Radiological Protection Ordinance
(RPO)

of 22 June 1994 (Status as of 1 January 2014)

The Swiss Federal Council,

on the basis of Article 47 paragraph 1 of the Radiological Protection Act (RPA) of 22 March 1991[1],

ordains:

Chapter 1
General Provisions and Principles of Radiological Protection

Art. 1 Scope

[1] This Ordinance applies to substances, articles and waste whose activity, concentration, contamination, dose rate or mass exceeds the values given in Annex 2.

[2] The Ordinance also applies to:

a. ionising radiation generators;

b. equipment and installations capable of emitting stray ionising radiation in cases where the ambient dose rate at 10 cm from the surface, determined in accordance with Annex 5, is greater than 1 microsievert (μSv) per hour;

c.[2] …

[3] For the implementation of radiological protection regulations, the values given in Annex 3 are applicable.

Art. 2 Exemptions

[1] This Ordinance does not apply to the handling of raw materials of natural origin and nuclide composition that are not mentioned in Annex 2 and give rise to a dose of less than 1 mSv per year.[3]

AS **1994** 1947

1 SR **814.50**

2 Repealed by No I of the Ordinance of 17 Nov. 1999, with effect from 1 Jan. 2000 (AS **2000** 107).

3 Amended by No I of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107).

2 This Ordinance does not apply to substances with a specific activity below the exemption limit specified in Annex 3 Column 9 and a local dose rate at 10 cm from the surface, after subtraction of background radiation, of more than 0.1 μSv per hour, if it has been demonstrated to the supervisory authority that at no time will anyone accumulate an effective dose of more than 10 μSv per year.

3 Articles 125–127, 133 and 134 do not apply to activities requiring a licence under the Nuclear Energy Act of 21 March 2003[4].[5]

Art. 3 Mixtures

1 Mixtures of radioactive substances with inactive materials that are intended solely to circumvent this Ordinance are not permissible.

2 Subject to the provisions of Article 82, the supervisory authority may allow substances defined in Article 2 paragraph 2 to be mixed with inactive materials for recycling purposes, provided that the evidence required by that provision can be furnished.

Art. 4 Definitions

For the purposes of this Ordinance, the definitions given in Annex 1 are applicable.

Art. 5 Justification

1 An activity is justified within the meaning of Article 8 of the Radiological Protection Act (RPA) if the associated benefits clearly outweigh the radiation-related drawbacks and no alternative not involving radiation exposure is available which would be more favourable overall for humans and the environment.

2 Activities involving ionising radiation that give rise to an effective dose of less than 10 μSv per year for the persons concerned are deemed to be justified in any event.

Art. 6 Optimization

1 In the case of justified activities, radiological protection is deemed to be optimised if:

a. the various appropriate options have been assessed and compared in terms of radiological protection;

b. it is possible to trace the steps in the decision-making process leading to the solution adopted;

c.[6] the possibility of abnormal occurrences and the disposal of radiation sources have been taken into account.

4 SR **732.1**

5 Amended by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).

6 Amended by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).

2 The supervisory authority (Art. 136) may specify guidance values for optimisation on a case-by-case basis.

3 The principle of optimisation is deemed to be satisfied where activities do not lead in any cases to an effective dose of more than 100 μSv per year for occupationally exposed persons and more than 10 μSv per year for non-occupationally exposed persons.

Art. 7[7] Source-related dose guidance value

1 The source-related dose guidance value must not be higher than the dose limit specified in Article 37.

2 The licensing authority (Art. 127) shall decide for which enterprises a source-related dose guidance value is required and shall specify the value.

3 The source-related dose guidance value shall be specified in accordance with the principle of optimisation, with discharges of radioactive substances and direct radiation from other enterprises also being taken into account.

Art. 8 Research

1 The supervisory authorities may commission research projects concerning the effects of radiation and radiological protection, or participate in such projects.

2 The Paul Scherrer Institute (PSI) and other federal institutions shall place themselves as far as possible at the disposal of the supervisory authorities to carry out research projects concerning the effects of radiation and radiological protection.

3 The supervisory authorities shall consult each other before awarding a research contract.

Art. 9[8] Federal Commission for Radiological Protection[9]

1 The Federal Commission for Radiological Protection is a body providing advice on matters of radiological protection to the Federal Council, the Federal Department of Home Affairs (FDHA), the Federal Department of the Environment, Transport, Energy and Communications (DETEC), the Federal Department of Defence, Civil Protection and Sport (DDPS), interested public offices and the Swiss Accident Insurance Fund (Suva).

2 It has the following duties:

a. It shall regularly inform the public about the radiological protection situation in Switzerland.

7 Amended by No I of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107).

8 Amended by No I 2.7 of the Ordinance of 9 Nov. 2011 (Review of the Extra-Parliamentary Commissions), in force since 1 Jan. 2012 (AS **2011** 5227).

9 The name of this administrativ unit was amended by Art. 16 para. 3 of the Publications Ordinace of 17 Nov. 2004 (SR **170.512.1**), in force since 1 Jan. 2015. This amendment has been made throughout the text.

b. It provides advice on the following matters in particular:
   1. the interpretation and appraisal of international recommendations in the field of radiological protection with regard to their application in Switzerland;
   2. the elaboration and development of harmonised principles for the application of radiological protection regulations;
   3. environmental radioactivity, the results of monitoring, their interpretation and the resultant radiation doses for the public.

3 It is composed of experts from academia and industry.

4 The Federal Council shall appoint its president, vice-president and other members based on proposals submitted by the FDHA.

5 The CPR may submit proposals for replacement and new members to the FDHA.

6 Administratively, it shall be attached to the Federal Office of Public Health (FOPH).

7 It shall work with the Federal Commission for NBC Protection (ComNBC), the Swiss Federal Nuclear Safety Commission (NSC) and the Emergency Organisation for Radioactivity (EOR). In doing so, it shall give particular consideration to joint tasks in the field of radiological protection.

8 The CPR and its committees may engage external experts for the examination of special issues. The CPR may issue assignments to its members or to external experts.

Chapter 2
Qualifications, Experts, Training and Continuing Education

Section 1 Principle

Art. 10

1 Persons handling ionising radiation must undergo radiological protection training and continuing education in line with their activities and responsibility.

2 The training must ensure that such persons:

a. are familiar with the basic rules of radiological protection;

b. learn appropriate working methods;

c. can apply the radiological protection regulations relevant to the activity concerned;

d. are aware of the risks of radiation exposure which may arise from malpractice;

e. are aware of the health risks involved in working with ionising radiation.

Section 2 Qualifications for Medical Applications

Art. 11[10] Diagnostic applications

1 The following shall be regarded as evidence that a person is duly qualified:

a. for diagnostic applications of ionising radiation generators (radiation generators) and sealed radioactive sources, a Swiss medical degree or a foreign medical degree recognised as equivalent;

b. for diagnostic applications of radiation generators for chiropractic purposes, FOPH-recognised training, including an examination, in radiology and radiological protection.

2 For high-dose diagnostic procedures as specified in paragraph 1 letter a, evidence must also be furnished of a relevant Swiss specialist title, a foreign specialist title recognised as equivalent, or equivalent specialist training in the relevant diagnostic method.

3 The following shall be regarded as evidence that a person is duly qualified for diagnostic applications of radiation generators for dental purposes:

a. a Swiss dental degree or a foreign dental degree recognised as equivalent; or

b. a successfully completed examination as a cantonally certified dentist.

4 For persons serving as experts, the above provisions are without prejudice to Article 18.

Art. 12[11] Therapeutic applications

1 The following shall be regarded as evidence that a person is duly qualified for therapeutic applications of radiation generators and sealed radioactive sources:

a. a Swiss medical degree or a foreign medical degree recognised as equivalent;

b. a relevant Swiss specialist title, a foreign specialist title recognised as equivalent, or equivalent specialist training in the relevant therapeutic method;

c. appropriate practical hospital training; and

d. FOPH-recognised training in radiological protection.

2 If the content of the training specified in paragraph 1 Letters c and d is already covered by the specialist training specified in paragraph 1 letter b, the FOPH may exempt physicians from additional training requirements.

10 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

11 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

Art. 13[12] Diagnosis and therapy with unsealed radioactive sources

[1] The following shall be regarded as evidence that a person is duly qualified for the application of unsealed radioactive sources:

a. a Swiss medical degree or a foreign medical degree recognised as equivalent;

b. a relevant Swiss specialist title, a foreign specialist title recognised as equivalent, or equivalent specialist training in the relevant diagnostic and therapeutic method;

c. appropriate practical hospital training; and

d. FOPH-recognised training in radiological protection for the medical application of radionuclides.

[2] If the content of the training specified in paragraph 1 Letters c and d is already covered by the specialist training specified in paragraph 1 letter b, the FOPH may exempt physicians from additional training requirements.

Art. 14 Veterinary surgeons

[1] A Swiss veterinary degree or a foreign veterinary degree recognised as equivalent shall be regarded as evidence that a person is duly qualified for veterinary applications of ionising radiation.[13]

[2] For persons serving as experts, the above is without prejudice to Article 18.

Art. 15[14] Medical personnel

[1] For the following occupational groups, FOPH-recognised training, including a final examination, in radiological protection shall be regarded as evidence that a person is duly qualified:

a. medical radiation technologists (MTRA);

b. medical practice assistants, dental assistants and dental hygienists;

c. veterinary practice assistants;

d. other medical personnel who are involved in medical radiography or have radiological protection responsibilities vis-à-vis other people.

[2] If training as specified in paragraph 1 is already provided as part of training under the Vocational Training Act of 13 December 2002[15], the appropriate certificate or a foreign certificate recognised as equivalent shall be regarded as evidence that a person is duly qualified.

12 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
13 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
14 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
15 SR **412.10**

Section 3 Qualifications for other Applications

Art. 16 Requirements for qualifications

1 For persons in research, teaching, medical analysis, industry, nuclear facilities, transport and trade who have radiological protection responsibilities vis-à-vis other people, radiological protection training, including an examination, recognised by the supervisory authority shall be regarded as evidence that they are duly qualified.

2 If the risk involved in an activity is low, the supervisory authority may in individual cases waive the examination requirement.

Art. 17 Qualifications for service in emergency organizations

1 Persons belonging to an emergency organisation, such as the police, fire brigade, civil protection, emergency management teams or medical services, who have radiological protection responsibilities in the event of a radiological emergency must be trained in line with their function and activities.

2 Training shall be coordinated by the Federal Office for Civil Protection.[16]

Section 4 Experts

Art. 18

1 Experts as specified in Article 16 RPA must demonstrably have undergone training in radiological protection, including an examination, which is appropriate to their activities and responsibilities and recognised by the supervisory authority, and have a knowledge of radiological protection legislation.

2 Physicians, veterinary surgeons and chiropractors who have been trained as specified in Articles 11–14 and who serve as experts must have undergone FOPH-recognised training, including a final examination, in radiological protection and medical applications of ionising radiation.[17]

3 If the content of the training specified in paragraph 1 or 2 is already covered by the training or specialist training specified in Articles 11–16, the supervisory authority may exempt the person concerned from additional training requirements.[18]

4 If the risk involved in an activity is low, the supervisory authority may in individual cases waive the examination requirement.

5 Dentists and cantonally certified dentists who have been trained as specified in Article 11 paragraph 3 shall be regarded as experts in their field of activity.[19]

16 Amended by Art. 10 No 2 of the Ordinance of 18 June 2008 on the Federal Commission for NBC Protection, in force since 15 July 2008 (AS **2008** 3153).
17 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
18 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

Section 5
Training and Continuing Education Courses; Financial Assistance

Art. 19 Training and continuing education courses

1 The supervisory authorities and the PSI shall organise radiological protection courses as required.

2 Within the scope of their responsibilities, the FDHA and DETEC may request other agencies or institutions to organise radiological protection courses.[20]

Art. 19*a*[21] Training and continuing education registry

1 The licensing authority may maintain a registry of persons who have completed training and continuing education courses to attain expertise in the area for which a licence is granted.

2 The purpose of the registry is to simplify the administrative procedures required for the granting of licences.

3 The following data shall be stored in the registry:

a. name, first name, maiden name;

b. date of birth;

c. occupational training;

d. type, provider and date of radiological protection courses;

e. date of recognition of equivalence in the case of training undergone abroad.

4 All entries relating to a person shall be deleted from the registry after 80 years, calculated from the date of birth.

5 The data specified in paragraph 3 on persons who have successfully completed training and continuing education courses shall be transmitted by the recognised training institutions to the competent licensing authority.

Art. 20 Financial assistance for third-party training and continuing education courses

1 Within the limits of their approved budgets, the FOPH or the Swiss Federal Nuclear Safety Inspectorate (ENSI) may provide financial assistance for training or continuing education courses in radiological protection organised by third parties (colleges, professional organisations).[22]

19 Inserted by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
20 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
21 Inserted by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
22 Amended by Annex No 22 of the Ordinance of 12 Nov. 2008 on the Swiss Federal Nuclear Safety Inspectorate, in force since 1 Jan. 2009 (AS **2008** 5747).

2 Financial assistance shall only be provided if the training has been recognised by the supervisory authority.

3 Financial assistance shall be calculated so that, taken together with other revenues, it does not exceed the course organiser's documented costs.

Section 6
Delegation to the FDHA and DETEC; Recognition of Training undergone abroad

Art. 21

1 Within the scope of their responsibilities, the FDHA and DETEC shall define:

a. the requirements for recognition of training or a course specified in Articles 11, 12, 13, 15, 16 and 18;

b. the conditions for service in emergency organisations as specified in Article 17.

2 They may define the content of examinations and the examination procedure.

3 They shall define the activities that qualified persons are entitled to perform.

Art. 22[23] Recognition of training undergone abroad

The supervisory authority shall recognise radiological protection training, as specified in Articles 11–16 and 18, which is undergone abroad.

Chapter 3 Medical Applications
Section 1 Principles

Art. 23 Patient information and consent

Where radiation is to be used for diagnostic or therapeutic applications, patient information and consent shall be governed by the relevant federal regulations concerning the protection of life, limb and personality and by the provisions of cantonal health law.

Art. 24 Protection of the patient

The licence holder must ensure that, for every medical radiation generator, the elements required to protect the patient are in place and are used.

23 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

Art. 25 Record-keeping

The licence holder must record therapeutic, high-dose or interventional diagnostic procedures in such a way that the radiation dose received by the patient can also be determined at a later date.

Art. 26 Fluoroscopy

1 Fluoroscopy may only be performed by a physician; for radiation field verification in radiotherapy, fluoroscopy may also be performed by a MTRA under the direction of a physician.

2 For this purpose, only systems with an image intensifier and automatic dose rate control may be used.

3 It is not permissible to perform fluoroscopic examinations for fitness tests and in particular for pre-enrolment insurance assessments.

Section 2 Special Examinations

Art. 27 Radiological screening

1 Radiological screening may only be carried out if it is justified on medical and epidemiological grounds.

2 It is not permissible to use fluoroscopy or photofluorography for screening purposes.

Art. 28[24] Physiological studies involving radioactive sources

1 The conduct of research projects involving radiation sources requires authorisation from the responsible ethics committee in accordance with Article 45 paragraph 1 letter a of the Human Research Act of 30 September 2011[25], and from the Swiss Agency for Therapeutic Products in accordance with Article 54 paragraphs 1 and 2 of the Therapeutic Products Act of 15 December 2000[26].

2 In the calculation or estimation of the dose, all radiation sources to which the persons concerned are exposed must be taken into account. The uncertainty factor is to be taken into account in the final result.

3 In research projects where no direct benefit is expected for the participants, the effective dose must not exceed the limit of 5 mSv per person per year.

4 In exceptional cases, for research projects where no direct benefit is expected for the participants, the limit may be up to 20 mSv per person per year, with consideration being given to age, fertility, life expectancy or health status, provided that this is absolutely essential for methodological reasons.

24 Amended by Annex 6 No 3 of the Ordinance of 20 Sept. 2013 on Clinical Trials, in force since 1 Jan. 2014 (AS **2013** 3407).
25 SR **810.30**
26 SR **812.21**

5 Persons who have already participated in a research project involving radiation sources where no direct benefit is expected and were exposed to an effective dose of more than 5 mSv per year must not be included in any further research projects in the following 12 months.

Section 3 Special Provisions for Radiopharmaceuticals[27]

Art. 29[28]

Art. 30[29] Placing on the market and use of radiopharmaceuticals

1 Radiopharmaceuticals may only be placed on the market or used in humans if they meet the requirements of the HMG[30]. Approval is required from the FOPH for:

a. the registration of radiopharmaceuticals under Article 9 paragraph 1 HMG;

b. the simplified registration of radiopharmaceuticals under Article 14 HMG;

c. the licensing of radiopharmaceuticals for a limited period under Article 9 paragraph 4 HMG.

2 The FOPH shall grant approval if the quality controls for the radiopharmaceutical are carried out in accordance with the current state of science and technology.

3 Radiopharmaceuticals must be labelled as such and include at least the following information:

a. the product name;

b. the hazard warning symbol in accordance with Annex 6;

c. the radionuclides, their chemical form and activity, as well as other radionuclides present and their activity on a particular date;

d. other chemical forms of the radionuclides present;

e. non-radioactive substances contained as additives;

f. earliest and latest dates for use (expiry date).

Art. 31 Quality control

1 Anyone who produces radiopharmaceuticals or uses them in humans must regularly carry out quality controls.

27 Repealed by Annex 6 No 3 of the Ordinance of 20 Sept. 2013 on Clinical Trials, with effect from 1 Jan. 2014 (AS **2013** 3407).
28 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
29 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
30 SR **812.21**

2 The FOPH may take samples of radiopharmaceuticals at any time in order to determine whether the requirements specified in Article 30 are still met.[31] For this purpose, it may engage specialist laboratories.

Art. 31*a*[32] Preparation and synthesis of radiopharmaceuticals

1 The preparation and synthesis of finished radiopharmaceutical products must comply with the cGRPP[33] Guidelines issued in March 2007 by the EANM[34].

2 The preparation and synthesis of radiopharmaceuticals with increased hazard potential must be carried out under the direction of a person responsible for technical matters who fulfils the professional requirements specified in Article 5 paragraph 4 letter d of the Ordinance of 17 October 2001[35] on Establishment Licences or has completed equivalent training. Radiotherapeutic products from radiolabelling kits registered in Switzerland may be prepared under the direction of a person who, while not fulfilling these requirements himself/herself, has been instructed and is supervised by a person responsible for technical matters.

Art. 32[36] Expert Commission for Radiopharmaceuticals

1 The Expert Commission for Radiopharmaceuticals (ECRP) shall advise Swissmedic and the FOPH on radiopharmaceutical matters. It shall prepare expert reports on:

a. applications for the authorisation of radiopharmaceuticals;

b. safety-related questions connected with radiopharmaceuticals.

2 The ECRP is comprised of specialists from the fields of nuclear medicine, pharmaceutics, chemistry and radiological protection.

3 The Federal Council shall appoint its president, vice-president and other members based on proposals submitted by the FDHA.

4 The FOPH und Swissmedic may submit proposals for replacement and new members to the FDHA.

31 Amended by No II 7 of the Ordinance of 17 Oct. 2001, in force since 1 Jan. 2002 (AS **2001** 3294).
32 Inserted by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
33 Guidelines on Current Good Radiopharmacy Practice (cGRPP) in the Preparation of Radiopharmaceuticals, version 2, March 2007.
34 European Association of Nuclear Medicine
The EANM Guidelines referred to in this Ordinance can be obtained from the Federal Office of Public Health, Radiological Protection Division, CH-3003 Bern, or downloaded from the EANM website (www.eanm.org).
35 SR **812.212.1**
36 Amended by No I 2.7 of the Ordinance of 9 Nov. 2011 (Review of the Extra-Parliamentary Commissions), in force since 1 Jan. 2012 (AS **2011** 5227).

Chapter 4 Protection of Exposed Persons
Section 1 Dose Limitation

Art. 33 Occupationally exposed persons

1 The licence holder shall designate all occupationally exposed persons within the enterprise and inform them of their special status as occupationally exposed persons.

2 In particular, the licence holder shall inform them of:

a. the radiation doses to be expected in the course of their work;

b. the dose limits applicable for them.

3 The licence holder must not employ persons under 16 years of age as occupationally exposed persons.

Art. 34 Dose limits

1 The dose limits specified in Articles 35–37 apply to the dose from controllable radiation exposure accumulated in a calendar year.

2 They are not applicable for:

a. exposures of patients for diagnostic or therapeutic purposes;

b. exposures in exceptional situations as specified in Article 20 RPA;

c. exposures to natural radiation from a source that is not amenable to control;

d. the exposure of persons helping to support and care for patients in a non-occupational capacity.

3 For the calculation of dose limits, exposures due to natural radiation or to any medical measures shall not be taken into account, subject to the consideration of radon exposure as specified in Article 110 paragraph 3.

Art. 35 Dose limit for occupationally exposed persons

1 For occupationally exposed persons, the effective dose must not exceed the limit of 20 mSv per year, subject to the provisions of Article 36.

2 For occupationally exposed persons carrying out important tasks, the dose limit by way of exception and with an authorisation granted by the supervisory authority shall be up to 50 mSv per year, provided that the cumulative dose for the last five years including the current year is less than 100 mSv.

3 For occupationally exposed persons, the equivalent dose must not exceed the following limits:

a. for the lens of the eye, 150 mSv per year;

b. for the skin, hands and feet, 500 mSv per year.

Art. 36 Protection of young people and women

1 For occupationally exposed persons aged 16–18 years, the effective dose must not exceed the limit of 5 mSv per year.

2 For occupationally exposed women, from the time when the pregnancy becomes known until the end of the pregnancy, the equivalent dose to the surface of the abdomen must not exceed 2 mSv and the effective dose from internal exposure must not exceed 1 mSv.

3 Breast-feeding women must not perform any work with radioactive substances involving a risk of intake or radioactive contamination.

Art. 37 Dose limit for non-occupationally exposed persons

For non-occupationally exposed persons, the effective dose must not exceed the limit of 1 mSv per year.

Art. 37*a*[37] Diagnostic reference levels

1 The FOPH shall issue recommendations on radiation doses for diagnostic procedures in the form of diagnostic reference levels. In doing so, it shall take into account data from national surveys and international recommendations.

2 In the case of high-dose procedures, the person who is qualified as specified in Article 11 must record the relevant dose or activity levels in the patient's file and regularly compare these with the associated reference level. A justification is to be given if reference levels are exceeded.

3 In the case of high-dose diagnostic radiological procedures, at the request of the FOPH, data on the following is to be recorded for a month and made available to the FOPH:

a. time and type of examination;

b. radiation dose or activity levels;

c. equipment specifications;

d. age and sex of patients.

Art. 38 Measures to be taken if dose limits are exceeded

1 Anyone who suspects or observes that a dose limit has been exceeded must notify the supervisory authority immediately.

2 The licence holder must initiate an investigation as specified in Article 99.

3 The supervisory authority shall adopt the necessary measures.

4 If the dose limit for occupationally exposed persons is exceeded, the person concerned may accumulate an effective dose of no more than 1 mSv during the rest of

37 Inserted by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

the year, subject to the granting of an authorisation by the supervisory authority in accordance with Article 35 paragraph 2.

Art. 39 Medical surveillance in the event of dose limits being exceeded

1 Any person who, in the course of a year, has received an effective dose of more than 250 mSv, an equivalent dose to the skin or bone surface of more than 2500 mSv, or an equivalent dose to any other organ of more than 1000 mSv is to be placed under medical surveillance.

2 The physician shall inform the person concerned and the supervisory authority of the results of the investigation and propose measures to be adopted. If the person concerned is an employee, the physician shall notify Suva[38].

3 The physician shall disclose to the supervisory authority:

a. data concerning any early effects detected;

b. data concerning illnesses or special predispositions making it necessary to declare the person unfit for radiation work;

c. biological dosimetry data.

4 The supervisory authority shall retain this data for as long as the person concerned remains occupationally exposed.

5 The supervisory authority shall take the necessary measures in the case of persons who are not in employment. It may order a temporary or permanent exclusion from work.

Art. 40 Exceptional radiation exposures

1 The dose limits specified in Articles 35–37 may be exceeded in efforts to manage abnormal occurrences in accordance with Article 97, if this is necessary to protect the public and in particular to save human lives.

2 For persons with special obligations under Article 120, the values specified in Article 121 paragraph 1 are applicable.

Art. 41 Flight personnel

1 On commencing flight duties, jet aircraft personnel are to be informed by the operator of the exposure occurring in the course of their work.

2 Pregnant women may request exemption from flight duties.

38 Designation in accordance with No I of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107). This amendment has been applied throughout the text.

Section 2 Determination of Radiation Doses (Dosimetry)

Art. 42 Dosimetry in occupationally exposed persons

1 In occupationally exposed persons, exposure to radiation is to be determined individually in accordance with Annex 5 (personal dosimetry).

2 External exposure is to be determined every month.

3 The supervisory authority shall define on a case-by-case basis how and at what intervals internal exposure is to be determined. In doing so, it shall take into account the working conditions and the type of radionuclides used.

4 The supervisory authority may request the use of a second, independent dosimetry system fulfilling an additional function.

5 The supervisory authority may grant exemptions from paragraphs 1 and 2 in cases where an additional or another appropriate dose monitoring system is available.

Art. 43 Duties of the licence holder

1 The licence holder must have the exposure of all the occupationally exposed persons working in the enterprise determined by an approved personal dosimetry laboratory. The licence holder may also carry out screening measurements in-house to detect internal exposure.

2 The licence holder must inform these persons of the results of dosimetry.

3 The licence holder must bear the costs of dosimetry.

4 The licence holder must provide Suva with the operational, personal and dosimetry data required for preventive occupational medicine.

Art. 44 Dosimetry in non-occupationally exposed persons[39]

1 Exposure of non-occupationally exposed persons shall be determined via monitoring of the off-site limits specified in Article 102 or by modelling. In isolated cases, exposure may also be determined individually.

2 For non-occupationally exposed persons within an enterprise, the supervisory authority shall define the method for determining exposure on a case-by-case basis.

3 Exposure is to be determined in accordance with Annexes 3, 4, 5 and 7.[40]

39 Amended by No I of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107).

40 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

Section 3 Personal Dosimetry Laboratories

Art. 45 Approval and requirements

1 Anyone wishing to operate a personal dosimetry laboratory must obtain official approval.

2 Approval shall be granted if the following requirements are met:

a. The manager responsible for the personal dosimetry laboratory must have been trained as an expert in radiological protection, have a degree in a scientific or technical discipline from a university or university of applied sciences, and have a practical knowledge of the measurement technique concerned.

b. The personal dosimetry laboratory must be located in Switzerland and have an appropriate organisation with a sufficient number of adequately trained staff.

c. The measurement system must be in line with the current state of technology and be linked to national or international standards (traceability[41]).

3 If a personal dosimetry laboratory is accredited for this activity, it shall be assumed that the requirements specified in paragraph 2 are met.

Art. 46 Approval procedure and term

1 The competent authority shall determine, by means of an inspection and a technical review, whether the requirements for approval are met. It may engage third parties for this purpose.

2 Traceability in accordance with Article 45 paragraph 2 letter c shall be defined on a case-by-case basis by the Swiss Federal Institute of Metrology (METAS) and verified by a body recognised by METAS.[42]

3 Approval shall be valid for five years.

Art. 47 Competent authorities

1 The following authorities are responsible for approval:

a. the FOPH, in cases where a personal dosimetry laboratory wishes to operate wholly or largely within the area supervised by the FOPH or Suva;

b.[43] the ENSI, in cases where a personal dosimetry laboratory wishes to operate wholly or largely within the area supervised by this authority.

41 Designation in accordance with No I of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107). This amendment has been applied throughout the text.

42 Amended by No I 5 of the Ordinance of 7 Dez. 2012 (New Legal Basis for Metrology), in force since 1 Jan. 2013 (AS **2012** 7065).

43 Amended by Annex No 22 of the Ordinance of 12 Nov. 2008 on the Swiss Federal Nuclear Safety Inspectorate, in force since 1 Jan. 2009 (AS **2008** 5747).

2 In cases where a personal dosimetry laboratory wishes to operate in various areas, the competent authorities shall jointly decide which of them is to be responsible for approval.

3 The competent authorities must not operate any personal dosimetry laboratories themselves.

Art. 48 Information to be notified by the licence holder

The licence holder must notify to the appointed personal dosimetry laboratory the personal details (name, first name, maiden name, date of birth, social insurance [AHV] number, sex) of the occupationally exposed persons working in the enterprise and the data relating to the enterprise (name and address).

Art. 49 Information to be notified by the personal dosimetry laboratory

1 Within a month after the end of the monitoring period, the personal dosimetry laboratory must notify the data specified in Article 48 and the radiation doses determined to the licence holder and to the Central Dose Registry in a form prescribed by the FOPH (Art. 53). Data from the area supervised by the ENSI is also to be notified directly to this authority.[44]

2 If the effective dose determined over the monitoring period is greater than 2 mSv or the equivalent dose to an organ is greater than 10 mSv, this must be reported by the personal dosimetry laboratory to the licence holder and to the competent supervisory authority (FOPH or Suva) no later than ten calendar days after receipt of the dosimeter.

3 In cases where it is suspected that a dose limit has been exceeded, the personal dosimetry laboratory must report the result to the licence holder within 24 hours. If the dose exceeds the limit specified in Article 35 or 36, the personal dosimetry laboratory must inform the competent supervisory authority immediately. It shall also inform Suva if the case concerns an employee.

Art. 50 Duties of the personal dosimetry laboratory

1 The personal dosimetry laboratory must retain the dose measurements and personal details, as well as all the raw data required for subsequent calculation of the notifiable doses, for a period of two years after submission to the Central Dose Registry.

2 In accordance with the instructions of the competent authority, it must participate at its own expense in intercomparison measurements.

Art. 51 Duty of confidentiality and data protection

1 The personal dosimetry laboratory must not disclose the personal details or results of dosimetry to anyone other than the subject concerned, the client, the supervisory authority, the licensing authority and the Central Dose Registry.

44 Amended by Annex No 22 of the Ordinance of 12 Nov. 2008 on the Swiss Federal Nuclear Safety Inspectorate, in force since 1 Jan. 2009 (AS **2008** 5747).

2 With regard to the duty of confidentiality and data protection, the persons engaged to carry out dosimetry are subject to the regulations applicable for federal civil servants.

Art. 52 Technical provisions

1 After consulting METAS, the FDHA and DETEC shall jointly issue technical provisions for personal dosimetry.

2 The technical provisions shall specify in particular:

a. minimum requirements for measurement systems;

b. minimum requirements for measurement accuracy in routine operations and for intercomparison measurements;

c. standard models for calculation of radiation doses;

d. the format for notifications.

Section 4 Recording of Radiation Doses

Art. 53 Central Dose Registry

1 The FOPH shall maintain a registry of the doses accumulated by occupationally exposed persons in Switzerland (Central Dose Registry).

2 The purpose of the Central Dose Registry is:

a. to make it possible for the supervisory authorities to review at any time the doses accumulated by all occupationally exposed persons in Switzerland;

b. to permit statistical analyses;

c. to ensure that the data is retained.

Art. 54 Data processed

1 The following data may be stored in the Central Dose Registry:

a. name, first name and maiden name;

b. date of birth;

c. social insurance (AHV) number;

d. sex;

e. name and address of the enterprise;

f. dose measurements;

g. occupational group.

2 For persons working in Switzerland only temporarily, the doses accumulated in Switzerland shall be recorded. For other occupationally exposed persons, the doses accumulated abroad shall also be recorded.

3 The supervisory authorities and the occupational medicine unit of Suva shall have direct access to data in the area for which they are responsible.

Art. 55 Retention and publication of data

1 The FOPH must retain all data recorded in the Central Dose Registry for 100 years.

2 The supervisory authorities shall produce annual reports on the results of personal dosimetry.

3 The reports shall be published by the FOPH.

Art. 56 Use of data for research projects

1 The FOPH may use, or disclose to third parties, data stored in the Central Dose Registry for research projects concerning the effects of radiation and radiological protection.

2 The FOPH shall only make data available in an anonymised form, unless the disclosure of personal details is indispensable to the research project.

3 The data shall be made available if:

a. the recipient cannot carry out a particular research project without it;

b. the recipient guarantees compliance with data protection.

4 The recipient may only use the data in connection with the research project. He/she may only transmit it to third parties in connection with the research project.

5 The recipient must anonymise or destroy the data if it is no longer required for the research project. If a follow-on project is planned, the data must be deposited with the FOPH.

Art. 57 Personal dose record form

1 The FOPH shall issue a personal dose record form.

2 The approved personal dosimetry laboratories must distribute this dose record form free of charge to occupationally exposed persons.

3 The licence holder must record the doses accumulated. The personal dose record form, with the doses entered, must be handed over to occupationally exposed persons when they leave the employment of the licence holder or before they undertake an assignment at another enterprise.

Chapter 5
Handling of Radiation Generators and Radioactive Sources

Section 1 Controlled Areas

Art. 58

1 The licence holder must establish controlled areas to limit and monitor radiation exposure.

2 Controlled areas are to be clearly delimited and marked with signs as specified in Annex 6.

3 The licence holder must control access to and presence in controlled areas.

4 Within the scope of their responsibilities, the FDHA and DETEC shall issue the necessary regulations governing behaviour in controlled areas.[45]

Section 2
Shielding and Location of Radiation Generators and Radioactive Sources

Art. 59[46] Shielding

1 The room or area in which stationary radiation generators or radioactive sources are operated or stored shall be designed and shielded in such a way that, taking into account the frequency of use:

a. in places situated within the premises but outside controlled areas, where non-occupationally exposed persons may be present, the local dose does not exceed 0.02 mSv per week; in places where people are not continuously present, this value may be exceeded by up to a factor of five;

b. in places outside the premises, the off-site limits specified in Article 102 are not exceeded.

2 With the agreement of the supervisory authority, in rarely occupied places outside controlled areas within continuously monitored premises, where exceeding the dose limit specified in Article 37 is prevented by appropriate measures, the ambient dose rate may be up to 0.0025 mSv per hour.

Art. 60 Location of non-medical radiation generators and radioactive sources

1 Radiation generators for non-medical applications and irradiators used for non-destructive material testing (macrostructural analysis) must be installed in an irradiation room or equipped with a full protection system.

45 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
46 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

2 The irradiation room must meet the following requirements:

a. The control unit must be located outside the irradiation room.

b. Access to the irradiation room must be prevented by suitable devices while the installation is in operation. Egress must be assured at all times.

c. The operating state of the installation must be clearly indicated by an acoustic or visual signal in the irradiation room, at the entrance to the irradiation room and at the control unit.

3 The supervisory authority may grant exemptions from paragraph 1 in cases where a radiation generator or irradiator cannot be operated in an irradiation room. The ambient dose at the perimeter of the controlled area must not exceed 0.1 mSv per week outdoors and 0.02 mSv per week indoors.

4 If a radiation generator or irradiator is used outside an irradiation room, it must be ensured that the operator can call on another person for assistance at all times.

5 Analytical and other X-ray systems and units containing sealed radioactive sources for radiometric measurements such as level meters, level controllers and thickness gauges must be installed in a controlled area or equipped with a full protection system.

Art. 61 Location of medical radiation generators and radioactive sources

1 The FDHA shall define the requirements for the location of medical radiation generators. In particular, it shall specify structural measures and the basis for calculations.

2 The time spent by people in the vicinity of patients to whom radioactive sources have been administered for therapeutic purposes is to be kept to a minimum. The physician responsible for the patient shall ensure that the area around the patient is appropriately monitored.

