

RADIONUCLIDE AND RADIATION PROTECTION DATA HANDBOOK 2002

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RADIONUCLIDE AND RADIATION PROTECTION DATA HANDBOOK
2nd Edition (2002)

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Radiation Protection Dosimetry is abstracted or indexed in RADIATION PROTECTION ABSTRACTS, Chemical Abstracts, CURRENT CONTENTS, Energy Information Abstracts (Cambridge), EXCERPTA MEDICA (EMBASE), Health and Safety Science Abstracts (Cambridge), INIS ATOMINDEX (hard copy and CD ROM), INSPEC, Nuclear Energy (Czech Republic), QUEST and Referativnaja Zhurnal.

Preface

RADIONUCLIDE AND RADIATION PROTECTION DATA HANDBOOK (2002)

This handbook is an updated and expanded (2nd edition) version of the handbook with the same title published in 1998. That handbook was in turn based on an earlier French laboratory guidebook *A Guide on Radionuclides and Radioprotection* by D. Delacroix, J.P. Guerre, and P. Leblanc, published in 1994⁽¹⁾. The earlier publication was very much oriented towards guidance on the handling of radionuclides used in medicine. The present handbook is much more broadly based in its outlook and application and incorporates updated information to take account of the most recent ICRP and IAEA recommendations⁽¹⁻⁴⁾. The radionuclides listed in the earlier publication were supplemented by commonly used radionuclides in the nuclear industry and in other areas. Moreover, the main purpose of this handbook (and its 1998 predecessor) is the provision of data sheets and the models or sources used to assemble the data, rather than as a radiation protection guide for laboratory users.

This practical handbook of data for handling radioactive materials is intended for radiation protection specialists as well as all others who use or transport radionuclides. Its publication should satisfy a major need for all health physics departments and is intended to assist in informing and training personnel in radiation protection. It consists of an explanatory text followed by specific radiation data sheets for selected radionuclides. Because of the disparities in the approaches adopted by different countries, it is essential that users also refer to the relevant national regulations with which they must comply.

The present handbook includes 36 additional radionuclides than the previous edition, giving a total of 144 nuclides. Additional data are included covering dose rates above uniformly contaminated surfaces (infinite plane source). Some corrections to data in the previous edition have been incorporated. The list of nuclides is not exhaustive but those included have been selected on the basis of being most commonly used, taking into account the requirements of users in industry, medicine and research. Finally, account is taken of the need to consider decay chain products for several heavy elements. To this end, an appendix is provided giving the decay products and their activities as a function of time (age), together with decay charts for four of the more complex chains.

**Directeur Central de la Sécurité
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Abstract— This handbook is a reference source of radionuclide and radiation protection information. Its purpose is to provide users of radionuclides in medicine, research and industry with consolidated and appropriate information and data to handle and transport radioactive substances safely. It is mainly intended for users in low and intermediate activity laboratories. Individual data sheets are provided for a wide range of commonly used radionuclides (144 in total). These radionuclides are classified into five different groups as a function of risk level, represented by colours red, orange, yellow, green and blue, in descending order of risk.

INTRODUCTION

In recent years the need for a compilation of essential data for commonly used radionuclides, for both practice and training, has become increasingly apparent.

This handbook contains individual data sheets for a range of radionuclides and is mainly intended for users of unsealed radioactive sources in low and intermediate activity laboratories, industrial applications and transport.

Individual data sheets corresponding to the different radionuclides give the physical characteristics, reference transport activities, exemption levels, contamination derived limits and appropriate detection probes, dose rates from skin contamination, half and tenth value shielding thicknesses, external exposure data, dose coefficients for ingestion and inhalation, derived 20 mSv ALI values, and the highest dose organ. The maximum activities recommended to be handled on benches, under fume hoods and in glove boxes are also given. However, this information is most appropriate in laboratories handling low and intermediate levels of radioactive materials. In order to facilitate the user's understanding, pictorial illustrations have been employed and data is presented in tabular form.

It should be noted that the data provided, although drawn from appropriate recent international recommendations, should in no way be taken to supersede existing local or national regulations. The data may, of course, be used to review existing local regulations which may have become out of date.

The text preceding the data sheets provides the background, derivation and substantiation for the data given, enabling users to satisfy any quality assurance arrangements that may be in place.

SCOPE

This handbook provides the most up to date internal and external dosimetry information and control criteria

in the form of data sheets in an easy to use format for 144 of the most commonly used radionuclides in medicine, research and industry. It is designed as a ready reference source of information, gathering together in one place, in the form of individual data sheets, the most up to date isotopic and radiation protection data. The information includes:

- ◆ half-life and specific activity,
- ◆ main emissions,
- ◆ IAEA Basic Safety Standards exemption levels,
- ◆ IAEA A₁ and A₂ transport values,
- ◆ external exposure data for a range of geometries,
- ◆ surface contamination data, detection and limits,
- ◆ shielding information,
- ◆ ICRP dose per unit intake data by ingestion and inhalation,
- ◆ 20 mSv ALI values and the highest organ dose, and,
- ◆ maximum recommended activities in Controlled and Supervised Areas.

Most of the data provided are relevant to all users. However, the section and data dealing with maximum recommended activities are only appropriate to low and intermediate activity laboratories. These laboratories are frequently limited to two to three orders of magnitude higher than the exemption limits by local or national regulations.

CLASSIFICATION OF RADIONUCLIDES

Radionuclides have been divided in this handbook into five 'risk groups'. The classification used is based on the BSS 'quantity' exemption limit values. Exemption limit values have been chosen for this purpose because they reflect both internal and external exposure risks. Each group is associated with a colour (red, orange, yellow, green and blue successively represent decreasing levels of risk). The data sheets have been appropriately coloured providing the reader with a rapid visual means of appreciating the risk associated with

particular radionuclides. The five risk groups have been defined as follows:

- Group 1: exemption limit $\leq 10^4$ Bq (red)
- Group 2: exemption limit = 10^5 Bq (orange)
- Group 3: exemption limit = 10^6 Bq (yellow)
- Group 4: exemption limit = 10^7 Bq (green)
- Group 5: exemption limit $\geq 10^8$ Bq (blue)

In the rare cases for which exemption levels have not been defined (e.g. ^{11}C , a nuclide sometimes used for medical imaging) a group has been assigned by analogy with other radionuclides of the same type.

Attention is drawn to the fact that radioactive substances are also chemical substances, the handling of which may involve hazards of non-radiological origin. Moreover, radioactive substances are often intimately mixed with chemical products having an aggressive action on the human body (toxic, mutagenic and carcinogenic effects). Chemical hazards should therefore never be neglected.

PHYSICAL CHARACTERISTICS OF RADIONUCLIDES

The following characteristics are considered in these sheets.

Half-lives expressed in the most appropriate units (hours, days, years).

Specific activities expressed as $\text{Bq}\cdot\text{g}^{-1}$.

Exemption levels

Exempt activity concentrations ($\text{Bq}\cdot\text{g}^{-1}$) and exempt activities (Bq) are defined in the IAEA Basic Safety Standards⁽²⁾ and in the L159 Euratom Directive⁽³⁾. These limits can be used by regulatory authorities to define criteria for exemption against formal registration of the premises and may also be used to develop clearance levels for materials leaving the premises. The exemption levels also apply in the transport regulations. The correct use of these limits by users is of utmost importance. Users should refer to the above mentioned references.

A₁ and A₂ reference transport activities

A₁ and A₂ are the maximum activities (expressed in TBq) that can be transported by A type packages. A₁ corresponds to radioactive matter in 'special form' and A₂ to the other cases.

In the data sheets, the values correspond to values in the 1996 edition of The IAEA publication *Regulations for the Safe Transport of Radioactive Materials*⁽⁴⁾, with which the international modal transport authorities (RID, ADR, IMO, ICAO, etc.) are harmonised. Users seeking further details are referred to the referenced texts.

The nature of the main radiation⁽⁵⁾

α , β , e^- , X, γ radiation and neutron emissions are given, together with the corresponding energies expressed in keV, and corresponding percentage emissions. A maximum of the three most characteristic emissions is given for each type of radiation, the criterion adopted being the relevance of the emissions from the radiation protection standpoint. However, in order to remedy the restrictive effects of this approach (some radionuclides exhibit multiple emissions, e.g. ^{140}La and ^{152}Eu), the relative percentage emissions not taken into consideration are nevertheless given.

RADIOLOGICAL CONTROL

External exposure risks

The following modes of exposure are considered.

Contact

When handling radioactive materials, the operator may touch the receptacle (e.g. beaker, pipette, syringe) containing the radioactive substance or materials contaminated with this substance. The radioactive substance can also become deposited on the skin.

Distant source

All parts of the operator's body generally remain distant from the radioactive substances being handled, even though certain parts of the body such as the hands and forearms occasionally approach these substances during handling operations with or without manipulators.

Immersion in a cloud

This type of relatively infrequent hazard is encountered when handling gaseous radioactive sources. The corresponding risks must be taken into consideration, for example, in laboratories using cyclotrons to manufacture short half-life radionuclides (e.g. ^{18}F , ^{11}C , ^{123}I).

Internal exposure risks

The risks arise from three different possible paths into the human body:

- ◆ *Inhalation* after the dispersion of gases, vapours or aerosols in the environment;
- ◆ *Ingestion* by contaminated hands or objects through contact with the mouth;
- ◆ *Transfer through the skin* with or without an associated wound following contamination of parts of the body (which have not been sufficiently rapidly decontaminated) or following simple contact with highly penetrating radionuclides (e.g. tritium in

tritiated water) or chemically aggressive substances (acidic solutions, solvents, etc.).

Dose limits for workers^(2,6)

The occupational exposure of any worker should not exceed the following limits, but may also be subject to more restrictive limits in appropriate local or national regulations.

- ◆ an effective dose of 100 mSv over a period of five consecutive years (i.e. 20 mSv per year) averaged over this period;
- ◆ an effective dose of 50 mSv in any single year;
- ◆ an equivalent dose to the lens of the eye of 150 mSv in a year;
- ◆ an equivalent dose to the extremities (hands and feet) or the skin of 500 mSv in a year.

It is noted that the IAEA⁽²⁾ states that

Compliance with the foregoing requirements for application of the dose limits on effective dose shall be determined by one of the following methods:

(a) by comparing the total effective dose with the relevant limit, where the total effective dose E_T is calculated according to the following formula:

$$E_T = H_p(d) + \sum_j e(g)_{j, \text{ingestion}} \cdot I_{j, \text{ingestion}} + \sum_j e(g)_{j, \text{inhalation}} \cdot I_{j, \text{inhalation}}$$

where $H_p(d)$ is the personal dose equivalent from exposure to penetrating radiation during the year. Note that $e(g)_{j, \text{ingestion}}$ and $e(g)_{j, \text{inhalation}}$ are the committed effective dose per unit intake by ingestion and inhalation for radionuclide j by the group of age g , and $I_{j, \text{ingestion}}$ and $I_{j, \text{inhalation}}$ are the intakes via ingestion or inhalation for radionuclide j during the same period.

(b) by satisfying the following conditions:

$$H_p(d)/DL + \sum_j (I_{j, \text{ingestion}}/I_{j, \text{ingestion,L}}) + \sum_j (I_{j, \text{inhalation}}/I_{j, \text{inhalation,L}}) \leq 1$$

where DL is the relevant dose limit on effective dose, and $I_{j, \text{ingestion,L}}$ and $I_{j, \text{inhalation,L}}$ are the annual limits on intake (ALI) via ingestion or inhalation of radionuclide j .

(c) by any other approved method.

Note that the symbols used in the quote are consistent with those used in this handbook but not the original IAEA document. The above quantities are briefly explained in Schedule II of Reference 2.

EXTERNAL EXPOSURE

Assumptions

X ray, γ , β , e^- and neutron emissions lead to external exposures depending on the nature and energies of the corresponding radiation as well as the packaging and geometry of the source. Depending on the particular case being studied, superficial exposures (or skin exposures) defined at a depth of 7 mg.cm^{-2} or deep body exposures⁽⁷⁾ are taken into consideration.

Various handling postures and situations commonly encountered in laboratories are considered. Calculations have been performed for unique values of source or solution activity; in this way a direct comparison between the values obtained under different circumstances can be made. A nominal activity of 1 MBq has been adopted for external exposures, exposures resulting from contacts with receptacles and exposures to distant sources. A nominal value of 1 kBq has been adopted for the case of skin contamination due to droplets and 1 kBq.cm^{-2} for uniform skin contamination. Exposures due to an infinite and uniformly contaminated surface at 1 MBq.cm^{-2} are also considered. Data are provided for distances of 10 cm and 1 m from the contaminated surface for beta and photon radiation for the skin and deep tissue. The quantity adopted for all geometries for tabulated data is dose equivalent, expressed in mSv.h^{-1} (millisievert per hour).

The handling postures adopted in this handbook for some operations with radionuclides in the form of unsealed sources may not actually represent what is done in practice (e.g. use of a syringe or beaker). However, the user, by analogy, can transform the values indicated into those corresponding to other receptacles of similar dimensions, on the basis that the situations shown are reasonably typical.

The following codes have been used for the calculations:

- ◆ Microshield Version 4.10 has been used for γ and X ray calculations (Grove Engineering, 15215 Shady Grove Road, Rockville, USA, 1996)
- ◆ Varskin mod 2 for β radiation and Varskin mod 2 modified for monoenergetic electrons (J.S. Durham, Pacific Northwest Laboratory, PO Box 999, Richland, Washington 99352, USA).

Distant (point source) external exposure

The cases of a point source at a distance of 30 cm (average length of forearm) in air and a 'penicillin' type vial at a distance of 1 m in air⁽⁸⁾ are considered successively. In the latter case, the source is represented by a cylinder with a density of 1 g.cm^{-3} , 2.3 cm in diameter and 2.5 cm high enclosed in a 1.5 mm thick glass (density 2.7 g.cm^{-3}) envelope.

In the case of a point source at 30 cm, the deep or whole-body dose equivalent due to X and γ ray compo-

nents is distinguished from the superficial or skin dose equivalent due to β and e^- components. This is done in order to draw the operator's attention to the fact that the superficial dose equivalent can be considerably reduced by interposing a screen with a thickness equivalent to the maximum range of the β and e^- components.

A deep dose equivalent is given for a vial at 1 m (this corresponds to the distance between the operator and the bench or table).

Exposures to a uniformly contaminated surface

Exposures due to a uniformly contaminated source (floors) are considered. The contributions due to beta radiation and photons are considered separately for distances of 10 cm and 1 m from an infinitely and uniformly contaminated surface. This separation enables users to make appropriate decisions as to what measurement equipment should be used. Pure beta emitters generally cannot be detected with gamma detectors. Dose rates at 10 cm and 1 m are often similar because the increased distance is compensated by the increased solid angle. Data is quoted for the dose equivalent at depths representing the skin and deep tissue respectively.

External contact exposure (receptacles)

The cases of a 50 cm³ beaker containing 20 cm³ of solution and a 5 cm³ syringe containing 2.5 cm³ of solution are considered. The beaker is represented by a cylinder with a density of 1 g.cm⁻³, 4 cm in diameter, 1.6 cm high enclosed in a 2 mm thick glass (density 2.7 g.cm⁻³) envelope.

The syringe is represented by a cylinder with a density of 1 g.cm⁻³, 1.2 cm in diameter, 2.2 cm high enclosed in a 1 mm thick plastic (density 1 g.cm⁻³) envelope.

In both cases dose equivalents have been calculated under 7 mg.cm⁻² at the level of the solution (an arrow indicates the position taken into consideration)⁽⁸⁾.

The position indicated corresponds to the maximum dose equivalent to which an operator can be exposed when manipulating these receptacles. Attention is drawn to the fact that these drawings, for pedagogical reasons, show the operator's hands and fingers as far away from the source as possible.

The dose equivalents depicted take both β and γ components into consideration. It should, however, be noted that in the case of a beaker (2 mm thick glass), β components (other than those emitted by radionuclides such as ⁴²K, ⁹⁰Y and ¹⁴⁴Pr) can be neglected. In the case of a syringe (1 mm thick plastic), the β contribution can be highly significant (e.g. 24 mSv.h⁻¹ for 1 MBq ³²P).

Note that good agreement is observed between the values quoted here and those found in the literature⁽⁹⁻¹²⁾.

β ray absorption in shielding gives rise to bremsstrahlung (X rays).

With high activity sources bremsstrahlung radiation can make a significant contribution to dose. Attention is drawn to this in the data sheets. It is for this reason that 'Brem. Rad.' is indicated on data sheets corresponding to pure β emitters (¹⁴C, ³⁵S, ³³P, ³⁶Cl and ⁴⁵Ca) for which the calculated dose rates behind shielding are very low or even zero. These radionuclides are very much used in laboratories.

SHIELDING OF BETA AND GAMMA EMITTERS

The range of betas and electrons and the attenuation of X and γ rays in shielding materials depends on the energies of the incident radiation and the nature of the shielding material.

Total absorption thicknesses have been determined for β and e^- radiation in glass and plastic⁽¹³⁾; these materials are those most commonly used for this purpose. In the case of γ and X rays, the first half-value and tenth-value thicknesses of lead and steel (attenuating the incident radiation by a factor of 2 and 10 respectively) are given.

Attention is drawn to the fact that some radionuclides simultaneously emit significant low and high energy components for which first half-value and tenth-value thicknesses may be considerably less than second half-value and tenth-value thicknesses. ¹²³I is an example but the data provided here do not cover this situation.

CONTAMINATION

Contact exposure due to external skin contamination

Two situations have been considered to illustrate body contamination. Firstly, exposure due to an extensive uniformly spread out contamination of the skin^(9,14,15) is considered and secondly, the projection of a 0.05 cm³ droplet of a radioactive substance. The droplet is represented by a cylinder with a density of 1 g.cm⁻³, a cross sectional area of 1 cm² and a height of 0.5 mm⁽⁸⁾.

Dose equivalent values have been calculated for an average 70 μ m basal layer depth. At this depth the main component of the dose resulting from superficial contamination of the skin is due to β rays and electrons from the radionuclide; the γ contribution to the dose is generally just a few per cent. Comparison between the values due to a uniform (infinitely thin) deposit and those due to a droplet highlights the effects of β attenuation in tissue. It is assumed here that penetration of the contamination in the skin can be neglected.

Decay products

Decaying radionuclides are generally treated as follows:

- ◆ radionuclides (parent–progeny) couples are assumed to be in equilibrium;
- ◆ calculations are performed for a nominal activity of the parent nuclide (e.g. 1 kBq.cm⁻² for uniform skin contamination);
- ◆ parent–progeny radionuclide decay schemes are normally covered in a single sheet, but when physical separation of the constituents is possible (e.g. by elution), progeny products are treated in individual sheets. The ⁹⁹Mo–^{99m}Tc couple is an example of this. The reader will find both ⁹⁹Mo–^{99m}Tc and ^{99m}Tc sheets.
- ◆ transfer of surface contamination to the skin leading to external extremity exposures
- ◆ whole-body exposure due to surface contamination.

The DSCL is defined by the following equation:

$$1/DSCL = 1/As_{atm} + 1/As_{ingestion} + 1/As_{skin} + 1/As_{surf}$$

where As_j is the activity per unit surface area of the contaminated zone leading to annual limits due to each of the four modes of exposure (considered separately). Limits of 20 mSv.y⁻¹ and 500 mSv.y⁻¹ are considered for whole body external exposure and skin exposure, respectively. The most restrictive ALI_{inhalation} and ALI_{ingestion} values calculated for 20 mSv.y⁻¹ are used in the following derivations of surface activity for limiting internal contamination.

Decay of heavy elements

In the case of heavy element decay chains (e.g. lead, radium, uranium, plutonium and americium), where the parent and progeny are not necessarily in equilibrium (e.g. after chemical separation or extraction of an element) the respective activities of each of the progeny in the chain will depend upon the age of the sample. It is not possible to cover all situations likely to be encountered but the Appendix to this handbook includes selected major heavy element decay chains and the activities of respective progeny in the chain are given as a fraction of the parent activity as a function of time (age since separation) for 0.1 day, 1 day, 10 days, 100 days, 1 year, 10 years and 100 years. The parent radionuclides for which this information is provided are marked '!' in the main data sheets, including an indication of the first and last elements within the chains.

A similar approach can be adopted if data on natural uranium or re-constituted 'natural' uranium are required by taking into account the isotopic composition.

The data in the Appendix are derived using RadDecay version 1.13⁽¹⁶⁾.

Derived surface contamination limits

The derived surface contamination limit (DSCL) is a non-regulatory quantity enabling exposure risks due to removable and/or fixed surface contamination to be quantified. Exposure to the DSCL leads to a dose which does not exceed the maximum annual occupational exposure limit (corresponding to 2000 working hours). A model is used to determine the DSCL values corresponding to the different radionuclides dealt with⁽¹⁷⁾. This model takes different modes of exposure and transfer parameters into consideration. These data are given for completeness and the values do not supersede limits imposed by regulations, which are invariably much lower.

Occupational exposures may result from:

- ◆ transfer of surface contamination to the atmosphere leading to internal exposure through inhalation
- ◆ transfer of surface contamination to the organism through ingestion

Calculation of As_{atm}

As_{atm} is the value of the activity per unit surface area of the contaminated zone which leads to an ALI_{inhalation} dose with an atmospheric re-suspension factor, T_{atm} , of 10⁻⁴ m⁻¹ and an annual occupational exposure of 2000 h with a respiratory volume rate, R , of 1.2 m³.h⁻¹.

As_{atm} (Bq.cm⁻²) is given by the following equation:

$$As_{atm} = ALI_{inhalation} / (T_{atm} \times 2000 R \times 10^4)$$

Calculation of $As_{ingestion}$

$As_{ingestion}$ is the value of the activity per unit surface area of the contaminated zone which leads to an ALI_{ingestion} dose with an organ transfer factor, $T_{ingestion}$, of 1 cm².h⁻¹ and an annual occupational exposure of 2000 h. This component may simulate, for example, the risk due to a chronic exposure at a working post.

$As_{ingestion}$ (Bq.cm⁻²) is given by the following equation:

$$As_{ingestion} = ALI_{ingestion} / (2000 T_{ingestion})$$

Calculation of As_{skin}

As_{skin} is the value of the activity per unit surface area of the contaminated zone leading to an annual skin dose of 500 mSv for an occupational exposure of 2000 h and a skin transfer factor, T_{skin} of 0.1. It is assumed that contamination is eliminated on a daily basis when the user washes on leaving the working zone. Neither radioactive decay nor the renewal of skin cells (which contribute towards eliminating radioactivity) are taken into account.

As_{skin} (Bq.cm⁻²) is given by the following equation:

$$As_{skin} = 500 / (T_{skin} \times 2000 \times D_p)$$

where D_p (mSv.h⁻¹) is a conversion coefficient giving

the dose rate in tissue beneath 7 mg.cm^{-2} for a skin contamination of $1 \text{ Bq.cm}^{-2(14,15)}$.

Calculation of $A_{s_{\text{surf}}}$

$A_{s_{\text{surf}}}$ (Bq.cm^{-2}) is the value of the activity per unit surface area of the contaminated zone leading to an effective dose equivalent of 20 mSv for an occupation exposure of 2000 h.

$A_{s_{\text{surf}}}$ (Bq.cm^{-2}) is given by the following equation:

$$A_{s_{\text{surf}}} = 20 / (2000 D_{\text{floor}})$$

where D_{floor} (mSv.h^{-1}) is a conversion coefficient giving the effective dose equivalent 1 m above a floor infinitely and uniformly contaminated at $1 \text{ Bq.cm}^{-2(14)}$.

Alpha emitters

The DSCL value corresponding to most radionuclides lies between 1 Bq.cm^{-2} and 10^5 Bq.cm^{-2} , and, in general, is of the order of 100 Bq.cm^{-2} . In the case of alpha emitters, the model can lead to very restrictive values; a lower limit of 0.04 Bq.cm^{-2} has been imposed for alpha emitters.

Determination of removable and fixed contamination values

DSCL values enable derived limits to be determined for removable (or non-fixed) and fixed contamination. The above limits enable the potential risk to users from surface contamination to be assessed together with the most appropriate means for decontamination.

In the case of removable contamination, the derived limit is defined as being equivalent to 1/10th of the DSCL value of the radionuclide considered (this allows possible occupational exposures of other origins to be taken into consideration).

In the case of fixed contamination, the derived level is defined as the value corresponding to a whole-body exposure from a uniformly contaminated floor equivalent to 1/10th of the annual exposure limits of 20 mSv. The DSCL value for fixed contamination always exceeds the value for removable contamination. For some radionuclides such as 'pure' beta or alpha emitters, the ratio of the two values can be highly significant (radiation from the floor being negligible). In this handbook, the DSCL value for fixed contamination is set at a maximum of 100 times the derived limit for removable contamination (e.g. see ^{14}C on page 24). Regulations do not usually include specific limits for fixed contamination since its effect is taken into account in external radiation levels.

Contamination control

The level of removable contamination of working zones and materials must be kept as low as reasonably

practicable by appropriate maintenance and cleaning operations. When accidental contamination (even of very low level) occurs, decontamination must be carried out as quickly as possible.

Detection probes

Surface contamination due to many of the radionuclides covered in these sheets can be detected with soft β , β , α , X ray or γ probes.

Preferences given to particular types of probe or instrument are indicated for each type of radiation. A single + means that such a type of probe or instrument can possibly be used, double ++ means that this type of probe or instrument is recommended, whilst the absence of a + sign means that that type of probe or instrument is not suitable. Absence of a + sign in any box means that direct measurement is inappropriate and a wipe test, in association with a suitable detection system, such as liquid scintillation methods, would be appropriate. This applies only to tritium in this handbook but the same technique can be applied with advantage to low levels of contamination of other radionuclides, especially those with low penetration emissions.

INTERNAL EXPOSURE

Committed effective dose per unit intake

Internal exposures resulting from ingestion and inhalation are evaluated with the dose coefficients, $e(g)_{\text{ingestion}}$ and $e(g)_{\text{inhalation}}$, expressed in Sv.Bq^{-1} , and identically given by the ICRP⁽¹⁸⁾, the IAEA Basic Safety Standards⁽²⁾ and the L159 Euratom Directive⁽³⁾. Listed values take the age of exposed individuals into account (>1 year, 1–2 years, 2–7 years, 7–12 years, 12–17 years and >17 years) as well as their status (public or occupational exposure). In this handbook only occupational exposures are considered.

The committed effective dose per unit intake via ingestion is given for different gut transfer factor, f_1 , values. This factor quantifies the proportion of intake transferred to body fluids in the gut and depends on the chemical form of the radionuclide.

The committed effective dose per unit intake via inhalation is given for three default lung absorption types (fast, moderate, slow). These coefficients depend on the chemical form and particle size of the aerosol. It is recalled that particle size is quantified by aerodynamic median activity diameter (AMAD) parameters. Inhalation coefficients are given for 1 and 5 μm AMAD values. Indication of the different forms for each nuclide that correspond to different gut transfer factors and lung absorption types are given in the data sheets. In some cases, for example phosphorus and sulphur, where the nuclide may form part of the anion, the gut transfer factor or lung absorption types may be predominantly

determined by the associated cation. These are indicated in the data sheets.

Annual Limits on Intake (ALI)

Annual Limits on Intake by ingestion and inhalation ($I_{\text{ingestion,L}}$ and $I_{\text{inhalation,L}}$) are given in order to assist users who are not familiar with the dose per unit intake coefficients discussed above. $I_{\text{ingestion,L}}$ and $I_{\text{inhalation,L}}$ are calculated using the following relationship⁽¹⁹⁾:

$$I_L = D_L/e(g)$$

where D_L is the average annual limit of 20 mSv. I_L values can be considered to be ALI values.

$ALI_{\text{ingestion}}$ and $ALI_{\text{inhalation}}$ values are given in the data sheets for an average annual 20 mSv limit and the most restrictive $e(g)$ values, respectively. They are calculated values⁽¹⁹⁾, not values given by ICRP, and users should be aware of this. The references should be consulted, where appropriate, for further information.

The 'highest dose organ'

Various metabolic and dosimetric models have enabled retention and excretion functions after intake by inhalation by Reference Man to be established⁽¹⁹⁻²¹⁾. These models have also enabled committed whole-body and organ doses to be determined. Some organs preferentially concentrate particular radionuclides. Therefore, the data sheets indicate which is the 'highest dose organ' (e.g. the thyroid in the case of iodine nuclides). The 'highest dose organ' depends on physicochemical form and whether intake results from ingestion or inhalation. Only inhalation (for an AMAD of 1 μm) is considered in this handbook. It should also be noted that these functions depend on the clearance time from the pulmonary region to the remainder of the body (F, M, S). Therefore, the 'highest dose organ' may also depend on the elimination class. ^{90}Sr is an example; depending on whether F or S classes are considered either bone surface or lungs can be considered as being the 'highest dose organ'. However, for some chemical forms the associated anion or cation may be more important in this context.

General

Internal exposure values are determined using various established metabolic and dosimetric models and hypotheses, which are subject to review by ICRP. *Interpretation of the results of these analyses should be done by specialists.*

MAXIMUM RECOMMENDED ACTIVITIES

Operators or competent radiation protection personnel often require order-of-magnitude estimates on the maximum activities that can be handled with available

equipment (chemical benches, fume hoods, glove boxes) or in given working areas (controlled or supervised areas). Whilst the purpose of this handbook is to provide data rather than advice on practices, it is felt appropriate to include information on 'maximum recommended activities'.

The data provided are appropriate to low and intermediate level laboratories and not to high level laboratories, where extensive professional radiation protection expertise will be available.

Calculation models

The maximum activity (A_o) corresponding to a particular nuclide and handling situation is characterised by the potential risk associated with handling specific nuclides. External exposure due to γ and β radiation components and the re-suspension of the nuclide in the atmosphere are taken into consideration.

A_o (Bq) is determined from the following relationship:

$$1/A_o = 1/A_{\text{beta}} + 1/A_{\text{gamma}} + 1/A_{\text{volatile}}$$

where A_{beta} (Bq) and A_{gamma} (Bq) represent the maximum activities determined for a point source at a distance of 30 cm in air. These activities are calculated for the following dose rate limits:

250 $\mu\text{Sv.h}^{-1}$ under 7 mg.cm^{-2} for beta components,
10 $\mu\text{Sv.h}^{-1}$ for gamma components.

A_{volatile} (Bq) is related to potential atmospheric contamination risks directly dependent on the volatility of the radioactive product.

In free air, A_{volatile} is given by the expression:

$$A_{\text{volatile}} = 10^{-2} ALI_{\text{inhalation}}/k,$$

where k is the volatility factor.

It should be noted that the maximum recommended activities given in these sheets have been determined using the most restrictive $ALI_{\text{inhalation}}$ values described above; k values, related to the volatility of the product, are defined as follows:

- ◆ $k = 1$: gases, substances with high saturation vapour pressures of about 1 bar at 20°C, substances penetrating the skin, particles smaller than 5 μm .
- ◆ $k = 0.1$: substances with saturation vapour pressures of about 0.1 bar at 20°C, particles larger than 5 μm .
- ◆ $k = 0.01$: low volatility substances with saturation vapour pressures of about 0.01 bar at 20°C (e.g. water).
- ◆ $k = 0.001$: non-volatile substances with saturation vapour pressures less than 0.01 bar at 20°C.

Dependence of maximum recommended activities on equipment and working areas

The following additional rules are used to determine

the recommended limits for benches, fume cupboards and glove boxes:

- ◆ It is forbidden to manipulate highly volatile substances ($k > 0.01$) or radionuclides with $ALI_{\text{inhalation}}$ values lower than 1000 Bq on chemical benches because even a low level contamination could lead to a significant $ALI_{\text{inhalation}}$ fraction that would be difficult to detect.
- ◆ Manipulating substances under a fume hood is considered to increase protection by a factor of 10 in comparison with an open bench.
- ◆ Manipulating substances in a glove box is considered to increase protection by a factor of 100 in comparison with fume hoods.
- ◆ Maximum recommended levels of activity in supervised areas are nominally 3/10 of those in controlled zones (this approximately represents the respective exposure limits defined for these areas). However, the installation of glove boxes in supervised zones is generally deprecated; the level of protection afforded by a glove box is considered incompatible with the definition of such zones. It should be noted that the factor of 3/10 may be masked by rounding the data to one significant figure; rounding in any other way may imply an unjustified degree of accuracy in the models used for deriving the recommended levels of activity.

Limitations

Area control

The values indicated in these sheets apply mainly to the supervised and controlled areas of low and intermediate activity laboratories. Maximum recommended activities have further been limited to:

- Group 1 (red) 0.5 GBq
- Group 2 (orange) 5 GBq
- Group 3 (yellow) 5 GBq
- Group 4 (green) 5 GBq
- Group 5 (blue) 50 GBq

These limits have been imposed because such laboratories are not generally equipped with either a means for continuously monitoring the working environment, or for rejecting gases at a sufficient height to ensure that no recycling takes place.

It should be noted that values calculated in compliance with these rules are *guide values and are only indicative* since other non-quantifiable parameters such as working methods and human factors must also be taken into account. Nevertheless, it has been observed that when practices are performed in accordance with these simple rules, only very low levels of atmospheric contamination and exposure occur.

The maximum recommended levels for elemental trit-

ium (^3H), tritiated water and ^{37}Ar have been deliberately reduced because of the difficulty of detecting the corresponding surface or atmospheric contamination. This factor can be modified in particular situations, depending on survey and control frequencies. In the case of iodine isotopes (^{123}I , ^{125}I , ^{131}I), the existence of particularly unstable states (with the possibility of I_2 release) has been considered. The corresponding limitations are consequently much more stringent.

Radiation control

Handled or stored activity values must comply with external exposure limits in situations where the external radiation hazard may be more restrictive than the internal radiation hazard. Attention is drawn to this fact in the data sheets by the remark 'Subject to external exposure requirements which may be more restrictive'. Stored activities may exceed maximum recommended activities by a factor of 10, subject to any limits imposed by local or national regulations.

In particular cases, listed values may be varied in local regulations, based upon assessments by professional radiation protection specialists.

DESCRIPTION OF DATA SHEETS

General

Individual data sheets provide data in five main areas, namely basic radionuclide data, external exposure, contamination, internal exposure and maximum recommended activities in laboratory situations. These are divided into physical characteristics, (half life, specific activity and decay scheme, A_1 and A_2 reference transport activities, exemption levels, data for external exposure for five different geometries, external and internal exposure limits, appropriate contamination detection probes and half-value and tenth-value shielding thicknesses. The maximum activities that can be handled on benches, under fume hoods or in glove boxes are also given. The 'highest dose organ' is indicated, even where this is the whole body. As described earlier the data sheets are coloured red, orange, yellow, green or blue, indicating, in descending order of risk, the level of risk posed by the particular radionuclide.

GLOSSARY

Activity

The number of nuclear transformations occurring in a given amount of radionuclide per unit time. The SI unit of activity is the reciprocal second, s^{-1} , with the special name becquerel (Bq).

Annual limit of intake

The intake by inhalation or ingestion of a given radionuclide in a year by the Reference Man which would result in a committed dose equal to the relevant dose limit.

Bremsstrahlung

X rays produced by deceleration of β particles in materials.

Committed equivalent dose

Following an intake to the body of a radioactive material, the time integral of the equivalent dose rate is called the committed equivalent dose. If the integration time following the intake is not specified, it is implied that the value is 50 years for adults.

Equivalent dose

The equivalent dose, $H_{T,R}$ is defined as

$$H_{T,R} = W_R D_{T,R}$$

where $D_{T,R}$ is the absorbed dose delivered by radiation type R averaged over a tissue or organ T and W_R is the radiation weighting factor for type R radiation. When the radiation field is composed of different radiation types, the equivalent dose is $H_T = \sum_R W_R D_{T,R}$.

Effective dose

The quantity E, defined as a summation of the tissue equivalent doses, each multiplied by the appropriate tissue weighting factor ($E = \sum_T W_T H_T$ where H_T is the equivalent dose in tissue T and W_T is the tissue weighting factor for tissue T). From the definition of equivalent dose it follows that $E = \sum_T W_T \sum_R W_R D_{T,R}$.

Radioactive half-life

Time required for a radioactive substance to lose 50% of its activity by radioactive decay.

Half-value and tenth-value thickness (or layer)

The thickness of material necessary to reduce the intensity of X or gamma radiation by a factor of 2 and 10, respectively.

