

COMMISSION OF THE EUROPEAN COMMUNITIES

**COM(94) 298 final
Brussels, 08.07.1994**

Amended proposal for a

COUNCIL DIRECTIVE (EURATOM)

**laying down the basic safety standards for the protection
of the health of workers and the general public against
the dangers arising from ionizing radiation**

**(submitted by the Commission pursuant to
Article 119 second paragraph of the Euratom Treaty)**

EXPLANATORY MEMORANDUM

1. INTRODUCTION

At its sitting of 20 April 1994, the European Parliament gave its opinion on a proposal for a Council directive (Euratom) laying down the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation. The proposal was approved by the Commission on 20 July 1993¹ having considered the opinion given by the Economic and Social Committee on 25 February 1993² on a draft proposal put forward on 6 July 1992³.

The present modified proposal takes account of the amendments requested by the European Parliament where the Commission has been able to accept them.

¹ COM (93) 349 final, O.J. C 245 of 9.9.93.

² O.J. C 108 of 19.4.93.

³ SEC (92) 1322 final.

2. ACCEPTED AMENDMENTS

The new recital 7 bis takes account of Amendment 1. It mentions that interactive aspects of radiation with other carcinogenic factors have been qualitatively observed and that when the necessary technical basis has been developed, they will have to be taken into account.

The new recital 5 bis, together with the modified Article 10 takes account of Amendment 2. It addresses the need for ensuring early protection to the conceptus.

The new recital 6 bis, addresses the subject of Amendment N° 3 and in part of Amendments 11 and 43. The Community does not have the power to impose its own rules on third countries, nor to restrict trade with countries in which the protection of workers is less strict. The Community cooperates with international organizations for the widest possible application of internationally agreed radiation protection measures and standards.

The new recital 13 bis, as requested by Amendment 4, makes a reference to the provisions of Articles 16 and 56 by which, in exceptional circumstances, dose limits different from those of general application may be authorised.

The modified definition of the term accident in Article 1 makes clear the difference between dose limits and intervention levels.

The modified definition of the term intervention clarifies the meaning of removing existing sources, as requested by Amendment 8.

The modification of Article 7, together with the modified definition of practice in Article 1, takes account of a situation in which several sources contribute to the exposure of individuals as requested by Amendment 9.

The modified Article 4 requires explicitly that the authorization shall be given by the competent authorities, as requested by Amendment 15. It also subjects any release of radioactive effluent or waste to a prior authorization, as requested by Amendment 16.

The modified Article 5 prohibits the export out of the Community of consumer goods containing radioactive substances, whose placing on the market is prohibited in the Community, as requested by Amendment 18.

The modified Articles 10 and 11 make explicit that the present Directive is without prejudice to Directive 92/58/EEC.

The modified Article 13, in line with Amendment 27 reinforces the social protection of workers who exceeded a dose limit as a consequence of a specially authorised exposure and subjects their further working conditions to a medical agreement.

The modified Articles 17 and 18 require the use of the methods laid down by the Directive or the use of equivalent methods approved by the competent authorities for the estimation of doses, as requested by Amendments 30 and 31.

The modified Articles 21, 22, 24 and 26 on the requirements of controlled and supervised areas are restructured and completed in the direction indicated by Amendments 35, 36, 37 and 38.

The modified Article 30 stipulates that the results of monitoring of the exposure of workers are available to their representatives, as requested by Amendment 39.

The modified Article 43 specifies that Title VIII of the Directive may apply to working premises in particular geological areas liable to cause a high radon concentration. It also clarifies that the title does not apply to exposures to radionuclides in the undisturbed earth's crust resulting from outdoor activities. The modifications introduced are requested by Amendments 41 and 42

The modified Article 46 in the line indicated by Amendment 44 requires that the members of the public shall benefit from the best possible protection in accordance with the principle of optimisation of protection laid down in Article 7.

The objective of Amendment 49 is that the personnel effecting interventions have received adequate training. This is a requirement under Article 51 (2) (d) of the proposal and is also the subject of Article 7 of Directive 89/618/Euratom. The Commission considers that the objective of the proposed amendment is reached by these existing provisions.

3. REJECTED AMENDMENTS

Amendment 6 requests that the definition of the term emergency exposure in Article 1 be modified by deleting the reference to saving a valuable undertaking or source. The Commission believes that in certain circumstances an emergency exposure aimed at saving a complex industrial or medical installation creating important social benefits would be justified.