3 The FDHA shall define:

a. the requirements for rooms where radioactive sources are administered;

b. the radiological protection measures for the care and accommodation of patients receiving such therapy.

Art. 62 Technical requirements

The FDHA and DETEC shall specify the technical requirements for radiation generators and radioactive sources and define the protective measures required for the handling thereof.

Section 3 Radiation Measuring Devices

Art. 63 Radiation measuring devices

1 The licence holder must ensure that the enterprise is equipped with the necessary number of suitable radiation measuring devices.

2 In rooms or areas where radioactive sources are handled, suitable radiation measuring devices must be available at all times to monitor dose rates or contamination.

3 If non-medical radiation generators or irradiators for macrostructural analysis of materials are operated without fixed shielding or outside irradiation rooms, operating staff must have at their disposal, in addition to a personal dosimeter, a radiation measuring device incorporating a warning system.

4 If the position and dimensions of shielding elements can be altered or if barriers are to be erected to demarcate a controlled area, at least one suitable radiation measuring device with a direct read-out must be available at the radiation generator to measure ambient dose rates.

Art. 64[47] Testing and verification of measuring instruments for ionising radiation

1 Measuring instruments for ionising radiation are governed by the Measuring Instruments Ordinance of 15 February 2006[48] and the implementing provisions issued by the Federal Department of Justice and Police in consultation with the FDHA and the FOEN.

2 The licence holder must carry out functional testing of measuring instruments for ionising radiation at appropriate intervals, using suitable test sources.

3 The supervisory authority may require the licence holder to participate in intercomparison measurements.

Section 4 Design and Labelling of Sealed Radioactive Sources

Art. 65 Design

1 With regard to design, sealed radioactive sources must be in line with the current state of science and technology.[49]

2 For sealed radioactive sources, the radionuclides selected must be chemically as stable as possible.

3 If sealed radioactive sources are used exclusively as gamma emitters, shielding must be provided which prevents the escape of primary particle radiation.

47 Amended by No I of the Ordinance of 7 Dec. 2012, in force since 1 Jan. 2013 (AS **2012** 7157).
48 SR **941.210**
49 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

Art. 66 Labelling

1 Sealed radioactive sources and their containers are to be labelled in such a way as to permit identification of the source at any time. The supervisory authority may grant exemptions in cases where labelling cannot be affixed.

2 The radionuclide, activity, date of manufacture and measurement, and classification according to ISO[50] 2919[51] must be immediately apparent or ascertainable from the labelling.[52]

Art. 67 Testing

1 Every sealed radioactive source must be tested for leak tightness and absence of contamination by a body accredited for this task or recognised by the supervisory authority.

2 Every sealed radioactive source whose activity is greater than 100 times the licensing limit specified in Annex 3 Column 10 must undergo type testing in accordance with accepted technical standards and be classified accordingly.[53]

3 In justified cases, the supervisory authority may grant exemptions from paragraphs 1 and 2 or require additional quality tests.

Art. 68 Use and operation

1 For irradiators and protective containers with sealed radioactive sources which are handled outside irradiation rooms, with shielding in place, the maximum ambient dose rate at 1 m from the surface shall be 0.1 mSv per hour.

2 When not in use, sealed radioactive sources for non-destructive material testing must be kept in a protective container (irradiator). The useful beam from the radioactive source in the extended position must be collimated to the required field size.

Section 5
Working Areas for the Handling of Unsealed Radioactive Sources

Art. 69 Working areas

1 Work with unsealed radioactive sources whose activity exceeds the licensing limit specified in Annex 3 Column 10 must be carried out in working areas.

50 International Organization for Standardization
The ISO technical standards referred to in this Ordinance can be consulted free of charge at the Federal Office of Public Health, CH-3003 Bern, or purchased from the Swiss information centre for technical rules (switec), Bürglistrasse 29, CH-8400 Winterthur or from the website of the Swiss Association for Standardization (www.snv.ch).

51 ISO 2919:1999, 2nd edition, Radiation protection – Sealed radioactive sources – General requirements and classification.

52 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

53 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

2 Working areas are to be established in separate rooms reserved for these purposes.

3 The working areas shall be classified into the following types, according to the activities handled per operation or per day:

a. Type C: An activity from 1 to 100 times the licensing limit specified in Annex 3 Column 10;

b. Type B: An activity from 1 to 10 000 times the licensing limit specified in Annex 3 Column 10;

c. Type A: An activity from one times the licensing limit to an upper limit that shall be defined in the licensing procedure.

4 For activities not involving a risk of inhalation, the supervisory authority may define the type of working area on a case-by-case basis, taking into account the risk of intake.

5 The FDHA and DETEC shall issue the necessary regulations concerning protective measures for the handling of unsealed radioactive sources.[54]

Art. 70 Exceptions

1 The supervisory authority may allow exceptions to Article 69 paragraph 2 on operational grounds, provided that radiological protection is assured.

2 Where handling involves a low risk of intake, the supervisory authority may in exceptional cases increase the values specified in Article 69 paragraph 3 by up to a factor of 10, provided that radiological protection is assured.

3 The supervisory authority may increase the values specified in Article 69 paragraph 3 by up to a factor of 100 if a working area is only used for storage of radioactive sources.

4 The supervisory authority may grant exemptions from Article 69 paragraph 1 in facilities with a zoning plan.[55]

Art. 71 Guidance values for contamination

1 The guidance values specified in Annex 3 Column 12 are applicable for the contamination of skin, underwear, clothing, materials and surfaces outside controlled areas.

2 If in accessible parts of controlled areas the contamination of materials and surfaces is greater than ten times the guidance value specified in Annex 3 Column 12, decontamination measures must be implemented or other appropriate protective measures adopted.

54 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
55 Inserted by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

3 If, in a controlled area, part of the contamination will remain attached to the surface under foreseeable conditions of handling, the guidance values specified in Annex 3 Column 12 shall only apply to the removable contamination.

Art. 72 Treatment and release of working areas after discontinuation of work

1 Working areas where the handling of unsealed radioactive sources has been discontinued and if necessary also the surrounding areas, including all installations and the remaining material, must be decontaminated by the licence holder at least to such an extent that the guidance values specified in Annex 3 Column 12 and the off-site limits specified in Article 102 are not exceeded.

2 The licence holder must submit a report to the supervisory authority on the measures carried out in accordance with paragraph 1.

3 The licence holder may only use the working areas concerned for other purposes after they have been released by the supervisory authority.

Section 6
Operation and Maintenance of Radiation Generators and Radioactive Sources[56]

Art. 73 Principle

1 The licence holder must ensure that radiation generators are comprehensively inspected and serviced at appropriate intervals.

2 The supervisory authority shall specify the intervals for non-medical radiation generators on a case-by-case basis.

3 The licence holder must regularly inspect the condition of sealed radioactive sources and keep records of the inspections.

Art. 74 Medical radiation generators and medical equipment containing sealed radioactive sources

1 The licence holder must ensure that an acceptance test is carried out before a medical radiation generator or medical equipment containing sealed radioactive sources is used for the first time.

2 After commissioning of the medical radiation generator or medical equipment containing sealed radioactive sources, the licence holder must implement a regular quality assurance programme.

3 Medical X-ray systems and medical equipment containing sealed radioactive sources must undergo a condition inspection during servicing at least once every six

56 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

years, and radiotherapy systems operating at a voltage of more than 100 kV and irradiators at least once a year.[57]

4 In the case of radiotherapy systems or irradiators, the elements relevant to safety and those determining the dose must be inspected at least once a year and whenever a component is changed which could affect the dose rate. The inspection of the dose-determining elements must be carried out under the supervision of a medical physicist with certification in medical radiophysics from the Swiss Society of Radiobiology and Medical Physics or other equivalent training.[58]

5 For the operation of medical accelerators and medical irradiators and for dosimetry in the planning of radiotherapy, the licence holder must have one or more medical physicists as specified in paragraph 4 at his disposal.

6 The FDHA shall define the minimum scope of the acceptance test and the quality assurance programme, taking international quality assurance standards into account.

7 For nuclear medicine applications and for fluoroscopy-guided interventional radiology and computer tomography, the licence holder must periodically enlist the services of a medical physicist as specified in paragraph 4.[59]

Section 7
Storage, Transport, Import, Export and Transit of Radioactive Sources

Art. 75 Storage

1 Radioactive sources whose activity is above the licensing limit specified in Annex 3 Column 10 must be stored in such a way that they are only accessible to persons who are authorised to use them.

2 Within the scope of their responsibilities, the FDHA and DETEC shall specify the type of storage and the requirements for storage facilities.[60]

Art. 76 Off-site transport

1 Anyone who transports or arranges the transport of radioactive sources off-site must comply with the relevant federal regulations concerning the transport of hazardous goods.

2 Such persons must provide evidence of and implement an appropriate quality assurance programme.

57 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
58 Wording of the sentence according to No I of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107).
59 Inserted by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
60 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

3 The consignor and the transporter of radioactive sources must designate a person responsible for quality assurance and define quality assurance measures in writing.

4 If the consignor or the transporter has in place a quality assurance system for the transport of radioactive sources, certified by an accredited body, it shall be assumed that they implement an appropriate quality assurance programme.

5 The consignor and the transporter must make sure that the transport containers or packaging materials comply with the relevant regulations and are properly maintained.

6 The consignor must make sure that the contracted transporter has a licence for the transport of radioactive sources.

Art. 77[61] On-site transport

Within the scope of their responsibilities, the FDHA and DETEC shall specify the requirements to be met by transport packaging materials for radioactive sources that are to be transported on-site.

Art. 78[62] Import, export and transit

1 Radioactive sources may only be imported, exported or undergo transit via the customs offices designated by the Directorate General of Customs.

2 The customs declaration for imports and exports must include the following details:[63]

a. the precise designation of the goods;

b. the radionuclides;

c. the total activity per radionuclide (in becquerels);

d. the licence number of the recipient or sender in Switzerland.

3 An individual licence is required for storage in a customs bonded warehouse or in a duty-free warehouse. This must be presented to the customs office.

Chapter 6 Radioactive Waste

Section 1 Discharge to the Environment

Art. 79 Principle

1 Radioactive waste may only be discharged to the environment with a licence and under the supervision of the licence holder.

61 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
62 Amended by Annex 4 No 44 of the Customs Ordinance of 1 Nov. 2006, in force since 1 May 2007 (AS **2007** 1469).
63 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

2 Only low-level radioactive waste may be discharged to the environment.

Art. 80 Discharge of gaseous, aerosol and liquid waste

1 Gaseous, aerosol or liquid radioactive waste may only be discharged via exhaust air to the atmosphere or via liquid effluent to surface waters.

2 The licensing authority shall specify maximum permissible discharge rates and, where appropriate, discharge concentrations for each enterprise on a case-by-case basis.

3 It shall specify the discharge rates and discharge concentrations in such a way that the source-related dose guidance value specified in Article 7 and the off-site limits specified in Article 102 are not exceeded.

Art. 81 Control measures

1 In the licence, the licensing authority shall specify the monitoring of emissions. It may provide for mandatory reporting.

2 Off-site monitoring shall be based on Article 103.

3 The licence holder may engage external bodies to carry out monitoring measurements, provided that they are recognised by the supervisory authority.

4 The licensing or supervisory authority may request that a meteorological assessment and local background radiation measurements be carried out before operations are commenced.

Art. 82[64] Discharge of solid waste

1 Solid radioactive waste with specific activities no greater than 100 times the exemption limit specified in Annex 3 Column 9 may by way of exception, with the agreement of the licensing authority, be discharged to the environment, provided it can be ensured by mixing with inactive materials that the values specified in Annex 2 are not exceeded.

2 With the agreement of the licensing authority, materials containing radium or uranium from urban areas with specific activities no greater than 1000 times the exemption limit specified in Annex 3 Column 9 may also be discharged to the environment if:

a. they arose before the commencement of the RPA;

b. disposal via the usual channels would be impossible or would involve disproportionate costs;

c. removal represents a significantly better option for humans and the environment overall than maintenance of the status quo; and

64 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

d. it can be ensured that, after mixing with inactive materials, the values specified in Annex 2 will not be exceeded.

Art. 83 Incineration of waste at enterprises

1 Combustible radioactive waste may be incinerated at the enterprise where it arises or, with the agreement of the licensing authority, at other enterprises if:

a. the enterprise has a waste incinerator complying with the requirements of the Clean Air Ordinance of 16 December 1985[65] and the Technical Ordinance on Waste of 10 December 1990[66]; and

b. an appropriate monitoring programme is in place.[67]

2 The waste may only contain the radionuclides H-3, C-14 or S-35. In justified cases, waste containing other radionuclides may be incinerated with the agreement of the licensing authority.[68]

3 The activity approved for incineration per week must not exceed 1000 times the licensing limit specified in Annex 3 Column 10.

4 Radioactive residues from incineration and flue gas scrubbing must be treated as radioactive waste.

Section 2 Management of Waste within the Enterprise

Art. 84 Record-keeping

The holder of radioactive waste must monitor waste holdings and keep records of the activities and composition relevant for subsequent management.

Art. 85 Waste with short half-lives

1 Waste exclusively containing radionuclides with a half-life of 60 days or less must be stored at the sites where it arises until its activity has decreased to such a level that it no longer comes under the scope of Article 1 or is below the licensed discharge rate specified in Article 80.

2 In the absence of an alternative that is more favourable overall for humans and the environment, waste which, as a result of radioactive decay, will fall outside the scope of Article 1 no later than 30 years after arising is to be separated from radioactive waste. In the event of separation, it shall be:

a. packaged and retained in such a way as to prevent the uncontrolled release of radioactive substances and avoid creating a fire hazard;

65 SR **814.318.142.1**
66 SR **814.600**
67 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
68 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

b. labelled and provided with documentation indicating the type of waste and the activity content.[69]

3 The activity must be verified in an appropriate manner immediately prior to disposal of the waste.[70]

4 The licence holder must ensure that labels, hazard warning symbols or other markings drawing attention to radioactivity are removed after the activity has decayed and before the material is disposed of as inactive waste.[71]

Art. 86 Gases, dust, aerosols and liquids

Where appropriate and possible at reasonable expense:

a. radioactive waste in the form of gases, dust or aerosols is to be retained by means of suitable devices such as filters or scrubbing towers;

b. liquid radioactive waste is to be converted to solid form.

Section 3 Surrender

Art. 87[72] Radioactive waste subject to mandatory surrender

1 Radioactive waste not arising as a result of the use of nuclear energy must be surrendered, following any treatment that may be required, to the federal collection centre.

2 The federal collection centre is the PSI.

3 The following is exempted from mandatory surrender to the PSI:

a. radioactive waste that may be discharged to the environment;

b. radioactive waste with short half-lives as specified in Article 85.

4 The FDHA shall define the technical details for the treatment of radioactive waste subject to mandatory surrender prior to its receipt by the federal collection centre.

Art. 87*a* [73] Duties of the PSI

The PSI shall take receipt of radioactive waste subject to mandatory surrender and be responsible for stacking, treatment and interim storage.

69 Inserted by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).
70 Originally Para. 2.
71 Originally Para. 3.
72 Amended by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).
73 Inserted by No I of the Ordinance of 3 June 1996 (AS **1996** 2129). Amended by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).

Art. 87*b*[74] Coordination Commission

A Coordination Commission comprising representatives from the FOPH, the ENSI and the PSI shall make recommendations on further action to the supervisory and licensing authorities if new or additional licences or permits are required.

Section 4 …

Art. 88–92[75]

Section 5 …

Art. 93[76]

Chapter 7 Abnormal Occurrences

Section 1 Prevention of Abnormal Occurrences

Art. 94 Prevention

[1] The licence holder must adopt appropriate measures to prevent abnormal occurrences.

[2] The enterprise must be designed in such a way that the source-related dose guidance value specified in Article 7 can also be complied with in the event of abnormal occurrences with a frequency of more than 10^{-1} per year.

[3] For abnormal occurrences with an expected frequency of between 10^{-1} and 10^{-2} per year, the enterprise must be designed in such a way that the additional dose resulting from a single abnormal occurrence is no greater than the yearly source-related dose guidance value specified for the enterprise.

[4] For abnormal occurrences with an expected frequency of between 10^{-2} and 10^{-4} per year, the enterprise must be designed in such a way that the dose resulting from a single abnormal occurrence for non-occupationally exposed persons is no greater than 1 mSv.[77]

74 Inserted by No I of the Ordinance of 3 June 1996 (AS **1996** 2129). Amended by Annex No 22 of the Ordinance of 12 Nov. 2008 on the Swiss Federal Nuclear Safety Inspectorate, in force since 1 Jan. 2009 (AS **2008** 5747).

75 Repealed by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, with effect from 1 Feb. 2005 (AS **2005** 601).

76 Repealed by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, with effect from 1 Feb. 2005 (AS **2005** 601).

77 Amended by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).

5 For abnormal occurrences with an expected frequency of between 10^{-4} and 10^{-6} per year, the enterprise must be designed in such a way that the dose resulting from a single abnormal occurrence for non-occupationally exposed persons is no greater than 100 mSv. The licensing authority may specify a lower dose in particular cases.[78]

6 The enterprise must be designed in such a way that only a small number of abnormal occurrences of the type referred to in paragraphs 4 and 5 can occur.[79]

7 For abnormal occurrences of the type referred to in paragraphs 4 and 5, and for abnormal occurrences which have an expected frequency of less than 10^{-6} per year but which could have major impacts, the supervisory authority shall order the necessary preventive measures.[80]

8 The supervisory authority shall specify on a case-by-case basis the methodology and conditions for analysis of abnormal occurrences and for the assignment of abnormal occurrences to the frequency classes specified in paragraphs 3–5. The effective dose or the organ doses arising from abnormal occurrence-related exposure of persons are to be determined in accordance with the current state of science and technology, using the assessment quantities and dose coefficients specified in Annexes 3, 4 and 7.[81]

Art. 95 Safety report

1 The supervisory authority may require the licence holder to submit a safety report.

2 The safety report shall include descriptions of:

a. the safety systems and equipment;

b. the measures adopted to ensure safety;

c. the operational organisation playing a decisive role in safety and radiological protection;

d. abnormal occurrences, their effects on the site and the vicinity, and their approximate frequency;

e. in the case of enterprises covered by Article 101 paragraph 1, emergency planning for protection of the public.

3 The supervisory authority may request additional documentation.

78 Amended by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).
79 Inserted by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).
80 Inserted by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (SR **732.11**).
81 Originally Para. 6. Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2005** 601).

Art. 96 Preventive measures

1 The licence holder must make the necessary in-house preparations so that abnormal occurrences can be managed.

2 The licence holder shall issue instructions concerning the emergency measures to be adopted.

3 The licence holder must ensure that appropriate resources are available at all times for the management of abnormal occurrences; in rooms where radioactive substances are handled, this also applies to firefighting.

4 The licence holder must ensure that staff receive regular instruction in rules of conduct, are trained in emergency measures and are familiarised with the location and use of the relevant resources.

5 The licence holder must take appropriate measures to ensure that, in the first year after the event, the staff deployed to deal with abnormal occurrences do not receive an effective dose of more than 50 mSv, or more than 250 mSv in the case of efforts to protect the public and in particular to save human lives.[82]

5bis For enterprises where abnormal occurrences as specified in Article 94 paragraph 5 may occur, the supervisory authority may order:

a. the recording of plant parameters that are required to monitor the course of an accident, to produce diagnoses and forecasts, and to determine the measures necessary to protect the public;

b. the continuous transmission of these plant parameters to the supervisory authorities via a network capable of withstanding an abnormal occurrence.[83]

6 The supervisory authority may require that exercises be conducted to test reporting channels, the functionality of resources and the training of staff. It may organise exercises itself.

7 The licence holder must inform the competent cantonal authorities and emergency services of the radiation sources present on the site.

Section 2 Management of Abnormal Occurrences

Art. 97 Emergency measures

1 The licence holder must make every effort to manage abnormal occurrences.

2 In particular, the licence holder must, without delay:

a. control the extent of the abnormal occurrence, in particular by taking measures at source;

82 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

83 Inserted by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).

b. ensure that all persons not involved in management of the abnormal occurrence do not enter the danger zone or leave it immediately;

c. take measures to protect the staff deployed, such as dose monitoring and appropriate instruction;

d. ensure that all those involved are registered, monitored for contamination and intake, and if necessary decontaminated.

3 The licence holder must, as soon as possible:

a. remove any contamination that has arisen;

b. take the measures required to analyse the abnormal occurrence.

Art. 98 Mandatory reporting

1 The licence holder must report every abnormal occurrence to the supervisory authority.

2 The licence holder must also report radiological incidents to the National Emergency Operations Centre (NEOC) without delay.

3 In the event of a radiation accident, the licence holder must notify the supervisory authority without delay. If the victim is an employee, the licence holder must additionally report the radiation accident to Suva without delay.

Art. 99 Investigation

1 After an abnormal occurrence, the licence holder must, without delay, request an expert to carry out an investigation.

2 The results of the investigation are to be recorded in a report. The report must contain:

a. a description of the abnormal occurrence, the cause, the effects determined and other possible effects, and the measures taken;

b. an account of measures that are planned or have already been taken to prevent further similar abnormal occurrences.

3 The licence holder shall submit the report to the supervisory authority no later than six weeks after the abnormal occurrence.

Art. 100[84] Provision of information on the abnormal occurrence

The supervisory authority shall ensure that the persons and the cantons concerned and the general public are informed about radiological incidents or technical failures in a timely manner. Article 9 of the Ordinance of 20 October 2010[85] on the Organisation of the Emergency Response to NBC and Natural Disasters (NBCN-Response Ordinance is reserved.

84 Amended by Annex 2 No II 3 of the NBCN Response Ordinance of 20 Oct. 2010, in force since 1 Jan. 2011 (AS **2010** 5395).

85 SR **520.17**

Section 3
Emergency Protection Measures in the vicinity of Enterprises

Art. 101

[1] For enterprises where the dose limit specified in Article 37 may be exceeded as a result of an abnormal occurrence, the licensing authority shall specify on a case-by-case basis to what extent they are required to participate in the preparation and implementation of emergency protection measures in the vicinity of the site, or to adopt such measures themselves.

[2] The licensing authority shall involve the competent cantonal authorities and emergency services in the preparation of emergency protection measures and inform them of the measures adopted.

[3] For warnings and alerts and for the preparation and implementation of measures to protect against increased radioactivity in the vicinity of nuclear facilities, the Emergency Protection Ordinance of 20 October 2010[86] and the Alarm Ordinance of 18 August[87] are applicable.[88]

Chapter 8 Monitoring of the Environment and Foodstuffs
Section 1 Monitoring of the Environment

Art. 102 Off-site limits

[1] The yearly average concentration of airborne radioactive substances off-site shall not exceed a three-hundredth of the guidance value specified in Annex 3 Column 11.

[2] The weekly average concentration of radioactive substances in publicly accessible waters shall not exceed a fiftieth of the exemption limit for specific activity specified in Annex 3 Column 9.

[3] Direct radiation off-site must not lead to ambient doses exceeding 1 mSv per year in premises where people live, spend time or work, or 5 mSv per year in other areas.

Art. 103 Off-site monitoring by the enterprise

[1] The licensing authority may require the licence holder to monitor levels of radioactive substances in the environment and direct radiation from the site and to report the results to the supervisory authority.

[2] The licence holder may engage external bodies to carry out measurements for monitoring purposes, provided that they are recognised by the supervisory authority.

86 SR **732.33**
87 SR **520.12**
88 Amended by Art. 20 No 4 of the Emergency Response Ordinance of 20 Oct. 2010, in force since 1 Jan. 2011 (AS **2010** 5191).

Art. 104 Monitoring of environmental radioactivity

[1] The FOPH shall monitor ionising radiation and radioactivity in the environment.

[2] The ENSI shall additionally monitor ionising radiation and radioactivity in the vicinity of nuclear facilities and the PSI.[89]

[3] In monitoring radioactivity in foodstuffs, the FOPH shall cooperate with the Federal Food Safety and Veterinary (FSVO) and the cantons.[90]

Art. 105 Sampling and measurement programme

[1] The FOPH shall prepare a sampling and measurement programme in cooperation with the ENSI, Suva, the NEOC and the cantons.[91]

[2] For the implementation of the sampling and measurement programme, federal laboratories, in particular the PSI, the Swiss Federal Institute of Aquatic Science and Technology and the Spiez Laboratory, are required to cooperate and to make available at all times the necessary human and material resources. Third parties may be involved for this purpose.

Art. 106 Data collection and report

[1] The ENSI, Suva, the NEOC, the cantons and the participating laboratories shall make available to the FOPH the monitoring data generated and interpreted.[92]

[2] The FOPH shall use this input to prepare an annual report on the monitoring data and the resultant radiation doses to the public. It shall publish this report.

Art. 107[93]

Section 2 Monitoring of Foodstuffs

Art. 108 Limit and tolerance values for radionuclides in foodstuffs

For radionuclides in foodstuffs, the limit and tolerance values specified in the Contaminants and Constituents Ordinance of 27 February 1986[94] are applicable.

89 Amended by Annex No 22 of the Ordinance of 12 Nov. 2008 on the Swiss Federal Nuclear Safety Inspectorate, in force since 1 Jan. 2009 (AS **2008** 5747).
90 Amended by No I 5 of the Ordinance of 4 Sept. 2013 (Reorganisation in the field of Food Safety and Veterinary Medicine), in force since 1 Jan. 2014 (AS **2013** 3041).
91 Amended by Annex No 22 of the Ordinance of 12 Nov. 2008 on the Swiss Federal Nuclear Safety Inspectorate, in force since 1 Jan. 2009 (AS **2008** 5747).
92 Amended by Annex No 22 of the Ordinance of 12 Nov. 2008 on the Swiss Federal Nuclear Safety Inspectorate, in force since 1 Jan. 2009 (AS **2008** 5747).
93 Repealed by No I of the Ordinance of 15 Nov. 2000 (AS **2000** 2894).
94 [AS **1986** 647, **1987** 1288, **1988** 1235 1342, **1989** 1197, **1990** 1094, **1991** 1878, **1994** 2051 Art. 2. AS **1995** 2893 Art. 6 Letter a]. See now the Ordinance of 26 June 1995 on Contaminants and Constituents in Foodstuffs (SR **817.021.23**).

Art. 109[95] Information

[1] If the monitoring bodies detect that a limit or tolerance value has been exceeded, they shall inform the FSVO.

[2] The FSVO shall inform the FOPH and the monitoring bodies of any reports it receives under paragraph 1.

Section 3 Elevated Radon Concentrations

Art. 110 Limits and guidance value

[1] For radon concentrations in premises where people live (residential) or spend time (non-residential), a yearly average limit of 1000 becquerels per cubic metre (Bq/m^3) is applicable.

[2] For radon concentrations in workplaces, a limit of 3000 Bq/m^3 averaged over a monthly working period is applicable.

[3] If an occupationally exposed person is additionally exposed to radon concentrations of more than 1000 Bq/m^3 in the course of his/her work, the additionally accumulated dose due to radon must also be taken into account when calculating the permissible yearly dose in accordance with Article 35.

[4] For new and converted buildings (Art. 114) and for remediation projects (Art. 113 and 116), a guidance value of 400 Bq/m^3 is applicable, provided that this can be achieved by simple structural measures.

Art. 111 Measurements

[1] Radon concentrations must be determined by approved measurement laboratories.

[1bis] The measurement period in residential and non-residential premises must be at least a month.[96]

[2] Measurements may be requested by the owner or by any other person concerned.

[3] If measurements are not performed in accordance with paragraph 2, they shall be ordered by the cantonal authorities at the request of the person concerned. The cantonal authorities shall ensure that the results of the measurements are communicated to the person concerned.

[4] Persons are deemed to be "concerned" if they have reason to suppose that the limits specified in Article 110 are exceeded as a result of the occupation of premises or workplaces. This applies in particular to persons in areas with elevated radon concentrations as specified in Article 115.

[5] Building users must make rooms accessible for the performance of measurements.

95 Amended by No I 5 of the Ordinance of 4 Sept. 2013 (Reorganisation in the field of Food Safety and Veterinary Medicine), in force since 1 Jan. 2014 (AS **2013** 3041).
96 Inserted by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

6 The costs of measurements ordered by the cantonal authorities shall be borne by the owner.

Art. 112[97] Approval and duties of measurement laboratories

1 The FOPH shall approve a radon measurement laboratory if it:

a. has the specialist staff and measurement system required for due fulfilment of its responsibilities;

b. can assure proper fulfilment of its responsibilities, and in particular if staff in the course of their work are not subject to any influences leading to conflicts of interest.

2 The Federal Department of Justice and Police shall specify the technical requirements for measurement systems and the methods for maintenance of measurement stability.

3 The measurement laboratories are required to enter their data in the radon database (Art. 118*a*).

4 The FOPH shall supervise the measurement laboratories.

Art. 113 Mitigation measures

1 If the limit specified in Article 110 is exceeded, the owner must, at the request of a person concerned, undertake the necessary remedial work within a period of three years.

2 If the deadline passes unmet or the owner refuses to comply, the cantonal authorities shall order the necessary remedial work. They shall set a time limit of up to three years for the completion of the work, depending on the urgency of the particular case.

3 The costs of the remedial work shall be borne by the owner.

4 The above provisions are without prejudice to remediation measures adopted by Suva in accordance with the Federal Accident Insurance Act of 20 March 1981[98].

Art. 114 Building regulations

1 The cantonal authorities shall take the necessary measures to ensure that the limit of 1000 Bq/m^3 is not exceeded in new and converted buildings. They shall ensure that efforts are made, through appropriate structural measures, to prevent radon concentrations from exceeding the guidance value of 400 Bq/m^3.

2 After the completion of construction work, the cantonal authorities shall carry out spot checks to assess compliance with the limit.

97 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
98 SR **832.20**

Art. 115 High radon areas

1 The cantons shall ensure that sufficient numbers of measurements are carried out on their territory.

2 They shall compile a register of areas with elevated radon concentrations and continuously revise the register on the basis of measurement data.

3 The cantons shall ensure that, in areas with elevated radon concentrations, measurements are carried out in sufficient numbers of residential and non-residential premises and workplaces in public buildings.

4 The maps of areas with elevated radon concentrations may be consulted by members of the public.

Art. 116 Remediation programmes

1 In areas with elevated radon concentrations, the cantons shall specify the remediation measures to be adopted for premises where the limit specified in Article 110 paragraph 1 is exceeded.

2 They shall determine the period within which the remediation measures are to be implemented according to the urgency of the particular case and the economic acceptability.

3 The remediation measures must have been implemented no later than 20 years after the commencement of this Ordinance.

4 The costs of the remediation measures shall be borne by the owner.

Art. 117 Information

1 The cantons shall regularly submit the updated maps of high radon areas to the FOPH.[99]

2 They shall regularly inform the FOPH of the status of remediation activities.

Art. 118 Radon Technical and Information Centre

1 The FOPH shall operate a Radon Technical and Information Centre.

2 It shall carry out the following tasks:

a. in cooperation with the cantons, regularly making recommendations on measurements and conducting measurement programmes;

b. advising cantons, property owners and other interested parties on radon problems;

c. regularly informing the public on the radon issue in Switzerland;

d. advising persons concerned and interested bodies on appropriate mitigation measures;

99 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

e. regularly evaluating the effects of measures;

f. possibly carrying out studies on the origins and effects of radon;

g. regularly providing the cantons with an overview of the high radon areas reported to it in accordance with Article 117.

3 The FOPH shall make the measurement data available to the cantons via an online access system.[100]

4 The FOPH may organise training courses.

Art. 118*a*[101] Radon database

1 The FOPH shall maintain a central radon database. In this database, it shall store the data that is required to allow continuous assessment of the implementation of measurements and remediation projects and to draw statistical and scientific conclusions.

2 The following data shall be stored in the central radon database:

a. building location (coordinates, plot number);

b. information on the building;

c. information on the premises;

d. measurement data;

e. remediation data;

f. building owner or user (name, address, postcode, town).

3 The staff of the Radon Technical and Information Centre are entitled to process the data in the database in accordance with the processing regulations.

4 The approved measurement laboratories, dosimeter vendors and the competent authorities are obliged to enter the data they have gathered in the central radon database. For this purpose, the data collected may be made available to the above-mentioned bodies via an online access system.

5 The persons charged with measurement and remediation may consult the building data and are authorised to enter information on measurement and remediation. For this purpose, the data collected may be made available to them via an online access system.

6 The data held in the database shall be deleted after 100 years.

100 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

101 Inserted by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

Chapter 9
Protection of the Public in the event of increased Radioactivity

Section 1 Emergency Response Organization

Art. 119[102]

For events that may endanger the public as a result of increased radioactivity, the die NBCN Response Ordinance of 20 October 2010[103] applies in addition to the provisions of this Ordinance.

Section 2 Persons and Undertakings with Special Obligations

Art. 120 Categories of persons

[1] In the event of danger arising as a result of increased radioactivity, the following are obliged to assume responsibilities under Article 20 paragraph 2 letter b of the RPA:

a. persons and undertakings such as measurement and radiological protection teams, for direct intervention;

b. persons and undertakings in the public and private transport sector, for passenger and freight transport and evacuations;

c. persons and undertakings, for indirect intervention, such as at-source measures designed to prevent further contamination of the vicinity;

d. customs authorities, for border controls;

e. healthcare professionals and medical staff, for the care of radiation victims or other persons affected.

[2] Persons under 18 years of age and pregnant women shall be exempted from deployment under paragraph 1.

Art. 121 Protection of health

[1] The persons with special obligations may only be deployed for tasks where it is not to be expected that, in the first year after the event, they will accumulate an effective dose of more than 50 mSv, or more than 250 mSv for life-saving actions.

[2] If a person with special obligations has received an effective dose of more than 250 mSv, he/she is to be placed under medical surveillance. The physician responsible shall communicate the results of the investigation to the person concerned and to the FOPH, together with a proposal concerning measures to be adopted. If the person concerned is an employee, the physician shall notify Suva.

102 Amended by Annex 2 No II 3 of the NBCN Response Ordinance of 20 Oct. 2010, in force since 1 Jan. 2011 (AS **2010** 5395).
103 SR **520.17**

3 The disclosure of data by the physician shall be governed by Article 39 paragraph 3.

4 The radiation exposure of persons with special obligations is to be determined at appropriate intervals by means of suitable measurements.

5 If members of the armed forces, civil protection or the emergency services are deployed under the provisions of the RPA, the protection of health shall be governed by paragraph 1.

Art. 122 Equipment

The Federal Staff (FST NBCN) responsible under Article 5 of the NBCN Response Ordinance of 20 October 2010[104] for NBCN events as well as the federal and cantonal agencies under Article 4 of the NBCN Response Ordinance of 20 October 2010 shall ensure that persons with special obligations have the necessary equipment to perform their tasks and protect their health.[105]

2 The necessary equipment shall include in particular:

a. an adequate number of measurement devices for the determination of radiation exposure;

b. means of protection against intake or contamination.

Art. 123 Instruction and training

1 The FST NBCN as well as the federal and cantonal agencies under Article 4 of the NBCN Response Ordinance of 20 October 2010[106] shall ensure that, before they perform their tasks, persons with special obligations are appropriately instructed and are informed of the risks involved.[107]

2 Instruction must cover at least:

a. behaviour in a radiation field (self-protection);

b. the risks of radiation exposure;

c. working and measurement methods for deployments.

