

Official Journal

of the European Communities

Volume 19 No L 187

12 July 1976

English Edition

Legislation

Contents

I *Acts whose publication is obligatory*

.....

II *Acts whose publication is not obligatory*

Council

76/579/Euratom:

★ Council Directive of 1 June 1976 laying down the revised basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation	1
Title I: Definitions	2
Title II: Scope, reporting and authorization	5
Title III: Limitation of doses for controllable exposures	6
Title IV: Derived working limits	8
Title V: Accidental and emergency exposures	9
Title VI: Fundamental principles governing health surveillance for exposed workers	9
Title VII: Fundamental principles governing protection of the health of the population	13
Annex I	15
Annex II	23
Annex III	30
Annex IV	44

II

(Acts whose publication is not obligatory)

COUNCIL

COUNCIL DIRECTIVE

of 1 June 1976

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

(76/579/Euratom)

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Atomic Energy Community, and in particular Articles 31 and 32 thereof,

Having regard to the proposal from the Commission, worked out after obtaining the opinion of a group of persons appointed by the Scientific and Technical Committee from among scientific experts, in the Member States,

Having regard to the opinion of the European Parliament ⁽¹⁾,

Having regard to the opinion of the Economic and Social Committee ⁽²⁾,

Whereas the Treaty establishing the European Atomic Energy Community prescribes that the basic standards for the protection of the health of the general public and workers against the dangers arising from ionizing radiations, as provided for in particular in Article 30 thereof, must be laid down in order to enable each Member State, in accordance with Article 33, to lay down the appropriate provisions by legislation, regulation or administrative action to ensure compliance with the basic standards,

to take the necessary measures with regard to teaching, education and vocational training and to lay down such provisions in harmony with the provisions applicable in this field in the other Member States;

Whereas the Council, on 2 February 1959, adopted Directives laying down such basic standards ⁽³⁾ and whereas these were last amended by Directive 66/45/Euratom ⁽⁴⁾;

Whereas the usefulness of a general review of these Directives has become progressively apparent in the light of increasing scientific knowledge of radiation protection and as a result of the practical experience of applying these Directives in national laws;

Whereas the protection of the health of workers and the general public requires that any activity involving danger arising from ionizing radiations must be made subject to regulation;

Whereas the basic standards must be adapted to the conditions under which nuclear energy is used and whereas they vary according to whether they are concerned with the individual safety of workers exposed to ionizing radiations or with the protection of the general public;

⁽¹⁾ OJ No C 40, 8. 4. 1974, p. 12.

⁽²⁾ Opinion delivered on 24. 5. 1973.

⁽³⁾ OJ No 11, 20. 2. 1959, p. 221/59.

⁽⁴⁾ OJ No 216, 26. 11. 1966, p. 3693/66.

Whereas the protection of the health of workers exposed to ionizing radiations requires, on the one hand, the organization of measures to restrict exposure and procedures for measuring exposure and, on the other hand, an adequate degree of medical surveillance;

Whereas the protection of the health of the general public entails a system of surveillance, inspection and, in the case of accident, intervention,

HAS ADOPTED THIS DIRECTIVE:

TITLE I

DEFINITIONS

Article 1

For the purposes of this Directive, the following terms have the meaning hereby assigned to them:

(a) Physical terms, quantities and units

Ionizing radiation: radiation consisting of photons or of particles capable of producing ions directly or indirectly.

Activity (A): the activity of a quantity of a radionuclide is the quotient of dN by dt , where dN is the number of spontaneous nuclear transformations which occur in this quantity in the time interval dt .

$$A = \frac{dN}{dt}$$

This definition does not apply to the words 'activity' and 'activities' in Articles 2, 3 and 4 and in Article 6 (3).

Curie (Ci): the curie is the special unit of activity. In the International System of Units the unit is the second to the power minus one: s^{-1} .

$$1 \text{ Ci} = 3.7 \times 10^{10} \text{ s}^{-1} \text{ (exactly)}$$

Absorbed dose (D): the quotient of $d\bar{e}$ by dm , where $d\bar{e}$ is the mean energy imparted by ionizing radiation to matter in a volume element and dm is the mass of matter in that volume element.

$$D = \frac{d\bar{e}}{dm}$$

Rad (rd): the rad is the special unit of absorbed dose. In the International System of Units, the unit used is the joule per kilogramme ($J \text{ kg}^{-1}$).

$$1 \text{ rd} = 10^{-2} \text{ J kg}^{-1}$$

Linear energy transfer or restricted linear collision stopping power (L_A) of charged particles in a medium is the quotient of dE by dl , where dl is the distance

traversed by the particle and dE is the energy loss due to collisions with energy transfers less than a given value ' Δ '.

$$L_A = \left(\frac{dE}{dl} \right)_\Delta$$

For radiation protection calculations, all the transferred energies are included, so that

$$L_A \text{ becomes } L_\infty$$

Fluence (Φ) of particles: the quotient of dN by da , where dN is the number of particles which enter a sphere of cross-sectional area da .

$$\Phi = \frac{dN}{da}$$

Fluence rate (φ): the quotient of $d\Phi$ by dt , where $d\Phi$ is the increment of particle fluence in the time interval dt .

$$\varphi = \frac{d\Phi}{dt}$$

(b) Radiological, biological and medical terms

Exposure: any exposure of persons to ionizing radiation. A distinction is made between:

- external exposure: exposure resulting from sources outside the body;
- internal exposure: exposure resulting from sources inside the body;
- total exposure: the sum of external and internal exposure.

Continuous exposure: external exposure where the source of radiation subjects the body or the critical organ to prolonged exposure (although its intensity may vary with time) or internal exposure due to continuous intake (although its level may vary with time).

Single exposure: external exposure where the source of radiation subjects the body or the critical organ to exposure of short duration, or internal exposure following the intake of radionuclides over a short period.

Dose equivalent (H): the product of the absorbed dose (D), the quality factor (Q) and the product of all other modifying factors (N). Where the word 'dose' is used alone the meaning is always that of 'dose equivalent'.

Rem: the special unit of dose equivalent.

Quality factor (Q): a function of linear energy transfer (L_{∞}), used to weight absorbed doses in such a way as to indicate their significance for radiation protection purposes.

Cumulative dose: the sum of all doses received during working hours by an exposed worker from known sources, with the exception of those due to natural background radiation and to medical examination and treatment.

Whole body dose: the dose resulting from what is regarded as uniform exposure of the whole body.

Partial body dose: the dose resulting from exposure of part of the body or of one or more organs.

Total dose: the sum of all doses resulting from total exposure.

Dose commitment: the dose to an organ or to a tissue, over a period of 50 years, resulting from an intake of one or more radionuclides.

Genetic dose: the genetic dose to a population is the dose which, if it were received by each person from conception to the mean age of childbearing, would result in the same genetic burden to the whole population as do the actual doses received by the individuals of this population. The genetic dose can be assessed as the annual genetically significant dose multiplied by the mean age of childbearing, which is taken to be 30 years.

Annual genetically significant dose to a population: the average of the individual annual gonad doses, weighted in the case of each individual dose for the

expected number of children conceived subsequent to exposure.

The critical organ: the organ in which the ratio of the dose resulting from exposure to external and internal radiation to the maximum permissible partial body dose for the said organ is highest.

Maximum permissible doses: the limits set for the exposure of workers. They apply only to occupational exposure, excluding exposure to natural background radiation and that resulting from medical examination and treatment undergone by workers.

Derived limit of concentration of radionuclides in the air inhaled expressed in units of activity per unit volume, is the annual mean concentration in the air which, inhaled over 2 000 hours of work, delivers to the body or to the critical organ, a dose commitment equal to the annual maximum permissible dose.

Radioactive contamination: the contamination of any material, surface or environment or of a person by radioactive substances.

In the specific case of the human body, this contamination includes both external skin contamination and internal contamination irrespective of method of intake.

Intake: the quantity of activity entering the body from the external environment.

Limit of annual intake: for a given individual, the activity which, when introduced into the body, results, for the whole body or the critical organ, in a dose commitment equal to the appropriate limit fixed for the annual dose in Articles 7, 8, 9 and 11.

Radiotoxicity: the toxicity attributable to ionizing radiation emitted by an incorporated radionuclide and its daughters; radiotoxicity is related not only to the radioactive characteristics of the radionuclide but also to its chemical and physical state and to the metabolism of the element in the body or in the organ.

(c) Other terms

Source: an apparatus or substance capable of emitting ionizing radiation.

Sealed source: a source consisting of radioactive substances firmly incorporated in solid and effectively inactive materials, or sealed in an inactive container of sufficient strength to prevent, under normal conditions of use, any dispersion of radioactive substances and any possibility of contamination.

Radioactive substance: any substance that contains one or more radionuclides of which the activity or the concentration cannot be disregarded as far as radiation protection is concerned.

Natural background radiation: consists of all ionizing radiation from natural terrestrial and cosmic sources, to the extent that the exposure which it causes is not significantly increased by man.

Critical assembly: an assembly of fissile materials in which it is feasible to maintain a chain reaction.

Whole population: the entire population, including exposed workers, apprentices, students and members of the public.

Exposed workers: persons whose annual exposure in the course of their work may exceed one-tenth of the annual maximum permissible doses.

Critical groups of the population: groups comprising persons whose exposure is reasonably uniform and representative of that of the more highly exposed individuals in the population.

Members of the public: individuals in the population excluding exposed workers, apprentices and students, during their working hours.

Controlled area: an area subject to special rules for the purposes of protection against ionizing radiation and to which access is controlled.

Supervised area: an area subject to appropriate supervision for the purpose of protection against ionizing radiation.

Dose limits: the limits of dose that are established for members of the public and for the whole population, as well as for apprentices and students. They do not apply to exposure to natural background radiation or to the exposure of individuals as a result of medical examination and treatment undergone by them.

Action level: a value of absorbed dose or dose equivalent or a derived value fixed in connection with the drawing up of emergency plans.

Approved medical practitioner: a medical practitioner responsible for the medical surveillance of workers of category A as defined in Article 19, whose capacity to act in this respect is recognized by the competent authorities.

Qualified experts: persons having the knowledge and training needed to carry out physical or technical tests, or radiochemical tests, or to give advice in order to ensure effective protection of individuals and correct operation of protective installations, as the case may be, whose capacity to act as a qualified expert is recognized by the competent authority.

Accident: an unforeseen event that causes damage to an installation or disrupts the normal operation of an installation, and is likely to result for one or more persons in a dose exceeding the maximum permissible doses.

Planned special exposures: exposure in excess of the quarterly maximum permissible dose authorized in a situation during normal operations when alternative techniques which do not involve such exposure are either unavailable or impracticable.

Accidental exposure: exposure which is of a fortuitous and involuntary nature and in which a maximum permissible dose is exceeded.

Emergency exposure: voluntary exposure justified in the interests of bringing help to endangered individuals, preventing the exposure of a large number of people or saving a valuable installation and in which a maximum permissible dose is exceeded.

TITLE II

SCOPE, REPORTING AND AUTHORIZATION

Article 2

This Directive shall apply to the production, processing, handling, use, holding, storage, transport and disposal of natural and artificial radioactive substances and to any other activity which involves a hazard arising from ionizing radiation.

Article 3

Each Member State shall make the reporting of the activities referred to in Article 2 compulsory.

Without prejudice to Article 5 and in the light of possible dangers and other relevant considerations, these activities shall be subject to prior authorization in cases decided upon by each Member State.

Article 4

Without prejudice to Article 5, these requirements for reporting and obtaining prior authorization need not be applied to activities involving:

- (a) radioactive substances when the quantities do not exceed in total the values given in Annex I;
- (b) radioactive substances of a concentration of less than $0.002 \mu\text{Ci g}^{-1}$, this limit being increased to $0.01 \mu\text{Ci g}^{-1}$ for solid natural radioactive substances;
- (c) the use of navigation instruments or timepieces containing radioluminescent paint, but not their manufacture or repair except as provided for in paragraph (a);
- (d) apparatus emitting ionizing radiations and containing radioactive substances in amounts greater than the values specified in (a), provided that:
 - (1) it is of a type approved by the competent authority;
 - (2) it possesses advantages in relation to the potential hazard that, in the opinion of the competent authority, justify its use;
 - (3) it is constructed in the form of sealed sources ensuring effective protection against any

contact with the radioactive substances and against any leakage of them; and

- (4) it does not cause at any point situated at a distance of 0.1 m from the accessible surface of the apparatus and under normal operating conditions, a dose rate exceeding 0.1 mrem h^{-1} ;
- (e) apparatus other than television receivers emitting ionizing radiation but not containing any radioactive substances, provided that:
 - (1) it is of a type approved by the competent authority;
 - (2) it possesses advantages in relation to the potential hazard that, in the opinion of the competent authority, justify its use; and
 - (3) it does not cause, at any point situated at a distance of 0.1 m from the accessible surface of the apparatus and under normal operating conditions, a dose rate exceeding 0.1 mrem h^{-1} ;
- (f) television receivers which do not cause, at any point situated at a distance of 0.05 m from the accessible surface of the receiver, a dose rate exceeding 0.5 mrem h^{-1} .

Article 5

Apart from the prohibitions provided for by national law, and irrespective of the degree of danger involved, a system of prior authorization must be applied in respect of:

- (a) the administration of radioactive substances to persons for purposes of diagnosis, treatment or research;
- (b) the use of radioactive substances in toys and the importation of toys containing radioactive substances;
- (c) the addition of radioactive substances in the production and manufacture of foodstuffs, medicinal products, cosmetics and products for household use (except for the instruments and timepieces referred to in Article 4 (c)) and the importation for commercial purposes of such goods if they contain radioactive substances.

TITLE III

LIMITATION OF DOSES FOR CONTROLLABLE EXPOSURES

Article 6

1. The exposure of persons and the number of persons exposed to ionizing radiation must be kept as low as is reasonably practicable. In any event, the doses received must not exceed the maximum permissible doses for exposed workers and the dose limits for members of the public, apprentices and students, as specified in this Title.

2. As far as possible, in the event of total exposure, the sum of the doses resulting from external and internal exposure shall be calculated by an appropriate method.

3. Workers under 18 years of age may not carry out any activity which would result in their being exposed workers.

4. During pregnancy or the nursing period, women must not be employed in work involving a risk of high exposure; if necessary a special watch will be kept for bodily radioactive contamination.

and that the quarterly dose does not exceed the value given in paragraph 4.

3. When the dose previously accumulated is not known with certainty for a certain number of years of work involving exposure to ionizing radiation, it shall be assumed to be equal for each of those years to the maximum permissible whole body dose laid down in paragraph 1.

4. The maximum permissible whole body dose during one quarter shall be 3 rem. The quarterly dose of 3 rem is acceptable as a single dose only under exceptional circumstances. For women of reproductive capacity, the dose to the abdomen shall not exceed 1.3 rem during a quarter.

5. As soon as pregnancy is declared, measures shall be taken to ensure that exposure of the woman concerned in the context of her employment is such that the dose to the foetus accumulated over the period of time between declaration of pregnancy and the date of delivery remains as small as is reasonably practicable and never at any time exceeds 1 rem.

CHAPTER I

MAXIMUM PERMISSIBLE DOSES FOR EXPOSED WORKERS

Article 7

Whole body dose

1. Except as provided in paragraph 2, the maximum permissible whole body dose for exposed workers shall be 5 rem/year.

2. In certain cases, for valid reasons, paragraph 1 may be waived, provided that this does not involve exceeding the maximum permissible cumulative dose for a given age as obtained from the following formula:

$$D = 5(N - 18)$$

where D = the cumulative dose in rem
and N = the age in years

Article 8

Partial body doses

In the case of partial exposure of the body, the maximum permissible doses are as follows:

- (a) for exposure of the bone marrow or the gonads: 5 rem/year and 3 rem during a quarter. Article 7 (2) and (3) shall apply *mutatis mutandis*.
- (b) for external exposure of the extremities (hands, forearms, feet, ankles): 75 rem/year and 40 rem during a quarter;
- (c) for exposure of the thyroid, skin or bone, with the exception of the extremities specified in paragraph (b): 30 rem/year and 15 rem during a quarter;
- (d) for exposure of organs or tissues other than the extremities, the thyroid, skin, bone, bone marrow and gonads: 15 rem/year and 8 rem during a quarter.

CHAPTER II

LIMITATION OF DOSES FOR APPRENTICES AND STUDENTS

Article 9

1. The dose limits for apprentices and students aged 18 years or over who are training for employment involving exposure to ionizing radiation or who, in the course of their studies, are obliged to use sources, shall be equal to the maximum permissible doses for exposed workers laid down in Article 7 (with the exception of paragraph 2) and Article 8;

2. the dose limits for apprentices and students aged between 16 and 18 years who are training for employment involving exposure to ionizing radiation or who, in the course of their studies, are obliged to use sources, shall be equal to three-tenths of the annual maximum permissible doses for exposed workers laid down in Articles 7 and 8;

3. the dose limits for apprentices and students aged 16 years or over who are not subject to the provisions of paragraphs 1 and 2 and for apprentices and students aged less than 16 years, shall be the same as the dose limits for members of the public specified in Article 11. In addition, the contribution to the annual doses that they are liable to receive by virtue of the training shall not exceed one-tenth of the dose limits specified in Article 11 and each single exposure shall not exceed one-hundredth of those dose limits.

CHAPTER III

PLANNED SPECIAL EXPOSURES

Article 10

1. Only workers of category A defined in Article 19 may be subjected to planned special exposures. All planned special exposures must be subject to appropriate authorization.

2. The doses or dose commitments received in the course of planned special exposures must not exceed twice the annual maximum permissible doses laid down in Articles 7 and 8 in any single event or, in a lifetime, five times those doses.

3. Planned special exposures must not be authorized:

(a) if, in the case of whole body exposure or exposure of the bone marrow or the gonads, the

value obtained by adding the dose expected to result from the planned special exposure to the dose previously accumulated exceeds the limit established by means of the formula set out in Article 7 (2) or

(b) if, during the previous 12 months, the worker has received a single exposure exceeding the quarterly maximum permissible doses laid down in Articles 7 and 8, or

(c) if the worker has previously received accidental or emergency exposures, the sum of which exceeds five times the annual maximum permissible doses laid down in Articles 7 and 8, or

(d) if the worker is a woman of reproductive capacity.

4. Doses resulting from a planned special exposure shall be added to the doses received previously. Subsequent exposures shall be limited in such a way that:

(a) in the case of whole body exposure or exposure of the bone marrow or the gonads, the dose or dose commitment received during a quarter is less than one-half of the quarterly limit laid down in Articles 7 and 8, until such time as the average dose rate in the period commencing immediately prior to the planned special exposure and terminating at the time when the removal of these restrictions is contemplated falls below the dose rate corresponding to the quarterly maximum permissible dose;

(b) in the case of exposure of a part of the body or of one or more organs, other than the bone marrow or the gonads, the dose or dose commitment received during a year is less than one-half of the annual limit laid down in Article 8, until such time as the average dose rate in the period commencing immediately prior to the planned special exposure and terminating at the time when the removal of these restrictions is contemplated falls below the dose rate corresponding to the annual maximum permissible dose.

5. The exceeding of maximum permissible doses as a result of a planned special exposure shall not, in itself, be a reason for excluding the worker from his usual occupation.

6. All planned special exposures must be entered in the medical record provided for in Article 31, in which the estimated value of the dose and of the activities taken into the body shall also be entered.

7. Any worker receiving a planned special exposure shall be given appropriate information about the risks involved and the precautions to be taken during the operation.