Amendment 7 deletes the reference to probability of deleterious effects in the definition of harm in Article 1. One essential aim of radiation protection is the protection of individuals from the so-called stochastic effects of ionizing radiation, which means effects which are of a random or

statistical nature and which, in general, will not be expressed before a latent period of some years. The deletion of the concept of probability would exclude taking into account such effects.

Amendment 10 requests that the definition of radioactive substance in Article 1 be modified, especially to consider possible contamination of the environment.

The definition of the proposal is the same as the 1980 Directive. The objective of radiation protection is protection of individuals. The environment is considered with regard to the transfer of radionuclides to man. This results in preventing deleterious effects on the environment itself. However, the new recital 5 ter explains that protection of the environment has been considered and that it is indirectly achieved.

Amendments 12 and 56 request that the criteria be amended for exempting certain practices from the obligation of reporting to the competent authorities set out by the Directive. The amendments request specific identification of the radionuclides involved in the practice possibly exempted on the basis of their radiotoxicity and half-life. It also requests the drawing up of a list of such exempt practices.

The Commission, in line with the current development within the international organisations concerned with radiation protection suppressed the subdivision of radionuclides in

radiotoxicity classes used in the 1980 Directive to be amended. With the support of the Group of Experts referred to in Article 31 of the Euratom Treaty, the Commission analyzed several possible exposure pathways for each radionuclide which may be of practical importance. The quantities and concentrations were verified against internationally agreed radiological criteria. However, as the explanatory memorandum of the proposal made plain at the time of approval of the proposal by the Commission the calculations were still being completed, and the values of Annex I were given on a provisional basis. The calculations have now been completed⁴ and their results are taken into account in the modified Annex I. In addition, Article 3.2.b was modified, relating the concept of small scale to the concentration values laid down in the Annex.

Amendment 13 deletes the exemption notifying the occupancy of dwellings and other exposures to natural radiation sources. The subject of protection against the dangers of radon in dwellings is dealt with in Commission Recommendation 90/143/Euratom. The ubiquitous presence of natural radiation sources leads to a practical impossibility of reporting all practices involving exposure to such sources.

⁴ Radiation Protection 65. Doc.XI-028/93 Principles and methods for establishing concentrations and quantities (exemption values) below which reporting is not required in the European Directive.

Amendment 14 deletes the applicability of the accelerated procedure for revising the list of practices exempted from reporting. As Article 3.2 sets out a rigid prohibition from reporting the listed practices, it seems prudent to have a procedure in case of a possible identification of problems.

Amendment 17 deletes the addition of radioactive substances to consumer goods from the list of practices subject to prior authorization. Efficient smoke detectors rely on the presence of radioactive substances. Other consumer goods, such as watches, may need the addition of radioactive substances for luminescence. Their production and placing on the market need to be authorised.

Amendment 19 requires the supplier of radioactive substances to inform the authorities in the Member States of destination of the expected use of such substances. The procedure, modelled on the procedure laid down by Council Regulation 1493/93/Euratom, must be simple. Its important feature is that the consignee is known to his competent authorities. The supplier does not necessarily have the information required by the amendment.

Amendment 20 deletes the explicit reference to economic and social factors in the optimisation. The Commission shares the view of the International Commission on Radiological Protection (ICRP) that the primary aim of radiation protection

is to provide an appropriate standard of protection for man without unduly limiting the beneficial practices giving rise to radiation exposure. Value judgements about the balancing of risks and benefits are therefore necessary. This is implicit in the 1980 Directive. The Commission prefers to set it out explicitly, as it is in the 1990 ICRP Recommendations.

Amendments 22 and 28 require the averaging of annual dose limits allowed by the proposal to be applied retrospectively. It would be very difficult and in many cases impossible to apply such retroactivity. In view of these difficulties, it is explicitly discouraged by the ICRP.

Amendments 23, 29 and 51 require regular review of the Directive and its provisions. The Commission continuously monitors the implementation and adequacy of the provisions of the Directive with the support of the Group of Experts referred to in Article 31 of the Euratom Treaty; in case of need it will put forward the appropriate proposals.

Amendment 24 requires the foetus to be protected as if it were a member of the public. Article 10 requires it to be protected as far as possible as if it were a member of the public. It would in fact be impossible to apply to the foetus, whose organs are in rapid evolution, the concept of effective dose which is at the base of the protection of individuals.

Amendment 26 requires that only volunteers may undergo specially authorised exposures. Article 13 lays down a number of conditions, including a restriction of exposures within authorised levels, which ensure an adequate level of safety even if one or other dose limit is exceptionally exceeded.