3 Persons with special obligations may be required to participate in exercises.

Art. 124 Insurance cover and compensation

1 In the event of increased radioactivity, persons with special obligations are insured against accidents and illness. If the cover provided by compulsory accident insurance and existing private insurance is not sufficient, the Confederation shall guaran-

104 SR **520.17**
105 Amended by Annex 2 No II 3 of the NBCN Response Ordinance of 20 Oct. 2010, in force since 1 Jan. 2011 (AS **2010** 5395).
106 SR **520.17**
107 Amended by Annex 2 No II 3 of the NBCN Response Ordinance of 20 Oct. 2010, in force since 1 Jan. 2011 (AS **2010** 5395).

tee benefits in accordance with the provisions of the Federal Act of 19 June 1992[108] on Military Insurance. If necessary, the military insurance organisation may be involved for purposes of implementation.[109]

2 If, as a result of their activities, persons and undertakings with special obligations incur costs that are not covered, they shall receive compensation from the Confederation. The FDHA shall regulate the processing of financial claims.

Chapter 10 Licences and Supervision

Section 1 Mandatory Licensing and Licensing Procedure

Art. 125 Mandatory licensing

1 Mandatory licensing is based on Article 28 of the RPA.

2 Anyone who deploys persons as occupationally exposed persons in a third-party enterprise shall also be subject to mandatory licensing.[110]

3 The following shall be exempt from mandatory licensing:

a.[111] work involving radioactive substances where the activity handled per operation or per day does not exceed the licensing limit specified in Annex 3 Column 10;

b. the handling of radiation sources approved in accordance with Article 128, with the exception of distribution;

c.[112] the distribution, use, storage, transport, disposal, import, export and transit of finished timepieces containing radioactive substances, provided that they comply with the ISO standards[113] 3157[114] and 4168[115], and of no more than 1000 timepiece components with radioluminescent paint;

108 SR **833.1**

109 Sentence Amended by No 7 of the Ordinance of 27 April 2005, in force since 1 July 2005 (AS **2005** 2885).

110 Amended by No I of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107).

111 Amended by No I of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107).

112 Inserted by No I of the Ordinance of 3 June 1996 (AS **1996** 2129). Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

113 International Organization for Standardization
The ISO technical standards referred to in this Ordinance can be consulted free of charge at the Federal Office of Public Health, CH-3003 Bern, or purchased from the Swiss information centre for technical rules (switec), Bürglistrasse 29, CH-8400 Winterthur or from the website of the Swiss Association for Standardization (www.snv.ch).

114 ISO 3157:1991, 2nd edition, Radioluminescence for time measurement instruments – Specifications.

115 ISO 4168:2002, 2nd edition, Timekeeping instruments – Conditions for carrying out checks on radioluminescent deposits.

d.[116] the transport of radioactive substances as excepted packages (UN numbers 2908, 2909, 2910 and 2911 in accordance with Annex A, Section 3.2.1, Table A, ADR[117]/SDR[118], RID/RSD[119], LTrR[120], Ordinance of 10 January 1973[121] on the Carriage of Dangerous Goods by Sea, ADNR[122]);

e.[123] the transport of radioactive substances by air (UN numbers 2912, 2915, 2916, 3321 and 3332 in accordance with Annex 18 to the Convention on International Civil Aviation of 7 December 1944[124] and the associated Technical Instructions[125]).

Art. 126 Granting and term of licences

1 Licence applications are to be submitted to the competent licensing authority, together with the necessary documentation.

2 The licensing authority shall limit the term of the licence to a maximum of ten years.

3 A licence for the import or export of radioactive sources whose activity exceeds the licensing limit by a factor of more than 10 000 000 shall only be granted for a single import or export movement.

4 The licensing authority shall communicate its decision to the cantons concerned, to the supervisory authority and, in the case of companies subject to the Employment Act of 13 March 1964[126], also to the competent federal employment inspectorate.

Art. 127 Licensing authorities

1 The ENSI is the licensing authority for:[127]

a. activities at nuclear facilities;

b.[128] …

116 Inserted by No I of the Ordinance of 17 Nov. 1999 (AS **2000** 107). Amended by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).
117 SR **0.741.621**
118 SR **741.621**
119 SR **742.401.6**
120 SR **748.411**
121 [AS **1973** 123. AS **2007** 4477 No I 88]
122 SR **747.224.141.1**
123 Inserted by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
124 SR **0.748.0**. This Annex is not published either in the Official Compilation (AS) or in the Classified Compilation of Federal Legislation (SR). It can be consulted at or obtained from the Federal Office of Civil Aviation, CH-3003 Bern.
125 The Technical Instructions are not published either in the Official Compilation (AS) or in the Classified Compilation of Federal Legislation (SR). They can be consulted in English and French at the Federal Office of Civil Aviation, CH-3003 Bern, and at the national airports' information centres; they are not translated into German or Italian.
126 SR **822.11**
127 Amended by Annex No 22 of the Ordinance of 12 Nov. 2008 on the Swiss Federal Nuclear Safety Inspectorate, in force since 1 Jan. 2009 (AS **2008** 5747).

c.[129] …

d.[130] experiments involving radioactive substances in the context of geological studies as specified in Article 35 of the Nuclear Energy Act of 21 March 2003[131];

e.[132] the import or export of radioactive substances for or from nuclear facilities;

f.[133] the transport of radioactive substances to and from nuclear facilities.

2 In all other cases, the FOPH is the licensing authority.

Section 2 Approval

Art. 128 Conditions

1 Radiation generators and radioactive sources may be approved by the FOPH if:

a. they are constructed in such a way as to prevent inadmissible exposure or radioactive contamination of persons;

b.[134] it is assured that, where appropriate, they will be surrendered to the federal collection centre as radioactive waste at the end of their useful life;

c. the ambient dose rate at a distance of 10 cm from the surface does not exceed 1 μSv per hour.

2 The FDHA may issue regulations concerning the approval of particular radiation generators and radioactive sources.

Art. 129 Type testing

The FOPH shall subject radiation generators and radioactive sources submitted for approval to type testing. It may engage other bodies for this purpose.

Art. 130 Effects of approval

1 Anyone who handles approved radiation generators and radioactive sources does not require a licence to do so, except in the case of distribution.

2 As part of the approval process, the FOPH shall specify:

128 Repealed by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, with effect from 1 Feb. 2005 (AS **2005** 601).
129 Repealed by No II 2 of the Ordinance of 15 Nov. 1995 (AS **1995** 4959).
130 Amended by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).
131 SR **732.1**
132 Inserted by No I of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107).
133 Inserted by No I of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107).
134 Amended by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).

a. under what conditions radioactive sources may be handled like inactive substances;

b.[135] how, where appropriate, radioactive sources at the end of their useful life must be surrendered to the federal collection centre as radioactive waste;

c. which radiation generators and radioactive sources must bear a warning label.

3 It shall limit approval to a maximum of ten years.

Art. 131 Duties of the approval holder

1 The approval holder is subject to the record-keeping and reporting duties specified in Article 134.

2 The approval holder must label the approved radiation generators and radioactive sources with an approval mark specified by the FOPH.

3 The FOPH may wholly or partly exempt certain categories of approved radiation generators and radioactive sources from labelling.

Section 3 Duties of the Licence Holder

Art. 132 Organizational duties

1 The licence holder must issue internal directives concerning working methods and protective measures and monitor compliance.

2 The licence holder shall specify in writing the powers of the various line managers and radiological protection experts, and of persons handling radiation sources. Experts shall be granted the power to intervene wherever necessary on safety grounds.

3 The licence holder must ensure that all persons working in the enterprise are appropriately informed about the health risks that may arise from handling ionising radiation at the workplace.

4 If the licence holder deploys persons from service companies or other enterprises as occupationally exposed persons, these enterprises must be apprised of the relevant radiological protection regulations.

Art. 133 Notification duties

1 The licence holder must notify the supervisory authority of any changes before they are effected, in particular:

a. changes to the output of a radiation generator, structural and design characteristics, and beam direction;

135 Amended by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).

b.[136] …

c. a change of radiological protection expert.

2 Every year, the licence holder must report to the supervisory authority the precise location of each radiation source whose activity is greater than 100 000 times the licensing limit specified in Annex 3 Column 10 or for which the unshielded dose rate at a distance of 1 m exceeds 1 mSv/h.[137]

3 The loss of a radioactive source whose activity exceeds the licensing limit specified in Annex 3 Column 10 is to be reported to the supervisory authority without delay.

Art. 134 Record-keeping and reporting duties

1 Anyone who handles radioactive sources whose activity exceeds the licensing limit specified in Annex 3 Column 10 must maintain an inventory thereof.

2 Anyone who handles unsealed radioactive sources whose activity exceeds the licensing limit specified in Annex 3 Column 10 must keep records thereof.

3 Anyone who distributes radiation sources must report the following information to the supervisory authority on request:[138]

a. the designation of the radionuclides and their chemical and physical form;

b. the designation of the equipment or articles that contain radioactive substances, with details of the radionuclides and their activity;

c. the designation of the radiation generators and the associated parameters;

d. the addresses of domestic suppliers;

e. the addresses of domestic clients and the activity of the individual radionuclides purchased.

4 For all other forms of handling, record-keeping and reporting requirements may be specified in the licence on a case-by-case basis.[139]

Art. 135 Distributor's duty of care

Within Switzerland, the distributor may only transfer radiation generators or radioactive sources whose activity exceeds the licensing limit specified in Annex 3 Column 10 to enterprises or persons with an appropriate licence.

136 Repealed by No I of the Ordinance of 24 Oct. 2007, with effect from 1 Jan. 2008 (AS **2007** 5651).
137 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
138 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
139 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

Section 4 Supervision

Art. 136 Supervisory authorities

1 The FOPH, Suva and the ENSI are responsible for supervision of the protection of people and the environment.[140]

2 The FOPH shall supervise those enterprises where there is a need, above all, for protection of the public, in particular medical enterprises and research and teaching departments at higher education institutions.

3 Suva shall supervise those enterprises where there is a need, above all, for protection of employees, in particular industrial and commercial enterprises.

4 The ENSI shall supervise:[141]

a. nuclear facilities;

b.[142] geological studies as specified in Article 35 of the Nuclear Energy Act of 21 March 2003[143];

c.[144] …

d.[145] …

e.[146] the receipt or shipment of radioactive substances at or from nuclear facilities.

5 The supervisory authorities shall consult each other to resolve any uncertainties regarding responsibility.

6 The supervisory authorities shall assume that licence holders are in compliance with the organisational duties specified in Article 132 if they have in place a quality assurance system certified by an accredited body.

Art. 137[147] Monitoring of medical radiation generators and medical equipment containing sealed radioactive sources

1 The supervisory authority shall carry out spot checks to monitor radiological protection at enterprises with medical radiation generators or medical equipment containing sealed radioactive sources.

140 Amended by Annex No 22 of the Ordinance of 12 Nov. 2008 on the Swiss Federal Nuclear Safety Inspectorate, in force since 1 Jan. 2009 (AS **2008** 5747).
141 Amended by Annex No 22 of the Ordinance of 12 Nov. 2008 on the Swiss Federal Nuclear Safety Inspectorate, in force since 1 Jan. 2009 (AS **2008** 5747).
142 Amended by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).
143 SR **732.1**
144 Repealed by No I of the Ordinance of 17 Nov. 1999 (AS **2000** 107).
145 Repealed by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, with effect from 1 Feb. 2005 (AS **2005** 601).
146 Inserted by No I of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107).
147 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

2 Third parties carrying out servicing of diagnostic equipment in medical, dental and veterinary practices and the practices of chiropractors and cantonally certified dentists in accordance with Article 74 paragraph 3 may be requested by the FOPH to perform checks.

Art. 138 Monitoring of import, export and transit

1 The Directorate General of Customs, in consultation with the FOPH and the ENSI, shall issue instructions for monitoring of the import, export and transit of radioactive sources.[148]

2 The Swiss Federal Customs Administration shall grant the FOPH access to the database in which customs declarations with the details specified in Article 78 paragraph 2 are stored.[149] In the case of storage in a customs bonded warehouse or in a duty-free warehouse, it shall cancel the individual licence and forward it to the FOPH.[150]

3 In the course of import and transit controls, the customs offices shall check whether a transport licence has been issued by the FOPH.[151]

4 The FOPH shall decide on approval of the agreement concerning the return of radioactive waste referred to in Article 25 paragraph 3 letter d of the RPA.[152]

Chapter 11 Criminal and Final Provisions

Art. 139 Criminal provisions

1 Any person who wilfully or negligently:

a. without the consent of the supervisory authority mixes radioactive substances with inactive materials solely for the purpose of circumventing this Ordinance (Art. 3 Para. 1);

b.[153] performs an activity that may involve an ionising radiation hazard without having the necessary training as specified in Articles 10–18;

c. places radiopharmaceuticals on the market or uses them in humans without the approval of the FOPH (Art. 30 Para. 1);

148 Amended by Annex No 22 of the Ordinance of 12 Nov. 2008 on the Swiss Federal Nuclear Safety Inspectorate, in force since 1 Jan. 2009 (AS **2008** 5747).
149 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
150 Amended by Annex 4 No 44 of the Customs Ordinance of 1 Nov. 2006, in force since 1 May 2007 (AS **2007** 1469).
151 Amended by Annex 4 No 44 of the Customs Ordinance of 1 Nov. 2006, in force since 1 May 2007 (AS **2007** 1469).
152 Inserted by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004, in force since 1 Feb. 2005 (AS **2005** 601).
153 Amended by No I of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107).

d. fails to notify the supervisory authority immediately when it is suspected or established that a dose limit has been exceeded (Art. 38);

e. operates a personal dosimetry laboratory without official approval (Art. 45);

f. operates a personal dosimetry laboratory and contravenes the duties imposed thereon by Articles 49–51;

g.[154] fails to include in a customs declaration the details specified in Article 78 paragraph 2;

h. causes an abnormal occurrence in performing an activity.

shall be liable to the penalties under Article 44 paragraph 1 letter f of the RPA.

2 Any person who wilfully or negligently:[155]

a. fails to assume responsibilities imposed on him/her in accordance with Article 20 paragraph 2 letter b of the RPA (Art. 120);

b. fails, without excuse, to take part in exercises where participation is required in accordance with Article 123 paragraph 3

shall be liable to a fine of up to 20 000 Swiss francs.

Art. 140 Repeal and amendment of current legislation

1 The following shall be repealed:

1. the Ordinance of 30 June 1976[156] on Radiological Protection;
2. the Dosimetry Ordinance of 11 November 1981[157];
3. the Ordinance of 30 August 1978[158] on Basic and Advanced Training in Radiological Protection.

2 …[159]

Art. 141 Transitional provisions

1 Physicians, dentists and veterinary surgeons who have not undergone the training specified in Article 18 paragraph 2 shall be considered to be experts:

a. until no later than 30 September 2004 if, when this Ordinance commences, they have a licence for applications specified in Articles 11 to 14;

154 Amended by Annex 4 No 44 of the Customs Ordinance of 1 Nov. 2006, in force since 1 May 2007 (AS **2007** 1469).
155 Amended by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).
156 [AS **1976** 1573, **1979** 256, **1981** 537, **1983** 1964, **1984** 876, **1987** 652 Art. 21 No 4, **1988** 1561, **1991** 1459 Art. 22 No 2]
157 [AS **1981** 1872]
158 [AS **1978** 1404]
159 The amendment can be consulted under AS **1994** 1947.

b. until no later than 30 September 1997 if they obtain a licence for applications specified in Articles 11 to 14 after the commencement of this Ordinance.

2 Physicians and veterinary surgeons who, when this Ordinance commences, carry out applications specified in Article 11 paragraph 2 and Articles 12–14 and do not have the qualifications required by these provisions must furnish evidence of the necessary qualifications by 30 September 2004.

3 Registrations of radiopharmaceuticals granted under existing legislation shall remain valid until 30 September 1999.

4 The dose limits specified in Article 35 paragraphs 1 and 2 shall only be valid from 1 January 1995.

5 The shielding and location of approved radiation generators or radioactive sources must comply with Articles 59 and 60 from 1 October 2004 at the latest.

6 Fluoroscopy may be performed using approved radiation generators without an image intensifier and automatic dose rate control until 30 September 1996 at the latest.

7 Screening may be carried out with approved radiation generators using photofluorography without an image intensifier until 30 September 1999 at the latest. For chest screening using image intensifier and storage screen systems, Article 27 paragraph 1 is applicable.[160]

8 Subject to the provisions of paragraphs 6 and 7, unlimited licences, approvals in accordance with Article 45 or approvals in accordance with Article 128 granted under existing legislation shall remain valid until 30 September 2004.

9 Proceedings that are pending when this Ordinance commences shall be subject to the new legislation.

10 If there is no danger to humans or the environment and in the absence of legitimate opposing interests of parties concerned, the supervisory authority may until 30 September 1997 use existing legislation to assess in individual cases:

a. the minimum requirements for the measurement system of a personal dosimetry laboratory, the measurement accuracy and the threshold for rapid notifications (Art. 52);

b. the location of medical radiation generators and radioactive sources (Art. 61);

c. the type of storage for radioactive sources and the requirements for storage facilities (Art. 75);

d. the on-site transport of radioactive sources (Art. 77).

160 Amended by No I of the Ordinance of 3 June 1996, in force since 1 Aug. 1996 (AS **1996** 2129).

Art. 141*a*[161] Transitional provisions concerning the Amendment of 24 October 2007

[1] The preparation or synthesis of finished radiopharmaceutical products must comply with Article 31*a* from 1 January 2012 at the latest.

[2] The medical physicist referred to in Article 74 paragraph 7 must be consulted from 1 January 2012 at the latest.

Art. 142 Commencement

This Ordinance comes into force on 1 October 1994.

[161] Inserted by No I of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

Annex 1[162]
(Art. 4)

Definitions

Abnormal occurrence

An event during which a facility deviates from normal operation and:

a. the safety of the facility or an article is compromised (technical failure);

b. which may lead to an off-site limit or the dose limit for non-occupationally exposed persons (radiological incident) being exceeded; or

c. during which someone is exposed to a dose of more than 50 mSv (radiation accident).

Acceptance test

Inspection of a product that has been offered for delivery or delivered in order to establish whether the technical specifications and safety requirements for its intended use are met.

Activity

Number of disintegrations per unit time. The unit of activity is the becquerel (Bq); 1 Bq = 1 s^{-1}.

Activity concentration

Activity per unit volume. The activity concentration is expressed in becquerels per cubic metre (Bq/m^3).

Activity, specific

Activity per unit mass. Specific activity is expressed in becquerels per kilogram (Bq/kg).

Area, controlled

Controlled areas are:

a. working areas for the handling of unsealed radioactive sources, as specified in Art. 69;

b. areas in which air concentrations may exceed $^1/_{20}$ of the guidance values specified in Annex 3 Column 11;

c. areas in which surface contamination may exceed the guidance values specified in Annex 3 Column 12;

[162] Amended by No II of the Ordinance of 17 Nov. 1999 (AS **2000** 107). Corrected by Annex 7 No 3 of the Nuclear Energy Ordinance of 10 Dec. 2004 (AS **2005** 601), Annex 4 No 44 of the Customs Ordinance of 1 Nov. 2006 (AS **2007** 1469), No III Para. 1 of the Ordinance of 24 Oct. 2007 (AS **2007** 5651) and Annex 6 No 3 of the Ordinance of 20 Sept. 2013 on Clinical Trials, in force since 1 Jan. 2014 (AS **2013** 3407).

d. areas in which people may accumulate an effective dose of more than 1 mSv per year as a result of external exposure;

e. areas in which equipment is operated without a full protection system;

f. areas designated as such by the supervisory authority.

Articles of daily use

Articles such as linen and clothing, furniture, fittings, etc., but excluding building materials.

Becquerel (Bq)

Unit of activity of a radionuclide. 1 Bq = 1 disintegration per second. The becquerel supersedes the curie (1 Ci = 3.7×10^{10} Bq).

Condition inspection

Inspection of the condition of a product in use to assess compliance with specified requirements.

Constancy tests

Testing of specific parameters for deviations from reference values, carried out at regular intervals.

Contamination, radioactive

Presence of radioactive substances in a material, where this is unintended or undesirable.

Discharge

Controlled release of radioactive substances to the environment, mainly in the form of gases and aerosols via the exhaust air pathway, or in the form of liquids via the liquid effluent pathway. The emplacement of radioactive wastes in a repository is not considered to be a discharge to the environment within the meaning of Article 79.

Dose

Quantity used to assess the health risks of ionising radiation. Unless indicated to the contrary, the term is used in this Ordinance to mean “effective dose”.

Dose, absorbed

The amount of energy deposited per unit mass of material as a result of interaction with ionising radiation. The unit of absorbed dose is given the special name gray (Gy); 1 Gy = 1 J/kg.

Dose, ambient

The ambient dose is taken to be

a. the quantity H*(10) (ambient dose equivalent) for strongly penetrating radiation;

b. the quantity H′(0.07) (directional dose equivalent) for weakly penetrating radiation.

Dose, ambient equivalent, H*(10)

The ambient dose equivalent H*(10) at the point of interest in the real radiation field is the dose equivalent that would be produced by the corresponding expanded and aligned field in the ICRU sphere at a depth of 10 mm on the radius opposing the direction of the aligned field.

Dose, committed effective (E_{50})

The effective dose that accumulates in the body over a period of 50 years as a result of the intake of a nuclide.

Dose, directional equivalent H′(0.07)

The directional dose equivalent H′(0.07) at the point of interest in the real radiation field is the dose equivalent that would be produced by the corresponding expanded field in the ICRU sphere at a depth of 0.07 mm on a radius in a specified direction.

Dose, effective (E)

The sum of the equivalent doses in all organs and tissues weighted with the factor w_T.

$E = \Sigma_T w_T H_T = \Sigma_T w_T \Sigma_R w_R D_{T,R}$

$D_{T,R}$ = absorbed dose in tissue T due to radiation R

w_R = radiation weighting factor

w_T = tissue weighting factor (contribution of tissue/organ T to the overall risk)

H_T = equivalent dose for tissue/organ T

The special name for the unit of effective dose is the sievert (Sv); 1 Sv = 1 J/kg.

Radiation weighting factors

Radiation type and energy range		Radiation weighting factor, w_R
Photons, all energies		1
Electrons and muons, all energies		1
Neutrons, energy	– < 10 keV	5
	– 10 keV to 100 keV	10
	– 100 keV to 2 MeV	20
	– 2 MeV to 20 MeV	10
	– > 20 MeV	5
Protons, other than recoil protons, energy	– > 2 MeV	5
Alpha particles, fission fragments, heavy nuclei		20

Tissue weighting factors

Tissue or organ	Tissue weighting factors, w_T
Gonads	0.20
Bone marrow (red)	0.12
Colon	0.12
Lung	0.12
Stomach	0.12
Bladder	0.05
Breast	0.05
Liver	0.05
Oesophagus	0.05
Thyroid	0.05
Skin	0.01
Bone surface	0.01
Remainder	0.05

Dose, equivalent (H)

The product of the absorbed dose $D_{T,R}$ due to radiation R in tissue T and the radiation weighting factor w_R (cf. *Dose, effective*). The special name for the unit of equivalent dose is the sievert (Sv); 1 Sv = 1 J/kg. $H_{T,R} = w_R \cdot D_{T,R}$; for a mixture of radiation types: $H_T = \Sigma_R\, w_R \cdot D_{T,R}$

Dose, personal deep, $H_p(10)$ [short form: H_p]

Equivalent dose in soft tissue at a depth of 10 mm in the thoracic region.

Dose, personal surface, $H_p(0.07)$ [short form: H_s]

Equivalent dose in soft tissue at a depth of 0.07 mm in the thoracic region.

Dosimeter

Instrument used to measure ambient or personal doses.

Full protection system

Shielding of an ionising radiation generator and of sealed source equipment which ensures that, during operation, useful, stray and incidental radiation is completely contained and shielded to such an extent that the ambient dose rate at a distance of 10 cm from the outer surface is reduced to less than 1 microsievert per hour and that, in all accessible areas, the dose limits applicable for non-occupationally exposed persons cannot be exceeded.

Gray (Gy)

The special name for the unit of absorbed dose. 1 Gy = 1 J/kg.

Guidance value

General term for a value which is derived from a limit; exceeding this value triggers certain measures, while compliance with it also ensures compliance with the associated limit.

The guidance value for concentrations of radon gas is regarded as a value to be aimed for. Exceeding this value has no legal implications.

Half-life

The time taken for the activity of a radionuclide to lose half its value by decay.

High-dose diagnostic procedures

Examinations of the axial skeleton, pelvis and abdomen, and direct or indirect cross-sectional imaging studies. Such procedures also include fluoroscopy, fluoroscopic contrast studies and fluoroscopy-guided interventions. Fluoroscopic examinations of the peripheral extremities, including the elbow and ankle, are not considered to be high-dose diagnostic procedures.

ICRU sphere

A sphere defined as having a diameter of 30 cm, a density of 1 g/cm^3 and a mass composition of 76.2% oxygen, 11.1% carbon, 10.1% hydrogen and 2.6% nitrogen (simulating soft tissue).

Import/export

Import or export is deemed to be such whether it is definitive or temporary. The term “import” also applies to storage in a customs bonded warehouse, a bulk goods warehouse or a duty-free warehouse.

Ingestion

Intake of radioactive substances via the gastrointestinal tract.

Inhalation

Intake of radioactive substances through breathing.

Intake

Act or process of taking radioactive substances into the body by ingestion or inhalation, or through the skin or wounds.

Ionizing radiation

Radiation that has sufficient energy to eject electrons from an atomic shell (ionisation).

Ionizing radiation generators

Equipment and devices used to generate photon or particle radiation with an energy greater than 5 kiloelectronvolts.

Irradiator

A device used for irradiation purposes, containing a sealed radioactive source. The radiation source is enclosed within shielding, to which it remains mechanically connected irrespective of the operating state.

Management of radioactive waste

Activities whereby radioactive waste is prepared for surrender to the federal collection centre.

Non-occupationally exposed persons

People who could be exposed to higher-than-background levels of controllable radiation as a result of circumstances not related to work or training.

Occupationally exposed persons

People who:

a. could accumulate an effective dose of more than 1 mSv per year in the course of their work or training through controllable radiation exposure; or

b. regularly work or undergo training in controlled areas.

Preparation of a radiopharmaceutical

Process in which the final radiopharmaceutical product is produced by following the radiolabelling instructions specified by the licence of a radiolabelling kit for diagnostic purposes.

Quality assurance

Planning, monitoring, testing and adjusting the execution of a product or activity with the goal of fulfilling specified quality requirements.

Radioactivity

Spontaneous disintegration of nuclides, accompanied by the emission of ionising radiation.

Radiation sources

Equipment and articles containing radioactive substances (sealed and unsealed radioactive sources) and installations capable of emitting ionising radiation.

Radionuclide

Nuclide that disintegrates spontaneously, emitting radiation.

Radionuclide generator

Radioactive source with a fixed parent radionuclide producing a daughter radionuclide which can be removed by elution or by any other method.

Radiopharmaceuticals

Drugs containing radionuclides whose radiation is used for diagnostic or therapeutic purposes.
For the purposes of this Ordinance, the following are considered to be radiopharmaceuticals:

a. medicinal products containing one or more radionuclides in a form which can be directly used;

b. non-radioactive components (kits) used to produce radiopharmaceuticals by reconstitution of or combination with radionuclides immediately prior to use in humans;

c. radionuclide generators with a fixed parent radionuclide producing a daughter radionuclide which is removed by elution or by any other method and used in a radiopharmaceutical;

d. radionuclides used directly or as precursors for the radiolabelling of other substances (carrier compounds, cells, plasma proteins) prior to their administration.

Radiopharmaceuticals with increased hazard potential

Radiolabelling kit for therapeutic purposes, positron emission tomography (PET) radiopharmaceuticals and radiopharmaceuticals produced in-house (with or without kits).

Screening measurement

Procedure for detecting possible intakes without determining the effective dose. If a predefined threshold is exceeded, personal dosimetry must be performed to assess the committed effective dose.

Screening, radiological

Radiological examination carried out systematically on a large number of people in the absence of a specific indication. Routine occupational health examinations are not regarded as screening.

Servicing

Ensuring the functionality and safety of equipment by means of preventive measures.

Sievert (Sv)

The special name for the unit of equivalent dose or effective dose. 1 Sv = 1 J/kg.

Sources, radioactive

Sealed and unsealed sources.

Sources, sealed radioactive

Radiation sources which contain radioactive substances and whose structure is such as to prevent, under normal conditions of use, any release of the radioactive substances and thus preclude any risk of contamination. The source encapsulation must satisfy the requirements of the ISO standards for the intended use and be classified as such.

Sources, unsealed radioactive

Radiation sources containing radioactive substances that are capable of spreading and causing contamination.

Standard

Measuring instrument or embodiment of a measurement, used as a reference for testing other measuring instruments.

Stray radiation

Ionising radiation emitted from a device not primarily intended as an ionising radiation generator, or from components thereof, as a by-product of normal operation or as a result of faults.

Substances, radioactive

Substances containing radionuclides whose activity exceeds the exemption limits specified in Annex 3, Column 9.

Summation rule

Rule used to assess compliance with activity limits for mixtures of nuclides. Here, the various nuclides are weighted according to the hazard they pose. If the following inequalities are satisfied, then the mixtures are respectively below the exemption limit or below the guidance value for surface contamination.

$$\frac{a_1}{LE_1} + \frac{a_2}{LE_2} + \cdots + \frac{a_n}{LE_n} < 1$$

$a_1, a_2, \ldots a_n$: specific activities of nuclides 1, 2, … n in Bq/kg

$LE_1, LE_2, \ldots LE_n$: exemption limits for nuclides 1, 2, … n in Bq/kg as specified in Annex 3 Column 9

$$\frac{c_1}{CS_1} + \frac{c_2}{CS_2} + \cdots + \frac{c_n}{CS_n} < 1$$

$c_1, c_2, \ldots c_n$: contamination values for nuclides 1, 2, … n in Bq/cm^2

$CS_1, CS_2, \ldots CS_n$: guidance values for surface contamination for nuclides 1, 2, … n in Bq/cm^2 as specified in Annex 3, Column 12

Synthesis of a finished radiopharmaceutical product

All the steps involved in the synthesis of a ready-to-use radiopharmaceutical (finished radiopharmaceutical product), in particular the incorporation of the radioisotope into a molecule (e.g. formation of a covalent bond, complexation or attainment of the required radionuclide oxidation state by reduction/oxidation).

Traceability

The property of the result of a measurement or the value of a standard whereby it can be related to the stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties.

Verification

Official testing and certification that a particular radiation measuring device (measuring instrument) complies with the legal requirements.

Waste, radioactive

Radioactive substances or radioactively contaminated materials which will not be reused.

Annex 2[163]
(Article 1 paragraph 1 and Article 2 paragraph 1)

Scope

1. Substances and articles

The Ordinance is applicable when, for a substance or article, all the values in at least one row are exceeded.

For ores, minerals, and rock collections, only the row specifically concerned with this category is relevant.

Substances, articles	Specific activity	Absolute activity, mass	Concentration, contamination, dose rate
Solids	Exemption limit specified in Annex 3 Column 9	Exemption limit specified in Annex 3 Column 9	
Solids			Ambient dose rate at 10 cm from the surface after subtraction of background: 0.1 µSv per hour
Solids			Guidance value specified in Annex 3 Column 12
Liquids	Exemption limit specified in Annex 3 Column 9	Exemption limit specified in Annex 3 Column 9	
Water	1% of the exemption limit specified in Annex 3 Column 9	Exemption limit specified in Annex 3 Column 9	
Gases and air (including radon)			$^{1}/_{300}$ of the guidance value specified in Annex 3 Column 11
Foodstuffs	Tolerance or limit values specified in the DHA Ordinanceof 26 June 1995[164] on Contaminants and Constituents in Foodstuffs		

163 Amended by No II of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107).
164 SR **817.021.23**

Substances, articles	Specific activity	Absolute activity, mass	Concentration, contamination, dose rate
Articles of daily use	1% of the exemption limit specified in Annex 3 Column 9 for artificially produced radionuclides	Exemption limit specified in Annex 3 Column 9	
Ores, minerals and rock collections	1000 times the exemption limit specified in Annex 3 Column 9	10 g natural thorium or 100 g natural uranium	

2. Wastes and wastewater

The Ordinance is applicable when, for wastes or wastewater, all the values in at least one row are exceeded.

The monthly values relate to discharges to the environment.

Wastes, wastewater	Specific activity	Absolute activity per licence	Contamination, dose rate
Solid wastes	Exemption limit specified in Annex 3 Column 9	100 times the exemption limit specified in Annex 3 Column 9 per month	
Solid wastes			Ambient dose rate at 10 cm from the surface after subtraction of background: 0.1 µSv per hour
Solid wastes			Guidance value specified in Annex 3 Column 12
Liquid wastes	Exemption limit specified in Annex 3 Column 9	100 times the exemption limit specified in Annex 3 Column 9 per month	
Wastewater	1% of the exemption limit specified in Annex 3 Column 9 (weekly average in working area wastewater)	100 times the exemption limit specified in Annex 3 Column 9 per month	
Gaseous wastes, contained		Licensing limit specified in Annex 3 Column 10	

Annex 3[165]

Data for Operational Radiation Protection

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/(kBq/cm²)	Exemption limit: **LE** Bq/kg or LE_{abs} Bq	Licensing limit: **LA** Bq	Guidance values: **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
H-3	12.35 y	β^-	4.1 E-11	4.2 E-11	<0.001	<1	<0.1	2 E+05	1 E+08	2 E+05	1000	
H-3, HTO	12.35 y	β^-	1.8 E-11	1.8 E-11	<0.001	<1	<0.1	6 E+05	3 E+08	5 E+05	1000	
H-3, gas [7]	12.35 y	β^-	1.8 E-15		<0.001	<1	<0.1		3 E+12	5 E+09		
Be-7	53.3 d	ε, γ	4.6 E-11	2.8 E-11	0.008	<1	0.1	4 E+05	1 E+08	1 E+05	1000	
Be-10	1.6 E6 y	β^-	1.9 E-08	1.1 E-09	<0.001	2000	1.6	9 E+03	3 E+05	9 E+01	3	
C-11	20.38 m	ε, β^+	3.2 E-12	2.4 E-11	0.160	1000	1.7	4 E+05	7 E+07	7 E+04 [3]	3	
C-11 monoxide	20.38 m	ε, β^+	1.2 E-12	1.2 E-12					7 E+07	7 E+04 [3]		
C-11 dioxide	20.38 m	ε, β^+	2.2 E-12	2.2 E-12					7 E+07	7 E+04 [3]		
C-14	5730 y	β^-	5.8 E-10	5.8 E-10	<0.001	200	0.3	2 E+04	9 E+06	1 E+04	30	
C-14 monoxide	5730 y	β^-	8.0 E-13	8.0 E-13					6 E+09	1 E+07		
C-14 dioxide	5730 y	β^-	6.5 E-12	6.5 E-12					8 E+08	1 E+06		
N-13	9.965 m	ε, β^+			0.160	1000	1.7		7 E+07	7 E+04 [3]	3	
O-15	122.24 s	ε, β^+			0.161	1000	1.7		7 E+07	7 E+04 [3]	3	
F-18	109.77 m	ε, β^+	9.3 E-11	4.9 E-11	0.160	2000	1.7	2 E+05	5 E+07	7 E+04 [3]	3	
Na-22	2.602 y	ε, β^+, γ	2.0 E-09	3.2 E-09	0.330	2000	1.6	3 E+03	3 E+06	4 E+03	3	
Na-24	15 h	β^-, γ	5.3 E-10	4.3 E-10	0.506	1000	1.9	2 E+04	9 E+06	3 E+04	3	
Mg-28/Al-28	20.91 h	β^-, γ	1.7 E-09	2.2 E-09	0.529	2000	3.1	5 E+03	3 E+06	6 E+03	3	

165 Amended by No II of the Ordinance of 17 Nov. 1999 (AS **2000** 107). Corrected in accordance with No II of the Ordinance of 15 Nov. 2000, in force since 1 Jan. 2001 (AS **2000** 2894).