- (4) for exposure of the thyroid of persons aged 16 years or over: 3 rem/year;
for exposure of the thyroid of persons aged less than 16 years: 1.5 rem/year;
- (5) for exposure of other organs or tissues: 1.5 rem/year.

CHAPTER IV

Article 12

DOSE LIMITS FOR THE POPULATION

Dose for the population as a whole

Article 11

Each Member State shall see that:

Dose limits for members of the public

Without prejudice to Article 12, the dose limits for members of the public shall be as follows:

- (a) the whole body dose limit shall be 0.5 rem/year;
- (b) the partial body dose limits shall be as follows:
 - (1) for the bone marrow or the gonads: 0.5 rem/year;
 - (2) for external exposure of the extremities (hands, forearms, feet, ankles) 7.5 rem/year;
 - (3) for exposure of the skin or bone, with the exception of the extremities specified in (b) (2): 3 rem/year;

- (a) the contributions to the dose for the population as a whole are kept to the minimum amount necessitated by the practice causing these contributions;
- (b) the total of all such contributions is kept under review;
- (c) taking into account the fact that good radiation protection planning and practice will ensure a very low level of exposure, the total genetic dose from all sources excluding contributions from natural background radiation and from medical examination and treatment shall not exceed 5 rem in any generation, taken to mean a period of 30 years;
- (d) the total of the contributions to the genetic dose is estimated;
- (e) the contribution to the genetic dose from medical examination and treatment is kept to the minimum value consistent with medical requirements.

TITLE IV

DERIVED WORKING LIMITS

Article 13

1. The values of the quality factors and the fluence rates that are to be used to arrive at an evaluation of the dose for different types of radiation shall be those laid down in Annex II.

2. The values of intake and concentration of radionuclides in the air to be used in implementing the requirements of Articles 7 to 12 shall be those laid down in Annex III.

- (a) The following limits and values listed in the table in Annex III, Number 1 shall be complied with:
 - the annual limits of intake by inhalation of radionuclides for exposed workers;
 - the derived limits of concentration of radionuclides in the air inhaled for exposed

workers. They must be considered as average values for one year. However, the average concentration over a quarter of a year may be twice this maximum value;

- the annual limits for intake by inhalation and by ingestion of radionuclides for members of the public;
 - (b) Where contamination is caused by a mixture of radionuclides, the values given or the method indicated in Number 2 of Annex III to this Directive shall be used as appropriate.
3. The annual limits of intake relating to apprentices and students and the population as a whole shall be derived from the limitations of dose laid down in Articles 9 and 12 respectively.

TITLE V

ACCIDENTAL AND EMERGENCY EXPOSURES

Article 14

Wherever possible doses and dose commitments received voluntarily or involuntarily in the course of accidental and emergency exposures must be recorded separately on the exposure record and in the medical record of the worker provided for in Articles 26 and 31.

TITLE VI

FUNDAMENTAL PRINCIPLES GOVERNING HEALTH SURVEILLANCE FOR EXPOSED WORKERS

Article 15

Surveillance of the health of exposed workers shall be based on the following principles:

- (a) classification of places of work into different areas;
- (b) classification of workers into different categories;
- (c) implementation of control measures and monitoring relating to these different areas and to the different categories of workers.

These principles of surveillance shall also apply to the apprentices and students referred to in Article 9 (1) and (2).

CHAPTER I

MEASURES FOR THE RESTRICTION OF EXPOSURE

Section 1

Classification and demarcation of areas

Article 16

For the purposes of radiation protection, each Member State shall make arrangements as regards all places of work where there is a risk of exposure to ionizing radiation.

In working areas where the exposure is not liable to exceed one-tenth of the annual maximum permissible doses for exposed workers, it shall not be necessary to make special arrangements for the purposes of radiation protection.

In working areas where the exposure is liable to exceed one-tenth of the annual maximum permissible doses laid down for exposed workers, the arrangements must be appropriate to the nature of the installation and sources and to the magnitude and nature of the hazards. The scope of the precautions and monitoring, as well as their type and quality, must be appropriate to the hazards associated with the work involving exposure to ionizing radiation.

A distinction shall be made between:

- (a) controlled areas,
 - (b) supervised areas.
- (a) Any area in which doses are liable to exceed three-tenths of the annual maximum permissible doses laid down for exposed workers shall constitute or be included in a controlled area.
- Annex IV lists examples of establishments and plants in which the presence of generators or sources liable to be the cause of exposure generally justifies the demarcation of one or more controlled areas.
- (b) Any area which is not considered as a controlled area and in which doses are liable to exceed one-tenth of the annual maximum permissible doses laid down for exposed workers shall be considered as a supervised area.

Article 17

Controlled areas must be demarcated.

Taking into account the nature and extent of the radiation hazards:

- (a) radiological environmental surveillance shall be organized in controlled and supervised areas, and, in particular, activities, doses and dose rates as the case may be shall be monitored and results recorded;
- (b) in controlled and supervised areas, working instructions appropriate to the radiation hazard shall be laid down;
- (c) the hazards inherent in the sources shall be indicated in controlled areas;
- (d) signs indicating sources shall be displayed in controlled and supervised areas.

Qualified experts shall be concerned in the discharge of these duties.

Article 18

The minimum requirement for a controlled area shall be the control of access by appropriate warning signs.

*Section 2***Classification of exposed workers***Article 19*

For the purposes of monitoring and surveillance, a distinction shall be made between two categories of exposed workers:

- category A: those who are liable to receive a dose greater than three-tenths of the annual maximum permissible dose;
- category B: those who are not liable to receive this dose.

Article 20

Exposed workers must be informed of the health risks involved in their work, the precautions to be taken, and the importance of complying with the technical and medical requirements.

Apprentices and students referred to in Article 9 (1) and (2) shall also be given adequate training in the

field of radiation protection and appropriate information regarding the risks involved in their work.

*Section 3***Examination and testing of protective devices and measuring instruments***Article 21*

The examination and testing of protective devices and measuring instruments shall be the responsibility of qualified experts.

The examination and testing shall comprise:

- (a) prior critical examination of plans for installations from the point of view of radiation protection;
- (b) the acceptance of new installations from the point of view of radiation protection;
- (c) regular checking of the effectiveness of protective devices and techniques ;
- (d) regular checking that measuring instruments are serviceable and correctly used.

CHAPTER II**ASSESSMENT OF EXPOSURE***Article 22*

The nature and frequency of assessment of exposure shall be such as to facilitate compliance with this Directive in each case.

*Section 1***Collective monitoring of exposure***Article 23*

Taking into account the radiological hazards, measurements shall be carried out:

- (a) of dose rates and fluence rates, indicating the nature and the quality of the radiation in question,
- (b) of the atmospheric concentration and surface density of contaminating radioactive substances, indicating their nature and their physical and chemical states.

Where appropriate, the results of these measurements shall be used for estimating individual doses.

Section 2

Individual monitoring of exposure

Article 24

The assessment of the individual doses must be systematic for workers of category A. This assessment shall be based on individual measurements or, in cases where these are impossible or inadequate, on an estimate arrived at either from individual measurements made on other exposed workers, or from the results of the collective monitoring provided for in Article 23.

Section 3

Assessment of accidental or emergency exposures

Article 25

In the case of accidental or emergency exposure, the absorbed dose shall be assessed, whether a whole or a partial body exposure has occurred.

Section 4

Recording of results

Article 26

The following shall be kept in the archives for a period of at least 30 years:

- (a) the results of collective monitoring measurements used to assess individual doses;
- (b) the exposure record containing documents relating to the assessment of individual doses;
- (c) in case of accidental or emergency exposure, the reports relating to the circumstances and to the action taken.

For the documents referred to in (b) and (c), the period of 30 years shall start at the time of cessation of work involving exposure to ionizing radiation.

CHAPTER III

MEDICAL SURVEILLANCE OF EXPOSED WORKERS

Article 27

The medical surveillance of exposed workers shall be based on the principles that govern occupational medicine generally. It shall include, as appropriate, pre-employment medical examinations and periodic reviews of health, the frequency and the form of the latter being determined by the worker's state of health, the conditions of work and the incidents that may accompany it.

Article 28

No worker may be employed for any period as an exposed worker if the medical findings are unfavourable.

Section 1

Medical surveillance of workers of category A

Article 29

The medical surveillance of workers of category A shall be the responsibility of approved medical practitioners.

It shall include:

(a) *a pre-employment medical examination*

The purpose of this examination shall be to determine the worker's fitness for the first post for which he is being considered. It shall include an enquiry into his medical history including all known previous exposures to ionizing radiation resulting either from his employment or from medical examination and treatment, and also the clinical and other investigations necessary for assessing his general state of health.

(b) *general medical surveillance*

The approved medical practitioner must have access to any information he requires in order to ascertain the state of health of workers under surveillance and to assess the existing environmental conditions in the working premises, in so far as they might affect the fitness of workers for the tasks assigned to them.

(c) periodic reviews of health

The health of workers shall be subject to review as a matter of routine to determine whether they remain fit to perform their duties. The nature of this review shall depend on the type and extent of exposure to ionizing radiation and on the individual worker's state of health. The state of health of each worker shall be reviewed at least once a year and more frequently if the worker's exposure conditions or state of health so require.

The approved medical practitioner may indicate the need for medical surveillance after cessation of work for as long as he considers it necessary to safeguard the health of the person concerned.

Article 30

The following medical classification shall be adopted with respect to fitness for work as a worker of category A:

- fit;
- fit, subject to certain conditions;
- unfit.

Article 31

1. A medical record shall be opened for each worker of category A and kept up to date so long as he remains a worker of that category. Thereafter it shall be retained in the archives for a period of at least 30 years.

2. The medical record shall include information regarding the nature of the employment, the results of the pre-employment medical examination and periodic reviews of health, the record of doses that is used to check that the values laid down in Articles 7, 8 and 10 have not been exceeded, and the record of doses received in the course of accidental and emergency exposures.

*Section 2**Special surveillance of exposed workers**Article 32*

Special surveillance shall be provided in each case where the maximum permissible doses laid down in Articles 7 and 8 are exceeded. Subsequent conditions of exposure shall be subject to the agreement of the approved medical practitioner.

Article 33

In addition to the routine reviews of health provided for in Article 29, provisions shall be made for any further examinations, decontamination measures or urgent remedial treatment considered necessary by the approved medical practitioner.

*Section 3**Appeals**Article 34*

Each Member State shall lay down the procedure for appeal against the findings and decisions made in pursuance of Articles 28 and 32.

*CHAPTER IV**Article 35*

1. Each Member State shall take all necessary measures to ensure the effective surveillance of the health of exposed workers. It shall make provisions relating to the classification of places of work, to the classification of workers, to the implementation of arrangements aimed at restricting exposure and to monitoring. It shall also establish a system or systems of inspection to supervise the examinations and monitoring specified in this Directive and to initiate surveillance and intervention measures wherever necessary.

2. Each Member State shall make the necessary arrangements to recognize the capacity of the experts responsible for the examination and control of the various protective devices and measuring instruments and to approve medical practitioners responsible for the medical surveillance of category A workers. To this end, each Member State shall arrange for the training of such specialists.

3. Each Member State shall make sure that the means necessary for proper surveillance are placed at the disposal of the departments responsible. The creation of a specialized radiation protection unit shall be required for all establishments in which there is a serious risk of exposure or contamination. This unit, which may be shared by several establishments, shall be distinct from production and operation units.

4. Each Member State shall facilitate appropriate access within the Community to all relevant information concerning the posting of each exposed worker and the doses received.

5. For the guidance of medical practitioners responsible for the surveillance of exposed workers, each Member State shall draw up a list, which need

not be exhaustive, of the criteria which should be taken into account when judging a worker's fitness to be exposed to ionizing radiation.

TITLE VII

FUNDAMENTAL PRINCIPLES GOVERNING PROTECTION OF THE HEALTH OF THE POPULATION

Article 36

The health surveillance of the population shall be based, in particular, on the assessment of the doses received by critical groups of the population and by the population as a whole, both in normal circumstances and in the event of an accident.

Article 37

Surveillance means all arrangements and surveys for detecting and eliminating the factors which, in the production and use of ionizing radiation or in the course of any operation involving exposure to its effects, are liable to create an unjustifiable risk of exposure for the population at large. The extent of the precautions taken shall depend upon the magnitude of the risk of exposure, especially in the event of an accident, and upon demographic data.

Surveillance shall be carried out:

- (a) on the critical groups of the population and, in particular, in all places where such groups may occur;
- (b) over the whole area for which the dose limit is that laid down for the whole population.

Article 38

Surveillance shall include the examination and testing of protective arrangements and the dose determinations to be carried out for the protection of the population.

(a) The examination and testing of protective arrangements shall include:

- (1) examination and approval of proposed installations involving a radiation hazard, and of the proposed siting of installations in the State;
- (2) acceptance into service of new nuclear installations with regard to protection against any radiation or contamination liable to

extend beyond the perimeter of the installations taking into account demographic, meteorological, geological, hydrological and ecological conditions;

- (3) checking the effectiveness of technical protective devices;
- (4) acceptance, from the point of view of surveillance of radiological hazards, of equipment for measuring radiation and contamination;
- (5) checking that measuring instruments are serviceable and correctly used;
- (6) whenever necessary, the establishment of emergency plans and their approval;
- (7) the establishment and application of waste discharge formulae and provisions to be made for measurement.

The tasks listed in 1 to 7 shall be carried out in accordance with rules laid down by the competent authorities on the basis of the extent of the radiation hazard involved.

(b) Taking into account the radiological hazards, the dose determinations to be carried out for the protection of the population shall include:

- (1) assessment of external exposure, indicating, where appropriate, the quality of the radiation in question;
- (2) assessment of radioactive contamination, indicating the nature and the physical and chemical state of the radioactive contaminants, and determination of their activity and their concentration;
- (3) assessment of the doses that the critical groups of the population are liable to receive in normal or exceptional circumstances, and specification of the characteristics of these groups;
- (4) assessment of the genetic dose and of the annual genetically significant dose, taking demographic characteristics into account.

Doses due to exposure to various sources must be added together wherever possible.

- (c) The frequency of assessments shall be such as to facilitate compliance with this Directive.
- (d) Records relating to measurements of external exposure and radioactive contamination, and the assessment of the doses received by the population, shall be kept in the archives.

Article 39

1. Each Member State shall establish a system of inspection to supervise the protection of the health of the population and the observance of the dose limits given in Articles 11 and 12;
2. Each Member State shall initiate action in regard to surveillance and intervention wherever necessary;
3. Each Member State shall take measures to ensure and effectively coordinate the health surveillance of the population, shall decide the frequency of assessments and shall take all necessary steps to identify the critical groups of the population, taking into account the effective pathway of transmission of the radioactive material. These measures may, if necessary, be taken by one Member State jointly with other Member States;
4. In relation to possible accidents, each Member State:
 - (a) shall stipulate action levels, measures to be taken by the competent authorities and surveillance procedures with respect to the population groups

that are liable to receive a dose in excess of the limits given in Articles 11 and 12;

- (b) shall determine and provide the necessary resources both in personnel and in equipment to enable action to be taken to safeguard and maintain the health of the population. These measures may, if necessary, be taken by one Member State jointly with other Member States.

5. Any accident involving exposure of the population to radiation must be notified as a matter of urgency, when the circumstances so require, to neighbouring Member States and to the Commission of the European Communities.

Article 40

1. Each Member State shall put into effect the necessary measures to conform to this Directive within a period of two years from the date of notification.
2. Each Member State shall inform the Commission of the arrangements it has made to comply with this Directive.

Article 41

This Directive is addressed to the Member States.

Done at Brussels, 1 June 1976.

For the Council

The President

G. THORN

ANNEX I

1. Maximum permissible values of activities not to be exceeded, in compliance with Article 4(a), for the radionuclides (*) listed in the left-hand column are indicated by an X in the various columns of the following table:

Radionuclides	Group I 10 ⁻⁷ Ci	Group II 10 ⁻⁶ Ci	Group III 10 ⁻⁵ Ci	Group IV 10 ⁻⁴ Ci
1 H — 3				X
4 Be — 7			X	
6 C — 14			X	
8 O — 15				X
9 F — 18			X	
11 Na — 22		X		
11 Na — 24			X	
14 Si — 31			X	
15 P — 32			X	
16 S — 35			X	
17 Cl — 36		X		
17 Cl — 38			X	
18 Ar — 37				X
18 Ar — 41			X	
19 K — 42			X	
19 K — 43			X	
20 Ca — 45		X		
20 Ca — 47			X	
21 Sc — 46		X		
21 Sc — 47			X	
21 Sc — 48			X	
23 V — 48			X	
24 Cr — 51			X	
25 Mn — 52			X	
25 Mn — 54		X		
25 Mn — 56			X	
26 Fe — 52			X	
26 Fe — 55			X	
26 Fe — 59			X	
27 Co — 56		X		
27 Co — 57			X	
27 Co — 58			X	
27 Co — 58m				X
27 Co — 60		X		
28 Ni — 59				X
28 Ni — 63			X	

(*) L'elenco alfabetico degli elenchi di figura alle fine del presente allegato.