Amendments 32, 33 and 53 deal with Annex III. This Annex is of a technical nature, and its text makes plain that it has to be completed. Work is well under way in the preparation of all the necessary values with the objective of having it completed and enforced at the same time as the amended Directive. Following the advice of the Group of Experts referred to in Article 31 of the Euratom Treaty, Annex III will contain relationships dose/intake and not limits. These relationships may be used in conjunction with the methods set out in Annex II to ensure that both external and internal exposures are taken into account. While it is desirable to incorporate these relationships as soon as possible with a view to harmonised implementation of the Directive, this is not a prerequisite for its applicability.

Amendment 34 goes back to the criteria laid down in the 1980 Directive by which controlled and supervised areas are defined on the basis of fractions on the dose limits liable to be exceeded. Following a long period of practical experience, it is now felt that the designation of controlled and supervised

areas should be decided for each facility, or type of facility, on the basis of operational experience and judgement, taking into account the expected level and the likely variation of the doses and intakes and the potential for accidents.

Amendment 40 requires the medical surveillance of exposed workers to extend for fifteen years after cessation of work. This requirement is extremely difficult and in some cases impossible to carry out.

Amendment 45 requires that the benefits of an intervention be balanced only against its social costs and not, as in the original text, against its harm and costs, including social costs. The original text has to be retained as considerations other than the social costs inevitably come into play.

Amendments 46 and 47 require intervention levels for possible accidents to be laid down by Community legislation. It is in practice impossible to establish suitable intervention levels without taking into account the specific features of the accident in relation to which they should be applied. The Commission issued a guide in 1982 which includes ranges of values, which may be used by the competent authorities following actual accidents and emergencies.

An updated version of this guide is being prepared with the support of the Group of Experts referred to in Article 31 of the Euratom Treaty. The desirable continuity of protective measures across national borders is ensured by Article 52.

Amendment 48 requires Member States to make enquiries and public reports on accidents having made an intervention necessary. The Commission considers the obligation for the management to report in such situations to the authorities (Article 54) as being sufficient to cover this request. Member States assess the consequences and effectiveness of the intervention (Article 51.2.f). Member States may then evaluate the opportunity of updating the information to the public under Directive 89/618/Euratom.

Amendment 50 requires that the accelerated procedure laid down in Article 56 includes consultation of the European Parliament.

This procedure was proposed with the objective of taking into account possible unforeseen difficulties that Member States might have in applying some provisions of the Directive which considerably reduce the discretion they have under the existing Directive (e.g. Articles 3 and 4). It cannot therefore be excluded that some situations could require urgent action.

However, in all the other cases in which there is no such urgency, the Commission shall follow the standard procedure laid down by Article 31 of the Euratom Treaty.

Amendment 54 introduces specific measures for the medical radiological examination of women of the reproductive capacity with a view to protecting a possible embryo during its first days of development.

The Commission shares the preoccupation of the European Parliament. It considers however that the subject should not be dealt with in the Directive in question, but rather in Directive 84/466/Euratom laying down basic measures for the radiation protection of persons undergoing medical examination or treatment⁵.

This Directive requires in particular that all medical exposures must be medically justified, and that any ionizing radiation used in medical procedures is effected by persons specifically entitled. The Commission with the support of the Group of Experts referred to in Article 31 of the Euratom Treaty is presently considering the opportunity of updating this Directive and it will certainly give due consideration in this context to the proposed amendment.

⁵ O.J. L 265 of 5.10.84.

Amended proposal for a Council Directive (Euratom) laying down the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation

(Submitted by the Commission pursuant to Article 119(2) of the Euratom Treaty)

Initial text

Amended text

Recital 5a (new)

Whereas particular measures are required with regard to pregnant women to ensure protection of the foetus;

Recital 5b (new)

Whereas individual radiation protection involves control of the transfer of ionizing radiation or radionuclides to people via the environment, thereby ensuring adequate environmental protection;

Recital 6a (new)

Whereas, in order to avoid any divergence at international level, the Community continues to cooperate with those international organisations responsible for drawing up recommendations relating to radiation protection;

Recital 7a (new)

Whereas the provisions of this Directive are to be applied without conflicting with existing or future Community provisions relating to all agents likely to affect health, taking into account possible synergistic effects;

Initial text

Amended text

Recital 11a (new)

Whereas, under the terms of this Directive and the Council Directive of 4 December 1990 on the operational protection of outside workers exposed to the risk of ionizing radiation during their activities in controlled areas, it is important to ensure that these workers enjoy protection equivalent to that available to workers permanently employed in installations;

Recital 13a (new)

Whereas this Directive lays down, in accordance with Article 30 of the Treaty, dose limits compatible with adequate safety; whereas, however, under exceptional circumstances laid down at Community level, dose limits differing from those laid down by this Directive may be adopted;

Article 1

Article 1

Accident: an unintended event that causes damage to a source or that results or could result in exposure of members of the public in excess of the appropriate intervention level or in exposure of workers above the appropriate dose limits.