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: **LE** Bq/kg or LE_{abs} Bq	Licensing limit: **LA** Bq	Guidance values: **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Al-26	7.16 E5 y	ε, β^+, γ	1.4 E-08	3.5 E-09	0.382	1000	1.5	3 E+03	4 E+05	4 E+02		3
Si-31	157.3 m	β^-, γ	1.1 E-10	1.6 E-10	<0.001	1000	1.6	6 E+04	5 E+07	1 E+05		3
Si-32	450 y	β^-	5.5 E-08	5.6 E-10	<0.001	500	0.6	2 E+04	9 E+04	3 E+01		3→ P-32
P-30	2.499 m	ε, β^+, γ			0.371	900	1.7					3
P-32	14.29 d	β^-	2.9 E-09	2.4 E-09	<0.001	1000	1.6	4 E+03	2 E+06	2 E+03		3
P-33	25.4 d	β^-	1.3 E-09	2.4 E-10	<0.001	700	0.8	4 E+04	4 E+06	1 E+04		10
S-35 (inorg.)	87.44 d	β^-	1.1 E-09	1.9 E-10	<0.001	200	0.3	5 E+04	5 E+06	1 E+04		30
S-35 (org.)	87.44 d	β^-	1.2 E-10	7.7 E-10	<0.001	200	0.3	1 E+04	4 E+07	7 E+04		30
Cl-36	3.01 E5 y	β^-, ε, β^+	5.1 E-09	9.3 E-10	<0.001	1000	1.5	1 E+04	1 E+06	1 E+03		3
Cl-38	37.21 m	β^-, γ	7.3 E-11	1.2 E-10	1.551	1000	1.8	8 E+04	7 E+07	4 E+04 [3]		3
Cl-39	55.6 m	β^-, γ	7.6 E-11	8.5 E-11	0.241	1000	1.7	1 E+05	7 E+07	2 E+05		3→ Ar-39
Ar-37	35. 02 d	ε			<0.001	<1	<0.1		1 E+14	1 E+11		
Ar-39	269 y	β^-			<0.001	2000	1.5		3 E+10	7 E+06 [4]		
Ar-41	1.827 h	β^-, γ			0.188	1000	1.7		5 E+07	5 E+04		
K-38	7.636 m	ε, β^+, γ			0.480	1000	1.8					3
K-40	1.28 E9 y	β^-, ε, γ	3.0 E-09	6.2 E-09	0.022	1000	1.5	2 E+03	2 E+06	3 E+03		3
K-42	12.36 h	β^-, γ	2.0 E-10	4.3 E-10	0.464	1000	1.7	2 E+04	3 E+07	2 E+04		3
K-43	22.6 h	β^-, γ	2.6 E-10	2.5 E-10	0.152	1000	1.6	4 E+04	2 E+07	4 E+04		3
K-44	22.13 m	β^-, γ	3.7 E-11	8.4 E-11	1.553	1000	1.8	1 E+05	1 E+08	3 E+05		3
K-45	20 m	β^-, γ	2.8 E-11	5.4 E-11	0.302	1000	1.7	2 E+05	2 E+08	5 E+05		3
Ca-41	1.4 E5 y	ε	1.9 E-10	2.9 E-10	<0.001	<1	<0.1	3 E+04	3 E+07	3 E+04		300
Ca-45	163 d	β^-, γ	2.3 E-09	7.6 E-10	<0.001	700	0.8	1 E+04	2 E+06	5 E+03		10
Ca-47	4.53 d	β^-, γ	2.1 E-09	1.6 E-09	0.156	1000	1.6	6 E+03	2 E+06	4 E+03		3→ Sc-47
Sc-43	3.891 h	ε, β^+, γ	1.8 E-10	1.9 E-10	0.174	1000	1.4	5 E+04	3 E+07	1 E+05		3
Sc-44	3.927 h	ε, β^+, γ	3.0 E-10	3.5 E-10	0.324	1000	1.7	3 E+04	2 E+07	7 E+04		3
Sc-44m	58.6 h	ε, γ	2.0 E-09	2.4 E-09	0.045	200	0.2	4 E+03	3 E+06	4 E+03		3→ Sc-44 [6]

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit **LE** Bq/kg or LE_{abs} Bq	Licensing limit **LA** Bq	Guidance values **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Sc-46	83.83 d	β^-, γ	4.8 E-09	1.5 E-09	0.299	1000	1.2	7 E+03	1 E+06	1 E+03	3	
Sc-47	3.351 d	β^-, γ	7.3 E-10	5.4 E-10	0.017	1000	1.3	2 E+04	7 E+06	1 E+04	3	
Sc-48	43.7 h	β^-, γ	1.6 E-09	1.7 E-09	0.495	2000	1.7	6 E+03	3 E+06	7 E+03	3	
Sc-49	57.4 m	β^-, γ	6.1 E-11	8.2 E-11	0.001	1000	1.6	1 E+05	8 E+07	3 E+05	3	
Ti-44	47.3 y	ε, γ	7.2 E-08	5.8 E-09	0.026	2	<0.1	2 E+03	7 E+04	3 E+02	30	→ Sc-44 [6]
Ti-45	3.08 h	ε, β^+, γ	1.5 E-10	1.5 E-10	0.136	1000	1.5	7 E+04	3 E+07	2 E+05	3	
V-47	32.6 m	ε, β^+, γ	5.0 E-11	6.3 E-11	0.156	1000	1.7	2 E+05	1 E+08	4 E+05	3	
V-48	16.238 d	ε, β^+, γ	2.7 E-09	2.0 E-09	0.432	900	1.0	5 E+03	2 E+06	3 E+03	3	
V-49	330 d	ε	2.6 E-11	1.8 E-11	<0.001	<1	<0.1	6 E+05	2 E+08	9 E+04	100	
Cr-48	22.96 h	ε, β^+, γ	2.5 E-10	2.0 E-10	0.071	50	0.1	5 E+04	2 E+07	3 E+04	100	→ V-48 [6]
Cr-49	42.09 m	ε, β^+, γ	5.9 E-11	6.1 E-11	0.166	1000	1.7	2 E+05	8 E+07	1 E+05	3	→ V-49
Cr-51	27.704 d	ε, γ	3.6 E-11	3.8 E-11	0.005	3	<0.1	3 E+05	1 E+08	2 E+05	100	
Mn-51	46.2 m	ε, β^+, γ	6.8 E-11	9.3 E-11	0.159	1000	1.7	1 E+05	7 E+07	1 E+05	3	→ Cr-51
Mn-52	5.591 d	ε, β^+, γ	1.8 E-09	1.8 E-09	0.510	600	0.7	6 E+03	3 E+06	5 E+03	10	
Mn-52m	21.1 m	ε, β^+, γ	5.0 E-11	6.9 E-11	0.389	1000	1.7	1 E+05	1 E+08	2 E+05	3	→ Mn-52
Mn-53	3.7 E6 y	ε	3.6 E-11	3.0 E-11	<0.001	20	<0.1	3 E+05	1 E+08	2 E+05	1000	
Mn-54	312.5 d	ε, γ	1.2 E-09	7.1 E-10	0.126	10	0.1	1 E+04	4 E+06	7 E+03	100	
Mn-56	2.5785 h	β^-, γ	2.0 E-10	2.5 E-10	0.275	1000	1.7	4 E+04	3 E+07	4 E+04	3	
Fe-52	8.275 h	ε, β^+, γ	9.5 E-10	1.4 E-09	0.116	900	1.0	7 E+03	5 E+06	9 E+03	3	→ Mn-52m [6]
Fe-55	2.70 y	ε	9.2 E-10	3.3 E-10	<0.001	20	<0.1	3 E+04	5 E+06	9 E+03	300	
Fe-59	44.529 d	β^-, γ	3.2 E-09	1.8 E-09	0.175	1000	1.1	6 E+03	2 E+06	3 E+03	3	
Fe-60	1 E5 y	β^-	3.3 E-07	1.1 E-07	<0.001	90	0.3	9 E+01	2 E+04	3 E+01	3	→ Co-60m
Co-55	17.54 h	ε, β^+, γ	8.3 E-10	1.1 E-09	0.302	1000	1.4	9 E+03	6 E+06	1 E+04	3	→ Fe-55
Co-56	78.76 d	ε, β^+, γ	4.9 E-09	2.5 E-09	0.485	300	0.6	4 E+03	1 E+06	2 E+03	10	
Co-57	270.9 d	ε, γ	6.0 E-10	2.1 E-10	0.021	100	0.1	5 E+04	8 E+06	1 E+04	100	
Co-58	70.80 d	ε, β^+, γ	1.7 E-09	7.4 E-10	0.147	300	0.3	1 E+04	3 E+06	5 E+03	30	
Co-58m	9.15 h	γ	1.7 E-11	2.4 E-11	<0.001	10	<0.1	4 E+05	3 E+08	5 E+05	1000	→ Co-58 [6]

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: LE Bq/kg or LE_{abs} Bq	Licensing limit: LA Bq	Guidance values: CA Bq/m³	CS Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Co-60	5.271 y	β^-, γ	1.7 E-08	3.4 E-09	0.366	1000	1.1	1 E+03[166]	9 E+04	5 E+02		3
Co-60m	10.47 m	β^-, γ	1.2 E-12	1.7 E-12	0.001	20	<0.1	6 E+06	4 E+09	7 E+06		300→ Co-60 [6]
Co-61	1.65 h	β^-, γ	7.5 E-11	7.4 E-11	0.017	1000	1.6	1 E+05	7 E+07	1 E+05		3
Co-62m	13.91 m	β^-, γ	3.7 E-11	4.7 E-11	0.436	1000	1.8	2 E+05	1 E+08	2 E+05		3
Ni-56	6.10 d	ε, γ	9.6 E-10	8.6 E-10	0.260	60	0.1	1 E+04	5 E+06	9 E+03		30→ Co-56 [6]
Ni-57	36.08 h	ε, β^+, γ	7.6 E-10	8.7 E-10	0.278	700	0.8	1 E+04	7 E+06	1 E+04		10→ Co-57
Ni-59	7.5 E4 y	ε	2.2 E-10	6.3 E-11	<0.001	10	<0.1	2 E+05	2 E+07	4 E+04		1000
Ni-63	96 y	β^-	5.2 E-10	1.5 E-10	<0.001	<1	<0.1	7 E+04	1 E+07	2 E+04		1000
Ni-65	2.520 h	β^-, γ	1.3 E-10	1.8 E-10	0.081	1000	1.6	6 E+04	4 E+07	6 E+04		3
Ni-66 / Cu-66	54.6 h	β^-, γ	1.9 E-09	3.0 E-09	0.039	2000	2.2	3 E+03	3 E+06	4 E+03		3
Cu-60	23.2 m	ε, β^+, γ	6.2 E-11	7.0 E-11	0.596	1000	1.8	1 E+05	8 E+07	1 E+05		3
Cu-61	3.408 h	ε, β^+, γ	1.2 E-10	1.2 E-10	0.128	900	1.1	8 E+04	4 E+07	7 E+04		3
Cu-64	12.701 h	ε, β^+, β^-, γ	1.5 E-10	1.2 E-10	0.030	900	0.8	8 E+04	3 E+07	6 E+04		10
Cu-67	61.86 h	β^-, γ	5.8 E-10	3.4 E-10	0.018	1000	1.4	3 E+04	9 E+06	1 E+04		3
Zn-62 / Cu-62	9.26 h	ε, β^+, γ	6.6 E-10	9.4 E-10	0.319	1000	1.9	1 E+04	8 E+06	1 E+04		3
Zn-63	38.1 m	ε, β^+, γ	6.1 E-11	7.9 E-11	0.175	1000	1.6	1 E+05	8 E+07	1 E+05		3
Zn-65	243.9 d	ε, β^+, γ	2.8 E-09	3.9 E-09	0.086	40	0.1	3 E+03	2 E+06	3 E+03		30
Zn-69	57 m	β^-, γ	4.3 E-11	3.1 E-11	<0.001	1000	1.6	3 E+05	1 E+08	2 E+05		3
Zn-69m	13.76 h	β^-, γ	3.3 E-10	3.3 E-10	0.067	70	0.1	3 E+04	2 E+07	3 E+04		3→ Zn-69
Zn-71m	3.92 h	β^-, γ	2.4 E-10	2.4 E-10	0.240	1000	1.7	4 E+04	2 E+07	3 E+04		3
Zn-72	46.5 h	β^-, γ	1.5 E-09	1.4 E-09	0.026	900	0.9	7 E+03	3 E+06	6 E+03		3→ Ga-72 [6]
Ga-65	15.2 m	ε, β^+, γ	2.9 E-11	3.7 E-11	0.183	1000	1.6	3 E+05	2 E+08	3 E+05		3→ Zn-65
Ga-66	9.40 h	ε, β^+, γ	7.1 E-10	1.2 E-09	0.877	600	1.1	8 E+03	7 E+06	1 E+04		3
Ga-67	78.26 h	ε, γ	2.8 E-10	1.9 E-10	0.025	30	0.3	5 E+04	2 E+07	3 E+04		30
Ga-68	68.0 m	ε, β^+, γ	8.1 E-11	1.0 E-10	0.149	1000	1.5	1 E+05	6 E+07	1 E+05		3

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Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: LE Bq/kg or LE_{abs} Bq	Licensing limit: LA Bq	Guidance values: CA Bq/m³	CS Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Ga-70	21.15 m	ε, β^-, γ	2.6 E-11	3.1 E-11	0.001	1000	1.6	3 E+05	2 E+08	3 E+05		3
Ga-72	14.1 h	β^-, γ	8.4 E-10	1.1 E-09	0.386	1000	1.7	9 E+03	6 E+06	1 E+04		3
Ga-73	4.91 h	β^-, γ	2.0 E-10	2.6 E-10	0.052	1000	1.6	4 E+04	3 E+07	4 E+04		3
Ge-66	2.27 h	ε, β^+, γ	1.3 E-10	1.0 E-10	0.108	400	0.5	1 E+05	4 E+07	6 E+04		10→ Ga-66 [6]
Ge-67	18.7 m	ε, β^+, γ	4.2 E-11	6.5 E-11	0.407	1000	1.7	2 E+05	1 E+08	2 E+05		3→ Ga-67
Ge-68	288d	ε	7.9 E-09	1.3 E-09	<0.001	10	<0.1	8 E+03	6 E+05	1 E+03		3→ Ga-68 [6]
Ge-69	39.05 h	ε, β^+, γ	3.7 E-10	2.4 E-10	0.132	500	0.6	4 E+04	1 E+07	2 E+04		10
Ge-71	11.8 d	ε	1.1 E-11	1.2 E-11	<0.001	10	<0.1	8 E+05	5 E+08	8 E+05		1000
Ge-75	82.78 m	β^-, γ	5.4 E-11	4.6 E-11	0.006	1000	1.6	2 E+05	9 E+07	2 E+05		3
Ge-77	11.3 h	β^-, γ	4.5 E-10	3.3 E-10	0.163	1000	1.6	3 E+04	1 E+07	2 E+04		3
Ge-78	87 m	β^-, γ	1.4 E-10	1.2 E-10	0.045	1000	1.5	8 E+04	4 E+07	6 E+04		3→ As-78 [6]
As-69	15.2 m	ε, β^+, γ	3.5 E-11	5.7 E-11	0.250	900	1.7	2 E+05	1 E+08	2 E+05		3→ Ge-69
As-70	52.6 m	ε, β^+, γ	1.2 E-10	1.3 E-10	0.603	1000	1.7	8 E+04	4 E+07	7 E+04		3
As-71	64.8 h	ε, β^+, γ	5.0 E-10	4.6 E-10	0.088	700	0.7	2 E+04	1 E+07	2 E+04		10→ Ge-71
As-72	26.0 h	ε, β^+, γ	1.3 E-09	1.8 E-09	0.339	900	1.6	6 E+03	4 E+06	6 E+03		3
As-73	80.30 d	ε, γ	6.5 E-10	2.6 E-10	0.003	20	<0.1	4 E+04	8 E+06	1 E+04		300
As-74	17.76 d	ε, β^+, β^-, γ	1.8 E-09	1.3 E-09	0.117	900	1.1	8 E+03	3 E+06	5 E+03		3
As-76	26.32 h	β^-, γ	9.2 E-10	1.6 E-09	0.132	1000	1.6	6 E+03	5 E+06	9 E+03		3
As-77	38.8 h	β^-, γ	4.2 E-10	4.0 E-10	0.001	1000	1.5	3 E+04	1 E+07	2 E+04		3
As-78	90.7 m	β^-, γ	1.4 E-10	2.1 E-10	0.804	1000	1.7	5 E+04	4 E+07	6 E+04		3
Se-70	41.0 m	ε, β^+, γ	1.2 E-10	1.4 E-10	0.158	900	1.3	7 E+04	4 E+07	7 E+04		3→ As-70 [6]
Se-73	7.15 h	ε, β^+, γ	2.4 E-10	3.9 E-10	0.174	900	1.2	3 E+04	2 E+07	3 E+04		3→ As-73
Se-73m	39 m	ε, β^+, γ	2.7 E-11	4.1 E-11	0.038	300	0.4	2 E+05	2 E+08	3 E+05		10→ Se-73
Se-75	119.8 d	ε, γ	1.7 E-09	2.6 E-09	0.064	80	0.1	4 E+03	3 E+06	5 E+03		30
Se-79	6.5 E4 y	β^-, γ	3.1 E-09	2.9 E-09	<0.001	200	0.4	3 E+03	2 E+06	3 E+03		10
Se-81	18.5 m	β^-, γ	2.4 E-11	2.7 E-11	0.002	1000	1.6	4 E+05	2 E+08	3 E+05		3
Se-81m	57.25 m	β^-, γ	6.8 E-11	5.9 E-11	0.004	100	1.1	2 E+05	7 E+07	1 E+05		3→ Se-81
Se-83	22.5 m	β^-, γ	5.3 E-11	5.1 E-11	0.362	1000	1.7	2 E+05	9 E+07	2 E+05		3→ Br-83

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: LE Bq/kg or LE_{abs} Bq	Licensing limit: LA Bq	Guidance values: CA Bq/m³	CS Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Br-74	25.3 m	ε, β^+, γ	6.8 E-11	8.4 E-11	1.022	1000	1.8	1 E+05	7 E+07	1 E+05		3
Br-74m	41.5 m	ε, β^+, γ	1.1 E-10	1.4 E-10	1.347	900	1.8	7 E+04	5 E+07	8 E+04		3
Br-75	98 m	ε, β^+, γ	8.5 E-11	7.9 E-11	0.189	900	1.3	1 E+05	6 E+07	1 E+05		3→ Se-75
Br-76	16.2 h	ε, β^+, γ	5.8 E-10	4.6 E-10	0.503	700	1.1	2 E+04	9 E+06	1 E+04		3
Br-77	56 h	ε, β^+, γ	1.3 E-10	9.6 E-11	0.051	60	0.1	1 E+05	4 E+07	6 E+04		100
Br-80	17.4 m	ε, β^+, β^-, γ	1.7 E-11	3.1 E-11	0.013	1000	1.5	3 E+05	3 E+08	5 E+05		3
Br-80m	4.42 h	γ	1.0 E-10	1.1 E-10	0.012	10	<0.1	9 E+04	5 E+07	8 E+04		3→ Br-80
Br-82	35.30 h	β^-, γ	8.8 E-10	5.4 E-10	0.395	1000	1.4	2 E+04	6 E+06	9 E+03		3
Br-83	2.39 h	β^-, γ	6.7 E-11	4.3 E-11	0.001	1000	1.5	2 E+05	7 E+07	1 E+05		3
Br-84	31.80 m	β^-, γ	6.2 E-11	8.8 E-11	0.923	1000	1.7	1 E+05	8 E+07	1 E+05		3
Kr-79	35.04 h	ε, β^+, γ			0.042	100	0.2		3 E+08	3 E+05		
Kr-81	2.1 E5 y	ε, γ			0.004	8	<0.1		7 E+09	7 E+06		
Kr-83m	1.83 h	γ			0.002	3	<0.1		1 E+12	1 E+09		
Kr-85	10.72 y	β^-, γ			0.001	1000	1.5		5 E+07 [8]	5 E+06 [4]		
Kr-85m	4.48 h	β^-, γ			0.026	1000	1.4		5 E+08	5 E+05		→ Kr-85
Kr-87	76.3 m	β^-, γ			0.501	1000	1.7		8 E+07	8 E+04		→ Rb-87
Kr-88	2.84 h	β^-, γ			0.264	1000	1.5		2 E+07	2 E+04 [1]		→ Rb-88 [6]
Kr-89	3.18 m	β^-, γ			2.047	900	1.8		3 E+07	3 E+04		→ Rb-89 [6]
Rb-79	22.9 m	ε, β^+, γ	3.0 E-11	5.0 E-11	0.217	2000	2.1	2 E+05	2 E+08	3 E+05		3→ Kr-79
Rb-81	4.58 h	ε, β^+, γ	6.8 E-11	5.4 E-11	0.101	1000	1.2	2 E+05	7 E+07	1 E+05		3→ Kr-81
Rb-81m	32 m	γ	1.3 E-11	9.7 E-12	0.006	5	0.3	1 E+06	4 E+08	6 E+05		30→ Rb-81 [6]
Rb-82m	6.2 h	ε, β^+, γ	2.2 E-10	1.3 E-10	0.436	400	0.6	8 E+04	2 E+07	4 E+04		10
Rb-83	86.2 d	ε, γ	1.0 E-09	1.9 E-09	0.082	20	<0.1	5 E+03	5 E+06	8 E+03		100
Rb-84	32.77 d	ε, β^+, β^-, γ	1.5 E-09	2.8 E-09	0.141	400	0.6	4 E+03	3 E+06	6 E+03		10
Rb-86	18.66 d	β^-, γ	1.3 E-09	2.8 E-09	0.014	1000	1.6	4 E+03	4 E+06	6 E+03		3
Rb-87	4.7 E10 y	β^-	7.6 E-10	1.5 E-09	<0.001	1000	1.2	7 E+03	7 E+06	1 E+04		3
Rb-88	17.8 m	β^-, γ	2.8 E-11	9.0 E-11	2.314	900	1.7	1 E+05	2 E+08	3 E+05		3
Rb-89	15.2 m	β^-, γ	2.5 E-11	4.7 E-11	0.659	1000	1.8	2 E+05	2 E+08	3 E+05		3→ Sr-89

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: **LE** Bq/kg or LE_{abs} Bq	Licensing limit: **LA** Bq	Guidance values: **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Sr-80 / Rb-80	100m	ε, β^+, γ	2.1 E-10	3.5 E-10	1.750	900	1.7	3 E+04	2 E+07	4 E+04		3
Sr-81	25.5 m	ε, β^+, γ	6.1 E-11	7.8 E-11	0.247	1000	1.6	1 E+05	8 E+07	1 E+05		3→ Rb-81 [6]
Sr-82 / Rb-82	25.0 d	ε, β^+, γ	7.7 E-09	6.1 E-09	0.434	900	1.6	2 E+03	6 E+05	1 E+03		3
Sr-83	32.4 h	ε, β^+, γ	4.9 E-10	5.8 E-10	0.127	400	0.5	2 E+04	1 E+07	2 E+04		10→ Rb-83
Sr-85	64.84 d	ε, γ	6.4 E-10	5.6 E-10	0.086	20	0.1	2 E+04	8 E+06	1 E+04		100
Sr-85m	69.5 m	ε, γ	7.4 E-12	6.1 E-12	0.035	70	0.1	2 E+06	7 E+08	1 E+06		100→ Sr-85
Sr-87m	2.805 h	ε, γ	3.5 E-11	3.3 E-11	0.053	300	0.3	3 E+05	1 E+08	2 E+05		30→ Rb-87
Sr-89	50.5 d	β^-, γ	5.6 E-09	2.6 E-09	<0.001	1000	1.6	4 E+03	9 E+05	1 E+03		3
Sr-90	29.12 y	β^-	7.7 E-08	2.8 E-08	<0.001	1000	1.4	4 E+02	6 E+04	1 E+02		3→ Y-90 [6]
Sr-91	9.5 h	β^-, γ	5.7 E-10	7.6 E-10	0.117	1000	1.6	1 E+04	9 E+06	1 E+04		3→ Y-91m, Y-91
Sr-92	2.71 h	β^-, γ	3.4 E-10	4.9 E-10	0.194	1000	1.4	2 E+04	1 E+07	2 E+04		3→ Y-92 [6]
Y-86	14.74 h	ε, β^+, γ	8.1 E-10	9.6 E-10	0.515	500	0.8	1 E+04	6 E+06	1 E+04		10
Y-86m	48 m	ε, β^+, γ	4.9 E-11	5.6 E-11	0.034	200	0.1	2 E+05	1 E+08	2 E+05		30→ Y-86 [6]
Y-87	80.3 h	ε, β^+, γ	5.3 E-10	5.5 E-10	0.080	20	<0.1	2 E+04	9 E+06	2 E+04		100
Y-88	106.64 d	ε, β^+, γ	3.3 E-09	1.3 E-09	0.380	40	0.2	8 E+03	2 E+06	3 E+03		30
Y-90	64.0 h	β^-, γ	1.7 E-09	2.7 E-09	0.007	1000	1.6	4 E+03	3 E+06	5 E+03		3
Y-90m	3.19 h	γ	1.3 E-10	1.7 E-10	0.098	200	0.2	6 E+04	4 E+07	6 E+04		30→ Y-90
Y-91	58.51 d	β^-, γ	6.1 E-09	2.4 E-09	0.001	1000	1.6	4 E+03	8 E+05	1 E+03		3
Y-91m	49.71 m	γ	1.5 E-11	1.1 E-11	0.082	70	0.1	9 E+05	3 E+08	6 E+05		30→ Y-91
Y-92	3.54 h	β^-, γ	2.8 E-10	4.9 E-10	0.546	1000	1.7	2 E+04	2 E+07	3 E+04		3
Y-93	10.1 h	β^-, γ	6.0 E-10	1.2 E-09	0.098	1000	1.6	8 E+03	8 E+06	1 E+04		3→ Zr-93
Y-94	19.1 m	β^-, γ	4.6 E-11	8.1 E-11	1.111	900	1.7	1 E+05	1 E+08	2 E+05		3
Y-95	10.7 m	β^-, γ	2.6 E-11	4.6 E-11	1.219	1000	1.7	2 E+05	2 E+08	3 E+05		3→ Zr-95 [6]
Zr-86	16.5 h	ε, γ	7.0 E-10	8.6 E-10	0.069	100	0.1	1 E+04	7 E+06	1 E+04		30→ Y-86 [6]
Zr-88	83.4 d	ε, γ	4.1 E-09	3.3 E-10	0.076	50	0.1	3 E+04	1 E+06	2 E+03		100→ Y-88 [6]
Zr-89	78.43 h	ε, β^+, γ	7.5 E-10	7.9 E-10	0.182	400	0.5	1 E+04	7 E+06	1 E+04		10
Zr-93	1.53 E6 y	β^-	2.9 E-08	2.8 E-10	<0.001	<1	<0.1	4 E+04	2 E+05	3 E+02		100→ Nb-93m
Zr-95	63.98 d	β^-, γ	4.2 E-09	8.8 E-10	0.112	1000	1.1	1 E+04	1 E+06	2 E+03		3→ Nb-95 [6]

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit **LE** Bq/kg or LE_{abs} Bq	Licensing limit **LA** Bq	Guidance values **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Zr-97	16.90 h	β^-, γ	1.4 E-09	2.1 E-09	0.027	1000	1.6	5 E+03	4 E+06	6 E+03		3→ Nb-97
Nb-88	14.3 m	ε, β^+, γ	5.0 E-11	6.3 E-11	0.719	1000	1.8	2 E+05	1 E+08	2 E+05		3→ Zr-88
Nb-89-1 [2]	66 m	ε, β^+, γ	1.2 E-10	1.4 E-10	0.306	900	1.5	7 E+04	4 E+07	7 E+04		3→ Zr-89
Nb-89-2 [2]	122 m	ε, β^+, γ	1.9 E-10	3.0 E-10	0.392	700	1.3	3 E+04	3 E+07	4 E+04		3→ Zr-89
Nb-90	14.60 h	ε, β^+, γ	1.1 E-09	1.2 E-09	0.574	2000	1.9	8 E+03	5 E+06	8 E+03		3
Nb-91	680 y	ε	4.1 E-09	6.4 E-11				2 E+05	1 E+06	2 E+03		
Nb-91m	62 d	ε, γ	2.3 E-09	6.3 E-10				2 E+04	2 E+06	4 E+03		
Nb-92m	10.15 d	β^+, γ	5.9 E-10	6.0 E-10				2 E+04	8 E+06	1 E+04		
Nb-93m	13.6 y	γ	8.6 E-10	1.2 E-10	0.003	<1	<0.1	8 E+04	6 E+06	1 E+04	1000	
Nb-94	2.03 E4 y	β^-, γ	2.5 E-08	1.7 E-09	0.237	1000	1.5	6 E+03	2 E+05	3 E+02	3	
Nb-95	35.15 d	β^-, γ	1.3 E-09	5.8 E-10	0.116	100	0.3	2 E+04	4 E+06	6 E+03	30	
Nb-95m	86.6 h	γ	8.5 E-10	5.6 E-10	0.021	2000	1.4	2 E+04	6 E+06	1 E+04	3→ Nb-95 [6]	
Nb-96	23.35 h	β^-, γ	9.7 E-10	1.1 E-09	0.372	1000	1.6	9 E+03	5 E+06	9 E+03	3	
Nb-97	72.1 m	β^-, γ	7.2 E-11	6.8 E-11	0.099	1000	1.6	1 E+05	7 E+07	1 E+05	3	
Nb-98	51.5 m	β^-, γ	9.9 E-11	1.1 E-10	0.393	1000	1.8	9 E+04	5 E+07	8 E+04	3	
Mo-90	5.67 h	ε, β^+, γ	5.6 E-10	6.2 E-10	0.147	1000	1.4	2 E+04	9 E+06	1 E+04	3→ Nb-90 [6]	
Mo-93	3.5 E3 y	ε	1.4 E-09	2.6 E-09	0.016	4	<0.1	4 E+03	4 E+06	6 E+03	300	
Mo-93m	6.85 h	γ	3.0 E-10	2.8 E-10	0.330	800	0.8	4 E+04	2 E+07	3 E+04	10→ Mo-93	
Mo-99	66.0 h	β^-, γ	1.1 E-09	1.2 E-09	0.024	1000	1.6	8 E+03	5 E+06	8 E+03	3→ Tc-99m, Tc-99	
Mo-101	14.62 m	β^-, γ	4.5 E-11	4.2 E-11	0.196	1000	1.7	2 E+05	1 E+08	2 E+05	3→ Tc-101	
Tc-93	2.75 h	ε, γ	6.5 E-11	4.9 E-11	0.222	20	0.1	2 E+05	8 E+07	1 E+05	100→ Mo-93	
Tc-93m	43.5 m	ε, γ	3.1 E-11	2.4 E-11	0.098	300	0.4	4 E+05	2 E+08	3 E+05	10→ Tc-93, Mo-93	
Tc-94	293 m	ε, β^+, γ	2.2 E-10	1.8 E-10	0.414	200	0.4	6 E+04	2 E+07	4 E+04	10	
Tc-94m	52 m	ε, β^+, γ	8.0 E-11	1.1 E-10	0.285	700	1.3	9 E+04	6 E+07	1 E+05	3	
Tc-95	20.0 h	ε, γ	1.8 E-10	1.6 E-10	0.135	20	0.1	6 E+04	3 E+07	5 E+04	100	
Tc-95m	61 d	ε, β^+, γ	8.6 E-10	6.2 E-10	0.117	100	0.1	2 E+04	6 E+06	1 E+04	30→ Tc-95	
Tc-96	4.28 d	ε, γ	1.0 E-09	1.1 E-09	0.388	40	0.2	9 E+03	5 E+06	8 E+03	30	
Tc-96m	51.5 m	ε, γ	1.1 E-11	1.3 E-11	0.016	3	<0.1	8 E+05	5 E+08	8 E+05	1000→ Tc-96	

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: **LE** Bq/kg or LE_{abs} Bq	Licensing limit: **LA** Bq	Guidance values: **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Tc-97	2.6 E6 y	ε	1.6 E-10	8.3 E-11	0.017	4	<0.1	1 E+05	3 E+07	5 E+04	1000	
Tc-97m	87 d	γ	2.7 E-09	6.6 E-10	0.014	30	0.7	2 E+04	2 E+06	3 E+03	10	→ Tc-97
Tc-98	4.2 E6 y	β^-, γ	6.1 E-09	2.3 E-09	0.215	2000	1.5	4 E+03	8 E+05	1 E+03	3	
Tc-99	2.13 E5 y	β^-	3.2 E-09	7.8 E-10	<0.001	1000	1.1	1 E+04	2 E+06	3 E+03	3	
Tc-99m	6.02 h	γ	2.9 E-11	2.2 E-11	0.022	300	0.2	5 E+05	2 E+08	3 E+05	30	→ Tc-99
Tc-101	14.2 m	β^-, γ	2.1 E-11	1.9 E-11	0.055	1000	1.6	5 E+05	2 E+08	4 E+05	3	
Tc-104	18.2 m	β^-, γ	4.8 E-11	8.1 E-11	1.219	1000	1.8	1 E+05	1 E+08	2 E+05	3	
Ru-94	51.8 m	ε, γ	7.4 E-11	9.4 E-11	0.100	20	0.1	1 E+05	7 E+07	1 E+05	100	→ Tc-94
Ru-97	2.9 d	ε, γ	1.6 E-10	1.5 E-10	0.055	100	0.1	7 E+04	3 E+07	5 E+04	100	→ Tc-97
Ru-103	39.28 d	β^-, γ	2.2 E-09	7.3 E-10	0.073	500	0.6	1 E+04	2 E+06	4 E+03	10	
Ru-105	4.44 h	β^-, γ	2.5 E-10	2.6 E-10	0.119	1000	1.6	4 E+04	2 E+07	3 E+04	3	→ Rh-105
Ru-106 / Rh-106	368.2 d	β^-, γ	3.5 E-08	7.0 E-09	0.357	1000	1.6	1 E+03	1 E+05	2 E+02	3	
Rh-99	16 d	ε, β^+, γ	8.9 E-10	5.1 E-10	0.115	100	0.2	2 E+04	6 E+06	9 E+03	30	
Rh-99m	4.7 h	ε, β^+, γ	7.3 E-11	6.6 E-11	0.122	100	0.2	2 E+05	7 E+07	1 E+05	30	
Rh-100	20.8 h	ε, β^+, γ	6.3 E-10	7.1 E-10	0.392	100	0.3	1 E+04	8 E+06	1 E+04	30	
Rh-101	3.200 y	ε, γ	3.1 E-09	5.5 E-10	0.062	300	0.4	2 E+04	2 E+06	3 E+03	10	
Rh-101m	4.34 d	ε, γ	2.7 E-10	2.2 E-10	0.066	200	0.2	5 E+04	2 E+07	3 E+04	30	→ Rh-101
Rh-102	2.900 y	ε, β^+, γ	9.0 E-09	2.6 E-09	0.339	50	0.2	4 E+03	6 E+05	9 E+02	30	
Rh-102m	207 d	ε, β^+, β^-, γ	4.2 E-09	1.2 E-09	0.085	400	0.6	8 E+03	1 E+06	2 E+03	10	→ Rh-102
Rh-103m	56.12 m	γ	2.5 E-12	3.8 E-12	0.002	<1	<0.1	3 E+06	2 E+09	3 E+06	1000	
Rh-105	35.36 h	β^-, γ	4.4 E-10	3.7 E-10	0.013	1000	1.2	3 E+04	1 E+07	2 E+04	3	
Rh-106m	132 m	β^-, γ	1.9 E-10	1.6 E-10	0.436	1000	1.7	6 E+04	3 E+07	4 E+04	3	
Rh-107	21.7 m	β^-, γ	2.8 E-11	2.4 E-11	0.051	1000	1.6	4 E+05	2 E+08	3 E+05	3	→ Pd-107
Pd-100	3.63 d	ε, γ	9.7 E-10	9.4 E-10	0.050	20	0.1	1 E+04	5 E+06	9 E+03	100	→ Rh-100 [6]
Pd-101	8.27 h	ε, β^+, γ	1.0 E-10	9.4 E-11	0.081	100	0.2	1 E+05	5 E+07	8 E+04	30	→ Rh-101m
Pd-103	16.96 d	ε, γ	3.0 E-10	1.9 E-10	0.019	3	<0.1	5 E+04	2 E+07	3 E+04	300	→ Rh-103m
Pd-107	6.5 E6 y	β^-	2.9 E-10	3.7 E-11	<0.001	<1	<0.1	3 E+05	2 E+07	3 E+04	1000	
Pd-109	13.427 h	β^-,γ	5.0 E-10	5.5 E-10	0.010	1000	2.0	2 E+04	1 E+07	2 E+04	3	

