100 megabecquerel (2,7 millicurie). The values for ALI_{min} which must be applied are shown in Table 1 (see Annexure 2). If the waste contains more than one radionuclide, the maximum permitted activity must be calculated in accordance with section 6.3.

Urine and faeces from patients who have been administered radionuclides in connection with diagnostic and therapeutic treatments may be released to the sewage system without the activity being included in the maximum permitted activity.

6.2 Solid waste

The total activity supplied to an incinerator or landfill of which SAHPRA has been informed may not exceed 10 ALImin per month per laboratory or corresponding entity. The maximum activity per waste package may not exceed 1 ALImin. The values for ALImin which must be applied are shown in Table 1 (see Annexure 2). If the waste contains more than one radionuclide, the highest permitted activity must be calculated in accordance with section 6.3.

6.3 Waste containing more than one radionuclide

Where more than one type of nuclide is disposed of to the sewage system or sent to an incinerator or landfill, the sum of the ratios of the activity of each nuclide released (A_k) to the ALI_{min} for that nuclide ($ALI_{min\ k}$) must not exceed 10 in any one month. In other words, the following shall apply to the total activity released during any one month:

$$\sum_K \frac{A_K}{ALI_{min_K}} < 10$$

For the activity in one individual waste package, or for a single release to the sewage system the following shall apply:

$$\sum_K \frac{A_K}{ALI_{min_K}} < 1$$

Thus, for example, a waste package containing two nuclides would be acceptable if it contained half an ALI_{min} of the one nuclide and half an ALI_{min} of the other, or if it contained 1/3 ALI_{min} of the one nuclide and 2/3 ALI_{min} of the other, etc.

In addition to satisfying the above equations, where a solution containing a mixture of radionuclides is released to the sewer at one time, the total activity of that solution may not exceed 100 megabecquerels (2,7 millicurie).

7. REFERENCES

The following related documents are referenced:

7.1 IAEA (1985). Safety Series no. 6, Regulations for the Safe Transport of Radioactive Material, IAEA, Vienna.

7.2 ICRP (1991). Annual Limits on Intake of Radionuclides by workers Based on the 1990 Recommendations, ICRP Publication 61, Annals of the ICRP 21(4), Pergammon Press, Oxford.

8. VALIDITY

This guideline is valid for a period of 5 years from the effective date of revision and replaces the old Code of Practice for the management and disposal of non-nuclear radioactive waste, revised May 2005. It will be reviewed on this timeframe or as and when required.

9. ANNEXURES

9.1 Annexure 1: Transport Signage Categories

ANNEXURE 1

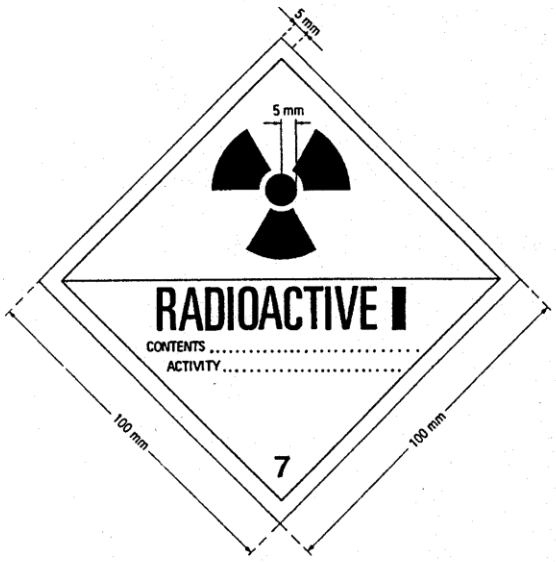

Fig 2: Category I-WHITE label. The background colour of the label shall be white, the colour of the trefoil and the printing shall be black, and the colour of the category bar shall be red.

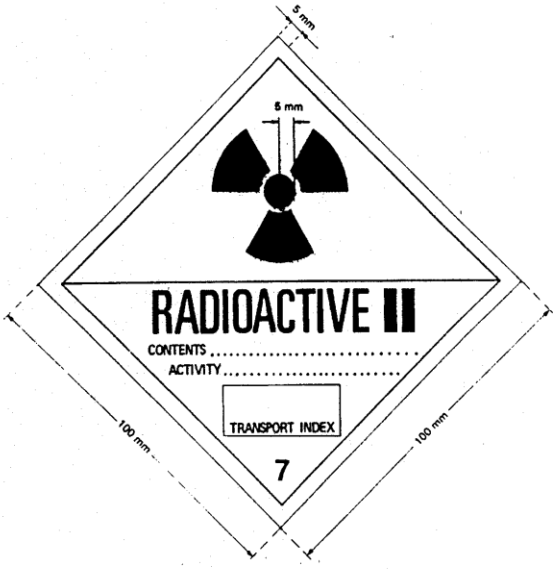

Fig 3: Category II-YELLOW label. The background colour of the upper half of the label shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