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TABLE OF RADIONUCLIDES LISTED

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Cerium - 141	(¹⁴¹ Ce ₅₈)	119	Bismuth - 214	(²¹⁴ Bi ₈₃)	145
Cerium - 143	(¹⁴³ Ce ₅₈)	120	Polonium - 210	(²¹⁰ Po ₈₄)	146
Praseodymium - 143	(¹⁴³ Pr ₅₉)	121	Radium - 226	(²²⁶ Ra ₈₈)	147
Praseodymium - 144	(¹⁴⁴ Pr ₅₉)	122	Thorium - 231	(²³¹ Th ₉₀)	148
Promethium - 147	(¹⁴⁷ Pm ₆₁)	123	Thorium - 234	(²³⁴ Th ₉₀)	149
Samarium - 153	(¹⁵³ Sm ₆₂)	124	Protactinium - 234	(²³⁴ Pa ₉₁)	150
Europium - 152	(¹⁵² Eu ₆₃)	125	Protactinium - 234m	(^{234m} Pa ₉₁)	151
Europium - 154	(¹⁵⁴ Eu ₆₃)	126	Uranium - 233	(²³³ U ₉₂)	152
Europium - 155	(¹⁵⁵ Eu ₆₃)	127	Uranium - 234	(²³⁴ U ₉₂)	153
Europium - 156	(¹⁵⁶ Eu ₆₃)	128	Uranium - 235	(²³⁵ U ₉₂)	154
Erbium - 169	(¹⁶⁹ Er ₆₈)	129	Uranium - 238	(²³⁸ U ₉₂)	155
Thulium - 170	(¹⁷⁰ Tm ₆₉)	130	Neptunium - 239	(²³⁹ Np ₉₃)	156
Thulium - 171	(¹⁷¹ Tm ₆₉)	131	Plutonium - 238	(²³⁸ Pu ₉₄)	157
Ytterbium - 169	(¹⁶⁹ Yb ₇₀)	132	Plutonium - 239	(²³⁹ Pu ₉₄)	158
Rhenium - 186	(¹⁸⁶ Re ₇₅)	133	Plutonium - 240	(²⁴⁰ Pu ₉₄)	159
Rhenium - 188	(¹⁸⁸ Re ₇₅)	134	Plutonium - 241	(²⁴¹ Pu ₉₄)	160
Iridium - 192	(¹⁹² Ir ₇₇)	135	Americium - 241	(²⁴¹ Am ₉₅)	161
Gold - 198	(¹⁹⁸ Au ₇₉)	136	Americium - 243	(²⁴³ Am ₉₅)	162
Mercury - 197	(¹⁹⁷ Hg ₈₀)	137	Curium - 244	(²⁴⁴ Cm ₉₆)	163
Mercury - 203	(²⁰³ Hg ₈₀)	138	Californium - 252	(²⁵² Cf ₉₈)	164

Tritium




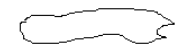
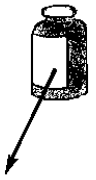


Half life: 12.3 years
 Specific activity: $3.59\text{E}+14 \text{ Bq.g}^{-1}$

Risk group: 5
 Risk colour: Blue


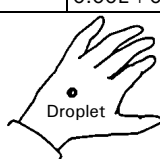
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			19	100				
E2								
E3								
% omitted			0					

Exemption levels	
Quantity (Bq)	1E+09
Concentration (Bq.g ⁻¹)	1E+06

Transport (TBq)	
IAEA ST1 A ₁ value	4E+1
IAEA ST1 A ₂ value	4E+1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
Betas, electrons (skin dose) 0.00E+0	Betas, electrons (skin) 10 cm 0.0E+00 1 m 0.0E+00	100 cm Brem. Rad.	Brem. Rad.	Brem. Rad.
Gammas, X rays (deep tissue dose) 0.00E+0	Photons (skin) 10 cm 0.0E+00 1 m 0.0E+00			
	Photons (deep dose) 10 cm 0.0E+00 1 m 0.0E+00			

The values above do not include Bremsstrahlung radiation. Brem. Rad. indicates that it may be significant.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 0.00E+0	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta		Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma												
X rays												
0.05 ml droplet (1 kBq) 0.00E+0		2E+4										
		Fixed contamination										
		2E+6										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	<0.1	
Plastic	<0.1	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	-	-
Steel	-	-

INTERNAL EXPOSURE FOR WORKERS			
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)			
Ingestion	f₁	Inhalation (for soluble and reactive gases and vapours)	
Tritiated water	1.000	1.8E-11	Elemental hydrogen 1.8E-15
Organically bound tritium	1.000	4.2E-11	Tritiated water 1.8E-11
			Organically bound tritium 4.1E-11
Highest dose organ	Whole body	20 mSv ALI _{ingestion} 4.8E+08 (Bq)	20 mSv ALI _{inhalation} 4.9E+08 (Bq)
Gaseous form 1.1 E+13 (Bq)			

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
Tritiated water	0.01	3E+06	3E+07	1E+07	1E+08	1E+10	
Elemental hydrogen	1E+00	Forbidden	2E+08	Forbidden	5E+08	5E+10	

Beryllium - 7




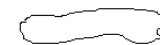

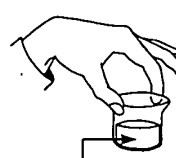

Half life: 53.2 days
 Specific activity: 1.30E+16 Bq.g⁻¹


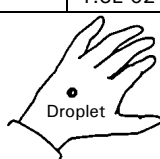
Risk group: 4
 Risk colour: Green

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	477	10						
E2								
E3								
% omitted	0							

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	0.7
IAEA ST1 A ₂ value	0.7

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.0E+00	10 cm 0.0E+00			
	1 m 0.0E+00			
	<i>Photons (skin)</i>			
	10 cm 3.4E-04			
	1 m 2.2E-06			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (deep dose)</i>	100 cm 8.2E-06	2.4E-02	1.3E-01
9.2E-05	10 cm 3.3E-04			
	1 m 2.1E-04			

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²) 2.9E-03	Recommended probes*	Removable contamination	
0.05 ml droplet (1 kBq) 1.3E-02			6E+02
			Fixed contamination
			6E+02
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	-	
Plastic	-	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	5	17
Steel	25	62

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.005	2.8E-11		
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	7.1E+08 (Bq)	20 mSv ALI _{inhalation}
				3.8E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	3E+07	3E+08	8E+07	8E+08	5E+09	

Carbon - 11

¹¹C₆


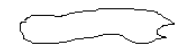
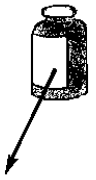


Half life: 20.4 minutes
 Specific activity: 3.10E+19 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


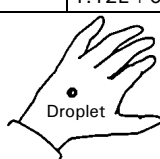
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	200	960	100				
E2								
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	1E+0
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 1.35E-1	<i>Betas, electrons (skin)</i> 10 cm 1.2E-01 1 m 1.2E-02	100 cm 1.63E-4	5.81E-1	6.41E+0
<i>Gammas, X rays (deep tissue dose)</i> 1.87E-3	<i>Photons (skin)</i> 10 cm 7.0E-03 1 m 4.4E-03			
	<i>Photons (deep dose)</i> 10 cm 6.6E-03 1 m 4.2E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.95E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq) 1.12E+0		2E+1										
		Fixed contamination										
		3E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.6	
Plastic	3.0	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	6	17
Steel	27	64

INTERNAL EXPOSURE FOR WORKERS			
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)			
Ingestion	f₁	Inhalation (for soluble and reactive gases and vapours)	
Labelled organic compounds	1.000	Vapour	3.2E-12
		Dioxide	2.2E-12
		Monoxide	1.2E-12
Highest dose organ	Soft tissues	20 mSv A _{LI,ingestion}	8.3E+08 (Bq) 20 mSv A _{LI,inhalation}
			6.3E+09 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds except below	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	
Oxide & anhydride	1	Forbidden	4E+06	Forbidden	1E+07	1E+09	

Carbon - 14

¹⁴C₆


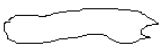



Half life: 5730 years
 Specific activity: 1.65E+11 Bq.g⁻¹

Risk group: 4
 Risk colour: Green


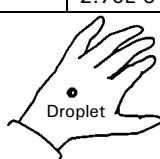
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			157	100				
E2								
E3								
% omitted			0					

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+04

Transport (TBq)	
IAEA ST1 A ₁ value	4E+1
IAEA ST1 A ₂ value	3E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.00E+0	10 cm 0.0E+00			
	1 m 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
0.00E+0	10 cm 0.0E+00			
	1 m 0.0E+00			
	<i>Photons (deep dose)</i>			
	10 cm 0.0E+00			
	1 m 0.0E+00			
		100 cm	Brem. Rad.	Brem. Rad.
			Brem. Rad.	Brem. Rad.

The values above do not include Bremsstrahlung radiation. Brem. Rad. indicates that it may be significant.

CONTAMINATION	
Contamination skin dose (mSv.h⁻¹)	Detection
Uniform deposit (1kBq.cm ⁻²) 3.24E-1	Recommended probes*
0.05 ml droplet (1 kBq) 2.70E-3	Alpha
	Beta ++
	Gamma
	X rays
	Derived limits (Bq.cm⁻²)
	Removable contamination
	4E+2
	Fixed contamination
	4E+4

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)	
Betas and electrons (Total absorption)	
Glass	0.2
Plastic	0.3
Gamma and X rays (half and tenth value thickness)	
	1/2 1/10
Lead	- -
Steel	- -

INTERNAL EXPOSURE FOR WORKERS			
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)			
Ingestion	f₁	Inhalation (for soluble and reactive gases and vapours)	
Labelled organic compounds	1.000	Vapour	5.8E-10
		Dioxide	6.2E-12
		Monoxide	8.0E-13
Highest dose organ	Whole body	20 mSv ALI _{ingestion} 3.4E+07 (Bq)	20 mSv ALI _{inhalation} 3.4E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds except below	0.01	1E+07	1E+08	3E+07	3E+08	5E+09
Oxide & anhydride	1	Forbidden	1E+06	Forbidden	3E+06	3E+08

Nitrogen - 13



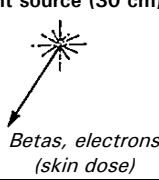
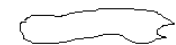
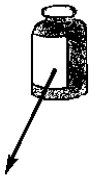


Half life: 9.97 minutes
 Specific activity: 5.37E+19 Bq.g⁻¹

Risk group: 4
 Risk colour: Green


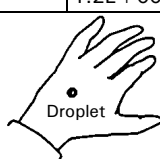
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	200	1199	100				
E2								
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	9E-1
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)																
Point source (30 cm)  Betas, electrons (skin dose) 1.20E-1 Gammas, X rays (deep tissue dose) 1.87E-3	Infinite plane source  Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>1.3E-01</td></tr> <tr><td>1 m</td><td>2.5E-02</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>7.0E-03</td></tr> <tr><td>1 m</td><td>4.5E-03</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>6.7E-03</td></tr> <tr><td>1 m</td><td>4.2E-03</td></tr> </table>	10 cm	1.3E-01	1 m	2.5E-02	10 cm	7.0E-03	1 m	4.5E-03	10 cm	6.7E-03	1 m	4.2E-03	10 ml glass vial  100 cm 1.63E-4	Contact with 50 ml glass beaker  5.81E-1	Contact with 5 ml plastic syringe  1.29E+1
10 cm	1.3E-01															
1 m	2.5E-02															
10 cm	7.0E-03															
1 m	4.5E-03															
10 cm	6.7E-03															
1 m	4.2E-03															

The values above do not include Bremsstrahlung radiation.

CONTAMINATION																				
Contamination skin dose (mSv.h⁻¹) <table border="1"> <tr> <td>Uniform deposit (1kBq.cm⁻²)</td> <td>1.90E+0</td> </tr> <tr> <td>0.05 ml droplet (1 kBq)</td> <td>1.2E+00</td> </tr> </table>	Uniform deposit (1kBq.cm ⁻²)	1.90E+0	0.05 ml droplet (1 kBq)	1.2E+00	Detection <table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td></td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays		Derived limits (Bq.cm⁻²) <table border="1"> <tr> <th>Removable contamination</th> <td>-</td> </tr> <tr> <th>Fixed contamination</th> <td>-</td> </tr> </table>	Removable contamination	-	Fixed contamination	-
Uniform deposit (1kBq.cm ⁻²)	1.90E+0																			
0.05 ml droplet (1 kBq)	1.2E+00																			
Recommended probes*																				
Alpha																				
Beta	++																			
Gamma	++																			
X rays																				
Removable contamination	-																			
Fixed contamination	-																			
 Uniform deposit  Droplet * If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique																				

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	2.1	
Plastic	4.0	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	6	17
Steel	27	64

INTERNAL EXPOSURE FOR WORKERS			
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)			
Ingestion	f ₁	Inhalation (for soluble and reactive gases and vapours)	
		n/a	n/a
		n/a	n/a
		n/a	n/a
Highest dose organ	-	20 mSv A _{LI} ingestion	- (Bq) 20 mSv A _{LI} inhalation - (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	
Volatile form	1	Forbidden	4.0E+06	Forbidden	1.0E+07	1.0E+09	

Oxygen - 15

¹⁵O₈

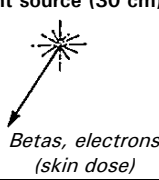
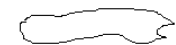



Half life: 2.04 minutes
 Specific activity: 2.28E+20 Bq.g⁻¹

Risk group: 5
 Risk colour: Blue


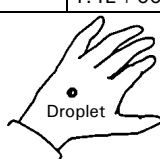
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	200	1732	100				
E2								
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+09
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	-
IAEA ST1 A ₂ value	-

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)																
Point source (30 cm)  Betas, electrons (skin dose) 1.20E-1 Gammas, X rays (deep tissue dose) 1.87E-3	Infinite plane source  Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>1.4E-01</td></tr> <tr><td>1 m</td><td>5.1E-02</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>7.0E-03</td></tr> <tr><td>1 m</td><td>4.5E-03</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>6.7E-03</td></tr> <tr><td>1 m</td><td>4.2E-03</td></tr> </table>	10 cm	1.4E-01	1 m	5.1E-02	10 cm	7.0E-03	1 m	4.5E-03	10 cm	6.7E-03	1 m	4.2E-03	10 ml glass vial  100 cm 1.67E-4	Contact with 50 ml glass beaker  5.93E-1	Contact with 5 ml plastic syringe  3.05E+1
10 cm	1.4E-01															
1 m	5.1E-02															
10 cm	7.0E-03															
1 m	4.5E-03															
10 cm	6.7E-03															
1 m	4.2E-03															

The values above do not include Bremsstrahlung radiation.

CONTAMINATION																								
Contamination skin dose (mSv.h⁻¹) <table border="1"> <tr> <td>Uniform deposit (1kBq.cm⁻²)</td> <td>2.00E+0</td> </tr> <tr> <td>0.05 ml droplet (1 kBq)</td> <td>1.4E+00</td> </tr> </table>	Uniform deposit (1kBq.cm ⁻²)	2.00E+0	0.05 ml droplet (1 kBq)	1.4E+00	Detection <table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td></td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays		Derived limits (Bq.cm⁻²) <table border="1"> <tr> <th colspan="2">Removable contamination</th> </tr> <tr> <td></td> <td>-</td> </tr> <tr> <th colspan="2">Fixed contamination</th> </tr> <tr> <td></td> <td>-</td> </tr> </table>	Removable contamination			-	Fixed contamination			-
Uniform deposit (1kBq.cm ⁻²)	2.00E+0																							
0.05 ml droplet (1 kBq)	1.4E+00																							
Recommended probes*																								
Alpha																								
Beta	++																							
Gamma	++																							
X rays																								
Removable contamination																								
	-																							
Fixed contamination																								
	-																							
 Uniform deposit  Droplet * If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique																								

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	3.4	
Plastic	6.4	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	6	17
Steel	27	64

INTERNAL EXPOSURE FOR WORKERS		
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)		
Ingestion	f ₁	Inhalation (for soluble and reactive gases and vapours)
		n/a
		n/a
		n/a
Highest dose organ	-	20 mSv A _{LI} ingestion - (Bq) 20 mSv A _{LI} inhalation - (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	
Volatile form	1	Forbidden	4E+06	Forbidden	1E+07	1.0E+09	

Fluorine - 18


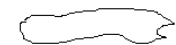
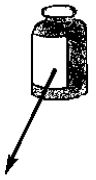


¹⁸F₉

Half life: 1.83 hours
Specific activity: 3.52E+18 Bq.g⁻¹


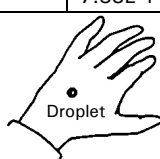
Risk group: 3
Risk colour: Yellow

Main emissions (keV)						Exemption levels		
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	194	634	97	1	3		
E2								
E3								
% omitted	0		0		0			

Transport (TBq)	
IAEA ST1 A ₁ value	1E+0
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.20E-1	10 cm: 9.6E-02 1 m: 5.3E-04	100 cm: 1.58E-4	5.63E-1	2.88E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.81E-3	10 cm: 6.8E-03 1 m: 4.3E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 6.4E-03 1 m: 4.1E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			SHIELDING (mm)																			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	Betas and electrons (Total absorption)																			
Uniform deposit (1kBq.cm ⁻²): 1.95E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>+</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>++</td></tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma	++	X rays	++	<table border="1"> <tr><th colspan="2">Removable contamination</th></tr> <tr><td></td><td>2E+1</td></tr> <tr><th colspan="2">Fixed contamination</th></tr> <tr><td></td><td>3E+1</td></tr> </table>	Removable contamination			2E+1	Fixed contamination			3E+1	Glass	0.9
Recommended probes*																						
Alpha																						
Beta		+																				
Gamma	++																					
X rays	++																					
Removable contamination																						
	2E+1																					
Fixed contamination																						
	3E+1																					
0.05 ml droplet (1 kBq): 7.88E-1			Plastic	1.7																		
			Gamma and X rays (half and tenth value thickness)																			
				1/2	1/10																	
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			Lead	6	17																	
			Steel	27	64																	

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f_i		Inhalation	1 μm	5 μm
All compounds	1.000	4.9E-11	Determined by combining cation	F 3.0E-11	5.4E-11
			Determined by combining cation	M 5.7E-11	8.9E-11
			Determined by combining cation	S 6.0E-11	9.3E-11
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	4.1E+08 (Bq)	20 mSv A _{LI} inhalation	2.2E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	
Volatile form	1	Forbidden	3E+06	Forbidden	9E+06	9E+08	

Sodium - 22




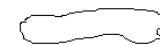

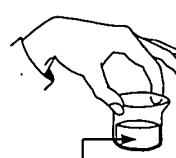

Half life: 2.6 years
 Specific activity: 2.31E+14 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


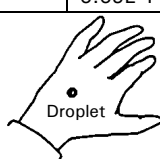
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	181	546	90				
E2	1275	100						
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	5E-1
IAEA ST1 A ₂ value	5E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.01E-1	10 cm: 7.2E-02 1 m: 0.0E+00	100 cm: 3.14E-4	1.13E+0	5.36E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
3.64E-3	10 cm: 1.4E-02 1 m: 9.2E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 1.3E-02 1 m: 8.7E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²): 1.68E+0	Recommended probes*	Removable contamination	
0.05 ml droplet (1 kBq): 6.69E-1	Alpha: <table border="1"><tr><td></td></tr></table>		1E+1
	Beta: ++	Fixed contamination	
	Gamma: ++	2E+1	
	X rays: +		
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.8	
Plastic	1.4	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	10	37
Steel	31	80

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 µm 5 µm
All compounds	1.000	3.2E-09	All compounds	F 1.3E-09 2.0E-09
				M
				S
Highest dose organ	Red marrow	20 mSv ALI _{ingestion}	6.3E+06 (Bq)	20 mSv ALI _{inhalation}
				1.0E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	

Sodium - 24




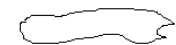
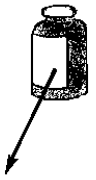


Half life: 15.0 hours
 Specific activity: $3.22\text{E}+17 \text{ Bq.g}^{-1}$

Risk group: 2
 Risk colour: Orange


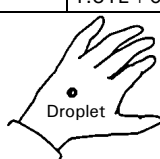
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	1369	100	1390	100				
E2	2754	100						
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	2E-1
IAEA ST1 A ₂ value	2E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.24E-1	10 cm: 1.3E-01 1 m: 3.3E-02	100 cm: 4.64E-4	1.64E+0	2.17E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
5.40E-3	10 cm: 2.2E-02 1 m: 1.5E-02			
	<i>Photons (deep dose)</i>			
	10 cm: 2.1E-02 1 m: 1.4E-02			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 2.22E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 1.31E+0		8E+0										
		Fixed contamination										
		9E+0										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	2.6	
Plastic	4.8	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	20	58
Steel	41	111

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All compounds	1.000	4.3E-10	All compounds	F 2.9E-10 5.3E-10
				M
				S
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	4.7E+07 (Bq)	20 mSv A _{LI} inhalation
				3.8E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	3E+05	3E+06	9E+05	9E+06	9E+08	

Aluminium - 26



Half life: 7.2E+5 years
 Specific activity: 7.07E+08 Bq.g⁻¹


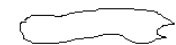
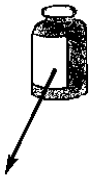


Risk group: 2
 Risk colour: Orange

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	164	1174	82				
E2	1130	3						
E3	1809	100						
% omitted	<1		0					

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-


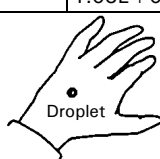
Transport (TBq)	
IAEA ST1 A ₁ value	1E-1
IAEA ST1 A ₂ value	1E-1

EXTERNAL EXPOSURE (mSv.h⁻¹) for an activity of 1 MBq or 1 MBq.m⁻² (as appropriate)

Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe												
 Betas, electrons (skin dose) 1.02E-1 Gammas, X rays (deep tissue dose) 4.10E-3	 Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>1.0E-01</td></tr> <tr><td>1 m</td><td>2.6E-02</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>1.6E-02</td></tr> <tr><td>1 m</td><td>1.1E-02</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>1.5E-02</td></tr> <tr><td>1 m</td><td>1.0E-02</td></tr> </table>	10 cm	1.0E-01	1 m	2.6E-02	10 cm	1.6E-02	1 m	1.1E-02	10 cm	1.5E-02	1 m	1.0E-02	 100 cm 3.53E-4	 1.26E+0	 1.72E+1
10 cm	1.0E-01															
1 m	2.6E-02															
10 cm	1.6E-02															
1 m	1.1E-02															
10 cm	1.5E-02															
1 m	1.0E-02															

The values above do not include Bremsstrahlung radiation.

CONTAMINATION

Contamination skin dose (mSv.h ⁻¹)		Detection		Derived limits (Bq.cm ⁻²)																			
Uniform deposit (1kBq.cm ⁻²)	1.81E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>		Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	<table border="1"> <tr><th colspan="2">Removable contamination</th></tr> <tr><td></td><td>9E+0</td></tr> <tr><th colspan="2">Fixed contamination</th></tr> <tr><td></td><td>1E+1</td></tr> </table>		Removable contamination			9E+0	Fixed contamination			1E+1
Recommended probes*																							
Alpha																							
Beta	++																						
Gamma	++																						
X rays	+																						
Removable contamination																							
	9E+0																						
Fixed contamination																							
	1E+1																						
0.05 ml droplet (1 kBq)	1.03E+0																						
 																							
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique																							

SHIELDING (mm)

Betas and electrons (Total absorption)		
Glass	2.1	
Plastic	3.8	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	12	47
Steel	34	92

INTERNAL EXPOSURE FOR WORKERS

COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq⁻¹)

Ingestion	f _i		Inhalation	
			1 µm	5 µm
All compounds	0.010	3.5E-09	F	1.1E-08 1.4E-08
			M	1.8E-08 1.2E-08
			S	

Highest dose organ: Red marrow 20 mSv A_{LI} ingestion 5.7E+06 (Bq) 20 mSv A_{LI} inhalation 1.1E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)

PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	2E+05	2E+06	6E+05	6E+06	6E+08	

Silicon - 31

³¹Si₁₄


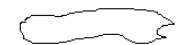

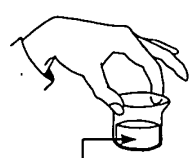

Half life: 2.62 hours
 Specific activity: 1.43E+18 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


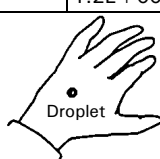
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	1266	<1	1491	100				
E2								
E3								
% omitted	0		<1					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	0.6
IAEA ST1 A ₂ value	0.6

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.2E-01	10 cm 1.3E-01 1 m 4.0E-02	100 cm 1.2E-07	3.5E-04	1.7E+01
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.4E-06	10 cm 5.5E-06 1 m 3.6E-06			
	<i>Photons (deep dose)</i>			
	10 cm 5.2E-06 1 m 3.4E-06			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.8E+00	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma												
X rays												
0.05 ml droplet (1 kBq) 1.2E+00		1E+02										
		Fixed contamination										
		4E+02										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	3.1	
Plastic	5.2	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	18	52
Steel	37	93

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.010	1.6E-10	1 µm	5 µm
			F	2.9E-11 5.1E-11
			M	7.5E-11 1.1E-10
			S	8.0E-11 1.1E-10
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	1.3E+08 (Bq)	20 mSv ALI _{inhalation}
				1.8E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	6E+05	6E+06	2E+06	2E+07	2E+09	

Phosphorus - 32

³²P₁₅


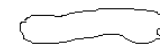

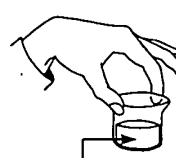

Half life: 14.3 days
Specific activity: 1.06E+16 Bq.g⁻¹

Risk group: 2
Risk colour: Orange


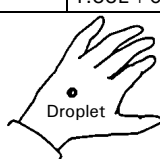
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			1710	100				
E2								
E3								
% omitted			0					

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	5E-1
IAEA ST1 A ₂ value	5E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.18E-1	10 cm: 1.4E-01 1 m: 4.8E-02	100 cm		
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
0.00E+0	10 cm: 0.0E+00 1 m: 0.0E+00			
	<i>Photons (deep dose)</i>			
	10 cm: 0.0E+00 1 m: 0.0E+00			
		1.31E-6	7.11E-4	2.39E+1

The values above do not include Bremsstrahlung radiation.

CONTAMINATION		
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)
Uniform deposit (1kBq.cm ⁻²): 1.89E+0	Recommended probes*	Removable contamination
0.05 ml droplet (1 kBq): 1.33E+0	Alpha: Beta: ++ Gamma: X rays:	5E+1
		Fixed contamination
		3E+2
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique		

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	3.4	
Plastic	6.3	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	-	-
Steel	-	-

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.800	2.4E-09	1 μm	5 μm
			All unspec. compounds	F 8.0E-10 1.1E-09
			Some phosphat. det. by comb. cation	M 3.2E-09 2.9E-09
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	8.3E+06 (Bq)	20 mSv ALI _{inhalation}
				6.3E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Phosphorus - 33

³³P₁₅


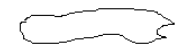



Half life: 25.6 days
Specific activity: 5.72E+15 Bq.g⁻¹

Risk group: 5
Risk colour: Blue


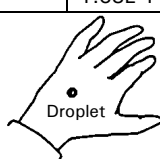
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			249	100				
E2								
E3								
% omitted				0				

Exemption levels	
Quantity (Bq)	1E+08
Concentration (Bq.g ⁻¹)	1E+05

Transport (TBq)	
IAEA ST1 A ₁ value	4E+1
IAEA ST1 A ₂ value	1E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
Betas, electrons (skin dose)	Betas, electrons (skin)			
0.00E+0	10 cm 4.9E-02			
	1 m 0.0E+00			
	Photons (skin)			
	10 cm 0.0E+00			
	1 m 0.0E+00			
Gammas, X rays (deep tissue dose)	Photons (deep dose)	100 cm		
0.00E+0	10 cm 0.0E+00	Brem. Rad.	Brem. Rad.	Brem. Rad.
	1 m 0.0E+00			

The values above do not include Bremsstrahlung radiation. Brem. Rad. indicates that it may be significant.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 8.65E-1	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma												
X rays												
0.05 ml droplet (1 kBq) 1.38E-1		2E+2										
		Fixed contamination										
		2E+4										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)	
Betas and electrons (Total absorption)	
Glass	0.3
Plastic	0.5
Gamma and X rays (half and tenth value thickness)	
	1/2 1/10
Lead	- -
Steel	- -

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.800	2.4E-10	1 μm	5 μm
			F	9.6E-11 1.4E-10
			M	1.4E-09 1.3E-09
			S	
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	8.3E+07 (Bq)	20 mSv ALI _{inhalation}
				1.4E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+06	4E+07	1E+07	1E+08	1E+10	

Sulphur - 35

³⁵S₁₆


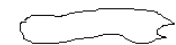



Half life: 87.5 days
Specific activity: 1.58E+15 Bq.g⁻¹

Risk group: 5
Risk colour: Blue


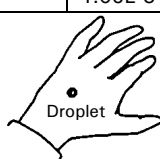
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			168	100				
E2								
E3								
% omitted			0					

Exemption levels	
Quantity (Bq)	1E+08
Concentration (Bq.g ⁻¹)	1E+05

Transport (TBq)	
IAEA ST1 A ₁ value	4E+1
IAEA ST1 A ₂ value	3E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
Betas, electrons (skin dose)	Betas, electrons (skin)			
0.00E+0	10 cm 0.0E+00			
	1 m 0.0E+00			
	Photons (skin)			
	10 cm 0.0E+00			
	1 m 0.0E+00			
Gammas, X rays (deep tissue dose)	Photons (deep dose)			
0.00E+0	10 cm 0.0E+00			
	1 m 0.0E+00			
		100 cm	Brem. Rad.	Brem. Rad.
			Brem. Rad.	Brem. Rad.

The values above do not include Bremsstrahlung radiation. Brem. Rad. indicates that it may be significant.

CONTAMINATION	
Contamination skin dose (mSv.h⁻¹)	Detection
Uniform deposit (1kBq.cm ⁻²) 3.54E-1	Recommended probes*
0.05 ml droplet (1 kBq) 4.05E-3	Alpha
	Beta ++
	Gamma
	X rays
	Derived limits (Bq.cm⁻²)
	Removable contamination
	3E+2
	Fixed contamination
	3E+4

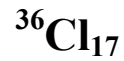
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)	
Betas and electrons (Total absorption)	
Glass	0.2
Plastic	0.3
Gamma and X rays (half and tenth value thickness)	
	1/2 1/10
Lead	- -
Steel	- -

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i	Inhalation	1 μm	5 μm
Inorganic compounds	0.800	1.4E-10	Sulphid. & sulphat. det. by comb. cat.	F 5.3E-11 8.0E-11
Elemental sulphur	0.100	1.9E-10	S, sulphid., sulphat. det. by comb. cat.	M 1.3E-09 1.1E-09
Organic sulphur	1.000	7.7E-10		S
Highest dose organ	Lungs	20 mSv A_{LI} ingestion	2.6E+07 (Bq)	20 mSv A_{LI} inhalation
				1.5E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds except below	0.01	5E+06	5E+07	2E+07	2E+08	2E+10
Vapour (SO ₂ ,.)	1	Forbidden	5E+06	Forbidden	2E+07	2E+09

Chlorine - 36



Half life: 3.0E+5 years
 Specific activity: 1.23E+09 Bq.g⁻¹


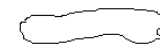



Risk group: 3
 Risk colour: Yellow

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			710	98				
E2								
E3								
% omitted				0				

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+04


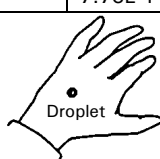
Transport (TBq)	
IAEA ST1 A ₁ value	1E+1
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h⁻¹) for an activity of 1 MBq or 1 MBq.m⁻² (as appropriate)

Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
Betas, electrons (skin dose) 1.08E-1	Betas, electrons (skin) 10 cm 9.9E-02 1 m 2.6E-03	100 cm Brem. Rad.	Brem. Rad.	5.05E-1
Gammas, X rays (deep tissue dose) 0.00E+0	Photons (skin) 10 cm 0.0E+00 1 m 0.0E+00			
	Photons (deep dose) 10 cm 0.0E+00 1 m 0.0E+00			

The values above do not include Bremsstrahlung radiation. Brem. Rad. indicates that it may be significant.

CONTAMINATION

Contamination skin dose (mSv.h ⁻¹)		Detection		Derived limits (Bq.cm ⁻²)	
Uniform deposit (1kBq.cm ⁻²)	1.78E+0	Recommended probes*		Removable contamination	
0.05 ml droplet (1 kBq)	7.73E-1	Alpha		6E+1	
		Beta	++	Fixed contamination	
		Gamma		4E+3	
		X rays			

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)

Betas and electrons (Total absorption)		
Glass	1.1	
Plastic	2.0	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	-	-
Steel	-	-

INTERNAL EXPOSURE FOR WORKERS

COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq⁻¹)

Ingestion	f _i		Inhalation	
			1 μm	5 μm
All compounds	1.000	9.3E-10	Determined by combining cation	F 3.4E-10 4.9E-10
			Determined by combining cation	M 6.9E-09 5.1E-09
				S

Highest dose organ: Lungs 20 mSv ALI_{ingestion} 2.2E+07 (Bq) 20 mSv ALI_{inhalation} 2.9E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)

Subject to external exposure requirements which may be more restrictive

PHYSICOCHEMICAL STATE	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09

Argon - 37

³⁷Ar₁₈


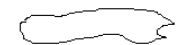



Half life: 35.0 days
Specific activity: 3.73E+15 Bq.g⁻¹


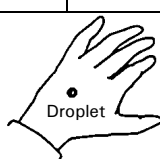
Risk group: 5
Risk colour: Blue

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	3	8			2	82		
E2								
E3								
% omitted	0				0			

Exemption levels	
Quantity (Bq)	1E+08
Concentration (Bq.g ⁻¹)	1E+06

Transport (TBq)	
IAEA ST1 A ₁ value	40
IAEA ST1 A ₂ value	40

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
Betas, electrons (skin dose)	Betas, electrons (skin)			
0.0E+00	10 cm - 1 m -	100 cm		
	Photons (skin)			
	10 cm - 1 m -			
Gammas, X rays (deep tissue dose)	Photons (deep dose)			
0.0E+00	10 cm - 1 m -			

CONTAMINATION	
Contamination skin dose (mSv.h ⁻¹)	Detection
Uniform deposit (1kBq.cm ⁻²) -	Recommended probes*
0.05 ml droplet (1 kBq) -	Alpha -
	Beta -
	Gamma -
	X rays -
	Derived limits (Bq.cm ⁻²)
	Removable contamination
	Fixed contamination

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	<	0.1
Plastic	<	0.1
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	<	1
Steel	<	1

INTERNAL EXPOSURE FOR WORKERS	
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)	
Ingestion f ₁	SUBMERSION DOSE RATE (Sv per day)
	Sv.d ⁻¹ per Bq.m ⁻³ 4.1E-15
Highest dose organ -	20 mSv ALI _{ingestion} - (Bq) 20 mSv ALI _{inhalation} - (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	1	Forbidden	1E+08	Forbidden	5E+08	5E+10

Argon - 41

⁴¹Ar₁₈


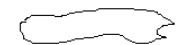



Half life: 1.83 hours
 Specific activity: 1.54E+18 Bq.g⁻¹

Risk group: 5
 Risk colour: Blue


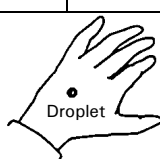
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	1294	100	1198	100				
E2			2492	1				
E3								
% omitted	<1		<1					

Exemption levels	
Quantity (Bq)	1E+09
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	0.3
IAEA ST1 A ₂ value	0.3

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.3E-01	10 cm - 1 m -	100 cm		
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
2.0E-03	10 cm - 1 m -			
	<i>Photons (deep dose)</i>			
	10 cm - 1 m -			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION	
Contamination skin dose (mSv.h⁻¹)	Detection
Uniform deposit (1kBq.cm ⁻²) -	Recommended probes*
0.05 ml droplet (1 kBq) -	Alpha
	Beta ++
	Gamma ++
	X rays +
	Derived limits (Bq.cm⁻²)
	Removable contamination
	-
	Fixed contamination
	-

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	6.1	
Plastic	10.0	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	31	72
Steel	44	100

INTERNAL EXPOSURE FOR WORKERS		
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)		
Ingestion	f ₁	
		SUBMERSION DOSE RATE (Sv per day)
		Sv.d ⁻¹ per Bq.m ⁻³ 5.3E-09
Highest dose organ	-	20 mSv A _{LI} ingestion - (Bq) 20 mSv A _{LI} inhalation - (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	1	Forbidden	9E+05	Forbidden	3E+06	3E+08	

Potassium - 40

⁴⁰K₁₉


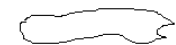

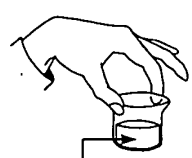

Half life: 1.3E+9 years
 Specific activity: 2.54E+05 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


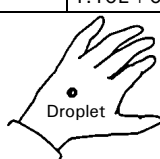
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	1461	11	1312	89	3	7		
E2								
E3								
% omitted	0		0		0			

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	9E-1
IAEA ST1 A ₂ value	9E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.07E-1	10 cm: 1.0E-01 1 m: 3.0E-02	100 cm: 1.98E-5	7.08E-2	1.35E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
2.30E-4	10 cm: 9.4E-04 1 m: 6.2E-04			
	<i>Photons (deep dose)</i>			
	10 cm: 8.8E-04 1 m: 5.8E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²): 1.65E+0	Recommended probes*	Removable contamination	
0.05 ml droplet (1 kBq): 1.10E+0		4E+1	
		Alpha	Fixed contamination
		Beta: ++ Gamma: ++ X rays: +	2E+2
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	2.4	
Plastic	4.4	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	18	51
Steel	38	98

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All compounds	1.000	6.2E-09	All compounds	F: 2.1E-09 3.0E-09
				M:
				S:
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	3.2E+06 (Bq)	20 mSv A _{LI} inhalation
				6.7E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Potassium - 42

⁴²K₁₉


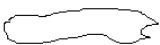

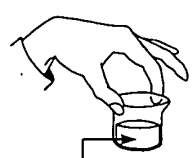

Half life: 12.4 hours
 Specific activity: 2.23E+17 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


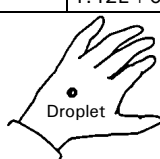
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	313	<1	1996	18				
E2	1525	18	3521	82				
E3								
% omitted		<1		<1				

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	2E-1
IAEA ST1 A ₂ value	2E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.01E-1	10 cm: 1.5E-01 1 m: 6.9E-02	100 cm: 4.32E-4	1.70E+0	7.73E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
4.04E-4	10 cm: 1.6E-03 1 m: 1.1E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 1.6E-03 1 m: 1.0E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 2.24E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>+</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	+	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	+											
X rays	+											
0.05 ml droplet (1 kBq): 1.42E+0		4E+1										
		Fixed contamination										
		8E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	8.6	
Plastic	16.2	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	18	53
Steel	38	100

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 µm 5 µm
All compounds	1.000	4.3E-10	All compounds	F: 1.3E-10 2.0E-10
				M:
				S:
Highest dose organ	Lungs	20 mSv A _{LI,ingestion}	4.7E+07 (Bq)	20 mSv A _{LI,inhalation}
				1.0E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	7E+05	7E+06	2E+06	2E+07	2E+09	

Potassium - 43

⁴³K₁₉


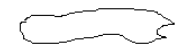
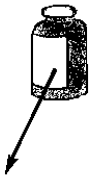


Half life: 22.2 hours
 Specific activity: 1.21E+17 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


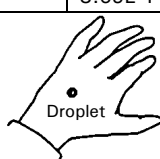
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	373	87	827	92				
E2	593	11	1224	4				
E3	618	81						
% omitted		18.2		4				

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	7E-1
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 1.22E-1	<i>Betas, electrons (skin)</i> 10 cm 1.0E-01 1 m 6.6E-03	100 cm 1.55E-4	5.50E-1	2.88E+0
<i>Gammas, X rays (deep tissue dose)</i> 1.78E-3	<i>Photons (skin)</i> 10 cm 8.8E-03 1 m 6.4E-03			
	<i>Photons (deep dose)</i> 10 cm 8.3E-03 1 m 6.1E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²) 1.86E+0	Recommended probes*	Removable contamination 2E+1	
0.05 ml droplet (1 kBq) 8.69E-1			Alpha
			Beta ++
			Gamma ++
	X rays +	Fixed contamination 3E+1	
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	2.2	
Plastic	4.0	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	5	18
Steel	26	64

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 µm 5 µm
All compounds	1.000	2.5E-10	All compounds	F 1.5E-10 2.6E-10
				M
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	8.0E+07 (Bq)	20 mSv ALI _{inhalation}
				7.7E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Calcium - 45




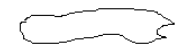



Half life: 163 days
 Specific activity: 6.58E+14 Bq.g⁻¹

Risk group: 4
 Risk colour: Green


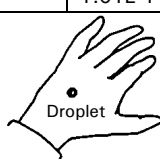
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			257	100				
E2								
E3								
% omitted			0					

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+04

Transport (TBq)	
IAEA ST1 A ₁ value	4E+1
IAEA ST1 A ₂ value	1E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 1.1E-02 1 m 0.0E+00	100 cm Brem. Rad.	Brem. Rad.	Brem. Rad.
<i>Gammas, X rays (deep tissue dose)</i> 0.00E+0	<i>Photons (skin)</i> 10 cm 1.0E-10 1 m 3.9E-11			
	<i>Photons (deep dose)</i> 10 cm 8.0E-12 1 m 3.0E-12			

The values above do not include Bremsstrahlung radiation. Brem. Rad. indicates that it may be significant.