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit **LE** Bq/kg or LE_{abs} Bq	Licensing limit **LA** Bq	Guidance values **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Ag-102	12.9 m	ε, β^+, γ	3.2 E-11	4.0 E-11	0.546	800	1.4	3 E+05	2 E+08	3 E+05		3
Ag-103	65.7 m	ε, β^+, γ	4.5 E-11	4.3 E-11	0.125	500	0.8	2 E+05	1 E+08	2 E+05		10→ Pd-103
Ag-104	69.2 m	ε, β^+, γ	7.1 E-11	6.0 E-11	0.410	300	0.5	2 E+05	7 E+07	1 E+05		10
Ag-104m	33.5 m	ε, β^+, γ	4.5 E-11	5.4 E-11	0.188	400	0.8	2 E+05	1 E+08	2 E+05		10→ Ag-104 [6]
Ag-105	41.0 d	ε, β^+, γ	8.0 E-10	4.7 E-10	0.102	50	0.1	2 E+04	6 E+06	1 E+04		100
Ag-106	23.96 m	ε, β^+, γ	2.7 E-11	3.2 E-11	0.117	700	1.0	3 E+05	2 E+08	3 E+05		10
Ag-106m	8.41 d	ε, γ	1.6 E-09	1.5 E-09	0.435	60	0.2	7 E+03	3 E+06	5 E+03		30
Ag-108m / Ag-108	127 y	ε, β^+, β^-, γ	1.9 E-08	2.3 E-09	0.263	100	0.3	4 E+03	3 E+05	4 E+02		30
Ag-110m / Ag-110	249.9 d	ε, β^-, γ	7.3 E-09	2.8 E-09	0.409	500	0.6	4 E+03	7 E+05	1 E+03		10
Ag-111	7.45 d	β^-, γ	1.6 E-09	1.3 E-09	0.004	1000	1.6	8 E+03	3 E+06	5 E+03		3
Ag-112	3.12 h	β^-, γ	2.6 E-10	4.3 E-10	0.640	1000	1.7	2 E+04	2 E+07	3 E+04		3
Ag-115	20.0 m	β^-, γ	4.4 E-11	6.0 E-11	0.181	1000	1.7	2 E+05	1 E+08	2 E+05		3→ Cd-115, Cd-115m
Cd-104	57.7 m	ε, β^+, γ	6.3 E-11	5.8 E-11	0.062	20	0.1	2 E+05	8 E+07	1 E+05		100→ Ag-104 [6]
Cd-107	6.49 h	ε, β^+, γ	1.1 E-10	6.2 E-11	0.030	20	0.6	2 E+05	5 E+07	8 E+04		10
Cd-109	464 d	ε, γ	9.6 E-09	2.0 E-09	0.027	5	0.4	5 E+03	5 E+05	9 E+02		10
Cd-113	9.3 E15 y	β^-	1.4 E-07	2.5 E-08	<0.001	1000	0.9	4 E+02	4 E+04	6 E+01		10
Cd-113m	13.6 y	β^-	1.3 E-07	2.3 E-08	<0.001	1000	1.4	4 E+02	4 E+04	6 E+01		3
Cd-115	53.46 h	β^-, γ	1.3 E-09	1.4 E-09	0.037	1000	1.5	7 E+03	4 E+06	6 E+03		3→ In-115
Cd-115m	44.6 d	β^-, γ	6.4 E-09	3.3 E-09	0.003	1000	1.6	3 E+03	8 E+05	1 E+03		3→ In-115
Cd-117	2.49 h	β^-, γ	2.5 E-10	2.8 E-10	0.158	1000	1.5	4 E+04	2 E+07	3 E+04		3→ In-117m, In-117
Cd-117m	3.36 h	β^-, γ	3.2 E-10	2.8 E-10	0.282	1000	1.5	4 E+04	2 E+07	3 E+04		3→ In-117, In-117m
In-109	4.2 h	ε, β^+, γ	7.3 E-11	6.6 E-11	0.117	300	0.3	2 E+05	7 E+07	1 E+05		30→ Cd-109
In-110L [2]	4.9 h	ε, β^+ ,γ	2.5 E-10	2.4 E-10	0.468	60	0.2	4 E+04	2 E+07	3 E+04		30
In-110S [2]	69.1 m	ε, β^+, γ	8.1 E-11	1.0 E-10	0.238	700	1.1	1 E+05	6 E+07	1 E+05		3
In-111	2.83 d	ε, γ	3.1 E-10	2.9 E-10	0.082	400	0.3	3 E+04	2 E+07	3 E+04		10
In-112	14.4 m	ε, β^+, β^-, γ	1.3 E-11	1.0 E-11	0.047	900	1.0	1 E+06	4 E+08	6 E+05		10
In-113m	1.658 h	γ	3.2 E-11	2.8 E-11	0.047	500	0.6	4 E+05	2 E+08	3 E+05		10
In-114m / In-114	49.51 d	ε, β^+, β^-, γ	1.1 E-08	4.1 E-09	0.023	3000	3.2	2 E+03	5 E+05	8 E+02		3

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit **LE** Bq/kg or LE_{abs} Bq	Licensing limit **LA** Bq	Guidance values **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
In-115	5.1 E14 y	β^-	4.5 E-07	3.2 E-08	<0.001	1000	1.3	3 E+02	1 E+04	2 E+01		3
In-115m	4.486 h	β^-, γ	8.7 E-11	8.6 E-11	0.033	900	1.0	1 E+05	6 E+07	1 E+05		10→ In-115
In-116m	54.15 m	β^-, γ	8.0 E-11	6.4 E-11	0.356	1000	1.7	2 E+05	6 E+07	1 E+05		3
In-117	43.8 m	β^-, γ	4.8 E-11	3.1 E-11	0.109	2000	1.8	3 E+05	1 E+08	2 E+05		3
In-117m	116.5 m	β^-, γ	1.1 E-10	1.2 E-10	0.019	1000	1.4	8 E+04	5 E+07	8 E+04		3→ In-117 [6]
In-119m / In-119	18.0 m	β^-, γ	2.9 E-11	4.7 E-11	0.033	1000	1.7	2 E+05	2 E+08	3 E+05		3
Sn-110	4.0 h	ε, γ	2.6 E-10	3.5 E-10	0.064	70	0.1	3 E+04	2 E+07	3 E+04		100→ In-110S [6]
Sn-111	35.3 m	ε, β^+, γ	2.2 E-11	2.3 E-11	0.087	400	0.6	4 E+05	2 E+08	4 E+05		10→ In-111
Sn-113	115.1 d	ε, γ	1.9 E-09	7.3 E-10	0.019	4	<0.1	1 E+04	3 E+06	4 E+03		100→ In-113m
Sn-117m	13.61 d	γ	2.2 E-09	7.1 E-10	0.038	3000	2.4	1 E+04	2 E+06	4 E+03		3
Sn-119m	293.0 d	γ	1.5 E-09	3.4 E-10	0.011	1	<0.1	3 E+04	3 E+06	6 E+03		300
Sn-121	27.06 h	β^-	2.8 E-10	2.3 E-10	<0.001	1000	1.1	4 E+04	2 E+07	3 E+04		3
Sn-121m	55 y	β^-, γ	3.3 E-09	3.8 E-10	0.004	300	0.3	3 E+04	2 E+06	3 E+03		30→ Sn-121
Sn-123	129.2 d	β^-, γ	5.6 E-09	2.1 E-09	0.001	1000	1.6	5 E+03	9 E+05	1 E+03		3
Sn-123m	40.08 m	β^-, γ	4.4 E-11	3.8 E-11	0.024	2000	1.9	3 E+05	1 E+08	2 E+05		3
Sn-125	9.64 d	β^-, γ	2.8 E-09	3.1 E-09	0.053	1000	1.5	3 E+03	2 E+06	3 E+03		3→ Sb-125
Sn-126	1.0 E5 y	β^-, γ	1.8 E-08	4.7 E-09	0.017	1000	1.2	2 E+03	3 E+05	5 E+02		3→ Sb-126 [6]
Sn-127	2.10 h	β^-, γ	2.0 E-10	2.0 E-10	0.313	1000	1.6	5 E+04	3 E+07	4 E+04		3→ Sb-127 [6]
Sn-128	59.1 m	β^-, γ	1.5 E-10	1.5 E-10	0.138	1000	1.5	7 E+04	3 E+07	6 E+04		3→ Sb-128S [6]
Sb-115	31.8 m	ε, β^+, γ	2.3 E-11	2.4 E-11	0.151	400	0.6	4 E+05	2 E+08	4 E+05		10
Sb-116	15.8 m	ε, β^+, γ	2.3 E-11	2.6 E-11	0.321	500	0.9	4 E+05	2 E+08	4 E+05		10
Sb-116m	60.3 m	ε, β^+, γ	8.5 E-11	6.7 E-11	0.487	400	0.9	1 E+05	6 E+07	1 E+05		10
Sb-117	2.80 h	ε, β^+, γ	2.7 E-11	1.8 E-11	0.045	400	0.3	6 E+05	2 E+08	3 E+05		10
Sb-118m	5.00 h	ε, β^+, γ	2.3 E-10	2.1 E-10	0.411	200	0.3	5 E+04	2 E+07	4 E+04		30
Sb-119	38.1 h	ε, γ	5.9 E-11	8.1 E-11	0.022	3	<0.1	1 E+05	8 E+07	1 E+05		1000
Sb-120-1 [2]	15.89 m	ε, β^+, γ	1.2 E-11	1.4 E-11	0.079	500	0.7	7 E+05	4 E+08	7 E+05		10
Sb-120-2 [2]	5.76 d	ε, γ	1.3 E-09	1.2 E-09	0.386	400	0.4	8 E+03	4 E+06	6 E+03		10
Sb-122	2.70 d	ε, β^-, γ	1.2 E-09	1.7 E-09	0.068	1000	1.6	6 E+03	4 E+06	7 E+03		3

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: **LE** Bq/kg or LE_{abs} Bq	Licensing limit: **LA** Bq	Guidance values: **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Sb-124	60.20 d	β⁻, γ	4.7 E-09	2.5 E-09	0.261	1000	1.5	4 E+03	1 E+06	2 E+03		3
Sb-124m-2 [2]	20.2 m	γ	8.3 E-12	8.0 E-12	<0.001	<1	<0.1	1 E+06	6 E+08	1 E+06		100→ Sb-124 [6]
Sb-125	2.77 y	β⁻, γ	3.3 E-09	1.1 E-09	0.076	700	0.7	9 E+03	2 E+06	3 E+03		10→ Te-125m
Sb-126	12.4 d	β⁻, γ	3.2 E-09	2.4 E-09	0.434	1000	1.5	4 E+03	2 E+06	3 E+03		3
Sb-126m	19.0 m	β⁻, γ	3.3 E-11	3.6 E-11	0.239	1000	1.5	3 E+05	2 E+08	3 E+05		3→ Sb-126 [6]
Sb-127	3.85 d	β⁻, γ	1.7 E-09	1.7 E-09	0.106	1000	1.6	6 E+03	3 E+06	5 E+03		3→ Te-127, Te-127m
Sb-128S [2]	10.4 m	β⁻, γ	2.6 E-11	3.3 E-11	0.313	1000	1.8	3 E+05	2 E+08	3 E+05		3
Sb-128L [2]	9.01 h	β⁻, γ	6.7 E-10	7.6 E-10	0.472	1000	1.8	1 E+04	7 E+06	1 E+04		3
Sb-129	4.32 h	β⁻, γ	3.5 E-10	4.2 E-10	0.212	1000	1.6	2 E+04	1 E+07	2 E+04		3→ Te-129, Te-129m
Sb-130	40 m	β⁻, γ	9.1 E-11	9.1 E-11	0.505	2000	2.1	1 E+05	5 E+07	9 E+04		3
Sb-131	23 m	β⁻, γ	8.3 E-11	1.0 E-10	0.278	1000	1.7	1 E+05	6 E+07	1 E+05		3→ Te-131, Te-131m
Te-116	2.49 h	ε, γ	1.7 E-10	1.7 E-10	0.033	8	0.2	6 E+04	3 E+07	5 E+04		10→ Sb-116 [6]
Te-119m	16 h	ε, β⁺, γ	6.3 E-10	8.3 E-10				1 E+04	8 E+06	1 E+04		10
Te-121	17 d	ε, γ	4.4 E-10	4.3 E-10	0.104	20	0.1	2 E+04	1 E+07	2 E+04		100
Te-121m	154 d	ε, γ	3.6 E-09	2.3 E-09	0.043	200	0.4	4 E+03	1 E+06	2 E+03		10→ Te-121 [6]
Te-123	1 E13 y	ε	5.0 E-09	4.4 E-09	0.017	2	<0.1	2 E+03	1 E+06	2 E+03		300
Te-123m	119.7 d	γ	3.4 E-09	1.4 E-09	0.032	400	0.8	7 E+03	1 E+06	2 E+03		10→ Te-123
Te-125m	58 d	γ	2.9 E-09	8.7 E-10	0.027	500	1.1	1 E+04	2 E+06	3 E+03		3
Te-127	9.35 h	β⁻, γ	1.8 E-10	1.7 E-10	0.001	1000	1.4	6 E+04	3 E+07	5 E+04		3
Te-127m	109 d	β⁻, γ	6.2 E-09	2.3 E-09	0.009	40	0.5	4 E+03	8 E+05	1 E+03		10→ Te-127
Te-129	69.6 m	β⁻, γ	5.7 E-11	6.3 E-11	0.012	1000	1.6	2 E+05	9 E+07	1 E+05		3→ I-129
Te-129m	33.6 d	β⁻, γ	5.4 E-09	3.0 E-09	0.011	600	1.2	3 E+03	9 E+05	2 E+03		3→ Te-129
Te-131	25 m	β⁻, γ	6.1 E-11	8.7 E-11	0.067	2000	2.0	1 E+05	8 E+07	1 E+05		3→ I-131
Te-131m	30 h	β⁻, γ	1.6 E-09	1.9 E-09	0.208	2000	1.5	5 E+03	3 E+06	5 E+03		3→ I-131, Te-131
Te-132	78.2 h	β⁻, γ	3.0 E-09	3.7 E-09	0.050	700	0.7	3 E+03	2 E+06	3 E+03		10→ I-132 [6]
Te-133	12.45 m	β⁻, γ	4.4 E-11	7.2 E-11	0.151	1000	1.7	1 E+05	1 E+08	2 E+05		3→ I-133
Te-133m	55.4 m	β⁻, γ	1.9 E-10	2.8 E-10	0.344	1000	1.8	4 E+04	3 E+07	4 E+04		3→ I-133, Te-133
Te-134	41.8 m	β⁻,γ	1.1 E-10	1.1 E-10	0.142	2000	1.7	9 E+04	5 E+07	8 E+04		3→ I-134 [6]

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: LE Bq/kg or LE_{abs} Bq	Licensing limit: LA Bq	Guidance values: CA Bq/m³	CS Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
I-120	81.0 m	ε, β^+, γ	1.9 E-10	3.4 E-10	1.155	800	1.5	3 E+04	3 E+07	4 E+04		3
I-120m	53 m	ε, β^+, γ	1.4 E-10	2.1 E-10	1.108	800	1.7	5 E+04	4 E+07	6 E+04		3
I-121	2.12 h	ε, β^+, γ	3.9 E-11	8.2 E-11	0.077	400	0.4	1 E+05	1 E+08	2 E+05		10→ Te-121
I-123	13.2 h	ε, γ	1.1 E-10	2.1 E-10	0.043	400	0.3	5 E+04	5 E+07	8 E+04		10→ Te-123
I-124	4.18 d	ε, β^+, γ	6.3 E-09	1.3 E-08	0.170	300	0.5	8 E+02	8 E+05	1 E+03		10
I-125	60.14 d	ε, γ	7.3 E-09	1.5 E-08	0.033	4	<0.1	7 E+02	7 E+05	1 E+03		10
I-126	13.02 d	ε, β^+, β^-, γ	1.4 E-08	2.9 E-08	0.078	700	0.7	3 E+02	4 E+05	6 E+02		3
I-128	24.99 m	ε, β^+, β^-, γ	2.2 E-11	4.6 E-11	0.016	1000	1.5	2 E+05	2 E+08	4 E+05		3
I-129	1.57 E7 y	β^-, γ	5.1 E-08	1.1 E-07	0.016	100	0.3	9 E+01	1 E+05	2 E+02		1→ Xe-129
I-130	12.36 h	β^-, γ	9.6 E-10	2.0 E-09	0.325	1000	1.6	5 E+03	5 E+06	9 E+03		3
I-131	8.04 d	β^-, γ	1.1 E-08	2.2 E-08	0.062	1000	1.4	5 E+02	5 E+05	8 E+02		3→ Xe-131m
I-132	2.30 h	β^-, γ	2.0 E-10	2.9 E-10	0.338	1000	1.7	3 E+04	3 E+07	4 E+04		3
I-132m	83.6 m	β^-, γ	1.1 E-10	2.2 E-10	0.055	300	1.0	5 E+04	5 E+07	8 E+04		10→ I-132 [6]
I-133	20.8 h	β^-, γ	2.1 E-09	4.3 E-09	0.093	1000	1.6	2 E+03	2 E+06	4 E+03		3→ Xe-133, Xe-133m
I-134	52.6 m	β^-, γ	7.9 E-11	1.1 E-10	0.385	1000	1.8	9 E+04	6 E+07	1 E+05		3
I-135	6.61 h	β^-, γ	4.6 E-10	9.3 E-10	0.223	1000	1.6	1 E+04	1 E+07	2 E+04		3→ Xe-135, Xe-135m
Xe-122 / I-122	20.1 h	ε, β^+, γ			0.284	800	1.3		7 E+07	7 E+04		
Xe-123	2.08 h	ε, β^+, γ			0.107	800	0.9		1 E+08	1 E+05		→ I-123
Xe-125	17.0 h	ε, β^+, γ			0.060	300	0.2		3 E+08	3 E+05		→ I-125
Xe-127	36.41 d	ε, γ			0.059	400	0.3		3 E+08	3 E+05		
Xe-129m	8.0 d	γ			0.030	3000	1.9		4 E+09	4 E+06		
Xe-131m	11.9 d	γ			0.012	3000	2.1		9 E+09	9 E+06		
Xe-133	5.245 d	β^-, γ			0.016	1000	1.0		2 E+09	2 E+06		
Xe-133m	2.188 d	γ			0.016	2000	1.7		2 E+09	2 E+06		→ Xe-133
Xe-135	9.09 h	β^-, γ			0.040	2000	1.6		3 E+08	3 E+05		→ Cs-135
Xe-135m	15.29 m	β^-, γ			0.069	200	0.4		2 E+08	2 E+05		→ Cs-135
Xe-137	3.83 m	β^-, γ			1.167	2	1.7		3 E+08	3 E+05		
Xe-138	14.17 m	β^-, γ			0.166	1000	1.7		6 E+07	6 E+04		→ Cs-138 [6]

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: **LE** Bq/kg or LE_{abs} Bq	Licensing limit: **LA** Bq	Guidance values: **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Cs-125	45 m	ε, β^+, γ	2.3 E-11	3.5 E-11	0.114	500	0.7	3 E+05	2 E+08	4 E+05		10→ Xe-125
Cs-127	6.25 h	ε, β^+, γ	4.0 E-11	2.4 E-11	0.079	100	0.2	4 E+05	1 E+08	2 E+05		30→ Xe-127
Cs-129	32.06 h	ε, β^+, γ	8.1 E-11	6.0 E-11	0.063	30	<0.1	2 E+05	6 E+07	1 E+05		100
Cs-130	29.9 m	ε, β^+, γ	1.5 E-11	2.8 E-11	0.087	500	0.8	4 E+05	3 E+08	6 E+05		10
Cs-131	9.69 d	ε	4.5 E-11	5.8 E-11	0.016	2	<0.1	2 E+05	1 E+08	2 E+05		1000
Cs-132	6.475 d	ε, β^+, β^-, γ	3.8 E-10	5.0 E-10	0.119	50	0.1	2 E+04	1 E+07	2 E+04		100
Cs-134	2.062 y	ε, β^-, γ	9.6 E-09	1.9 E-08	0.236	1000	1.1	5 E+02	5 E+05	9 E+02		3
Cs-134m	2.90 h	γ	2.6 E-11	2.0 E-11	0.009	1000	1.5	5 E+05	2 E+08	3 E+05		3→ Cs-134 [6]
Cs-135	2.3 E6 y	β^-	9.9 E-10	2.0 E-09	0.000	600	0.7	5 E+03	5 E+06	8 E+03		10
Cs-135m	53 m	γ	2.4 E-11	1.9 E-11	0.239	70	0.2	5 E+05	2 E+08	3 E+05		30→ Cs-135
Cs-136	13.1 d	β^-, γ	1.9 E-09	3.0 E-09	0.327	1000	1.5	3 E+03	3 E+06	4 E+03		3
Cs-137 / Ba-137m	30.0 y	β^-, γ	6.7 E-09	1.3 E-08	0.092	2000	1.5	8 E+02	7 E+05	1 E+03		3
Cs-138	32.2 m	β^-, γ	4.6 E-11	9.2 E-11	0.445	1000	1.8	1 E+05	1 E+08	2 E+05		3
Ba-126 / Cs-126	96.5 m	ε, β^+, γ	1.2 E-10	2.6 E-10	0.805	900	1.6	4 E+04	4 E+07	7 E+04		3
Ba-128 / Cs-128	2.43 d	ε, β^+, γ	1.3 E-09	2.7 E-09	0.209	700	1.2	4 E+03	4 E+06	6 E+03		3
Ba-131	11.8 d	ε, β^+, γ	3.5 E-10	4.5 E-10	0.087	300	0.4	2 E+04	1 E+07	2 E+04		10→ Cs-131
Ba-131m	14.6 m	γ	6.4 E-12	4.9 E-12	0.019	50	0.4	2 E+06	8 E+08	1 E+06		10→ Ba-131
Ba-133	10.74 y	ε, γ	1.8 E-09	1.0 E-09	0.085	70	0.1	1 E+04	3 E+06	5 E+03		30
Ba-133m	38.9 h	γ	2.8 E-10	5.5 E-10	0.019	2000	1.5	2 E+04	2 E+07	3 E+04		3→ Ba-133
Ba-135m	28.7 h	γ	2.3 E-10	4.5 E-10	0.018	2000	1.5	2 E+04	2 E+07	4 E+04		3
Ba-139	82.7 m	β^-, γ	5.5 E-11	1.2 E-10	0.012	1000	1.7	8 E+04	9 E+07	2 E+05		3
Ba-140	12.74 d	β^-, γ	1.6 E-09	2.5 E-09	0.031	1000	1.5	4 E+03	3 E+06	5 E+03		3→ La-140 [6]
Ba-141	18.27 m	β^-, γ	3.5 E-11	7.0 E-11	0.152	1000	1.9	1 E+05	1 E+08	2 E+05		3→ La-141
Ba-142	10.6 m	β^-, γ	2.7 E-11	3.5 E-11	0.160	1000	1.7	3 E+05	2 E+08	3 E+05		3→ La-142 [6]
La-131	59 m	ε, β^+, γ	3.6 E-11	3.5 E-11	0.116	400	0.6	3 E+05	1 E+08	2 E+05		10→ Ba-131
La-132	4.8 h	ε, β^+, γ	2.8 E-10	3.9 E-10	0.379	400	0.8	3 E+04	2 E+07	3 E+04		10
La-135	19.5 h	ε, β^+, γ	2.5 E-11	3.0 E-11	0.017	2	<0.1	3 E+05	2 E+08	3 E+05		1000
La-137	6 E4 y	ε	1.0 E-08	8.1 E-11	0.014	2	<0.1	1 E+05	5 E+05	8 E+02		1000

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit **LE** Bq/kg or LE_{abs} Bq	Licensing limit **LA** Bq	Guidance values **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
La-138	1.35E11 y	ε, β^-, γ	1.8 E-07	1.1 E-09	0.185	400	0.4	9 E+03	3 E+04	5 E+01		10
La-140	40.272 h	β^-, γ	1.5 E-09	2.0 E-09	0.332	1000	1.8	5 E+03	3 E+06	6 E+03		3
La-141	3.93 h	β^-, γ	2.2 E-10	3.6 E-10	0.016	1000	1.6	3 E+04	2 E+07	4 E+04		3→ Ce-141
La-142	92.5 m	β^-, γ	1.5 E-10	1.8 E-10	0.490	1000	1.8	6 E+04	3 E+07	6 E+04		3
La-143	14.23 m	β^-, γ	3.3 E-11	5.6 E-11	0.219	1000	1.6	2 E+05	2 E+08	3 E+05		3→ Ce-143
Ce-134 / La-134	72.0 h	ε, β^+, γ	1.6 E-09	2.5 E-09	0.149	600	1.0	4 E+03	3 E+06	5 E+03		10
Ce-135	17.6 h	ε, β^+, γ	7.6 E-10	7.9 E-10	0.271	2000	1.8	1 E+04	7 E+06	1 E+04		3→ La-135
Ce-137	9.0 h	ε, γ	1.9 E-11	2.5 E-11	0.016	10	<0.1	4 E+05	3 E+08	4 E+05		1000→ La-137
Ce-137m	34.4 h	ε, γ	5.9 E-10	5.4 E-10	0.016	2000	1.6	2 E+04	8 E+06	1 E+04		3→ Ce-137, La-137
Ce-139	137.66 d	ε, γ	1.4 E-09	2.6 E-10	0.036	500	0.5	4 E+04	4 E+06	6 E+03		10
Ce-141	32.501 d	β^-,γ	3.1 E-09	7.1 E-10	0.014	2000	1.6	1 E+04	2 E+06	3 E+03		3
Ce-143	33.0 h	β^-, γ	1.0 E-09	1.1 E-09	0.053	1000	1.6	9 E+03	5 E+06	8 E+03		3→ Pr-143
Ce-144 / Pr-144m	284.3 d	β^-, γ	2.9 E-08	5.2 E-09	0.005	800	0.9	2 E+03	2 E+05	3 E+02		10→ Pr-144
Pr-136	13.1 m	ε, β^+, γ	2.5 E-11	3.3 E-11	0.375	600	1.1	3 E+05	2 E+08	3 E+05		3
Pr-137	76.6 m	ε, β^+, γ	3.5 E-11	4.0 E-11	0.083	300	0.5	3 E+05	1 E+08	2 E+05		10→ Ce-137
Pr-138m	2.1 h	ε, β^+, γ	1.3 E-10	1.3 E-10	0.379	600	0.8	8 E+04	4 E+07	6 E+04		10
Pr-139	4.51 h	ε, β^+, γ	3.0 E-11	3.1 E-11	0.028	100	0.1	3 E+05	2 E+08	3 E+05		30→ Ce-139
Pr-142	19.13 h	ε, β^-, γ	7.4 E-10	1.3 E-09	0.011	1000	1.6	8 E+03	7 E+06	1 E+04		3
Pr-142m	14.6 m	γ	9.4 E-12	1.7 E-11	<0.001	<1	<0.1	6 E+05	5 E+08	9 E+05		10→ Pr-142
Pr-143	13.56 d	β^-, γ	2.2 E-09	1.2 E-09	0.000	1000	1.5	8 E+03	2 E+06	4 E+03		3
Pr-144	17.28 m	β^-, γ	3.0 E-11	5.0 E-11	0.099	1000	1.6	2 E+05	2 E+08	3 E+05		3
Pr-145	5.98 h	β^-, γ	2.6 E-10	3.9 E-10	0.002	1000	1.6	3 E+04	2 E+07	3 E+04		3
Pr-147	13.6 m	β^-, γ	3.0 E-11	3.3 E-11	0.144	1000	1.8	3 E+05	2 E+08	3 E+05		3→ Nd-147
Nd-136	50.65 m	ε, β^+, γ	8.9 E-11	9.9 E-11	0.061	200	0.3	1 E+05	6 E+07	9 E+04		30→ Pr-136 [6]
Nd-138 / Pr-138	5.04 h	ε, β^+, γ	3.8 E-10	6.4 E-10	0.398	700	1.3	2 E+04	1 E+07	2 E+04		3
Nd-139	29.7 m	ε, β^+, γ	1.7 E-11	2.0 E-11	0.070	300	0.4	5 E+05	3 E+08	5 E+05		10→ Pr-139
Nd-139m	5.5 h	ε, β^+, γ	2.5 E-10	2.5 E-10	0.246	500	0.6	4 E+04	2 E+07	3 E+04		10→ Pr-139, Nd-139
Nd-140	3.37 d	ε	2.0 E-09	2.8 E-09				4 E+03	3 E+06	4 E+03		3

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit **LE** Bq/kg or LE_{abs} Bq	Licensing limit **LA** Bq	Guidance values **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Nd-141	2.49 h	ε, β^+, γ	8.8 E-12	8.3 E-12	0.021	50	0.1	1 E+06	6 E+08	9 E+05	100	
Nd-147	10.98 d	β^-, γ	2.1 E-09	1.1 E-09	0.027	1000	1.5	9 E+03	2 E+06	4 E+03	3	→ Pm-147
Nd-149	1.73 h	β^-, γ	1.3 E-10	1.2 E-10	0.063	2000	1.8	8 E+04	4 E+07	6 E+04	3	→ Pm-149
Nd-151	12.44 m	β^- ,γ	2.9 E-11	3.0 E-11	0.137	1000	1.7	3 E+05	2 E+08	3 E+05	3	→ Pm-151
Pm-141	20.90 m	ε, β^+, γ	2.5 E-11	3.6 E-11	0.137	500	0.9	3 E+05	2 E+08	3 E+05	10	→ Nd-141, Nd-141m
Pm-143	265 d	ε, γ	9.6 E-10	2.3 E-10	0.057	7	<0.1	4 E+04	5 E+06	9 E+03	300	
Pm-144	363 d	ε, γ	5.4 E-09	9.7 E-10	0.248	40	0.1	1 E+04	9 E+05	2 E+03	100	
Pm-145	17.7 y	ε, γ	2.4 E-09	1.1 E-10	0.013	10	<0.1	9 E+04	2 E+06	3 E+03	1000	
Pm-146	2020 d	ε, β^-, γ	1.3 E-08	9.0 E-10	0.122	500	0.6	1 E+04	4 E+05	6 E+02	10	→ Sm-146
Pm-147	2.6234 y	β^-, γ	3.5 E-09	2.6 E-10	<0.001	500	0.6	4 E+04	1 E+06	2 E+03	10	→ Sm-147
Pm-148	5.37 d	β^-, γ	2.2 E-09	2.7 E-09	0.091	1000	1.6	4 E+03	2 E+06	4 E+03	3	
Pm-148m	41.3 d	β^-, γ	4.3 E-09	1.8 E-09	0.306	1000	1.4	6 E+03	1 E+06	2 E+03	3	→ Sm-148
Pm-149	53.08 h	β^-, γ	8.2 E-10	9.9 E-10	0.002	1000	1.6	1 E+04	6 E+06	1 E+04	3	
Pm-150	2.68 h	β^-, γ	2.1 E-10	2.6 E-10	0.226	1000	1.8	4 E+04	2 E+07	4 E+04	3	
Pm-151	28.4 h	β^-, γ	6.4 E-10	7.3 E-10	0.052	1000	1.5	1 E+04	8 E+06	1 E+04	3	→ Sm-151
Sm-141	10.2 m	ε, β^+, γ	2.7 E-11	3.9 E-11	0.287	500	1.0	3 E+05	2 E+08	3 E+05	10	→ Pm-141 [6]
Sm-141m	22.6 m	ε, β^+, γ	5.6 E-11	6.5 E-11	0.338	900	1.1	2 E+05	9 E+07	1 E+05	3	→ Pm-141, Sm-141
Sm-142 / Pm-142	72.49 m	ε, β^+, γ	1.1 E-10	1.9 E-10	0.752	800	1.5	5 E+04	5 E+07	8 E+04	3	
Sm-145	340 d	ε, γ	1.1 E-09	2.1 E-10	0.026	20	<0.1	5 E+04	5 E+06	8 E+03	100	→ Pm-145
Sm-146	1.03 E8 y	α	6.7 E-06	5.4 E-08	<0.001	<1	<0.1	2 E+02	7 E+02	1 E+00	1	
Sm-147	1.06E11 y	α	6.1 E-06	4.9 E-08	<0.001	<1	<0.1	2 E+02	8 E+02	1 E+00	1	
Sm-151	90 y	β^-, γ	2.6 E-09	9.8 E-11	<0.001	<1	<0.1	1 E+05	2 E+06	3 E+03	100	
Sm-153	46.7 h	β^-, γ	6.8 E-10	7.4 E-10	0.016	1000	1.6	1 E+04	7 E+06	1 E+04	3	
Sm-155	22.1 m	β^-, γ	2.8 E-11	2.9 E-11	0.019	1000	1.6	3 E+05	2 E+08	3 E+05	3	→ Eu-155
Sm-156	9.4 h	β^-, γ	2.8 E-10	2.5 E-10	0.022	1000	1.4	4 E+04	2 E+07	3 E+04	3	→ Eu-156 [6]
Eu-145	5.94 d	ε, β^+, γ	7.3 E-10	7.5 E-10	0.217	60	0.2	1 E+04	7 E+06	1 E+04	30	→ Sm-145
Eu-146	4.61 d	ε, β^+, γ	1.2 E-09	1.3 E-09	0.375	100	0.3	8 E+03	4 E+06	7 E+03	30	→ Sm-146
Eu-147	24 d	α, ε, β^+, γ	1.0 E-09	4.4 E-10	0.085	300	0.3	2 E+04	5 E+06	8 E+03	30	→ Sm-147, Pm-143