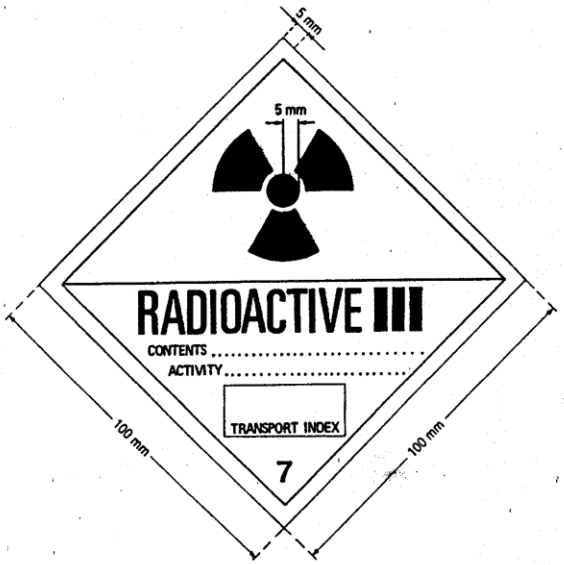

Fig 4: Category III-YELLOW label. The background colour of the upper half of the label shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

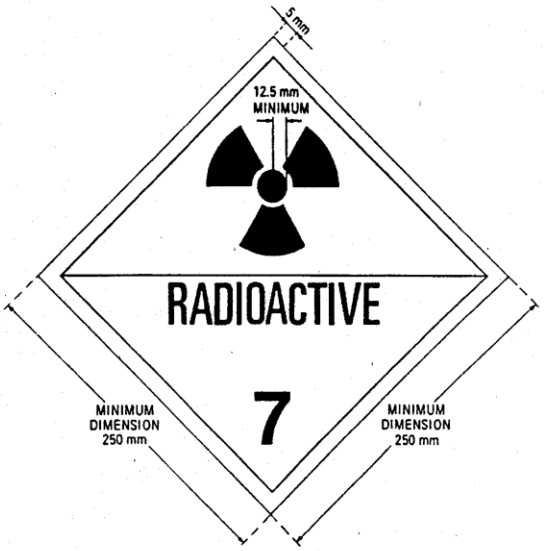

Fig 5: Placard. Minimum dimensions are given; when larger dimensions are used the relative proportions must be maintained. The figure '7' shall not be less than 25mm high. The background colour of the upper half of the placard shall be yellow and the lower half white, the colour of the trefoil and the printing shall be black.

9.2 Annexure 2: The Concept ALI_{min}

ALI's (Annual Limits on Intake) are prescribed in ICRP Publication 61 (ref 2). The limits are based on the ICRP's recommended annual dose limit of 20 mSv (2 rem). There are different ALI values for ingestion and inhalation. ALI_{min} for each nuclide means the lesser of these two values.Table 1 shows the values for ALI_{min} for the most common radionuclides. For nuclides not included in the table, SAHPRA specifies applicable values.