Radionuclides	Group I 10 ⁻⁷ Ci	Group II 10 ⁻⁶ Ci	Group III 10 ⁻⁵ Ci	Group IV 10 ⁻⁴ Ci
28 Ni -65			X	
29 Cu -64			X	
30 Zn -65			X	
30 Zn -69m			X	
30 Zn -69				X
31 Ga -72			X	
32 Ge -71				X
33 As -73			X	
33 As -74			X	
33 As -76			X	
33 As -77			X	
34 Se -75			X	
35 Br -82			X	
36 Kr -85m			X	
36 Kr -85				X
36 Kr -87			X	
37 Rb -86			X	
38 Sr -85m				X
38 Sr -85			X	
38 Sr -89		X		
38 Sr -90		X		
38 Sr -91			X	
38 Sr -92			X	
39 Y -90			X	
39 Y -91m				X
39 Y -91		X		
39 Y -92			X	
39 Y -93			X	
40 Zr -93				X
40 Zr -95		X		
40 Zr -97			X	
41 Nb -93m			X	
41 Nb -95			X	
41 Nb -97				X
42 Mo -99			X	
43 Tc -96m				X
43 Tc -96			X	
43 Tc -97m			X	
43 Tc -97			X	
43 Tc -99m				X
43 Tc -99			X	
44 Ru -97			X	
44 Ru -103			X	
44 Ru -105			X	
44 Ru -106		X		

Radionuclides	Group I 10 ⁻⁷ Ci	Group II 10 ⁻⁶ Ci	Group III 10 ⁻⁵ Ci	Group IV 10 ⁻⁴ Ci
45 Rh — 103m				X
45 Rh — 105			X	
46 Pd — 103			X	
46 Pd — 109			X	
47 Ag — 105			X	
47 Ag — 110m		X		
47 Ag — 111			X	
48 Cd — 109			X	
48 Cd — 115m		X		
48 Cd — 115			X	
49 In — 113m				X
49 In — 114m		X		
49 In — 115m			X	
50 Sn — 113			X	
50 Sn — 125			X	
51 Sb — 122			X	
51 Sb — 124		X		
51 Sb — 125		X		
52 Te — 125m			X	
52 Te — 127m		X		
52 Te — 127			X	
52 Te — 129m		X		
52 Te — 129			X	
52 Te — 131m			X	
52 Te — 132			X	
53 I — 124		X		
53 I — 126		X		
53 I — 129				X
53 I — 130			X	
53 I — 131		X		
53 I — 132			X	
53 I — 133		X		
53 I — 134			X	
53 I — 135			X	
54 Xe — 131m				X
54 Xe — 133				X
54 Xe — 135			X	
55 Cs — 131			X	
55 Cs — 134m				X
55 Cs — 134		X		
55 Cs — 135				X
55 Cs — 136			X	
55 Cs — 137		X		
56 Ba — 131			X	
56 Ba — 140		X		

Radionuclides	Group I 10 ⁻⁷ Ci	Group II 10 ⁻⁶ Ci	Group III 10 ⁻⁵ Ci	Group IV 10 ⁻⁴ Ci
57 La — 140			X	
58 Ce — 141			X	
58 Ce — 143			X	
58 Ce — 144		X		
59 Pr — 142			X	
59 Pr — 143			X	
60 Nd — 147			X	
60 Nd — 149			X	
61 Pm — 147			X	
61 Pm — 149			X	
62 Sm — 151			X	
62 Sm — 153			X	
63 Eu — 152m (9 h)			X	
63 Eu — 152 (13 a)		X		
63 Eu — 154		X		
63 Eu — 155			X	
64 Gd — 153			X	
64 Gd — 159			X	
65 Tb — 160		X		
66 Dy — 165			X	
66 Dy — 166			X	
67 Ho — 166			X	
68 Er — 169			X	
68 Er — 171			X	
69 Tm — 170		X		
69 Tm — 171			X	
70 Yb — 175			X	
71 Lu — 177			X	
72 Hf — 181		X		
73 Ta — 182		X		
74 W — 181			X	
74 W — 185			X	
74 W — 187			X	
75 Re — 183			X	
75 Re — 186			X	
75 Re — 188			X	
76 Os — 185			X	
76 Os — 191m				X
76 Os — 191			X	
76 Os — 193			X	
77 Ir — 190			X	
77 Ir — 192		X		
77 Ir — 194			X	
78 Pt — 191			X	
78 Pt — 193m				X

Radionuclides	Group I 10 ⁻⁷ Ci	Group II 10 ⁻⁶ Ci	Group III 10 ⁻⁵ Ci	Group IV 10 ⁻⁴ Ci
78 Pt — 193			X	
78 Pt — 197m				X
78 Pt — 197			X	
79 Au — 196			X	
79 Au — 198			X	
79 Au — 199			X	
80 Hg — 197			X	
80 Hg — 197m			X	
80 Hg — 203			X	
81 Tl — 200			X	
81 Tl — 201			X	
81 Tl — 202			X	
81 Tl — 204		X		
82 Pb — 203			X	
82 Pb — 210	X			
82 Pb — 212		X		
83 Bi — 206			X	
83 Bi — 207		X		
83 Bi — 210		X		
83 Bi — 212			X	
84 Po — 210	X			
85 At — 211		X		
86 Rn — 220			X	
86 Rn — 222			X	
88 Ra — 223	X			
88 Ra — 224		X		
88 Ra — 226	X			
88 Ra — 228	X			
89 Ac — 227	X			
89 Ac — 228		X		
90 Th — 227	X			
90 Th — 228	X			
90 Th — 230	X			
90 Th — 231			X	
90 Th — 232				X
90 Th — 234		X		
90 Th nat (*)				X
91 Pa — 230		X		
91 Pa — 231	X			
91 Pa — 233			X	
92 U — 230	X			
92 U — 232	X			

(*) One curie of natural thorium conventionally corresponds to:
 $3 \cdot 7 \cdot 10^{10}$ disintegrations per second of Th-232 and
 $3 \cdot 7 \cdot 10^{10}$ disintegrations per second of Th-228.

Radionuclides	Group I 10 ⁻⁷ Ci	Group II 10 ⁻⁶ Ci	Group III 10 ⁻⁵ Ci	Group IV 10 ⁻⁴ Ci
92 U — 233	X			
92 U — 234	X			
92 U — 235				X
92 U — 236		X		
92 U — 238				X
92 U nat (*)				X
92 U — 240 + 93Np-240			X	
93 Np — 237	X			
93 Np — 239			X	
94 Pu — 238	X			
94 Pu — 239	X			
94 Pu — 240	X			
94 Pu — 241	X			
94 Pu — 242	X			
94 Pu — 243			X	
94 Pu — 244		X		
95 Am — 241	X			
95 Am — 242m	X			
95 Am — 242		X		
95 Am — 243	X			
95 Am — 244			X	
96 Cm — 242	X			
96 Cm — 243	X			
96 Cm — 244	X			
96 Cm — 245	X			
96 Cm — 246	X			
96 Cm — 247		X		
96 Cm — 248	X			
96 Cm — 249				X
97 Bk — 249		X		
97 Bk — 250			X	
98 Cf — 249	X			
98 Cf — 250	X			
98 Cf — 251	X			
98 Cf — 252	X			
98 Cf — 253		X		
98 Cf — 254	X			
99 Es — 253		X		
99 Es — 254m		X		
99 Es — 254	X			

(*) One curie of natural uranium conventionally corresponds to:
 $3.7 \cdot 10^{10}$ disintegrations per second of U-238,
 $3.7 \cdot 10^{10}$ disintegrations per second of U-234 and
 $1.7 \cdot 10^9$ disintegrations per second of U-235.

Radionuclides	Group I 10 ⁻⁷ Ci	Group II 10 ⁻⁶ Ci	Group III 10 ⁻⁵ Ci	Group IV 10 ⁻⁴ Ci
99 Es — 255	X			
100 Fm — 254			X	
100 Fm — 255		X		
100 Fm — 256		X		

2. In the case of the nuclides In—115, Nd—144, Rb—87, Re—187 and Sm—147 the requirement for reporting and obtaining prior authorization may be waived, irrespective of the quantities used
3. In the case of a mixture of radionuclides belonging to different radiotoxicity groups, the requirements for reporting and obtaining prior authorization may be waived only if the sum of the ratios between the activity of each of the radionuclides and the limit laid down in paragraph 1 for the group to which it belongs is less than or equal to 1.
4. For radioluminescent paint, the requirements for reporting and obtaining prior authorization need not be applied if the overall activity in radioactive substances does not exceed 50 mCi of tritium, 2 mCi of Pm—147 or 10 μ Ci of Ra—226, and where this paint is kept or used for the manufacture or repair of the instruments and timepieces referred to in Article 4 (c).
5. Radionuclides not included in this Annex shall, where necessary, be assigned to a toxicity group by the competent authority.

Alphabetical list of the elements

Atomic Number	Name	Atomic Number	Name
Ac 89	Actinium	N 7	Nitrogen
Ag 47	Silver	Na 11	Sodium
Al 13	Aluminium	Nb 41	Niobium
Am 95	Americium	Nd 60	Neodymium
Ar 18	Argon	Ne 10	Neon
As 33	Arsenic	Ni 28	Nickel
At 85	Astatine	No 102	Nobelium
Au 79	Gold	Np 93	Neptunium
B 5	Boron	O 8	Oxygen
Ba 56	Barium	Os 76	Osmium
Be 4	Beryllium	P 15	Phosphorus
Bi 83	Bismuth	Pa 91	Protactinium
Bk 97	Berkelium	Pb 82	Lead
Br 35	Bromine	Pd 46	Palladium
C 6	Carbon	Pm 61	Promethium
Ca 20	Calcium	Po 84	Polonium
Cd 48	Cadmium	Pr 59	Praseodymium
Ce 58	Cerium	Pt 78	Platinum
Cf 98	Californium	Pu 94	Plutonium
Cl 17	Chlorine	Ra 88	Radium
Cm 96	Curium	Rb 37	Rubidium
Co 27	Cobalt	Re 75	Rhenium
Cr 24	Chromium	Rh 45	Rhodium
Cs 55	Caesium/Cesium	Rn 86	Radon
Cu 29	Copper	Ru 44	Ruthenium
Dy 66	Dysprosium	S 16	Sulphur
Er 68	Erbium	Sb 51	Antimony
Es 99	Einsteinium	Sc 21	Scandium
Eu 63	Europium	Se 34	Selenium
F 9	Fluorine	Si 14	Silicon
Fe 26	Iron	Sm 62	Samarium
Fm 100	Fermium	Sn 50	Tin
Fr 87	Francium	Sr 38	Strontium
Ga 31	Gallium	Ta 73	Tantalum
Gd 64	Gadolinium	Tb 65	Terbium
Ge 32	Germanium	Tc 43	Technetium
H 1	Hydrogen	Te 52	Tellurium
He 2	Helium	Th 90	Thorium
Hf 72	Hafnium	Ti 22	Titanium
Hg 80	Mercury	Tl 81	Thallium
Ho 67	Holmium	Tm 69	Thulium
I 53	Iodine	U 92	Uranium
In 49	Indium	V 23	Vanadium
Ir 77	Iridium	W 74	Tungsten
K 19	Potassium	Xe 54	Xenon
Kr 36	Krypton	Y 39	Yttrium
La 57	Lanthanum	Yb 70	Ytterbium
Li 3	Lithium	Zn 30	Zinc
Lu 71	Lutecium	Zr 40	Zirconium
Md 101	Mendelevium		
Mg 12	Magnesium		
Mn 25	Manganese		
Mo 42	Molybdenum		

ANNEX II

A. Relationship between the quality factor Q and linear energy transfer L_{∞}

L_{∞} in water (keV/ μ m)	Q (*)
3.5 and less	1
7	2
23	5
53	10
175 and above	20

(*) Intermediate values are to be obtained from the curve in figure 1.

B. Values of effective quality factor $\bar{Q}$

Values of effective quality factor $\bar{Q}$ depend on the conditions of irradiation, as well as on the type and energy of the incident radiation. For uniform irradiation of the whole body by external irradiation, the following values are to be applied. The same values will usually be adequate for other irradiation conditions. If other values are needed, they are to be calculated from the values of Q given in A and from the curves in figure 2.

Radiation	$\bar{Q}$
X-rays, γ rays, β rays, electrons and positrons	1
Neutrons of unknown energy	10

C. Conversion factor (neutron fluence rate ($\text{cm}^{-2} \text{s}^{-1}$) corresponding to a dose equivalent rate of 1 mrem h^{-1}) and effective quality factor $\bar{Q}$ as functions of neutron energy (*)

Neutron energy, MeV	Conversion factor ($\text{cm}^{-2} \text{s}^{-1}$) per (mrem h^{-1}) (*) (**)	Effective quality factor $\bar{Q}$ (**) (***)
$2.5 \cdot 10^{-8}$ (thermal)	260	2.3
$1 \cdot 10^{-7}$	240	2
$1 \cdot 10^{-6}$	220	2
$1 \cdot 10^{-5}$	230	2
$1 \cdot 10^{-4}$	240	2
$1 \cdot 10^{-3}$	270	2
$1 \cdot 10^{-2}$	280	2
$2 \cdot 10^{-2}$	170	3.3
$5 \cdot 10^{-2}$	85	5.7
$1 \cdot 10^{-1}$	48	7.4
$5 \cdot 10^{-1}$	14	11
1	8.5	10.6
2	7.0	9.3
5	6.8	7.8
10	6.8	6.8
20	6.5	6.0
50	6.1	5.0
$1 \cdot 10^2$	5.6	4.4
$2 \cdot 10^2$	5.1	3.8
$5 \cdot 10^2$	3.6	3.2
$1 \cdot 10^3$	2.2	2.8
$2 \cdot 10^3$	1.6	2.6
$3 \cdot 10^3$	1.4	2.5

(*) For unidirectional broad beams of monoenergetic neutrons at normal incidence.

(**) At the point where the dose equivalent rate is maximum.

(***) Intermediate values are to be obtained from the curves in figures 3 and 4.

D. Conversion factor (proton fluence rate ($\text{cm}^{-2}\text{s}^{-1}$) corresponding to a dose equivalent rate of 1 mrem h^{-1}) and effective quality factor $\bar{Q}$ as functions of proton energy (*)

Proton energy, MeV	Conversion factor ($\text{cm}^{-2}\text{s}^{-1}$) per (mrem h^{-1}) (**) (***)	Effective quality factor $\bar{Q}$ (**) (***)
2 to 60	0.40	1.4
$1 \cdot 10^2$	0.41	1.4
$1.5 \cdot 10^2$	0.42	1.4
$2 \cdot 10^2$	0.43	1.4
$2.5 \cdot 10^2$	2.1	1.4
$3 \cdot 10^2$	2.4	1.5
$4 \cdot 10^2$	2.5	1.6
$6 \cdot 10^2$	2.4	1.7
$8 \cdot 10^2$	2.2	1.8
$1 \cdot 10^3$	2.0	1.9
$1.5 \cdot 10^3$	1.6	2.0
$2 \cdot 10^3$	1.4	2.1
$3 \cdot 10^3$	1.1	2.2

(*) Calculated for unidirectional broad beams of monoenergetic protons at normal incidence.

(**) At the point where the dose equivalent rate is maximum.

(***) Intermediate values are to be obtained from the curve in figure 5.

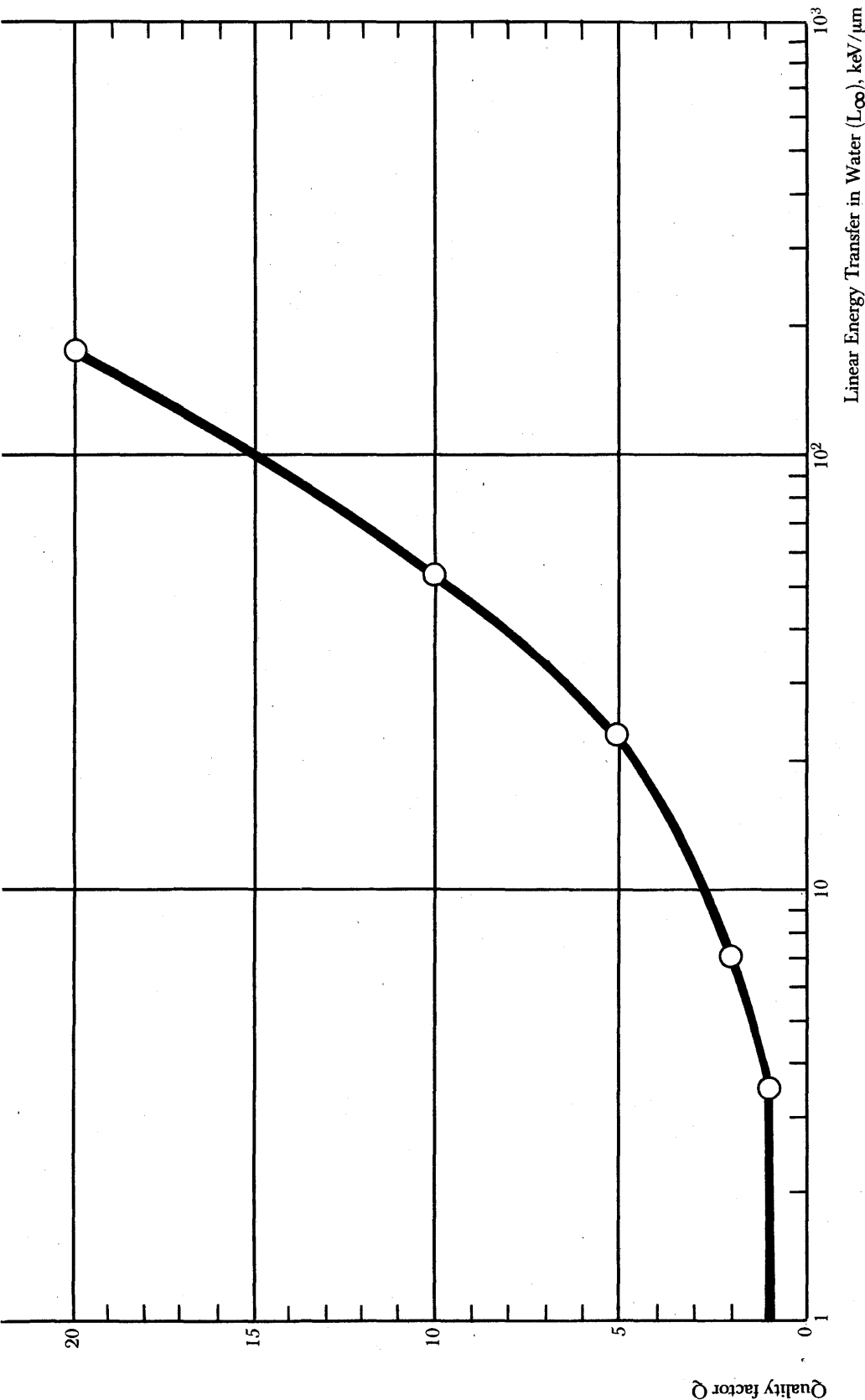


Figure 1: Quality factor as a function of Linear Energy Transfer in Water (L_{∞})

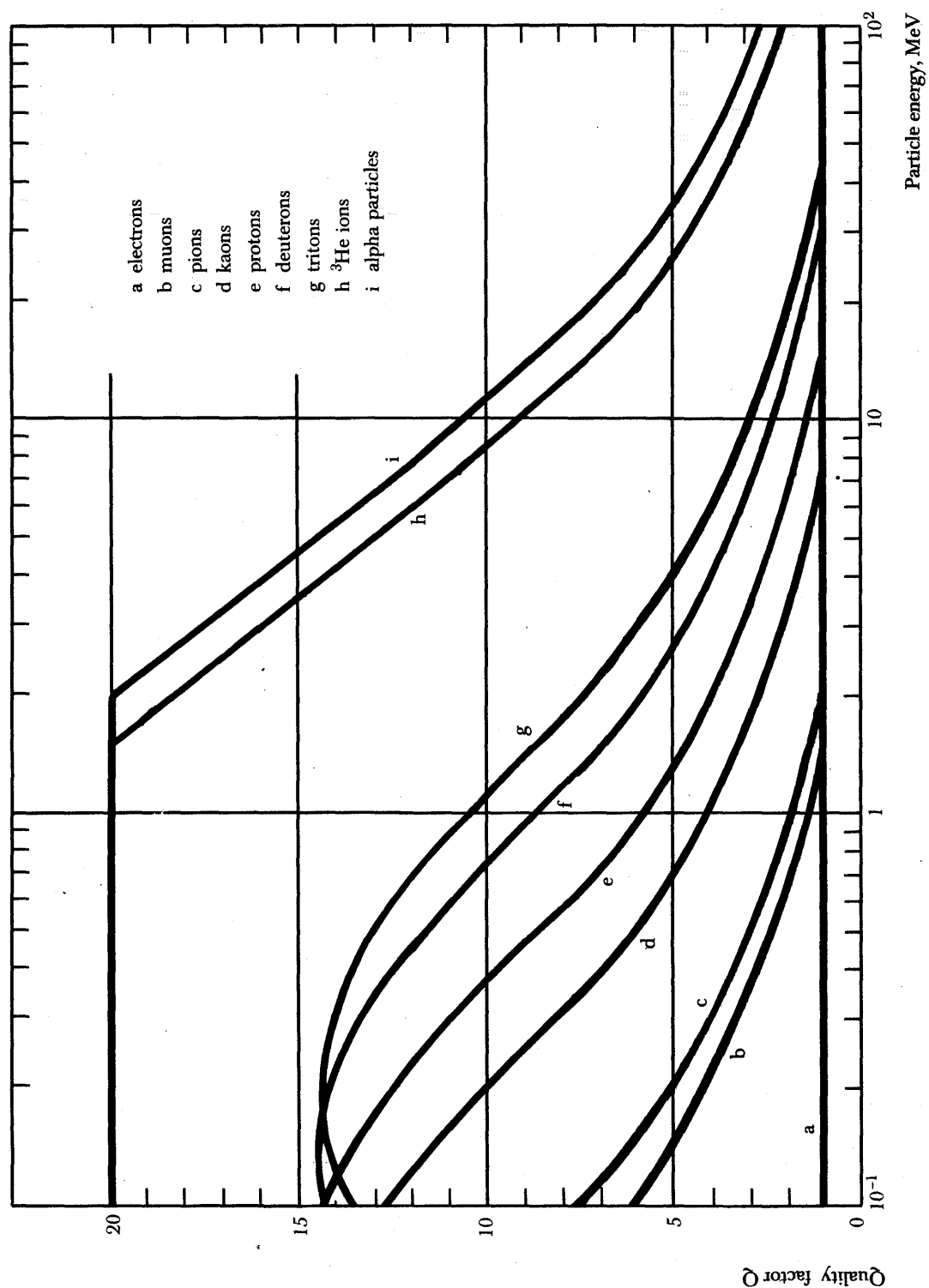


Figure 2. Quality factors of charged particles as a function of energy for external radiation