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: LE Bq/kg or LE_{abs} Bq	Licensing limit: LA Bq	Guidance values: CA Bq/m³	CS Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Eu-148	54.5 d	α, ε, β^+, γ	2.3 E-09	1.3 E-09	0.327	70	0.2	8 E+03	2 E+06	4 E+03		30→ Pm-144
Eu-149	93.1 d	ε, γ	2.3 E-10	1.0 E-10	0.018	20	<0.1	1 E+05	2 E+07	4 E+04		300
Eu-150-1	12.62 h	ε, β^+, β^-, γ	2.8 E-10	3.8 E-10	0.008	1000	1.4	3 E+04	2 E+07	3 E+04		3
Eu-150-2	34.2 y	ε, γ	3.4 E-08	1.3 E-09	0.238	100	0.2	8 E+03	1 E+05	2 E+02		30
Eu-152	13.33 y	ε, β^+, β^-, γ	2.7 E-08	1.4 E-09	0.179	700	0.8	7 E+03	2 E+05	3 E+02		10→ Gd-152
Eu-152m	9.32 h	ε, β^+, β^-, γ	3.2 E-10	5.0 E-10	0.047	900	1.3	2 E+04	2 E+07	3 E+04		3→ Gd-152
Eu-154	8.80 y	ε, β^-, γ	3.5 E-08	2.0 E-09	0.185	2000	1.8	5 E+03	1 E+05	2 E+02		3
Eu-155	4.96 y	β^-, γ	4.7 E-09	3.2 E-10	0.012	200	0.3	3 E+04	1 E+06	2 E+03		30
Eu-156	15.19 d	β^-, γ	3.0 E-09	2.2 E-09	0.188	1000	1.5	5 E+03	2 E+06	3 E+03		3
Eu-157	15.15 h	β^-, γ	4.4 E-10	6.0 E-10	0.049	1000	1.6	2 E+04	1 E+07	2 E+04		3
Eu-158	45.9 m	β^-, γ	7.5 E-11	9.4 E-11	0.220	1000	1.8	1 E+05	7 E+07	1 E+05		3
Gd-145	22.9 m	ε, β^+, γ	3.5 E-11	4.4 E-11	0.360	500	0.9	2 E+05	1 E+08	2 E+05		10→ Eu-145 [6]
Gd-146	48.3 d	ε, γ	5.2 E-09	9.6 E-10	0.057	600	0.9	1 E+04	1 E+06	2 E+03		10→ Eu-146 [6]
Gd-147	38.1 h	ε, β^+, γ	5.9 E-10	6.1 E-10	0.206	400	0.4	2 E+04	8 E+06	1 E+04		10→ Eu-147
Gd-148	93 y	α	3.0 E-05	5.5 E-08	<0.001	<1	<0.1	2 E+02	2 E+02 [5]	3 E-01		1
Gd-149	9.4 d	ε, γ	7.9 E-10	4.5 E-10	0.076	400	0.6	2 E+04	6 E+06	1 E+04		10→ Eu-149
Gd-151	120 d	α, ε, γ	9.3 E-10	2.0 E-10	0.018	200	0.2	5 E+04	5 E+06	9 E+03		30→ Sm-147
Gd-152	1.08E14 y	α	2.2 E-05	4.1 E-08	<0.001	<1	<0.1	2 E+02	2 E+02 [5]	4 E-01		1
Gd-153	242 d	ε, γ	2.5 E-09	2.7 E-10	0.029	30	0.1	4 E+04	2 E+06	3 E+03		30
Gd-159	18.56 h	β^-, γ	3.9 E-10	4.9 E-10	0.010	1000	1.5	2 E+04	1 E+07	2 E+04		3
Tb-147	1.65 h	ε, β^+, γ	1.2 E-10	1.6 E-10	0.356	400	0.8	6 E+04	4 E+07	7 E+04		10→ Gd-147 [6]
Tb-149	4.15 h	α, ε, β^+, γ	3.1 E-09	2.5 E-10	0.241	400	0.6	4 E+04	2 E+06	3 E+03		10→ Gd-149, Eu-145
Tb-150	3.27 h	ε, β^+, γ	1.8 E-10	2.5 E-10	0.346	400	0.8	4 E+04	3 E+07	5 E+04		10
Tb-151	17.6 h	α, ε, β^+, γ	3.3 E-10	3.4 E-10	0.147	400	0.6	3 E+04	2 E+07	3 E+04		10→ Gd-151, Eu-147
Tb-153	2.34 d	ε, β^+, γ	2.4 E-10	2.5 E-10	0.045	100	0.1	4 E+04	2 E+07	3 E+04		30→ Gd-153
Tb-154	21.4 h	ε, β^+, γ	6.0 E-10	6.5 E-10	0.313	400	0.6	2 E+04	8 E+06	1 E+04		10
Tb-155	5.32 d	ε, γ	2.5 E-10	2.1 E-10	0.031	200	0.2	5 E+04	2 E+07	3 E+04		30
Tb-156	5.34 d	ε, γ	1.4 E-09	1.2 E-09	0.277	500	0.8	8 E+03	4 E+06	6 E+03		10

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: LE Bq/kg or LE_{abs} Bq	Licensing limit: LA Bq	Guidance values: CA Bq/m³	CS Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Tb-156m-1 [2]	5.0 h	γ	1.3 E-10	8.1 E-11	0.001	8	0.6	1 E+05	4 E+07	6 E+04		10→ Tb-156 [6]
Tb-156m-2 [2]	24.4 h	γ	2.3 E-10	1.7 E-10	0.007	4	<0.1	6 E+04	2 E+07	4 E+04	1000	
Tb-157	150 y	ε, γ	7.9 E-10	3.4 E-11	0.001	6	<0.1	3 E+05	6 E+06	1 E+04	1000	
Tb-158	150 y	ε, $β^-$, γ	3.0 E-08	1.1 E-09	0.127	400	0.6	9 E+03	2 E+05	3 E+02	10	
Tb-160	72.3 d	$β^-$, γ	5.4 E-09	1.6 E-09	0.169	1000	1.7	6 E+03	9 E+05	2 E+03	3	
Tb-161	6.91 d	$β^-$, γ	1.2 E-09	7.2 E-10	0.013	1000	1.3	1 E+04	4 E+06	7 E+03	3	
Dy-155	10.0 h	ε, $β^+$, γ	1.2 E-10	1.3 E-10	0.094	100	0.1	8 E+04	4 E+07	7 E+04	30→ Tb-155	
Dy-157	8.1 h	ε, γ	5.5 E-11	6.1 E-11	0.065	40	0.1	2 E+05	9 E+07	2 E+05	100→ Tb-157	
Dy-159	144.4 d	ε, γ	2.5 E-10	1.0 E-10	0.015	10	<0.1	1 E+05	2 E+07	3 E+04	1000	
Dy-165	2.334 h	$β^-$, γ	8.7 E-11	1.1 E-10	0.005	1000	1.6	9 E+04	6 E+07	1 E+05	3	
Dy-166	81.6 h	$β^-$, γ	1.8 E-09	1.6 E-09	0.010	1000	1.1	6 E+03	3 E+06	5 E+03	3→ Ho-166	
Ho-155	48 m	ε, $β^+$, γ	3.2 E-11	3.7 E-11	0.066	300	0.5	3 E+05	2 E+08	3 E+05	10→ Dy-155	
Ho-157	12.6 m	ε, $β^+$, γ	7.6 E-12	6.5 E-12	0.088	300	0.3	2 E+06	7 E+08	1 E+06	30→ Dy-157	
Ho-159	33 m	ε, $β^+$, γ	1.0 E-11	7.9 E-12	0.069	200	0.2	1 E+06	5 E+08	8 E+05	30→ Dy-159	
Ho-161	2.5 h	ε, γ	1.0 E-11	1.3 E-11	0.022	20	<0.1	8 E+05	5 E+08	8 E+05	300	
Ho-162	15 m	ε, $β^+$, γ	4.5 E-12	3.3 E-12	0.032	70	0.2	3 E+06	1 E+09	2 E+06	30	
Ho-162m	68 m	ε, γ	3.3 E-11	2.6 E-11	0.094	300	0.3	4 E+05	2 E+08	3 E+05	30→ Ho-162	
Ho-164	29 m	ε, $β^-$, γ	1.3 E-11	9.5 E-12	0.009	600	0.7	1 E+06	4 E+08	6 E+05	10	
Ho-164m	37.5 m	γ	1.6 E-11	1.6 E-11	0.014	20	<0.1	6 E+05	3 E+08	5 E+05	300→ Ho-164	
Ho-166	26.80 h	$β^-$, γ	8.3 E-10	1.4 E-09	0.005	1000	1.7	7 E+03	6 E+06	1 E+04	3	
Ho-166m	1.20 E3 y	$β^-$, γ	7.8 E-08	2.0 E-09	0.268	800	0.9	5 E+03	6 E+04	1 E+02	10	
Ho-167	3.1 h	$β^-$, γ	1.0 E-10	8.3 E-11	0.061	1000	1.4	1 E+05	5 E+07	8 E+04	3	
Er-161	3.24 h	ε, $β^+$, γ	8.5 E-11	8.0 E-11	0.139	400	0.4	1 E+05	6 E+07	1 E+05	10→ Ho-161	
Er-165	10.36 h	ε	1.4 E-11	1.9 E-11	0.011	7	<0.1	5 E+05	4 E+08	6 E+05	1000	
Er-169	9.3 d	$β^-$, γ	9.2 E-10	3.7 E-10	<0.001	1000	1.0	3 E+04	5 E+06	9 E+03	10	
Er-171	7.52 h	$β^-$, γ	3.0 E-10	3.6 E-10	0.064	2000	1.9	3 E+04	2 E+07	3 E+04	3→ Tm-171	
Er-172	49.3 h	$β^-$, γ	1.2 E-09	1.0 E-09	0.084	1000	1.0	1 E+04	4 E+06	7 E+03	10→ Tm-172	
Tm-162	21.7 m	ε, $β^+$, γ	2.7 E-11	2.9 E-11	0.261	300	0.9	3 E+05	2 E+08	3 E+05	10	

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit **LE** Bq/kg or LE_{abs} Bq	Licensing limit **LA** Bq	Guidance values **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Tm-166	7.70 h	ε, β⁺, γ	2.8 E-10	2.8 E-10	0.270	200	0.4	4 E+04	2 E+07	3 E+04	10	
Tm-167	9.24 d	ε, γ	1.0 E-09	5.6 E-10	0.029	2000	1.1	2 E+04	5 E+06	8 E+03	3	
Tm-170	128.6 d	ε, β⁻, γ	5.2 E-09	1.3 E-09	0.001	1000	1.6	8 E+03	1 E+06	2 E+03	3	
Tm-171	1.92 y	β⁻, γ	9.1 E-10	1.1 E-10	<0.001	<1	<0.1	9 E+04	5 E+06	9 E+03	1000	
Tm-172	63.6 h	β⁻, γ	1.4 E-09	1.7 E-09	0.069	1000	1.5	6 E+03	4 E+06	6 E+03	3	
Tm-173	8.24 h	β⁻, γ	2.6 E-10	3.1 E-10	0.063	1000	1.6	3 E+04	2 E+07	3 E+04	3	
Tm-175	15.2 m	β⁻, γ	3.1 E-11	2.7 E-11	0.160	2000	2.0	4 E+05	2 E+08	3 E+05	3	→ Yb-175
Yb-162	18.9 m	ε, γ	2.3 E-11	2.3 E-11	0.027	60	0.1	4 E+05	2 E+08	4 E+05	100	→ Tm-162 [6]
Yb-166	56.7 h	ε, γ	9.5 E-10	9.5 E-10	0.022	10	0.1	1 E+04	5 E+06	9 E+03	100	→ Tm-166 [6]
Yb-167	17.5 m	ε, β⁺, γ	9.5 E-12	6.7 E-12	0.053	200	0.4	1 E+06	5 E+08	9 E+05	10	→ Tm-167
Yb-169	32.01 d	ε, γ	2.4 E-09	7.1 E-10	0.061	1000	1.0	1 E+04	2 E+06	3 E+03	10	
Yb-175	4.19 d	β⁻, γ	7.0 E-10	4.4 E-10	0.007	1000	1.1	2 E+04	7 E+06	1 E+04	3	
Yb-177	1.9 h	β⁻, γ	9.4 E-11	9.7 E-11	0.028	1000	1.5	1 E+05	5 E+07	9 E+04	3	→ Lu-177
Yb-178	74 m	β⁻, γ	1.1 E-10	1.2 E-10	0.006	1000	1.3	8 E+04	5 E+07	8 E+04	3	→ Lu-178
Lu-169	34.06 h	ε, β⁺, γ	4.9 E-10	4.6 E-10	0.154	100	0.2	2 E+04	1 E+07	2 E+04	30	→ Yb-169
Lu-170	2.00 d	ε, β⁺, γ	9.5 E-10	9.9 E-10	0.281	60	0.3	1 E+04	5 E+06	9 E+03	10	
Lu-171	8.22 d	ε, γ	9.3 E-10	6.7 E-10	0.115	30	0.1	1 E+04	5 E+06	9 E+03	100	
Lu-172	6.70 d	ε, β⁺, γ	1.8 E-09	1.3 E-09	0.283	300	0.5	8 E+03	3 E+06	5 E+03	10	
Lu-173	1.37 y	ε, γ	1.5 E-09	2.6 E-10	0.028	30	0.1	4 E+04	3 E+06	6 E+03	100	
Lu-174	3.31 y	ε, β⁺, γ	2.9 E-09	2.7 E-10	0.024	10	<0.1	4 E+04	2 E+06	3 E+03	100	
Lu-174m	142 d	ε, γ	2.6 E-09	5.3 E-10	0.015	30	<0.1	2 E+04	2 E+06	3 E+03	300	→ Lu-174
Lu-176	3.60E10 y	β⁻, γ	4.6 E-08	1.8 E-09	0.081	2000	2.3	6 E+03	1 E+05	2 E+02	3	
Lu-176m	3.68 h	β⁻, γ	1.6 E-10	1.7 E-10	0.003	1000	1.8	6 E+04	3 E+07	5 E+04	3	
Lu-177	6.71 d	β⁻, γ	1.1 E-09	5.3 E-10	0.006	1000	1.3	2 E+04	5 E+06	8 E+03	3	
Lu-177m	160.9 d	β⁻, γ	1.2 E-08	1.7 E-09	0.166	2000	2.6	6 E+03	4 E+05	7 E+02	3	→ Lu-177
Lu-178	28.4 m	β⁻, γ	4.1 E-11	4.7 E-11	0.022	1000	1.8	2 E+05	1 E+08	2 E+05	3	
Lu-178m	22.7 m	β⁻, γ	5.6 E-11	3.8 E-11	0.182	2000	2.8	3 E+05	9 E+07	1 E+05	3	
Lu-179	4.59 h	β⁻, γ	1.6 E-10	2.1 E-10	0.005	1000	1.6	5 E+04	3 E+07	5 E+04	3	

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit **LE** Bq/kg or LE_{abs} Bq	Licensing limit **LA** Bq	Guidance values **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Hf-170	16.01 h	ε, γ	4.3 E-10	4.8 E-10	0.091	200	0.3	2 E+04	1 E+07	2 E+04		30→ Lu-170 [6]
Hf-172	1.87 y	ε, γ	3.7 E-08	1.0 E-09	0.030	100	0.1	1 E+04	1 E+05	2 E+02		100→ Lu-172 [6]
Hf-173	24.0 h	ε, β^+, γ	2.2 E-10	2.3 E-10	0.071	300	0.3	4 E+04	2 E+07	4 E+04		30→ Lu-173
Hf-175	70 d	ε, γ	8.8 E-10	4.1 E-10	0.065	200	0.2	2 E+04	6 E+06	9 E+03		30
Hf-177m	51.4 m	γ	1.5 E-10	8.1 E-11	0.370	4000	4.5	1 E+05	3 E+07	6 E+04		1
Hf-178m	31 y	γ	3.1 E-07	4.7 E-09	0.378	2000	2.1	2 E+03	2 E+04	3 E+01		3
Hf-179m	25.1 d	γ	3.2 E-09	1.2 E-09	0.149	1000	1.6	8 E+03	2 E+06	3 E+03		3
Hf-180m	5.5 h	γ	2.0 E-10	1.7 E-10	0.166	700	1.1	6 E+04	3 E+07	4 E+04		3
Hf-181	42.4 d	β^-, γ	4.1 E-09	1.1 E-09	0.089	2000	1.9	9 E+03	1 E+06	2 E+03		3
Hf-182	9 E6 y	β^-, γ	3.6 E-07	3.0 E-09	0.039	500	0.6	3 E+03	1 E+04	2 E+01		10→ Ta-182 [6]
Hf-182m	61.5 m	β^-, γ	7.1 E-11	4.2 E-11	0.150	1000	1.8	2 E+05	7 E+07	1 E+05		3→ Ta-182 [6], Hf-182
Hf-183	64 m	β^-, γ	8.3 E-11	7.3 E-11	0.116	1000	1.6	1 E+05	6 E+07	1 E+05		3→ Ta-183
Hf-184	4.12 h	β^-, γ	4.5 E-10	5.2 E-10	0.043	2000	2.2	2 E+04	1 E+07	2 E+04		3→ Ta-184
Ta-172	36.8 m	ε, β^+, γ	5.7 E-11	5.3 E-11	0.244	700	1.5	2 E+05	9 E+07	1 E+05		3→ Hf-172 [6]
Ta-173	3.65 h	ε, β^+, γ	1.6 E-10	1.9 E-10	0.098	500	0.7	5 E+04	3 E+07	5 E+04		10→ Hf-173
Ta-174	1.2 h	ε, β^+, γ	6.6 E-11	5.7 E-11	0.106	700	1.2	2 E+05	8 E+07	1 E+05		3→ Hf-174
Ta-175	10.5 h	ε, β^+, γ	2.0 E-10	2.1 E-10	0.137	200	0.3	5 E+04	3 E+07	4 E+04		30→ Hf-175
Ta-176	8.08 h	ε, β^+, γ	3.3 E-10	3.1 E-10	0.280	100	0.5	3 E+04	2 E+07	3 E+04		10
Ta-177	56.6 h	ε, γ	1.3 E-10	1.1 E-10	0.015	100	0.2	9 E+04	4 E+07	6 E+04		30
Ta-178-1 [2]	9.31 m	ε, γ			0.021	10	0.2					30
Ta-178-2 [2]	2.2 h	ε, γ	1.1 E-10	7.8 E-11	0.172	700	1.2	1 E+05	5 E+07	8 E+04		3
Ta-179	664.9 d	ε	2.9 E-10	6.5 E-11	0.008	6	<0.1	2 E+05	2 E+07	3 E+04		1000
Ta-180	1.0 E13 y	ε, γ	1.4 E-08	8.4 E-10	0.094	600	1.0	1 E+04	4 E+05	6 E+02		10
Ta-180m	8.1 h	ε, β^-, γ	6.2 E-11	5.4 E-11	0.011	200	0.4	2 E+05	8 E+07	1 E+05		10
Ta-182	115.0 d	β^-, γ	7.4 E-09	1.5 E-09	0.194	1000	1.8	7 E+03	7 E+05	1 E+03		3
Ta-182m	15.84 m	γ	3.6 E-11	1.2 E-11	0.044	3000	2.7	8 E+05	1 E+08	2 E+05		3→ Ta-182 [6]
Ta-183	5.1 d	β^-, γ	2.0 E-09	1.3 E-09	0.051	2000	2.3	8 E+03	3 E+06	4 E+03		3

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit **LE** Bq/kg or LE_{abs} Bq	Licensing limit **LA** Bq	Guidance values **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Ta-184	8.7 h	β⁻, γ	6.3 E-10	6.8 E-10	0.247	2000	2.8	1 E+04	8 E+06	1 E+04		3
Ta-185	49 m	β⁻, γ	7.2 E-11	6.8 E-11	0.033	2000	2.3	1 E+05	7 E+07	1 E+05		3→ W-185
Ta-186	10.5 m	β⁻, γ	3.1 E-11	3.3 E-11	0.252	2000	2.5	3 E+05	2 E+08	3 E+05		3
W-176	2.3 h	ε, γ	7.6 E-11	1.1 E-10	0.036	20	0.1	9 E+04	7 E+07	1 E+05		30→ Ta-176 [6]
W-177	135 m	ε, β⁺, γ	4.6 E-11	6.1 E-11	0.140	300	0.4	2 E+05	1 E+08	2 E+05		10→ Ta-177
W-178 / Ta-178-1	21.7 d	ε, γ	1.2 E-10	2.5 E-10	0.024	20	0.2	4 E+04	4 E+07	7 E+04		30
W-179	37.5 m	ε, γ	1.8 E-12	3.3 E-12	0.019	10	<0.1	3 E+06	3 E+09	5 E+06		300→ Ta-179
W-181	121.2 d	ε, γ	4.3 E-11	8.2 E-11	0.009	7	<0.1	1 E+05	1 E+08	2 E+05		1000
W-185	75.1 d	β⁻, γ	2.2 E-10	5.0 E-10	<0.001	1000	1.1	2 E+04	2 E+07	4 E+04		3
W-187	23.9 h	β⁻, γ	3.3 E-10	7.1 E-10	0.075	2000	1.6	1 E+04	2 E+07	3 E+04		3→ Re-187
W-188	69.4 d	β⁻, γ	8.4 E-10	2.3 E-09	<0.001	1000	1.0	4 E+03	6 E+06	1 E+04		10→ Re-188
Re-177	14.0 m	ε, β⁺, γ	2.2 E-11	2.2 E-11	0.100	300	0.8	5 E+05	2 E+08	4 E+05		10→ W-177 [6]
Re-178	13.2 m	ε, β⁺, γ	2.4 E-11	2.5 E-11	0.256	700	1.6	4 E+05	2 E+08	3 E+05		3→ W-178
Re-181	20 h	ε, β⁺, γ	3.7 E-10	4.2 E-10	0.124	500	0.6	2 E+04	1 E+07	2 E+04		10→ W-181
Re-182-1 [2]	12.7 h	ε, β⁺, γ	3.0 E-10	2.7 E-10	0.282	900	1.7	4 E+04	2 E+07	3 E+04		3
Re-182-2 [2]	64.0 h	ε, γ	1.7 E-09	1.4 E-09	0.177	80	0.6	7 E+03	3 E+06	5 E+03		10
Re-183	71 d	ε, γ	1.8 E-09	7.6 E-10				1 E+04	3 E+06	5 E+03		10
Re-184	38.0 d	ε, γ	1.8 E-09	1.0 E-09	0.138	300	0.6	1 E+04	3 E+06	5 E+03		10
Re-184m	165 d	ε, γ	4.8 E-09	1.5 E-09	0.063	300	0.8	7 E+03	1 E+06	2 E+03		10→ Re-184 [6]
Re-186	90.64 h	ε, β⁻, γ	1.2 E-09	1.5 E-09	0.004	2000	1.6	7 E+03	4 E+06	7 E+03		3
Re-186m	2.0 E5 y	γ	7.9 E-09	2.2 E-09	0.004	10	0.1	5 E+03	6 E+05	1 E+03		100→ Re-186
Re-187	5 E10 y	β⁻	4.6 E-12	5.1 E-12	<0.001	<1	<0.1	2 E+06	1 E+09	2 E+06		100
Re-188	16.98 h	β⁻, γ	7.4 E-10	1.4 E-09	0.010	1000	1.8	7 E+03	7 E+06	1 E+04		3
Re-188m	18.6 m	γ	2.0 E-11	3.0 E-11	0.016	40	0.2	3 E+05	3 E+08	4 E+05		30→ Re-188
Re-189	24.3 h	β⁻, γ	6.0 E-10	7.8 E-10	0.011	2000	1.6	1 E+04	8 E+06	1 E+04		3→ Os-189m
Os-180 / Re-180	22 m	ε, β⁺, γ	2.5 E-11	1.7 E-11	0.199	300	1.0	6 E+05	2 E+08	3 E+05		10
Os-181	105 m	ε, β⁺, γ	1.0 E-10	8.9 E-11	0.186	400	0.6	1 E+05	5 E+07	8 E+04		10→ Re-181 [6]
Os-182	22 h	ε, γ	5.2 E-10	5.6 E-10	0.071	100	0.2	2 E+04	1 E+07	2 E+04		30→ Re-182-1 [6]

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: **LE** Bq/kg or LE_{abs} Bq	Licensing limit: **LA** Bq	Guidance values: **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Os-185	94 d	ε, γ	1.4 E-09	5.1 E-10	0.112	40	0.1	2 E+04	4 E+06	6 E+03	100	
Os-189m	6.0 h	γ	7.9 E-12	1.8 E-11	<0.001	5	<0.1	6 E+05	6 E+08	1 E+06	1000	
Os-191	15.4 d	β^-, γ	1.5 E-09	5.7 E-10	0.015	400	0.4	2 E+04	3 E+06	6 E+03	10	
Os-191m	13.03 h	γ	1.4 E-10	9.6 E-11	0.002	5	0.1	1 E+05	4 E+07	6 E+04	100	→ Os-191
Os-193	30.0 h	β^-, γ	6.8 E-10	8.1 E-10	0.012	1000	1.6	1 E+04	7 E+06	1 E+04	3	
Os-194	6.0 y	β^-, γ	4.2 E-08	2.4 E-09	0.001	2	<0.1	4 E+03	1 E+05	2 E+02	30	→ Ir-194
Ir-182	15 m	ε, β^+, γ	4.0 E-11	4.8 E-11	0.584	1000	1.9	2 E+05	1 E+08	2 E+05	3	→ Os-182
Ir-184	3.02 h	ε, β^+, γ	1.9 E-10	1.7 E-10	0.296	1000	1.5	6 E+04	3 E+07	4 E+04	3	
Ir-185	14.0 h	ε, β^+, γ	2.6 E-10	2.6 E-10	0.091	300	0.5	4 E+04	2 E+07	3 E+04	10	→ Os-185 [6]
Ir-186-1 [2]	1.75 h	ε, β^+, γ	7.1 E-11	6.1 E-11	0.152	900	0.9	2 E+05	7 E+07	1 E+05	10	
Ir-186-2 [2]	15.8 h	ε, β^+, γ	5.0 E-10	4.9 E-10	0.243	1000	1.0	2 E+04	1 E+07	2 E+04	10	
Ir-187	10.5 h	ε, γ	1.2 E-10	1.2 E-10	0.059	100	0.1	8 E+04	4 E+07	7 E+04	30	
Ir-188	41.5 h	ε, β^+, γ	6.2 E-10	6.3 E-10	0.223	500	0.5	2 E+04	8 E+06	1 E+04	10	
Ir-189	13.3 d	ε, γ	4.6 E-10	2.4 E-10	0.016	50	0.1	4 E+04	1 E+07	2 E+04	100	
Ir-190	12.1 d	ε, γ	2.5 E-09	1.2 E-09	0.228	800	1.3	8 E+03	2 E+06	3 E+03	3	
Ir-190m-1 [2]	3.1 h	ε, γ	1.4 E-10	1.2 E-10	0.247	900	0.9	8 E+04	4 E+07	6 E+04	10	→ Ir-190
Ir-190m-2 [2]	1.2 h	γ	1.1 E-11	8.0 E-12	<0.001	5	<0.1	1 E+06	5 E+08	8 E+05	100	→ Ir-190 [6]
Ir-192	74.02 d	ε, β^-, γ	4.9 E-09	1.4 E-09	0.131	2000	1.6	7 E+03	1 E+06	2 E+03	3	
Ir-192m	241 y	γ	1.9 E-08	3.1 E-10	0.025	2	<0.1	3 E+04	3 E+05	4 E+02	300	→ Ir-192 [6]
Ir-193m	10.6 d	γ	1.0 E-09	2.7 E-10				4 E+04	5 E+06	8 E+03	100	
Ir-194	19.15 h	β^-, γ	7.5 E-10	1.3 E-09	0.017	1000	1.6	8 E+03	7 E+06	1 E+04	3	
Ir-194m	171 d	β^-, γ	8.2 E-09	2.1 E-09	0.367	1000	1.5	5 E+03	6 E+05	1 E+03	3	
Ir-195	2.5 h	β^-, γ	1.0 E-10	1.0 E-10	0.012	1000	1.7	1 E+05	5 E+07	8 E+04	3	
Ir-195m	3.8 h	β^-, γ	2.4 E-10	2.1 E-10	0.073	2000	2.6	5 E+04	2 E+07	3 E+04	3	→ Ir-195
Pt-186	2.0 h	α, ε, γ	6.6 E-11	9.3 E-11	0.115	20	0.1	1 E+05	8 E+07	1 E+05	100	→ Ir-186-1 [6], Os-182
Pt-188	10.2 d	ε, γ	6.3 E-10	7.6 E-10	0.035	800	0.8	1 E+04	8 E+06	1 E+04	10	→ Ir-188 [6]
Pt-189	10.87 h	ε, β^+, γ	7.3 E-11	1.2 E-10	0.054	200	0.2	8 E+04	7 E+07	1 E+05	30	→ Ir-189

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: **LE** Bq/kg or LE_{abs} Bq	Licensing limit: **LA** Bq	Guidance values: **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Pt-190	6.1 E11 y	α	2.3 E-07	8.2 E-09				1 E+03	2 E+04	4 E+01		3
Pt-191	2.8 d	ε, γ	1.9 E-10	3.4 E-10	0.053	200	0.3	3 E+04	3 E+07	4 E+04		30
Pt-193	50 y	ε	2.7 E-11	3.1 E-11	0.001	4	<0.1	3 E+05	2 E+08	3 E+05		1000
Pt-193m	4.33 d	γ	2.1 E-10	4.5 E-10	0.003	2000	1.8	2 E+04	2 E+07	4 E+04		3→ Pt-193
Pt-195m	4.02 d	γ	3.1 E-10	6.3 E-10	0.016	2000	2.1	2 E+04	2 E+07	3 E+04		3
Pt-197	18.3 h	β^-, γ	1.6 E-10	4.0 E-10	0.005	1000	1.5	3 E+04	3 E+07	5 E+04		3
Pt-197m	94.4 m	β^-, γ	4.3 E-11	8.4 E-11	0.015	2000	1.6	1 E+05	1 E+08	2 E+05		3→ Pt-197
Pt-199	30.8 m	β^-, γ	2.2 E-11	3.9 E-11	0.031	1000	1.7	3 E+05	2 E+08	4 E+05		3→ Au-199
Pt-200	12.5 h	β^-, γ	4.0 E-10	1.2 E-09	0.011	1000	1.5	8 E+03	1 E+07	2 E+04		3→ Au-200
Au-193	17.65 h	ε, γ	1.6 E-10	1.3 E-10	0.029	400	0.5	8 E+04	3 E+07	5 E+04		10→ Pt-193
Au-194	39.5 h	ε, β^+, γ	3.8 E-10	4.2 E-10	0.157	200	0.2	2 E+04	1 E+07	2 E+04		30
Au-195	183 d	ε, γ	1.2 E-09	2.5 E-10	0.017	40	0.2	4 E+04	4 E+06	7 E+03		30
Au-196	6.2 d	ε, β^-, γ	3.7 E-10	4.4 E-10				2 E+04	1 E+07	2 E+04		10
Au-198	2.696 d	β^-, γ	1.1 E-09	1.0 E-09	0.065	1000	1.6	1 E+04	5 E+06	8 E+03		3
Au-198m	2.30 d	γ	2.0 E-09	1.3 E-09	0.094	3000	3.9	8 E+03	3 E+06	4 E+03		1→ Au-198
Au-199	3.139 d	β^-, γ	7.6 E-10	4.4 E-10	0.015	2000	1.5	2 E+04	7 E+06	1 E+04		3
Au-200	48.4 m	β^-, γ	5.6 E-11	6.8 E-11	0.044	1000	1.6	1 E+05	9 E+07	1 E+05		3
Au-200m	18.7 h	β^-, γ	1.0 E-09	1.1 E-09	0.323	2000	2.1	9 E+03	5 E+06	8 E+03		3→ Au-200
Au-201	26.4 m	β^-, γ	2.9 E-11	2.4 E-11	0.008	1000	1.6	4 E+05	2 E+08	3 E+05		3
Hg-193	3.5 h	ε, β^+, γ	1.0 E-10	8.2 E-11	0.037	800	1.1	1 E+05	5 E+07	8 E+04		3→ Au-193
Hg-193m	11.1 h	ε, β^+, γ	3.8 E-10	4.0 E-10	0.162	1000	0.9	3 E+04	1 E+07	2 E+04		10→ Hg-193
Hg-194	260 y	ε	1.9 E-08	5.1 E-08	0.001	4	<0.1	2 E+02	3 E+05	4 E+02		3→ Au-194 [6]
Hg-195	9.9 h	ε, γ	9.2 E-11	9.7 E-11	0.034	60	0.1	1 E+05	5 E+07	9 E+04		100→ Au-195
Hg-195m	41.6 h	ε, γ	6.5 E-10	5.6 E-10	0.037	1000	1.3	2 E+04	8 E+06	1 E+04		3→ Hg-195, Au-195
Hg-197	64.1 h	ε, γ	2.8 E-10	2.3 E-10	0.014	20	0.1	4 E+04	2 E+07	3 E+04		100
Hg-197m	23.8 h	ε, γ	6.6 E-10	4.7 E-10	0.017	3000	2.7	2 E+04	8 E+06	1 E+04		3→ Hg-197
Hg-199m	42.6 m	γ	5.2 E-11	3.1 E-11	0.032	2000	2.3	3 E+05	1 E+08	2 E+05		3
Hg-203	46.60 d	β^-, γ	1.9 E-09	1.9 E-09	0.039	800	0.9	5 E+03	3 E+06	4 E+03		10