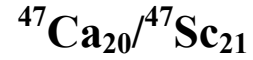
CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 8.38E-1	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma												
X rays												
0.05 ml droplet (1 kBq) 1.01E-1		1E+2										
		Fixed contamination										
		1E+4										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.3	
Plastic	0.6	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	-	-
Steel	-	-

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.300	7.6E-10		
			1 μm	5 μm
			F	
			M	2.7E-09 2.3E-09
			S	
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	2.6E+07 (Bq)	20 mSv ALI _{inhalation}
				7.4E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	2E+06	2E+07	7E+06	7E+07	5E+09	

Calcium - 47 / Scandium - 47




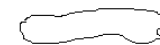

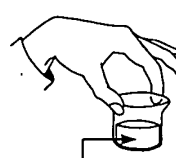

Half life: 4.54 days
 Specific activity: 2.26E+16 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


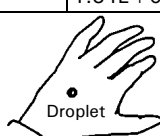
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	159	68	441	68				
E2	808	7	691	82				
E3	1297	75	1988	18				
% omitted		7.2		32				

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	3E+0
IAEA ST1 A ₂ value	3E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.79E-1	10 cm: 1.6E-01 1 m: 1.2E-02	100 cm: 1.61E-4	5.74E-1	8.84E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.85E-3	10 cm: 7.3E-03 1 m: 4.8E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 6.9E-03 1 m: 4.5E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION				
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)		
Uniform deposit (1kBq.cm ⁻²): 3.51E+0	Recommended probes*	Removable contamination		
0.05 ml droplet (1 kBq): 1.34E+0	Alpha: <table border="1"><tr><td></td><td></td></tr></table>			2E+1
	Beta: ++	Fixed contamination		
	Gamma: ++	3E+1		
	X rays: ++			
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique				

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	4.1	
Plastic	7.7	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	14	45
Steel	33	89

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All compounds	0.300	1.6E-09		F
			All compounds	M 1.8E-09 2.1E-09
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	1.3E+07 (Bq)	20 mSv ALI _{inhalation}
				9.5E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	3E+05	3E+06	1E+06	1E+07	1E+09	

Scandium - 46

⁴⁶Sc₂₁


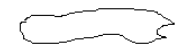
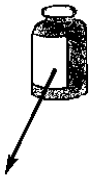


Half life: 83.8 days
 Specific activity: 1.25E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


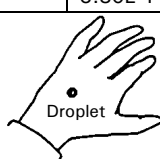
Main emissions (keV)							
	Gamma or X		Beta (E _{max})		Electrons		Alpha
	E	%	E	%	E	%	E
E1	889	100	357	100			
E2	1121	100					
E3							
% omitted	0		0				

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	5E-1
IAEA ST1 A ₂ value	5E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
2.29E-2	10 cm: 6.0E-02 1 m: 0.0E+00	100 cm: 2.81E-4	1.02E+0	4.82E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
3.27E-3	10 cm: 1.3E-02 1 m: 8.5E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 1.2E-02 1 m: 7.5E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.35E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 3.80E-1		1E+1										
		Fixed contamination										
		2E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.5	
Plastic	0.8	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	13	39
Steel	34	85

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.0001	1.5E-09		
Highest dose organ	Lungs	20 mSv A _{LI,ingestion}	1.3E+07 (Bq)	20 mSv A _{LI,inhalation}
				3.1E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	

Scandium - 47

⁴⁷Sc₂₁


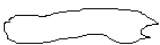



Half life: 3.4 days
Specific activity: 3.02E+16 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


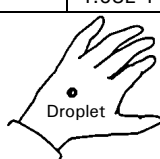
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	159	68	441	68				
E2			601	32				
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	1E+1
IAEA ST1 A ₂ value	7E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
6.81E-2	10 cm: 6.5E-01 1 m: 0.0E+00	100 cm: 1.90E-5	6.53E-2	3.00E-1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
2.05E-4	10 cm: 6.8E-04 1 m: 4.1E-04			
	<i>Photons (deep dose)</i>			
	10 cm: 6.8E-04 1 m: 4.2E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²): 1.54E+0	Recommended probes*	Removable contamination	
0.05 ml droplet (1 kBq): 4.58E-1		9E+1	
		Alpha	Fixed contamination
		Beta: ++	3E+2
	Gamma: +		
	X rays: ++		

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.9	
Plastic	1.6	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	2
Steel	10	25

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i	Inhalation		
			1 μm	5 μm
All compounds	0.0001	5.4E-10	F	
			M	
			S	
All compounds			7.0E-10	7.3E-10

Highest dose organ: Lower large intestine 20 mSv ALI_{ingestion} 3.7E+07 (Bq) 20 mSv ALI_{inhalation} 2.7E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	9E+05	9E+06	3E+06	3E+07	3E+09

Vanadium - 48

⁴⁸V₂₃


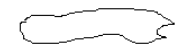
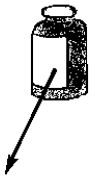


Half life: 16.2 days
 Specific activity: 6.21E+15 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


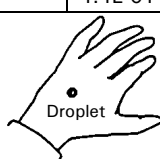
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	100	697	50	4	35		
E2	1312	98			1	74		
E3	2240	2						
% omitted		119		0		0		

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	0.4
IAEA ST1 A ₂ value	0.4

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
5.8E-02	10 cm 4.9E-02			
	1 m 5.0E-03			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
4.7E-03	10 cm 2.0E-02			
	1 m 1.4E-02			
	<i>Photons (deep dose)</i>			
	10 cm 1.9E-02			
	1 m 1.3E-02			
		100 cm 4.1E-04	1.2E+00	6.5E+00

The values above do not include Bremsstrahlung radiation.

CONTAMINATION		
Contamination skin dose (mSv.h⁻¹)	Detection	
Uniform deposit (1kBq.cm ⁻²) 1.0E+00	Recommended probes*	
0.05 ml droplet (1 kBq) 4.4E-01	Alpha	
	Beta	++
	Gamma	++
	X rays	+
	Derived limits (Bq.cm⁻²)	
	Removable contamination	
	1E+01	
	Fixed contamination	
	1E+01	

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.1	
Plastic	2.0	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	13	43
Steel	33	85

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i	Inhalation		
		1 µm	5 µm	
All compounds	0.010	2.0E-09	F	1.1E-09 1.7E-09
			M	2.3E-09 2.7E-09
			S	
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	1.0E+07 (Bq)	20 mSv A _{LI} inhalation 7.4E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	

Chromium - 51

⁵¹Cr₂₄


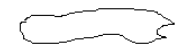
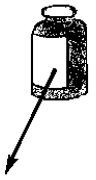


Half life: 27.7 days
Specific activity: 3.42E+15 Bq.g⁻¹

Risk group: 4
Risk colour: Green


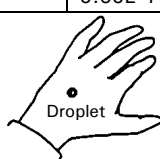
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	5	20			4	67		
E2	320	10						
E3								
% omitted	0				0			

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	3E+1
IAEA ST1 A ₂ value	3E+1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 0.0E+00 1 m 0.0E+00	100 cm 5.35E-6	1.87E-2	8.69E-2
<i>Gammas, X rays (deep tissue dose)</i> 6.04E-5	<i>Photons (skin)</i> 10 cm 2.1E-04 1 m 1.3E-04			
	<i>Photons (deep dose)</i> 10 cm 2.1E-04 1 m 1.3E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.49E-2	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td></td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>++</td></tr> </table>	Recommended probes*		Alpha		Beta		Gamma	++	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma	++											
X rays	++											
0.05 ml droplet (1 kBq) 5.65E-4		8E+2										
		Fixed contamination										
		9E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	<0.1	
Plastic	<0.1	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	2	7
Steel	21	50

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f_i		Inhalation	1 μm	5 μm
Hexavalent compounds	0.100	3.8E-11	All unspec. compounds	F 2.1E-11	3.0E-11
Trivalent compounds	0.010	3.7E-11	Halides & nitrat.	M 3.1E-11	3.4E-11
			Oxid. & hydrox.	S 3.6E-11	3.6E-11
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	5.3E+08 (Bq)	20 mSv A _{LI} inhalation	5.6E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+07	4E+08	1E+08	1E+09	5E+09	

Manganese - 52m




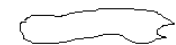
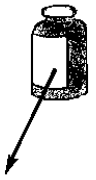


Half life: 21.2 minutes
 Specific activity: 6.31E+18 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


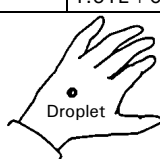
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	378	2	2633	96				
E2	511	193						
E3	1434	98						
% omitted	<1		<1					

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	-
IAEA ST1 A ₂ value	-

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.04E-1	10 cm: 1.4E-01 1 m: 6.8E-02	100 cm: 5.35E-4	1.80E+0	6.33E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
3.93E-3	10 cm: 1.5E-02 1 m: 1.0E-02			
	<i>Photons (deep dose)</i>			
	10 cm: 1.5E-02 1 m: 9.4E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 2.14E+0	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 1.61E+0		1E+1										
		Fixed contamination										
		1E+1										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	5.8	
Plastic	10.9	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	10	39
Steel	32	84

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.100	6.9E-11	1 µm	5 µm
			All unspec. compounds	F 2.0E-11 3.5E-11
			Oxid., hydrox., halid. & nitrat.	M 3.0E-11 5.0E-11
				S
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	2.9E+08 (Bq)	20 mSv A _{LI} inhalation
				4.0E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	

Manganese - 52




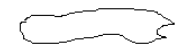
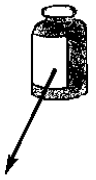


Half life: 5.6 days
 Specific activity: 1.66E+16 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


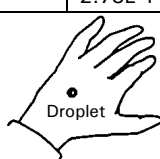
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	59	575	29				
E2	936	95						
E3	1434	100						
% omitted		105		0				

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	3E-1
IAEA ST1 A ₂ value	3E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
3.49E-2	10 cm: 8.6E-03 1 m: 5.0E-06	100 cm: 4.79E-4	1.72E+0	8.20E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
5.57E-3	10 cm: 2.9E-02 1 m: 2.1E-02			
	<i>Photons (deep dose)</i>			
	10 cm: 2.7E-02 1 m: 2.0E-02			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 7.57E-1	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>+</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		+										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 2.78E-1		9E+0										
		Fixed contamination										
		1E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.8	
Plastic	1.5	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	12	40
Steel	34	86

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.100	1.8E-09	All unspec. compounds	F 9.9E-10 1.6E-09
			Oxid., hydrox., halid. & nitrat.	M 1.4E-09 1.8E-09
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	1.1E+07 (Bq)	20 mSv ALI _{inhalation} 1.1E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	

Manganese - 54

⁵⁴Mn₂₅


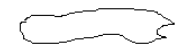
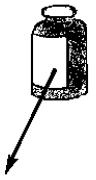
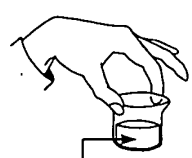

Half life: 312 days
Specific activity: 2.87E+14 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


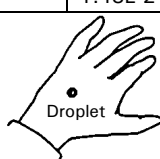
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	5	23			4	67		
E2	6	3						
E3	835	100						
% omitted	0				0			

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	1E+0
IAEA ST1 A ₂ value	1E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 0.0E+00 1 m 0.0E+00	100 cm 1.22E-4	4.41E-1	2.09E+0
<i>Gammas, X rays (deep tissue dose)</i> 1.42E-3	<i>Photons (skin)</i> 10 cm 5.6E-03 1 m 3.6E-02			
	<i>Photons (deep dose)</i> 10 cm 5.2E-03 1 m 3.4E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 6.22E-2	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </table>	Recommended probes*		Alpha		Beta		Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq) 1.48E-2		3E+1										
		Fixed contamination										
		4E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	<0.1	
Plastic	<0.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	11	32
Steel	32	79

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.100	7.1E-10	1 µm	5 µm
			F	8.7E-10 1.1E-09
			M	1.5E-09 1.2E-09
			S	
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	2.8E+07 (Bq)	20 mSv A _{LI} inhalation
				1.3E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	2E+06	2E+07	5E+06	5E+07	5E+09	

Manganese - 56




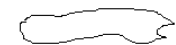

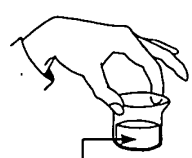

Half life: 2.58 hours
 Specific activity: 8.02E+17 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


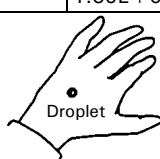
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	847	99	735	15				
E2	1811	27	1037	28				
E3	2113	14	2848	56				
% omitted		2.3		1				

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	3E-1
IAEA ST1 A ₂ value	3E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.15E-1	10 cm: 1.3E-01 1 m: 4.4E-02	100 cm: 3.47E-4	1.21E+0	3.97E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
2.57E-3	10 cm: 1.0E-02 1 m: 6.8E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 9.8E-03 1 m: 6.4E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION																				
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)																		
Uniform deposit (1kBq.cm ⁻²): 2.35E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	<table border="1"> <tr><th colspan="2">Removable contamination</th></tr> <tr><td></td><td>2E+1</td></tr> <tr><th colspan="2">Fixed contamination</th></tr> <tr><td></td><td>2E+1</td></tr> </table>	Removable contamination			2E+1	Fixed contamination			2E+1
Recommended probes*																				
Alpha																				
Beta		++																		
Gamma	++																			
X rays	+																			
Removable contamination																				
	2E+1																			
Fixed contamination																				
	2E+1																			
0.05 ml droplet (1 kBq): 1.35E+0																				
																				
																				

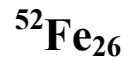
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass		6.5
Plastic		12.3
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	14	45
Steel	36	93

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f_i		Inhalation	1 μm	5 μm
All compounds	0.100	2.5E-10	All unspec. compounds	F 6.9E-11	1.2E-10
			Oxid., hydrox., halid. & nitrat.	M 1.3E-10	2.0E-10
				S	
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	8.0E+07 (Bq)	20 mSv ALI _{inhalation}	1.0E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	

Iron - 52




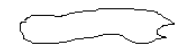



Half life: 8.26 hours
 Specific activity: 2.70E+17 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


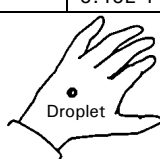
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	169	99	804	56				
E2	511	112						
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	3E-1
IAEA ST1 A ₂ value	3E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)																
Point source (30 cm)  Betas, electrons (skin dose) 7.43E-2 Gammas, X rays (deep tissue dose) 1.36E-3	Infinite plane source  Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>5.9E-02</td></tr> <tr><td>1 m</td><td>5.6E-03</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>4.9E-03</td></tr> <tr><td>1 m</td><td>3.1E-03</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>4.8E-03</td></tr> <tr><td>1 m</td><td>3.0E-03</td></tr> </table>	10 cm	5.9E-02	1 m	5.6E-03	10 cm	4.9E-03	1 m	3.1E-03	10 cm	4.8E-03	1 m	3.0E-03	10 ml glass vial  100 cm 1.20E-4	Contact with 50 ml glass beaker  4.23E-1	Contact with 5 ml plastic syringe  1.98E+0
10 cm	5.9E-02															
1 m	5.6E-03															
10 cm	4.9E-03															
1 m	3.1E-03															
10 cm	4.8E-03															
1 m	3.0E-03															

The values above do not include Bremsstrahlung radiation.

CONTAMINATION																
Contamination skin dose (mSv.h⁻¹) <table border="1"> <tr> <td>Uniform deposit (1kBq.cm⁻²)</td> <td>1.07E+0</td> </tr> <tr> <td>0.05 ml droplet (1 kBq)</td> <td>5.45E-1</td> </tr> </table>	Uniform deposit (1kBq.cm ⁻²)	1.07E+0	0.05 ml droplet (1 kBq)	5.45E-1	Detection <table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	++	Derived limits (Bq.cm⁻²) Removable contamination 3E+1 Fixed contamination 4E+1
Uniform deposit (1kBq.cm ⁻²)	1.07E+0															
0.05 ml droplet (1 kBq)	5.45E-1															
Recommended probes*																
Alpha																
Beta	++															
Gamma	++															
X rays	++															
 Uniform deposit  Droplet * If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique																

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.3	
Plastic	2.3	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	4	15
Steel	22	59

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All compounds	0.100	1.4E-09	All unspec. compounds	F 4.1E-10 6.9E-10
			Oxid., hydrox. & halid.	M 6.3E-10 9.5E-10
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion} 1.4E+07 (Bq)	20 mSv ALI _{inhalation}	2.1E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	6E+05	6E+06	2E+06	2E+07	2E+09	

Iron - 55




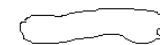

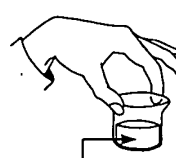

Half life: 2.68 years
 Specific activity: 8.98E+13 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


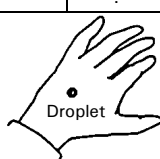
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	6	25			5	61		
E2	7	3						
E3								
% omitted	<1				<1			

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+04

Transport (TBq)	
IAEA ST1 A ₁ value	4E+1
IAEA ST1 A ₂ value	4E+1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.00E+0	10 cm 0.0E+00			
	1 m 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
0.00E+0	10 cm 0.0E+00			
	1 m 0.0E+00			
	<i>Photons (deep dose)</i>			
	10 cm 0.0E+00			
	1 m 0.0E+00			
		100 cm ?	?	?

? indicates that insufficient information is available for reliable calculations to be made.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.62E-2	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </table>	Recommended probes*		Alpha		Beta		Gamma		X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma												
X rays	+											
0.05 ml droplet (1 kBq) ?		7E+2										
		Fixed contamination										
		7E+4										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	< 1	
Plastic	< 1	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.100	3.3E-10	All unspec. compounds	F 7.7E-10 9.2E-10
			Oxid., hydrox. & halid.	M 3.7E-10 3.3E-10
				S
Highest dose organ	Spleen	20 mSv A_{LI} ingestion	6.1E+07 (Bq)	20 mSv A_{LI} inhalation
				2.2E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds except below	0.01	7E+06	7E+07	2E+07	2E+08	5E+09	
Oxid., hydroxid. & halog.	0.01	2E+07	2E+08	5E+07	5E+08	5E+09	

Iron - 59

⁵⁹Fe₂₆


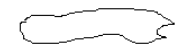
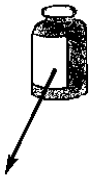


Half life: 44.5 days
 Specific activity: 1.84E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


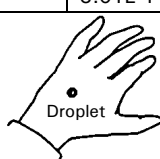
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	192	3	131	1				
E2	1099	56	273	46				
E3	1292	44	466	53				
% omitted		1.4		0.3				

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	9E-1
IAEA ST1 A ₂ value	9E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 3.46E-2	<i>Betas, electrons (skin)</i> 10 cm 4.1E-02 1 m 0.0E+00	100 cm 1.60E-4	5.77E-1	2.74E+0
<i>Gammas, X rays (deep tissue dose)</i> 1.86E-3	<i>Photons (skin)</i> 10 cm 7.5E-03 1 m 4.9E-03			
	<i>Photons (deep dose)</i> 10 cm 7.0E-03 1 m 4.6E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²) 9.73E-1	Recommended probes*	Removable contamination 2E+1	
0.05 ml droplet (1 kBq) 3.01E-1			Alpha
			Beta ++
			Gamma ++
	X rays +	Fixed contamination 3E+1	
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.6	
Plastic	1.2	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	15	45
Steel	35	91

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.100	1.8E-09	All unspec. compounds	F 2.2E-09 3.0E-09
			Oxid., hydrox. & halid.	M 3.5E-09 3.2E-09
				S
Highest dose organ	Spleen	20 mSv ALI _{ingestion}	1.1E+07 (Bq)	20 mSv ALI _{inhalation} 5.7E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	6E+05	6E+06	2E+06	2E+07	2E+09	

Cobalt - 56

⁵⁶Co₂₇


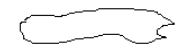



Half life: 77.1 days
 Specific activity: 1.12E+15 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


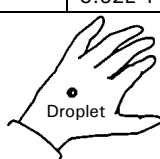
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	39	422	1				
E2	847	100	1460	19				
E3	1238	67						
% omitted		83.8		0				

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	3E-1
IAEA ST1 A ₂ value	3E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)																
Point source (30 cm)  Betas, electrons (skin dose) 2.89E-2 Gammas, X rays (deep tissue dose) 5.35E-3	Infinite plane source  Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>5.1E-03</td></tr> <tr><td>1 m</td><td>1.4E-03</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>2.6E-03</td></tr> <tr><td>1 m</td><td>1.9E-03</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>2.5E-03</td></tr> <tr><td>1 m</td><td>1.8E-03</td></tr> </table>	10 cm	5.1E-03	1 m	1.4E-03	10 cm	2.6E-03	1 m	1.9E-03	10 cm	2.5E-03	1 m	1.8E-03	10 ml glass vial  100 cm 4.60E-4	Contact with 50 ml glass beaker  1.64E+0	Contact with 5 ml plastic syringe  1.17E+1
10 cm	5.1E-03															
1 m	1.4E-03															
10 cm	2.6E-03															
1 m	1.9E-03															
10 cm	2.5E-03															
1 m	1.8E-03															

The values above do not include Bremsstrahlung radiation.

CONTAMINATION																
Contamination skin dose (mSv.h⁻¹) <table border="1"> <tr><td>Uniform deposit (1kBq.cm⁻²)</td><td>5.49E-1</td></tr> <tr><td>0.05 ml droplet (1 kBq)</td><td>3.62E-1</td></tr> </table>	Uniform deposit (1kBq.cm ⁻²)	5.49E-1	0.05 ml droplet (1 kBq)	3.62E-1	Detection <table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>+</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma	++	X rays	+	Derived limits (Bq.cm⁻²) Removable contamination 9E+0 Fixed contamination 1E+1
Uniform deposit (1kBq.cm ⁻²)	5.49E-1															
0.05 ml droplet (1 kBq)	3.62E-1															
Recommended probes*																
Alpha																
Beta	+															
Gamma	++															
X rays	+															
 Uniform deposit  Droplet * If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique																

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass		2.7
Plastic		5.1
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	15	47
Steel	36	96

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All unspec. compounds	0.100	2.5E-09		F
Oxid., hydrox. & inorg. compounds	0.050	2.3E-09	All unspec. compounds	M 4.6E-09 4.0E-09
			Oxid., hydrox., halid. & nitrat.	S 6.3E-09 4.9E-09
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	8.0E+06 (Bq)	20 mSv ALI _{inhalation}
				3.2E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	3E+05	3E+06	1E+06	1E+07	1E+09	

Cobalt - 57

⁵⁷Co₂₇


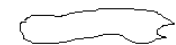

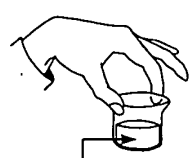

Half life: 271.8 days
Specific activity: 3.12E+14 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


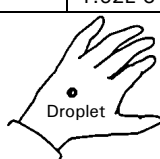
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	14	9			6	106		
E2	122	86			7	70		
E3	137	11						
% omitted		<1				11		

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	1E+1
IAEA ST1 A ₂ value	1E+1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 8.4E-06 1 m 0.0E+00	100 cm 2.17E-5	7.47E-2	3.35E-1
<i>Gammas, X rays (deep tissue dose)</i> 2.52E-4	<i>Photons (skin)</i> 10 cm 2.4E-03 1 m 2.0E-03			
	<i>Photons (deep dose)</i> 10 cm 2.3E-03 1 m 2.0E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.19E-1	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td>+</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta		Gamma	+	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma	+											
X rays	++											
0.05 ml droplet (1 kBq) 1.62E-3		2E+2										
		Fixed contamination										
		2E+2										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	<0.1	
Plastic	<0.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	<1	1
Steel	6	18

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All unspec. compounds	0.100	2.1E-10		
Oxid., hydrox. & inorg. compounds	0.050	1.9E-10		
			1 µm	5 µm
			F	
			M	5.2E-10 3.9E-10
			S	9.4E-10 6.0E-10
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	9.5E+07 (Bq)	20 mSv A _{LI} inhalation
				2.1E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box	
Oxid., hydroxid., halog. & nitrat.	0.01	4E+06	4E+07	1E+07	1E+08	5E+09	
Other compounds	0.01	6E+06	6E+07	2E+07	2E+08	5E+09	

Cobalt - 58

⁵⁸Co₂₇


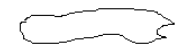
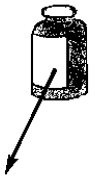


Half life: 70.8 days
Specific activity: 1.18E+15 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


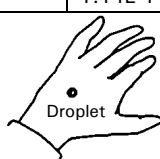
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	30	475	15				
E2	811	99						
E3	1675	< 1						
% omitted		< 1		0				

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	1E+0
IAEA ST1 A ₂ value	1E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.56E-2	10 cm: 1.9E-03 1 m: 0.0E+00	100 cm: 1.45E-4	5.22E-1	2.47E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.68E-3	10 cm: 6.5E-03 1 m: 4.2E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 6.1E-03 1 m: 4.0E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 2.97E-1	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>+</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		+										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 1.14E-1		3E+1										
		Fixed contamination										
		3E+1										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.7	
Plastic	1.2	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	10	29
Steel	31	76

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All unspec. compounds	0.100	7.4E-10		1 μm 5 μm
Oxid., hydrox. & inorg. compounds	0.050	7.0E-10		
Highest dose organ	Lungs	20 mSv A_{LI}	2.7E+07 (Bq)	20 mSv A_{LI}
				1.0E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	9E+05	9E+06	3E+06	3E+07	3E+09	

Cobalt - 60




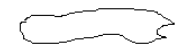



Half life: 5.27 years
 Specific activity: 4.18E+13 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


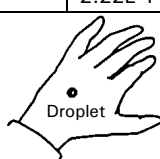
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	1173	100	318	100				
E2	1333	100	1491	<1				
E3								
% omitted	<1		0					

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	4E-1
IAEA ST1 A ₂ value	4E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.26E-2	10 cm: 2.6E-02 1 m: 0.0E+00	100 cm: 3.32E-4	1.19E+0	5.67E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
3.86E-3	10 cm: 1.6E-02 1 m: 1.0E-02			
	<i>Photons (deep dose)</i>			
	10 cm: 1.5E-02 1 m: 9.6E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 7.84E-1	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 2.22E-1		9E+0										
		Fixed contamination										
		1E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.4	
Plastic	0.7	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	16	46
Steel	36	93

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All unspec. compounds	0.100	3.4E-09		
Oxid., hydrox. & inorg. compounds	0.050	2.5E-09		
			1 µm	5 µm
			F	
			M	9.6E-09
			S	2.9E-08
				1.7E-08
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	5.9E+06 (Bq)	20 mSv A _{LI} inhalation
				6.9E+05 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
Oxid., hydroxid., halog. & nitrat.	0.01	2E+05	2E+06	5E+05	5E+06	5E+08	
Other compounds	0.01	3E+05	3E+06	1E+06	1E+07	1E+09	

Nickel - 63




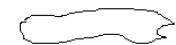



Half life: 100 years
 Specific activity: 2.10E+12 Bq.g⁻¹

Risk group: 5
 Risk colour: Blue


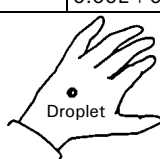
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			66	100				
E2								
E3								
% omitted			0					

Exemption levels	
Quantity (Bq)	1E+08
Concentration (Bq.g ⁻¹)	1E+05

Transport (TBq)	
IAEA ST1 A ₁ value	4E+1
IAEA ST1 A ₂ value	3E+1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 0.0E+00 1 m 0.0E+00	100 cm Brem. Rad.	Brem. Rad.	Brem. Rad.
<i>Gammas, X rays (deep tissue dose)</i> 0.00E+0	<i>Photons (skin)</i> 10 cm 0.0E+00 1 m 0.0E+00			
	<i>Photons (deep dose)</i> 10 cm 0.0E+00 1 m 0.0E+00			

The values above do not include Bremsstrahlung radiation. Brem. Rad. indicates that it may be significant.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²) 0.00E+0	Recommended probes*	Removable contamination 1E+3	
0.05 ml droplet (1 kBq) 0.00E+0			Fixed contamination 1E+5
			Alpha
			Beta +
	Gamma		
	X rays		

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)	
Betas and electrons (Total absorption)	
Glass	<0.1
Plastic	0.1
Gamma and X rays (half and tenth value thickness)	
	1/2 1/10
Lead	- -
Steel	- -

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.050	1.5E-10	1 μm	5 μm
			F	4.4E-10 5.2E-10
			M	4.4E-10 3.1E-10
			S	
Highest dose organ	Lower large intestine	20 mSv ALI _{ingestion}	1.3E+08 (Bq)	20 mSv ALI _{inhalation}
				3.8E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box	
All compounds except below	0.01	1E+07	1E+08	4E+07	4E+08	4E+10	
Vapour	1	Forbidden	1E+06	Forbidden	4E+06	4E+08	

Nickel - 65




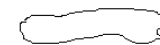

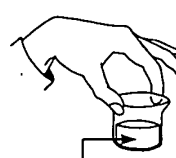

Half life: 2.52 hours
 Specific activity: 7.08E+17 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


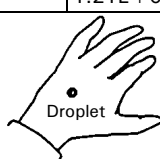
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	366	5	655	28				
E2	1116	15	1021	10				
E3	1482	24	2137	61				
% omitted		1.3		1				

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	4E-1
IAEA ST1 A ₂ value	4E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 1.12E-1	<i>Betas, electrons (skin)</i> 10 cm 1.2E-01 1 m 3.9E-02	100 cm 1.12E-4	3.01E-1	2.43E+1
<i>Gammas, X rays (deep tissue dose)</i> 8.35E-4	<i>Photons (skin)</i> 10 cm 3.4E-03 1 m 2.2E-03			
	<i>Photons (deep dose)</i> 10 cm 3.2E-03 1 m 2.1E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 2.19E+0	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq) 1.21E+0		4E+1										
		Fixed contamination										
		6E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	4.5	
Plastic	8.4	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	16	48
Steel	36	94

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.050	1.8E-10	1 μm	5 μm
			F	4.4E-11 7.5E-11
			M	8.7E-11 1.3E-10
			S	
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	1.1E+08 (Bq)	20 mSv A _{LI} inhalation
				1.5E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds except below	0.01	6E+05	6E+06	2E+06	2E+07	2E+09	
Vapour	1	Forbidden	3E+06	Forbidden	9E+06	9E+08	

Copper - 64

⁶⁴Cu₂₉


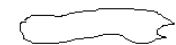

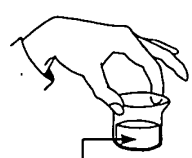

Half life: 12.7 hours
Specific activity: 1.43E+17 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


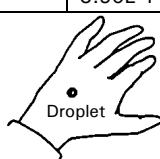
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	36	578	37				
E2	1346	<1	653	18				
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	6E+0
IAEA ST1 A ₂ value	1E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
5.92E-2	10 cm: 3.5E-03 1 m: 2.5E-05	100 cm: 3.00E-5	1.07E-1	5.79E-1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
3.45E-4	10 cm: 1.3E-03 1 m: 8.2E-04			
	<i>Photons (deep dose)</i>			
	10 cm: 1.2E-03 1 m: 7.8E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.00E+0	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 3.90E-1		1E+2										
		Fixed contamination										
		2E+2										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1	
Plastic	1.8	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	6	17
Steel	27	65

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
			1 µm	5 µm
All compounds	0.500	1.2E-10	All unspec. inorganic compounds	F 3.8E-11 6.8E-11
			Sulphides, halid. & nitrat.	M 1.1E-10 1.5E-10
			Oxid. & hydrox.	S 1.2E-10 1.5E-10
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	1.7E+08 (Bq)	20 mSv A _{LI} inhalation
				1.3E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	1E+06	1E+07	3E+06	3E+07	3E+09	

Copper - 67

⁶⁷Cu₂₉


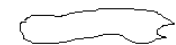
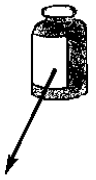


Half life: 2.58 days
Specific activity: 2.79E+16 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


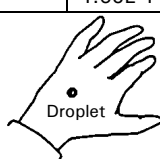
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	91	7	390	57	84	12		
E2	93	16	482	22	92	2		
E3	185	49	575	20				
% omitted		1.1		1		2		

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	1E+1
IAEA ST1 A ₂ value	7E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
4.92E-2	10 cm: 6.7E-02 1 m: 0.0E+00	100 cm: 2.03E-5	6.95E-2	3.16E-1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
2.20E-4	10 cm: 1.7E-03 1 m: 1.4E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 1.7E-03 1 m: 1.4E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.32E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 4.65E-1		1E+2										
		Fixed contamination										
		2E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.8	
Plastic	1.5	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	2
Steel	11	30

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f_i		Inhalation	1 µm	5 µm
All compounds	0.500	3.4E-10	All unspec. inorganic compounds	F 1.1E-10	1.8E-10
			Sulphides, halid. & nitrat.	M 5.2E-10	5.3E-10
			Oxid. & hydrox.	S 5.8E-10	5.8E-10
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	5.9E+07 (Bq)	20 mSv ALI _{inhalation}	3.4E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	1E+06	1E+07	4E+06	4E+07	4E+09	

Zinc - 65

⁶⁵Zn₃₀


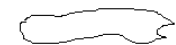



Half life: 243.9 days
Specific activity: 3.05E+14 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


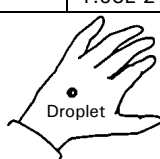
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	3	330	2				
E2	1116	51						
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	2E+0
IAEA ST1 A ₂ value	2E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
5.19E-4	10 cm: 8.1E-06 1 m: 0.0E+00	100 cm: 7.96E-5	2.87E-1	1.36E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
9.27E-4	10 cm: 3.7E-03 1 m: 2.4E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 3.5E-03 1 m: 2.3E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION		
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)
Uniform deposit (1kBq.cm ⁻²): 7.57E-2	Recommended probes*	Removable contamination
0.05 ml droplet (1 kBq): 1.53E-2	Alpha: <input type="checkbox"/>	4E+1
	Beta: <input type="checkbox"/>	Fixed contamination
	Gamma: ++	6E+1
	X rays: +	
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique		

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.4	
Plastic	0.8	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	14	42
Steel	35	87

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All compounds	0.500	3.9E-09		
			F	
			M	
			S	2.9E-09 2.8E-09
Highest dose organ	Lungs	20 mSv A _{LI,ingestion}	5.1E+06 (Bq)	20 mSv A _{LI,inhalation}
				6.9E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	1E+06	1E+07	4E+06	4E+07	4E+09	

Gallium - 66

⁶⁶Ga₃₁


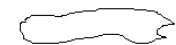
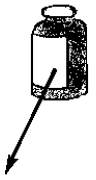


Half life: 9.45 hours
 Specific activity: 1.86E+17 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


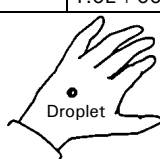
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	113	361	1				
E2	1039	38	924	4				
E3	2752	23	4153	51				
% omitted	34.7		1					

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	-
IAEA ST1 A ₂ value	-

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 6.14E-2	<i>Betas, electrons (skin)</i> 10 cm 7.5E-02 1 m 3.9E-02	100 cm 5.85E-4	2.23E+0	6.06E+1
<i>Gammas, X rays (deep tissue dose)</i> 3.53E-3	<i>Photons (skin)</i> 10 cm 1.8E-02 1 m 1.3E-02			
	<i>Photons (deep dose)</i> 10 cm 1.7E-02 1 m 1.2E-02			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.62E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td></td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays												
0.05 ml droplet (1 kBq) 1.0E+00		1E+1										
		Fixed contamination										
		1E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	10.7	
Plastic	20.2	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	13	48
Steel	35	98

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.001	1.2E-09	1 µm	5 µm
			All unspec. compounds	F 2.7E-10 4.7E-10
			Oxid., hydr., carbid., halid. & nitrat.	M 4.6E-10 7.1E-10
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	1.7E+07 (Bq)	20 mSv ALI _{inhalation}
				2.8E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood		Bench	Fume hood
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09

Gallium - 67


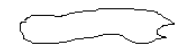
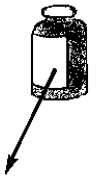


⁶⁷Ga₃₁

Half life: 3.26 days
Specific activity: 2.21E+16 Bq.g⁻¹


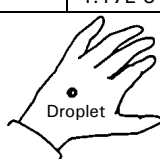
Risk group: 3
Risk colour: Yellow

Main emissions (keV)					Exemption levels			
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	93	39			8	62		
E2	185	21			84	29		
E3	300	17			93	6		
% omitted	67.5				2			

Transport (TBq)	
IAEA ST1 A ₁ value	7E+0
IAEA ST1 A ₂ value	3E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.00E+0	10 cm: 2.6E-04 1 m: 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>	100 cm		
2.79E-4	10 cm: 2.0E-03 1 m: 1.6E-03	2.54E-5	8.77E-2	4.02E-1
	<i>Photons (deep tissue dose)</i>			
	10 cm: 2.0E-03 1 m: 1.6E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			SHIELDING (mm)											
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	Betas and electrons (Total absorption)											
Uniform deposit (1kBq.cm ⁻²): 3.51E-1	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>+</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>++</td></tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma	++	X rays	++	Removable contamination	Glass	0.1
Recommended probes*														
Alpha														
Beta		+												
Gamma	++													
X rays	++													
0.05 ml droplet (1 kBq): 4.17E-3	Fixed contamination	Plastic	0.2											
		1E+2	Gamma and X rays (half and tenth value thickness)											
		2E+2		1/10										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			Lead	1	6									
			Steel	14	41									

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.001	1.9E-10	All unspec. compounds	F 6.8E-11 1.1E-10
			Oxid., hydr., carbid., halid. & nitrat.	M 2.3E-10 2.8E-10
				S
Highest dose organ	Lower large intestine	20 mSv A _{LI,ingestion}	1.1E+08 (Bq)	20 mSv A _{LI,inhalation}
				7.1E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	7E+06	7E+07	2E+07	2E+08	5E+09	