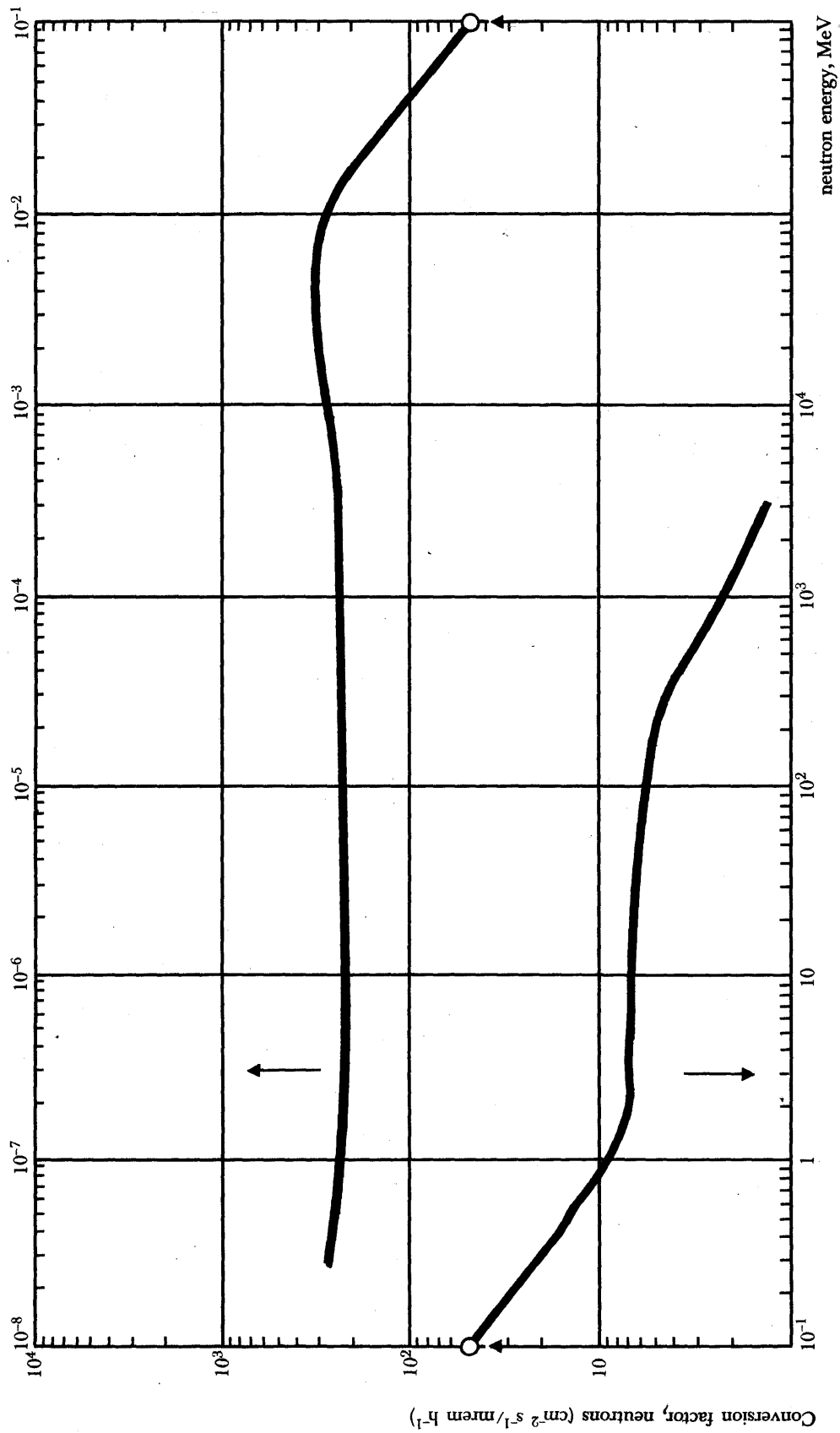


Figure 3: Factors for converting neutron fluence rate to dose equivalent rate

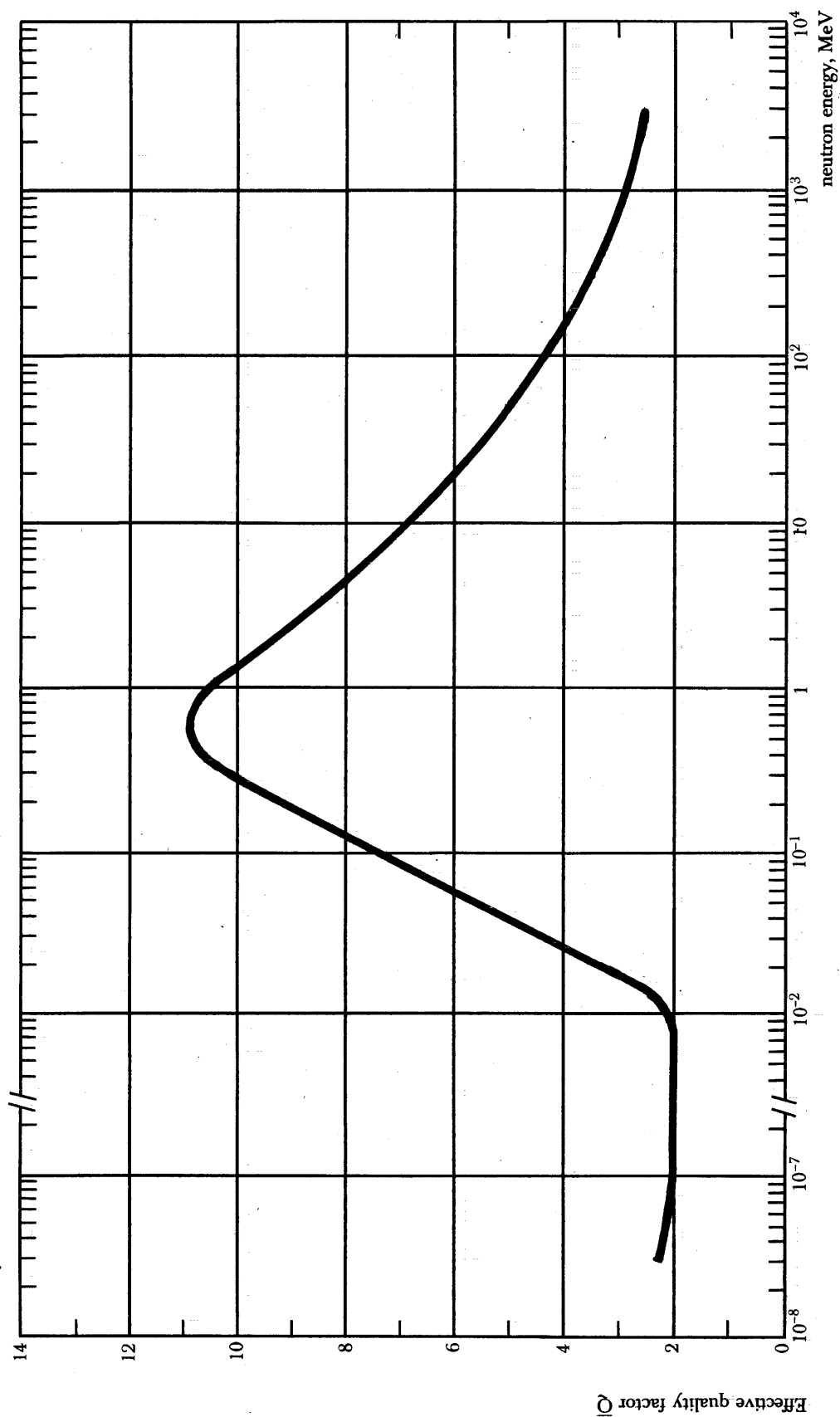


Figure 4: Effective quality factors for neutrons

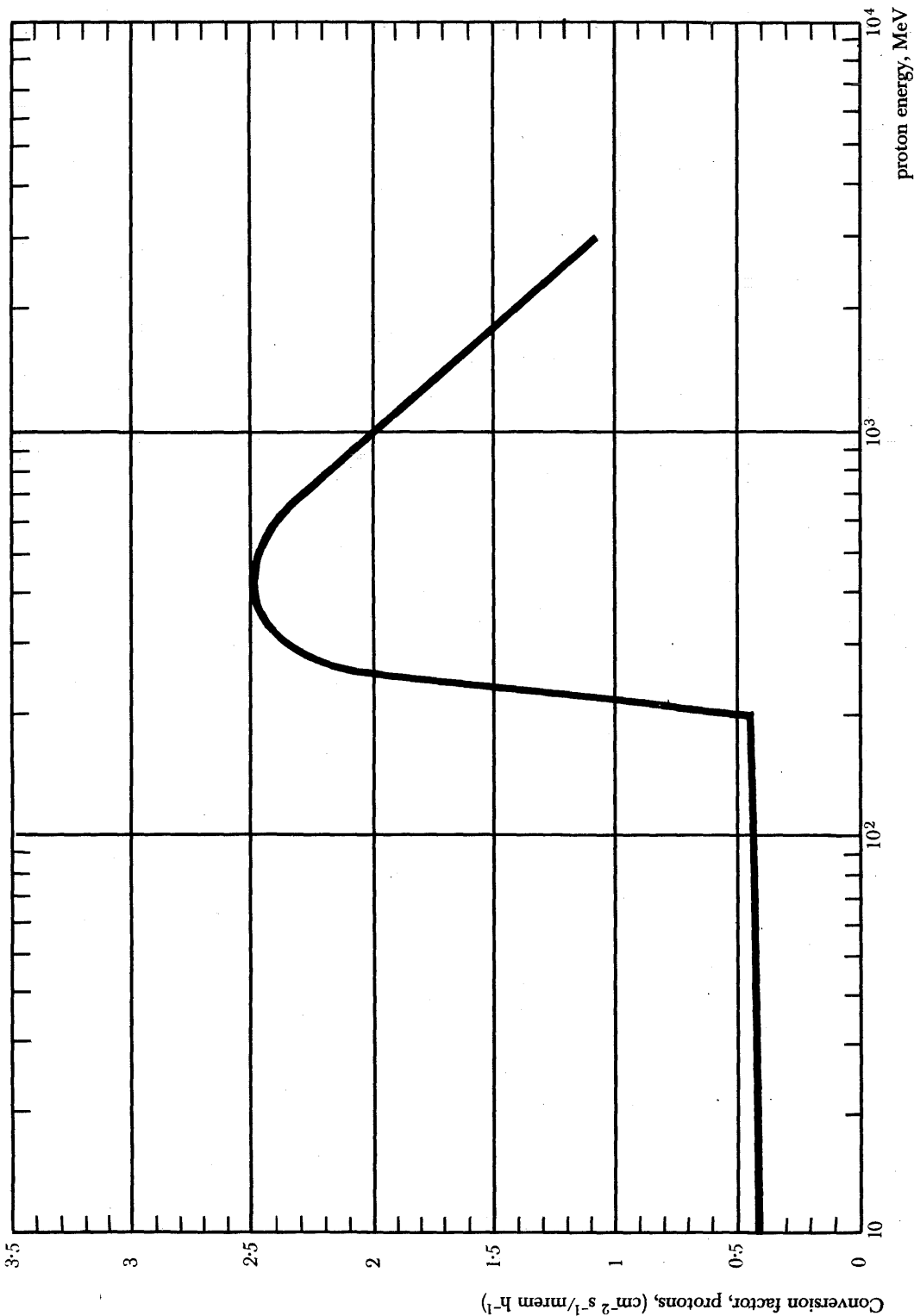


Figure 5: Factors for converting proton fluence rate to dose equivalent rate

ANNEX III

1. Limits of annual intake by inhalation, and derived limits of concentration of radionuclides in the air inhaled for exposed workers, and limits of annual intake by inhalation and ingestion for members of the public

The figures in the following tables correspond to the annual maximum permissible doses laid down for exposed workers, and to the annual dose limits for members of the public.

They are in accordance with the annual maximum permissible concentrations in the Directives of 2 February 1959 as amended by the Directives of 5 March 1962 and 27 October 1966.

The figures for limits of annual intake by inhalation for exposed workers are equal to the product (before rounding off) of the maximum permissible concentration in question and the volume of air inhaled annually over 2 000 working hours (2 500 m³).

The limits of annual intake by inhalation for the members of the public are one-tenth of the limits laid down for exposed workers.

The limits of annual intake by ingestion for members of the public are equal to the product (before rounding off) of the maximum permissible concentration and the total volume of all liquid ingested annually (0.8 m³).

These figures relate to adults. Their application to children may require corrections to take certain anatomical and physiological characteristics into account. The values to be used shall be fixed, where necessary, by the competent authority.

		Exposed workers		Members of public	
Radionuclides		Limits of annual intake by inhalation	Derived limits of concentration in the air for exposure of 2 000 h/year	Limits of annual intake by inhalation	Limits of annual intake by ingestion
		μCi	Ci/m^3	μCi	μCi
^3_1H (HTO, T_2O)	soluble	$1.2 \cdot 10^4$	$5 \cdot 10^{-6}$	$1.2 \cdot 10^3$	$2.6 \cdot 10^3$
	insoluble	—	—	—	—
^7_4Be	soluble	$1.4 \cdot 10^4$	$6 \cdot 10^{-6}$	$1.4 \cdot 10^3$	$1.4 \cdot 10^3$
	insoluble	$3.0 \cdot 10^3$	$1 \cdot 10^{-6}$	$3.0 \cdot 10^2$	$1.4 \cdot 10^3$
$^{14}_6\text{C}$ (CO_2)	soluble	$8.7 \cdot 10^3$	$4 \cdot 10^{-6}$	$8.7 \cdot 10^2$	$6.6 \cdot 10^2$
	insoluble	—	—	—	—
$^{18}_9\text{F}$	soluble	$1.3 \cdot 10^4$	$5 \cdot 10^{-6}$	$1.3 \cdot 10^3$	$6.6 \cdot 10^2$
	insoluble	$6.4 \cdot 10^3$	$3 \cdot 10^{-6}$	$6.4 \cdot 10^2$	$4.0 \cdot 10^2$
$^{22}_{11}\text{Na}$	soluble	$4.3 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.3 \cdot 10^1$	$3.2 \cdot 10^1$
	insoluble	$2.1 \cdot 10^1$	$9 \cdot 10^{-9}$	2.1	$2.4 \cdot 10^1$
$^{24}_{11}\text{Na}$	soluble	$3.1 \cdot 10^3$	$1 \cdot 10^{-6}$	$3.1 \cdot 10^2$	$1.5 \cdot 10^2$
	insoluble	$3.6 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.6 \cdot 10^1$	$2.2 \cdot 10^1$
$^{31}_{14}\text{Si}$	soluble	$1.4 \cdot 10^4$	$6 \cdot 10^{-6}$	$1.4 \cdot 10^3$	$7.0 \cdot 10^2$
	insoluble	$2.5 \cdot 10^3$	$1 \cdot 10^{-6}$	$2.5 \cdot 10^2$	$1.5 \cdot 10^2$
$^{32}_{15}\text{P}$	soluble	$1.8 \cdot 10^2$	$7 \cdot 10^{-8}$	$1.8 \cdot 10^1$	$1.5 \cdot 10^1$
	insoluble	$2.0 \cdot 10^2$	$8 \cdot 10^{-8}$	$2.0 \cdot 10^1$	$1.8 \cdot 10^1$
$^{35}_{16}\text{S}$	soluble	$6.8 \cdot 10^2$	$3 \cdot 10^{-7}$	$6.8 \cdot 10^1$	$5.0 \cdot 10^1$
	insoluble	$6.3 \cdot 10^2$	$3 \cdot 10^{-7}$	$6.3 \cdot 10^1$	$2.2 \cdot 10^2$
$^{36}_{17}\text{Cl}$	soluble	$8.7 \cdot 10^2$	$4 \cdot 10^{-7}$	$8.7 \cdot 10^1$	$6.6 \cdot 10^1$
	insoluble	$5.7 \cdot 10^1$	$2 \cdot 10^{-8}$	5.7	$4.6 \cdot 10^1$
$^{38}_{17}\text{Cl}$	soluble	$6.4 \cdot 10^3$	$3 \cdot 10^{-6}$	$6.4 \cdot 10^2$	$3.2 \cdot 10^2$
	insoluble	$5.1 \cdot 10^3$	$2 \cdot 10^{-6}$	$5.1 \cdot 10^2$	$3.2 \cdot 10^2$
$^{37}_{18}\text{A}$			$6 \cdot 10^{-3}$		
$^{41}_{18}\text{A}$			$2 \cdot 10^{-6}$		
$^{42}_{19}\text{K}$	soluble	$5.0 \cdot 10^3$	$2 \cdot 10^{-6}$	$5.0 \cdot 10^2$	$2.5 \cdot 10^2$
	insoluble	$2.7 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.7 \cdot 10^1$	$1.6 \cdot 10^1$
$^{45}_{20}\text{Ca}$	soluble	$8.0 \cdot 10^1$	$3 \cdot 10^{-8}$	8	7.3
	insoluble	$3.0 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.0 \cdot 10^1$	$1.4 \cdot 10^2$
$^{47}_{20}\text{Ca}$	soluble	$4.3 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.3 \cdot 10^1$	$4.0 \cdot 10^1$
	insoluble	$4.2 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.2 \cdot 10^1$	$2.6 \cdot 10^1$
$^{46}_{21}\text{Sc}$	soluble	$6.0 \cdot 10^2$	$2 \cdot 10^{-7}$	$6.0 \cdot 10^1$	$3.0 \cdot 10^1$
	insoluble	$6.0 \cdot 10^1$	$2 \cdot 10^{-8}$	6	$3.0 \cdot 10^1$
$^{47}_{21}\text{Sc}$	soluble	$1.5 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.5 \cdot 10^2$	$7.1 \cdot 10^1$
	insoluble	$1.2 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.2 \cdot 10^2$	$7.1 \cdot 10^1$
$^{48}_{21}\text{Sc}$	soluble	$4.3 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.3 \cdot 10^1$	$2.2 \cdot 10^1$
	insoluble	$3.5 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.5 \cdot 10^1$	$2.2 \cdot 10^1$
$^{48}_{23}\text{V}$	soluble	$4.5 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.5 \cdot 10^1$	$2.3 \cdot 10^1$
	insoluble	$1.4 \cdot 10^2$	$6 \cdot 10^{-8}$	$1.4 \cdot 10^1$	$2.3 \cdot 10^1$
$^{51}_{24}\text{Cr}$	soluble	$2.6 \cdot 10^4$	$1 \cdot 10^{-5}$	$2.6 \cdot 10^3$	$1.3 \cdot 10^3$
	insoluble	$5.6 \cdot 10^3$	$2 \cdot 10^{-6}$	$5.6 \cdot 10^2$	$1.2 \cdot 10^3$
$^{52}_{25}\text{Mn}$	soluble	$5.3 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.3 \cdot 10^1$	$2.6 \cdot 10^1$
	insoluble	$3.5 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.5 \cdot 10^1$	$2.4 \cdot 10^1$
$^{54}_{25}\text{Mn}$	soluble	$9.5 \cdot 10^2$	$4 \cdot 10^{-7}$	$9.5 \cdot 10^1$	$1.0 \cdot 10^2$
	insoluble	$8.7 \cdot 10^1$	$4 \cdot 10^{-8}$	8.7	$9.6 \cdot 10^1$
$^{56}_{25}\text{Mn}$	soluble	$1.9 \cdot 10^3$	$8 \cdot 10^{-7}$	$1.9 \cdot 10^2$	$9.6 \cdot 10^1$
	insoluble	$1.3 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.3 \cdot 10^2$	$8.0 \cdot 10^1$
$^{55}_{26}\text{Fe}$	soluble	$2.1 \cdot 10^3$	$9 \cdot 10^{-7}$	$2.1 \cdot 10^2$	$6.3 \cdot 10^2$
	insoluble	$2.6 \cdot 10^3$	$1 \cdot 10^{-6}$	$2.6 \cdot 10^2$	$1.8 \cdot 10^3$