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: **LE** Bq/kg or LE_{abs} Bq	Licensing limit: **LA** Bq	Guidance values: **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Tl-194	33 m	ε, γ	8.9 E-12	8.1 E-12	0.125	90	0.1	1 E+06	6 E+08	9 E+05		30→ Hg-194
Tl-194m	32.8 m	ε, β^+, γ	3.6 E-11	4.0 E-11	0.368	700	1.3	3 E+05	1 E+08	2 E+05		3→ Hg-194
Tl-195	1.16 h	ε, β^+, γ	3.0 E-11	2.7 E-11	0.159	200	0.3	4 E+05	2 E+08	3 E+05		30→ Hg-195
Tl-197	2.84 h	ε, β^+, γ	2.7 E-11	2.3 E-11	0.065	300	0.3	4 E+05	2 E+08	3 E+05		30→ Hg-197
Tl-198	5.3 h	ε, β^+, γ	1.2 E-10	7.3 E-11	0.280	100	0.2	1 E+05	4 E+07	7 E+04		30
Tl-198m	1.87 h	ε, β^+, γ	7.3 E-11	5.4 E-11	0.188	2000	1.5	2 E+05	7 E+07	1 E+05		3→ Tl-198 [6]
Tl-199	7.42 h	ε, β^+, γ	3.7 E-11	2.6 E-11	0.042	600	0.5	4 E+05	1 E+08	2 E+05		10
Tl-200	26.1 h	ε, β^+, γ	2.5 E-10	2.0 E-10	0.198	100	0.2	5 E+04	2 E+07	3 E+04		30
Tl-201	3.044 d	ε, γ	7.6 E-11	9.5 E-11	0.018	100	0.2	1 E+05	7 E+07	1 E+05		30
Tl-202	12.23 d	ε, β^+, γ	3.1 E-10	4.5 E-10	0.077	60	0.1	2 E+04	2 E+07	3 E+04		100
Tl-204	3.779 y	ε, β^-	6.2 E-10	1.3 E-09	<0.001	1000	1.4	8 E+03	8 E+06	1 E+04		3→ Pb-204
Tl-209	2.20 m	β^-, γ			0.296	1000	1.9					3→ Pb-209
Pb-195m	15.8 m	ε, β^+, γ	3.0 E-11	2.9 E-11	0.254	600	1.9	3 E+05	2 E+08	3 E+05		3→ Tl-195 [6]
Pb-198	2.4 h	ε, γ	8.7 E-11	1.0 E-10	0.073	600	0.6	1 E+05	6 E+07	1 E+05		10→ Tl-198 [6]
Pb-199	90 m	ε, β^+, γ	4.8 E-11	5.4 E-11	0.218	200	0.3	2 E+05	1 E+08	2 E+05		30→ Tl-199
Pb-200	21.5 h	ε, γ	2.6 E-10	4.0 E-10	0.037	1000	1.0	3 E+04	2 E+07	3 E+04		10→ Tl-200 [6]
Pb-201	9.4 h	ε, β^+, γ	1.2 E-10	1.6 E-10	0.120	300	0.3	6 E+04	4 E+07	7 E+04		30→ Tl-201
Pb-202	3 E5 y	ε	1.4 E-08	8.7 E-09	0.001	4	<0.1	1 E+03	4 E+05	6 E+02		10→ Tl-202
Pb-202m	3.62 h	ε, γ	1.2 E-10	1.3 E-10	0.310	900	1.0	8 E+04	4 E+07	7 E+04		10→ Pb-202, Tl-202
Pb-203	52.05 h	ε, γ	1.6 E-10	2.4 E-10	0.054	500	0.4	4 E+04	3 E+07	5 E+04		10
Pb-205	1.43 E7 y	ε	4.1 E-10	2.8 E-10	0.001	4	<0.1	4 E+04	1 E+07	2 E+04		300
Pb-209	3.253 h	β^-	3.2 E-11	5.7 E-11	<0.001	1000	1.4	2 E+05	2 E+08	3 E+05		3
Pb-210	22.3 y	β^-, γ	1.1 E-06	6.8 E-07	0.003	3	<0.1	1 E+01	5 E+03	8 E+00		0.3→ Bi-210
Pb-211 / Bi-211	36.1 m	α, β^-, γ	5.6 E-09	1.8 E-10	0.016	1000	1.7	6 E+04	9 E+05	1 E+03		3
Pb-212	10.64 h	β^-, γ	3.3 E-08	5.9 E-09	0.025	2000	1.8	2 E+03	2 E+05	3 E+02		3→ Bi-212 [6]
Pb-214	26.8 m	β^-, γ	4.8 E-09	1.4 E-10	0.041	2000	1.9	7 E+04	1 E+06	2 E+03		3→ Bi-214 [6]
Bi-200	36.4 m	ε, β^+, γ	5.6 E-11	5.1 E-11	0.371	600	0.7	2 E+05	9 E+07	1 E+05		10→ Pb-200
Bi-201	108 m	ε, γ	1.1 E-10	1.2 E-10	0.205	500	0.8	8 E+04	5 E+07	8 E+04		10→ Pb-201 [6]

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: LE Bq/kg or LE_{abs} Bq	Licensing limit: LA Bq	Guidance values: CA Bq/m³	CS Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Bi-202	1.67 h	ε, β^+, γ	1.0 E-10	8.9 E-11	0.367	500	0.6	1 E+05	5 E+07	8 E+04		10→ Pb-202
Bi-203	11.76 h	ε, β^+, γ	4.5 E-10	4.8 E-10	0.310	200	0.4	2 E+04	1 E+07	2 E+04		10→ Pb-203
Bi-205	15.31 d	ε, β^+, γ	1.0 E-09	9.0 E-10	0.239	100	0.2	1 E+04	5 E+06	8 E+03		30→ Pb-205
Bi-206	6.243 d	ε, γ	2.1 E-09	1.9 E-09	0.487	600	1.0	5 E+03	2 E+06	4 E+03		10
Bi-207	38 y	ε, β^+, γ	3.2 E-09	1.3 E-09	0.233	100	0.3	8 E+03	2 E+06	3 E+03		30
Bi-208	3.68 E5 y	ε, γ	4.0 E-09	1.4 E-09				7 E+03	1 E+06	2 E+03		10
Bi-210	5.012 d	β^-	6.0 E-08	1.3 E-09	<0.001	1000	1.6	8 E+03	8 E+04	1 E+02		3→ Po-210
Bi-210m	3.0 E6 y	α, γ	2.1 E-06	1.5 E-08	0.042	500	0.4	7 E+02	2 E+03	4 E+00		10→ Tl-206
Bi-212 / Po-212, Tl-208	60.55 m	α, β^-, γ	3.9 E-08	2.6 E-10	0.180	1000	1.7	4 E+04	1 E+05	2 E+02		3
Bi-213 / Po-213, Tl-209	45.65 m	α, β^-, γ	4.1 E-08	2.0 E-10	0.027	1000	1.6	5 E+04	1 E+05	2 E+02		3
Bi-214	19.9 m	β^-, γ	2.1 E-08	1.1 E-10	0.239	1000	1.7	9 E+04	2 E+05	4 E+02		3→ Po-214 → Pb-210
Po-203	36.7 m	ε, β^+, γ	6.1 E-11	5.2 E-11	0.245	1000	1.0	2 E+05	8 E+07	1 E+05		10→ Bi-203 [6]
Po-205	1.80 h	α, ε, β^+ ,γ	8.9 E-11	5.9 E-11	0.233	200	0.3	2 E+05	6 E+07	9 E+04		30→ Bi-205 [6], Pb-201
Po-206	8.8 d	α, ε, γ	3.7 E-07	1.3 E-07				8 E+01	1 E+04	2 E+01		1→ Bi-206 [6]
Po-207	350 m	ε, β^+, γ	1.5 E-10	1.4 E-10	0.201	200	0.3	7 E+04	3 E+07	6 E+04		30→ Bi-207 [6]
Po-208	2.898 y	α, ε, γ	2.4 E-06	7.7 E-07				1 E+01	2 E+03	3 E+00		0.3→ Bi-208
Po-209	102 y	α, ε, γ	2.4 E-06	7.7 E-07				1 E+01	2 E+03	3 E+00		0.3→ Pb-205
Po-210	138.38 d	α, γ	2.2 E-06	2.4 E-07	<0.001	<1	<0.1	4 E+01	2 E+03	4 E+00		1.0
At-207	1.80 h	α, ε, γ	1.9 E-09	2.3 E-10	0.198	500	0.5	4 E+04	3 E+06	4 E+03		10→ Po-207 [6], Bi-203
At-211	7.214 h	α, ε, γ	1.1 E-07	1.1 E-08	0.008	3	<0.1	9 E+02	5 E+04	5 E+01		10→ Po-211, Bi-207 [6]
Rn-220	55.6 s	α, γ			<0.001	<1	<0.1			1 E+03		→ Po-216 → Pb-212
Rn-222	3.8235 d	α, γ			<0.001	<1	<0.1			3 E+03		→ Po-218 → Pb-214
Fr-222	14.4 m	β^-	2.1 E-08	7.1 E-10	0.001	1000	1.6	1 E+04	2 E+05	4 E+02		3→ Ra-222 etc.
Fr-223	21.8 m	β^-, γ	1.3 E-09	2.3 E-09	0.017	2000	1.8	4 E+03	4 E+06	6 E+03		3→ Ra-223

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit LE Bq/kg or LE_{abs} Bq	Licensing limit LA Bq		Guidance values: CA Bq/m³	CS Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10		11	12	13
Ra-223	11.434 d	α, γ	5.7 E-06	1.0 E-07	0.024	600	0.5	1 E+02	9 E+02		1 E+00		1→ Rn-219 → Po-215 → Pb-211
Ra-224	3.66 d	α, γ	2.4 E-06	6.5 E-08	0.002	30	<0.1	2 E+02	2 E+03		3 E+00		3→ Rn-220 etc.
Ra-225	14.8 d	β^-, γ	4.8 E-06	9.5 E-08	0.007	1000	0.9	1 E+02	1 E+03		2 E+00		3→ Ac-225
Ra-226	1600 y	α, γ	2.2 E-06	2.8 E-07	0.001	50	<0.1	4 E+01	2 E+03		4 E+00		1→ Rn-222
Ra-226 incl. daughters	1600 y	α, β, γ			0.283	5000	5.2	4 E+01	2 E+03		4 E+00		1
Ra-227	42.2 m	β^-, γ	2.1 E-10	8.4 E-11	0.038	2000	1.8	1 E+05	2 E+07		4 E+04		3→ Ac-227
Ra-228	5.75 y	β^-, γ	1.7 E-06	6.7 E-07	<0.001	<1	<0.1	1 E+01	3 E+03		5 E+00		0.3→ Ac-228
Ac-224	2.9 h	α, ε, γ	9.9 E-08	7.0 E-10	0.038	100	0.2	1 E+04	5 E+04		8 E+01		30→ Ra-224, Fr-220 etc.
Ac-225	10.0 d	α, γ	6.5 E-06	2.4 E-08	0.005	20	0.1	4 E+02	8 E+02		1 E+00		3→ Fr-221 etc.
Ac-226	29 h	α, ε, β^-, γ	1.0 E-06	1.0 E-08	0.024	1000	1.3	1 E+03	5 E+03		8 E+00		3→ Th-226, Ra-226, Fr-222
Ac-227	21.773 y	α, β^-, γ	6.3 E-04	1.1 E-06	<0.001	<1	<0.1	9 E+00	9 E+00	[5]	1 E-02		0.1→ Th-227, Fr-223
Ac-228	6.13 h	β^-, γ	2.9 E-08	4.3 E-10	0.145	2000	1.8	2 E+04	2 E+05		3 E+02		3→ Th-228
Th-226	30.9 m	α, γ	7.8 E-08	3.6 E-10	0.002	100	0.3	3 E+04	6 E+04		1 E+02		30→ Ra-222 etc.
Th-227	18.718 d	α, γ	7.6 E-06	8.9 E-09	0.023	200	0.2	1 E+03	1 E+03	[5]	1 E+00		10→ Ra-223
Th-228	1.9131 y	α, γ	3.2 E-05	7.0 E-08	0.002	3	<0.1	1 E+02	2 E+02		3 E-01		0.1→ Ra-224
Th-229	7340 y	α, γ	6.9 E-05	4.8 E-07	0.027	300	0.5	2 E+01	7 E+01		1 E-01		0.1→ Ra-225
Th-230	7.7 E4 y	α, γ	2.8 E-05	2.1 E-07	0.001	3	<0.1	5 E+01	2 E+02		3 E-01		0.1→ Ra-226
Th-231	25.52 h	β^-, γ	4.0 E-10	3.4 E-10	0.019	700	0.8	3 E+04	1 E+07		2 E+04		10→ Pa-231
Th-232	1.4 E10 y	α, γ	2.9 E-05	2.2 E-07	0.001	3	<0.1	5 E+01	2 E+02		3 E-01		0.1→ Ra-228
Th-234 / Pa-234m	24.10 d	β^-, γ	5.8 E-09	3.4 E-09	0.008	1000	1.9	3 E+03	9 E+05		1 E+03		3→ Pa-234
Th nat incl.daughters	(1.4 E10 y)	α, β, γ			0.355	6000	5.4	6 E+00	2 E+01		4 E-02		0.1
Pa-227	38.3 m	α, ε, γ	9.7 E-08	4.5 E-10	0.007	5	<0.1	2 E+04	5 E+04		9 E+01		100→ Ac-223
Pa-228	22 h	α, ε, β^+, γ	5.1 E-08	7.8 E-10	0.168	400	0.9	1 E+04	1 E+05		2 E+02		10→ Th-228, Ac-224

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit **LE** Bq/kg or LE_{abs} Bq	Licensing limit **LA** Bq	Guidance values **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Pa-230	17.4 d	α, ε, β^-, γ	5.7 E-07	9.2 E-10	0.108	200	0.3	1 E+04	1 E+04 [5]	1 E+01		30→ Th-230, U-230, Ac-226
Pa-231	3.3 E4 y	α, γ	8.9 E-05	7.1 E-07	0.020	40	0.1	1 E+01	6 E+01	9 E-02		0.3→ Ac-227
Pa-232	1.31 d	β^-, γ	6.8 E-09	7.2 E-10	0.151	1000	1.3	1 E+04	7 E+05	1 E+03		3→ U-232
Pa-233	27.0 d	β^-, γ	3.2 E-09	8.7 E-10	0.041	2000	1.4	1 E+04	2 E+06	3 E+03		3→ U-233
Pa-234	6.70 h	β^-, γ	5.8 E-10	5.1 E-10	0.281	2000	2.9	2 E+04	9 E+06	1 E+04		3→ U-234
U-230	20.8 d	α, γ	1.2 E-05	5.5 E-08	0.003	6	<0.1	2 E+02	4 E+02	7 E-01		1→ Th-226
U-231	4.2 d	α, ε, γ	4.0 E-10	2.8 E-10	0.032	10	0.1	4 E+04	1 E+07	2 E+04		100→ Pa-231, Th-227
U-232	72 y	α, γ	2.6 E-05	3.3 E-07	0.002	6	<0.1	3 E+01	2 E+02	3 E-01		0.3→ Th-228
U-233	1.6 E5 y	α, γ	6.9 E-06	5.0 E-08	0.001	2	<0.1	2 E+02	7 E+02	1 E+00		1→ Th-229
U-234	2.4 E5 y	α, γ	6.8 E-06	4.9 E-08	0.002	3	<0.1	2 E+02	7 E+02	1 E+00		1→ Th-230
U-235	7.0 E8 y	α, γ	6.1 E-06	4.6 E-08	0.028	100	0.2	2 E+02	8 E+02	1 E+00		3→ Th-231
U-236	2.3 E7 y	α, γ	6.3 E-06	4.6 E-08	0.002	1	<0.1	2 E+02	8 E+02	1 E+00		1→ Th-232
U-237	6.75 d	β^-, γ	1.7 E-09	7.7 E-10	0.037	1000	1.6	1 E+04	3 E+06	5 E+03		3→ Np-237
U-238	4.5 E9 y	α, γ, ϕ	5.7 E-06	4.4 E-08	0.002	1	<0.1	2 E+02	9 E+02	1 E+00		1→ Th-234
U-239	23.54 m	β^-, γ	3.5 E-11	2.8 E-11	0.012	1000	1.6	4 E+05	1 E+08	2 E+05		3→ Np-239
U-240	14.1 h	β^-, γ	8.4 E-10	1.1 E-09	0.009	1000	1.0	9 E+03	6 E+06	1 E+04		→ Np-240
U nat incl. daughters		α, β, γ			0.296	6000	7.1	4 E+02	4 E+02	3 E-01		1
Np-232	14.7 m	ε, β^+, γ	3.5 E-11	9.7 E-12	0.199	400	0.6	1 E+06	1 E+08	2 E+05		10→ U-232
Np-233	36.2 m	ε, γ	3.0 E-12	2.2 E-12	0.022	40	<0.1	5 E+06	2 E+09	3 E+06		100→ U-233
Np-234	4.4 d	ε, β^+, γ	7.3 E-10	8.1 E-10	0.219	80	0.2	1 E+04	7 E+06	1 E+04		30→ U-234
Np-235	396.1 d	α, ε, γ	2.7 E-10	5.3 E-11	0.008	3	<0.1	2 E+05	2 E+07	3 E+04		1000→ U-235, Pa-231
Np-236L [2]	1.15 E5 y	ε, β^-, γ	2.0 E-06	1.7 E-08	0.046	1000	1.8	6 E+02	3 E+03	4 E+00		3→ U-236, Pu-236
Np-236S [2]	22.5 h	ε, β^-, γ	3.6 E-09	1.9 E-10	0.013	600	0.6	5 E+04	1 E+06	2 E+03		10→ U-236, Pu-236
Np-237	2.14 E6 y	α, γ	1.5 E-05	1.1 E-07	0.018	30	0.1	9 E+01	3 E+02	6 E-01		0.3→ Pa-233
Np-238	2.117 d	β^-, γ	1.7 E-09	9.1 E-10	0.089	1000	1.1	1 E+04	3 E+06	5 E+03		3→ Pu-238
Np-239	2.355 d	β^-, γ	1.1 E-09	8.0 E-10	0.039	2000	2.3	1 E+04	5 E+06	8 E+03		3→ Pu-239

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit **LE** Bq/kg or LE_{abs} Bq	Licensing limit **LA** Bq	Guidance values **CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Np-240	65 m	β⁻, γ	1.3 E-10	8.2 E-11	0.225	3000	3.4	1 E+05	4 E+07	6 E+04		1→ Pu-240
Np-240m	7.4 m	β⁻, γ			0.060	1000	1.6					3→ Pu-240
Pu-234	8.8 h	α, ε, γ	1.8 E-08	1.6 E-10	0.018	6	<0.1	6 E+04	3 E+05	5 E+02		300→ Np-234, U-230
Pu-235	25.3 m	α, ε, γ	2.6 E-12	2.1 E-12	0.026	8	<0.1	5 E+06	2 E+09	3 E+06		300→ Np-235, U-231
Pu-236	2.851 y	α, γ, ϕ	1.3 E-05	8.6 E-08	0.003	1	<0.1	1 E+02	4 E+02	6 E-01		1→ U-232
Pu-237	45.3 d	α, ε, γ	3.0 E-10	1.0 E-10	0.018	6	<0.1	1 E+05	2 E+07	3 E+04		300→ Np-237, U-233
Pu-238	87.74 y	α, γ, ϕ	3.0 E-05	2.3 E-07	0.002	<1	<0.1	4 E+01	2 E+02	3 E-01		0.3→ U-234
Pu-239	2.4 E4 y	α, γ	3.2 E-05	2.5 E-07	0.001	<1	<0.1	4 E+01	2 E+02	3 E-01		0.3→ U-235
Pu-240	6537 y	α, γ, ϕ	3.2 E-05	2.5 E-07	0.002	<1	<0.1	4 E+01	2 E+02	3 E-01		0.3→ U-236
Pu-241	14.4 y	α, β⁻, γ	5.8 E-07	4.7 E-09	<0.001	<1	<0.1	2 E+03	9 E+03	1 E+01		10→ Am-241, U-237
Pu-242	3.76 E5 y	α, γ, ϕ	3.1 E-05	2.4 E-07	0.002	<1	<0.1	4 E+01	2 E+02	3 E-01		0.3→ U-238
Pu-243	4.956 h	β⁻, γ	1.1 E-10	8.5 E-11	0.007	1000	1.3	1 E+05	5 E+07	8 E+04		3→ Am-243
Pu-244 [9]	8.26 E7 y	α, γ, ϕ	3.0 E-05	2.4 E-07	0.053	1	0.1	4 E+01	2 E+02	3 E-01		0.3→ U-240
Pu-245	10.5 h	β⁻, γ	6.5 E-10	7.2 E-10	0.070	2000	2.0	1 E+04	8 E+06	1 E+04		3→ Am-245
Pu-246	10.85 d	β⁻, γ	7.0 E-09	3.3 E-09	0.034	700	0.7	3 E+03	7 E+05	1 E+03		10→ Am-246
Am-237	73.0 m	α, ε, γ	3.6 E-11	1.8 E-11	0.073	800	0.7	6 E+05	1 E+08	2 E+05		10→ Pu-237, Np-233
Am-238	98 m	α, ε, γ	6.6 E-11	3.2 E-11	0.145	60	0.1	3 E+05	8 E+07	1 E+05		30→ Pu-238, Np-234
Am-239	11.9 h	α, ε, γ	2.9 E-10	2.4 E-10	0.059	1000	1.4	4 E+04	2 E+07	3 E+04		3→ Pu-239, Np-235
Am-240	50.8 h	α, ε, γ	5.9 E-10	5.8 E-10	0.171	50	0.3	2 E+04	8 E+06	1 E+04		30→ Pu-240, Np-236
Am-241	432.2 y	α, γ	2.7 E-05	2.0 E-07	0.019	6	<0.1	5 E+01	2 E+02	3 E-01		0.3→ Np-237
Am-242	16.02 h	ε, β⁻, γ	1.2 E-08	3.0 E-10	0.009	1000	1.1	3 E+04	4 E+05	7 E+02		3→ Cm-242, Pu-242
Am-242m	152 y	α, γ	2.4 E-05	1.9 E-07	0.006	2	<0.1	5 E+01	2 E+02	3 E-01		0.3→ Am-242, Np-238
Am-243	7380 y	α, γ	2.7 E-05	2.0 E-07	0.014	2	<0.1	5 E+01	2 E+02	3 E-01		0.3→ Np-239
Am-244	10.1 h	β⁻, γ	1.5 E-09	4.6 E-10	0.145	3000	2.9	2 E+04	3 E+06	6 E+03		3→ Cm-244
Am-244m	26 m	β⁻, γ	6.2 E-11	2.9 E-11	0.002	1000	1.6	3 E+05	8 E+07	1 E+05		3→ Cm-244
Am-245	2.05 h	β⁻, γ	7.6 E-11	6.2 E-11	0.007	2000	1.8	2 E+05	7 E+07	1 E+05		3→ Cm-245
Am-246	39 m	β⁻, γ	1.1 E-10	5.8 E-11	0.135	4000	4.5	2 E+05	5 E+07	8 E+04		1→ Cm-246
Am-246m	25.0 m	β⁻, γ	3.8 E-11	3.4 E-11	0.154	1000	1.7	3 E+05	1 E+08	2 E+05		3→ Cm-246

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities: h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	Exemption limit: LE Bq/kg or LE_{abs} Bq	Licensing limit: LA Bq	Guidance values: CA Bq/m³	CS Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Cm-238	2.4 h	α, ε	4.8 E-09	8.0 E-11	0.021	7	<0.1	1 E+05	1 E+06	2 E+03		300→ Am-238, Pu-234
Cm-240	27 d	α, γ	2.3 E-06	7.6 E-09	0.003	<1	<0.1	1 E+03	2 E+03	4 E+00		10→ Pu-236
Cm-241	32.8 d	α, ε, γ	2.6 E-08	9.1 E-10	0.100	600	0.7	1 E+04	2 E+05	3 E+02		10→ Am-241, Pu-237
Cm-242	162.8 d	α, γ, ϕ	3.7 E-06	1.2 E-08	0.002	<1	<0.1	8 E+02	1 E+03	2 E+00		10→ Pu-238
Cm-243	28.5 y	α, ε, γ	2.0 E-05	1.5 E-07	0.033	1000	1.1	7 E+01	3 E+02	4 E-01		0.3→ Pu-239, Am-243
Cm-244	18.11 y	α, γ, ϕ	1.7 E-05	1.2 E-07	0.002	<1	<0.1	8 E+01	3 E+02	5 E-01		0.3→ Pu-240
Cm-245	8500 y	α, γ	2.7 E-05	2.1 E-07	0.028	400	0.4	5 E+01	2 E+02	3 E-01		0.3→ Pu-241
Cm-246 [9]	4370 y	α, γ, ϕ	2.7 E-05	2.1 E-07	0.013	<1	<0.1	5 E+01	2 E+02	3 E-01		0.3→ Pu-242
Cm-247	1.56 E7 y	α, γ	2.5 E-05	1.9 E-07	0.053	100	0.1	5 E+01	2 E+02	3 E-01		0.3→ Pu-243
Cm-248 [9]	3.39 E5 y	α, γ, ϕ	9.5 E-05	7.7 E-07	3.8	<1	<0.1	1 E+01	5 E+01	9 E-02		0.1→ Pu-244
Cm-249	64.15 m	β^-, γ	5.1 E-11	3.1 E-11	0.003	1000	1.5	3 E+05	1 E+08	2 E+05		3→ Bk-249
Cm-250 [9]	6900 y	α, β^-, ϕ	5.4 E-04	4.4 E-06	36	<1	<0.1	2 E+00	9 E+00	2 E-02		0.03→ Pu-246, Bk-250
Bk-245	4.94 d	α, ε, γ	1.8 E-09	5.7 E-10	0.054	2000	1.6	2 E+04	3 E+06	5 E+03		3→ Cm-245, Am-241
Bk-246	1.83 d	ε, γ	4.6 E-10	4.8 E-10	0.161	30	0.1	2 E+04	1 E+07	2 E+04		30→ Cm-246
Bk-247	1380 y	α, γ	4.5 E-05	3.5 E-07	0.021	800	0.7	3 E+01	1 E+02	2 E-01		0.3→ Am-243
Bk-249	320 d	α, β^-, γ, ϕ	1.0 E-07	9.7 E-10	<0.001	20	<0.1	1 E+04	5 E+04	8 E+01		100→ Cf-249, Am-245
Bk-250	3.222 h	β^-, γ	7.1 E-10	1.4 E-10	0.137	1000	1.5	7 E+04	7 E+06	1 E+04		3→ Cf-250
Cf-244	19.4 m	α, γ	1.8 E-08	7.0 E-11	0.003	<1	<0.1	1 E+05	3 E+05	5 E+02		300→ Cm-240
Cf-246	35.7 h	α, γ, ϕ	3.5 E-07	3.3 E-09	0.002	<1	<0.1	3 E+03	1 E+04	2 E+01		30→ Cm-242
Cf-248 [9]	333.5 d	α, γ, ϕ	6.1 E-06	2.8 E-08	0.003	<1	<0.1	4 E+02	8 E+02	1 E+00		3→ Cm-244
Cf-249	350.6 y	α, γ, ϕ	4.5 E-05	3.5 E-07	0.060	200	0.2	3 E+01	1 E+02	2 E-01		0.3→ Cm-245
Cf-250 [9]	13.08 y	α, γ, ϕ	2.2 E-05	1.6 E-07	0.035	<1	<0.1	6 E+01	2 E+02	4 E-01		0.3→ Cm-246
Cf-251	898 y	α, γ	4.6 E-05	3.6 E-07	0.037	1000	1.8	3 E+01	1 E+02	2 E-01		0.3→ Cm-247
Cf-252 [9]	2.638 y	α, γ, ϕ	1.3 E-05	9.0 E-08	1.3	<1	<0.1	1 E+02	4 E+02	6 E-01		1→ Cm-248
Cf-253	17.81 d	α, β^-, γ	1.0 E-06	1.4 E-09	<0.001	800	0.8	7 E+03	7 E+03 [5]	8 E+00		10→ Es-253, Cm-249
Cf-254 [9]	60.5 d	α, γ, ϕ	2.2 E-05	4.0 E-07	42	<1	<0.1	3 E+01	2 E+02	4 E-01		0.3→ Cm-250
Es-250	2.1 h	ε, γ	4.2 E-10	2.1 E-11	0.071	20	0.1	5 E+05	1 E+07	2 E+04		100→ Cf-250
Es-251	33 h	α, ε, γ	1.7 E-09	1.7 E-10	0.028	200	0.2	6 E+04	3 E+06	5 E+03		30→ Cf-251, Bk-247

Nuclide	Half-life	Type of decay/ radiation	e_{inh} Sv/Bq	e_{ing} Sv/Bq	Assessment quantities			Exemption limit	Licensing limit	Guidance values		
					h_{10} (mSv/h)/GBq at 1 m	$h_{0,07}$ (mSv/h)/GBq at 10 cm	$hc_{0,07}$ (mSv/h)/ (kBq/cm²)	**LE** Bq/kg or LE_{abs} Bq	**LA** Bq	**CA** Bq/m³	**CS** Bq/cm²	Unstable daughter nuclide
1	2	3	4	5	6	7	8	9	10	11	12	13
Es-253	20.47 d	α, γ, ϕ	2.1 E-06	6.1 E-09	0.001	1	<0.1	2 E+03	2 E+03	4 E+00		10→ Bk-249
Es-254	275.7 d	α, γ	6.0 E-06	2.8 E-08	0.021	6	<0.1	4 E+02	8 E+02	1 E+00		3→ Bk-250
Es-254m	39.3 h	α, β^-, γ	3.7 E-07	4.2 E-09	0.077	1000	1.4	2 E+03	1 E+04	2 E+01		3→ Fm-254, Bk-250
Fm-252	22.7 h	α, γ	2.6 E-07	2.7 E-09	0.002	<1	<0.1	4 E+03	2 E+04	3 E+01		30→ Cf-248
Fm-253	3.00 d	α, ε, γ	3.0 E-07	9.1 E-10	0.023	200	0.2	1 E+04	2 E+04	3 E+01		30→ Es-253, Cf-249
Fm-254	3.240 h	α, γ	7.7 E-08	4.4 E-10	0.002	<1	<0.1	2 E+04	6 E+04	1 E+02		300→ Cf-250
Fm-255	20.07 h	α, γ	2.6 E-07	2.5 E-09	0.016	5	0.1	4 E+03	2 E+04	3 E+01		30→ Cf-251
Fm-257	100.5 d	α, γ	5.2 E-06	1.5 E-08	0.032	600	0.8	7 E+02	1 E+03	2 E+00		3→ Cf-253
Md-257	5.2 h	α, ε, γ	2.0 E-08	1.2 E-10	0.027	30	<0.1	8 E+04	3 E+05	4 E+02		100→ Fm-257, Es-253
Md-258	55 d	α, γ	4.4 E-06	1.3 E-08	0.007	2	<0.1	8 E+02	1 E+03	2 E+00		10→ Es-254

Explanatory notes on the individual columns

1–3 General data on the radionuclide [source: International Commission on Radiological Protection, ICRP 38]. Daughter nuclides with a half-life of less than ten minutes are not listed separately. Their properties are included in the row for the parent nuclide.

1 Radionuclide; m, metastable. A daughter nuclide with a half-life of less than ten minutes is given after a slash. [2]: Two nuclides with the same number of protons and neutrons but with different configurations and half-lives.

2 Half-life: s, second(s); m, minute(s); h, hour(s); y, year(s); E, exponential expression.

3 Type of decay/radiation: α, alpha radiation; β^+, β^-, beta radiation; γ, gamma radiation; ε, electron capture; Φ, spontaneous fission.

4, 5 Dose coefficients for inhalation (breathing in) and ingestion (eating or drinking) for adults [source: Council Directive 96/29/Euratom of 13 May 1996 (Table C1, Col. h(g)$_{5\mu m}$ for inhalation, Col. h(g) for ingestion). For individual nuclides not listed therein: International Commission on Radiological Protection, Oak Ridge National Laboratory, database for ICRP 61, K. F. Eckerman, February 1993, or National Radiological Protection Board, UK, NRPB-R245, 1991].

4 Assessment quantity for inhalation: the inhalation of 1 Bq yields, at most, the committed effective dose (in Sv) indicated.

5 Assessment quantity for ingestion: the ingestion of 1 Bq yields, at most, the committed effective dose (in Sv) indicated.

6–8 Assessment quantities for external radiation [source: Petoussi et al., GSF Report 7/93, National Research Center for Environment and Health, Neuherberg]. If the daughter nuclide has a half-life of less than 10 minutes, the sum of the values for parent and daughter is given.

6 Dose rate at a depth of 10 mm in tissue (ambient dose equivalent rate) at a distance of 1 m from a source of radiation with an activity of 1 GBq (10^9 Bq).

7 Dose rate at a depth of 0.07 mm in tissue (directional dose equivalent rate) at a distance of 10 cm from a source of radiation with an activity of 1 GBq (10^9 Bq).

8 Assessment quantity for skin contamination: contamination of 1 kBq/cm^2 (averaged over 100 cm^2) yields the dose rate (directional dose equivalent rate) indicated.

9–12 Exemption limit, licensing limit and guidance values

9 Exemption limit for specific activity in Bq/kg and exemption limit for absolute activity in Bq. The exemption limits are derived from Column 5. The ingestion of 1 kg of a substance with a specific activity of LE (i.e. an activity of LE$_{abs}$) yields a committed effective dose of 10 μSv.

10 Licensing limit for daily handling. The values for the licensing limits are derived from Column 4 since inhalation is the main risk when radionuclides are handled in the laboratory. The inhalation of an activity LA on a single occasion yields a committed effective dose of 5 mSv. In some cases, the value derived for LA is lower than the value for LE, which is not consistent. In such cases, the LA value has been replaced by the LE value [5].

For inert gases, the licensing limit corresponds to the activity in an enclosed space of 1000 m^3 and a concentration CA specified in Column 11.

11 Guidance value for chronic occupational exposure to airborne activity. Exposure to an airborne activity concentration CA for 40 hours per week and 50 weeks per year yields a committed effective dose of 20 mSv.

For inhalation: CA [Bq/m^3] = 0.02 Sv / (e_{inh} · 2400 m^3/year).

For inert gases, immersion in a semi-infinite hemispherical cloud for 40 hours per week and 50 weeks per year yields an effective dose of 20 mSv (gases and inert gases: D. C. Kocher, Oak Ridge National Laboratory, TN Jnl. 1981, NUREG/CR-1918).

In most cases, the CA value relates to the parent nuclide. The exceptional cases where the CA value is given for the daughter nuclide are indicated as such. Also indicated by a footnote are those cases where immersion leads to irradiation of the skin or all organs and where the dose resulting from immersion is greater than that from inhalation. [1]: In the case of Kr-88, values are given for the daughter nuclide for immersion. [3]: Derived from the effective dose for immersion. [4]: Derived from the skin dose for immersion.

12 Guidance value for surface contamination outside controlled areas, averaged over 100 cm^2. To derive each value, irradiation of the skin, intake and the licensing limit (relation to inhalation) were considered and the most unfavourable case was selected:

Irradiation of the skin for 8760 hours per year, exhaustion of one tenth of the limit for the skin, corresponding to an effective dose of 0.5 mSv per year.

– Daily ingestion of the activity that may be present on an area of 10 cm^2 (parts of the hand), corresponding to an effective dose of 0.5 mSv per year.
– CS_{inh} = LA / 100 cm^2= (5 mSv / [1000 · mSv/Sv e_{inh}]) / 100 cm^2

13 Unstable daughter nuclide

13 Unstable daughter nuclide; → means “decays into …”; in the case of branching, the different nuclides formed are separated by commas; a second arrow indicates a decay series. [6]: The h_{10} value of the daughter nuclide exceeds 0.1 (mSv/h)/GBq at a distance of 1 m (attention may need to be paid to the daughter nuclide!).

List of footnotes:

[l] In the case of Kr-88, values are given for the daughter nuclide for immersion (Column 11).

[2] Two nuclides with the same number of protons and neutrons but with different configurations and half-lives (Column 1).

[3] Derived from the effective dose with immersion (Column 11).

[4] Derived from the skin dose with immersion (Column 11).

[5] The LA value has been replaced by the LE value (Column 10).

[6] The h_{10} value of the daughter nuclide exceeds 0.1 (mSv/h)/GBq at a distance of 1 m (attention may need to be paid to the daughter nuclide!) (Column 13).

[7] The H-3, HTO fraction is also to be considered.

[8] For Kr-85, LA was selected so that the dose rate at a distance of 10 cm is 1 μSv/h.

[9] Spontaneous fission is included in h_{10}. The spontaneous fission rate is taken from Table of Isotopes (8th edition, 1996, John Wiley & Sons) and from the ENDF database, Brookhaven National Laboratory. For the average number of neutrons per fission and the dose coefficient, the values for Cf-252 were used. Photons produced during nuclear fission and photons emitted by the resultant fission products are not considered.

Nuclide mixtures

In the case of nuclide mixtures, the summation rule specified in Annex 1 is applicable for Columns 9, 11 and 12.