Gallium - 68

⁶⁸Ga₃₁


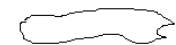
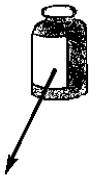


Half life: 1.13 hours
 Specific activity: 1.51E+18 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


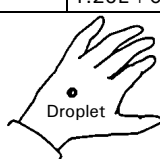
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	178	822	1				
E2	1077	3	1899	88				
E3	1883	<1						
% omitted		<1		0				

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	5E-1
IAEA ST1 A ₂ value	5E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.03E-1	10 cm: 1.2E-01 1 m: 4.5E-02	100 cm: 1.60E-4	5.49E-1	3.14E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.73E-3	10 cm: 6.5E-03 1 m: 4.1E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 6.2E-03 1 m: 3.9E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.81E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 1.25E+0		2E+1										
		Fixed contamination										
		3E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	3.9	
Plastic	7.2	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	6	17
Steel	27	65

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.001	1.0E-10	1 μm	5 μm
			All unspec. compounds	F 2.8E-11 4.9E-11
			Oxid., hydr., carbid., halid. & nitrat.	M 5.1E-11 8.1E-11
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	2.0E+08 (Bq)	20 mSv ALI _{inhalation}
				2.5E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Arsenic - 73

⁷³As₃₃


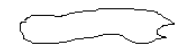
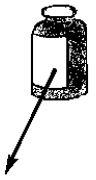


Half life: 80.3 days
Specific activity: 8.24E+14 Bq.g⁻¹

Risk group: 4
Risk colour: Green


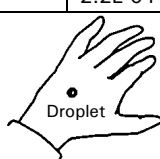
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	10	89			12	61		
E2	11	13			42	75		
E3	53	10			53	15		
% omitted		2				445		

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	40
IAEA ST1 A ₂ value	40

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.0E+00	10 cm 0.0E+00			
	1 m 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
2.4E-05	10 cm 6.0E-04			
	1 m 2.8E-04			
	<i>Photons (deep dose)</i>			
	10 cm 1.3E-04	100 cm 1.4E-06	4.0E-03	3.1E-02
	1 m 9.4E-05			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 4.5E-03	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta		Gamma		X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma												
X rays	++											
0.05 ml droplet (1 kBq) 2.2E-04		6E+02										
		Fixed contamination										
		3E+03										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	<	0.1
Plastic	<	0.1
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	< 1
Steel	< 1	2

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.500	2.6E-10		
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	7.7E+07 (Bq)	20 mSv ALI _{inhalation}
				2.2E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	6E+06	6E+07	2E+07	2E+08	5E+09	

Arsenic - 74

⁷⁴As₃₃


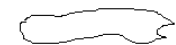
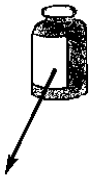


Half life: 17.8 days
 Specific activity: 3.67E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


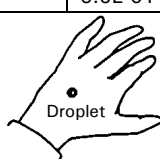
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	59	944	27	1	43		
E2	596	60	1353	19	9	15		
E3	1204	<1	1540	3				
% omitted		33		16		0		

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	1
IAEA ST1 A ₂ value	0.9

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
7.5E-02	10 cm: 7.1E-02 1 m: 1.3E-02	100 cm: 1.2E-04	3.6E-01	3.5E+00
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.4E-03	10 cm: 5.3E-03 1 m: 3.4E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 5.0E-03 1 m: 3.2E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.4E+00	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 6.5E-01		1E+00										
		Fixed contamination										
		4E+01										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	3.2	
Plastic	5.5	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	7	21
Steel	28	67

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i	Inhalation		
All compounds	0.500	1.3E-09	1 µm	5 µm
			F	
			M	2.1E-09
			S	1.8E-09
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	1.5E+07 (Bq)	20 mSv ALI _{inhalation}
				9.5E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09

Arsenic - 76

⁷⁶As₃₃


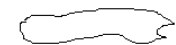
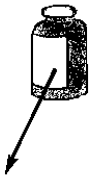


Half life: 1.10 days
Specific activity: 5.78E+16 Bq.g⁻¹

Risk group: 2
Risk colour: Orange


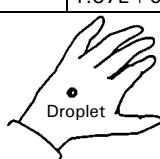
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	559	45	1748	8				
E2	657	6	2405	35				
E3	1216	3	2964	51				
% omitted		6.8		5				

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	3E-1
IAEA ST1 A ₂ value	3E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 1.04E-1	<i>Betas, electrons (skin)</i> 10 cm 1.4E-01 1 m 6.1E-02	100 cm 4.56E-4	7.32E-1	5.49E+1
<i>Gammas, X rays (deep tissue dose)</i> 7.39E-4	<i>Photons (skin)</i> 10 cm 4.0E-03 1 m 3.0E-03			
	<i>Photons (deep dose)</i> 10 cm 3.8E-03 1 m 2.8E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²) 2.14E+0	Recommended probes*	Removable contamination 3E+1	
0.05 ml droplet (1 kBq) 1.37E+0			Alpha
			Beta ++
			Gamma ++
	X rays +	Fixed contamination 6E+1	
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	6.9	
Plastic	12.9	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	8	28
Steel	30	75

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i	Inhalation		
All compounds	0.500	1.6E-09	1 μm	5 μm
			F	
			M	7.4E-10
			S	9.2E-10
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	1.3E+07 (Bq)	20 mSv ALI _{inhalation}
				2.2E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	6E+05	6E+06	2E+06	2E+07	2E+09	

Arsenic - 77

⁷⁷As₃₃


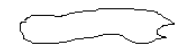
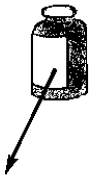


Half life: 1.62 days
 Specific activity: 3.87E+16 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


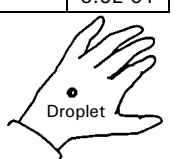
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	239	2	452	2				
E2	520	<1	690	97				
E3								
% omitted		<2		1				

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	20
IAEA ST1 A ₂ value	0.7

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
9.4E-02	10 cm: 8.9E-02 1 m: 0.0E+00	100 cm: 1.5E-06	4.3E-03	2.3E-02
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.6E-05	10 cm: 5.7E-05 1 m: 3.6E-05			
	<i>Photons (deep dose)</i>			
	10 cm: 5.6E-05 1 m: 3.5E-05			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.8E+00	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>+</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	+	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	+											
X rays	+											
0.05 ml droplet (1 kBq): 6.5E-01		1E+02										
		Fixed contamination										
		2E+03										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.1	
Plastic	2.0	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	7	24
Steel	38	70

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i	Inhalation		
All compounds	0.500	4.0E-10	1 μm	5 μm
			F	
			M	3.8E-10
			S	4.2E-10
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	5.0E+07 (Bq)	20 mSv ALI _{inhalation}
				4.8E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	8E+05	8E+06	3E+06	3E+07	3E+09	

Selenium - 75




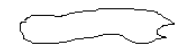
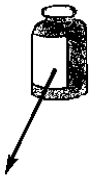


Half life: 119.8 days
 Specific activity: $5.37\text{E}+14 \text{ Bq.g}^{-1}$

Risk group: 3
 Risk colour: Yellow


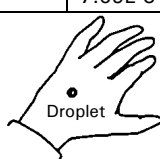
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	136	59			14	6		
E2	265	59			85	3		
E3	401	12			124	2		
% omitted		106				3		

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	3E+0
IAEA ST1 A ₂ value	3E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.00E+0	10 cm: 8.8E-04 1 m: 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
7.40E-4	10 cm: 7.4E-03 1 m: 5.1E-03	100 cm: 6.69E-5	2.32E-1	1.07E+0
	<i>Photons (deep dose)</i>			
	10 cm: 5.2E-03 1 m: 4.2E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION		
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)
Uniform deposit (1kBq.cm ⁻²): 1.43E-1	Recommended probes*	Removable contamination
0.05 ml droplet (1 kBq): 7.59E-3	Alpha: <input type="checkbox"/>	5E+1
	Beta: <input type="checkbox"/>	Fixed contamination
	Gamma: ++	7E+1
	X rays: ++	
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique		

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.1	
Plastic	0.2	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	5
Steel	15	42

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
			1 μm	5 μm
All unspec. compounds	0.800	2.6E-09	F	1.0E-09
Elemental selenium & selenides	0.050	4.1E-10	M	1.4E-09
			S	
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	7.7E+06 (Bq)	20 mSv A _{LI} inhalation
				1.2E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	2E+06	2E+07	6E+06	6E+07	5E+09	

Bromine - 77

⁷⁷Br₃₅


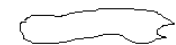
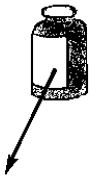


Half life: 2.38 days
 Specific activity: 2.64E+16 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


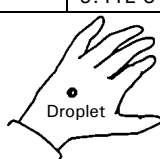
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	239	24	343	<1				
E2	521	23						
E3	818	2						
% omitted		82		0				

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	3E+0
IAEA ST1 A ₂ value	3E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 4.46E-4	<i>Betas, electrons (skin)</i> 10 cm 7.2E-04 1 m 0.0E+00	100 cm 5.07E-5	1.80E-1	8.41E-1
<i>Gammas, X rays (deep tissue dose)</i> 5.78E-4	<i>Photons (skin)</i> 10 cm 4.4E-03 1 m 3.0E-03			
	<i>Photons (deep dose)</i> 10 cm 3.5E-03 1 m 2.6E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.03E-2	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta		Gamma	++	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma	++											
X rays	++											
0.05 ml droplet (1 kBq) 9.41E-3		9E+1										
		Fixed contamination										
		1E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.4	
Plastic	0.8	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	4	17
Steel	24	62

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	1.000	9.6E-11	1 µm	5 µm
			Determined by combining cation	F 6.7E-11 1.2E-10
			Determined by combining cation	M 8.7E-11 1.3E-10
			S	
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	2.1E+08 (Bq)	20 mSv ALI _{inhalation}
				1.5E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+06	5E+07	2E+07	2E+08	5E+09	

Bromine - 82



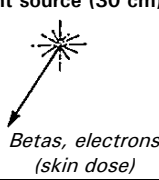
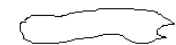



Half life: 1.47 days
 Specific activity: 4.01E+16 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


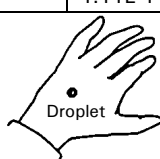
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	554	71	265	1				
E2	777	83	448	99				
E3	1318	27						
% omitted	148.6		0					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	4E-1
IAEA ST1 A ₂ value	4E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)																
Point source (30 cm)  Betas, electrons (skin dose) 4.95E-2 Gammas, X rays (deep tissue dose) 4.44E-3	Infinite plane source  Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>5.4E-02</td></tr> <tr><td>1 m</td><td>0.0E+00</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>2.3E-02</td></tr> <tr><td>1 m</td><td>1.7E-02</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>2.2E-02</td></tr> <tr><td>1 m</td><td>1.6E-02</td></tr> </table>	10 cm	5.4E-02	1 m	0.0E+00	10 cm	2.3E-02	1 m	1.7E-02	10 cm	2.2E-02	1 m	1.6E-02	10 ml glass vial  100 cm 3.83E-4	Contact with 50 ml glass beaker  1.38E+0	Contact with 5 ml plastic syringe  6.53E+0
10 cm	5.4E-02															
1 m	0.0E+00															
10 cm	2.3E-02															
1 m	1.7E-02															
10 cm	2.2E-02															
1 m	1.6E-02															

The values above do not include Bremsstrahlung radiation.

CONTAMINATION																				
Contamination skin dose (mSv.h⁻¹) <table border="1"> <tr> <td>Uniform deposit (1kBq.cm⁻²)</td> <td>1.51E+0</td> </tr> <tr> <td>0.05 ml droplet (1 kBq)</td> <td>4.11E-1</td> </tr> </table>  	Uniform deposit (1kBq.cm ⁻²)	1.51E+0	0.05 ml droplet (1 kBq)	4.11E-1	Detection <table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Derived limits (Bq.cm⁻²) <table border="1"> <tr> <th>Removable contamination</th> </tr> <tr> <td>1E+1</td> </tr> <tr> <th>Fixed contamination</th> </tr> <tr> <td>1E+1</td> </tr> </table>	Removable contamination	1E+1	Fixed contamination	1E+1
Uniform deposit (1kBq.cm ⁻²)	1.51E+0																			
0.05 ml droplet (1 kBq)	4.11E-1																			
Recommended probes*																				
Alpha																				
Beta	++																			
Gamma	++																			
X rays	+																			
Removable contamination																				
1E+1																				
Fixed contamination																				
1E+1																				

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.6	
Plastic	1.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	10	33
Steel	32	80

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 µm 5 µm
All compounds	1.000	5.4E-10	Determined by combining cation	F 3.7E-10 6.4E-10
			Determined by combining cation	M 6.4E-10 8.8E-10
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	3.7E+07 (Bq)	20 mSv ALI _{inhalation}
				2.3E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Krypton - 85

⁸⁵Kr₃₆


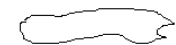



Half life: 10.7 years
 Specific activity: 1.45E+13 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


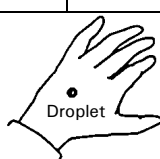
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	514	<1	687	100				
E2			173	<1				
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+05

Transport (TBq)	
IAEA ST1 A ₁ value	1E+1
IAEA ST1 A ₂ value	1E+1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.15E-1	10 cm - 1 m -	100 cm		
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
4.09E-6	10 cm - 1 m -			
	<i>Photons (deep dose)</i>			
	10 cm - 1 m -			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION	
Contamination skin dose (mSv.h⁻¹)	Detection
Uniform deposit (1kBq.cm ⁻²) -	Recommended probes*
0.05 ml droplet (1 kBq) -	Alpha
	Beta ++
	Gamma
	X rays
	Derived limits (Bq.cm⁻²)
	Removable contamination
	-
	Fixed contamination
	-

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1	
Plastic	1.9	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	6	17
Steel	27	64

INTERNAL EXPOSURE FOR WORKERS	
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)	
Ingestion	f ₁
	SUBMERSION DOSE RATE (Sv per day)
	Sv.d ⁻¹ per Bq.m ⁻³ 2.2E-11
Highest dose organ	20 mSv ALI _{ingestion} (Bq) 20 mSv ALI _{inhalation} (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	1	Forbidden	6E+06	Forbidden	2E+07	5E+08	

Krypton - 81

⁸¹Kr₃₆


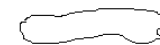



Half life: 2.1E+5 years
 Specific activity: 7.78E+08 Bq.g⁻¹


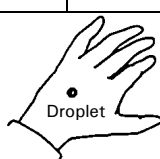
Risk group: 4
 Risk colour: Green

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	12	44			1	110		
E2	13	7			10	31		
E3	276	4						
% omitted		1				0		

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+04

Transport (TBq)	
IAEA ST1 A ₁ value	40
IAEA ST1 A ₂ value	40

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.0E+00	10 cm - 1 m -	100 cm		
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
6.6E-05	10 cm - 1 m -			
	<i>Photons (deep dose)</i>			
	10 cm - 1 m -			

CONTAMINATION	
Contamination skin dose (mSv.h⁻¹)	Detection
Uniform deposit (1kBq.cm ⁻²) -	Recommended probes*
0.05 ml droplet (1 kBq) -	Alpha
	Beta
	Gamma ++
	X rays ++
	Derived limits (Bq.cm⁻²)
	Removable contamination
	-
	Fixed contamination
	-

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	<	0.1
Plastic	<	0.1
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	<	3
Steel	<	27

INTERNAL EXPOSURE FOR WORKERS	
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)	
Ingestion	f ₁
	SUBMERSION DOSE RATE (Sv per day)
	Sv.d ⁻¹ per Bq.m ⁻³
	2.1E-11
Highest dose organ	20 mSv A _{LI} ingestion (Bq) 20 mSv A _{LI} inhalation (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	1	Forbidden	2E+08	Forbidden	6E+08	5E+09	

Krypton - 83m

^{83m}Kr₃₆


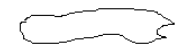



Half life: 1.83 hours
 Specific activity: 7.63E+17 Bq.g⁻¹


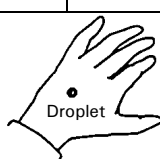
Risk group: 5
 Risk colour: Blue

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	13	14			10	26		
E2	14	2			18	24		
E3					31	75		
% omitted		8				243		

Exemption levels	
Quantity (Bq)	1E+12
Concentration (Bq.g ⁻¹)	1E+05

Transport (TBq)	
IAEA ST1 A ₁ value	-
IAEA ST1 A ₂ value	-

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
Betas, electrons (skin dose)	Betas, electrons (skin)			
0.0E+00	10 cm - 1 m -	100 cm		
	Photons (skin)			
	10 cm - 1 m -			
Gammas, X rays (deep tissue dose)	Photons (deep dose)			
2.1E-05	10 cm - 1 m -			

CONTAMINATION	
Contamination skin dose (mSv.h ⁻¹)	Detection
Uniform deposit (1kBq.cm ⁻²) -	Recommended probes*
0.05 ml droplet (1 kBq) -	Alpha
	Beta
	Gamma
	X rays +
	Derived limits (Bq.cm ⁻²)
	Removable contamination
	Fixed contamination

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	<	0.1
Plastic	<	0.1
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS	
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)	
Ingestion f ₁	SUBMERSION DOSE RATE (Sv per day)
	Sv.d ⁻¹ per Bq.m ⁻³ 2.1E-13
Highest dose organ	20 mSv ALI _{ingestion} (Bq) 20 mSv ALI _{inhalation} (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	1	Forbidden	1E+09	Forbidden	5E+09	5E+10

Krypton - 85m

^{85m}Kr₃₆


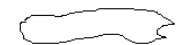



Half life: 4.48 hours
Specific activity: 3.04E+17 Bq.g⁻¹

Risk group: 5
Risk colour: Blue


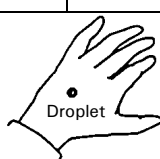
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	151	75	840	79	136	3		
E2	305	14			290	6		
E3	581	<1			303	1		
% omitted		7		<1		15		

Exemption levels	
Quantity (Bq)	1E+10
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	8
IAEA ST1 A ₂ value	3

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
9.6E-02	10 cm - 1 m -	100 cm		
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
3.1E-04	10 cm - 1 m -			
	<i>Photons (deep dose)</i>			
	10 cm - 1 m -			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION	
Contamination skin dose (mSv.h⁻¹)	Detection
Uniform deposit (1kBq.cm ⁻²) -	Recommended probes*
0.05 ml droplet (1 kBq) -	Alpha
	Beta ++
	Gamma ++
	X rays ++
	Derived limits (Bq.cm⁻²)
	Removable contamination
	-
	Fixed contamination
	-

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.4	
Plastic	2.5	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	3
Steel	11	31

INTERNAL EXPOSURE FOR WORKERS		
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)		
Ingestion	f ₁	
		SUBMERSION DOSE RATE (Sv per day)
		Sv.d ⁻¹ per Bq.m ⁻³ 5.9E-10
Highest dose organ	-	20 mSv ALI _{ingestion} - (Bq) 20 mSv ALI _{inhalation} - (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	1	Forbidden	4E+06	Forbidden	1E+07	1E+09	

Rubidium - 86

⁸⁶Rb₃₇


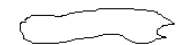

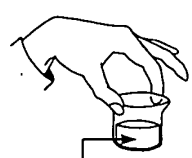

Half life: 18.64 days
 Specific activity: 3.01E+15 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


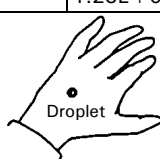
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	1077	9	698	9				
E2			1774	91				
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	5E-1
IAEA ST1 A ₂ value	5E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 1.12E-1	<i>Betas, electrons (skin)</i> 10 cm 1.3E-01 1 m 4.4E-02	100 cm 1.77E-5	5.16E-2	2.41E+1
<i>Gammas, X rays (deep tissue dose)</i> 1.52E-4	<i>Photons (skin)</i> 10 cm 6.1E-04 1 m 4.0E-04			
	<i>Photons (deep dose)</i> 10 cm 5.7E-04 1 m 3.7E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.89E+0	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>+</td> </tr> <tr> <td>X rays</td> <td></td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	+	X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	+											
X rays												
0.05 ml droplet (1 kBq) 1.23E+0		5E+1										
		Fixed contamination										
		2E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	3.5	
Plastic	6.6	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	14	41
Steel	35	87

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	
All compounds	1.000	2.8E-09	All compounds	1 µm 5 µm
				F 9.6E-10 1.3E-09
				M
				S
Highest dose organ	Bone surfaces	20 mSv ALI _{ingestion}	7.1E+06 (Bq)	20 mSv ALI _{inhalation}
				1.5E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	6E+05	6E+06	2E+06	2E+07	2E+09	

Strontium - 85

⁸⁵Sr₃₈


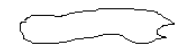

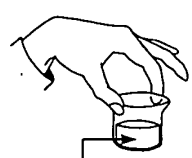

Half life: 64.9 days
 Specific activity: 8.75E+14 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


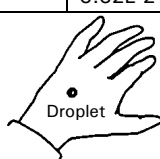
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	13	50			499	< 1		
E2	15	8						
E3	514	99						
% omitted	< 1				< 1			

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	2E+0
IAEA ST1 A ₂ value	2E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 1.05E-3	<i>Betas, electrons (skin)</i> 10 cm 9.6E-04 1 m 0.0E+00	100 cm 8.13E-5	2.90E-1	1.37E+0
<i>Gammas, X rays (deep tissue dose)</i> 9.58E-4	<i>Photons (skin)</i> 10 cm 4.9E-03 1 m 2.8E-03			
	<i>Photons (deep dose)</i> 10 cm 3.5E-03 1 m 2.2E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 5.95E-2	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </table>	Recommended probes*		Alpha		Beta		Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq) 3.32E-2		5E+1										
		Fixed contamination										
		6E+1										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.7	
Plastic	1.3	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	6	17
Steel	27	64

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 µm 5 µm
All unspec. compounds	0.300	5.6E-10	All unspec. compounds	F 3.9E-10 5.6E-10
Strontium titanate (SrTiO ₃)	0.010	3.3E-10		M
			Strontium titanate (SrTiO ₃)	S 7.7E-10 6.4E-10
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	3.6E+07 (Bq)	20 mSv A _{LI} inhalation
				2.6E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	2E+06	2E+07	7E+06	7E+07	5E+09	

Strontium - 89

⁸⁹Sr₃₈


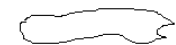

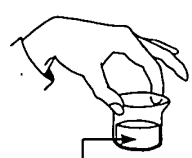

Half life: 50.7 days
 Specific activity: 1.07E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


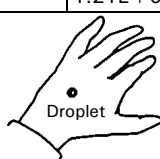
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	909	<1	1492	100				
E2								
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	6E-1
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.15E-1	10 cm: 1.3E-01 1 m: 3.9E-02	100 cm: 2.87E-5	1.01E-2	1.64E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
2.27E-7	10 cm: 9.0E-07 1 m: 5.9E-07			
	<i>Photons (deep dose)</i>			
	10 cm: 8.4E-07 1 m: 5.5E-07			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.78E+0	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma												
X rays												
0.05 ml droplet (1 kBq): 1.21E+0		4E+1										
		Fixed contamination										
		4E+2										

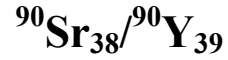
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	2.8	
Plastic	5.3	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	12	35
Steel	33	82

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All unspec. compounds	0.300	2.6E-09	All unspec. compounds	F 1.0E-09 1.4E-09
Strontium titanate (SrTiO ₃)	0.010	2.3E-09		M
			Strontium titanate (SrTiO ₃)	S 7.5E-09 5.6E-09
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	7.7E+06 (Bq)	20 mSv ALI _{inhalation}
				2.7E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	

Strontium - 90 / Yttrium - 90




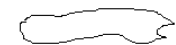



Half life: 28.2 years
 Specific activity: 5.21E+12 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


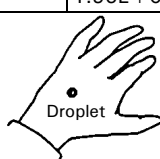
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			523	<1				
E2			546	100				
E3			2284	100				
% omitted			0					

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	3E-1
IAEA ST1 A ₂ value	3E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
2.04E-1	10 cm: 2.2E-01 1 m: 6.1E-02	100 cm: 7.11E-5	1.39E-1	4.35E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
0.00E+0	10 cm: 0.0E+00 1 m: 0.0E+00			
	<i>Photons (deep dose)</i>			
	10 cm: 0.0E+00 1 m: 0.0E+00			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 3.51E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td></td></tr> <tr><td>X rays</td><td></td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma												
X rays												
0.05 ml droplet (1 kBq): 1.96E+0		5E+0										
		Fixed contamination										
		5E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass		4.9
Plastic		9.2
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	-	-
Steel	-	-

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All unspec. compounds	0.300	2.8E-08	All unspec. compounds	F 1 μm: 2.4E-08, 5 μm: 3.0E-08
Strontium titanate (SrTiO ₃)	0.010	2.7E-09		M
			Strontium titanate (SrTiO ₃)	S 1.5E-07, 7.7E-08
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	7.1E+05 (Bq)	20 mSv ALI _{inhalation}
				1.3E+05 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
Strontium titanate (SrTiO ₃)	0.01	4E+04	4E+05	1E+05	1E+06	1E+08
Soluble compounds except SrTiO ₃	0.01	1E+05	1E+06	4E+05	4E+06	4E+08

Yttrium - 90

⁹⁰Y₃₉


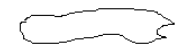



Half life: 2.7 days
Specific activity: 1.99E+16 Bq.g⁻¹

Risk group: 2
Risk colour: Orange


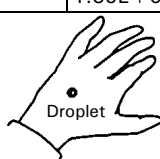
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			523	<1				
E2			2284	100				
E3								
% omitted			0					

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	3E-1
IAEA ST1 A ₂ value	3E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 1.08E-1	<i>Betas, electrons (skin)</i> 10 cm 1.4E-01 1 m 6.1E-02	100 cm 7.11E-5	1.39E-1	4.35E+1
<i>Gammas, X rays (deep tissue dose)</i> 0.00E+0	<i>Photons (skin)</i> 10 cm 0.0E+00 1 m 0.0E+00			
	<i>Photons (deep dose)</i> 10 cm 0.0E+00 1 m 0.0E+00			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 2.03E+0	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma												
X rays												
0.05 ml droplet (1 kBq) 1.35E+0		6E+1										
		Fixed contamination										
		3E+2										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	4.9	
Plastic	9.2	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	-	-
Steel	-	-

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i	Inhalation		
			1 µm	5 µm
All compounds	0.0001	2.7E-09	F	
			M	1.4E-09 1.6E-09
			S	1.5E-09 1.7E-09
				Oxid.& hydrox.
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	7.4E+06 (Bq)	20 mSv ALI _{inhalation}
				1.2E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	6E+05	6E+06	2E+06	2E+07	2E+09	

Yttrium - 91

⁹¹Y₃₉


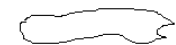

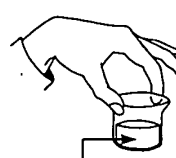

Half life: 58.5 days
 Specific activity: 9.07E+14 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


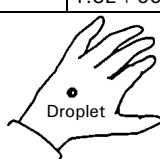
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	1205	<1	1543	100				
E2								
E3								
% omitted	0		<1					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	0.6
IAEA ST1 A ₂ value	0.6

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 1.2E-01	<i>Betas, electrons (skin)</i> 10 cm 1.3E-01 1 m 4.1E-02	100 cm 4.9E-07	1.4E-03	1.8E+01
<i>Gammas, X rays (deep tissue dose)</i> 5.6E-06	<i>Photons (skin)</i> 10 cm 2.3E-05 1 m 1.5E-05			
	<i>Photons (deep dose)</i> 10 cm 2.1E-05 1 m 1.4E-05			

The values above do not include Bremsstrahlung radiation.

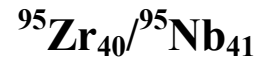
CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.8E+00	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td></td></tr> <tr><td>X rays</td><td></td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma												
X rays												
0.05 ml droplet (1 kBq) 1.3E+00		4E+01										
		Fixed contamination										
		4E+02										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	3.2	
Plastic	5.5	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	16	46
Steel	36	91

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.0001	2.4E-09		
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	8.3E+06 (Bq)	20 mSv ALI _{inhalation}
				2.4E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	3E+05	3E+06	1E+06	1E+07	1E+09	

Zirconium - 95 / Niobium - 95




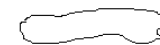

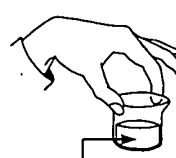

Half life: 64.0 days
 Specific activity: 7.94E+14 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


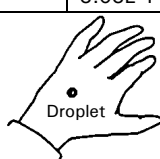
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	724	44	160	100				
E2	757	55	366	55				
E3	766	100	399	44				
% omitted	<1		1					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	2E+0
IAEA ST1 A ₂ value	8E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
3.16E-2	10 cm: 4.1E-02 1 m: 0.0E+00	100 cm: 2.23E-4	8.07E-1	3.82E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
2.59E-3	10 cm: 1.0E-02 1 m: 6.5E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 9.5E-03 1 m: 6.1E-03			

The values above do not include Bremsstrahlung radiation.

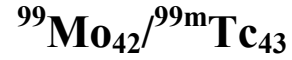
CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.57E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 3.03E-1		3E+1										
		Fixed contamination										
		4E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.5	
Plastic	1.0	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	10	28
Steel	31	76

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f_i		Inhalation	1 μm	5 μm
All compounds	0.002	8.8E-10	All unspec. compounds	F 2.5E-09	3.0E-09
			Oxid., hydrox., halid. & nitrat.	M 4.5E-09	3.6E-09
			Zirconium carbide	S 5.5E-09	4.2E-09
Highest dose organ	Bone surfaces	20 mSv A _{LI} ingestion	2.3E+07 (Bq)	20 mSv A _{LI} inhalation	3.6E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Molybdenum - 99 / Technetium - 99m




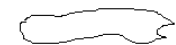

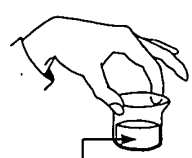

Half life: 2.75 days
 Specific activity: 1.77E+16 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


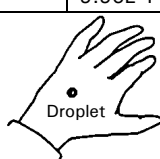
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	141	89	436	17	120	9		
E2	740	12	848	1	138	1		
E3	778	4	1214	82				
% omitted	20.1		<1		1			

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	1E+0
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.08E-1	10 cm: 1.1E-01 1 m: 1.8E-02	100 cm: 4.61E-5	1.62E-1	7.43E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
5.43E-4	10 cm: 3.7E-03 1 m: 2.9E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 3.5E-03 1 m: 2.8E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION				
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)		
Uniform deposit (1kBq.cm ⁻²): 1.89E+0	Recommended probes*	Removable contamination		
0.05 ml droplet (1 kBq): 9.96E-1	Alpha: <table border="1"><tr><td></td><td></td></tr></table>			6E+1
	Beta: ++	Fixed contamination		
	Gamma: +	2E+2		
	X rays: ++			
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique				

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	2.2	
Plastic	4.0	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	1	19
Steel	13	55

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f_i		Inhalation	1 μm	5 μm
All unspec. compounds	0.800	7.4E-10	All unspec. compounds	F: 2.3E-10	3.6E-10
Molybdenum sulphide	0.050	1.2E-09		M:	
			Molyb. sulphide, oxid. & hydrox.	S: 9.7E-10	1.1E-09
Highest dose organ	Lower large intestine	20 mSv A _{LI,ingestion}	1.7E+07 (Bq)	20 mSv A _{LI,inhalation}	1.8E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Technetium - 99m

^{99m}Tc₄₃


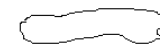

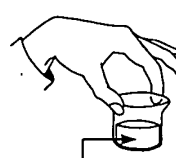

Half life: 6.0 hours
Specific activity: 1.95E+17 Bq.g⁻¹

Risk group: 4
Risk colour: Green


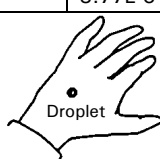
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	18	6			120	9		
E2	21	1			138	1		
E3	141	89						
% omitted		1				1		

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	1E+1
IAEA ST1 A ₂ value	4E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 2.3E-04 1 m 0.0E+00	100 cm 2.24E-5	7.70E-2	3.54E-1
<i>Gammas, X rays (deep tissue dose)</i> 2.61E-4	<i>Photons (skin)</i> 10 cm 9.0E-03 1 m 5.4E-04			
	<i>Photons (deep dose)</i> 10 cm 8.5E-03 1 m 5.1E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 2.46E-1	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td>+</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta		Gamma	+	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma	+											
X rays	++											
0.05 ml droplet (1 kBq) 8.77E-3		2E+2										
		Fixed contamination										
		2E+2										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.2	
Plastic	0.3	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	1
Steel	1	19

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.800	2.2E-11	1 µm	5 µm
			All unspec. compounds	F 1.2E-11 2.0E-11
			Oxid., hydrox., halid. & nitrat.	M 1.9E-11 2.9E-11
				S
Highest dose organ	Thyroid	20 mSv A _{LI} ingestion	9.1E+08 (Bq)	20 mSv A _{LI} inhalation
				6.9E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	1E+07	1E+08	3E+07	3E+08	5E+09	

Technetium - 99

⁹⁹Tc₄₃

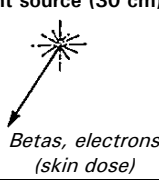
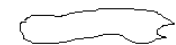
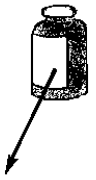


Half life: 2.1E+5 years
Specific activity: 6.36E+08 Bq.g⁻¹

Risk group: 4
Risk colour: Green


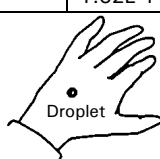
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	90	<1	294	100				
E2								
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+04

Transport (TBq)	
IAEA ST1 A ₁ value	4E+1
IAEA ST1 A ₂ value	9E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)																
Point source (30 cm)  Betas, electrons (skin dose) 5.19E-3 Gammas, X rays (deep tissue dose) 1.10E-9	Infinite plane source  Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>1.8E-02</td></tr> <tr><td>1 m</td><td>0.0E+00</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>3.4E-09</td></tr> <tr><td>1 m</td><td>2.0E-09</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>3.4E-09</td></tr> <tr><td>1 m</td><td>2.0E-09</td></tr> </table>	10 cm	1.8E-02	1 m	0.0E+00	10 cm	3.4E-09	1 m	2.0E-09	10 cm	3.4E-09	1 m	2.0E-09	10 ml glass vial  100 cm Brem. Rad.	Contact with 50 ml glass beaker  Brem. Rad.	Contact with 5 ml plastic syringe  Brem. Rad.
10 cm	1.8E-02															
1 m	0.0E+00															
10 cm	3.4E-09															
1 m	2.0E-09															
10 cm	3.4E-09															
1 m	2.0E-09															

The values above do not include Bremsstrahlung radiation. Brem. Rad. indicates that it may be significant.

CONTAMINATION																
Contamination skin dose (mSv.h⁻¹) <table border="1"> <tr> <td>Uniform deposit (1kBq.cm⁻²)</td> <td>1.16E+0</td> </tr> <tr> <td>0.05 ml droplet (1 kBq)</td> <td>1.32E-1</td> </tr> </table>  	Uniform deposit (1kBq.cm ⁻²)	1.16E+0	0.05 ml droplet (1 kBq)	1.32E-1	Detection <table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays		Derived limits (Bq.cm⁻²) Removable contamination 1E+2 Fixed contamination 1E+4
Uniform deposit (1kBq.cm ⁻²)	1.16E+0															
0.05 ml droplet (1 kBq)	1.32E-1															
Recommended probes*																
Alpha																
Beta	++															
Gamma																
X rays																

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass		0.4
Plastic		0.6
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	< 1
Steel	3	9

INTERNAL EXPOSURE FOR WORKERS			
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)			
Ingestion	f _i		Inhalation
All compounds	0.800	7.8E-10	1 μm 5 μm
			All unspec. compounds F 2.9E-10 4.0E-10
			Oxid., hydrox., halid. & nitrat. M 3.9E-09 3.2E-09
			S
Highest dose organ	Lungs	20 mSv A _{LI} ingestion 2.6E+07 (Bq)	20 mSv A _{LI} inhalation 5.1E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
Oxid., hydrox., halog., nitrat.	0.01	2E+06	2E+07	5E+06	5E+07	5E+09
Other compounds	0.01	8E+06	8E+07	3E+07	3E+08	5E+09

Ruthenium - 103 / Rhodium - 103m

¹⁰³Ru₄₄/^{103m}Rh₄₅


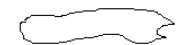

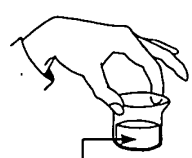

Half life: 39.3 days
 Specific activity: 1.19E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


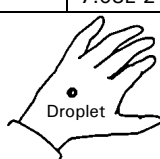
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	20	7	113	7	17	10		
E2	497	90	226	90	36	73		
E3	610	6	723	4	39	17		
% omitted		3.3		<1		3		

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	2E+0
IAEA ST1 A ₂ value	2E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
4.65E-3	10 cm: 6.3E-03 1 m: 0.0E+00	100 cm: 7.76E-5	2.77E-1	1.31E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
9.17E-4	10 cm: 5.2E-03 1 m: 3.9E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 4.9E-03 1 m: 3.8E-03			

The values above do not include Bremsstrahlung radiation.

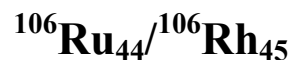
CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection		
Uniform deposit (1kBq.cm ⁻²): 7.84E-1	Recommended probes*		
0.05 ml droplet (1 kBq): 7.08E-2	Alpha: <table border="1"><tr><td></td><td></td></tr></table>		
	Beta: ++		
	Gamma: ++		
	X rays: ++		
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique	Derived limits (Bq.cm⁻²)		
	Removable contamination : 4E+1		
	Fixed contamination : 6E+1		

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.1	
Plastic	2.1	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	5	16
Steel	25	63

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.050	7.3E-10	All unspec. compounds	F 1 μm: 4.9E-10, 5 μm: 6.8E-10
			Halides	M 2.3E-09, 1.9E-09
			Oxid. & hydrox.	S 2.8E-09, 2.2E-09
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	2.7E+07 (Bq)	20 mSv A _{LI} inhalation
				7.1E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	1E+06	1E+07	4E+06	4E+07	4E+09	

Ruthenium - 106 / Rhodium - 106




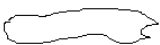



Half life: 372.6 days
Specific activity: 1.22E+14 Bq.g⁻¹

Risk group: 2
Risk colour: Orange


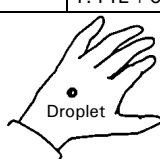
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	512	21	39	100				
E2	622	10	2407	10				
E3	1050	2	3541	79				
% omitted	1.8		11					

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	2E-1
IAEA ST1 A ₂ value	2E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.04E-1	10 cm: 1.5E-01 1 m: 7.1E-02	100 cm: 3.97E-4	1.47E+0	7.76E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
3.68E-4	10 cm: 1.4E-03 1 m: 9.0E-04			
	<i>Photons (deep dose)</i>			
	10 cm: 1.4E-03 1 m: 8.5E-04			

The values above do not include Bremsstrahlung radiation.