		Exposed workers		Members of public	
Radionuclides		Limits of annual intake by inhalation	Derived limits of concentration in the air for exposure of 2 000 h/year	Limits of annual intake by inhalation	Limits of annual intake by ingestion
		μCi	Ci/m^3	μCi	μCi
⁵⁹ Fe	soluble	$3.7 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.7 \cdot 10^1$	$4.7 \cdot 10^1$
	insoluble	$1.3 \cdot 10^2$	$5 \cdot 10^{-8}$	$1.3 \cdot 10^1$	$4.2 \cdot 10^1$
⁵⁷ Co	soluble	$8.7 \cdot 10^3$	$3 \cdot 10^{-6}$	$8.7 \cdot 10^2$	$4.3 \cdot 10^2$
	insoluble	$4.0 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.0 \cdot 10^1$	$3.0 \cdot 10^2$
^{58m} Co	soluble	$4.5 \cdot 10^4$	$2 \cdot 10^{-5}$	$4.5 \cdot 10^3$	$2.2 \cdot 10^3$
	insoluble	$2.2 \cdot 10^4$	$9 \cdot 10^{-6}$	$2.2 \cdot 10^3$	$1.6 \cdot 10^3$
⁵⁸ Co	soluble	$2.1 \cdot 10^3$	$8 \cdot 10^{-7}$	$2.1 \cdot 10^2$	$1.0 \cdot 10^2$
	insoluble	$1.4 \cdot 10^2$	$5 \cdot 10^{-8}$	$1.4 \cdot 10^1$	$7.2 \cdot 10^1$
⁶⁰ Co	soluble	$8.0 \cdot 10^2$	$3 \cdot 10^{-7}$	$8.0 \cdot 10^1$	$3.9 \cdot 10^1$
	insoluble	$2.2 \cdot 10^1$	$9 \cdot 10^{-9}$	2.2	$2.8 \cdot 10^1$
⁵⁹ Ni	soluble	$1.2 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.2 \cdot 10^2$	$1.6 \cdot 10^2$
	insoluble	$1.9 \cdot 10^3$	$8 \cdot 10^{-7}$	$1.9 \cdot 10^2$	$1.6 \cdot 10^3$
⁶³ Ni	soluble	$1.6 \cdot 10^2$	$6 \cdot 10^{-8}$	$1.6 \cdot 10^1$	$2.2 \cdot 10^1$
	insoluble	$7.0 \cdot 10^2$	$3 \cdot 10^{-7}$	$7.0 \cdot 10^1$	$5.7 \cdot 10^2$
⁶⁵ Ni	soluble	$2.3 \cdot 10^3$	$9 \cdot 10^{-7}$	$2.3 \cdot 10^2$	$1.1 \cdot 10^2$
	insoluble	$1.3 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.3 \cdot 10^2$	$8.0 \cdot 10^1$
⁶⁴ Cu	soluble	$5.3 \cdot 10^3$	$2 \cdot 10^{-6}$	$5.3 \cdot 10^2$	$2.6 \cdot 10^2$
	insoluble	$2.6 \cdot 10^3$	$1 \cdot 10^{-6}$	$2.6 \cdot 10^2$	$1.7 \cdot 10^2$
⁶⁵ Zn	soluble	$2.6 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.6 \cdot 10^1$	$7.9 \cdot 10^1$
	insoluble	$1.5 \cdot 10^2$	$6 \cdot 10^{-8}$	$1.5 \cdot 10^1$	$1.4 \cdot 10^2$
^{69m} Zn	soluble	$9.5 \cdot 10^2$	$4 \cdot 10^{-7}$	$9.5 \cdot 10^1$	$5.4 \cdot 10^1$
	insoluble	$8.0 \cdot 10^2$	$3 \cdot 10^{-7}$	$8.0 \cdot 10^1$	$4.9 \cdot 10^1$
⁶⁹ Zn	soluble	$1.8 \cdot 10^4$	$7 \cdot 10^{-6}$	$1.8 \cdot 10^3$	$1.4 \cdot 10^3$
	insoluble	$2.3 \cdot 10^4$	$9 \cdot 10^{-6}$	$2.3 \cdot 10^3$	$1.4 \cdot 10^3$
⁷² Ga	soluble	$5.9 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.9 \cdot 10^1$	$3.0 \cdot 10^1$
	insoluble	$4.7 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.7 \cdot 10^1$	$3.0 \cdot 10^1$
⁷¹ Ge	soluble	$2.6 \cdot 10^4$	$1 \cdot 10^{-5}$	$2.6 \cdot 10^3$	$1.3 \cdot 10^3$
	insoluble	$1.6 \cdot 10^4$	$6 \cdot 10^{-6}$	$1.6 \cdot 10^3$	$1.3 \cdot 10^3$
⁷³ As	soluble	$5.1 \cdot 10^3$	$2 \cdot 10^{-6}$	$5.1 \cdot 10^2$	$3.8 \cdot 10^2$
	insoluble	$9.5 \cdot 10^2$	$4 \cdot 10^{-7}$	$9.5 \cdot 10^1$	$3.7 \cdot 10^2$
⁷⁴ As	soluble	$8.7 \cdot 10^2$	$3 \cdot 10^{-7}$	$8.7 \cdot 10^1$	$4.2 \cdot 10^1$
	insoluble	$3.1 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.1 \cdot 10^1$	$4.2 \cdot 10^1$
⁷⁶ As	soluble	$3.2 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.2 \cdot 10^1$	$1.6 \cdot 10^1$
	insoluble	$2.5 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.5 \cdot 10^1$	$1.5 \cdot 10^1$
⁷⁷ As	soluble	$1.3 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.3 \cdot 10^2$	$6.6 \cdot 10^1$
	insoluble	$1.0 \cdot 10^3$	$4 \cdot 10^{-7}$	$1.0 \cdot 10^2$	$6.4 \cdot 10^1$
⁷⁵ Se	soluble	$3.1 \cdot 10^3$	$1 \cdot 10^{-6}$	$3.1 \cdot 10^2$	$2.4 \cdot 10^2$
	insoluble	$3.1 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.1 \cdot 10^1$	$2.2 \cdot 10^2$
⁸² Br	soluble	$2.8 \cdot 10^3$	$1 \cdot 10^{-6}$	$2.8 \cdot 10^2$	$2.1 \cdot 10^2$
	insoluble	$4.7 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.7 \cdot 10^1$	$3.0 \cdot 10^1$
^{85m} Kr	soluble		$6 \cdot 10^{-6}$		
	insoluble				
⁸⁵ Kr	soluble		$1 \cdot 10^{-5}$		
	insoluble				
⁸⁷ Kr	soluble		$1 \cdot 10^{-6}$		
	insoluble				
⁸⁶ Rb	soluble	$7.1 \cdot 10^2$	$3 \cdot 10^{-7}$	$7.1 \cdot 10^1$	$5.4 \cdot 10^1$
	insoluble	$1.7 \cdot 10^2$	$7 \cdot 10^{-8}$	$1.7 \cdot 10^1$	$1.9 \cdot 10^1$
^{85m} Sr	soluble	$1.0 \cdot 10^5$	$4 \cdot 10^{-5}$	$1.0 \cdot 10^4$	$5.2 \cdot 10^3$
	insoluble	$8.7 \cdot 10^4$	$3 \cdot 10^{-5}$	$8.7 \cdot 10^3$	$5.4 \cdot 10^3$

		Exposed workers		Members of public	
Radionuclides		Limits of annual intake by inhalation	Derived limits of concentration in the air for exposure of 2 000 h/year	Limits of annual intake by inhalation	Limits of annual intake by ingestion
		μCi	Ci/m^3	μCi	μCi
$^{85}_{38}\text{Sr}$	soluble	$5.8 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.8 \cdot 10^1$	$7.6 \cdot 10^1$
	insoluble	$2.6 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.6 \cdot 10^1$	$1.4 \cdot 10^2$
$^{89}_{38}\text{Sr}$	soluble	$6.9 \cdot 10^1$	$3 \cdot 10^{-8}$	6.9	9.6
	insoluble	$8.7 \cdot 10^1$	$4 \cdot 10^{-8}$	8.7	$2.2 \cdot 10^1$
$^{90}_{38}\text{Sr}$	soluble	2.9	$1 \cdot 10^{-9}$	$2.9 \cdot 10^{-1}$	$3.2 \cdot 10^{-1}$
	insoluble	$1.4 \cdot 10^1$	$5 \cdot 10^{-9}$	1.4	$2.8 \cdot 10^1$
$^{91}_{38}\text{Sr}$	soluble	$1.1 \cdot 10^3$	$4 \cdot 10^{-7}$	$1.1 \cdot 10^2$	$5.6 \cdot 10^1$
	insoluble	$6.3 \cdot 10^2$	$3 \cdot 10^{-7}$	$6.3 \cdot 10^1$	$3.9 \cdot 10^1$
$^{92}_{38}\text{Sr}$	soluble	$1.1 \cdot 10^3$	$4 \cdot 10^{-7}$	$1.1 \cdot 10^2$	$5.4 \cdot 10^1$
	insoluble	$7.3 \cdot 10^2$	$3 \cdot 10^{-7}$	$7.3 \cdot 10^1$	$4.6 \cdot 10^1$
$^{90}_{39}\text{Y}$	soluble	$3.2 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.2 \cdot 10^1$	$1.6 \cdot 10^1$
	insoluble	$2.6 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.6 \cdot 10^1$	$1.6 \cdot 10^1$
$^{91m}_{39}\text{Y}$	soluble	$5.5 \cdot 10^4$	$2 \cdot 10^{-5}$	$5.5 \cdot 10^3$	$2.7 \cdot 10^3$
	insoluble	$4.3 \cdot 10^4$	$2 \cdot 10^{-5}$	$4.3 \cdot 10^3$	$2.7 \cdot 10^3$
$^{91}_{39}\text{Y}$	soluble	$8.7 \cdot 10^1$	$4 \cdot 10^{-8}$	8.7	$2.1 \cdot 10^1$
	insoluble	$8.0 \cdot 10^1$	$3 \cdot 10^{-8}$	8.0	$2.1 \cdot 10^1$
$^{92}_{39}\text{Y}$	soluble	$9.5 \cdot 10^2$	$4 \cdot 10^{-7}$	$9.5 \cdot 10^1$	$4.6 \cdot 10^1$
	insoluble	$7.3 \cdot 10^2$	$3 \cdot 10^{-7}$	$7.3 \cdot 10^1$	$4.6 \cdot 10^1$
$^{93}_{39}\text{Y}$	soluble	$4.3 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.3 \cdot 10^1$	$2.2 \cdot 10^1$
	insoluble	$3.4 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.4 \cdot 10^1$	$2.2 \cdot 10^1$
$^{93}_{40}\text{Zr}$	soluble	$3.2 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.2 \cdot 10^1$	$6.4 \cdot 10^2$
	insoluble	$8.0 \cdot 10^2$	$3 \cdot 10^{-7}$	$8.0 \cdot 10^1$	$6.4 \cdot 10^2$
$^{95}_{40}\text{Zr}$	soluble	$3.2 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.2 \cdot 10^1$	$5.0 \cdot 10^1$
	insoluble	$8.0 \cdot 10^1$	$3 \cdot 10^{-8}$	8.0	$5.0 \cdot 10^1$
$^{97}_{40}\text{Zr}$	soluble	$2.9 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.9 \cdot 10^1$	$1.4 \cdot 10^1$
	insoluble	$2.3 \cdot 10^2$	$9 \cdot 10^{-8}$	$2.3 \cdot 10^1$	$1.4 \cdot 10^1$
$^{93m}_{41}\text{Nb}$	soluble	$3.1 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.1 \cdot 10^1$	$3.2 \cdot 10^2$
	insoluble	$4.0 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.0 \cdot 10^1$	$3.2 \cdot 10^2$
$^{95}_{41}\text{Nb}$	soluble	$1.2 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.2 \cdot 10^2$	$7.7 \cdot 10^1$
	insoluble	$2.5 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.5 \cdot 10^1$	$7.7 \cdot 10^1$
$^{97}_{41}\text{Nb}$	soluble	$1.5 \cdot 10^4$	$6 \cdot 10^{-6}$	$1.5 \cdot 10^3$	$7.4 \cdot 10^2$
	insoluble	$1.2 \cdot 10^4$	$5 \cdot 10^{-6}$	$1.2 \cdot 10^3$	$7.4 \cdot 10^2$
$^{99}_{42}\text{Mo}$	soluble	$1.8 \cdot 10^3$	$7 \cdot 10^{-7}$	$1.8 \cdot 10^2$	$1.4 \cdot 10^2$
	insoluble	$5.0 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.0 \cdot 10^1$	$3.1 \cdot 10^1$
$^{96m}_{43}\text{Tc}$	soluble	$1.9 \cdot 10^5$	$8 \cdot 10^{-5}$	$1.9 \cdot 10^4$	$9.6 \cdot 10^3$
	insoluble	$7.3 \cdot 10^4$	$3 \cdot 10^{-5}$	$7.3 \cdot 10^3$	$8.0 \cdot 10^3$
$^{96}_{43}\text{Tc}$	soluble	$1.6 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.6 \cdot 10^2$	$7.8 \cdot 10^1$
	insoluble	$6.0 \cdot 10^2$	$2 \cdot 10^{-7}$	$6.0 \cdot 10^1$	$3.8 \cdot 10^1$
$^{97m}_{43}\text{Tc}$	soluble	$5.8 \cdot 10^3$	$2 \cdot 10^{-6}$	$5.8 \cdot 10^2$	$2.8 \cdot 10^2$
	insoluble	$3.8 \cdot 10^2$	$2 \cdot 10^{-7}$	$3.8 \cdot 10^1$	$1.4 \cdot 10^2$
$^{97}_{43}\text{Tc}$	soluble	$2.7 \cdot 10^4$	$1 \cdot 10^{-5}$	$2.7 \cdot 10^3$	$1.4 \cdot 10^3$
	insoluble	$7.3 \cdot 10^2$	$3 \cdot 10^{-7}$	$7.3 \cdot 10^1$	$6.4 \cdot 10^2$
$^{99m}_{43}\text{Tc}$	soluble	$9.5 \cdot 10^4$	$4 \cdot 10^{-5}$	$9.5 \cdot 10^3$	$4.6 \cdot 10^3$
	insoluble	$3.5 \cdot 10^4$	$1 \cdot 10^{-5}$	$3.5 \cdot 10^3$	$2.2 \cdot 10^3$
$^{99}_{43}\text{Tc}$	soluble	$5.3 \cdot 10^3$	$2 \cdot 10^{-6}$	$5.3 \cdot 10^2$	$2.6 \cdot 10^2$
	insoluble	$1.5 \cdot 10^2$	$6 \cdot 10^{-8}$	$1.5 \cdot 10^1$	$1.3 \cdot 10^2$
$^{97}_{44}\text{Ru}$	soluble	$5.8 \cdot 10^3$	$2 \cdot 10^{-6}$	$5.8 \cdot 10^2$	$2.9 \cdot 10^2$
	insoluble	$4.4 \cdot 10^3$	$2 \cdot 10^{-6}$	$4.4 \cdot 10^2$	$2.8 \cdot 10^2$
$^{103}_{44}\text{Ru}$	soluble	$1.3 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.3 \cdot 10^2$	$6.6 \cdot 10^1$
	insoluble	$2.1 \cdot 10^2$	$8 \cdot 10^{-8}$	$2.1 \cdot 10^1$	$6.4 \cdot 10^1$