Annex 4[167]
(Art. 44 Para. 3)

Dose coefficients for members of the public

1. Inhalation

Nuclide	Infant (1 y)			Child (10 y)			Adult		
	e_{inh} Sv/Bq	$h_{inh, organ}$ Sv/Bq	**Organ**	e_{inh} Sv/Bq	$h_{inh, organ}$ Sv/Bq	**Organ**	e_{inh} Sv/Bq	$h_{inh, organ}$ Sv/Bq	**Organ**
H-3, HTO [1]	4.8 E-11	4.8 E-11	WB	2.3 E-11	2.3 E-11	WB	1.8 E-11	1.8 E-11	WB
H-3, OBT [2]	1.1 E-10	1.1 E-10	WB	5.5 E-11	5.5 E-11	WB	4.1 E-11	4.1 E-11	WB
C-14 organic	1.6 E-09	1.6 E-09	WB	7.9 E-10	7.9 E-10	WB	5.8 E-10	5.8 E-10	WB
Na-22	7.3 E-09	6.4 E-08	ET	2.4 E-09	2.0 E-08	ET	1.3 E-09	9.2 E-09	ET
Na-24	1.8 E-09	4.3 E-08	ET	5.7 E-10	1.3 E-08	ET	2.7 E-10	6.0 E-09	ET
Sc-47	2.8 E-09	1.4 E-08	Lu	1.1 E-09	6.7 E-09	Lu	7.3 E-10	5.1 E-09	Lu
Cr-51	1.9 E-10	8.2 E-10	ET	6.4 E-11	2.6 E-10	ET	3.2 E-11	1.4 E-10	Lu
Mn-54	6.2 E-09	2.5 E-08	ET	2.4 E-09	9.1 E-09	Lu	1.5 E-09	6.3 E-09	Lu
Fe-59	1.3 E-08	6.7 E-08	Lu	5.5 E-09	3.1 E-08	Lu	3.7 E-09	2.3 E-08	Lu
Co-57	2.2 E-09	1.2 E-08	Lu	8.5 E-10	4.8 E-09	Lu	5.5 E-10	3.3 E-09	Lu
Co-58	6.5 E-09	3.0 E-08	ET	2.4 E-09	1.2 E-08	Lu	1.6 E-09	8.9 E-09	Lu
Co-60	3.4 E-08	1.6 E-07	Lu	1.5 E-08	7.3 E-08	Lu	1.0 E-08	5.2 E-08	Lu
Zn-65	6.5 E-09	1.9 E-08	ET	2.4 E-09	7.5 E-09	Lu	1.6 E-09	5.1 E-09	Lu
Se-75	6.0 E-09	2.4 E-08	Ki	2.5 E-09	9.2 E-09	Ki	1.0 E-09	5.4 E-09	Ki
Br-82	3.0 E-09	5.0 E-08	ET	1.1 E-09	1.5 E-08	ET	6.3 E-10	7.0 E-09	ET
Sr-89	2.4 E-08	1.5 E-07	Lu	9.1 E-09	6.3 E-08	Lu	6.1 E-09	4.5 E-08	Lu
Sr-90	1.1 E-07	7.0 E-07	Lu	5.1 E-08	2.9 E-07	Lu	3.6 E-08	2.1 E-07	Lu
Y-91	3.0 E-08	1.7 E-07	Lu	1.1 E-08	6.9 E-08	Lu	7.1 E-09	5.0 E-08	Lu
Zr-95	1.6 E-08	9.1 E-08	Lu	6.8 E-09	4.2 E-08	Lu	4.8 E-09	3.1 E-08	Lu
Nb-95	5.2 E-09	2.8 E-08	Lu	2.2 E-09	1.3 E-08	Lu	1.5 E-09	9.5 E-09	Lu

167 Amended by No III of the Ordinance of 15 Nov. 2000 (AS **2000** 2894). Corrected in accordance with No III Para. 1 of the Ordinance of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).

Nuclide	Infant (1 y)			Child (10 y)			Adult		
	e_{inh} Sv/Bq	$h_{inh, organ}$ Sv/Bq	Organ	e_{inh} Sv/Bq	$h_{inh, organ}$ Sv/Bq	Organ	e_{inh} Sv/Bq	$h_{inh, organ}$ Sv/Bq	Organ
Mo-99	4.4 E-09	1.8 E-08	Co	1.5 E-09	7.2 E-09	Lu	8.9 E-10	5.3 E-09	Lu
Tc-99m	9.9 E-11	1.4 E-09	ET	3.4 E-11	4.3 E-10	ET	1.9 E-11	2.1 E-10	ET
Ru-103	8.4 E-09	5.3 E-08	Lu	3.5 E-09	2.4 E-08	Lu	2.4 E-09	1.8 E-08	Lu
Ru-106	1.1 E-07	7.1 E-07	Lu	4.1 E-08	2.8 E-07	Lu	2.8 E-08	2.0 E-07	Lu
Ag-110m	2.8 E-08	1.1 E-07	Lu	1.2 E-08	5.1 E-08	Lu	7.6 E-09	3.6 E-08	Lu
Sn-125	1.5 E-08	6.5 E-08	Lu	5.0 E-09	2.7 E-08	Lu	3.1 E-09	2.0 E-08	Lu
Sb-122	5.7 E-09	2.7 E-08	Co	1.8 E-09	7.5 E-09	Lu	1.0 E-09	5.5 E-09	Lu
Sb-124	2.4 E-08	1.4 E-07	Lu	9.6 E-09	6.1 E-08	Lu	6.4 E-09	4.4 E-08	Lu
Sb-125	1.6 E-08	1.0 E-07	Lu	6.8 E-09	4.5 E-08	Lu	4.8 E-09	3.2 E-08	Lu
Sb-127	7.3 E-09	3.1 E-08	Lu	2.7 E-09	1.4 E-08	Lu	1.7 E-09	1.1 E-08	Lu
Te-125m	1.1 E-08	7.4 E-08	Lu	4.8 E-09	3.5 E-08	Lu	3.4 E-09	2.6 E-08	Lu
Te-127m	2.6 E-08	1.7 E-07	Lu	1.1 E-08	7.7 E-08	Lu	7.4 E-09	5.6 E-08	Lu
Te-129m	2.6 E-08	1.5 E-07	Lu	9.8 E-09	6.6 E-08	Lu	6.6 E-09	4.8 E-08	Lu
Te-131m	5.8 E-09	3.2 E-08	ET	1.9 E-09	9.8 E-09	ET	9.4 E-10	4.6 E-09	Lu
Te-132	1.3 E-08	5.6 E-08	ET	4.0 E-09	1.7 E-08	ET	2.0 E-09	1.0 E-08	Lu
I-125	2.3 E-08	4.5 E-07	Th	1.1 E-08	2.2 E-07	Th	5.1 E-09	1.0 E-07	Th
I-125 organic	4.0 E-08	8.1 E-07	Th	2.2 E-08	4.4 E-07	Th	1.1 E-08	2.1 E-07	Th
I-125 elementary	5.2 E-08	1.0 E-06	Th	2.8 E-08	5.6 E-07	Th	1.4 E-08	2.7 E-07	Th
I-129	8.6 E-08	1.7 E-06	Th	6.7 E-08	1.3 E-06	Th	3.6 E-08	7.1 E-07	Th
I-129 organic	1.5 E-07	3.0 E-06	Th	1.3 E-07	2.7 E-06	Th	7.4 E-08	1.5 E-06	Th
I-129 elementary	2.0 E-07	3.9 E-06	Th	1.7 E-07	3.4 E-06	Th	9.6 E-08	1.9 E-06	Th
I-131	7.2 E-08	1.4 E-06	Th	1.9 E-08	3.7 E-07	Th	7.4 E-09	1.5 E-07	Th
I-131 organic	1.3 E-07	2.5 E-06	Th	3.7 E-08	7.4 E-07	Th	1.5 E-08	3.1 E-07	Th
I-131 elementary	1.6 E-07	3.2 E-06	Th	4.8 E-08	9.5 E-07	Th	2.0 E-08	3.9 E-07	Th
I-133	1.8 E-08	3.5 E-07	Th	3.8 E-09	7.4 E-08	Th	1.5 E-09	2.8 E-08	Th
I-133 organic	3.2 E-08	6.3 E-07	Th	7.6 E-09	1.5 E-07	Th	3.1 E-09	6.0 E-08	Th
I-133 elementary	4.1 E-08	8.0 E-07	Th	9.7 E-09	1.9 E-07	Th	4.0 E-09	7.6 E-08	Th
I-135	3.7 E-09	7.0 E-08	Th	7.9 E-10	1.5 E-08	Th	3.2 E-10	5.7 E-09	Th
I-135 organic	6.7 E-09	1.3 E-07	Th	1.6 E-09	3.1 E-08	Th	6.8 E-10	1.3 E-08	Th
I-135 elementary	8.5 E-09	1.6 E-07	Th	2.1 E-09	3.8 E-08	Th	9.2 E-10	1.5 E-08	Th
Cs-134	7.3 E-09	4.9 E-08	ET	5.3 E-09	1.8 E-08	ET	6.6 E-09	1.2 E-08	ET
Cs-136	5.2 E-09	5.9 E-08	ET	2.0 E-09	1.9 E-08	ET	1.2 E-09	8.8 E-09	ET
Cs-137	5.4 E-09	2.5 E-08	ET	3.7 E-09	9.7 E-09	ET	4.6 E-09	7.4 E-09	ET

Nuclide	Infant (1 y)			Child (10 y)			Adult		
	e_{inh} Sv/Bq	$h_{inh, organ}$ Sv/Bq	**Organ**	e_{inh} Sv/Bq	$h_{inh, organ}$ Sv/Bq	**Organ**	e_{inh} Sv/Bq	$h_{inh, organ}$ Sv/Bq	**Organ**
Ba-140	2.0 E-08	1.1 E-07	Lu	7.6 E-09	4.8 E-08	Lu	5.1 E-09	3.5 E-08	Lu
La-140	6.3 E-09	4.4 E-08	ET	2.0 E-09	1.3 E-08	ET	1.1 E-09	6.2 E-09	ET
Ce-141	1.1 E-08	6.9 E-08	Lu	4.6 E-09	3.2 E-08	Lu	3.2 E-09	2.4 E-08	Lu
Ce-144	1.6 E-07	6.5 E-07	Lu	5.5 E-08	2.6 E-07	Lu	3.6 E-08	1.9 E-07	Lu
Pr-143	8.4 E-09	4.6 E-08	Lu	3.2 E-09	2.1 E-08	Lu	2.2 E-09	1.5 E-08	Lu
Pb-210	3.7 E-06	2.2 E-05	Lu	1.5 E-06	1.1 E-05	BS	1.1 E-06	1.3 E-05	BS
Bi-210	3.0 E-07	2.4 E-06	Lu	1.3 E-07	1.1 E-06	Lu	9.3 E-08	7.7 E-07	Lu
Po-210	1.1 E-05	8.1 E-05	Lu	4.6 E-06	3.5 E-05	Lu	3.3 E-06	2.6 E-05	Lu
Ra-224	8.2 E-06	6.7 E-05	Lu	3.9 E-06	3.2 E-05	Lu	3.0 E-06	2.5 E-05	Lu
Ra-226	1.1 E-05	9.1 E-05	Lu	4.9 E-06	3.8 E-05	Lu	3.5 E-06	2.8 E-05	Lu
Th-227	3.0 E-05	2.5 E-04	Lu	1.4 E-05	1.2 E-04	Lu	1.0 E-05	8.7 E-05	Lu
Th-228	1.3 E-04	1.1 E-03	Lu	5.5 E-05	4.5 E-04	Lu	4.0 E-05	3.3 E-04	Lu
Th-230	3.5 E-05	2.6 E-04	BS	1.6 E-05	2.4 E-04	BS	1.4 E-05	2.8 E-04	BS
Th-232	5.0 E-05	3.5 E-04	Lu	2.6 E-05	2.6 E-04	BS	2.5 E-05	2.9 E-04	BS
Pa-231	2.3 E-04	1.0 E-02	BS	1.5 E-04	7.5 E-03	BS	1.4 E-04	6.8 E-03	BS
U-234	1.1 E-05	9.0 E-05	Lu	4.8 E-06	3.8 E-05	Lu	3.5 E-06	2.7 E-05	Lu
U-235	1.0 E-05	8.1 E-05	Lu	4.3 E-06	3.4 E-05	Lu	3.1 E-06	2.4 E-05	Lu
U-238	9.4 E-06	7.5 E-05	Lu	4.0 E-06	3.1 E-05	Lu	2.9 E-06	2.2 E-05	Lu
Np-237	4.0 E-05	8.3 E-04	BS	2.2 E-05	6.7 E-04	BS	2.3 E-05	1.0 E-03	BS
Np-239	4.2 E-09	1.8 E-08	ET	1.4 E-09	8.4 E-09	Lu	9.3 E-10	6.3 E-09	Lu
Pu-238	7.4 E-05	1.2 E-03	BS	4.8 E-05	9.8 E-04	BS	4.6 E-05	1.4 E-03	BS
Pu-239	7.7 E-05	1.3 E-03	BS	4.4 E-05	1.1 E-03	BS	5.0 E-05	1.5 E-03	BS
Pu-240	7.7 E-05	1.3 E-03	BS	4.8 E-05	1.1 E-03	BS	5.0 E-05	1.5 E-03	BS
Pu-241	9.7 E-07	2.2 E-05	BS	8.3 E-07	2.4 E-05	BS	9.0 E-07	3.1 E-05	BS
Am-241	6.9 E-05	1.4 E-03	BS	4.0 E-05	1.2 E-03	BS	4.2 E-05	1.7 E-03	BS
Cm-242	1.8 E-05	1.2 E-04	BS	7.3 E-06	4.8 E-05	Lu	5.2 E-06	3.5 E-05	Lu
Cm-244	5.7 E-05	9.6 E-04	BS	2.7 E-05	6.4 E-04	BS	2.7 E-05	9.2 E-04	BS

e_{inh}: Committed effective dose; integration period: 50 years for adults, 70 years for children
Dose coefficients taken from the ICRP CD-ROM (AMAD = 1µm)

Nuclide	Infant (1 y)			Child (10 y)			Adult		
	e_{inh} Sv/Bq	$h_{inh, organ}$ Sv/Bq	**Organ**	e_{inh} Sv/Bq	$h_{inh, organ}$ Sv/Bq	**Organ**	e_{inh} Sv/Bq	$h_{inh, organ}$ Sv/Bq	**Organ**

$h_{inh, organ}$: Committed dose in the most affected organ [WB: whole body, Go: gonads, BM: bone marrow (red), Co: colon, Lu: lung, St: stomach, Bl: bladder, Br: breast, Li: liver, Oe: oesophagus, Th: thyroid, Sk: skin, BS: bone surface, remainder (ET: extrathoracic airways, Ut: uterus, Ki: kidney, Sp: spleen)]
Dose coefficients taken from the ICRP CD-ROM (AMAD = 1µm)
[1] Tritiated water vapour
[2] Organically bound tritium

2. Ingestion

Nuclide	Infant (1 y)			Child (10 y)			Adult		
	e_{ing} Sv/Bq	$h_{ing, organ}$ Sv/Bq	**Organ**	e_{ing} Sv/Bq	$h_{ing, organ}$ Sv/Bq	**Organ**	e_{ing} Sv/Bq	$h_{ing, organ}$ Sv/Bq	**Organ**
H-3, HTO	4.8E-11	4.8E-11	WB	2.3E-11	2.3E-11	WB	1.8E-11	1.8E-11	WB
H-3, OBT [2]	1.2E-10	1.6E-10	St	5.7E-11	6.7E-11	St	4.2E-11	4.7E-11	St
C-14	1.6E-09	1.9E-09	St	8.0E-10	8.9E-10	St	5.8E-10	6.3E-10	St
Na-22	1.5E-08	2.8E-08	BS	5.5E-09	1.1E-08	BS	3.2E-09	6.3E-09	BS
Na-24	2.3E-09	6.7E-09	St	7.7E-10	2.1E-09	St	4.3E-10	1.2E-09	St
Sc-47	3.9E-09	3.0E-08	Co	1.2E-09	9.0E-09	Co	5.4E-10	4.1E-09	Co
Cr-51	2.3E-10	1.4E-09	Co	7.8E-11	4.5E-10	Co	3.8E-11	2.1E-10	Co
Mn-54	3.1E-09	8.3E-09	Co	1.3E-09	3.3E-09	Co	7.1E-10	1.8E-09	Co
Fe-59	1.3E-08	3.5E-08	Co	4.7E-09	1.2E-08	Co	1.8E-09	5.8E-09	Co
Co-57	1.6E-09	5.6E-09	Co	5.8E-10	1.8E-09	Co	2.1E-10	9.4E-10	Co
Co-58	4.4E-09	1.4E-08	Co	1.7E-09	4.9E-09	Co	7.4E-10	2.8E-09	Co
Co-60	2.7E-08	5.1E-08	Co	1.1E-08	2.0E-08	Li	3.4E-09	8.7E-09	Co
Zn-65	1.6E-08	2.2E-08	BS	6.4E-09	8.9E-09	BS	3.9E-09	5.4E-09	BS
Se-75	1.3E-08	5.1E-08	Ki	6.0E-09	2.2E-08	Ki	2.6E-09	1.4E-08	Ki
Br-82	2.6E-09	4.0E-09	Co	9.5E-10	1.5E-09	Co	5.4E-10	8.3E-10	St
Sr-89	1.8E-08	9.2E-08	Co	5.8E-09	2.7E-08	Co	2.6E-09	1.4E-08	Co

Nuclide	Infant (1 y)			Child (10 y)			Adult		
	e_{ing} Sv/Bq	$h_{ing,\ organ}$ Sv/Bq	**Organ**	e_{ing} Sv/Bq	$h_{ing,\ organ}$ Sv/Bq	**Organ**	e_{ing} Sv/Bq	$h_{ing,\ organ}$ Sv/Bq	**Organ**
Sr-90	7.3E-08	7.3E-07	BS	6.0E-08	1.0E-06	BS	2.8E-08	4.1E-07	BS
Y-91	1.8E-08	1.4E-07	Co	5.2E-09	4.2E-08	Co	2.4E-09	1.9E-08	Co
Zr-95	5.6E-09	3.4E-08	Co	1.9E-09	1.1E-08	Co	9.5E-10	5.1E-09	Co
Nb-95	3.2E-09	1.6E-08	Co	1.1E-09	5.6E-09	Co	5.8E-10	2.8E-09	Co
Mo-99	3.5E-09	1.6E-08	Li	1.1E-09	5.5E-09	Li/Ki	6.0E-10	3.1E-09	Ki
Tc-99m	1.3E-10	4.7E-10	Th	4.3E-11	1.4E-10	Co	2.2E-11	6.7E-11	Co
Ru-103	4.6E-09	2.9E-08	Co	1.5E-09	9.2E-09	Co	7.3E-10	4.3E-09	Co
Ru-106	4.9E-08	3.3E-07	Co	1.5E-08	1.0E-07	Co	7.0E-09	4.5E-08	Co
Ag-110m	1.4E-08	4.6E-08	Co	5.2E-09	1.7E-08	Co	2.8E-09	8.5E-09	Co
Sn-125	2.2E-08	1.8E-07	Co	6.7E-09	5.2E-08	Co	3.1E-09	2.4E-08	Co
Sb-122	1.2E-08	9.1E-08	Co	3.7E-09	2.7E-08	Co	1.7E-09	1.2E-08	Co
Sb-124	1.6E-08	9.6E-08	Co	5.2E-09	3.0E-08	Co	2.5E-09	1.4E-08	Co
Sb-125	6.1E-09	3.3E-08	BS	2.1E-09	1.3E-08	BS	1.1E-09	9.0E-09	BS
Sb-127	1.2E-08	8.4E-08	Co	3.6E-09	2.5E-08	Co	1.7E-09	1.2E-08	Co
Te-125m	6.3E-09	9.0E-08	BS	1.9E-09	3.4E-08	BS	8.7E-10	2.0E-08	BS
Te-127m	1.8E-08	1.4E-07	BS	5.2E-09	5.5E-08	BS	2.3E-09	3.2E-08	BS
Te-129m	2.4E-08	1.1E-07	Co	6.6E-09	3.2E-08	Co	3.0E-09	1.4E-08	Co
Te-131m	1.4E-08	1.5E-07	Th	4.3E-09	4.5E-08	Th	1.9E-09	1.8E-08	Th
Te-132	3.0E-08	3.2E-07	Th	8.3E-09	7.5E-08	Th	3.8E-09	3.1E-08	Th
I-125	5.7E-08	1.1E-06	Th	3.1E-08	6.2E-07	Th	1.5E-08	3.0E-07	Th
I-129	2.2E-07	4.3E-06	Th	1.9E-07	3.8E-06	Th	1.1E-07	2.1E-06	Th
I-131	1.8E-07	3.6E-06	Th	5.2E-08	1.0E-06	Th	2.2E-08	4.3E-07	Th
I-133	4.4E-08	8.6E-07	Th	1.0E-08	2.0E-07	Th	4.3E-09	8.2E-08	Th
I-135	8.9E-09	1.7E-07	Th	2.2E-09	3.9E-08	Th	9.3E-10	1.6E-08	Th
Cs-134	1.6E-08	2.4E-08	Co	1.4E-08	1.7E-08	Co	1.9E-08	2.1E-08	Co
Cs-136	9.5E-09	1.3E-08	Co	4.4E-09	5.3E-09	Co	3.0E-09	3.4E-09	Co
Cs-137	1.2E-08	2.3E-08	Co	1.0E-08	1.3E-08	Co	1.3E-08	1.5E-08	Co
Ba-140	1.8E-08	1.2E-07	Co	5.8E-09	3.5E-08	Co	2.6E-09	1.7E-08	Co
La-140	1.3E-08	8.7E-08	Co	4.2E-09	2.7E-08	Co	2.0E-09	1.3E-08	Co
Ce-141	5.1E-09	4.0E-08	Co	1.5E-09	1.2E-08	Co	7.1E-10	5.5E-09	Co
Ce-144	3.9E-08	3.1E-07	Co	1.1E-08	9.2E-08	Co	5.2E-09	4.2E-08	Co
Pr-143	8.7E-09	7.0E-08	Co	2.6E-09	2.1E-08	Co	1.2E-09	9.3E-09	Co
Pb-210	3.6E-06	3.8E-05	BS	1.9E-06	4.4E-05	BS	6.9E-07	2.3E-05	BS

Nuclide	Infant (1 y)			Child (10 y)			Adult		
	e_{ing} Sv/Bq	$h_{ing, organ}$ Sv/Bq	**Organ**	e_{ing} Sv/Bq	$h_{ing, organ}$ Sv/Bq	**Organ**	e_{ing} Sv/Bq	$h_{ing, organ}$ Sv/Bq	**Organ**
Bi-210	9.7E-09	7.6E-08	Co	2.9E-09	2.3E-08	Co	1.3E-09	1.0E-08	Co
Po-210	8.8E-06	7.6E-05	Sp	2.6E-06	2.5E-05	Sp	1.2E-06	1.3E-05	Ki
Ra-224	6.6E-07	2.3E-05	BS	2.6E-07	1.1E-05	BS	6.5E-08	1.7E-06	BS
Ra-226	9.6E-07	2.9E-05	BS	8.0E-07	3.9E-05	BS	2.8E-07	1.2E-05	BS
Th-227	7.0E-08	8.0E-07	BS	2.3E-08	3.9E-07	BS	8.8E-09	8.8E-08	BS
Th-228	3.7E-07	8.4E-06	BS	1.4E-07	4.3E-06	BS	7.2E-08	2.5E-06	BS
Th-230	4.1E-07	1.3E-05	BS	2.4E-07	1.1E-05	BS	2.1E-07	1.2E-05	BS
Th-232	4.5E-07	1.3E-05	BS	2.9E-07	1.2E-05	BS	2.3E-07	1.2E-05	BS
Pa-231	1.3E-06	6.0E-05	BS	9.2E-07	4.6E-05	BS	7.1E-07	3.6E-05	BS
U-234	1.3E-07	1.8E-06	BS	7.4E-08	1.5E-06	BS	4.9E-08	7.8E-07	BS
U-235	1.3E-07	1.7E-06	BS	7.1E-08	1.4E-06	BS	4.7E-08	7.4E-07	BS
U-238	1.2E-07	1.6E-06	BS	6.8E-08	1.4E-06	BS	4.5E-08	7.1E-07	BS
Np-237	2.1E-07	5.0E-06	BS	1.1E-07	4.1E-06	BS	1.1E-07	5.4E-06	BS
Np-239	5.7E-09	4.4E-08	Co	1.7E-09	1.3E-08	Co	8.0E-10	6.0E-09	Co
Pu-238	4.0E-07	6.9E-06	BS	2.4E-07	5.9E-06	BS	2.3E-07	7.4E-06	BS
Pu-239	4.2E-07	7.6E-06	BS	2.7E-07	6.8E-06	BS	2.5E-07	8.2E-06	BS
Pu-240	4.2E-07	7.6E-06	BS	2.7E-07	6.8E-06	BS	2.5E-07	8.2E-06	BS
Pu-241	5.7E-09	1.2E-07	BS	5.1E-09	1.4E-07	BS	4.8E-09	1.6E-07	BS
Am-241	3.7E-07	8.3E-06	BS	2.2E-07	7.3E-06	BS	2.0E-07	9.0E-06	BS
Cm-242	7.6E-08	9.7E-07	BS	2.4E-08	3.5E-07	BS	1.2E-08	1.9E-07	BS
Cm-244	2.9E-07	5.8E-06	BS	1.4E-07	3.9E-06	BS	1.2E-07	4.9E-06	BS

e_{ing}: Committed effective dose; integration period: 50 years for adults, 70 years for children
Dose coefficients taken from the ICRP CD-ROM (AMAD = 1µm)

$h_{ing, organ}$: Committed dose in the most affected organ [WB: whole body, Go: gonads, BM: bone marrow (red), Co: colon, Lu: lung, St: stomach, Bl: bladder, Br: breast, Li: liver, Oe: oesophagus, Th: thyroid, Sk: skin, BS: bone surface, remainder (ET: extrathoracic airways, Ut: uterus, Ki: kidney, Sp: spleen)]
Dose coefficients taken from the ICRP CD-ROM (AMAD = 1µm)

[2] Organically bound tritium

Annex 5[168]
(Art. 1 para.. 2, 42 and 44)

Method for determination of the radiation dose

1. Principle

The effective dose and organ doses are generally determined with the aid of operational quantities.

2. Operational quantities

The operational quantities used for individual monitoring for external exposure are

a. the personal deep dose $H_p(10)$, with the short form H_p;

b. the personal surface dose $H_p(0.07)$, with the short form H_s.

The operational quantities used for area monitoring are

a. the ambient dose equivalent $H^*(10)$;

b. the directional dose equivalent $H'(0.07)$.

The operational quantity for internal exposure is the committed effective dose E_{50}, calculated using standard models and the dose coefficients specified in Annexes 3 and 4.

3. Personal doses below the relevant dose limits

The organ dose equivalent for external radiation is taken to be equal to the personal deep dose equivalent $H_p(10)$, or the ambient dose equivalent $H^*(10)$, for all tissues and organs with the exception of the skin.

The skin dose equivalent for external radiation is taken to be equal to the personal surface dose equivalent $H_p(0.07)$, or the directional dose equivalent $H'(0.07)$.

The effective dose is taken to be equal to the sum of

a. the personal dose equivalent $H_p(10)$, or the ambient dose equivalent $H^*(10)$, and

b. the committed effective dose E_{50}.

4. Personal doses above the relevant dose limits

If the dose levels determined in accordance with point 3 are above the relevant limits, then the effective dose or organ doses for the person concerned are to be individually determined by an expert, in cooperation with the supervisory authority,

168 Amended by No II of the Ordinance of 17 Nov. 1999, in force since 1 Jan. 2000 (AS **2000** 107).

using calculation methods and dose coefficients in accordance with the current state of science and technology. The value thus determined is decisive in establishing whether or not a dose limit has been exceeded.

5. Area monitoring

Where ambient dose limits are specified by this Ordinance, the ambient dose is taken to be

a. the quantity H*(10) (ambient dose equivalent) for strongly penetrating radiation;

b. the quantity H′(0.07) (directional dose equivalent) for weakly penetrating radiation.

Annex 6[169]
(Art. 30 and 58)

Controlled area markings

Depending on the radiation sources used, signs are to be displayed in controlled areas indicating the following:

1. Unsealed radioactive sources:

a. the most radiotoxic nuclide and its maximum activity;

b. the classification of the working area (type A, B or C);

c. the maximum degree of contamination caused by loose contamination on surfaces, expressed in Bq/cm^2 or as the number of guidance values for the nuclide concerned;

d. the ambient dose rate in mSv per hour in the accessible area, if appropriate;

e. details of the protective clothing and protective measures required;

f. the hazard warning symbol.

2. Sealed radioactive sources:

a. the most radiotoxic nuclide and its maximum activity, or the activity of and nuclide with the highest-energy gamma radiation;

b. the ambient dose rate in mSv per hour in the accessible area, if appropriate;

c. the hazard warning symbol.

3. Equipment (e.g. X-ray equipment, accelerators):

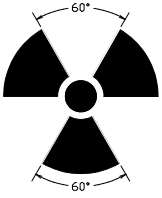
a. the designation of the equipment;

b. the type of radiation (e.g. electrons, X-rays, neutrons, where not apparent from the equipment designation);

c. the ambient dose rate in mSv per hour in the accessible area, if appropriate;

d. the hazard warning symbol.

Hazard warning symbol:



Ratio of radii: 1:1.5:5

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*Annex 7**
(Art. 44 Para. 3)

Dose coefficients for cloud and ground radiation

Nuclide	External exposure to cloud radiation	External exposure to ground radiation
	e_{imm} (mSv/h)/(Bq/m³)	e_{sol} (mSv/h)/(Bq/m²)
H-3	0.0E+00	0.0E+00
C-11	1.4E-07	3.0E-09
C-14	6.7E-12	0.0E+00
O-15	1.4E-07	3.2E-09
F-18	1.4E-07	2.8E-09
Na-22	3.1E-07	5.8E-09
Na-24	6.7E-07	1.0E-08
Sc-47	1.5E-08	3.3E-10
Cr-51	4.3E-09	9.2E-11
Mn-54	1.2E-07	2.4E-09
Fe-59	1.7E-07	3.1E-09
Co-57	1.6E-08	3.6E-10
Co-58	1.4E-07	2.8E-09
Co-60	3.6E-07	6.4E-09
Zn-65	8.5E-08	1.5E-09
Se-75	5.2E-08	1.1E-09
Br-82	3.8E-07	7.3E-09
Kr-79	3.5E-08	7.2E-10
Kr-81	1.4E-09	3.3E-11
Kr-83m	6.9E-12	1.6E-12
Kr-85	7.8E-10	3.6E-11
Kr-85m	2.2E-08	5.1E-10
Kr-87	1.3E-07	2.5E-09
Kr-88	3.2E-07	5.0E-09
Kr-88/Rb-88	4.2E-07	7.2E-09
Kr-89	2.9E-07	5.1E-09
Kr-90	1.9E-07	3.8E-09
Sr-89	1.4E-09	2.4E-10
Sr-90	3.3E-10	5.0E-12
Sr-90/Y-90	2.6E-09	3.9E-10
Y-91	1.9E-09	2.6E-10
Zr-95	1.1E-07	2.1E-09
Nb-95	1.1E-07	2.2E-09
Mo-99	2.3E-08	5.7E-10
Mo-99/Tc-99m	3.8E-08	9.1E-10
Tc-99m	1.7E-08	3.8E-10
Ru-103	6.7E-08	1.4E-09
Ru-106	0.0E+00	0.0E+00
Ru-106/Rh-106	3.3E-08	1.1E-09
Ag-110m	4.0E-07	7.5E-09
Sn-125	4.7E-08	1.1E-09
Sb-122	6.4E-08	1.5E-09
Sb-124	2.8E-07	5.0E-09
Sb-125	5.9E-08	1.2E-09
Sb-127	9.4E-08	2.0E-09
Te-125m	9.1E-10	3.9E-11
Te-127m	3.0E-10	1.3E-11
Te-129m	5.2E-09	1.9E-10

Nuclide	External exposure to cloud radiation	External exposure to ground radiation
	e_{imm} (mSv/h)/(Bq/m³)	e_{sol} (mSv/h)/(Bq/m²)
Te-131m	2.1E-07	3.9E-09
Te-132	2.9E-08	6.4E-10
Te-132/I-132	3.6E-07	7.2E-09
I-125	1.0E-09	4.5E-11
I-129	8.0E-10	4.2E-11
I-130	3.0E-07	6.1E-09
I-131	5.2E-08	1.1E-09
I-132	3.3E-07	6.6E-09
I-133	8.6E-08	1.8E-09
I-134	3.9E-07	7.5E-09
I-135	2.3E-07	4.2E-09
Xe-122	7.9E-09	1.8E-10
Xe-123	8.8E-08	1.8E-09
Xe-125	3.3E-08	7.3E-10
Xe-127	3.5E-08	7.8E-10
Xe-129m	2.8E-09	9.8E-11
Xe-131m	1.1E-09	3.7E-11
Xe-133	4.3E-09	1.2E-10
Xe-133m	4.0E-09	9.9E-11
Xe-135	3.4E-08	7.9E-10
Xe-135m	5.9E-08	1.3E-09
Xe-137	3.1E-08	1.1E-09
Xe-138	1.8E-07	3.2E-09
Cs-134	2.2E-07	4.4E-09
Cs-136	3.1E-07	6.0E-09
Cs-137	2.6E-10	8.5E-12
Cs-137/Ba-137m	8.1E-08	1.6E-09
Ba-140	2.6E-08	6.0E-10
Ba-140/La-140	3.7E-07	6.8E-09
La-140	3.5E-07	6.2E-09
Ce-141	1.0E-08	2.3E-10
Ce-144	2.4E-09	5.4E-11
Ce-144/Pr-144	1.0E-08	5.9E-10
Pr-143	6.2E-10	7.2E-11
Pb-210	1.4E-10	5.9E-12
Bi-210	8.1E-10	1.2E-10
Po-210	1.3E-12	2.5E-14
Ra-224	1.3E-09	2.9E-11
Ra-226	9.0E-10	2.0E-11
Th-227	1.4E-08	3.1E-10
Th-228	2.5E-10	6.4E-12
Th-230	4.6E-11	1.8E-12
Th-232	2.1E-11	1.2E-12
Pa-231	4.0E-09	9.1E-11
U-234	1.6E-11	1.3E-12
U-235	2.0E-08	4.4E-10
U-238	1.0E-11	1.0E-12
Np-237	2.8E-09	7.5E-11
Np-239	2.2E-08	4.9E-10
Pu-238	7.3E-12	1.3E-12
Pu-239	9.0E-12	6.2E-13
Pu-240	7.2E-12	1.2E-12
Pu-241	0.0E+00	0.0E+00
Am-241	2.2E-09	6.7E-11
Cm-242	8.0E-12	1.4E-12
Cm-244	6.6E-12	1.2E-12

e_{imm}	Dose coefficients for external exposure during immersion in a semi-infinite hemispherical cloud outdoors
e_{sol}	Dose coefficients for external exposure from ground deposition over a large area.
Zero values	Values less than 4.0E-19 are given as 0.0E+00.

* Inserted by No. III Para. 2 of the Amendment of 24 Oct. 2007, in force since 1 Jan. 2008 (AS **2007** 5651).