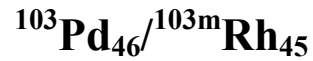
CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 2.24E+0	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>+</td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma	+	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	+											
X rays	+											
0.05 ml droplet (1 kBq): 1.44E+0		1E+1										
		Fixed contamination										
		1E+3										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	8.7	
Plastic	16.4	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	7	23
Steel	29	70

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.050	7.0E-09	All unspec. compounds	F 8.0E-09 9.8E-09
			Halides	M 2.6E-08 1.7E-08
			Oxid. & hydrox.	S 6.2E-08 3.5E-08
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	2.9E+06 (Bq)	20 mSv A _{LI} inhalation
				3.2E+05 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
Oxid. & hydrox.	0.01	8E+04	8E+05	3E+05	3E+06	3E+08	
Other compounds	0.01	2E+05	2E+06	6E+05	6E+06	6E+08	

Palladium-103 / Rhodium-103m




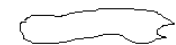

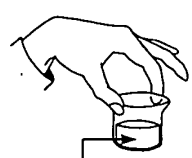

Half life: 17.0 days
 Specific activity: 2.76E+15 Bq.g⁻¹

Risk group: 5
 Risk colour: Blue


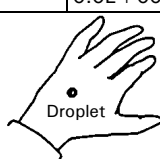
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	3	9			2	168		
E2	20	64			17	17		
E3	23	13						
% omitted	3				11			

Exemption levels	
Quantity (Bq)	1E+08
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	40
IAEA ST1 A ₂ value	40

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.0E+00	<i>Betas, electrons (skin)</i> 10 cm 0.0E+00 1 m 0.0E+00	100 cm 3.0E-06	4.8E-03	4.3E-01
<i>Gammas, X rays (deep tissue dose)</i> 2.4E-04	<i>Photons (skin)</i> 10 cm 1.1E-03 1 m 5.4E-04			
	<i>Photons (deep dose)</i> 10 cm 6.5E-04 1 m 3.4E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION		
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)
Uniform deposit (1kBq.cm ⁻²) 0.0E+00	Recommended probes* Alpha Beta Gamma X rays +	Removable contamination
0.05 ml droplet (1 kBq) 0.0E+00		2E+03
		Fixed contamination
		2E+05
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique		

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	< 0.1	
Plastic	< 0.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f_i		Inhalation	1 µm	5 µm
All compounds	0.005	1.9E-10	All unspec. compounds	F 9.0E-11	1.2E-10
			Nitrates & halid.	M 3.5E-10	3.0E-10
			Oxid. & hydrox.	S 4.0E-10	2.9E-10
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	1.1E+08 (Bq)	20 mSv A _{LI} inhalation	5.0E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	7E+06	7E+07	2E+07	2E+08	2E+10	

Silver - 110m

^{110m}Ag₄₇


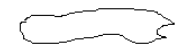

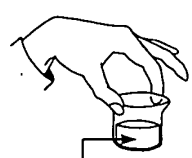

Half life: 249.8 days
Specific activity: 1.76E+14 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


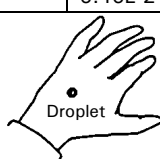
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	658	94	84	67	91	1		
E2	885	73	531	31	631	<1		
E3	1505	13						
% omitted	139.3		<1		<1			

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	4E-1
IAEA ST1 A ₂ value	4E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
2.15E-2	10 cm: 2.4E-02 1 m: 0.0E+00	100 cm: 3.92E-4	1.41E+0	6.70E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
4.56E-3	10 cm: 2.3E-02 1 m: 1.7E-02			
	<i>Photons (deep dose)</i>			
	10 cm: 2.2E-02 1 m: 1.6E-02			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 6.76E-1	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>+</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		+										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 6.46E-2		1E+1										
		Fixed contamination										
		1E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.8	
Plastic	1.4	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	11	35
Steel	32	81

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f_i		Inhalation	1 μm	5 μm
All compounds	0.050	2.8E-09	All unspec. comp. & metallic Ag	F 5.5E-09	6.7E-09
			Nitrates & sulphides	M 7.2E-09	5.9E-09
			Oxid., hydrox. & carbides	S 1.2E-08	7.3E-09
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	7.1E+06 (Bq)	20 mSv A _{LI} inhalation	1.7E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	3E+05	3E+06	9E+05	9E+06	9E+08	

Silver - 111

¹¹¹Ag₄₇


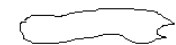
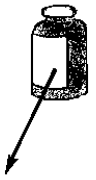


Half life: 7.5 days
 Specific activity: 5.80E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


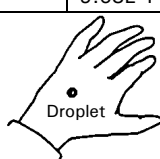
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	245	1	693	6				
E2	342	7	790	1				
E3			1035	93				
% omitted	<1		0					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	2E+0
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.17E-1	10 cm: 1.1E-01 1 m: 1.2E-02	100 cm: 4.47E-6	1.56E-2	3.75E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
5.07E-5	10 cm: 1.8E-04 1 m: 1.1E-04			
	<i>Photons (deep dose)</i>			
	10 cm: 1.8E-04 1 m: 1.1E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.76E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>+</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	+	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	+											
X rays	+											
0.05 ml droplet (1 kBq): 9.68E-1		8E+1										
		Fixed contamination										
		5E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.8	
Plastic	3.3	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	3	8
Steel	21	51

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.050	1.3E-09	All unspec. comp. & metallic Ag	F 1 μm: 4.1E-10, 5 μm: 5.7E-10
			Nitrates & sulphides	M 1.5E-09, 1.5E-09
			Oxid., hydrox. & carbides	S 1.7E-09, 1.6E-09
Highest dose organ	Lungs	20 mSv A _{LI,ingestion}	1.5E+07 (Bq)	20 mSv A _{LI,inhalation}
				1.2E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Cadmium - 109

¹⁰⁹Cd₄₈


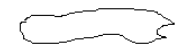

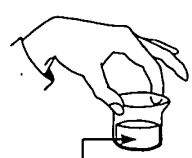

Half life: 462.6 days
Specific activity: 9.58E+13 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


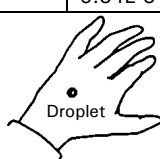
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	22	83			63	41		
E2	25	15			84	45		
E3	88	4			87	10		
% omitted	2.7				0			

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+04

Transport (TBq)	
IAEA ST1 A ₁ value	3E+1
IAEA ST1 A ₂ value	2E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 0.0E+00 1 m 0.0E+00	100 cm 3.44E-6	9.18E-3	1.22E-1
<i>Gammas, X rays (deep tissue dose)</i> 2.09E-4	<i>Photons (skin)</i> 10 cm 8.0E-04 1 m 4.3E-04			
	<i>Photons (deep dose)</i> 10 cm 5.6E-04 1 m 3.0E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 5.41E-1	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>+</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	+	Gamma		X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta		+										
Gamma												
X rays	++											
0.05 ml droplet (1 kBq) 6.34E-3		6E+1										
		Fixed contamination										
		3E+3										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.1	
Plastic	0.2	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
			1 μm	5 μm
All inorganic compounds	0.050	2.0E-09	All unspec. comp. & metallic Ag	F 8.1E-09 9.6E-09
			Sulphides, halid. & nitrat.	M 6.2E-09 5.1E-09
			Oxid. & hydrox.	S 5.8E-09 4.4E-09
Highest dose organ	Kidneys	20 mSv A _{LI} ingestion	1.0E+07 (Bq)	20 mSv A _{LI} inhalation 2.1E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	6E+05	6E+06	2E+06	2E+07	2E+09	

Indium - 111

¹¹¹In₄₉


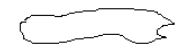



Half life: 2.80 days
Specific activity: 1.55E+16 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


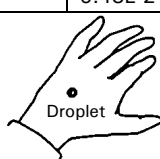
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	23	69			145	9		
E2	171	90			219	5		
E3	245	94						
% omitted		14.6					2	

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	3E+0
IAEA ST1 A ₂ value	3E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 8.92E-5	<i>Betas, electrons (skin)</i> 10 cm 1.2E-02 1 m 0.0E+00	100 cm 7.17E-5	2.43E-1	1.22E+0
<i>Gammas, X rays (deep tissue dose)</i> 9.94E-4	<i>Photons (skin)</i> 10 cm 3.5E-03 1 m 2.1E-03			
	<i>Photons (deep dose)</i> 10 cm 3.2E-03 1 m 1.9E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 3.78E-1	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>+</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma	++	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta		+										
Gamma	++											
X rays	++											
0.05 ml droplet (1 kBq) 6.48E-2		6E+1										
		Fixed contamination										
		7E+1										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.3	
Plastic	0.5	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	3
Steel	9	31

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.020	2.9E-10	1 µm	5 µm
			All unspec. compounds	F 1.3E-10 2.2E-10
			Oxid., hydrox., halid. & nitrat.	M 2.3E-10 3.1E-10
				S
Highest dose organ	Lower large intestine	20 mSv ALI _{ingestion}	6.9E+07 (Bq)	20 mSv ALI _{inhalation}
				6.5E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	3E+06	3E+07	9E+06	9E+07	5E+09	

Indium - 113m

^{113m}In₄₉


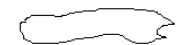



Half life: 1.66 hours
Specific activity: 6.18E+17 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


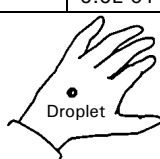
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	24	20			364	28		
E2	27	4			387	5		
E3	392	65			391	1		
% omitted	<1				0			

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	4E+0
IAEA ST1 A ₂ value	2E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 1.60E-1	<i>Betas, electrons (skin)</i> 10 cm 5.5E-02 1 m 0.0E+00	100 cm 4.41E-5	1.53E-1	7.46E-1
<i>Gammas, X rays (deep tissue dose)</i> 5.56E-4	<i>Photons (skin)</i> 10 cm 2.0E-03 1 m 1.3E-03			
	<i>Photons (deep dose)</i> 10 cm 1.9E-03 1 m 1.2E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 7.30E-1	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>+</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		+										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq) 5.5E-01		8E+1										
		Fixed contamination										
		1E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.5	
Plastic	0.9	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	3	10
Steel	19	53

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All compounds	0.020	2.8E-11	All unspec. compounds	F 1.0E-11 1.9E-11
			Oxid., hydrox., halid. & nitrat.	M 2.0E-11 3.2E-11
				S
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	7.1E+08 (Bq)	20 mSv A _{LI} inhalation
				6.3E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	

Indium - 115m

^{115m}In₄₉


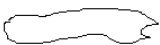

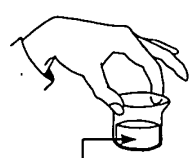

Half life: 4.49 hours
Specific activity: 2.24E+17 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


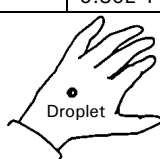
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	24	28	831	5	308	40		
E2	27	5			332	6		
E3	336	46			336	2		
% omitted	<1		<1		0			

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	7E+0
IAEA ST1 A ₂ value	1E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 1.67E-1	<i>Betas, electrons (skin)</i> 10 cm 8.3E-02 1 m 1.8E-04	100 cm 2.90E-5	9.95E-2	5.04E-1
<i>Gammas, X rays (deep tissue dose)</i> 4.04E-4	<i>Photons (skin)</i> 10 cm 1.5E-03 1 m 8.9E-04			
	<i>Photons (deep dose)</i> 10 cm 1.3E-03 1 m 8.2E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²) 1.33E+0	Recommended probes*	Removable contamination 9E+1	
0.05 ml droplet (1 kBq) 5.80E-1			Fixed contamination 2E+2
			Alpha
			Beta ++ Gamma ++ X rays +
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.3	
Plastic	2.5	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	1	7
Steel	13	45

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 µm 5 µm
All compounds	0.020	8.6E-11	All unspec. compounds	F 2.5E-11 4.5E-11
			Oxid., hydrox., halid. & nitrat.	M 6.0E-11 8.7E-11
				S
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	2.3E+08 (Bq)	20 mSv A _{LI} inhalation 2.3E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	

Tin - 125

¹²⁵Sn₅₀


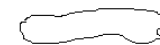



Half life: 9.64 days
 Specific activity: 4.01E+15 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


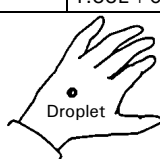
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	823	4	471	6				
E2	1067	9	1271	3				
E3	2002	2	2360	83				
% omitted		15.8		9				

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	4E-1
IAEA ST1 A ₂ value	4E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 9.73E-2	<i>Betas, electrons (skin)</i> 10 cm 1.2E-01 1 m 5.0E-02	100 cm 1.21E-4	2.68E-1	3.61E+1
<i>Gammas, X rays (deep tissue dose)</i> 4.83E-4	<i>Photons (skin)</i> 10 cm 2.5E-03 1 m 1.8E-03			
	<i>Photons (deep dose)</i> 10 cm 2.3E-03 1 m 1.7E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 2.32E+0	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq) 1.33E+0		4E+1										
		Fixed contamination										
		8E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	5.1	
Plastic	9.6	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	14	41
Steel	34	88

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.020	3.1E-09	1 µm	5 µm
			All unspec. compounds	F 9.2E-10 1.3E-09
			Phos., sulphid., ox., hydr., hal., nitrat	M 3.0E-09 2.8E-09
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	6.5E+06 (Bq)	20 mSv ALI _{inhalation}
				6.7E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Antimony - 122

¹²²Sb₅₁


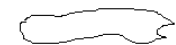
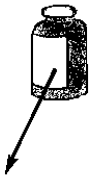


Half life: 2.70 days
 Specific activity: 1.47E+16 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


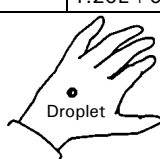
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	564	71	724	5				
E2	693	4	1417	67				
E3	1257	<1	1981	26				
% omitted		<1		<1				

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	4E-1
IAEA ST1 A ₂ value	4E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.19E-1	10 cm: 1.2E-01 1 m: 3.4E-02	100 cm: 7.40E-5	2.51E-1	1.71E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
8.03E-4	10 cm: 3.4E-03 1 m: 2.3E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 3.3E-03 1 m: 2.2E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 2.16E+0	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 1.20E+0		4E+1										
		Fixed contamination										
		6E+1										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	4.1	
Plastic	7.6	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	7	21
Steel	28	68

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.100	1.7E-09	All unspec. compounds	F 3.9E-10 6.3E-10
			Ox., hydr., hal., sulphid., sulphat., nitrat	M 1.0E-09 1.2E-09
				S
Highest dose organ	Lower large intestine	20 mSv ALI _{ingestion}	1.2E+07 (Bq)	20 mSv ALI _{inhalation}
				1.7E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	5E+08	

Antimony - 124

¹²⁴Sb₅₁


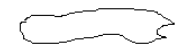
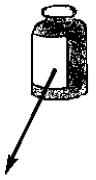


Half life: 60.2 days
 Specific activity: 6.47E+14 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


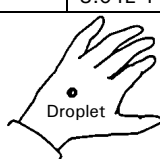
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	603	98	611	51				
E2	1691	48	1580	5				
E3	2091	6	2302	24				
% omitted	37.3		20					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	6E-1
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
8.92E-2	10 cm: 8.3E-02 1 m: 1.8E-02	100 cm: 2.64E-4	9.23E-1	1.52E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
2.94E-3	10 cm: 1.5E-02 1 m: 1.1E-02			
	<i>Photons (deep dose)</i>			
	10 cm: 1.4E-02 1 m: 1.0E-02			

The values above do not include Bremsstrahlung radiation.

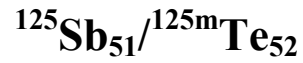
CONTAMINATION		
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)
Uniform deposit (1kBq.cm ⁻²): 2.16E+0	Recommended probes*	Removable contamination
0.05 ml droplet (1 kBq): 8.04E-1	Alpha: Beta: ++ Gamma: ++ X rays: +	1E+1
		Fixed contamination
		2E+1
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique		

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	5	
Plastic	9.3	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	12	43
Steel	34	89

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.100	2.5E-09	All unspec. compounds	F 1.3E-09 1.9E-09
			Ox., hydr., hal., sulphid., sulphat., nitrat	M 6.1E-09 4.7E-09
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	8.0E+06 (Bq)	20 mSv ALI _{inhalation}
				3.3E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	3E+05	3E+06	1E+06	1E+07	1E+09	

Antimony-125 / Tellurium-125m




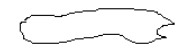



Half life: 2.77 years
 Specific activity: $3.82\text{E}+13 \text{ Bq.g}^{-1}$

Risk group: 3
 Risk colour: Yellow


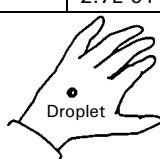
Main emissions (keV)							
	Gamma or X		Beta (E _{max})		Electrons		Alpha
	E	%	E	%	E	%	E %
E1	428	29	131	18	31	11	
E2	601	18	303	40	78	51	
E3	635	11	622	14	104	38	
% omitted		199		28		27	

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	2
IAEA ST1 A ₂ value	1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)																
Point source (30 cm)  Betas, electrons (skin dose) 1.3E-02 Gammas, X rays (deep tissue dose) 1.2E-03	Infinite plane source  Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>2.0E-02</td></tr> <tr><td>1 m</td><td>0.0E+00</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>6.4E-03</td></tr> <tr><td>1 m</td><td>4.5E-03</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>5.8E-03</td></tr> <tr><td>1 m</td><td>4.2E-03</td></tr> </table>	10 cm	2.0E-02	1 m	0.0E+00	10 cm	6.4E-03	1 m	4.5E-03	10 cm	5.8E-03	1 m	4.2E-03	10 ml glass vial  100 cm 8.6E-05	Contact with 50 ml glass beaker  2.9E-01	Contact with 5 ml plastic syringe  1.9E+00
10 cm	2.0E-02															
1 m	0.0E+00															
10 cm	6.4E-03															
1 m	4.5E-03															
10 cm	5.8E-03															
1 m	4.2E-03															

The values above do not include Bremsstrahlung radiation.

CONTAMINATION																
Contamination skin dose (mSv.h⁻¹) <table border="1"> <tr><td>Uniform deposit (1kBq.cm⁻²)</td><td>2.0E+00</td></tr> <tr><td>0.05 ml droplet (1 kBq)</td><td>2.7E-01</td></tr> </table>	Uniform deposit (1kBq.cm ⁻²)	2.0E+00	0.05 ml droplet (1 kBq)	2.7E-01	Detection <table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>+</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma	++	X rays	+	Derived limits (Bq.cm⁻²) Removable contamination 1E+01 Fixed contamination 7E+01
Uniform deposit (1kBq.cm ⁻²)	2.0E+00															
0.05 ml droplet (1 kBq)	2.7E-01															
Recommended probes*																
Alpha																
Beta	+															
Gamma	++															
X rays	+															
 Uniform deposit  Droplet * If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique																

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.9	
Plastic	1.7	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	8	30
Steel	23	70

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 µm 5 µm
All compounds	0.100	1.1E-09	All unspec. compounds	F 1.4E-09 1.7E-09
			Ox., hydr., hal., sulphid., sulphat., nitrat.	M 4.5E-09 3.3E-09
				S
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	1.8E+07 (Bq)	20 mSv A _{LI} inhalation
				4.4E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	8E+05	8E+06	3E+06	3E+07	3E+09	

Antimony - 126

¹²⁶Sb₅₁


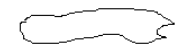
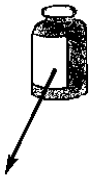


Half life: 12.4 days
 Specific activity: 3.09E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


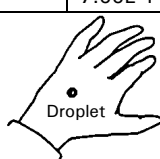
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	415	85	477	32				
E2	695	100	1174	10				
E3	720	54	1894	20				
% omitted	190.8		41					

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	4E-1
IAEA ST1 A ₂ value	4E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 7.78E-2	<i>Betas, electrons (skin)</i> 10 cm 8.4E-02 1 m 1.2E-02	100 cm 4.21E-4	1.51E+0	1.31E+1
<i>Gammas, X rays (deep tissue dose)</i> 4.87E-3	<i>Photons (skin)</i> 10 cm 2.5E-02 1 m 1.9E-02			
	<i>Photons (deep dose)</i> 10 cm 2.4E-02 1 m 1.8E-02			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²) 1.84E+0	Recommended probes*	Removable contamination 1E+1	
0.05 ml droplet (1 kBq) 7.55E-1			Alpha
			Beta ++
			Gamma ++
	X rays +	Fixed contamination 1E+1	
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	3.8	
Plastic	7.2	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	8	25
Steel	29	72

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.100	2.4E-09	1 µm	5 µm
			All unspec. compounds	F 1.1E-09 1.7E-09
			Ox., hydr., hal., sulphid., sulphat., nitrat	M 2.7E-09 3.2E-09
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	8.3E+06 (Bq)	20 mSv ALI _{inhalation}
				6.3E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	3E+05	3E+06	1E+06	1E+07	1E+09	

Tellurium - 123m

^{123m}Te₅₂


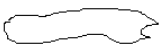



Half life: 119.7 days
Specific activity: 3.27E+14 Bq.g⁻¹

Risk group: 4
Risk colour: Green


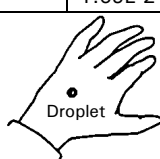
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	27	14			57	42		
E2	27	26			84	45		
E3	159	84			127	14		
% omitted		9.1				14		

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	8E+0
IAEA ST1 A ₂ value	1E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 8.4E-04 1 m 0.0E+00	100 cm 2.83E-5	9.43E-2	4.80E-1
<i>Gammas, X rays (deep tissue dose)</i> 3.88E-4	<i>Photons (skin)</i> 10 cm 1.4E-03 1 m 8.3E-04			
	<i>Photons (deep dose)</i> 10 cm 1.3E-03 1 m 8.0E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.05E+0	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>+</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	+	Gamma	++	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta		+										
Gamma	++											
X rays	++											
0.05 ml droplet (1 kBq) 1.69E-2		7E+1										
		Fixed contamination										
		2E+2										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.1	
Plastic	0.3	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	2
Steel	3	20

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f_i		Inhalation	1 µm	5 µm
All compounds	0.300	1.4E-09	All unspec. compounds	F 9.7E-10	1.2E-09
			Oxid., hydrox. & nitrat.	M 3.9E-09	3.4E-09
				S	
Highest dose organ	Bone surfaces	20 mSv ALI _{ingestion}	1.4E+07 (Bq)	20 mSv ALI _{inhalation}	5.1E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds except below	0.01	1E+06	1E+07	4E+06	4E+07	4E+09	
Oxid., hydrox. & nitrat.	0.01	3E+06	3E+07	1E+07	1E+08	5E+09	

Tellurium - 125m




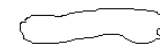

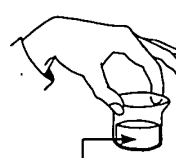

Half life: 57.4 days
 Specific activity: $6.73\text{E}+14 \text{ Bq.g}^{-1}$

Risk group: 4
 Risk colour: Green


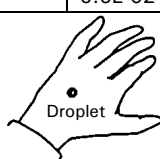
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	27	93			31	11		
E2	31	17			78	51		
E3	35	7			104	38		
% omitted	4				27			

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	20
IAEA ST1 A ₂ value	0.9

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.0E+00	10 cm 0.0E+00 1 m 0.0E+00	100 cm 1.3E-05	2.7E-02	4.4E-01
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
3.2E-04	10 cm 1.3E-03 1 m 7.8E-04			
	<i>Photons (deep dose)</i>			
	10 cm 1.1E-03 1 m 6.7E-04			

The values above do not include Bremsstrahlung radiation.

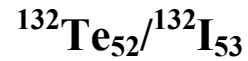
CONTAMINATION		
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)
Uniform deposit (1kBq.cm ⁻²) 1.1E+00	Recommended probes*	Removable contamination
0.05 ml droplet (1 kBq) 5.6E-02	Alpha	1E+02
	Beta +	Fixed contamination
	Gamma	2E+03
	X rays ++	
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique		

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	< 0.1	
Plastic	0.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS			
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)			
Ingestion	f_i	Inhalation	1 µm 5 µm
All compounds	0.300	All unspec. compounds	F 5.1E-10 6.7E-10
		Oxid., hydrox. & nitrat.	M 3.3E-09 2.9E-09
			S
Highest dose organ	Bone surface	20 mSv A_{LI} ingestion	2.3E+07 (Bq) 20 mSv A_{LI} inhalation
			6.1E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	2E+06	2E+07	5E+06	5E+07	5E+09

Tellurium - 132 / Iodine - 132



Half life: 3.26 days
 Specific activity: 1.12E+16 Bq.g⁻¹


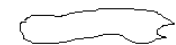
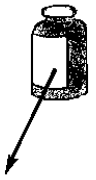


Risk group: 4
 Risk colour: Green

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	668	99	1185	19	195	7		
E2	773	76	1617	13	223	1		
E3	1399	176	2140	18				
% omitted		292		151		84		

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+02


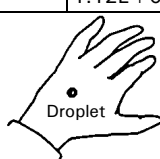
Transport (TBq)	
IAEA ST1 A ₁ value	5E-1
IAEA ST1 A ₂ value	4E-1

EXTERNAL EXPOSURE (mSv.h⁻¹) for an activity of 1 MBq or 1 MBq.m⁻² (as appropriate)

Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe												
 Betas, electrons (skin dose) 1.00E-1 Gammas, X rays (deep tissue dose) 4.48E-3	 Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>1.2E-01</td></tr> <tr><td>1 m</td><td>2.6E-02</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>2.2E-02</td></tr> <tr><td>1 m</td><td>1.6E-02</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>2.2E-02</td></tr> <tr><td>1 m</td><td>1.5E-02</td></tr> </table>	10 cm	1.2E-01	1 m	2.6E-02	10 cm	2.2E-02	1 m	1.6E-02	10 cm	2.2E-02	1 m	1.5E-02	 100 cm 3.90E-4	 1.10E+0	 1.60E+1
10 cm	1.2E-01															
1 m	2.6E-02															
10 cm	2.2E-02															
1 m	1.6E-02															
10 cm	2.2E-02															
1 m	1.5E-02															

The values above do not include Bremsstrahlung radiation.

CONTAMINATION

Contamination skin dose (mSv.h ⁻¹)		Detection		Derived limits (Bq.cm ⁻²)
Uniform deposit (1kBq.cm ⁻²)	2.90E+0	Recommended probes*		
0.05 ml droplet (1 kBq)	1.12E+0	Alpha		Fixed contamination 1E+1
 		Beta	++	
		Gamma	++	
		X rays	++	

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)

Betas and electrons (Total absorption)		
Glass	5.0	
Plastic	8.3	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	10	32
Steel	31	75

INTERNAL EXPOSURE FOR WORKERS

COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq⁻¹)

Ingestion	f _i		Inhalation		
			1 µm	5 µm	
All compounds	0.300	3.7E-09	F	1.9E-09	2.6E-09
			M	2.3E-09	3.2E-09
			S		

Highest dose organ: Thyroid 20 mSv ALI_{ingestion} 5.4E+06 (Bq) 20 mSv ALI_{inhalation} 6.7E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)

Subject to external exposure requirements which may be more restrictive

PHYSICOCHEMICAL STATE	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	3E+05	3E+06	1E+06	1E+07	1E+09

Iodine - 123

¹²³I₅₃


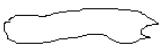

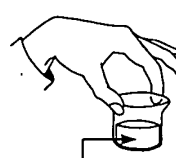

Half life: 13.2 hours
 Specific activity: 7.14E+16 Bq.g⁻¹

Risk group: 4
 Risk colour: Green


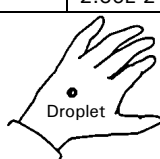
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	27	71			127	14		
E2	159	83			154	2		
E3	529	1			158	<1		
% omitted		17				4		

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	6E+0
IAEA ST1 A ₂ value	3E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 8.4E-04 1 m 0.0E+00	100 cm 3.43E-5	1.13E-1	6.05E-1
<i>Gammas, X rays (deep tissue dose)</i> 5.16E-4	<i>Photons (skin)</i> 10 cm 3.0E-03 1 m 2.3E-03			
	<i>Photons (deep dose)</i> 10 cm 2.9E-03 1 m 2.2E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 3.78E-1	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>+</td></tr> <tr><td>Gamma</td><td>+</td></tr> <tr><td>X rays</td><td>++</td></tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma	+	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta		+										
Gamma	+											
X rays	++											
0.05 ml droplet (1 kBq) 2.36E-2		1E+2										
		Fixed contamination										
		2E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.2	
Plastic	0.3	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	1	2
Steel	1	21

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 µm 5 µm
All compounds	1.000	2.1E-10	All compounds	F 7.6E-11 1.1E-10
				M
				S
Highest dose organ	Thyroid	20 mSv A _{LI} ingestion	9.5E+07 (Bq)	20 mSv A _{LI} inhalation
				1.8E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+06	5E+07	2E+07	2E+08	5E+09	
Volatile form	1	Forbidden	5E+06	Forbidden	2E+07	2E+09	

Iodine - 124

¹²⁴I₅₃


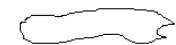

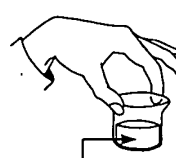

Half life: 4.18 days
 Specific activity: 9.32E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


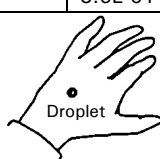
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	511	46	810	<1	23	8		
E2	603	61	1532	11	571	<1		
E3	1691	11	2135	11				
% omitted		84		0		0		

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	1E+0
IAEA ST1 A ₂ value	1E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
2.50E-2	10 cm: 7.9E-03 1 m: 2.8E-03	100 cm: 1.68E-4	5.85E-1	1.07E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.91E-3	10 cm: 9.9E-03 1 m: 7.2E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 9.3E-03 1 m: 6.8E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 5.20E-1	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 3.6E-01		2E+1										
		Fixed contamination										
		3E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	4.5	
Plastic	8.4	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	8	31
Steel	27	76

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f_i		Inhalation	1 μm	5 μm
All compounds	1.000	1.3E-08	All compounds	F: 4.5E-09	6.3E-09
				M:	
				S:	
Highest dose organ	Thyroid	20 mSv A _{LI}	ingestion	1.5E+06 (Bq)	20 mSv A _{LI}
					inhalation
					3.2E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09
Volatile form	1	Forbidden	9.0E+04	Forbidden	3.0E+05	3.0E+07

Iodine - 125

¹²⁵I₅₃


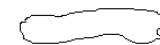

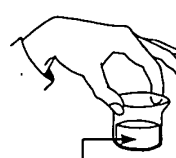

Half life: 59.9 days
 Specific activity: 6.45E+14 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


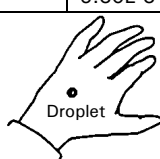
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	27	114			4	79		
E2	31	26			23	20		
E3	36	7			31	11		
% omitted	0				4			

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	2E+1
IAEA ST1 A ₂ value	3E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.00E+0	10 cm 0.0E+00 1 m 0.0E+00	100 cm 1.44E-5	4.07E-2	6.20E-1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
3.90E-4	10 cm 1.5E-03 1 m 9.5E-04			
	<i>Photons (deep dose)</i>			
	10 cm 1.3E-03 1 m 8.1E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 2.11E-2	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta		Gamma		X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma												
X rays	++											
0.05 ml droplet (1 kBq) 6.30E-3		4E+1										
		Fixed contamination										
		1E+3										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	<0.1	
Plastic	<0.1	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	<1	<1
Steel	<1	<1

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i	Inhalation	1 μm	5 μm
All compounds	1.000	1.5E-08	F 5.3E-09	7.3E-09
			M	
			S	
Highest dose organ	Thyroid	20 mSv A _{LI} ingestion	1.3E+06 (Bq)	20 mSv A _{LI} inhalation
				2.7E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	8E+05	8E+06	3E+06	3E+07	3E+09	
Volatile form	1	Forbidden	8E+04	Forbidden	3E+05	3E+07	

Iodine - 129

¹²⁹I₅₃


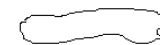



Half life: 1.57E+7 years
 Specific activity: 6.53E+06 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


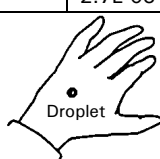
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	29	57	151	100	34	11		
E2	34	13			39	2		
E3	40	8						
% omitted	0		0		< 1			

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	Unlimited
IAEA ST1 A ₂ value	Unlimited

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.0E+00	10 cm: 0.0E+00 1 m: 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.9E-04	10 cm: 7.6E-04 1 m: 4.9E-04	100 cm: 9.2E-06	2.1E-02	2.8E-01
	<i>Photons (deep dose)</i>			
	10 cm: 6.9E-04 1 m: 4.4E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 3.4E-01	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>+</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma		X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta		+										
Gamma												
X rays	++											
0.05 ml droplet (1 kBq): 2.7E-03		6E+00										
		Fixed contamination										
		6E+02										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.2	
Plastic	0.3	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i	Inhalation	1 µm	5 µm
All compounds	1.000	1.1E-07	F: 3.7E-08	5.1E-08
			M:	
			S:	
Highest dose organ	Thyroid	20 mSv ALI _{ingestion}	1.8E+05 (Bq)	20 mSv ALI _{inhalation}
				3.9E+05 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	1E+05	1E+06	4E+05	4E+06	4E+08	
Volatile form	1	Forbidden	1E+04	Forbidden	4E+04	4E+06	

Iodine - 131

¹³¹I₅₃


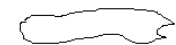



Half life: 8.0 days
 Specific activity: 4.61E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


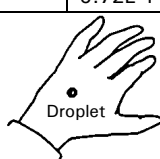
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	284	6	248	2	46	4		
E2	365	82	334	7	330	2		
E3	637	7	606	90				
% omitted		11		1		2		

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	3E+0
IAEA ST1 A ₂ value	7E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
8.62E-2	10 cm: 7.4E-02 1 m: 1.5E-04	100 cm: 6.36E-5	2.23E-1	1.13E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
7.29E-4	10 cm: 4.4E-03 1 m: 3.4E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 4.2E-03 1 m: 3.3E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.62E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>++</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	++											
0.05 ml droplet (1 kBq): 5.72E-1		2E+1										
		Fixed contamination										
		8E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.9	
Plastic	1.6	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	3	11
Steel	23	56

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All compounds	1.000	2.2E-08	All compounds	F 7.6E-09 1.1E-08
				M
				S
Highest dose organ	Thyroid	20 mSv A _{LI} ingestion	9.1E+05 (Bq)	20 mSv A _{LI} inhalation
				1.8E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	3E+05	3E+06	1E+06	1E+07	1E+09	
Volatile form	1	Forbidden	5E+04	Forbidden	2E+05	2E+07	

Iodine - 132

¹³²I₅₃


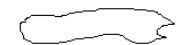

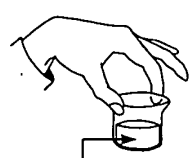

Half life: 2.30 hours
 Specific activity: 3.82E+17 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


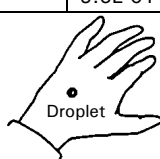
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	668	99	1185	19				
E2	773	76	1617	13				
E3	1399	7	2140	18				
% omitted		116		51				

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	0.4
IAEA ST1 A ₂ value	0.4

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
Betas, electrons (skin dose)	Betas, electrons (skin)			
1.0E-01	10 cm 1.1E-01			
	1 m 2.6E-02			
	Photons (skin)			
	10 cm 2.0E-02			
	1 m 1.5E-02			
Gammas, X rays (deep tissue dose)	Photons (deep dose)	100 cm		
3.9E-03	10 cm 2.0E-02	3.4E-04	1.0E+00	1.5E+01
	1 m 1.4E-02			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h ⁻¹)		Detection										
Uniform deposit (1kBq.cm ⁻²)	2.1E+00	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	++
Recommended probes*												
Alpha												
Beta	++											
Gamma	++											
X rays	++											
0.05 ml droplet (1 kBq)	9.6E-01											
												
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	5.0	
Plastic	8.3	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	10	32
Steel	31	75

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i	Inhalation		
			1 µm	5 µm
All compounds	1.000	2.9E-10	F	9.6E-11
			M	
			S	
Highest dose organ	Thyroid	20 mSv ALI _{ingestion}	6.9E+07 (Bq)	20 mSv ALI _{inhalation}
				1.0E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	
Volatile form	1	Forbidden	2E+06	Forbidden	6E+06	6E+08	

Iodine - 133

¹³³I₅₃


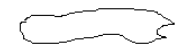
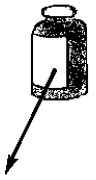


Half life: 20.8 hours
 Specific activity: 4.19E+16 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


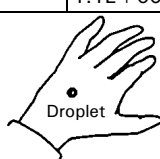
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	530	86	460	4				
E2	875	5	880	4				
E3	1298	2	1230	84				
% omitted		11		9				

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	0.7
IAEA ST1 A ₂ value	0.6

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.2E-01	10 cm: 1.0E-01 1 m: 2.1E-02	100 cm: 9.6E-05	2.8E-01	7.6E+00
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.1E-03	10 cm: 5.9E-03 1 m: 4.4E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 5.6E-03 1 m: 4.2E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²): 2.2E+00	Recommended probes*	Removable contamination	
0.05 ml droplet (1 kBq): 1.1E+00	Alpha: <table border="1"><tr><td></td></tr></table>		3E+01
	Beta: ++	Fixed contamination	
	Gamma: ++	5E+01	
	X rays: +		
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	2.4	
Plastic	4.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	7	22
Steel	28	67

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 µm 5 µm
All compounds	1.000	4.3E-09	All compounds	F 1.5E-09 2.1E-09
				M
				S
Highest dose organ	Thyroid	20 mSv ALI _{ingestion}	4.7E+06 (Bq)	20 mSv ALI _{inhalation}
				9.5E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	
Volatile form	1	Forbidden	3E+05	Forbidden	9E+05	9E+07	

Xenon - 133

¹³³Xe₅₄


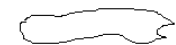



Half life: 5.2 days
 Specific activity: 6.98E+15 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


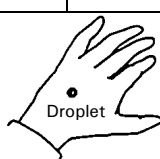
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	31	38	346	99	26	6		
E2	35	7			45	52		
E3	81	38			75	8		
% omitted		1.9		1		4		

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	2E+1
IAEA ST1 A ₂ value	1E+1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.78E-2	10 cm - 1 m -	100 cm		
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.78E-4	10 cm - 1 m -			
	<i>Photons (deep dose)</i>			
	10 cm - 1 m -			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION	
Contamination skin dose (mSv.h⁻¹)	Detection
Uniform deposit (1kBq.cm ⁻²) -	Recommended probes*
0.05 ml droplet (1 kBq) -	Alpha
	Beta ++
	Gamma
	X rays +
	Derived limits (Bq.cm⁻²)
	Removable contamination
	-
	Fixed contamination
	-

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)	
Betas and electrons (Total absorption)	
Glass	0.5
Plastic	0.8
Gamma and X rays (half and tenth value thickness)	
	1/2 1/10
Lead	< 1 < 1
Steel	< 1 4

INTERNAL EXPOSURE FOR WORKERS	
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)	
Ingestion	f ₁
	SUBMERSION DOSE RATE (Sv per day)
	Sv.d ⁻¹ per Bq.m ⁻³ 1.2E-10
Highest dose organ	20 mSv ALL _{ingestion} (Bq) 20 mSv ALL _{inhalation} (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	1	Forbidden	2E+07	Forbidden	7E+07	5E+08	

Caesium - 131

¹³¹Cs₅₅


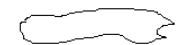

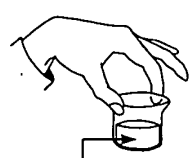

Half life: 9.69 days
 Specific activity: 3.80E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


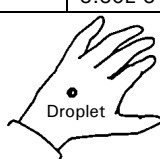
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	29	21			25	9		
E2	30	39						
E3	34	14						
% omitted	0				0			

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	3E+1
IAEA ST1 A ₂ value	3E+1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 0.0E+00 1 m 0.0E+00	100 cm 8.42E-6	2.41E-2	1.78E-1
<i>Gammas, X rays (deep tissue dose)</i> 1.84E-4	<i>Photons (skin)</i> 10 cm 7.4E-04 1 m 4.8E-04			
	<i>Photons (deep dose)</i> 10 cm 6.7E-04 1 m 4.3E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.00E-2	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta		Gamma		X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma												
X rays	++											
0.05 ml droplet (1 kBq) 3.30E-3		1E+3										
		Fixed contamination										
		2E+3										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	<0.1	
Plastic	<0.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	<1	<1
Steel	<1	<1

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 µm 5 µm
All compounds	1.000	5.8E-11	All compounds	F 2.8E-11 4.5E-11
				M
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	3.4E+08 (Bq)	20 mSv ALI _{inhalation}
				4.4E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	2E+07	2E+08	5E+07	5E+08	5E+09

Caesium - 134

¹³⁴Cs₅₅


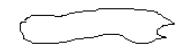
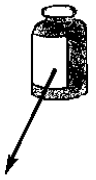


Half life: 2.07 years
 Specific activity: 4.77E+13 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


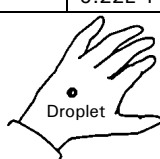
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	605	98	89	27				
E2	796	86	415	3				
E3	1365	3	658	70				
% omitted	36.8		<1					

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	7E-1
IAEA ST1 A ₂ value	7E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)																
Point source (30 cm)  Betas, electrons (skin dose) 6.97E-2 Gammas, X rays (deep tissue dose) 2.72E-3	Infinite plane source  Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>6.0E-02</td></tr> <tr><td>1 m</td><td>3.3E-04</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>1.3E-02</td></tr> <tr><td>1 m</td><td>9.0E-03</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>1.2E-02</td></tr> <tr><td>1 m</td><td>8.5E-03</td></tr> </table>	10 cm	6.0E-02	1 m	3.3E-04	10 cm	1.3E-02	1 m	9.0E-03	10 cm	1.2E-02	1 m	8.5E-03	10 ml glass vial  100 cm 2.34E-4	Contact with 50 ml glass beaker  8.43E-1	Contact with 5 ml plastic syringe  3.99E+0
10 cm	6.0E-02															
1 m	3.3E-04															
10 cm	1.3E-02															
1 m	9.0E-03															
10 cm	1.2E-02															
1 m	8.5E-03															

The values above do not include Bremsstrahlung radiation.