		Exposed workers		Members of public	
Radionuclides		Limits of annual intake by inhalation	Derived limits of concentration in the air for exposure of 2 000 h/year	Limits of annual intake by inhalation	Limits of annual intake by ingestion
		μCi	Ci/m^3	μCi	μCi
¹⁰⁵ ₄₄ Ru	soluble	$1.8 \cdot 10^3$	$7 \cdot 10^{-7}$	$1.8 \cdot 10^2$	$8.8 \cdot 10^1$
	insoluble	$1.3 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.3 \cdot 10^2$	$8.0 \cdot 10^1$
¹⁰⁶ ₄₄ Ru	soluble	$1.9 \cdot 10^2$	$8 \cdot 10^{-8}$	$1.9 \cdot 10^1$	9.6
	insoluble	$1.4 \cdot 10^1$	$6 \cdot 10^{-9}$	1.4	9.6
^{103m} ₄₅ Rh	soluble	$1.9 \cdot 10^5$	$8 \cdot 10^{-5}$	$1.9 \cdot 10^4$	$9.6 \cdot 10^3$
	insoluble	$1.5 \cdot 10^5$	$6 \cdot 10^{-5}$	$1.5 \cdot 10^4$	$9.6 \cdot 10^3$
¹⁰⁵ ₄₅ Rh	soluble	$2.1 \cdot 10^3$	$8 \cdot 10^{-7}$	$2.1 \cdot 10^2$	$1.0 \cdot 10^2$
	insoluble	$1.3 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.3 \cdot 10^2$	$8.0 \cdot 10^1$
¹⁰³ ₄₆ Pd	soluble	$3.4 \cdot 10^3$	$1 \cdot 10^{-6}$	$3.4 \cdot 10^2$	$2.7 \cdot 10^2$
	insoluble	$1.9 \cdot 10^3$	$7 \cdot 10^{-7}$	$1.9 \cdot 10^2$	$2.2 \cdot 10^2$
¹⁰⁹ ₄₆ Pd	soluble	$1.4 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.4 \cdot 10^2$	$7.0 \cdot 10^1$
	insoluble	$8.7 \cdot 10^2$	$4 \cdot 10^{-7}$	$8.7 \cdot 10^1$	$5.6 \cdot 10^1$
¹⁰⁵ ₄₇ Ag	soluble	$1.5 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.5 \cdot 10^2$	$7.8 \cdot 10^1$
	insoluble	$2.0 \cdot 10^2$	$8 \cdot 10^{-8}$	$2.0 \cdot 10^1$	$7.7 \cdot 10^1$
^{110m} ₄₇ Ag	soluble	$4.8 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.8 \cdot 10^1$	$2.4 \cdot 10^1$
	insoluble	$2.6 \cdot 10^1$	$1 \cdot 10^{-8}$	2.6	$2.4 \cdot 10^1$
¹¹¹ ₄₇ Ag	soluble	$7.1 \cdot 10^2$	$3 \cdot 10^{-7}$	$7.1 \cdot 10^1$	$3.5 \cdot 10^1$
	insoluble	$5.5 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.5 \cdot 10^1$	$3.4 \cdot 10^1$
¹⁰⁹ ₄₈ Cd	soluble	$1.3 \cdot 10^2$	$5 \cdot 10^{-8}$	$1.3 \cdot 10^1$	$1.4 \cdot 10^2$
	insoluble	$1.8 \cdot 10^2$	$7 \cdot 10^{-8}$	$1.8 \cdot 10^1$	$1.4 \cdot 10^2$
^{115m} ₄₈ Cd	soluble	$8.7 \cdot 10^1$	$4 \cdot 10^{-8}$	8.7	$2.0 \cdot 10^1$
	insoluble	$8.7 \cdot 10^1$	$4 \cdot 10^{-8}$	8.7	$2.0 \cdot 10^1$
¹¹⁵ ₄₈ Cd	soluble	$5.5 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.5 \cdot 10^1$	$2.7 \cdot 10^1$
	insoluble	$4.6 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.6 \cdot 10^1$	$2.9 \cdot 10^1$
^{113m} ₄₉ In	soluble	$2.1 \cdot 10^4$	$8 \cdot 10^{-6}$	$2.1 \cdot 10^3$	$1.0 \cdot 10^3$
	insoluble	$1.7 \cdot 10^4$	$7 \cdot 10^{-6}$	$1.7 \cdot 10^3$	$1.0 \cdot 10^3$
^{114m} ₄₉ In	soluble	$2.6 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.6 \cdot 10^1$	$1.4 \cdot 10^1$
	insoluble	$5.4 \cdot 10^1$	$2 \cdot 10^{-8}$	5.4	$1.4 \cdot 10^1$
^{115m} ₄₉ In	soluble	$5.9 \cdot 10^3$	$2 \cdot 10^{-6}$	$5.9 \cdot 10^2$	$3.0 \cdot 10^2$
	insoluble	$4.7 \cdot 10^3$	$2 \cdot 10^{-6}$	$4.7 \cdot 10^2$	$3.0 \cdot 10^2$
¹¹³ ₅₀ Sn	soluble	$8.7 \cdot 10^2$	$4 \cdot 10^{-7}$	$8.7 \cdot 10^1$	$6.8 \cdot 10^1$
	insoluble	$1.3 \cdot 10^2$	$5 \cdot 10^{-8}$	$1.3 \cdot 10^1$	$6.5 \cdot 10^1$
¹²⁵ ₅₀ Sn	soluble	$2.9 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.9 \cdot 10^1$	$1.4 \cdot 10^1$
	insoluble	$2.1 \cdot 10^2$	$8 \cdot 10^{-8}$	$2.1 \cdot 10^1$	$1.4 \cdot 10^1$
¹²² ₅₁ Sb	soluble	$4.7 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.7 \cdot 10^1$	$2.3 \cdot 10^1$
	insoluble	$3.6 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.6 \cdot 10^1$	$2.3 \cdot 10^1$
¹²⁴ ₅₁ Sb	soluble	$3.7 \cdot 10^2$	$2 \cdot 10^{-7}$	$3.7 \cdot 10^1$	$1.8 \cdot 10^1$
	insoluble	$4.8 \cdot 10^1$	$2 \cdot 10^{-8}$	4.8	$1.8 \cdot 10^1$
¹²⁵ ₅₁ Sb	soluble	$1.3 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.3 \cdot 10^2$	$8.0 \cdot 10^1$
	insoluble	$6.6 \cdot 10^1$	$3 \cdot 10^{-8}$	6.6	$7.9 \cdot 10^1$
^{125m} ₅₂ Te	soluble	$8.7 \cdot 10^2$	$4 \cdot 10^{-7}$	$8.7 \cdot 10^1$	$1.3 \cdot 10^2$
	insoluble	$3.2 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.2 \cdot 10^1$	$9.6 \cdot 10^1$
^{127m} ₅₂ Te	soluble	$3.3 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.3 \cdot 10^1$	$5.0 \cdot 10^1$
	insoluble	$1.0 \cdot 10^2$	$4 \cdot 10^{-8}$	$1.0 \cdot 10^1$	$4.2 \cdot 10^1$
¹²⁷ ₅₂ Te	soluble	$4.2 \cdot 10^3$	$2 \cdot 10^{-6}$	$4.2 \cdot 10^2$	$2.1 \cdot 10^2$
	insoluble	$2.1 \cdot 10^3$	$9 \cdot 10^{-7}$	$2.1 \cdot 10^2$	$1.4 \cdot 10^2$
^{129m} ₅₂ Te	soluble	$2.0 \cdot 10^2$	$8 \cdot 10^{-8}$	$2.0 \cdot 10^1$	$2.6 \cdot 10^1$
	insoluble	$8.0 \cdot 10^1$	$3 \cdot 10^{-8}$	8.0	$1.6 \cdot 10^1$
¹²⁹ ₅₂ Te	soluble	$1.3 \cdot 10^4$	$5 \cdot 10^{-6}$	$1.3 \cdot 10^3$	$6.6 \cdot 10^2$
	insoluble	$1.0 \cdot 10^4$	$4 \cdot 10^{-6}$	$1.0 \cdot 10^3$	$6.6 \cdot 10^2$

		Exposed workers		Members of public	
Radionuclides		Limits of annual intake by inhalation	Derived limits of concentration in the air for exposure of 2 000 h/year	Limits of annual intake by inhalation	Limits of annual intake by ingestion
		μCi	Ci/m^3	μCi	μCi
$^{131\text{m}}_{52}\text{Te}$	soluble	$9.5 \cdot 10^2$	$4 \cdot 10^{-7}$	$9.5 \cdot 10^1$	$4.6 \cdot 10^1$
	insoluble	$4.7 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.7 \cdot 10^1$	$3.0 \cdot 10^1$
$^{132}_{52}\text{Te}$	soluble	$5.1 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.1 \cdot 10^1$	$2.6 \cdot 10^1$
	insoluble	$2.6 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.6 \cdot 10^1$	$1.7 \cdot 10^1$
$^{126}_{53}\text{I} (*)$	soluble	$1.8 \cdot 10^1$	$8 \cdot 10^{-9}$	1.8	1.4
	insoluble	$8.0 \cdot 10^2$	$3 \cdot 10^{-7}$	$8.0 \cdot 10^1$	$7.4 \cdot 10^1$
$^{129}_{53}\text{I} (*)$	soluble	4.0	$2 \cdot 10^{-9}$	$4.0 \cdot 10^{-1}$	$3.0 \cdot 10^{-1}$
	insoluble	$1.8 \cdot 10^2$	$7 \cdot 10^{-8}$	$1.8 \cdot 10^1$	$1.7 \cdot 10^2$
$^{131}_{53}\text{I} (*)$	soluble	$2.1 \cdot 10^1$	$9 \cdot 10^{-9}$	2.1	1.6
	insoluble	$8.0 \cdot 10^2$	$3 \cdot 10^{-7}$	$8.0 \cdot 10^1$	$5.1 \cdot 10^1$
$^{132}_{53}\text{I} (*)$	soluble	$5.9 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.9 \cdot 10^1$	$4.5 \cdot 10^1$
	insoluble	$2.3 \cdot 10^3$	$9 \cdot 10^{-7}$	$2.3 \cdot 10^2$	$1.4 \cdot 10^2$
$^{133}_{53}\text{I} (*)$	soluble	$8.0 \cdot 10^1$	$3 \cdot 10^{-8}$	8.0	6.0
	insoluble	$5.2 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.2 \cdot 10^1$	$3.3 \cdot 10^1$
$^{134}_{53}\text{I} (*)$	soluble	$1.2 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.2 \cdot 10^2$	$9.6 \cdot 10^1$
	insoluble	$8.0 \cdot 10^3$	$3 \cdot 10^{-6}$	$8.0 \cdot 10^2$	$4.8 \cdot 10^2$
$^{135}_{53}\text{I} (*)$	soluble	$2.6 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.6 \cdot 10^1$	$1.9 \cdot 10^1$
	insoluble	$8.7 \cdot 10^2$	$4 \cdot 10^{-7}$	$8.7 \cdot 10^1$	$5.6 \cdot 10^1$
$^{131\text{m}}_{54}\text{Xe}$			$2 \cdot 10^{-5}$		
$^{133}_{54}\text{Xe}$			$1 \cdot 10^{-5}$		
$^{135}_{54}\text{Xe}$			$4 \cdot 10^{-6}$		
$^{131}_{55}\text{Cs}$	soluble	$2.6 \cdot 10^4$	$1 \cdot 10^{-5}$	$2.6 \cdot 10^3$	$1.9 \cdot 10^3$
	insoluble	$8.0 \cdot 10^3$	$3 \cdot 10^{-6}$	$8.0 \cdot 10^2$	$7.4 \cdot 10^2$
$^{134\text{m}}_{55}\text{Cs}$	soluble	$8.7 \cdot 10^4$	$4 \cdot 10^{-5}$	$8.7 \cdot 10^3$	$4.4 \cdot 10^3$
	insoluble	$1.5 \cdot 10^4$	$6 \cdot 10^{-6}$	$1.5 \cdot 10^3$	$8.8 \cdot 10^2$
$^{134}_{55}\text{Cs}$	soluble	$9.5 \cdot 10^1$	$4 \cdot 10^{-8}$	9.5	6.9
	insoluble	$3.2 \cdot 10^1$	$1 \cdot 10^{-8}$	3.2	$3.2 \cdot 10^1$
$^{135}_{55}\text{Cs}$	soluble	$1.2 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.2 \cdot 10^2$	$8.8 \cdot 10^1$
	insoluble	$2.3 \cdot 10^2$	$9 \cdot 10^{-8}$	$2.3 \cdot 10^1$	$1.8 \cdot 10^2$
$^{136}_{55}\text{Cs}$	soluble	$9.5 \cdot 10^2$	$4 \cdot 10^{-7}$	$9.5 \cdot 10^1$	$6.8 \cdot 10^1$
	insoluble	$4.2 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.2 \cdot 10^1$	$5.2 \cdot 10^1$
$^{137}_{55}\text{Cs}$	soluble	$1.6 \cdot 10^2$	$6 \cdot 10^{-8}$	$1.6 \cdot 10^1$	$1.2 \cdot 10^1$
	insoluble	$3.6 \cdot 10^1$	$1 \cdot 10^{-8}$	3.6	$3.5 \cdot 10^1$
$^{131}_{56}\text{Ba}$	soluble	$2.9 \cdot 10^3$	$1 \cdot 10^{-6}$	$2.9 \cdot 10^2$	$1.4 \cdot 10^2$
	insoluble	$8.7 \cdot 10^2$	$4 \cdot 10^{-7}$	$8.7 \cdot 10^1$	$1.4 \cdot 10^2$
$^{140}_{56}\text{Ba}$	soluble	$3.2 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.2 \cdot 10^1$	$2.1 \cdot 10^1$
	insoluble	$1.1 \cdot 10^2$	$4 \cdot 10^{-8}$	$1.1 \cdot 10^1$	$2.0 \cdot 10^1$
$^{140}_{57}\text{La}$	soluble	$3.9 \cdot 10^2$	$2 \cdot 10^{-7}$	$3.9 \cdot 10^1$	$1.9 \cdot 10^1$
	insoluble	$3.1 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.1 \cdot 10^1$	$1.9 \cdot 10^1$
$^{141}_{58}\text{Ce}$	soluble	$1.1 \cdot 10^3$	$4 \cdot 10^{-7}$	$1.1 \cdot 10^2$	$7.0 \cdot 10^1$
	insoluble	$3.9 \cdot 10^2$	$2 \cdot 10^{-7}$	$3.9 \cdot 10^1$	$7.2 \cdot 10^1$
$^{143}_{58}\text{Ce}$	soluble	$6.4 \cdot 10^2$	$3 \cdot 10^{-7}$	$6.4 \cdot 10^1$	$3.2 \cdot 10^1$
	insoluble	$5.2 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.2 \cdot 10^1$	$3.2 \cdot 10^1$
$^{144}_{58}\text{Ce}$	soluble	$2.4 \cdot 10^1$	$1 \cdot 10^{-8}$	2.4	9.6
	insoluble	$1.6 \cdot 10^1$	$6 \cdot 10^{-9}$	1.6	9.6

(*) Applies only to persons of 16 years or over.

		Exposed workers		Members of public	
Radionuclides		Limits of annual intake by inhalation	Derived limits of concentration in the air for exposure of 2 000 h/year	Limits of annual intake by inhalation	Limits of annual intake by ingestion
		μCi	Ci/m^3	μCi	μCi
$^{142}_{59}\text{Pr}$	soluble	$4.8 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.8 \cdot 10^1$	$2.4 \cdot 10^1$
	insoluble	$3.9 \cdot 10^2$	$2 \cdot 10^{-7}$	$3.9 \cdot 10^1$	$2.4 \cdot 10^1$
$^{143}_{59}\text{Pr}$	soluble	$8.0 \cdot 10^2$	$3 \cdot 10^{-7}$	$8.0 \cdot 10^1$	$3.9 \cdot 10^1$
	insoluble	$4.4 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.4 \cdot 10^1$	$3.9 \cdot 10^1$
$^{147}_{60}\text{Nd}$	soluble	$8.7 \cdot 10^2$	$4 \cdot 10^{-7}$	$8.7 \cdot 10^1$	$4.9 \cdot 10^1$
	insoluble	$5.7 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.7 \cdot 10^1$	$4.9 \cdot 10^1$
$^{149}_{60}\text{Nd}$	soluble	$4.5 \cdot 10^3$	$2 \cdot 10^{-6}$	$4.5 \cdot 10^2$	$2.2 \cdot 10^2$
	insoluble	$3.6 \cdot 10^3$	$1 \cdot 10^{-6}$	$3.6 \cdot 10^2$	$2.2 \cdot 10^2$
$^{147}_{61}\text{Pm}$	soluble	$1.6 \cdot 10^2$	$6 \cdot 10^{-8}$	$1.6 \cdot 10^1$	$1.8 \cdot 10^2$
	insoluble	$2.4 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.4 \cdot 10^1$	$1.8 \cdot 10^2$
$^{149}_{61}\text{Pm}$	soluble	$7.1 \cdot 10^2$	$3 \cdot 10^{-7}$	$7.1 \cdot 10^1$	$3.5 \cdot 10^1$
	insoluble	$5.6 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.6 \cdot 10^1$	$3.5 \cdot 10^1$
$^{151}_{62}\text{Sm}$	soluble	$1.6 \cdot 10^2$	$6 \cdot 10^{-8}$	$1.6 \cdot 10^1$	$3.0 \cdot 10^2$
	insoluble	$3.5 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.5 \cdot 10^1$	$3.0 \cdot 10^2$
$^{153}_{62}\text{Sm}$	soluble	$1.2 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.2 \cdot 10^2$	$6.2 \cdot 10^1$
	insoluble	$1.0 \cdot 10^3$	$4 \cdot 10^{-7}$	$1.0 \cdot 10^2$	$6.2 \cdot 10^1$
$^{152}_{63}\text{Eu}$	soluble	$1.0 \cdot 10^3$	$4 \cdot 10^{-7}$	$1.0 \cdot 10^2$	$5.0 \cdot 10^1$
	insoluble	$8.0 \cdot 10^2$	$3 \cdot 10^{-7}$	$8.0 \cdot 10^1$	$5.0 \cdot 10^1$
$^{152}_{63}\text{Eu}$	soluble	$3.1 \cdot 10^1$	$1 \cdot 10^{-8}$	3.1	$6.1 \cdot 10^1$
	insoluble	$4.6 \cdot 10^1$	$2 \cdot 10^{-8}$	4.6	$6.1 \cdot 10^1$
$^{154}_{63}\text{Eu}$	soluble	9.5	$4 \cdot 10^{-9}$	$9.5 \cdot 10^{-1}$	$1.8 \cdot 10^1$
	insoluble	$1.8 \cdot 10^1$	$7 \cdot 10^{-9}$	1.8	$1.8 \cdot 10^1$
$^{155}_{63}\text{Eu}$	soluble	$2.3 \cdot 10^2$	$9 \cdot 10^{-8}$	$2.3 \cdot 10^1$	$1.6 \cdot 10^2$
	insoluble	$1.8 \cdot 10^2$	$7 \cdot 10^{-8}$	$1.8 \cdot 10^1$	$1.6 \cdot 10^2$
$^{153}_{64}\text{Gd}$	soluble	$5.6 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.6 \cdot 10^1$	$1.7 \cdot 10^2$
	insoluble	$2.3 \cdot 10^2$	$9 \cdot 10^{-8}$	$2.3 \cdot 10^1$	$1.7 \cdot 10^2$
$^{159}_{64}\text{Gd}$	soluble	$1.2 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.2 \cdot 10^2$	$6.2 \cdot 10^1$
	insoluble	$1.0 \cdot 10^3$	$4 \cdot 10^{-7}$	$1.0 \cdot 10^2$	$6.2 \cdot 10^1$
$^{160}_{65}\text{Tb}$	soluble	$2.5 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.5 \cdot 10^1$	$3.5 \cdot 10^1$
	insoluble	$8.0 \cdot 10^1$	$3 \cdot 10^{-8}$	8.0	$3.6 \cdot 10^1$
$^{165}_{66}\text{Dy}$	soluble	$6.4 \cdot 10^3$	$3 \cdot 10^{-6}$	$6.4 \cdot 10^2$	$3.2 \cdot 10^2$
	insoluble	$5.2 \cdot 10^3$	$2 \cdot 10^{-6}$	$5.2 \cdot 10^2$	$3.2 \cdot 10^2$
$^{166}_{66}\text{Dy}$	soluble	$6.1 \cdot 10^2$	$2 \cdot 10^{-7}$	$6.1 \cdot 10^1$	$3.0 \cdot 10^1$
	insoluble	$4.9 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.9 \cdot 10^1$	$3.0 \cdot 10^1$
$^{166}_{67}\text{Ho}$	soluble	$5.0 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.0 \cdot 10^1$	$2.5 \cdot 10^1$
	insoluble	$4.1 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.1 \cdot 10^1$	$2.5 \cdot 10^1$
$^{169}_{68}\text{Er}$	soluble	$1.5 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.5 \cdot 10^2$	$7.4 \cdot 10^1$
	insoluble	$9.5 \cdot 10^2$	$4 \cdot 10^{-7}$	$9.5 \cdot 10^1$	$7.4 \cdot 10^1$
$^{171}_{68}\text{Er}$	soluble	$1.8 \cdot 10^3$	$7 \cdot 10^{-7}$	$1.8 \cdot 10^2$	$8.8 \cdot 10^1$
	insoluble	$1.5 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.5 \cdot 10^2$	$8.8 \cdot 10^1$
$^{170}_{69}\text{Tm}$	soluble	$8.7 \cdot 10^1$	$4 \cdot 10^{-8}$	8.7	$3.7 \cdot 10^1$
	insoluble	$8.7 \cdot 10^1$	$3 \cdot 10^{-8}$	8.7	$3.7 \cdot 10^1$
$^{171}_{69}\text{Tm}$	soluble	$2.8 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.8 \cdot 10^1$	$4.1 \cdot 10^2$
	insoluble	$5.8 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.8 \cdot 10^1$	$4.1 \cdot 10^2$
$^{175}_{70}\text{Yb}$	soluble	$1.8 \cdot 10^3$	$7 \cdot 10^{-7}$	$1.8 \cdot 10^2$	$8.8 \cdot 10^1$
	insoluble	$1.5 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.5 \cdot 10^2$	$8.8 \cdot 10^1$
$^{177}_{71}\text{Lu}$	soluble	$1.6 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.6 \cdot 10^2$	$8.0 \cdot 10^1$
	insoluble	$1.3 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.3 \cdot 10^2$	$8.0 \cdot 10^1$
$^{181}_{72}\text{Hf}$	soluble	$9.5 \cdot 10^1$	$4 \cdot 10^{-8}$	9.5	$5.6 \cdot 10^1$
	insoluble	$1.8 \cdot 10^2$	$7 \cdot 10^{-8}$	$1.8 \cdot 10^1$	$5.6 \cdot 10^1$