Accident: an unintended event that causes damage to a source or installation or that results or could result in abnormal exposure of members of the public or workers, the conditions of which could give cause for concern from the standpoint of radiation protection, or in exposure above the appropriate dose limits.

Intervention: a human activity that decreases the overall exposure of individuals to radiation by removing existing sources, modifying existing exposure pathways or reducing the number of individuals exposed to an existing source.

Intervention: a human activity that decreases the overall exposure of individuals to radiation by placing existing sources at a distance or in a containment, modifying existing exposure pathways or reducing the number of individuals exposed to an existing source.

Initial text

Practice: a human activity that can increase the overall exposure of individuals to radiation from a source.

Article 3(b)

- b) The use of radioactive substances or their subsequent disposal if the concentrations of activity per unit mass do not exceed the values given in column 3 of Table A in Annex 1; or

Article 4.1
Authorization

1. Prior authorization shall be required for the following practices:

Article 4.1b

- b) The disposal of radioactive substances or the recycling of materials containing radioactive substances, arising from any industrial, medical, veterinary or research undertaking, unless conditions laid down by the competent authorities are met;

Article 5

Prohibited practices

The deliberate addition of radioactive substances in the production of foodstuffs, toys, personal ornaments and cosmetics, the deliberate activation of such goods and their placing on the market shall be prohibited.

Amended text

Practice: a series of coordinated activities that can cause an increase in the overall exposure of individuals to radiation from sources and which have a definite objective.

Article 3(b)

- b) The use of radioactive substances or their subsequent disposal on a moderate scale if the concentrations of activity per unit mass do not exceed the values given in column 3 of Table A in Annex 1; or

Article 4.1
Authorization

1. Prior authorization shall be required from the competent authorities of the Member State for the following practices:

Article 4.1b

- b) The disposal of radioactive substances or the recycling of materials containing radioactive substances, arising from any industrial, medical, veterinary or research undertaking;

Article 5

Prohibited practices

The deliberate addition of radioactive substances in the production of foodstuffs, toys, personal ornaments and cosmetics, the deliberate activation of such goods and their placing on the market and commercial export shall be prohibited.

Initial text

Article 7.1(c)

- c) Without prejudice to Article 13, the sum of the doses from all relevant practices shall not exceed the dose limits laid down in this Title for exposed workers, apprentices, students and members of the public.

Article 10

Protection of pregnant women

As soon as a pregnant woman, in accordance with national legislation and/or national practice, informs the management of her condition, the foetus shall be protected as far as possible as though it were a member of the public. The exposure of the pregnant woman in the context of her employment shall be as low as reasonably achievable and the conditions of her work shall be such as to ensure that the equivalent dose to the foetus does not exceed 1 mSv during the remainder of the pregnancy.

Amended text

Article 7.1(c)

- c) Without prejudice to Article 13, the sum of the doses from all relevant sources and practices shall not exceed the dose limits laid down in this Title for exposed workers, apprentices, students and members of the public.

Article 10

Protection of pregnant women

As soon as a pregnant woman, in accordance with national legislation and/or national practice, informs the management of her condition, the embryo or foetus shall be protected as far as possible as though it were a member of the public. The exposure of the pregnant woman in the context of her employment shall be as low as reasonably achievable and the conditions of her work shall be such as to ensure that the equivalent dose to the foetus does not exceed 1 mSv during the remainder of the pregnancy.

These provisions shall apply without prejudice to Directive 92/85/EEC of 219 October 1992 on the introduction of measures to encourage improvements in the safety and health at work of pregnant workers and workers who have recently given birth or are breastfeeding¹

¹ OJ L 348, 28.11.1992, p.1

Initial text

Article 11.1

Protection of nursing mothers

1. Nursing mothers shall not be employed in work involving a risk of radioactive contamination.

SPECIALLY AUTHORISED EXPOSURES

Article 13.2

2. The exceeding of dose limits as a result of specially authorised exposures shall not necessarily be a reason for excluding the worker from his usual occupation.