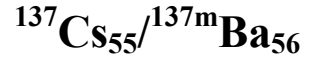
CONTAMINATION																
Contamination skin dose (mSv.h⁻¹) <table border="1"> <tr> <td>Uniform deposit (1kBq.cm⁻²)</td> <td>1.35E+0</td> </tr> <tr> <td>0.05 ml droplet (1 kBq)</td> <td>5.22E-1</td> </tr> </table>	Uniform deposit (1kBq.cm ⁻²)	1.35E+0	0.05 ml droplet (1 kBq)	5.22E-1	Detection <table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Derived limits (Bq.cm⁻²) Removable contamination 1E+1 Fixed contamination 2E+1
Uniform deposit (1kBq.cm ⁻²)	1.35E+0															
0.05 ml droplet (1 kBq)	5.22E-1															
Recommended probes*																
Alpha																
Beta	++															
Gamma	++															
X rays	+															
 Uniform deposit  Droplet * If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique																

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1	
Plastic	1.8	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	9	27
Steel	30	74

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All compounds	1.000	1.9E-08	All compounds	F 6.8E-09 9.6E-09
				M
				S
Highest dose organ	Soft tissues	20 mSv ALI _{ingestion}	1.1E+06 (Bq)	20 mSv ALI _{inhalation} 2.1E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	3E+05	3E+06	1E+06	1E+07	5E+08	

Caesium - 137 / Barium - 137m




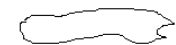
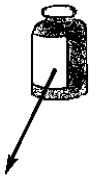
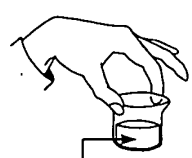

Half life: 30.2 years
 Specific activity: 3.20E+12 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


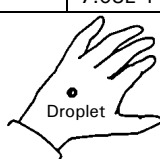
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	32	6	512	95	624	8		
E2	36	1	1173	5	656	1		
E3	662	85			660	<1		
% omitted	<1		0		<1			

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	2E+0
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
2.13E-1	10 cm: 9.0E-02 1 m: 6.0E-03	100 cm: 9.19E-5	3.30E-1	1.66E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.07E-3	10 cm: 3.9E-03 1 m: 2.5E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 3.7E-03 1 m: 2.4E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION				
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)		
Uniform deposit (1kBq.cm ⁻²): 1.57E+0	Recommended probes*	Removable contamination		
0.05 ml droplet (1 kBq): 7.08E-1	Alpha: <table border="1"><tr><td></td><td></td></tr></table>			4E+1
	Beta: ++	Fixed contamination		
	Gamma: ++	4E+3		
	X rays: ++			
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique				

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	2.1	
Plastic	3.8	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	8	24
Steel	29	72

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f_i	Inhalation		1 μm	5 μm
All compounds	1.000	1.3E-08	All compounds	F: 4.8E-09	6.7E-09
				M:	
				S:	
Highest dose organ	Soft tissues	20 mSv ALI _{ingestion}	1.5E+06 (Bq)	20 mSv ALI _{inhalation}	3.0E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	2E+05	2E+06	8E+05	8E+06	5E+08	

Barium - 133

¹³³Ba₅₆


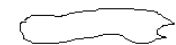
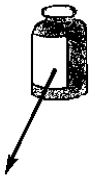


Half life: 10.5 years
 Specific activity: 9.47E+12 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


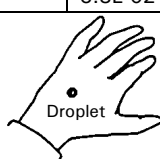
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	31	99			45	46		
E2	81	34			75	7		
E3	356	62			320	1		
% omitted		63				34		

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	3E+0
IAEA ST1 A ₂ value	3E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 2.80E-3	<i>Betas, electrons (skin)</i> 10 cm 4.4E-03 1 m 0.0E+00	100 cm 7.51E-5	2.53E-1	1.28E+0
<i>Gammas, X rays (deep tissue dose)</i> 9.71E-4	<i>Photons (skin)</i> 10 cm 5.5E-03 1 m 4.2E-03			
	<i>Photons (deep dose)</i> 10 cm 5.4E-03 1 m 4.1E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.30E-1	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta		Gamma	++	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma	++											
X rays	++											
0.05 ml droplet (1 kBq) 3.8E-02		6E+1										
		Fixed contamination										
		8E+1										

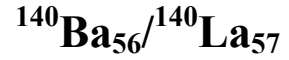
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.4	
Plastic	0.7	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	1	7
Steel	10	44

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.100	1E-09	All compounds	1 μm 5 μm
				F 1.5E-09 1.8E-09
				M
				S
Highest dose organ	Bone surfaces	20 mSv A _{LI,ingestion}	2.0E+07 (Bq)	20 mSv A _{LI,inhalation}
				1.1E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	2E+06	2E+07	5E+06	5E+07	5E+09	

Barium - 140 / Lanthanum - 140




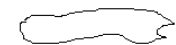
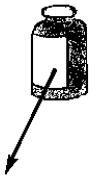


Half life: 12.8 days
 Specific activity: 2.70E+15 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


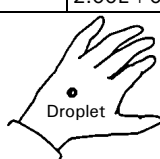
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	487	50	991	38				
E2	816	27	1349	51				
E3	1596	110	1677	23				
% omitted		113		103				

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	5E-1
IAEA ST1 A ₂ value	3E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
2.14E-1	10 cm: 2.1E-01 1 m: 3.7E-02	100 cm: 3.37E-4	1.20E+0	2.20E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
3.92E-3	10 cm: 2.0E-02 1 m: 1.5E-02			
	<i>Photons (deep dose)</i>			
	10 cm: 1.9E-02 1 m: 1.4E-02			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 3.78E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 2.00E+0		5E+1										
		Fixed contamination										
		1E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	4.6	
Plastic	8.5	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	13	46
Steel	34	91

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All compounds	0.100	2.5E-09	All compounds	F 1.0E-09 1.6E-09
				M
				S
Highest dose organ	Lower large intestine	20 mSv ALI _{ingestion}	8.0E+06 (Bq)	20 mSv ALI _{inhalation}
				1.3E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	2E+05	2E+06	8E+05	8E+06	8E+08	

Lanthanum - 140

¹⁴⁰La₅₇


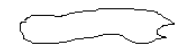
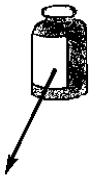


Half life: 1.7 days
Specific activity: 2.03E+16 Bq.g⁻¹

Risk group: 2
Risk colour: Orange


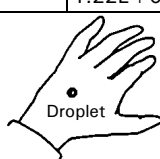
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	487	44	1349	45				
E2	816	24	1677	20				
E3	1596	95	2164	7				
% omitted		50.2		29				

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	4E-1
IAEA ST1 A ₂ value	4E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.19E-1	10 cm: 1.2E-01 1 m: 2.9E-02	100 cm: 3.05E-4	1.09E+0	1.91E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
3.54E-3	10 cm: 1.8E-02 1 m: 1.3E-02			
	<i>Photons (deep dose)</i>			
	10 cm: 1.7E-02 1 m: 1.2E-02			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²): 2.14E+0	Recommended probes*	Removable contamination	
0.05 ml droplet (1 kBq): 1.22E+0	Alpha: <table border="1"><tr><td></td></tr></table>		1E+1
	Beta: ++	Fixed contamination	
	Gamma: ++	1E+1	
	X rays: +		
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	4.6	
Plastic	8.5	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	14	48
Steel	35	94

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.0005	2.0E-09	All unspec. compounds	F 6.0E-10 1.0E-09
			Oxid. & hydrox.	M 1.1E-09 1.5E-09
				S
Highest dose organ	Lower large intestine	20 mSv ALI _{ingestion}	1.0E+07 (Bq)	20 mSv ALI _{inhalation}
				1.3E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	3E+05	3E+06	1E+06	1E+07	1E+09	

Cerium - 139


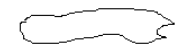
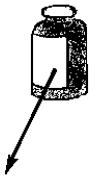


¹³⁹Ce₅₈

Half life: 137.6 days
Specific activity: 2.53E+14 Bq.g⁻¹


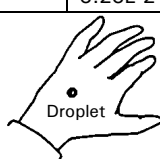
Risk group: 3
Risk colour: Yellow

Main emissions (keV)						Exemption levels		
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	33	65			26	5		
E2	38	15			127	17		
E3	166	80			160	2		
% omitted	0				3			

Transport (TBq)	
IAEA ST1 A ₁ value	7E+0
IAEA ST1 A ₂ value	2E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.00E+0	10 cm: 1.4E-03 1 m: 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
4.28E-4	10 cm: 1.5E-03 1 m: 9.7E-04	100 cm: 3.34E-5	1.10E-1	5.55E-1
	<i>Photons (deep dose)</i>			
	10 cm: 1.5E-03 1 m: 9.5E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			SHIELDING (mm)											
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	Betas and electrons (Total absorption)											
Uniform deposit (1kBq.cm ⁻²): 4.86E-1	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>++</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	++	Removable contamination	Glass	0.2
Recommended probes*														
Alpha														
Beta		++												
Gamma	++													
X rays	++													
0.05 ml droplet (1 kBq): 3.23E-2	Fixed contamination	Plastic	0.3											
		1E+2	Gamma and X rays (half and tenth value thickness)											
		2E+2		1/2	1/10									
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			Lead	< 1	2									
			Steel	3	21									

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All compounds	0.0005	2.6E-10		
			F	
			M	1.6E-09 1.3E-09
			S	1.8E-09 1.4E-09
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	7.7E+07 (Bq)	20 mSv A _{LI} inhalation
				1.1E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	2E+06	2E+07	8E+06	8E+07	5E+09	

Cerium - 141

¹⁴¹Ce₅₈


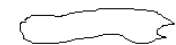



Half life: 32.5 days
 Specific activity: 1.05E+15 Bq.g⁻¹

Risk group: 4
 Risk colour: Green


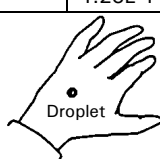
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	36	13	435	70	103	18		
E2	41	3	580	30	139	3		
E3	145	49						
% omitted	<1		0		2			

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	2E+1
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 5.73E-2	<i>Betas, electrons (skin)</i> 10 cm 5.9E-02 1 m 0.0E+00	100 cm 1.47E-5	4.97E-2	2.35E-1
<i>Gammas, X rays (deep tissue dose)</i> 1.70E-4	<i>Photons (skin)</i> 10 cm 5.9E-04 1 m 3.7E-04			
	<i>Photons (deep dose)</i> 10 cm 5.8E-04 1 m 3.6E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.84E+0	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	++											
0.05 ml droplet (1 kBq) 4.23E-1		6E+1										
		Fixed contamination										
		4E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.8	
Plastic	1.5	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	2
Steel	6	20

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f ₁		Inhalation	1 μm 5 μm
All compounds	0.0005	7.1E-10		F
			All unspec. compounds	M 3.1E-09 2.7E-09
			Oxid., hydrox. & fluorides	S 3.6E-09 3.1E-09
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	2.8E+07 (Bq)	20 mSv A _{LI} inhalation
				5.6E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	7E+05	7E+06	2E+06	2E+07	2E+09	

Cerium - 143

¹⁴³Ce₅₈


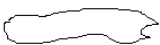
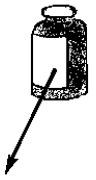


Half life: 1.38 days
Specific activity: 2.45E+16 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


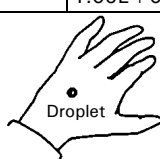
Main emissions (keV)							
	Gamma or X		Beta (E _{max})		Electrons		Alpha
	E	%	E	%	E	%	E %
E1	36	50	733	14	15	65	
E2	293	42	1104	49	51	9	
E3	722	5	1398	35	251	2	
% omitted	38.9		2		9		

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	9E-1
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
Betas, electrons (skin dose)	Betas, electrons (skin)			
1.28E-1	10 cm 1.1E-01			
	1 m 2.0E-02			
	Photons (skin)			
	10 cm 3.4E-04			
	1 m 2.6E-03			
Gammas, X rays (deep tissue dose)	Photons (deep dose)	100 cm 4.95E-5	1.70E-1	5.72E+0
6.00E-4	10 cm 3.3E-03			
	1 m 2.5E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.97E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>++</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	++											
0.05 ml droplet (1 kBq) 1.05E+0		5E+1										
		Fixed contamination										
		1E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	2.6	
Plastic	4.8	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	2	14
Steel	16	53

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f ₁	Inhalation	1 μm	5 μm
All compounds	0.0005	1.1E-09	F	
			M	7.4E-10 9.5E-10
			S	8.1E-10 1.0E-09
Highest dose organ	Lower large intestine	20 mSv A_{LI}	1.8E+07 (Bq)	20 mSv A_{LI}
				2.0E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09

Praseodymium - 143

¹⁴³Pr₅₉


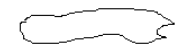
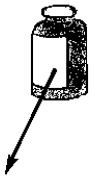


Half life: 13.6 days
Specific activity: 2.48E+15 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


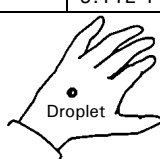
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			935	100				
E2								
E3								
% omitted	<1		0					

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+04

Transport (TBq)	
IAEA ST1 A ₁ value	3E+0
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
Betas, electrons (skin dose) 1.30E-1	Betas, electrons (skin) 10 cm 1.0E-01 1 m 5.0E-02	100 cm Brem. Rad.	Brem. Rad.	Brem. Rad.
Gammas, X rays (deep tissue dose) 0.00E+0	Photons (skin) 10 cm 6.0E-11 1 m 3.9E-11			
	Photons (deep dose) 10 cm 5.6E-11 1 m 3.6E-11			

The values above do not include Bremsstrahlung radiation. Brem. Rad. indicates that it may be significant.

CONTAMINATION		
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)
Uniform deposit (1kBq.cm ⁻²) 1.73E+0	Recommended probes*	Removable contamination
0.05 ml droplet (1 kBq) 9.11E-1	Alpha	8E+1
	Beta ++	Fixed contamination
	Gamma	1E+3
	X rays	
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique		

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.5	
Plastic	2.8	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	-	-
Steel	-	-

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i	Inhalation		
All compounds	0.0005	1.2E-09	1 μm	5 μm
			F	
			M	2.1E-09 1.9E-09
			S	2.3E-09 2.2E-09
Highest dose organ	Lungs	20 mSv ALI _{ingestion} 1.7E+07 (Bq)	20 mSv ALI _{inhalation} 8.7E+06 (Bq)	

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Praseodymium - 144

¹⁴⁴Pr₅₉


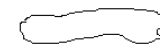

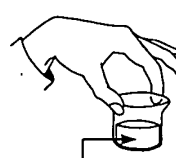

Half life: 17.3 minutes
 Specific activity: 2.79E+18 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


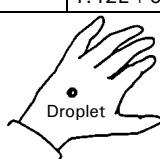
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	697	1	810	1				
E2	2186	<1	2300	1				
E3			2996	98				
% omitted		<1		0				

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	-
IAEA ST1 A ₂ value	-

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 1.05E-1	<i>Betas, electrons (skin)</i> 10 cm 1.5E-01 1 m 6.9E-02	100 cm 2.26E-4	6.85E-1	6.41E+1
<i>Gammas, X rays (deep tissue dose)</i> 4.72E-5	<i>Photons (skin)</i> 10 cm 1.9E-04 1 m 1.2E-04			
	<i>Photons (deep dose)</i> 10 cm 1.8E-04 1 m 1.2E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 2.14E+0	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma												
X rays												
0.05 ml droplet (1 kBq) 1.42E+0		6E+1										
		Fixed contamination										
		2E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	7	
Plastic	13.1	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	15	49
Steel	36	97

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁	Inhalation		
All compounds	0.0005	5.0E-11	1 μm	5 μm
			F	
			M	1.8E-11 2.9E-11
			S	1.9E-11 3.0E-11
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	4.0E+08 (Bq)	20 mSv A _{LI} inhalation
				6.7E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	7E+05	7E+06	2E+06	2E+07	2E+09	

Promethium - 147

¹⁴⁷Pm₆₁


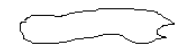
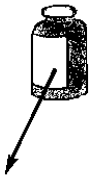


Half life: 2.6 years
Specific activity: 3.46E+13 Bq.g⁻¹

Risk group: 4
Risk colour: Green


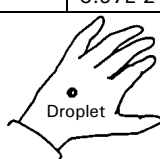
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	121	<1	225	100				
E2								
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+04

Transport (TBq)	
IAEA ST1 A ₁ value	4E+1
IAEA ST1 A ₂ value	2E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 4.4E-03 1 m 0.0E+00	100 cm Brem. Rad.	Brem. Rad.	Brem. Rad.
<i>Gammas, X rays (deep tissue dose)</i> 6.76E-9	<i>Photons (skin)</i> 10 cm 2.2E-08 1 m 1.3E-08			
	<i>Photons (deep dose)</i> 10 cm 2.2E-08 1 m 1.3E-08			

The values above do not include Bremsstrahlung radiation. Brem. Rad. indicates that it may be significant.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 5.95E-1	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma												
X rays												
0.05 ml droplet (1 kBq) 3.97E-2		1E+2										
		Fixed contamination										
		1E+4										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.3	
Plastic	0.5	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	1
Steel	6	16

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.0005	2.6E-10		
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	7.7E+07 (Bq)	20 mSv ALI _{inhalation}
				4.3E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	1E+06	1E+07	4E+06	4E+07	4E+09	

Samarium - 153

¹⁵³Sm₆₂


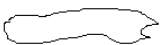
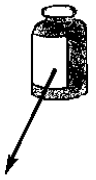


Half life: 1.95 days
 Specific activity: 1.62E+16 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


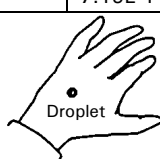
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	41	49	634	35	21	24		
E2	47	12	703	44	55	41		
E3	103	28	807	21	95	6		
% omitted		6.9		<1		13		

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	9E+0
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.03E-1	10 cm: 8.9E-02 1 m: 4.2E-04	100 cm: 1.48E-5	4.79E-2	2.41E-1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.86E-4	10 cm: 1.1E-03 1 m: 8.9E-04			
	<i>Photons (deep dose)</i>			
	10 cm: 1.1E-03 1 m: 8.9E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²): 1.62E+0	Recommended probes*	Removable contamination	
0.05 ml droplet (1 kBq): 7.19E-1	Alpha: <table border="1"><tr><td></td></tr></table>		1E+2
	Beta: ++	Fixed contamination	
	Gamma: +	4E+2	
	X rays: ++		

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.3	
Plastic	2.4	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	<1	<1
Steel	1	7

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All compounds	0.0005	7.4E-10		F
			All compounds	M 6.1E-10 6.8E-10
				S
Highest dose organ	Lower large intestine	20 mSv ALI _{ingestion}	2.7E+07 (Bq)	20 mSv ALI _{inhalation}
				2.9E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	7E+05	7E+06	2E+06	2E+07	2E+09	

Europium - 152

¹⁵²Eu₆₃


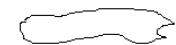
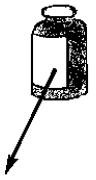


Half life: 13.5 years
 Specific activity: 6.45E+12 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


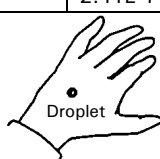
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	344	27	388	2	75	19		
E2	1112	14	699	14	114	11		
E3	1408	21	1478	8				
% omitted		98.5		4		8		

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	1E+0
IAEA ST1 A ₂ value	1E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
2.50E-2	10 cm: 2.3E-02 1 m: 2.9E-03	100 cm: 1.69E-4	6.01E-1	3.92E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.98E-3	10 cm: 1.1E-02 1 m: 7.7E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 9.8E-03 1 m: 7.2E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 9.19E-1	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 2.41E-1		1E+1										
		Fixed contamination										
		3E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	2.8	
Plastic	5.2	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	10	38
Steel	29	82

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁	Inhalation		
All compounds	0.0005	1.4E-09	1 μm	5 μm
			F	
			M	3.9E-08
			S	2.7E-08
Highest dose organ	Liver	20 mSv A _{LI} ingestion	1.4E+07 (Bq)	20 mSv A _{LI} inhalation
				5.1E+05 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	1E+05	1E+06	4E+05	4E+06	4E+08	

Europium - 154

¹⁵⁴Eu₆₃


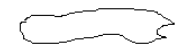

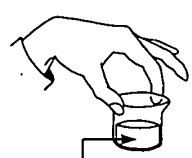

Half life: 8.59 years
 Specific activity: 1.00E+13 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


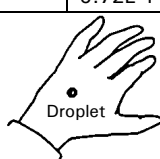
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	123	41	571	36	73	26		
E2	723	20	841	18	115	17		
E3	1274	35	1846	11				
% omitted		99.1		34		<1		

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	9E-1
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 6.54E-2	<i>Betas, electrons (skin)</i> 10 cm 6.2E-02 1 m 5.3E-03	100 cm 1.78E-4	6.40E-1	5.76E+0
<i>Gammas, X rays (deep tissue dose)</i> 2.07E-3	<i>Photons (skin)</i> 10 cm 1.1E-02 1 m 8.2E-03			
	<i>Photons (deep dose)</i> 10 cm 1.1E-02 1 m 7.7E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 2.05E+0	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	++											
0.05 ml droplet (1 kBq) 5.72E-1		9E+0										
		Fixed contamination										
		3E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	3.7	
Plastic	7.0	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	12	39
Steel	32	84

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i	Inhalation		
All compounds	0.0005	2.0E-09	1 μm	5 μm
			F	
			M	5.0E-08
			S	3.5E-08
Highest dose organ	Bone surfaces	20 mSv ALI _{ingestion}	1.0E+07 (Bq)	20 mSv ALI _{inhalation}
			4.0E+05 (Bq)	

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	1E+05	1E+06	3E+05	3E+06	3E+08	

Europium - 155

¹⁵⁵Eu₆₃


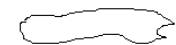

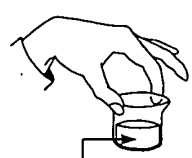

Half life: 4.96 years
 Specific activity: 1.72E+13 Bq.g⁻¹

Risk group: 4
 Risk colour: Green


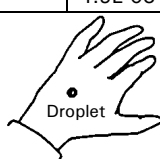
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	43	18	141	46	10	21		
E2	86	31	160	26	36	11		
E3	105	21	247	18	78	2		
% omitted		15		10		72		

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	20
IAEA ST1 A ₂ value	3

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.0E+00	10 cm 0.0E+00			
	1 m 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.5E-04	10 cm 1.1E-03			
	1 m 8.9E-04			
	<i>Photons (deep dose)</i>	100 cm 1.3E-05	3.7E-02	2.5E-01
	10 cm 1.1E-03			
	1 m 9.0E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 3.3E-01	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>+</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma	+	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	+											
X rays	++											
0.05 ml droplet (1 kBq) 4.9E-03		9E+01										
		Fixed contamination										
		4E+02										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.3	
Plastic	0.5	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	1
Steel	2	8

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.0005	3.2E-10		
Highest dose organ	Bone surface	20 mSv ALI _{ingestion}	6.3E+07 (Bq)	20 mSv ALI _{inhalation}
				3.1E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	9E+05	9E+06	3E+06	3E+07	3E+09	

Europium - 156

¹⁵⁶Eu₆₃


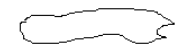

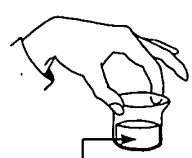

Half life: 15.2 days
 Specific activity: 2.04E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


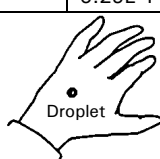
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	812	10	266	11				
E2	1231	9	487	32				
E3	2187	4	2453	27				
% omitted		94		28				

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	7E-1
IAEA ST1 A ₂ value	7E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 4.95E-2	<i>Betas, electrons (skin)</i> 10 cm 8.2E-02 1 m 2.0E-02	100 cm 2.05E-4	6.75E-1	1.50E+1
<i>Gammas, X rays (deep tissue dose)</i> 2.05E-3	<i>Photons (skin)</i> 10 cm 9.9E-03 1 m 7.2E-03			
	<i>Photons (deep dose)</i> 10 cm 9.3E-03 1 m 6.7E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION		
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)
Uniform deposit (1kBq.cm ⁻²) 1.22E+0	Recommended probes*	Removable contamination
0.05 ml droplet (1 kBq) 6.29E-1	Alpha	2E+1
	Beta ++	Fixed contamination
	Gamma ++	2E+1
	X rays +	
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique		

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	5.4	
Plastic	10.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	15	48
Steel	36	95

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.0005	2.2E-09		
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	9.1E+06 (Bq)	20 mSv ALI _{inhalation}
				6.1E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Erbium - 169

¹⁶⁹Er₆₈


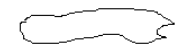



Half life: 9.40 days
 Specific activity: 3.04E+15 Bq.g⁻¹

Risk group: 4
 Risk colour: Green


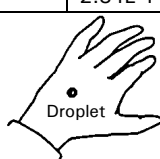
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	8	<1	344	42				
E2			352	58				
E3								
% omitted		<1		0				

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+04

Transport (TBq)	
IAEA ST1 A ₁ value	4E+1
IAEA ST1 A ₂ value	1E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
9.16E-3	10 cm 5.5E-02 1 m 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
0.00E+0	10 cm 9.9E-09 1 m 6.0E-09	100 cm		
	<i>Photons (deep dose)</i>	Brem. Rad.	Brem. Rad.	Brem. Rad.
	10 cm 1.0E-08 1 m 6.0E-09			

The values above do not include Bremsstrahlung radiation. Brem. Rad. indicates that it may be significant.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.11E+0	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma												
X rays												
0.05 ml droplet (1 kBq) 2.84E-1		2E+2										
		Fixed contamination										
		2E+4										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.5	
Plastic	0.8	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	<1	<1
Steel	<1	<1

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁	Inhalation		
All compounds	0.0005	3.7E-10	1 μm	5 μm
			F	
			M	9.8E-10
			S	9.2E-10
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	5.4E+07 (Bq)	20 mSv ALI _{inhalation}
			2.0E+07 (Bq)	

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+06	4E+07	1E+07	1E+08	5E+09	

Thulium - 170

¹⁷⁰Tm₆₉

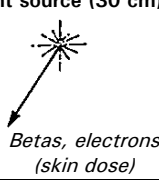
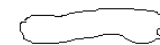



Half life: 129 days
Specific activity: 2.20E+14 Bq.g⁻¹

Risk group: 3
Risk colour: Yellow


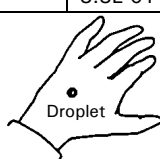
Main emissions (keV)						Exemption levels		
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	52	3	883	24	22	5		
E2	59	1	968	76	74	12		
E3	84	3			82	3		
% omitted		4		0		13		

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	3
IAEA ST1 A ₂ value	0.6

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)																
Point source (30 cm)  Betas, electrons (skin dose) 1.2E-01 Gammas, X rays (deep tissue dose) 1.3E-05	Infinite plane source  Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>1.0E-01</td></tr> <tr><td>1 m</td><td>5.0E-03</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>5.4E-05</td></tr> <tr><td>1 m</td><td>3.7E-05</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>5.5E-05</td></tr> <tr><td>1 m</td><td>3.7E-05</td></tr> </table>	10 cm	1.0E-01	1 m	5.0E-03	10 cm	5.4E-05	1 m	3.7E-05	10 cm	5.5E-05	1 m	3.7E-05	10 ml glass vial  100 cm 1.2E-06	Contact with 50 ml glass beaker  3.4E-03	Contact with 5 ml plastic syringe  2.1E-02
10 cm	1.0E-01															
1 m	5.0E-03															
10 cm	5.4E-05															
1 m	3.7E-05															
10 cm	5.5E-05															
1 m	3.7E-05															

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			SHIELDING (mm)																																				
Contamination skin dose (mSv.h⁻¹) <table border="1"> <tr> <td>Uniform deposit (1kBq.cm⁻²)</td> <td>2.0E+00</td> </tr> <tr> <td>0.05 ml droplet (1 kBq)</td> <td>8.8E-01</td> </tr> </table>  	Uniform deposit (1kBq.cm ⁻²)	2.0E+00	0.05 ml droplet (1 kBq)	8.8E-01	Detection <table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays	+	Derived limits (Bq.cm⁻²) <table border="1"> <tr> <th colspan="2">Removable contamination</th> </tr> <tr> <td></td> <td>5E+01</td> </tr> <tr> <th colspan="2">Fixed contamination</th> </tr> <tr> <td></td> <td>1E+03</td> </tr> </table>	Removable contamination			5E+01	Fixed contamination			1E+03	Betas and electrons (Total absorption) <table border="1"> <tr> <td>Glass</td> <td>1.7</td> </tr> <tr> <td>Plastic</td> <td>3.1</td> </tr> </table> Gamma and X rays (half and tenth value thickness) <table border="1"> <tr> <td></td> <td>1/2</td> <td>1/10</td> </tr> <tr> <td>Lead</td> <td>< 1</td> <td>< 1</td> </tr> <tr> <td>Steel</td> <td>1</td> <td>5</td> </tr> </table>		Glass	1.7	Plastic	3.1		1/2	1/10	Lead	< 1	< 1	Steel	1	5
Uniform deposit (1kBq.cm ⁻²)	2.0E+00																																						
0.05 ml droplet (1 kBq)	8.8E-01																																						
Recommended probes*																																							
Alpha																																							
Beta	++																																						
Gamma																																							
X rays	+																																						
Removable contamination																																							
	5E+01																																						
Fixed contamination																																							
	1E+03																																						
Glass	1.7																																						
Plastic	3.1																																						
	1/2	1/10																																					
Lead	< 1	< 1																																					
Steel	1	5																																					

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f ₁		Inhalation	
All compounds	0.0005	1.3E-09		
			F	
			M	6.6E-09
			S	5.2E-09
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	1.5E+07 (Bq)	20 mSv ALI _{inhalation}
				3.0E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	<i>Subject to external exposure requirements which may be more restrictive</i>						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	1E+09	

Thulium - 171

¹⁷¹Tm₆₉


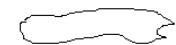
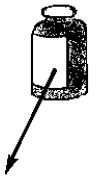


Half life: 1.92 years
 Specific activity: 4.03E+13 Bq.g⁻¹

Risk group: 5
 Risk colour: Blue


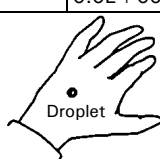
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	52	<1	30	2	56	1		
E2	59	<1	97	98				
E3	67	<1						
% omitted		<1		0		2		

Exemption levels	
Quantity (Bq)	1E+08
Concentration (Bq.g ⁻¹)	1E+04

Transport (TBq)	
IAEA ST1 A ₁ value	40
IAEA ST1 A ₂ value	40

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.0E+00	<i>Betas, electrons (skin)</i> 10 cm 0.0E+00 1 m 0.0E+00	100 cm 1.7E-07	4.7E-04	3.1E-03
<i>Gammas, X rays (deep tissue dose)</i> 2.0E-06	<i>Photons (skin)</i> 10 cm 8.9E-06 1 m 6.3E-06			
	<i>Photons (deep dose)</i> 10 cm 8.9E-06 1 m 6.3E-06			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 0.0E+00	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta		Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta												
Gamma												
X rays												
0.05 ml droplet (1 kBq) 0.0E+00		6E+02										
		Fixed contamination										
		4E+04										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	< 0.1	
Plastic	0.2	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁	Inhalation		
All compounds	0.0005	1.1E-10	1 µm	5 µm
			F	
			M	1.3E-09
			S	9.1E-10
Highest dose organ	Bone surface	20 mSv ALI _{ingestion}	1.8E+08 (Bq)	20 mSv ALI _{inhalation}
				1.5E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+06	5E+07	2E+07	2E+08	2E+10	

Ytterbium - 169

¹⁶⁹Yb₇₀


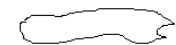
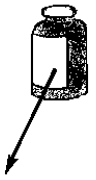


Half life: 32.0 days
 Specific activity: 8.93E+14 Bq.g⁻¹

Risk group: 4
 Risk colour: Green


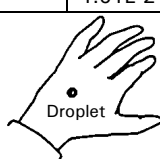
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	51	94			50	35		
E2	198	35			118	10		
E3	308	11			139	13		
% omitted	192.6				70			

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	4E+0
IAEA ST1 A ₂ value	1E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 8.2E-03 1 m 0.0E+00	100 cm 6.35E-5	2.13E-1	1.01E+0
<i>Gammas, X rays (deep tissue dose)</i> 7.34E-4	<i>Photons (skin)</i> 10 cm 5.0E-03 1 m 4.0E-03			
	<i>Photons (deep dose)</i> 10 cm 5.0E-03 1 m 4.0E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.00E+0	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>+</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma	++	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta		+										
Gamma	++											
X rays	++											
0.05 ml droplet (1 kBq) 4.51E-2		5E+1										
		Fixed contamination										
		9E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.2	
Plastic	0.3	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	2
Steel	3	26

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 µm 5 µm
All compounds	0.0005	7.1E-10		
			F	
			M	2.4E-09 2.1E-09
			S	2.8E-09 2.4E-09
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	2.8E+07 (Bq)	20 mSv ALI _{inhalation} 7.1E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	2E+06	2E+07	5E+06	5E+07	5E+09	

Rhenium - 186

¹⁸⁶Re₇₅


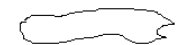



Half life: 3.78 days
 Specific activity: 6.87E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


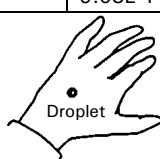
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	59	3	939	22	63	4		
E2	63	2	1077	72	124	6		
E3	137	9			134	2		
% omitted		11.1		<1		2		

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	2E+0
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.24E-1	10 cm: 9.3E-02 1 m: 1.1E-02	100 cm: 3.96E-6	1.35E-2	3.80E-1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
4.28E-5	10 cm: 3.4E-04 1 m: 2.9E-04			
	<i>Photons (deep dose)</i>			
	10 cm: 3.4E-04 1 m: 2.9E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.81E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>+</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	+	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	+											
X rays	+											
0.05 ml droplet (1 kBq): 9.08E-1		8E+1										
		Fixed contamination										
		6E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.8	
Plastic	3.4	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	1
Steel	5	18

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.800	1.5E-09	All unspec. compounds	F 1 μm: 5.3E-10, 5 μm: 7.3E-10
			Oxid., hydrox., halid. & nitrat.	M 1.1E-09, S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	1.3E+07 (Bq)	20 mSv ALI _{inhalation}
				1.7E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Rhenium - 188