Radionuclides		Exposed workers		Members of public	
		Limits of annual intake by inhalation	Derived limits of concentration in the air for exposure of 2 000 h/year	Limits of annual intake by inhalation	Limits of annual intake by ingestion
		μCi	Ci/m^3	μCi	μCi
$^{182}_{73}\text{Ta}$	soluble	$9.5 \cdot 10^1$	$4 \cdot 10^{-8}$	9.5	$3.2 \cdot 10^1$
	insoluble	$5.5 \cdot 10^1$	$2 \cdot 10^{-8}$	5.5	$3.2 \cdot 10^1$
$^{181}_{74}\text{W}$	soluble	$5.8 \cdot 10^3$	$2 \cdot 10^{-6}$	$5.8 \cdot 10^2$	$2.9 \cdot 10^2$
	insoluble	$3.1 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.1 \cdot 10^1$	$2.6 \cdot 10^2$
$^{185}_{74}\text{W}$	soluble	$1.9 \cdot 10^3$	$8 \cdot 10^{-7}$	$1.9 \cdot 10^2$	$9.6 \cdot 10^1$
	insoluble	$2.8 \cdot 10^2$	$1 \cdot 10^{-7}$	$2.8 \cdot 10^1$	$8.8 \cdot 10^1$
$^{187}_{74}\text{W}$	soluble	$1.1 \cdot 10^3$	$4 \cdot 10^{-7}$	$1.1 \cdot 10^2$	$5.4 \cdot 10^1$
	insoluble	$8.0 \cdot 10^2$	$3 \cdot 10^{-7}$	$8.0 \cdot 10^1$	$5.0 \cdot 10^1$
$^{183}_{75}\text{Re}$	soluble	$6.4 \cdot 10^3$	$3 \cdot 10^{-6}$	$6.4 \cdot 10^2$	$4.5 \cdot 10^2$
	insoluble	$3.9 \cdot 10^2$	$2 \cdot 10^{-7}$	$3.9 \cdot 10^1$	$2.2 \cdot 10^2$
$^{186}_{75}\text{Re}$	soluble	$1.5 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.5 \cdot 10^2$	$7.4 \cdot 10^1$
	insoluble	$6.0 \cdot 10^2$	$2 \cdot 10^{-7}$	$6.0 \cdot 10^1$	$3.8 \cdot 10^1$
$^{188}_{75}\text{Re}$	soluble	$1.0 \cdot 10^3$	$4 \cdot 10^{-7}$	$1.0 \cdot 10^2$	$5.0 \cdot 10^1$
	insoluble	$4.0 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.0 \cdot 10^1$	$2.5 \cdot 10^1$
$^{185}_{76}\text{Os}$	soluble	$1.2 \cdot 10^3$	$5 \cdot 10^{-7}$	$1.2 \cdot 10^2$	$5.9 \cdot 10^1$
	insoluble	$1.2 \cdot 10^2$	$5 \cdot 10^{-8}$	$1.2 \cdot 10^1$	$5.3 \cdot 10^1$
$^{191\text{m}}_{76}\text{Os}$	soluble	$4.0 \cdot 10^4$	$2 \cdot 10^{-5}$	$4.0 \cdot 10^3$	$2.0 \cdot 10^3$
	insoluble	$2.3 \cdot 10^4$	$9 \cdot 10^{-6}$	$2.3 \cdot 10^3$	$1.9 \cdot 10^3$
$^{191}_{76}\text{Os}$	soluble	$2.7 \cdot 10^3$	$1 \cdot 10^{-6}$	$2.7 \cdot 10^2$	$1.4 \cdot 10^2$
	insoluble	$1.0 \cdot 10^3$	$4 \cdot 10^{-7}$	$1.0 \cdot 10^2$	$1.3 \cdot 10^2$
$^{193}_{76}\text{Os}$	soluble	$9.5 \cdot 10^2$	$4 \cdot 10^{-7}$	$9.5 \cdot 10^1$	$4.7 \cdot 10^1$
	insoluble	$6.8 \cdot 10^2$	$3 \cdot 10^{-7}$	$6.8 \cdot 10^1$	$4.2 \cdot 10^1$
$^{190}_{77}\text{Ir}$	soluble	$3.2 \cdot 10^3$	$1 \cdot 10^{-6}$	$3.2 \cdot 10^2$	$1.6 \cdot 10^2$
	insoluble	$1.0 \cdot 10^3$	$4 \cdot 10^{-7}$	$1.0 \cdot 10^2$	$1.4 \cdot 10^2$
$^{192}_{77}\text{Ir}$	soluble	$3.1 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.1 \cdot 10^1$	$3.2 \cdot 10^1$
	insoluble	$6.4 \cdot 10^1$	$3 \cdot 10^{-8}$	6.4	$3.0 \cdot 10^1$
$^{194}_{77}\text{Ir}$	soluble	$5.5 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.5 \cdot 10^1$	$2.7 \cdot 10^1$
	insoluble	$3.9 \cdot 10^2$	$2 \cdot 10^{-7}$	$3.9 \cdot 10^1$	$2.4 \cdot 10^1$
$^{191}_{78}\text{Pt}$	soluble	$1.9 \cdot 10^3$	$8 \cdot 10^{-7}$	$1.9 \cdot 10^2$	$9.6 \cdot 10^1$
	insoluble	$1.4 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.4 \cdot 10^2$	$8.8 \cdot 10^1$
$^{193\text{m}}_{78}\text{Pt}$	soluble	$1.8 \cdot 10^4$	$7 \cdot 10^{-6}$	$1.8 \cdot 10^3$	$8.8 \cdot 10^2$
	insoluble	$1.3 \cdot 10^4$	$5 \cdot 10^{-6}$	$1.3 \cdot 10^3$	$8.0 \cdot 10^2$
$^{193}_{78}\text{Pt}$	soluble	$2.6 \cdot 10^3$	$1 \cdot 10^{-6}$	$2.6 \cdot 10^2$	$7.5 \cdot 10^2$
	insoluble	$8.0 \cdot 10^2$	$3 \cdot 10^{-7}$	$8.0 \cdot 10^1$	$1.2 \cdot 10^3$
$^{197\text{m}}_{78}\text{Pt}$	soluble	$1.6 \cdot 10^4$	$6 \cdot 10^{-6}$	$1.6 \cdot 10^3$	$8.0 \cdot 10^2$
	insoluble	$1.2 \cdot 10^4$	$5 \cdot 10^{-6}$	$1.2 \cdot 10^3$	$7.4 \cdot 10^2$
$^{197}_{78}\text{Pt}$	soluble	$1.9 \cdot 10^3$	$8 \cdot 10^{-7}$	$1.9 \cdot 10^2$	$9.6 \cdot 10^1$
	insoluble	$1.4 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.4 \cdot 10^2$	$8.8 \cdot 10^1$
$^{196}_{79}\text{Au}$	soluble	$2.6 \cdot 10^3$	$1 \cdot 10^{-6}$	$2.6 \cdot 10^2$	$1.3 \cdot 10^2$
	insoluble	$1.5 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.5 \cdot 10^2$	$1.2 \cdot 10^2$
$^{198}_{79}\text{Au}$	soluble	$8.0 \cdot 10^2$	$3 \cdot 10^{-7}$	$8.0 \cdot 10^1$	$4.1 \cdot 10^1$
	insoluble	$5.9 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.9 \cdot 10^1$	$3.7 \cdot 10^1$
$^{199}_{79}\text{Au}$	soluble	$2.7 \cdot 10^3$	$1 \cdot 10^{-6}$	$2.7 \cdot 10^2$	$1.4 \cdot 10^2$
	insoluble	$2.0 \cdot 10^3$	$8 \cdot 10^{-7}$	$2.0 \cdot 10^2$	$1.3 \cdot 10^2$
$^{197\text{m}}_{80}\text{Hg}$	soluble	$1.8 \cdot 10^3$	$7 \cdot 10^{-7}$	$1.8 \cdot 10^2$	$1.5 \cdot 10^2$
	insoluble	$2.1 \cdot 10^3$	$8 \cdot 10^{-7}$	$2.1 \cdot 10^2$	$1.4 \cdot 10^2$
$^{197}_{80}\text{Hg}$	soluble	$2.9 \cdot 10^3$	$1 \cdot 10^{-6}$	$2.9 \cdot 10^2$	$2.4 \cdot 10^2$
	insoluble	$6.2 \cdot 10^3$	$3 \cdot 10^{-6}$	$6.2 \cdot 10^2$	$3.9 \cdot 10^2$
$^{203}_{80}\text{Hg}$	soluble	$1.8 \cdot 10^2$	$7 \cdot 10^{-8}$	$1.8 \cdot 10^1$	$1.4 \cdot 10^1$
	insoluble	$3.1 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.1 \cdot 10^1$	$8.8 \cdot 10^1$

Radionuclides		Exposed workers		Members of public	
		Limits of annual intake by inhalation	Derived limits of concentration in the air for exposure of 2 000 h/year	Limits of annual intake by inhalation	Limits of annual intake by ingestion
		μCi	Ci/m^3	μCi	μCi
²⁰⁰ ₈₁ Tl	soluble	$6.6 \cdot 10^{-3}$	$3 \cdot 10^{-6}$	$6.6 \cdot 10^2$	$3.5 \cdot 10^2$
	insoluble	$2.8 \cdot 10^{-3}$	$1 \cdot 10^{-6}$	$2.8 \cdot 10^2$	$1.8 \cdot 10^2$
²⁰¹ ₈₁ Tl	soluble	$5.0 \cdot 10^{-3}$	$2 \cdot 10^{-6}$	$5.0 \cdot 10^2$	$2.5 \cdot 10^2$
	insoluble	$2.2 \cdot 10^{-3}$	$9 \cdot 10^{-7}$	$2.2 \cdot 10^2$	$1.4 \cdot 10^2$
²⁰² ₈₁ Tl	soluble	$1.9 \cdot 10^{-3}$	$8 \cdot 10^{-7}$	$1.9 \cdot 10^2$	$9.6 \cdot 10^1$
	insoluble	$6.0 \cdot 10^{-2}$	$2 \cdot 10^{-7}$	$6.0 \cdot 10^1$	$5.6 \cdot 10^1$
²⁰⁴ ₈₁ Tl	soluble	$1.5 \cdot 10^{-3}$	$6 \cdot 10^{-7}$	$1.5 \cdot 10^2$	$8.8 \cdot 10^1$
	insoluble	$6.6 \cdot 10^{-1}$	$3 \cdot 10^{-8}$	6.6	$4.9 \cdot 10^1$
²⁰³ ₈₂ Pb	soluble	$6.3 \cdot 10^{-3}$	$3 \cdot 10^{-6}$	$6.3 \cdot 10^2$	$3.1 \cdot 10^2$
	insoluble	$4.5 \cdot 10^{-3}$	$2 \cdot 10^{-6}$	$4.5 \cdot 10^2$	$2.8 \cdot 10^2$
²¹⁰ ₈₂ Pb	soluble	$3.1 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$3.1 \cdot 10^{-2}$	$9.6 \cdot 10^{-2}$
	insoluble	$6.0 \cdot 10^{-1}$	$2 \cdot 10^{-10}$	$6.0 \cdot 10^{-2}$	$1.4 \cdot 10^2$
²¹² ₈₂ Pb	soluble	$4.4 \cdot 10^{-1}$	$2 \cdot 10^{-8}$	4.4	$1.5 \cdot 10^1$
	insoluble	$4.8 \cdot 10^{-1}$	$2 \cdot 10^{-8}$	4.8	$1.4 \cdot 10^1$
²⁰⁶ ₈₃ Bi	soluble	$4.7 \cdot 10^{-2}$	$2 \cdot 10^{-7}$	$4.7 \cdot 10^1$	$3.0 \cdot 10^1$
	insoluble	$3.6 \cdot 10^{-2}$	$1 \cdot 10^{-7}$	$3.6 \cdot 10^1$	$3.0 \cdot 10^1$
²⁰⁷ ₈₃ Bi	soluble	$4.2 \cdot 10^{-2}$	$2 \cdot 10^{-7}$	$4.2 \cdot 10^1$	$5.1 \cdot 10^1$
	insoluble	$3.4 \cdot 10^{-1}$	$1 \cdot 10^{-8}$	3.4	$5.0 \cdot 10^1$
²¹⁰ ₈₃ Bi	soluble	$1.6 \cdot 10^{-1}$	$6 \cdot 10^{-9}$	1.6	$3.3 \cdot 10^1$
	insoluble	$1.5 \cdot 10^{-1}$	$6 \cdot 10^{-9}$	1.5	$3.3 \cdot 10^1$
²¹² ₈₃ Bi	soluble	$2.4 \cdot 10^{-2}$	$1 \cdot 10^{-7}$	$2.4 \cdot 10^1$	$2.8 \cdot 10^2$
	insoluble	$5.0 \cdot 10^{-2}$	$2 \cdot 10^{-7}$	$5.0 \cdot 10^1$	$2.8 \cdot 10^2$
²¹⁰ ₈₄ Po	soluble	1.2	$5 \cdot 10^{-10}$	$1.2 \cdot 10^{-1}$	$5.8 \cdot 10^{-1}$
	insoluble	$5.0 \cdot 10^{-1}$	$2 \cdot 10^{-10}$	$5.0 \cdot 10^{-2}$	$2.3 \cdot 10^1$
²¹¹ ₈₅ At (*)	soluble	$1.8 \cdot 10^{-1}$	$7 \cdot 10^{-9}$	1.8	1.4
	insoluble	$8.7 \cdot 10^{-1}$	$3 \cdot 10^{-8}$	8.7	$5.8 \cdot 10^1$
²²⁰ ₈₆ Rn (**)		$7.3 \cdot 10^{-2}$	$3 \cdot 10^{-7}$	$7.3 \cdot 10^1$	-
²²² ₈₆ Rn (*)		$7.3 \cdot 10^{-2}$	$3 \cdot 10^{-7}$	$7.3 \cdot 10^1$	-
²²³ ₈₈ Ra	soluble	4.3	$2 \cdot 10^{-9}$	$4.3 \cdot 10^{-1}$	$5.8 \cdot 10^{-1}$
	insoluble	$6.0 \cdot 10^{-1}$	$2 \cdot 10^{-10}$	$6.0 \cdot 10^{-2}$	3.0
²²⁴ ₈₈ Ra	soluble	$1.4 \cdot 10^{-1}$	$5 \cdot 10^{-9}$	1.4	1.8
	insoluble	1.8	$7 \cdot 10^{-10}$	$1.8 \cdot 10^{-1}$	4.2
²²⁶ ₈₈ Ra	soluble	$7.1 \cdot 10^{-2}$	$3 \cdot 10^{-11}$	$7.1 \cdot 10^{-3}$	$9.6 \cdot 10^{-3}$
	insoluble	$1.3 \cdot 10^{-1}$	$5 \cdot 10^{-11}$	$1.3 \cdot 10^{-2}$	$2.6 \cdot 10^1$
²²⁸ ₈₈ Ra	soluble	$1.7 \cdot 10^{-1}$	$7 \cdot 10^{-11}$	$1.7 \cdot 10^{-2}$	$2.2 \cdot 10^{-2}$
	insoluble	$9.5 \cdot 10^{-2}$	$4 \cdot 10^{-11}$	$9.5 \cdot 10^{-3}$	$2.0 \cdot 10^1$
²²⁷ ₈₉ Ac	soluble	$5.8 \cdot 10^{-3}$	$2 \cdot 10^{-12}$	$5.8 \cdot 10^{-4}$	1.5
	insoluble	$6.5 \cdot 10^{-2}$	$3 \cdot 10^{-11}$	$6.5 \cdot 10^{-3}$	$2.4 \cdot 10^2$
²²⁸ ₈₉ Ac	soluble	$1.9 \cdot 10^{-2}$	$8 \cdot 10^{-8}$	$1.9 \cdot 10^1$	$7.0 \cdot 10^1$
	insoluble	$4.2 \cdot 10^{-1}$	$2 \cdot 10^{-8}$	4.2	$7.0 \cdot 10^1$
²²⁷ ₉₀ Th	soluble	$8.7 \cdot 10^{-1}$	$3 \cdot 10^{-10}$	$8.7 \cdot 10^{-2}$	$1.4 \cdot 10^1$
	insoluble	$4.5 \cdot 10^{-1}$	$2 \cdot 10^{-10}$	$4.5 \cdot 10^{-2}$	$1.4 \cdot 10^1$

(*) Applies only to persons of 16 years or over.

(**) Daughter products of ²²⁰₈₆Rn and ²²²₈₆Rn are assumed to be present in the same quantities as in unfiltered air. In the case of all the other isotopes, daughter products are not considered to be present in the quantities absorbed; if they are found to be present, the rules for mixtures (see 2) must be applied.