Article 17

For the estimation of effective dose the methods referred to in this Title or any other appropriate methods shall be used.

Amended text

Article 11.1

Protection of nursing mothers

1. Without prejudice to Council Directive 92/85/EEC, nursing mothers shall not be employed in work involving a risk of radioactive contamination.

SPECIALLY AUTHORISED EXPOSURES

Article 13.2

2. Subsequent exposure conditions for a worker who has exceeded dose limits as a result of a specially authorised exposure shall be submitted to the approved medical practitioner or approved occupational health services for their agreement. These conditions shall not necessarily exclude the worker from his usual occupation.

Member States shall take the necessary measures to prohibit the dismissal of workers who have been subject to specially authorised exposures, except for reasons unrelated to the specially authorised exposure, in accordance with national legislation and/or practice and, where necessary, subject to the agreement of the competent authorities.

Article 17

For the estimation of effective dose the methods referred to in this Title or any other equivalent method approved by the competent authorities shall be used.

Initial text

Article 18

For external radiation, the values given in Annex II may be used to estimate the relevant equivalent and effective doses.

For internal exposure from a radionuclide or from a mixture of radionuclides, the methods given in Annex II and III may be used to estimate the effective doses.

Article 21

Requirements for controlled areas

The minimum requirements for a controlled area are that it shall be delineated and that access to it shall be controlled in accordance with written procedures provided by the management.

Amended text

Article 18

Without prejudice to the provisions of Article 17:

For external radiation, the values given in Annex II may be used to estimate the relevant equivalent and effective doses.

For internal exposure from a radionuclide or from a mixture of radionuclides, the methods given in Annex II and III may be used to estimate the effective doses.

Article 21

Requirements for controlled areas

The minimum requirements for a controlled area are as follows:

- a) it shall be delineated, access to it shall be limited to those persons who have received sufficient instructions in advance, and written rules concerning access shall be provided by the management;
- b) the placing of signs indicating the type of area, the nature of the sources and their inherent hazards;
- c) working instructions appropriate to the radiation hazard associated with the sources and the operations involved.

Depending on the nature and extent of the radiation hazards in controlled areas, radiological environmental surveillance shall be organised in accordance with the provisions of Article 26.

These duties shall be carried out by qualified experts.

Initial text

Article 22

Discretionary measures for controlled
and supervised areas

Taking into account the nature and extent of radiation hazards in the controlled and supervised areas:

- a) signs indicating type of area, nature of the sources and their inherent hazards shall be displayed;
- b) working instructions appropriate to the radiation hazard associated with the sources and the operations involved shall be laid down;
- c) radiological environmental surveillance shall be organised in accordance with the provisions of Article 26.

These duties shall be within the competence of qualified experts.

Article 24c

- c) be given training in the field of radiation protection.

Article 26.1

1. The radiological environmental surveillance, mentioned in Article 22, shall comprise:

Amended text

Article 22

Requirements for supervised areas

The minimum requirements for a supervised area shall be as follows:

- a) signs indicating type of area, nature of the sources and their inherent hazards shall be displayed;
- b) working instructions appropriate to the radiation hazard associated with the sources and the operations involved shall be laid down.

Depending on the nature and extent of the radiation hazards in controlled areas, radiological environmental surveillance shall be organised in accordance with the provisions of Article 26.

These duties shall be carried out by qualified experts.

Article 24c

- c) be given training in the field of radiation protection, particularly in relation to working in controlled areas.

Article 26.1

1. The radiological environmental surveillance, mentioned in Articles 21 and 22, shall comprise:

Initial text

Amended text

Article 30.1(a) (new)

- a) The overall results of the surveillance shall also be made available to workers' representatives

Article 43.2(a)

- a) Operations in identified workplaces where it has been declared that radon or gamma radiation needs attention such as: operations in spas, caves, mines (other than uranium mines) and other underground workplaces;

Article 43.2(a)

- a) Operations in identified workplaces where it has been declared that radon or gamma radiation needs attention such as: operations in spas, caves, mines (other than uranium mines), other underground workplaces and work sites in geological areas prone to radon emissions;

Article 43.3

3. Without prejudice to paragraphs 1 and 2, it does not apply to potassium-40 in the body, cosmic rays at ground level, and radionuclides in the earth's crust.

Article 43.3

3. Without prejudice to paragraphs 1 and 2, it does not apply to potassium-40 in the body, cosmic rays at ground level, and radionuclides in the earth's intact crust.