¹⁸⁸Re₇₅


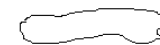



Half life: 17.0 hours
Specific activity: 3.63E+16 Bq.g⁻¹

Risk group: 2
Risk colour: Orange


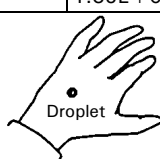
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	63	2	1962	25	81	5		
E2	155	15	2118	72	142	6		
E3	633	1						
% omitted		8.3		3		0		

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	4E-1
IAEA ST1 A ₂ value	4E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.10E-1	10 cm: 1.4E-01 1 m: 5.2E-02	100 cm: 2.66E-5	4.45E-2	2.88E+1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.06E-4	10 cm: 6.3E-04 1 m: 4.8E-04			
	<i>Photons (deep dose)</i>			
	10 cm: 6.1E-04 1 m: 4.7E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²): 2.32E+0	Recommended probes*	Removable contamination	
0.05 ml droplet (1 kBq): 1.35E+0	Alpha: <table border="1"><tr><td></td></tr></table>		6E+1
	Beta: ++	Fixed contamination	
	Gamma: +	2E+2	
	X rays: +		
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique			

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	4.4	
Plastic	8.3	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	3	23
Steel	18	63

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.800	1.4E-09	1 μm	5 μm
			All unspec. compounds	F 4.7E-10 6.6E-10
			Oxid., hydrox., halid. & nitrat.	M 5.5E-10 7.4E-10
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	1.4E+07 (Bq)	20 mSv ALI _{inhalation}
				2.7E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	6E+05	6E+06	2E+06	2E+07	2E+09	

Iridium - 192

¹⁹²Ir₇₇


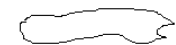
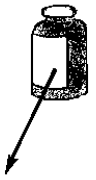


Half life: 73.8 days
 Specific activity: 3.41E+14 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


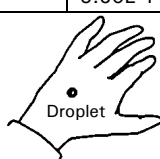
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	317	83	256	6	230	2		
E2	468	48	536	41	238	5		
E3	604	8	672	48	303	2		
% omitted	91.4		< 1		8			

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	1E+0
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
8.35E-2	10 cm: 8.6E-02 1 m: 3.0E-05	100 cm: 1.36E-4	4.78E-1	2.23E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.54E-3	10 cm: 9.6E-03 1 m: 7.5E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 9.2E-03 1 m: 7.2E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.86E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 6.50E-1		2E+1										
		Fixed contamination										
		4E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1	
Plastic	1.9	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	3	12
Steel	23	56

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.010	1.4E-09	All unspec. compounds	F 1.8E-09 2.2E-09
			Metallic Ir, halid. & nitrat.	M 4.9E-09 4.1E-09
			Oxid. & hydrox.	S 6.2E-09 4.9E-09
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	1.4E+07 (Bq)	20 mSv ALI _{inhalation}
				3.2E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	4E+05	4E+06	1E+06	1E+07	5E+08	

Gold - 198


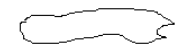

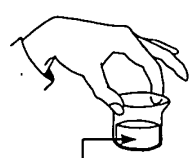

¹⁹⁸Au₇₉

Half life: 2.7 days
Specific activity: 9.03E+15 Bq.g⁻¹


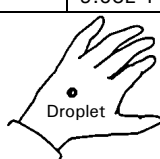
Risk group: 3
Risk colour: Yellow

Main emissions (keV)							Exemption levels	
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	412	96	285	1	8	2		
E2	676	<1	961	99	329	3		
E3	1088	<1			397	1		
% omitted		<1		0		<1		

Transport (TBq)	
IAEA ST1 A ₁ value	1E+0
IAEA ST1 A ₂ value	6E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.24E-1	10 cm: 1.1E-01 1 m: 8.2E-03	100 cm: 6.69E-5	2.36E-1	3.63E+0
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
7.64E-4	10 cm: 2.8E-03 1 m: 1.8E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 2.7E-03 1 m: 1.7E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			SHIELDING (mm)	
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	Betas and electrons (Total absorption)	
Uniform deposit (1kBq.cm ⁻²): 1.68E+0	Recommended probes*	Removable contamination	Glass: 1.6	
0.05 ml droplet (1 kBq): 9.53E-1	Alpha: Beta: ++ Gamma: ++ X rays: +	Fixed contamination	Plastic: 3.0	
		4E+1	Gamma and X rays (half and tenth value thickness)	
		7E+1		
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique				

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f_i		Inhalation	1 μm	5 μm
All compounds	0.100	1.0E-09	All unspec. compounds	F: 2.3E-10	3.9E-10
			Halides & nitrat.	M: 7.6E-10	9.8E-10
			Oxid. & hydrox.	S: 8.4E-10	1.1E-09
Highest dose organ	Lower large intestine	20 mSv ALI _{ingestion}	2.0E+07 (Bq)	20 mSv ALI _{inhalation}	1.8E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood		Bench	Fume hood
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09

Mercury - 197

¹⁹⁷Hg₈₀


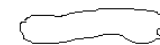



Half life: 2.67 days
Specific activity: 9.18E+15 Bq.g⁻¹

Risk group: 4
Risk colour: Green


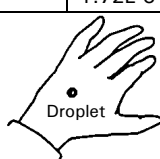
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	69	37			7	90		
E2	77	19			63	61		
E3	191	<1			74	21		
% omitted		89			3			

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	2E+1
IAEA ST1 A ₂ value	1E+1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 0.0E+00 1 m 0.0E+00	100 cm 1.43E-5	4.83E-2	2.19E-1
<i>Gammas, X rays (deep tissue dose)</i> 1.51E-4	<i>Photons (skin)</i> 10 cm 1.3E-03 1 m 1.2E-03			
	<i>Photons (deep dose)</i> 10 cm 1.4E-03 1 m 1.2E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION	
Contamination skin dose (mSv.h⁻¹)	Detection
Uniform deposit (1kBq.cm ⁻²) 9.19E-2	Recommended probes*
0.05 ml droplet (1 kBq) 1.72E-3	Alpha
	Beta +
	Gamma
	X rays ++
	Derived limits (Bq.cm⁻²)
	Removable contamination
	3E+2
	Fixed contamination
	4E+2

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.1	
Plastic	0.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	<1	1
Steel	2	5

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 µm 5 µm
All inorganic compounds	0.020	2.3E-10	Sulphates	F 6.0E-11 1.0E-10
			Ox., hydr., hal., nitrat. & sulphid	M 2.9E-10 2.8E-10
				S
Highest dose organ	Kidneys	20 mSv ALI _{ingestion}	8.7E+07 (Bq)	20 mSv ALI _{inhalation}
				6.9E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds except below	0.01	1E+07	1E+08	3E+07	3E+08	5E+09	
Vapour	1	Forbidden	2E+06	Forbidden	7E+06	7E+08	

Mercury - 203

²⁰³Hg₈₀


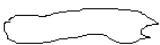

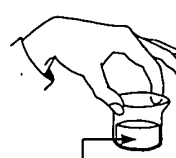

Half life: 46.6 days
Specific activity: 5.11E+14 Bq.g⁻¹

Risk group: 2
Risk colour: Orange


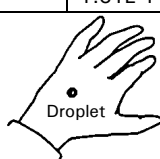
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	71	4	212	100	194	14		
E2	73	6			264	4		
E3	279	82						
% omitted		2.8		0		2		

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	5E+0
IAEA ST1 A ₂ value	1E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
4.05E-3	10 cm: 4.4E-02 1 m: 0.0E+00	100 cm: 3.95E-5	1.37E-1	6.34E-1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
4.42E-4	10 cm: 1.8E-03 1 m: 1.1E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 1.5E-03 1 m: 9.3E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION				
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)		
Uniform deposit (1kBq.cm ⁻²): 8.92E-1	Recommended probes*	Removable contamination		
0.05 ml droplet (1 kBq): 1.31E-1	Alpha: <table border="1"><tr><td></td><td></td></tr></table>			6E+1
	Beta: ++	Fixed contamination		
	Gamma: ++	1E+2		
	X rays: ++			
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique				

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.3	
Plastic	0.4	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	2	5
Steel	18	45

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
Methyl mercury	1.000	1.9E-09	Sulphates	F 5.7E-10 7.5E-10
All unspec. organic compounds	0.400	1.1E-09	Ox., hydr., hal., nitrat. & sulphid	M 2.3E-09 1.9E-09
				S
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	1.1E+07 (Bq)	20 mSv ALI _{inhalation}
				8.7E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds except below	0.01	2E+06	2E+07	6E+06	6E+07	5E+09	
Vapour	1	Forbidden	3E+05	Forbidden	9E+05	9E+07	

Thallium - 201

²⁰¹Tl₈₁


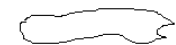
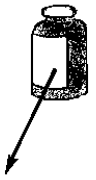


Half life: 3.04 days
 Specific activity: 7.90E+15 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


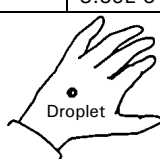
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	71	47			16	10		
E2	135	3			84	16		
E3	167	10			153	3		
% omitted	94.1				28			

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	1E+1
IAEA ST1 A ₂ value	4E+0

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 1.4E-03 1 m 0.0E+00	100 cm 1.85E-5	6.27E-2	2.85E-1
<i>Gammas, X rays (deep tissue dose)</i> 1.97E-4	<i>Photons (skin)</i> 10 cm 1.6E-03 1 m 1.3E-03			
	<i>Photons (deep dose)</i> 10 cm 1.6E-03 1 m 1.3E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 2.70E-1	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>+</td> </tr> <tr> <td>Gamma</td> <td>+</td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta	+	Gamma	+	X rays	++	Removable contamination
Recommended probes*												
Alpha												
Beta		+										
Gamma	+											
X rays	++											
0.05 ml droplet (1 kBq) 8.39E-3		2E+2										
		Fixed contamination										
		3E+2										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	0.2	
Plastic	0.3	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	1
Steel	3	12

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i	Inhalation		
All compounds	1.000	9.5E-11	1 μm	5 μm
			F	4.7E-11 7.6E-11
			M	
			S	
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	2.1E+08 (Bq)	20 mSv A _{LI} inhalation
				2.6E+08 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	1E+07	1E+08	4E+07	4E+08	5E+09	

Thallium - 204




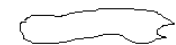
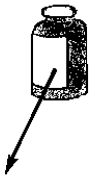


Half life: 3.8 years
 Specific activity: 1.71E+13 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


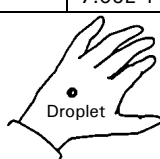
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	69	2	763	98				
E2								
E3								
% omitted	0		0					

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+04

Transport (TBq)	
IAEA ST1 A ₁ value	1E+1
IAEA ST1 A ₂ value	7E-1

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
9.49E-2	10 cm: 9.6E-02 1 m: 3.6E-03	100 cm: 2.30E-7	7.78E-4	7.93E-1
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
2.44E-6	10 cm: 7.7E-06 1 m: 4.6E-06			
	<i>Photons (deep dose)</i>			
	10 cm: 7.8E-06 1 m: 4.6E-06			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 1.62E+0	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td></td></tr> <tr><td>X rays</td><td></td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma												
X rays												
0.05 ml droplet (1 kBq): 7.05E-1		1E+2										
		Fixed contamination										
		2E+3										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.2	
Plastic	2.2	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	1
Steel	2	5

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i	Inhalation	1 μm	5 μm
All compounds	1.000	1.3E-09	F: 4.4E-10	6.2E-10
			M:	
			S:	
Highest dose organ	Kidneys	20 mSv ALI_{ingestion}	1.5E+07 (Bq)	20 mSv ALI_{inhalation}
				3.2E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	7E+05	7E+06	2E+06	2E+07	5E+08	

Lead - 210^{!!}

²¹⁰Pb₈₂

Half life: 22.2 years

Risk group: 1

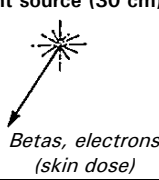
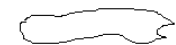
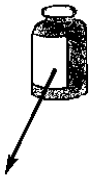


Specific activity: 2.84E+12 Bq.g⁻¹ !! Decay to be considered: ²¹⁰Pb to ²¹⁰Po (pages 13, 165)

Risk colour: Red


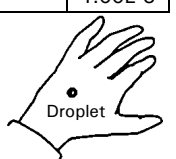
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	13	25	17	80	30	58	3720	< 1
E2	47	4	63	20	43	13		
E3					46	4		
% omitted	0		0		0		0	

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	1E+0
IAEA ST1 A ₂ value	5E-2

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)																
Point source (30 cm)  Betas, electrons (skin dose) 0.00E+0 Gammas, X rays (deep tissue dose) 7.23E-6	Infinite plane source  Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>0.0E+00</td></tr> <tr><td>1 m</td><td>0.0E+00</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>9.4E-04</td></tr> <tr><td>1 m</td><td>3.7E-04</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>4.3E-05</td></tr> <tr><td>1 m</td><td>2.1E-05</td></tr> </table>	10 cm	0.0E+00	1 m	0.0E+00	10 cm	9.4E-04	1 m	3.7E-04	10 cm	4.3E-05	1 m	2.1E-05	10 ml glass vial  100 cm 5.34E-7	Contact with 50 ml glass beaker  1.69E-3	Contact with 5 ml plastic syringe  8.95E-3
10 cm	0.0E+00															
1 m	0.0E+00															
10 cm	9.4E-04															
1 m	3.7E-04															
10 cm	4.3E-05															
1 m	2.1E-05															

The values above do not include Bremsstrahlung radiation.

CONTAMINATION																				
Contamination skin dose (mSv.h⁻¹) <table border="1"> <tr> <td>Uniform deposit (1kBq.cm⁻²)</td> <td>8.38E-3</td> </tr> <tr> <td>0.05 ml droplet (1 kBq)</td> <td>4.00E-3</td> </tr> </table>  	Uniform deposit (1kBq.cm ⁻²)	8.38E-3	0.05 ml droplet (1 kBq)	4.00E-3	Detection <table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha		Beta		Gamma		X rays	++	Derived limits (Bq.cm⁻²) <table border="1"> <tr> <td>Removable contamination</td> <td>5E-1</td> </tr> <tr> <td>Fixed contamination</td> <td>5E+1</td> </tr> </table>	Removable contamination	5E-1	Fixed contamination	5E+1
Uniform deposit (1kBq.cm ⁻²)	8.38E-3																			
0.05 ml droplet (1 kBq)	4.00E-3																			
Recommended probes*																				
Alpha																				
Beta																				
Gamma																				
X rays	++																			
Removable contamination	5E-1																			
Fixed contamination	5E+1																			

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass		0.1
Plastic		0.1
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	< 1
Steel	< 1	1

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f ₁		Inhalation	1 μm 5 μm
All compounds	0.200	6.8E-07	All compounds	F 8.9E-07 1.1E-06
				M
				S
Highest dose organ	Bone surfaces	20 mSv ALI _{ingestion}	2.9E+04 (Bq)	20 mSv ALI _{inhalation}
				1.8E+04 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	5E+03	5E+04	2E+04	2E+05	2E+07

Lead - 214

²¹⁴Pb₈₂


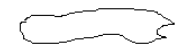
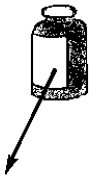
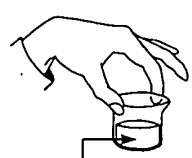

Half life: 26.8 minutes
 Specific activity: 1.21E+18 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


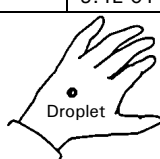
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	295	19	672	48	205	7		
E2	352	37	729	42	261	9		
E3	786	1	1024	6	335	2		
% omitted		47		3		42		

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	-
IAEA ST1 A ₂ value	-

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.7E-01	10 cm: 1.4E-01 1 m: 2.2E-03	100 cm: 4.4E-05	1.5E-01	1.5E+00
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
4.8E-04	10 cm: 3.6E-03 1 m: 2.6E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 2.1E-03 1 m: 2.4E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²): 2.5E+00	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq): 9.4E-01		4E+01										
		Fixed contamination										
		1E+02										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.9	
Plastic	3.3	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	9	21
Steel	37	73

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.200	1.4E-10	All compounds	1 µm: 2.9E-09 5 µm: 4.8E-09
				F: 2.9E-09 M: S:
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	1.4E+08 (Bq)	20 mSv A _{LI} inhalation
				4.2E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood		Bench	Fume hood
All compounds	0.01	3E+05	3E+06	1E+06	1E+07	1E+09

Bismuth - 207

²⁰⁷Bi₈₃


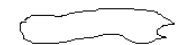
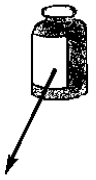


Half life: 32.8 years
 Specific activity: 1.95E+12 Bq.g⁻¹

Risk group: 3
 Risk colour: Yellow


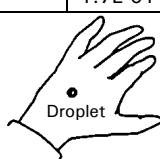
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	570	98			482	2		
E2	1064	75			976	7		
E3	1770	7			1048	2		
% omitted		89				55		

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	0.7
IAEA ST1 A ₂ value	0.7

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
9.5E-03	10 cm 1.7E-02 1 m 0.0E+00	100 cm 2.3E-04	6.7E-01	8.3E+00
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
2.6E-03	10 cm 1.2E-02 1 m 7.7E-03			
	<i>Photons (deep dose)</i>			
	10 cm 1.0E-02 1 m 6.8E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 2.1E-01	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td></td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays		Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays												
0.05 ml droplet (1 kBq) 1.7E-01		2E+01										
		Fixed contamination										
		2E+01										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.8	
Plastic	3.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	10	36
Steel	30	77

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.050	1.3E-09	1 µm	5 µm
			Bismuth nitrate	F 5.2E-10 8.4E-10
			All unspec. compounds	M 5.2E-09 3.2E-09
				S
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	1.5E+07 (Bq)	20 mSv A _{LI} inhalation
				3.8E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	5E+05	5E+06	2E+06	2E+07	2E+09	

Bismuth - 210




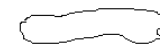



Half life: 5.01 days
 Specific activity: $4.60\text{E}+15 \text{ Bq.g}^{-1}$

Risk group: 3
 Risk colour: Yellow


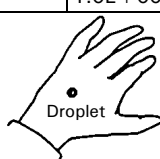
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			1161	100				
E2								
E3								
% omitted				0				

Exemption levels	
Quantity (Bq)	1E+06
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	1
IAEA ST1 A ₂ value	0.6

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
1.2E-01	10 cm: 1.1E-01 1 m: 1.6E-02			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
0.0E+00	10 cm: 0.0E+00 1 m: 0.0E+00	100 cm		
	<i>Photons (deep dose)</i>	Brem. Rad.	Brem. Rad.	4.1E+00
	10 cm: 0.0E+00 1 m: 0.0E+00			

The values above do not include Bremsstrahlung radiation. Brem. Rad. indicates that it may be significant.

CONTAMINATION		
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)
Uniform deposit (1kBq.cm ⁻²): 1.7E+00	Recommended probes*	Removable contamination
0.05 ml droplet (1 kBq): 1.0E+00	Alpha: Beta: ++ Gamma: X rays:	9E+00
		Fixed contamination
		8E+02
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique		

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	2.2	
Plastic	3.8	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f_i		Inhalation	
All compounds	0.050	1.3E-09	1 μm	5 μm
			Bismuth nitrate	F 1.1E-09 1.4E-09
			All unspec. compounds	M 8.4E-08 6.0E-08
				S
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	1.5E+07 (Bq)	20 mSv A _{LI} inhalation
				2.4E+05 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	7E+04	7E+05	2E+05	2E+06	2E+08	

Bismuth - 214

²¹⁴Bi₈₃


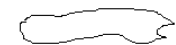
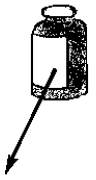


Half life: 19.83 minutes
 Specific activity: 1.64E+18 Bq.g⁻¹


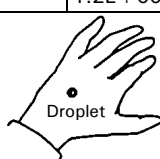
Risk group: 3
 Risk colour: Yellow

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	610	46	1540	18	592	< 1		
E2	1764	16	1892	8	1027	< 1		
E3	2205	5	3270	17	1323	< 1		
% omitted		54		57		1		

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	-
IAEA ST1 A ₂ value	-

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
 Betas, electrons (skin dose) 8.3E-02 Gammas, X rays (deep tissue dose) 2.3E-03	 Betas, electrons (skin) 10 cm 1.2E-01 1 m 3.5E-02 Photons (skin) 10 cm 1.2E-02 1 m 8.3E-03 Photons (deep dose) 10 cm 1.1E-02 1 m 7.9E-03	 100 cm 2.4E-04	 8.6E-01	 2.6E+01
The values above do not include Bremsstrahlung radiation.				

CONTAMINATION												
Contamination skin dose (mSv.h ⁻¹)		Detection										
Uniform deposit (1kBq.cm ⁻²)	2.3E+00	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td>++</td> </tr> <tr> <td>X rays</td> <td></td> </tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	
Recommended probes*												
Alpha												
Beta	++											
Gamma	++											
X rays												
0.05 ml droplet (1 kBq)	1.2E+00											
												
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique		<table border="1"> <tr> <th colspan="2">Derived limits (Bq.cm⁻²)</th> </tr> <tr> <td>Removable contamination</td> <td>4E-9</td> </tr> <tr> <td>Fixed contamination</td> <td>4E-7</td> </tr> </table>	Derived limits (Bq.cm ⁻²)		Removable contamination	4E-9	Fixed contamination	4E-7				
Derived limits (Bq.cm ⁻²)												
Removable contamination	4E-9											
Fixed contamination	4E-7											

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	8.9	
Plastic	14.3	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	27	68
Steel	43	101

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i	Inhalation		
			1 μm	5 μm
All compounds	0.050	1.1E-10	Bismuth nitrate F	7.2E-09 1.2E-08
			All unspec. compounds M	1.4E-08 2.1E-08
			S	
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	1.8E+08 (Bq)	20 mSv A _{LI} inhalation 9.5E+05 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood		Bench	Fume hood
All compounds	0.01	3E+05	3E+06	1E+06	1E+07	1E+09

Polonium - 210




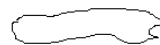



Half life: 138.4 days
 Specific activity: 1.66E+14 Bq.g⁻¹


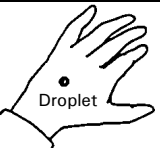
Risk group: 1
 Risk colour: Red

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	803	<1					5304	100
E2								
E3								
% omitted	0						0	

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	4E+1
IAEA ST1 A ₂ value	2E-2

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
-	10 cm 0.0E+00			
	1 m 0.0E+00			
	<i>Photons (skin)</i>			
	10 cm 5.7E-08			
	1 m 3.7E-08			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (deep dose)</i>	100 cm		
1.51E-8	10 cm 5.3E-08	1.30E-9	4.70E-6	2.23E-5
	1 m 3.4E-08			

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 6.90E-7	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td>++</td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </tbody> </table>	Recommended probes*		Alpha	++	Beta		Gamma		X rays		Removable contamination
Recommended probes*												
Alpha		++										
Beta												
Gamma												
X rays												
0.05 ml droplet (1 kBq) 0.00E+0		3E-1										
		Fixed contamination										
		3E+1										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	-	
Plastic	-	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	11	31
Steel	31	78

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i	Inhalation		
			1 µm	5 µm
All compounds	0.100	2.4E-07	F	
			M	
			S	
Highest dose organ	Whole body	20 mSv ALI_{ingestion}	8.3E+04 (Bq)	20 mSv ALI_{inhalation}
			6.7E+03 (Bq)	

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	2E+03	2E+04	7E+03	7E+04	7E+06

Radium - 226^{!!}

²²⁶Ra₈₈

Half life: 1600 years

Risk group: 1


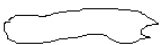
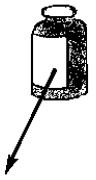


Specific activity: 3.66E+10 Bq.g⁻¹ !! Decay to be considered: ²²⁶Ra to ²¹⁰Po (pages 13, 165)

Risk colour: Red


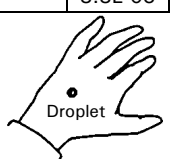
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	186	3			168	1	4602	6
E2							4784	95
E3								
% omitted	1				2		< 1	

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	0.2
IAEA ST1 A ₂ value	0.003

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
6.3E-05	10 cm 1.1E-03 1 m 0.0E+00	100 cm 1.2E-06	4.0E-03	2.6E-02
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.3E-05	10 cm 6.8E-05 1 m 3.6E-05			
	<i>Photons (deep dose)</i>			
	10 cm 4.3E-05 1 m 2.6E-05			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 4.8E-02	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td>++</td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </tbody> </table>	Recommended probes*		Alpha	++	Beta		Gamma		X rays	+	Removable contamination
Recommended probes*												
Alpha		++										
Beta												
Gamma												
X rays	+											
0.05 ml droplet (1 kBq) 8.8E-03		2E-01										
		Fixed contamination										
		2E+01										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	< 0.1	
Plastic	< 0.1	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	2
Steel	11	30

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All compounds	0.200	2.8E-07		
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	7.1E+04 (Bq)	20 mSv A _{LI} inhalation
				6.3E+03 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	2E+03	2E+04	6E+03	6E+04	6E+06	

Thorium - 231

²³¹Th₉₀

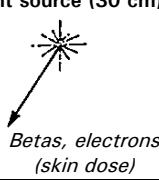
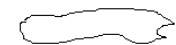
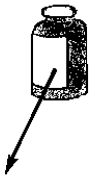


Half life: 25.5 hours
Specific activity: 1.97E+16 Bq.g⁻¹

Risk group: 4
Risk colour: Green


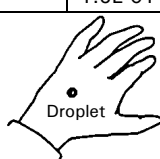
Main emissions (keV)							
	Gamma or X		Beta (E _{max})		Electrons		Alpha
	E	%	E	%	E	%	E %
E1	13	71	206	15	37	55	
E2	84	6	288	41	53	15	
E3	163	<1	305	35	63	15	
% omitted		20		14		220	

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+03

Transport (TBq)	
IAEA ST1 A ₁ value	40
IAEA ST1 A ₂ value	0.02

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)  Betas, electrons (skin dose) 0.0E+00 Gammas, X rays (deep tissue dose) 1.7E-04	Infinite plane source  Betas, electrons (skin) 10 cm 1.6E-02 1 m 0.0E+00 Photons (skin) 10 cm 2.1E-03 1 m 9.4E-04 Photons (deep dose) 10 cm 5.5E-04 1 m 3.2E-04	10 ml glass vial  100 cm 3.4E-06	Contact with 50 ml glass beaker  1.1E-02	Contact with 5 ml plastic syringe  6.3E-01

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹) Uniform deposit (1kBq.cm ⁻²) 9.4E-01 0.05 ml droplet (1 kBq) 1.5E-01	Detection <table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </tbody> </table>	Recommended probes*		Alpha		Beta	++	Gamma		X rays	+	Derived limits (Bq.cm⁻²) Removable contamination 2E+02 Fixed contamination 2E+03
Recommended probes*												
Alpha												
Beta	++											
Gamma												
X rays	+											
 Uniform deposit  Droplet	* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique											

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	<	0.1
Plastic	<	0.1
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	<	1
Steel		11

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f _i	Inhalation		1 µm	5 µm
All unspec. compounds	5.0E-04	3.4E-10		F	
Oxid. & hydrox.	2.0E-04	3.4E-10		M	2.9E-10 3.7E-10
				S	3.2E-10 4.0E-10
Highest dose organ	Lower large intestine	20 mSv ALI _{ingestion}	5.9E+07 (Bq)	20 mSv ALI _{inhalation}	5.0E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	2E+07	2E+08	5E+07	5E+08	5E+09

Thorium - 234

²³⁴Th₉₀

Half life: 24.1 days
 Specific activity: 8.56E+14 Bq.g⁻¹


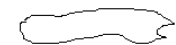
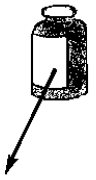


Risk group: 2
 Risk colour: Orange

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	13	10	76	2	72	12		
E2	63	4	96	25	87	3		
E3	92	5	189	73	91	1		
% omitted	<1		0		18			

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+03


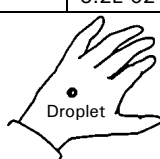
Transport (TBq)	
IAEA ST1 A ₁ value	0.3
IAEA ST1 A ₂ value	0.3

EXTERNAL EXPOSURE (mSv.h⁻¹) for an activity of 1 MBq or 1 MBq.m⁻² (as appropriate)

Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
 Betas, electrons (skin dose) 0.0E+00 Gammas, X rays (deep tissue dose) 3.2E-05	 Betas, electrons (skin) 10 cm 5.0E-06 1 m 0.0E+00 Photons (skin) 10 cm 3.1E-04 1 m 1.4E-04 Photons (deep dose) 10 cm 1.1E-04 1 m 6.4E-05	 100 cm 1.6E-06	 5.5E-03	 9.8E-02

The values above do not include Bremsstrahlung radiation.

CONTAMINATION

Contamination skin dose (mSv.h ⁻¹)		Detection		Derived limits (Bq.cm ⁻²)																			
Uniform deposit (1kBq.cm ⁻²)	3.5E-01	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td>++</td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </table>		Recommended probes*		Alpha		Beta	++	Gamma		X rays	+	<table border="1"> <tr> <th colspan="2">Removable contamination</th> </tr> <tr> <td></td> <td>7E+01</td> </tr> <tr> <th colspan="2">Fixed contamination</th> </tr> <tr> <td></td> <td>3E+03</td> </tr> </table>		Removable contamination			7E+01	Fixed contamination			3E+03
Recommended probes*																							
Alpha																							
Beta	++																						
Gamma																							
X rays	+																						
Removable contamination																							
	7E+01																						
Fixed contamination																							
	3E+03																						
0.05 ml droplet (1 kBq)	3.2E-02																						
 																							
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique																							

SHIELDING (mm)

Betas and electrons (Total absorption)		
Glass	< 0.1	
Plastic	< 0.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	1
Steel	8	18

INTERNAL EXPOSURE FOR WORKERS

COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq⁻¹)

Ingestion	f _i	Inhalation		
			1 µm	5 µm
All unspec. compounds	5.0E-04		F	
Oxid. & hydrox.	2.0E-04		M	6.3E-09
			S	7.3E-09
				5.8E-09

Highest dose organ: Lungs 20 mSv ALI_{ingestion} 5.9E+06 (Bq) 20 mSv ALI_{inhalation} 2.7E+06 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)

Subject to external exposure requirements which may be more restrictive

PHYSICOCHEMICAL STATE	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	8E+05	8E+06	3E+06	3E+07	3E+09

Protactinium - 234

²³⁴Pa₉₁


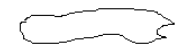



Half life: 6.7 hours
 Specific activity: 7.39E+16 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


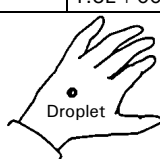
Main emissions (keV)							
	Gamma or X		Beta (E _{max})		Electrons		Alpha
	E	%	E	%	E	%	E %
E1	569	11	690	35	95	29	
E2	946	12	711	20	99	35	
E3	1690	13	1238	6	454	2	
% omitted	417		39		252		

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	-
IAEA ST1 A ₂ value	-

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
8.4E-02	10 cm 1.4E-01 1 m 5.4E-02	100 cm 3.9E-04	1.1E+00	4.2E+01
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
3.6E-03	10 cm 2.0E-02 1 m 1.4E-02			
	<i>Photons (deep dose)</i>			
	10 cm 1.8E-02 1 m 1.3E-02			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 5.4E+00	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td></td></tr> <tr><td>Beta</td><td>++</td></tr> <tr><td>Gamma</td><td>++</td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha		Beta	++	Gamma	++	X rays	+	Removable contamination
Recommended probes*												
Alpha												
Beta		++										
Gamma	++											
X rays	+											
0.05 ml droplet (1 kBq) 1.3E+00		1E+01										
		Fixed contamination										
		2E+01										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	2.5	
Plastic	4.2	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	28	61
Steel	48	97

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁	Inhalation		
All compounds	5.0E-04	5.1E-10	1 μm	5 μm
			F	
			M	3.8E-10 5.5E-10
			S	4.0E-10 5.8E-10
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	3.9E+07 (Bq)	20 mSv ALI _{inhalation}
				3.4E+07 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
All compounds	0.01	8E+05	8E+06	3E+06	3E+07	3E+09	

Protactinium - 234m

^{234m}Pa₉₁


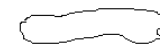



Half life: 1.17 minutes
 Specific activity: 2.54E+19 Bq.g⁻¹

Risk group: 2
 Risk colour: Orange


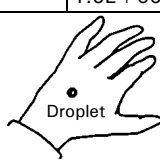
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	1001	<1	1236	<1	694	<1		
E2			1471	<1				
E3			2281	99				
% omitted	1		<1		1			

Exemption levels	
Quantity (Bq)	-
Concentration (Bq.g ⁻¹)	-

Transport (TBq)	
IAEA ST1 A ₁ value	-
IAEA ST1 A ₂ value	-

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 1.1E-01	<i>Betas, electrons (skin)</i> 10 cm 1.4E-01 1 m 5.6E-02	100 cm 2.9E-05	6.0E-02	4.0E+01
<i>Gammas, X rays (deep tissue dose)</i> 2.0E-05	<i>Photons (skin)</i> 10 cm 9.1E-05 1 m 5.7E-05			
	<i>Photons (deep dose)</i> 10 cm 7.6E-05 1 m 5.0E-05			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)	
Uniform deposit (1kBq.cm ⁻²) 2.4E+00	Recommended probes*	Removable contamination	
0.05 ml droplet (1 kBq) 1.5E+00			Alpha
			Beta ++
			Gamma
	X rays	Fixed contamination	
		-	

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	5.5	
Plastic	9.0	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	24	59
Steel	38	91

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f ₁	Inhalation		
			1 μm	5 μm
-	-	-	F	-
			M	-
			S	-

Highest dose organ - 20 mSv ALI_{ingestion} (Bq) 20 mSv ALI_{inhalation} (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.01	6E+05	6E+06	2E+06	2E+07	2E+09

Uranium - 233



Half life: 1.59E+5 years
 Specific activity: 3.57E+08 Bq.g⁻¹


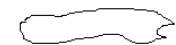

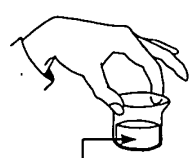

Risk group: 1
 Risk colour: Red

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	13	4			22	6	4729	2
E2	114	<1			37	2	4783	13
E3					77	<1	4824	84
% omitted		0				5		<1

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+01


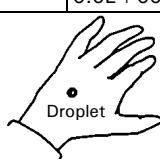
Transport (TBq)	
IAEA ST1 A ₁ value	40
IAEA ST1 A ₂ value	-

EXTERNAL EXPOSURE (mSv.h⁻¹) for an activity of 1 MBq or 1 MBq.m⁻² (as appropriate)

Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
 Betas, electrons (skin dose) 0.0E+00 Gammas, X rays (deep tissue dose) 5.9E-06	 Betas, electrons (skin) 10 cm 0.0E+00 1 m 0.0E+00 Photons (skin) 10 cm 1.0E-05 1 m 4.1E-06 Photons (deep dose) 10 cm 1.3E-05 1 m 5.3E-06	 100 cm 4.3E-08	 1.2E-04	 4.1E-03

The values above do not include Bremsstrahlung radiation.

CONTAMINATION

Contamination skin dose (mSv.h ⁻¹)		Detection		Derived limits (Bq.cm ⁻²)																			
Uniform deposit (1kBq.cm ⁻²)	0.0E+00	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td>++</td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </table>		Recommended probes*		Alpha	++	Beta		Gamma		X rays		<table border="1"> <tr> <th colspan="2">Removable contamination</th> </tr> <tr> <td></td> <td>1E-01</td> </tr> <tr> <th colspan="2">Fixed contamination</th> </tr> <tr> <td></td> <td>1E+01</td> </tr> </table>		Removable contamination			1E-01	Fixed contamination			1E+01
Recommended probes*																							
Alpha	++																						
Beta																							
Gamma																							
X rays																							
Removable contamination																							
	1E-01																						
Fixed contamination																							
	1E+01																						
0.05 ml droplet (1 kBq)	0.0E+00	 																					

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)

Betas and electrons (Total absorption)		
Glass	<0.1	
Plastic	<0.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS

COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq⁻¹)

Ingestion	f _i	Inhalation		1 µm	5 µm
All unspec. compounds	0.020	5.0E-08	Most hexava. comp. e.g. UF ₆ , UO ₂ F ₂	F 5.7E-07	6.6E-07
Most tetravalent comp., e.g. UO ₂ , U ₃ O ₈	0.002	8.5E-09	Less solub. comp., e.g. UO ₃ , UF ₄	M 3.2E-06	2.2E-06
			Highly insoluble comp. e.g. UO ₂ , U ₃ O ₈	S 8.7E-06	6.9E-06

Highest dose organ: Lungs 20 mSv A_{LI} ingestion 4.0E+05 (Bq) 20 mSv A_{LI} inhalation 2.3E+03 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)

PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.001	7E+03	7E+04	2E+04	2E+05	2E+07

Uranium - 234



Half life: 2.44E+5 years
 Specific activity: 2.32E+08 Bq.g⁻¹


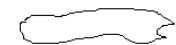
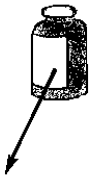


Risk group: 1
 Risk colour: Red

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	13	10			33	1	4724	27
E2	53	<1			52	2	4776	72
E3	121	<1			100	<1		
% omitted	0				15		<1	

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+01


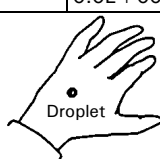
Transport (TBq)	
IAEA ST1 A ₁ value	40
IAEA ST1 A ₂ value	-

EXTERNAL EXPOSURE (mSv.h⁻¹) for an activity of 1 MBq or 1 MBq.m⁻² (as appropriate)

Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe												
 Betas, electrons (skin dose) 0.0E+00 Gammas, X rays (deep tissue dose) 1.5E-05	 Betas, electrons (skin) <table border="1"> <tr><td>10 cm</td><td>0.0E+00</td></tr> <tr><td>1 m</td><td>0.0E+00</td></tr> </table> Photons (skin) <table border="1"> <tr><td>10 cm</td><td>2.7E-05</td></tr> <tr><td>1 m</td><td>1.1E-05</td></tr> </table> Photons (deep dose) <table border="1"> <tr><td>10 cm</td><td>3.2E-05</td></tr> <tr><td>1 m</td><td>1.3E-05</td></tr> </table>	10 cm	0.0E+00	1 m	0.0E+00	10 cm	2.7E-05	1 m	1.1E-05	10 cm	3.2E-05	1 m	1.3E-05	 100 cm 3.6E-08	 8.0E-05	 9.7E-03
10 cm	0.0E+00															
1 m	0.0E+00															
10 cm	2.7E-05															
1 m	1.1E-05															
10 cm	3.2E-05															
1 m	1.3E-05															

The values above do not include Bremsstrahlung radiation.