TABLE 1

ALI_{min} values for some common radionuclides

Nuclide	ALI_{min}(Bq)	ALI_{min}(old units)	Nuclide	ALI_{min}(Bq)	ALI_{min}(old units)
^{3}H water	$1x10^{9}$	27 mCi	^{85m}Sr	$4x10^{9}$	108 mCi
^{14}C	$4x10^{7}$	1 mCi	^{85}Sr	$1x10^{7}$	270 µCi
^{18}F	$4x10^{8}$	11 mCi	^{87m}Sr	$7x10^{8}$	19 mCi
^{22}Na	$7x10^{6}$	189 µCi	^{89}Sr	$2x10^{6}$	54 µCi
^{24}Na	$5x10^{7}$	1.4 mCi	^{90}Sr	$6x10^{4}$	1.6 µCi
^{32}P	$5x10^{6}$	135 µCi	^{90}Y	$5x10^{6}$	135 µCi
^{33}P	$3x10^{7}$	810 µCi	^{99m}Tc	$1x10^{9}$	27 mCi
^{35}S	$3x10^{7}$	810 µCi	^{99}Mo	$1x10^{7}$	270 µCi
^{36}Cl	$3x10^{6}$	81 µCi	^{113m}In	$9x10^{8}$	24 mCi
^{38}Cl	$2x10^{8}$	5.4 mCi	^{124}Sb	$3x10^{6}$	81 µCi
^{42}K	$5x10^{7}$	1.4 mCi	^{123}I	$9x10^{7}$	2.4 Ci
^{43}K	$9x10^{7}$	2.4 mCi	^{125}I	$1x10^{6}$	27 µCi
^{45}Ca	$1x10^{7}$	270 µCi	^{129}I	$2x10^{5}$	5.4 µCi
^{47}Ca	$1x10^{7}$	270 µCi	^{130}I	$1x10^{7}$	270 µCi
^{51}Cr	$2x10^{8}$	5.4 mCi	^{131}I	$8x10^{5}$	22 µCi
^{52}Mn	$1x10^{7}$	270 µCi	^{132}I	$7x10^{7}$	1.9 mCi
^{52m}Mn	$3x10^{8}$	8.1 mCi	^{109}Cd	$1x10^{6}$	27 µCi
^{54}Mn	$1x10^{7}$	270 µCi	^{115}Cd	$1x10^{7}$	270 µCi
^{56}Mn	$9x10^{7}$	2.4 mCi	^{111}In	$5x10^{7}$	1.4 mCi
^{52}Fe	$1x10^{7}$	270 µCi	^{129}Cs	$3x10^{8}$	8 mCi
^{55}Fe	$3x10^{7}$	810 µCi	^{130}Cs	$7x10^{8}$	19 mCi
^{59}Fe	$5x10^{6}$	135 µCi	^{131}Cs	$3x10^{8}$	8 mCi
^{56}Co	$2x10^{6}$	54 µCi	^{134}Cs	$1x10^{6}$	27 µCi
^{57}Co	$8x10^{6}$	216 µCi	^{134m}Cs	$1x10^{9}$	27 mCi
^{58}Co	$7x10^{6}$	189 µCi	^{137}Cs	$1x10^{6}$	27 µCi
^{60}Co	$4x10^{5}$	11 µCi	^{131}Ba	$4x10^{7}$	1 mCi
^{63}Ni	$1x10^{7}$	270 µCi	^{133m}Ba	$3x10^{7}$	810 µCi
^{64}Cu	$2x10^{8}$	5.4 mCi	^{135m}Ba	$4x10^{7}$	1 mCi
^{67}Cu	$5x10^{7}$	1.4 mCi	^{140}La	$8x10^{6}$	216 µCi
^{65}Zn	$4x10^{6}$	110 µCi	^{192}Ir	$3x10^{6}$	81 µCi
^{69m}Zn	$5x10^{7}$	1.4 mCi	^{198}Au	$1x10^{7}$	270 µCi
^{67}Ga	$8x10^{7}$	2.16 mCi	^{197}Hg	$6x10^{7}$	1.6 mCi
^{68}Ga	$2x10^{8}$	5.4 mCi	^{203}Hg	$1x10^{7}$	270 µCi
^{73}As	$2x10^{7}$	540 µCi	^{201}Tl	$3x10^{8}$	8 mCi
^{74}As	$9x10^{6}$	243 µCi	^{204}Tl	$3x10^{7}$	810 µCi
^{75}Se	$9x10^{6}$	243 µCi	^{210}Pb	$1x10^{4}$	270 nCi
^{76}Br	$5x10^{7}$	1.4 mCi	^{212}Pb	$5x10^{5}$	14 µCi
^{77}Br	$2x10^{8}$	5.4 mCi	^{210}Po	$1x10^{4}$	270 nCi
^{82}Br	$4x10^{7}$	1.1 mCi	^{226}Ra	$9x10^{3}$	243 nCi
^{81m}Rb	$2x10^{9}$	54 mCi	^{232}Th	$9x10^{1}$	2.4 nCi
^{81}Rb	$4x10^{8}$	11 mCi	^{238}U	$6x10^{2}$	16 nCi
^{86}Rb	$8x10^{6}$	216 µCi	^{241}Am	$3x10^{2}$	8 nCi
^{88}Rb	$2x10^{8}$	5.4 mCi	^{244}Cm	$5x10^{2}$	14 nCi
^{89}Rb	$4x10^{8}$	11 mCi	^{252}Cf	$5x10^{2}$	14 nCi