Article 46

Basic principle

Each Member State shall take all necessary measures to ensure the protection of the population.

Article 46

Basic principle

Each Member State shall take all necessary measures to ensure the best possible protection of the population in accordance with the principles set out in Article 7.

MODIFIED ANNEX I

Values of quantities and concentrations of radionuclides to be used for the application of Article 3.

1. Table A below presents the values of quantities and concentrations of activity per unit mass not to be exceeded in compliance with Articles 3 (a) and (b) respectively for the principal radioactive nuclides concerned.
2. For radionuclides not listed in Table A, the competent authority shall assign appropriate values for the quantities and concentrations of activity per unit mass where the need arises. Values thus assigned shall be complementary to those in Table A.
3. The values laid down in Table A apply to the total inventory of radioactive substances held by a person or undertaking at any point in time.
4. Nuclides carrying the suffix '+' or 'sec' in Table A represent parent nuclides in equilibrium with their corresponding daughter nuclides as listed in Table B. In this case the values given in Table A refer to the parent nuclide alone but already take account of the daughter nuclide(s) present.
5. In all other cases of mixtures of more than one nuclide the requirement for reporting may be waived if the sum of the ratios for each nuclide of the total amount present divided by the value listed in Table A is less than or equal to 1. This summation rule also applies to activity concentrations where the various nuclides concerned are contained in the same matrix.

1. Table A: Values of quantities and of concentrations of activity per unit mass not to be exceeded in compliance with Article 3 (2) (a) and (b) respectively, for the principal radioactive nuclides listed below:

Nuclide	Quantity (Bq)	Concentration (kBq/kg)
H-3	10^9	10^6
Be-7	10^7	10^3
C-14	10^7	10^4
O-15	10^9	10^2
F-18	10^6	10
Na-22	10^6	10
Na-24	10^5	10
Si-31	10^6	10^3
P-32	10^5	10^3
P-33	10^8	10^5
S-35	10^8	10^5
Cl-36	10^6	10^4
Cl-38	10^5	10
Ar-37	10^8	10^6
Ar-41	10^9	10^2
K-40	10^6	10^2
K-42	10^6	10^2
K-43	10^6	10
Ca-45	10^7	10^4
Ca-47	10^6	10
Sc-46	10^6	10
Sc-47	10^6	10^2
Sc-48	10^5	10
V-48	10^5	10
Cr-51	10^7	10^3
Mn-51	10^5	10
Mn-52	10^5	10
Mn-52m	10^5	10
Mn-53	10^9	10^4
Mn-54	10^6	10
Mn-56	10^5	10

Nuclide	Quantity (Bq)	Concentration (kBq/kg)
Fe-52	10^6	10
Fe-55	10^6	10^4
Fe-59	10^6	10
Co-55	10^6	10
Co-56	10^5	10
Co-57	10^6	10^2
Co-58	10^6	10
Co-58m	10^7	10^4
Co-60	10^5	10
Co-60m	10^6	10^3
Co-61	10^6	10^2
Co-62m	10^5	10
Ni-59	10^8	10^4
Ni-63	10^8	10^5
Ni-65	10^6	10
Cu-64	10^6	10^2
Zn-65	10^6	10
Zn-69	10^6	10^4
Zn-69m	10^6	10^2
Ga-72	10^5	10
Ge-71	10^8	10^4
As-73	10^7	10^3
As-74	10^6	10
As-76	10^5	10^2
As-77	10^6	10^3
Se-75	10^6	10^2
Br-82	10^6	10
Kr-74	10^9	10^2
Kr-76	10^9	10^2
Kr-77	10^9	10^2
Kr-79	10^5	10^3
Kr-81	10^7	10^4
Kr-83m	10^{12}	10^5
Kr-85	10^4	10^5

Nuclide	Quantity (Bq)	Concentration (kBq/kg)
Kr-85m	10^{10}	10^3
Kr-87	10^9	10^2
Kr-88	10^9	10^2
Rb-86	10^5	10^2
Sr-85	10^6	10^2
Sr-85m	10^7	10^2
Sr-87m	10^6	10^2
Sr-89	10^6	10^3
Sr-90+	10^4	10^2
Sr-91	10^5	10
Sr-92	10^6	10
Y-90	10^5	10^3
Y-91	10^6	10^3
Y-91m	10^6	10^2
Y-92	10^5	10^2
Y-93	10^5	10^2
Zr-93+	10^7	10^3
Zr-95	10^6	10
Zr-97+	10^5	10
Nb-93m-	10^7	10^4
Nb-94	10^6	10
Nb-95	10^6	10
Nb-97	10^6	10
Nb-98	10^5	10
Mo-90	10^6	10
Mo-93	10^8	10^3
Mo-99	10^6	10^2
Mo-101	10^6	10
Tc-96	10^6	10
Tc-96m	10^7	10^3
Tc-97	10^8	10^3
Tc-97m	10^7	10^3
Tc-99	10^7	10^4
Tc-99m	10^7	10^2