CONTAMINATION

Contamination skin dose (mSv.h ⁻¹)		Detection		Derived limits (Bq.cm ⁻²)
Uniform deposit (1kBq.cm ⁻²)	0.0E+00	Recommended probes*		Removable contamination 1E-01
0.05 ml droplet (1 kBq)	0.0E+00	Alpha	++	
 		Beta		Fixed contamination 1E+01
		Gamma		
		X rays		

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)

Betas and electrons (Total absorption)		
Glass	< 0.1	
Plastic	< 0.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS

COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq⁻¹)

Ingestion	f _i		Inhalation	
			1 μm	5 μm
All unspec. compounds	0.020	4.9E-08	Most hexava. comp. e.g. UF ₆ , UO ₂ F ₃	F 5.5E-07 6.4E-07
Most tetravalent comp., e.g. UO ₂ , U ₃ O ₈	0.002	8.3E-09	Less solub. comp., e.g. UO ₃ , UF ₅	M 3.1E-06 2.1E-06
			Highly insoluble comp. e.g. UO ₂ , U ₃ O ₈	S 8.5E-06 6.8E-06

Highest dose organ: Lungs 20 mSv ALI_{ingestion} 4.1E+05 (Bq) 20 mSv ALI_{inhalation} 2.4E+03 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)

Subject to external exposure requirements which may be more restrictive

PHYSICOCHEMICAL STATE	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.001	7E+03	7E+04	2E+04	2E+05	2E+07

Uranium - 235^{!!}



Half life: 7.04E+8 years

Risk group: 1


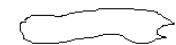



Specific activity: 8.00E+04 Bq.g⁻¹ !! Decay to be considered: ²³⁵U to ²¹¹Po (pages 13, 165)


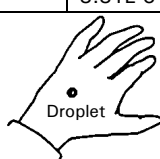
Risk colour: Red

Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	16	29					4365	17
E2	144	11					4400	55
E3	186	57					4599	5
% omitted		23.6						20.9

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	Unlimited
IAEA ST1 A ₂ value	Unlimited

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.00E+0	10 cm: 1.0E-03 1 m: 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>	100 cm		
3.28E-4	10 cm: 2.9E-03 1 m: 2.1E-03	2.67E-5	8.91E-2	4.05E-1
	<i>Photons (deep tissue dose)</i>			
	10 cm: 2.2E-03 1 m: 1.8E-03			

CONTAMINATION		
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)
Uniform deposit (1kBq.cm ⁻²): 1.78E-1	Recommended probes*	Removable contamination
0.05 ml droplet (1 kBq): 8.81E-3	Alpha: ++ Beta: + Gamma: ++ X rays: ++	1E-1
		Fixed contamination
		1E+1
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique		

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass		-
Plastic		-
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	2
Steel	12	29

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁		Inhalation	
All unspec. compounds	0.020	4.6E-08	Most hexavalent compounds	F 1 μm: 5.1E-07, 5 μm: 6.0E-07
Most tetravalent compounds	0.002	8.3E-09	Less solub. comp.; most hexav. comp.	M 2.8E-06, 1.8E-06
			Highly insoluble compounds	S 7.7E-06, 6.1E-06
Highest dose organ	Lungs	20 mSv A _{LI} ingestion	4.3E+05 (Bq)	20 mSv A _{LI} inhalation
				2.6E+03 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
UO ₂ U ₃ O ₈	0.001	8E+03	8E+04	3E+04	3E+05	3E+07	
Other compounds	0.001	2E+04	2E+05	7E+04	7E+05	7E+07	

Uranium - 238^{!!}



Half life: 4.47E+9 years

Risk group: 1

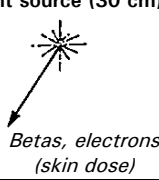
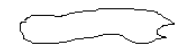
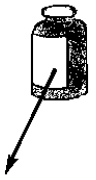


Specific activity: 1.24E+04 Bq.g⁻¹ !!Decay to be considered: ²³⁸U to ²¹⁰Po (pages 13, 166)

Risk colour: Red


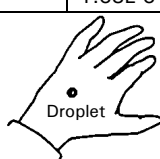
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	15	9					4039	< 1
E2	50	< 1					4147	23
E3							4196	77
% omitted	0						0	

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	Unlimited
IAEA ST1 A ₂ value	Unlimited

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)  Betas, electrons (skin dose) 0.00E+0 Gammas, X rays (deep tissue dose) 1.25E-5	Infinite plane source  Betas, electrons (skin) 10 cm 0.0E+00 1 m 0.0E+00 Photons (skin) 10 cm 2.3E-04 1 m 9.0E-05 Photons (deep dose) 10 cm 2.6E-05 1 m 1.0E-05	10 ml glass vial  100 cm 2.40E-8	Contact with 50 ml glass beaker  5.00E-5	Contact with 5 ml plastic syringe  2.29E-4

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection											
Uniform deposit (1kBq.cm ⁻²)	2.27E-3	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td>++</td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </tbody> </table>	Recommended probes*		Alpha	++	Beta		Gamma		X rays	+
Recommended probes*												
Alpha	++											
Beta												
Gamma												
X rays	+											
0.05 ml droplet (1 kBq)	1.38E-3											
		<table border="1"> <thead> <tr> <th colspan="2">Derived limits (Bq.cm⁻²)</th> </tr> </thead> <tbody> <tr> <td>Removable contamination</td> <td>1E-1</td> </tr> <tr> <td>Fixed contamination</td> <td>1E+1</td> </tr> </tbody> </table>	Derived limits (Bq.cm ⁻²)		Removable contamination	1E-1	Fixed contamination	1E+1				
Derived limits (Bq.cm ⁻²)												
Removable contamination	1E-1											
Fixed contamination	1E+1											

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	-	
Plastic	-	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f _i		Inhalation	1 μm 5 μm
All unspec. compounds	0.020	4.4E-08	Most hexavalent compounds	F 4.9E-07 5.8E-07
Most tetravalent compounds	0.002	7.6E-09	Less solub. comp., most hexav. comp.	M 2.6E-06 1.6E-06
			Highly insoluble compounds	S 7.3E-06 5.7E-06
Highest dose organ	Lungs	20 mSv AII _{ingestion}	4.5E+05 (Bq)	20 mSv AII _{inhalation}
				2.7E+03 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)							
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive						
	Volatility factor (k)	Supervised area			Controlled area		
		Bench	Fume hood		Bench	Fume hood	Glove box
UO ₂ U ₃ O ₈	0.001	8E+03	8E+04	3E+04	3E+05	3E+07	

Neptunium - 239

²³⁹Np₉₃


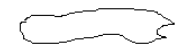

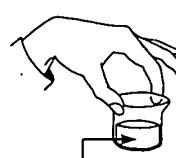

Half life: 2.35 days
Specific activity: 8.60E+15 Bq.g⁻¹

Risk group: 4
Risk colour: Green


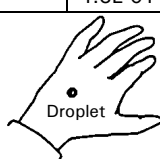
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	14	62	330	35	106	23		
E2	106	23	436	52	156	17		
E3	334	2	714	4	254	4		
% omitted		82		9		204		

Exemption levels	
Quantity (Bq)	1E+07
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	7
IAEA ST1 A ₂ value	4

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
2.6E-02	10 cm: 5.8E-02 1 m: 0.0E+00	100 cm: 3.0E-05	1.0E-01	8.6E-01
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
4.5E-04	10 cm: 3.8E-03 1 m: 2.5E-03			
	<i>Photons (deep dose)</i>			
	10 cm: 2.7E-03 1 m: 2.1E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION		
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)
Uniform deposit (1kBq.cm ⁻²): 2.6E+00	Recommended probes*	Removable contamination
0.05 ml droplet (1 kBq): 4.3E-01	Alpha: Beta: ++ Gamma: X rays: +	5E+01
		Fixed contamination
		2E+02
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique		

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	1.1	
Plastic	2.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	2	9
Steel	20	55

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁	Inhalation		
All compounds	5.0E-04	8.0E-10	1 µm	5 µm
			F	
			M	9.0E-10
			S	1.1E-09
Highest dose organ	Lungs	20 mSv ALI _{ingestion}	2.5E+07 (Bq)	20 mSv ALI _{inhalation}
			1.8E+07 (Bq)	

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.001	3E+06	3E+07	9E+06	9E+07	5E+09

Plutonium - 238

²³⁸Pu₉₄


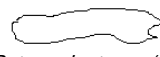



Half life: 87.7 years
 Specific activity: 6.34E+11 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


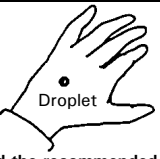
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	16	12					5456	29
E2	44	<1					5499	71
E3	100	<1						
% omitted	0						0	

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+00

Transport (TBq)	
IAEA ST1 A ₁ value	1E+1
IAEA ST1 A ₂ value	1E-3

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
Betas, electrons (skin dose)	Betas, electrons (skin)			
-	10 cm 0.0E+00			
	1 m 0.0E+00			
	Photons (skin)			
	10 cm 2.8E-04			
	1 m 1.1E-04			
Gammas, X rays (deep tissue dose)	Photons (deep dose)	100 cm 2.15E-8	2.16E-5	1.05E-4
2.04E-5	10 cm 4.3E-05			
	1 m 1.7E-05			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 3.70E-3	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td>++</td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </table>	Recommended probes*		Alpha	++	Beta		Gamma		X rays	+	Removable contamination
Recommended probes*												
Alpha		++										
Beta												
Gamma												
X rays	+											
0.05 ml droplet (1 kBq) 0.0E+00		4E-2										
		Fixed contamination										
		4E+0										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	-	
Plastic	-	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	<1	
Steel	<1	2

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f ₁		Inhalation	1 μm	5 μm
All unspec. compounds	0.0005	2.3E-07		F	
Nitrates	0.0001	4.9E-08	All unspec. compounds	M	4.3E-05 3.0E-05
Insoluble oxides	0.00001	8.8E-09	Insoluble oxides	S	1.5E-05 1.1E-05
Highest dose organ	Bone surfaces	20 mSv A_{LI} ingestion	8.7E+04 (Bq)	20 mSv A_{LI} inhalation	4.7E+02 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds except below	0.001	Forbidden	2E+04	Forbidden	5E+04	5E+06
PuO ₂	0.001	Forbidden	4E+04	Forbidden	1E+05	1.3E+07

Plutonium - 239

²³⁹Pu₉₄


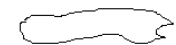
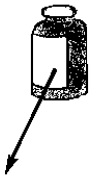


Half life: 2.41E+4 years
 Specific activity: 2.30E+09 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


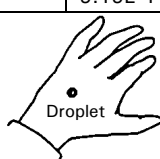
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	16	6					5105	11.7
E2	52	<1					5143	15.1
E3	129	<1					5156	73
% omitted		<1						<1

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+00

Transport (TBq)	
IAEA ST1 A ₁ value	1E+1
IAEA ST1 A ₂ value	1E-3

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.00E+0	10 cm 0.0E+00			
	1 m 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
7.87E-6	10 cm 1.1E-04			
	1 m 4.1E-05			
	<i>Photons (deep dose)</i>			
	10 cm 1.7E-05	100 cm 1.57E-8	3.39E-5	1.52E-4
	1 m 6.6E-06			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.43E-3	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td>++</td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </tbody> </table>	Recommended probes*		Alpha	++	Beta		Gamma		X rays	+	Removable contamination
Recommended probes*												
Alpha		++										
Beta												
Gamma												
X rays	+											
0.05 ml droplet (1 kBq) 9.19E-4		4E-2										
		Fixed contamination										
		4E+0										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass		-
Plastic		-
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	<1	<1
Steel	<1	<1

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f ₁		Inhalation	
				1 μm 5 μm
All unspec. compounds	0.0005	2.5E-07		F
Nitrates	0.0001	5.3E-08	All unspec. compounds	M 4.7E-05 3.2E-05
Insoluble oxides	0.00001	9.0E-09	Insoluble oxides	S 1.5E-05 8.3E-06
Highest dose organ	Bone surface	20 mSv ALL _{ingestion}	8.0E+04 (Bq)	20 mSv ALL _{inhalation}
				4.3E+02 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds except below	0.001	Forbidden	1E+04	Forbidden	4E+04	4E+06
PuO ₂	0.001	Forbidden	4E+04	Forbidden	1E+05	1E+07

Plutonium - 240

²⁴⁰Pu₉₄


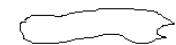

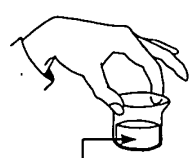

Half life: 6563 years
 Specific activity: 8.40E+09 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


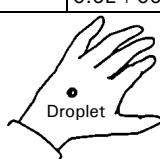
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	14	11			10	9	5124	27
E2	54	<1			23	20	5168	73
E3					40	7		
% omitted		<1				0		<1

Exemption levels	
Quantity (Bq)	1E+03
Concentration (Bq.g ⁻¹)	1E+00

Transport (TBq)	
IAEA ST1 A ₁ value	10
IAEA ST1 A ₂ value	0.001

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.0E+00	10 cm 0.0E+00			
	1 m 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
1.9E-05	10 cm 2.6E-04			
	1 m 1.0E-04			
	<i>Photons (deep dose)</i>	100 cm 2.1E-08	8.4E-05	7.9E-02
	10 cm 4.1E-05			
	1 m 1.6E-05			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 0.0E+00	<table border="1"> <thead> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td>++</td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </tbody> </table>	Recommended probes*		Alpha	++	Beta		Gamma		X rays		Removable contamination
Recommended probes*												
Alpha		++										
Beta												
Gamma												
X rays												
0.05 ml droplet (1 kBq) 0.0E+00		4E-02										
		Fixed contamination										
		2E+00										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	< 0.1	
Plastic	< 0.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f ₁		Inhalation	1 µm	5 µm
All unspec. compounds	5.0E-04	2.5E-07		F	
Nitrates	1.0E-04	5.3E-08	All unspec. compounds	M	4.7E-05 3.2E-05
Insoluble oxides	1.0E-05	9.0E-09	Insoluble oxides	S	1.5E-05 8.3E-06
Highest dose organ	Bone surface	20 mSv ALI _{ingestion}	8.0E+04 (Bq)	20 mSv ALI _{inhalation}	4.3E+02 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.001	Forbidden	1E+04	Forbidden	4E+04	4E+06

Plutonium - 241^{!!}

²⁴¹Pu₉₄

Half life: 14.4 years

Risk group: 2


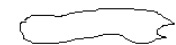
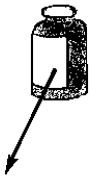


Specific activity: 3.81E+12 Bq.g⁻¹ !! Decay to be considered: ²⁴¹Pu to ²⁰⁹Pb (pages 13, 166)

Risk colour: Orange


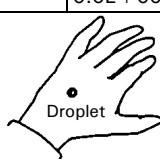
Main emissions (keV)					Exemption levels			
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1			21	100				
E2								
E3								
% omitted			0					

Exemption levels	
Quantity (Bq)	1E+05
Concentration (Bq.g ⁻¹)	1E+02

Transport (TBq)	
IAEA ST1 A ₁ value	40
IAEA ST1 A ₂ value	0.06

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.0E+00	10 cm 0.0E+00			
	1 m 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>			
0.0E+00	10 cm 9.1E-06			
	1 m 4.9E-06			
	<i>Photons (deep dose)</i>			
	10 cm 4.8E-06			
	1 m 3.2E-06			
		100 cm 0.0E+00	0.0E+00	0.0E+00

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			SHIELDING (mm)											
Contamination skin dose (mSv.h⁻¹)		Detection	Betas and electrons (Total absorption)											
Uniform deposit (1kBq.cm ⁻²)	0.0E+00	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td></td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td></td> </tr> </table>	Recommended probes*		Alpha		Beta		Gamma		X rays		Glass < 0.1	
Recommended probes*														
Alpha														
Beta														
Gamma														
X rays														
0.05 ml droplet (1 kBq)	0.0E+00	<table border="1"> <tr> <td>Derived limits (Bq.cm⁻²)</td> <td colspan="2"></td> </tr> <tr> <td>Removable contamination</td> <td colspan="2">1E+00</td> </tr> <tr> <td>Fixed contamination</td> <td colspan="2">1E+02</td> </tr> </table>	Derived limits (Bq.cm⁻²)			Removable contamination	1E+00		Fixed contamination	1E+02		Plastic < 0.1		
Derived limits (Bq.cm⁻²)														
Removable contamination	1E+00													
Fixed contamination	1E+02													
			Gamma and X rays (half and tenth value thickness)											
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique				1/2 1/10										
			Lead	- -										
			Steel	- -										

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f _i		Inhalation	1 μm	5 μm
All unspec. compounds	5.0E-04	4.7E-09		F	
Nitrates	1.0E-04	9.6E-10	All unspec. compounds	M	8.5E-07 5.8E-07
Insoluble oxides	1.0E-05	1.1E-10	Insoluble oxides	S	1.6E-07 8.4E-08
Highest dose organ	Bone surface	20 mSv ALI _{ingestion}	4.3E+06 (Bq)	20 mSv ALI _{inhalation}	2.4E+04 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.001	7E+04	7E+05	2E+05	2E+06	2E+08

Americium - 241

²⁴¹Am₉₅


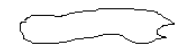



Half life: 432.7 years
 Specific activity: 1.27E+11 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


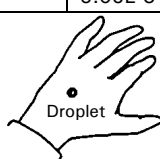
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	14	13					5388	1.4
E2	18	18					5443	12.8
E3	60	36					5486	85.2
% omitted	8.2						< 1	

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+00

Transport (TBq)	
IAEA ST1 A ₁ value	1E+1
IAEA ST1 A ₂ value	1E-3

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 0.0E+00 1 m 0.0E+00	100 cm 5.65E-6	1.81E-2	8.80E-2
<i>Gammas, X rays (deep tissue dose)</i> 1.49E-4	<i>Photons (skin)</i> 10 cm 1.2E-03 1 m 5.1E-04			
	<i>Photons (deep dose)</i> 10 cm 3.8E-04 1 m 1.9E-04			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 1.95E-2	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td>++</td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha	++	Beta		Gamma		X rays	++	Removable contamination
Recommended probes*												
Alpha		++										
Beta												
Gamma												
X rays	++											
0.05 ml droplet (1 kBq) 6.05E-3		4E-2										
		Fixed contamination										
		4E+0										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	-	
Plastic	-	
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	< 1	< 1
Steel	1	3

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f ₁	Inhalation		
			1 μm	5 μm
All compounds	0.0005	2.0E-07	F	
			M	3.9E-05 2.7E-05
			S	
Highest dose organ	Bone surfaces	20 mSv ALI _{ingestion}	1.0E+05 (Bq)	20 mSv ALI _{inhalation} 5.1E+02 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.001	2E+03	2E+04	5E+03	5E+04	5E+06

Americium - 243^{!!}

²⁴³Am₉₅

Half life: 7370 years

Risk group: 1


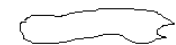
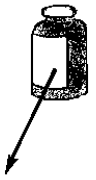


Specific activity: 7.39E+09 Bq.g⁻¹ !! Decay to be considered: ²⁴³Am to ²¹¹Po (pages 13, 166)

Risk colour: Red


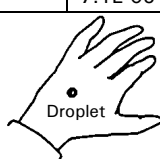
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	17	41			25	15	5181	1
E2	44	6			52	14	5234	11
E3	75	68			73	1	5276	88
% omitted	1				89		< 1	

Exemption levels	
Quantity (Bq)	1E+03
Concentration (Bq.g ⁻¹)	1E+00

Transport (TBq)	
IAEA ST1 A ₁ value	5
IAEA ST1 A ₂ value	0.001

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Betas, electrons (skin)</i>			
0.0E+00	10 cm 6.3E-02 1 m 0.0E+00			
<i>Gammas, X rays (deep tissue dose)</i>	<i>Photons (skin)</i>	100 cm		
2.0E-04	10 cm 2.0E-03 1 m 1.3E-03	1.2E-05	3.4E-02	2.4E-01
	<i>Photons (deep dose)</i>			
	10 cm 1.3E-03 1 m 1.0E-03			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 4.7E-03	<table border="1"> <tr> <th colspan="2">Recommended probes*</th> </tr> <tr> <td>Alpha</td> <td>++</td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>++</td> </tr> </table>	Recommended probes*		Alpha	++	Beta		Gamma		X rays	++	Removable contamination
Recommended probes*												
Alpha		++										
Beta												
Gamma												
X rays	++											
0.05 ml droplet (1 kBq) 7.1E-05		4E-02										
		Fixed contamination										
		2E+00										

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass	< 0.1	
Plastic	0.1	
Gamma and X rays (half and tenth value thickness)		
	½	1/10
Lead	< 1	< 1
Steel	< 1	< 1

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁	Inhalation		
All compounds	5.0E-04	2.0E-07		
			1 µm	5 µm
			F	
			M	3.9E-05
			S	2.7E-05
Highest dose organ	Bone surface	20 mSv A _{LI} ingestion	1.0E+05 (Bq)	20 mSv A _{LI} inhalation
				5.1E+02 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.001	Forbidden	2E+04	Forbidden	5E+04	5E+06

Curium - 244

²⁴⁴Cm₉₆


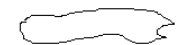
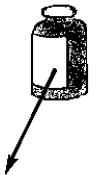


Half life: 18.1 years
 Specific activity: 3.00E+12 Bq.g⁻¹

Risk group: 1
 Risk colour: Red


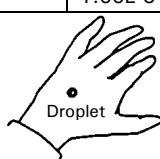
Main emissions (keV)								
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	17	11					5763	23.6
E2	43	<1					5805	76.4
E3								
% omitted		<1						<1

Exemption levels	
Quantity (Bq)	1E+04
Concentration (Bq.g ⁻¹)	1E+01

Transport (TBq)	
IAEA ST1 A ₁ value	2E+1
IAEA ST1 A ₂ value	2E-3

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i> 0.00E+0	<i>Betas, electrons (skin)</i> 10 cm 0.0E+00 1 m 0.0E+00	100 cm 2.05E-8	1.33E-5	6.37E-5
<i>Gammas, X rays (deep tissue dose)</i> 2.26E-5	<i>Photons (skin)</i> 10 cm 2.2E-04 1 m 8.6E-05			
	<i>Photons (deep dose)</i> 10 cm 4.7E-05 1 m 1.9E-05			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION												
Contamination skin dose (mSv.h⁻¹)	Detection	Derived limits (Bq.cm⁻²)										
Uniform deposit (1kBq.cm ⁻²) 2.24E-3	<table border="1"> <tr><th colspan="2">Recommended probes*</th></tr> <tr><td>Alpha</td><td>++</td></tr> <tr><td>Beta</td><td></td></tr> <tr><td>Gamma</td><td></td></tr> <tr><td>X rays</td><td>+</td></tr> </table>	Recommended probes*		Alpha	++	Beta		Gamma		X rays	+	Removable contamination
Recommended probes*												
Alpha		++										
Beta												
Gamma												
X rays	+											
0.05 ml droplet (1 kBq) 1.66E-3		4E-2										
		Fixed contamination										
		4E+0										
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique												

SHIELDING (mm)		
Betas and electrons (Total absorption)		
Glass		-
Plastic		-
Gamma and X rays (half and tenth value thickness)		
	1/2	1/10
Lead	<1	<1
Steel	1	3

INTERNAL EXPOSURE FOR WORKERS				
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)				
Ingestion	f₁	Inhalation		
All compounds	0.0005	1.2E-07	1 μm	5 μm
			F	
			M	2.5E-05
			S	1.7E-05
Highest dose organ	Bone surfaces	20 mSv A _{LI,ingestion}	1.7E+05 (Bq)	20 mSv A _{LI,inhalation}
			8.0E+02 (Bq)	

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area		Controlled area		
		Bench	Fume hood	Bench	Fume hood	Glove box
All compounds	0.001	Forbidden	2E+04	Forbidden	8E+04	8E+06

Californium - 252


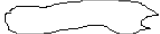



²⁵²Cf₉₈

Half life: 2.65 years
 Specific activity: 1.98E+13 Bq.g⁻¹


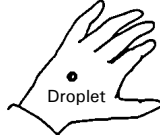
Risk group: 1
 Risk colour: Red

Main emissions (keV)					Exemption levels			
	Gamma or X		Beta (E _{max})		Electrons		Alpha	
	E	%	E	%	E	%	E	%
E1	18	7					6076	15.2
E2	43	<1					6118	81.6
E3	100	<1						
% omitted		<1						<1

Transport (TBq)	
IAEA ST1 A ₁ value	5E-2
IAEA ST1 A ₂ value	3E-3

EXTERNAL EXPOSURE (mSv.h ⁻¹) for an activity of 1 MBq or 1 MBq.m ⁻² (as appropriate)				
Point source (30 cm)	Infinite plane source	10 ml glass vial	Contact with 50 ml glass beaker	Contact with 5 ml plastic syringe
				
<i>Betas, electrons (skin dose)</i>	<i>Neutrons (deep dose)</i>			
1.5E-02	10 cm 4.2E-02	100 cm		
	1 m 5.7E-02			
	<i>Betas, electrons (skin)</i>	<i>Neutrons</i>	<i>Neutrons</i>	<i>Neutrons</i>
	10 cm 0.0E+00	1.9E-3	4.05E+0	2.03E+1
	1 m 0.0E+00			
	<i>Photons (skin)</i>			
	10 cm 1.4E-04			
<i>Gammas, X rays (deep tissue dose)</i>	1 m 5.5E-05			
1.88E-5	<i>Photons (deep dose)</i>	1.78E-8	4.66E-5	2.71E-3
	10 cm 3.9E-05			
	1 m 1.5E-05			

The values above do not include Bremsstrahlung radiation.

CONTAMINATION			SHIELDING (mm)																								
Contamination skin dose (mSv.h⁻¹)			Betas and electrons (Total absorption)																								
Uniform deposit (1kBq.cm ⁻²)	3.24E-3	<table border="1"> <thead> <tr> <th colspan="2">Detection</th> </tr> <tr> <th colspan="2">Recommended probes*</th> </tr> </thead> <tbody> <tr> <td>Alpha</td> <td>++</td> </tr> <tr> <td>Beta</td> <td></td> </tr> <tr> <td>Gamma</td> <td></td> </tr> <tr> <td>X rays</td> <td>+</td> </tr> </tbody> </table>	Detection		Recommended probes*		Alpha	++	Beta		Gamma		X rays	+	Glass -												
Detection																											
Recommended probes*																											
Alpha	++																										
Beta																											
Gamma																											
X rays	+																										
0.05 ml droplet (1 kBq)	7.08E-4	<table border="1"> <thead> <tr> <th colspan="2">Derived limits (Bq.cm⁻²)</th> </tr> <tr> <th colspan="2">Removable contamination</th> </tr> <tr> <td colspan="2">5E-2</td> </tr> <tr> <th colspan="2">Fixed contamination</th> </tr> <tr> <td colspan="2">5E+0</td> </tr> </thead> <tbody> <tr> <th colspan="3">Gamma and X rays (half and tenth value thickness)</th> </tr> <tr> <td></td> <td>1/2</td> <td>1/10</td> </tr> <tr> <td>Lead</td> <td><1</td> <td><1</td> </tr> <tr> <td>Steel</td> <td>2</td> <td>5</td> </tr> </tbody> </table>	Derived limits (Bq.cm ⁻²)		Removable contamination		5E-2		Fixed contamination		5E+0		Gamma and X rays (half and tenth value thickness)				1/2	1/10	Lead	<1	<1	Steel	2	5	Plastic -		
Derived limits (Bq.cm ⁻²)																											
Removable contamination																											
5E-2																											
Fixed contamination																											
5E+0																											
Gamma and X rays (half and tenth value thickness)																											
	1/2	1/10																									
Lead	<1	<1																									
Steel	2	5																									
																											
* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique																											

INTERNAL EXPOSURE FOR WORKERS					
COMMITTED EFFECTIVE DOSE PER UNIT INTAKE (Sv.Bq ⁻¹)					
Ingestion	f ₁		Inhalation		
All compounds	0.0005	9.0E-08			
Highest dose organ	Bone surfaces	20 mSv ALL _{ingestion}	2.2E+05 (Bq)	20 mSv ALL _{inhalation}	1.1E+03 (Bq)

MAXIMUM RECOMMENDED ACTIVITIES IN LOW LEVEL OR INTERMEDIATE LEVEL LABORATORIES (Bq)						
PHYSICOCHEMICAL STATE	Subject to external exposure requirements which may be more restrictive					
	Volatility factor (k)	Supervised area			Controlled area	
		Bench	Fume hood		Bench	Fume hood
All compounds	0.001	3E+03	3E+04	1E+04	1E+05	1E+07

APPENDIX – HEAVY ELEMENT DECAY

Pb-210 decay

Pb-210 to Po-210 (see pages 13 and 141)

Nuclide	Half-life	0.1 day	1 day	10 days	100 days	1 year	10 years	100 years
Pb-210	2.22E+1 yr	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Bi-210	5.01E+0 d	1.37E-02	1.29E-01	7.48E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Po-210	1.38E+2 d	3.44E-06	3.30E-04	2.52E-02	3.69E-01	8.43E-01	1.02E+00	1.02E+00

Ra-226 decay

Ra-226 to Po-210 (see pages 13 and 147)

Nuclide	Half-life	0.1 day	1 day	10 days	100 days	1 year	10 years	100 years
Ra-226	1.60E+3 yr	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Rn-222	3.82E+0 d	1.80E-03	1.65E-01	8.40E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Po-218	3.05E+0 min	1.74E-02	1.65E-01	8.40E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pb-214	2.68E+1 min	1.27E-02	1.61E-01	8.30E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Bi-214	1.99E+1 min	9.46E-03	1.58E-01	8.30E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Po-214	1.64E-4 sec	9.46E-03	1.58E-01	8.30E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pb-210	2.22E+1 yr	2.70E-08	6.60E-06	4.55E-04	8.01E-03	3.01E-02	2.66E-01	9.73E-01
Bi-210	5.01E+0 d	8.90E-11	2.84E-07	1.69E-04	7.40E-03	2.95E-02	2.66E-01	9.73E-01
Po-210	1.38E+2 d	8.40E-15	3.44E-10	2.40E-06	1.41E-03	1.57E-02	2.53E-01	9.73E-01

U-235 decay

U-235 to Po-211 (see pages 13 and 154)

Nuclide	Half-life	0.1 day	1 day	10 days	100 days	1 year	10 years	100 years
U-235	7.04E+8 yr	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Th-231	2.55E+1 hr	6.31E-02	4.78E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pa-231	3.28E+4 yr	1.84E-10	1.53E-08	4.90E-07	5.70E-06	2.10E-05	2.11E-04	2.11E-03
Ac-227	2.18E+1 yr	<E-10	<E-10	1.90E-10	2.44E-08	3.30E-07	3.03E-05	1.48E-03
Fr-223	2.18E+1 min	<E-10	<E-10	<E-10	3.36E-10	4.55E-09	4.18E-07	2.04E-05
Ra-223	1.14E+1 d	<E-10	<E-10	<E-10	2.42E-10	4.17E-09	4.15E-07	2.04E-05
Rn-219	3.96E+0 sec	<E-10	<E-10	<E-10	2.42E-10	4.17E-09	4.15E-07	2.04E-05
Po-215	1.78E-3 sec	<E-10	<E-10	<E-10	2.42E-10	4.17E-09	4.15E-07	2.04E-05
Pb-211	3.61E+1 min	<E-10	<E-10	<E-10	2.42E-10	4.17E-09	4.15E-07	2.04E-05
Bi-211	2.13E+0 min	<E-10	<E-10	<E-10	2.42E-10	4.17E-09	4.15E-07	2.04E-05
Tl-207	4.77E+0 min	<E-10	<E-10	<E-10	2.42E-10	4.15E-09	4.14E-07	2.03E-08
Po-211	5.16E-1 sec	<E-10	<E-10	<E-10	<E-10	<E-10	1.13E-09	5.6E-08
Th-227	1.87E+1 d	<E-10	<E-10	<E-10	1.44E-08	2.81E-07	2.95E-05	1.45E-03
Ra-223	1.14E+1 d	<E-10	<E-10	<E-10	9.76E-09	2.55E-07	2.93E-05	1.45E-03
Rn-219	3.96E+0 sec	<E-10	<E-10	<E-10	9.76E-09	2.55E-07	2.93E-05	1.45E-03
Po-215	1.78E-3 sec	<E-10	<E-10	<E-10	9.76E-09	2.55E-07	2.93E-05	1.45E-03
Pb-211	3.61E+1 min	<E-10	<E-10	<E-10	9.75E-09	2.55E-07	2.93E-05	1.45E-03
Bi-211	2.13E+0 min	<E-10	<E-10	<E-10	9.75E-09	2.55E-07	2.93E-05	1.45E-03
Tl-207	4.77E+0 min	<E-10	<E-10	<E-10	9.72E-09	2.55E-07	2.92E-05	1.45E-03
Po-211	5.16E-1 sec	<E-10	<E-10	<E-10	<E-10	6.97E-10	7.99E-08	3.97E-06

U-238 decay

U-238 to Po-210 (see pages 13 and 155)

Nuclide	Half-life	0.1 day	1 day	10 days	100 days	1 year	10 years	100 years
U-238	4.47E+9 yr	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Th-234	2.41E+1 d	2.87E-03	2.83E-02	2.50E-01	9.44E-01	1.00E+00	1.00E+00	1.00E+00
Pa-234m	1.17E+0 min	2.83E-03	2.83E-02	2.50E-01	9.44E-01	1.00E+00	1.00E+00	1.00E+00
Pa-234	6.70E+0 hr	5.14E-07	2.87E-05	3.86E-04	1.50E-03	1.60E-03	1.60E-03	1.60E-03
U-234	2.44E+5 yr	<E-10	<E-10	<E-10	8.30E-10	4.10E-09	4.49E-08	4.3E-07
Th-230	7.7E+4 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	2.0E-10
Ra-226	1.60E+3 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Rn-222	3.82E+0 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Po-218	3.05E+0 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Pb-214	2.68E+1 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Bi-214	1.99E+1 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Po-214	1.64E-4 sec	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Pb-210	2.23E+1 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Bi-210	5.0E+0 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Po-210	1.38E+2 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
U-234	2.44E+5 yr	<E-10	1.01E-08	1.01E-18	5.21E-07	2.56E-06	2.80E-05	2.83E-04
Th-230	7.7E+4 yr	<E-10	<E-10	<E-10	<E-10	<E-10	1.25E-09	1.27E-07
Ra-226	1.60E+3 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	2.27E-10
Rn-222	3.82E+0 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	1.81E-09
Po-218	3.05E+0 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	1.81E-09
Pb-214	2.68E+1 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	1.81E-09
Bi-214	1.99E+1 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	1.81E-09
Po-214	1.64E-4 sec	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	1.81E-09
Pb-210	2.23E+1 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	8.44E-10
Bi-210	5.01E+0 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	8.44E-10
Po-210	1.38E+2 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	8.28E-10

Pu-241 decay

Pu-241 to Pb-209 (see pages 13 and 160)

Nuclide	Half-life	0.1 day	1 day	10 days	100 days	1 year	10 years	100 years
Pu-241	1.44E+1 yr	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Am-241	4.32E+2 yr	4.39E-07	4.39E-06	4.39E-05	4.48E-04	1.64E-03	2.04E-02	3.58E+00
Np-237	2.14E+6 yr	<E-10	<E-10	<E-10	<E-10	2.69E-10	3.58E-08	9.85E-05
Pa-233	2.70E+1 d	<E-10	<E-10	<E-10	<E-10	2.17E-10	3.51E-08	9.85E-05
U-233	1.59E+5 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	1.85E-08
Th-229	7.34E+3 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Ra-225	1.48E+1 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Ac-225	1.00E+1 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Fr-221	4.8E+0 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
At-217	3.23E-2 sec	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Bi-213	4.56E+1 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Tl-209	2.20 E+0 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Pb-209	3.24E+0 hr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Po-213	4.20E-6 sec	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Pb-209	3.25E+0 hr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
U-237	6.75E+6	2.50E-07	2.39E-06	1.57E-05	2.48E-05	2.46E-05	2.45E-05	2.45E-05
Np-237	2.14E+6 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	2.00E-08
Pa-233	2.70E+1 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	2.00E-08
U-233	1.59E+5 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Th-229	7.34E+3 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Ra-225	1.48E+1 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10

Continued

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Pu-241 decay (Continued)

Ac-225	1.00E+1 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Fr-221	4.8E+0 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
At-217	3.23E-2 sec	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Bi-213	4.56E+1 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Tl-209	2.20 E+0 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Pb-209	3.24E+0 hr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Po-213	4.20E-6 sec	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Pb-209	3.25E+0 hr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10

Am-243 decay

Am-243 to Po-211 (see pages 13 and 162)

Nuclide	Half-life	0.1 day	1 day	10 days	100 days	1 year	10 years	100 years
Am-243	7.38E+3 yr	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Np-239	2.35E+0 d	2.90E-02	2.55E-01	9.47E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pu-239	2.41E+4 yr	1.14E-10	1.05E-08	5.33E-07	7.60E-06	2.84E-05	2.87E-04	2.88E-03
U-235	7.04E+8 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	1.42E-10
Th-231	2.55E+1 hr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	1.42E-10
Pa-231	3.28E+4 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Ac-227	2.18E+1 yr	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Fr-223	2.18E+1 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Ra-223	1.14E+1 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Rn-219	3.96E+0 sec	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Po-215	1.78E-3 sec	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Pb-211	3.61E+1 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Bi-211	2.13E+0 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Tl-207	4.77E+0 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Po-211	5.16E-1 sec	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Th-227	1.87E+1 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Ra-223	1.14E+1 d	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Rn-219	3.96E+0 sec	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Po-215	1.78E-3 sec	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Pb-211	3.61E+1 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Bi-211	2.13E+0 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Tl-207	4.77E+0 min	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10
Po-211	5.16E-1 sec	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10	<E-10

Note:

The above tables for U-235, U-238, Pu-241 and Am-243 should be read in conjunction with the corresponding decay chains shown overleaf. These chains clearly show the branching in the decay chains, clarifying the lines apparently repeated in the tables.

REFERENCE

1. RadDecay for Windows Version 1.13. Grove Engineering (Maryland) 1996.