Nuclide	Quantity (Bq)	Concentration (kBq/kg)
Ru-97	10^7	10^2
Ru-103	10^6	10^2
Ru-105	10^6	10
Ru-106+	10^5	10^2
Rh-103m	10^8	10^4
Rh-105	10^7	10^2
Pd-103	10^8	10^3
Pd-109	10^6	10^3
Ag-105	10^6	10^2
Ag-108m+	10^6	10
Ag-110m	10^6	10
Ag-111	10^6	10^3
Cd-109	10^6	10^4
Cd-115	10^6	10^2
Cd-115m	10^6	10^3
In-111	10^6	10^2
In-113m	10^6	10^2
In-114m	10^6	10^2
In-115m	10^6	10^2
Sn-113	10^7	10^3
Sn-125	10^5	10^2
Sb-122	10^4	10^2
Sb-124	10^6	10
Sb-125	10^6	10^2
Te-123m	10^7	10^2
Te-125m	10^7	10^3
Te-127	10^6	10^3
Te-127m	10^7	10^3
Te-129	10^6	10^2
Te-129m	10^6	10^3
Te-131	10^5	10^2
Te-131m	10^6	10
Te-132	10^7	10^2
Te-133	10^5	10
Te-133m	10^5	10
Te-134	10^6	10

Nuclide	Quantity (Bq)	Concentration (kBq/kg)
I-123	10^7	10^2
I-125	10^6	10^3
I-126	10^6	10^2
I-129	10^5	10^2
I-130	10^6	10
I-131	10^6	10^2
I-132	10^5	10
I-133	10^6	10
I-134	10^5	10
I-135	10^6	10
Xe-131m	10^4	10^4
Xe-133	10^4	10^3
Xe-135	10^{10}	10^3
Cs-129	10^5	10^2
Cs-131	10^6	10^3
Cs-132	10^5	10
Cs-134m	10^5	10^3
Cs-134	10^4	10
Cs-135	10^7	10^4
Cs-136	10^5	10
Cs-137+	10^4	10
Cs-138	10^4	10
Ba-131	10^6	10^2
Ba-140+	10^5	10
La-140	10^5	10
Ce-139	10^6	10^2
Ce-141	10^7	10^2
Ce-143	10^6	10^2
Ce-144+	10^5	10^2
Pr-142	10^5	10^2
Pr-143	10^6	10^4

Nuclide	Quantity (Bq)	Concentration (kBq/kg)
Nd-147	10^6	10^2
Nd-149	10^6	10^2
Pm-147	10^7	10^4
Pm-149	10^6	10^3
Sm-151	10^8	10^4
Sm-153	10^6	10^2
Eu-152	10^6	10
Eu-152m	10^6	10^2
Eu-154	10^6	10
Eu-155	10^7	10^2
Gd-153	10^7	10^2
Gd-159	10^6	10^3
Tb-160	10^6	10
Dy-165	10^6	10^3
Dy-166	10^6	10^3
Ho-166	10^5	10^3
Er-169	10^7	10^4
Er-171	10^6	10^2
Tm-170	10^6	10^3
Tm-171-	10^8	10^4
Yb-175	10^7	10^3
Lu-177	10^7	10^3
Hf-181	10^6	10
Ta-182	10^4	10
W-181	10^7	10^3
W-185	10^7	10^4
W-187	10^6	10^2
Re-186	10^6	10^3
Re-188	10^5	10^2
Os-185	10^6	10
Os-191	10^7	10^2
Os-191m	10^7	10^3
Os-193	10^6	10^2
Ir-190	10^6	10

Nuclide	Quantity (Bq)	Concentration (kBq/kg)
Ir-192	10^4	10
Ir-194	10^5	10^2
Pt-191	10^6	10^2
Pt-193m	10^7	10^3
Pt-197	10^6	10^3
Pt-197m	10^6	10^2
Au-198	10^6	10^2
Au-199	10^6	10^2
Hg-197	10^7	10^2
Hg-197m	10^6	10^2
Hg-203	10^5	10^2
Tl-200	10^6	10
Tl-201	10^6	10^2
Tl-202	10^6	10^2
Tl-204	10^4	10^4
Pb-203	10^6	10^2
Pb-210+	10^4	10
Pb-212+	10^5	10
Bi-206	10^5	10
Bi-207	10^6	10
Bi-210	10^6	10^3
Bi-212+	10^5	10
Po-203	10^6	10
Po-205	10^6	10
Po-207	10^6	10
Po-210	10^4	10
At-211	10^7	10^3
Rn-220+	10^7	10^4
Rn-222+	10^8	10
Ra-223+	10^5	10^2
Ra-224+	10^5	10
Ra-225	10^5	10^2

Nuclide	Quantity (Bq)	Concentration (kBq/kg)
Ra-226+	10^4	10
Ra-227	10^6	10^2
Ra-228+	10^5	10
Ac-228	10^6	10
Th-226+	10^7	10^3
Th-227	10^4	10
Th-228+	10^4	1
Th-229+	10^3	1
Th-230	10^4	1
Th-231	10^7	10^3
Th-232sec	10^3	1
Th-234+	10^5	10^3
Pa-230	10^6	10
Pa-231	10^3	1
Pa-233	10^7	10^2
U-230+	10^5	10
U-231	10^7	10^2
U-232+	10^3	1
U-233	10^4	10
U-234	10^4	10
U-235+ -	10^4	10
U-236	10^4	10
U-237	10^6	10^2
U-238+	10^4	10
U-238sec	10^3	1
U-239	10^6	10^2
U-240	10^7	10^3
U-240+	10^6	10
Np-237+	10^3	1
Np-239	10^7	10^2

Nuclide	Quantity (Bq)	Concentration (kBq/kg)
Np-240	10^6	10
Pu-234	10^7	10^2
Pu-235	10^7	10^2
Pu-236	10^4	10
Pu-237	10^7	10^3
Pu-238	10^4	1
Pu-239	10^4	1
Pu-240	10^3	1
Pu-241	10^5	10^2
Pu-242	10^4	1
Pu-243	10^7	10^3
Pu-244	10^4	1
Am-241	10^4	1
Am-242	10^6	10^3
Am-242m+	10^4	1
Am-243+	10^3	1
Cm-242	10^5	10^2
Cm-243	10^4	1
Cm-244	10^4	10
Cm-245	10^3	1
Cm-246	10^3	1
Cm-247	10^4	1
Cm-248	10^3	1
Bk-249	10^6	10^3
Cf-246	10^6	10^3
Cf-248	10^4	10
Cf-249	10^3	1
Cf-250	10^4	10
Cf-251	10^3	1
Cf-252	10^4	10
Cf-253	10^5	10^2
Cf-254	10^3	1

Nuclide	Quantity (Bq)	Concentration (kBq/kg)
Es-253	10^5	10^2
Es-254	10^4	10
Es-254m	10^6	10^2
Fm-254	10^7	10^4
Fm-255	10^6	10^3

Table B: List of nuclides in secular equilibrium as referred to in pt. 4

Parent nuclide	Daughter nuclides
Sr-80+	Rb-80
Sr-90+	Y-90
Zr-93+	Nb-93m
Zr-97+	Nb-97
Ru-106+	Rh-106
Ag-108m+	Ag-108
Cs-137+	Ba-137
Ba-140+	La-140
Ce-134+	La-134
Ce-144+	Pr-144
Pb-212+	Bi-212, Tl-208, Po-212
Pb-210+	Bi-210, Po-210
Bi-212+	Tl-208, Po-212
Rn-220+	Po-216
Rn-222+	Po-218, Pb-214, Bi-214
Ra-223+	Rn-219, Po-215, Pb-211, Bi-211
Ra-224+	Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Ra-226+	Rn-222, Po-218, Pb-214, Bi-214, Pb-210, Bi-210, Po-210
Ra-228+	Ac-228
Th-226+	Ra-222, Rn-218, Po-214
Th-228+	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Th-229+	Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209
Th-232sec	Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212

Parent nuclide	Daughter nuclides
Th-234+	Pa-234m
U-230+	Th-226, Ra-222, Rn-218, Po-214
U-232+	Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
U-235+	Th-231
U-238+	Th-234, Pa-234m
U-238sec	Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Pb-210, Bi-210, Po-210
U-240+	Np-240
Np-237+	Pa-233
Am-242m+	Am-242
Am-243+	Np-239

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