		Exposed workers		Members of public	
Radionuclides		Limits of annual intake by inhalation	Derived limits of concentration in the air for exposure of 2 000 h/year	Limits of annual intake by inhalation	Limits by annual intake by ingestion
		μCi	Ci/m^3	μCi	μCi
$^{228}_{90}\text{Th}$	soluble	$2.3 \cdot 10^{-2}$	$9 \cdot 10^{-12}$	$2.3 \cdot 10^{-3}$	5.8
	insoluble	$1.5 \cdot 10^{-2}$	$6 \cdot 10^{-12}$	$1.5 \cdot 10^{-3}$	$1.0 \cdot 10^1$
$^{230}_{90}\text{Th}$	soluble	$5.6 \cdot 10^{-3}$	$2 \cdot 10^{-12}$	$5.6 \cdot 10^{-4}$	1.4
	insoluble	$2.6 \cdot 10^{-2}$	$1 \cdot 10^{-11}$	$2.6 \cdot 10^{-3}$	$2.6 \cdot 10^1$
$^{231}_{90}\text{Th}$	soluble	$3.7 \cdot 10^3$	$1 \cdot 10^{-6}$	$3.7 \cdot 10^2$	$1.8 \cdot 10^2$
	insoluble	$3.0 \cdot 10^3$	$1 \cdot 10^{-6}$	$3.0 \cdot 10^2$	$1.8 \cdot 10^2$
$^{232}_{90}\text{Th}$	soluble	$8.0 \cdot 10^{-2}$	$3 \cdot 10^{-11}$	$8.0 \cdot 10^{-3}$	1.2
	insoluble	$8.0 \cdot 10^{-2}$	$3 \cdot 10^{-11}$	$8.0 \cdot 10^{-3}$	$3.0 \cdot 10^1$
$^{234}_{90}\text{Th}$	soluble	$1.5 \cdot 10^2$	$6 \cdot 10^{-8}$	$1.5 \cdot 10^1$	$1.4 \cdot 10^1$
	insoluble	$8.0 \cdot 10^1$	$3 \cdot 10^{-8}$	8.0	$1.4 \cdot 10^1$
$^{90}\text{Th nat (*)}$	soluble	$8.0 \cdot 10^{-2}$	$3 \cdot 10^{-11}$	$8.0 \cdot 10^{-3}$	1.0
	insoluble	$8.0 \cdot 10^{-2}$	$3 \cdot 10^{-11}$	$8.0 \cdot 10^{-3}$	7.8
$^{230}_{91}\text{Pa}$	soluble	4.2	$2 \cdot 10^{-9}$	$4.2 \cdot 10^{-1}$	$1.9 \cdot 10^2$
	insoluble	2.0	$8 \cdot 10^{-10}$	$2.0 \cdot 10^{-1}$	$2.0 \cdot 10^2$
$^{231}_{91}\text{Pa}$	soluble	$2.8 \cdot 10^{-3}$	$1 \cdot 10^{-12}$	$2.8 \cdot 10^{-4}$	$7.0 \cdot 10^{-1}$
	insoluble	$2.7 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.7 \cdot 10^{-2}$	$2.2 \cdot 10^1$
$^{233}_{91}\text{Pa}$	soluble	$1.5 \cdot 10^3$	$6 \cdot 10^{-7}$	$1.5 \cdot 10^2$	$9.6 \cdot 10^1$
	insoluble	$4.4 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.4 \cdot 10^1$	$9.6 \cdot 10^1$
$^{230}_{92}\text{U (**)}$	soluble	$7.3 \cdot 10^{-1}$	$3 \cdot 10^{-10}$	$7.3 \cdot 10^{-2}$	1.9
	insoluble	$2.8 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.8 \cdot 10^{-2}$	3.7
$^{232}_{92}\text{U (**)}$	soluble	$2.6 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.6 \cdot 10^{-2}$	$6.7 \cdot 10^{-1}$
	insoluble	$6.9 \cdot 10^{-2}$	$3 \cdot 10^{-11}$	$6.9 \cdot 10^{-3}$	$2.3 \cdot 10^1$
$^{233}_{92}\text{U}$	soluble	1.3	$5 \cdot 10^{-10}$	$1.3 \cdot 10^{-1}$	3.4
	insoluble	$3.0 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$3.0 \cdot 10^{-2}$	$2.6 \cdot 10^1$
$^{234}_{92}\text{U (**)}$	soluble	1.4	$6 \cdot 10^{-10}$	$1.4 \cdot 10^{-1}$	3.4
	insoluble	$3.0 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$3.0 \cdot 10^{-2}$	$2.6 \cdot 10^1$
$^{235}_{92}\text{U (**)}$	soluble	1.2	$5 \cdot 10^{-10}$	$1.2 \cdot 10^{-1}$	3.0
	insoluble	$3.2 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$3.2 \cdot 10^{-2}$	$2.2 \cdot 10^1$
$^{236}_{92}\text{U (**)}$	soluble	1.5	$6 \cdot 10^{-10}$	$1.5 \cdot 10^{-1}$	3.6
	insoluble	$3.1 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$3.1 \cdot 10^{-2}$	$2.7 \cdot 10^1$
$^{238}_{92}\text{U (**)}$	soluble	$1.8 \cdot 10^{-1}$	$7 \cdot 10^{-11}$	$1.8 \cdot 10^{-2}$	$4.7 \cdot 10^{-1}$
	insoluble	$3.4 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$3.4 \cdot 10^{-2}$	$2.8 \cdot 10^1$
$^{240}_{92}\text{U (**)} + ^{240}_{93}\text{Np}$	soluble	$5.5 \cdot 10^2$	$2 \cdot 10^{-7}$	$5.5 \cdot 10^1$	$2.7 \cdot 10^1$
	insoluble	$4.4 \cdot 10^2$	$2 \cdot 10^{-7}$	$4.4 \cdot 10^1$	$2.7 \cdot 10^1$
$^{92}\text{U nat (***)}$	soluble	$1.8 \cdot 10^{-1}$	$7 \cdot 10^{-11}$	$1.8 \cdot 10^{-2}$	$4.6 \cdot 10^{-1}$
	insoluble	$1.5 \cdot 10^{-1}$	$6 \cdot 10^{-11}$	$1.5 \cdot 10^{-2}$	$1.3 \cdot 10^1$
$^{237}_{93}\text{Np}$	soluble	$1.0 \cdot 10^{-2}$	$4 \cdot 10^{-12}$	$1.0 \cdot 10^{-3}$	2.5
	insoluble	$3.0 \cdot 10^{-1}$	$4 \cdot 10^{-10}$	$3.0 \cdot 10^{-2}$	$2.8 \cdot 10^1$
$^{239}_{93}\text{Np}$	soluble	$2.1 \cdot 10^3$	$8 \cdot 10^{-7}$	$2.1 \cdot 10^2$	$1.0 \cdot 10^2$
	insoluble	$1.7 \cdot 10^3$	$7 \cdot 10^{-7}$	$1.7 \cdot 10^2$	$1.0 \cdot 10^2$
$^{238}_{94}\text{Pu}$	soluble	$4.8 \cdot 10^{-3}$	$2 \cdot 10^{-12}$	$4.8 \cdot 10^{-4}$	4.0
	insoluble	$8.7 \cdot 10^{-2}$	$3 \cdot 10^{-11}$	$8.7 \cdot 10^{-3}$	$2.2 \cdot 10^1$

(*) One curie of natural thorium conventionally corresponds to:
 $3.7 \cdot 10^{10}$ disintegrations per second of ^{232}Th and
 $3.7 \cdot 10^{10}$ disintegrations per second of ^{228}Th .

(**) In view of the chemical toxicity of soluble uranium, inhalation and ingestion should not exceed 2.5 mg and 150 mg per day respectively, regardless of the isotopic composition.

(***) One curie of natural uranium conventionally corresponds to:
 $3.7 \cdot 10^{10}$ disintegrations per second of ^{238}U ,
 $3.7 \cdot 10^{10}$ disintegrations per second of ^{234}U and
 $1.7 \cdot 10^{10}$ disintegrations per second of ^{235}U .

		Exposed workers		Members of public	
Radionuclides		Limits of annual intake by inhalation	Derived limits of concentration in the air for exposure of 2 000 h/year	Limits of annual intake by inhalation	Limits of annual intake by ingestion
		μCi	Ci/m^3	μCi	μCi
$^{239}_{94}\text{Pu}$	soluble	$4.3 \cdot 10^{-3}$	$2 \cdot 10^{-12}$	$4.3 \cdot 10^{-4}$	3.6
	insoluble	$9.5 \cdot 10^{-2}$	$4 \cdot 10^{-11}$	$9.5 \cdot 10^{-3}$	$2.3 \cdot 10^1$
$^{240}_{94}\text{Pu}$	soluble	$4.3 \cdot 10^{-3}$	$2 \cdot 10^{-12}$	$4.3 \cdot 10^{-4}$	3.6
	insoluble	$9.5 \cdot 10^{-2}$	$4 \cdot 10^{-11}$	$9.5 \cdot 10^{-3}$	$2.3 \cdot 10^1$
$^{241}_{94}\text{Pu}$	soluble	$2.3 \cdot 10^{-1}$	$9 \cdot 10^{-11}$	$2.3 \cdot 10^{-2}$	$1.8 \cdot 10^2$
	insoluble	$9.5 \cdot 10^1$	$4 \cdot 10^{-8}$	9.5	$1.1 \cdot 10^3$
$^{242}_{94}\text{Pu}$	soluble	$4.5 \cdot 10^{-3}$	$2 \cdot 10^{-12}$	$4.5 \cdot 10^{-4}$	3.8
	insoluble	$9.5 \cdot 10^{-2}$	$4 \cdot 10^{-11}$	$9.5 \cdot 10^{-3}$	$2.5 \cdot 10^1$
$^{243}_{94}\text{Pu}$	soluble	$4.4 \cdot 10^3$	$2 \cdot 10^{-6}$	$4.4 \cdot 10^2$	$2.7 \cdot 10^2$
	insoluble	$5.5 \cdot 10^3$	$2 \cdot 10^{-6}$	$5.5 \cdot 10^2$	$2.7 \cdot 10^2$
$^{244}_{94}\text{Pu}$	soluble	$4.1 \cdot 10^{-3}$	$2 \cdot 10^{-12}$	$4.1 \cdot 10^{-4}$	3.4
	insoluble	$8.0 \cdot 10^{-2}$	$3 \cdot 10^{-11}$	$8.0 \cdot 10^{-3}$	8.8
$^{241}_{95}\text{Am}$	soluble	$1.5 \cdot 10^{-2}$	$6 \cdot 10^{-12}$	$1.5 \cdot 10^{-3}$	3.0
	insoluble	$2.6 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.6 \cdot 10^{-2}$	$2.2 \cdot 10^1$
$^{242m}_{95}\text{Am}$	soluble	$1.4 \cdot 10^{-2}$	$6 \cdot 10^{-12}$	$1.4 \cdot 10^{-3}$	3.5
	insoluble	$6.5 \cdot 10^{-1}$	$3 \cdot 10^{-10}$	$6.5 \cdot 10^{-2}$	$7.4 \cdot 10^1$
$^{242}_{95}\text{Am}$	soluble	$9.5 \cdot 10^1$	$4 \cdot 10^{-8}$	9.5	$1.0 \cdot 10^2$
	insoluble	$1.2 \cdot 10^2$	$5 \cdot 10^{-8}$	$1.2 \cdot 10^1$	$1.0 \cdot 10^2$
$^{243}_{95}\text{Am}$	soluble	$1.4 \cdot 10^{-2}$	$6 \cdot 10^{-12}$	$1.4 \cdot 10^{-3}$	3.5
	insoluble	$2.7 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.7 \cdot 10^{-2}$	$2.2 \cdot 10^1$
$^{244}_{95}\text{Am}$	soluble	$1.0 \cdot 10^4$	$4 \cdot 10^{-6}$	$1.0 \cdot 10^3$	$3.8 \cdot 10^3$
	insoluble	$6.0 \cdot 10^4$	$2 \cdot 10^{-5}$	$6.0 \cdot 10^3$	$3.8 \cdot 10^3$
$^{242}_{96}\text{Cm}$	soluble	$3.0 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$3.0 \cdot 10^{-2}$	$1.9 \cdot 10^1$
	insoluble	$4.1 \cdot 10^{-1}$	$2 \cdot 10^{-10}$	$4.1 \cdot 10^{-2}$	$2.0 \cdot 10^1$
$^{243}_{96}\text{Cm}$	soluble	$1.6 \cdot 10^{-2}$	$6 \cdot 10^{-12}$	$1.6 \cdot 10^{-3}$	4.1
	insoluble	$2.5 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.5 \cdot 10^{-2}$	$2.0 \cdot 10^1$
$^{244}_{96}\text{Cm}$	soluble	$2.3 \cdot 10^{-2}$	$9 \cdot 10^{-12}$	$2.3 \cdot 10^{-3}$	5.7
	insoluble	$2.5 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.5 \cdot 10^{-2}$	$2.1 \cdot 10^1$
$^{245}_{96}\text{Cm}$	soluble	$1.2 \cdot 10^{-2}$	$5 \cdot 10^{-12}$	$1.2 \cdot 10^{-3}$	2.8
	insoluble	$2.7 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.7 \cdot 10^{-2}$	$2.2 \cdot 10^1$
$^{246}_{96}\text{Cm}$	soluble	$1.2 \cdot 10^{-2}$	$5 \cdot 10^{-12}$	$1.2 \cdot 10^{-3}$	2.9
	insoluble	$2.6 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.6 \cdot 10^{-2}$	$2.2 \cdot 10^1$
$^{247}_{96}\text{Cm}$	soluble	$1.2 \cdot 10^{-2}$	$5 \cdot 10^{-12}$	$1.2 \cdot 10^{-3}$	2.9
	insoluble	$2.7 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.7 \cdot 10^{-2}$	$1.8 \cdot 10^1$
$^{248}_{96}\text{Cm}$	soluble	$1.5 \cdot 10^{-3}$	$6 \cdot 10^{-13}$	$1.5 \cdot 10^{-4}$	$3.5 \cdot 10^{-1}$
	insoluble	$3.3 \cdot 10^{-2}$	$1 \cdot 10^{-11}$	$3.3 \cdot 10^{-3}$	1.0
$^{249}_{96}\text{Cm}$	soluble	$3.1 \cdot 10^4$	$1 \cdot 10^{-5}$	$3.1 \cdot 10^3$	$1.8 \cdot 10^3$
	insoluble	$2.8 \cdot 10^4$	$1 \cdot 10^{-5}$	$2.8 \cdot 10^3$	$1.8 \cdot 10^3$
$^{249}_{97}\text{Bk}$	soluble	2.3	$9 \cdot 10^{-10}$	$2.3 \cdot 10^{-1}$	$4.7 \cdot 10^2$
	insoluble	$3.0 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.0 \cdot 10^1$	$4.7 \cdot 10^2$
$^{250}_{97}\text{Bk}$	soluble	$3.6 \cdot 10^2$	$1 \cdot 10^{-7}$	$3.6 \cdot 10^1$	$1.8 \cdot 10^2$
	insoluble	$2.8 \cdot 10^3$	$1 \cdot 10^{-6}$	$2.8 \cdot 10^2$	$1.8 \cdot 10^2$
$^{249}_{98}\text{Cf}$	soluble	$3.9 \cdot 10^{-3}$	$2 \cdot 10^{-12}$	$3.9 \cdot 10^{-4}$	3.3
	insoluble	$2.5 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.5 \cdot 10^{-2}$	$1.9 \cdot 10^1$
$^{250}_{98}\text{Cf}$	soluble	$1.2 \cdot 10^{-3}$	$5 \cdot 10^{-12}$	$1.2 \cdot 10^{-3}$	$1.0 \cdot 10^1$
	insoluble	$2.5 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.5 \cdot 10^{-2}$	$2.0 \cdot 10^1$
$^{251}_{98}\text{Cf}$	soluble	$4.2 \cdot 10^{-3}$	$2 \cdot 10^{-12}$	$4.2 \cdot 10^{-4}$	3.4
	insoluble	$2.5 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.5 \cdot 10^{-2}$	$2.1 \cdot 10^1$
$^{252}_{98}\text{Cf}$	soluble	$1.6 \cdot 10^{-2}$	$6 \cdot 10^{-12}$	$1.6 \cdot 10^{-3}$	5.8
	insoluble	$8.0 \cdot 10^{-2}$	$3 \cdot 10^{-11}$	$8.0 \cdot 10^{-3}$	5.8

		Exposed workers		Members of public	
Radionuclides		Limits of annual intake by inhalation	Derived limits of concentration in the air for exposure of 2 000 h/year	Limits of annual intake by inhalation	Limits of annual intake by ingestion
		μCi	Ci/m^3	μCi	μCi
$^{253}_{98}\text{Cf}$	soluble	2.1	$8 \cdot 10^{-10}$	$2.1 \cdot 10^{-1}$	$1.1 \cdot 10^2$
	insoluble	1.9	$8 \cdot 10^{-10}$	$1.9 \cdot 10^{-1}$	$1.1 \cdot 10^2$
$^{254}_{98}\text{Cf}$	soluble	$1.3 \cdot 10^{-2}$	$5 \cdot 10^{-12}$	$1.3 \cdot 10^{-3}$	$9.6 \cdot 10^{-2}$
	insoluble	$1.2 \cdot 10^{-2}$	$5 \cdot 10^{-12}$	$1.2 \cdot 10^{-3}$	$9.6 \cdot 10^{-2}$
$^{253}_{99}\text{Es}$	soluble	1.9	$8 \cdot 10^{-10}$	$1.9 \cdot 10^{-1}$	$1.8 \cdot 10^1$
	insoluble	1.5	$6 \cdot 10^{-10}$	$1.5 \cdot 10^{-1}$	$1.8 \cdot 10^1$
$^{254}_{99}\text{Es}$	soluble	$1.3 \cdot 10^1$	$5 \cdot 10^{-9}$	1.3	$1.5 \cdot 10^1$
	insoluble	$1.5 \cdot 10^1$	$6 \cdot 10^{-9}$	1.5	$1.5 \cdot 10^1$
$^{254}_{99}\text{Es}$	soluble	$4.7 \cdot 10^{-2}$	$2 \cdot 10^{-11}$	$4.7 \cdot 10^{-3}$	$1.1 \cdot 10^1$
	insoluble	$2.7 \cdot 10^{-1}$	$1 \cdot 10^{-10}$	$2.7 \cdot 10^{-2}$	$1.1 \cdot 10^1$
$^{255}_{99}\text{Es}$	soluble	1.2	$5 \cdot 10^{-10}$	$1.2 \cdot 10^{-1}$	$2.2 \cdot 10^1$
	insoluble	1.0	$4 \cdot 10^{-10}$	$1.0 \cdot 10^{-1}$	$2.2 \cdot 10^1$
$^{254}_{100}\text{Fm}$	soluble	$1.6 \cdot 10^2$	$6 \cdot 10^{-8}$	$1.6 \cdot 10^1$	$9.6 \cdot 10^1$
	insoluble	$1.8 \cdot 10^2$	$7 \cdot 10^{-8}$	$1.8 \cdot 10^1$	$9.6 \cdot 10^1$
$^{255}_{100}\text{Fm}$	soluble	$4.1 \cdot 10^1$	$2 \cdot 10^{-8}$	4.1	$2.6 \cdot 10^1$
	insoluble	$2.7 \cdot 10^1$	$1 \cdot 10^{-8}$	2.7	$2.6 \cdot 10^1$
$^{256}_{100}\text{Fm}$	soluble	6.9	$3 \cdot 10^{-9}$	$6.9 \cdot 10^{-1}$	$7.1 \cdot 10^{-1}$
	insoluble	4.4	$2 \cdot 10^{-9}$	$4.4 \cdot 10^{-1}$	$7.1 \cdot 10^{-1}$

2. Mixture of radionuclides

When several radionuclides are mixed in the air or water, the limits of annual intake for the mixtures shall be established as follows:

- (a) if the exact composition of the mixture is not known, but the radionuclides in it have been identified, use may be made of either the limits of annual intake given in the following tables, or the lowest of the limits laid down for the radionuclides present;
- (b) if the concentration and toxicity of one radionuclide in the mixture predominate, the annual intakes to be used are those given for the radionuclide concerned in 1;
- (c) when dealing with a radionuclide mixture of known composition:
 - either the intake of each radionuclide shall be divided by its annual intake limit, the ratios shall be added together and their sum must then not exceed unity,
 - or the doses in the different organs shall be worked out on the basis of more detailed data, taking the intake of each radionuclide into account. These doses must then not exceed the pertinent dose limits;
- (d) where (a), (b) and (c) are not applicable, expert advice shall be sought.

2.1. Inhalation of radionuclide mixtures of unknown or partly unknown composition

Type of mixture	Exposed workers	Members of public
	Limits of annual intake by inhalation μCi	Limits of annual intake by inhalation μCi
Any mixture	$1.5 \cdot 10^{-3}$	$1.5 \cdot 10^{-4}$
Any mixture in which ^{248}Cm may be disregarded (*)	$2.8 \cdot 10^{-3}$	$2.8 \cdot 10^{-4}$
Any mixture in which ^{231}Pa , ^{239}Pu , ^{240}Pu , ^{242}Pu , ^{244}Pu , ^{248}Cm , ^{249}Cf and ^{251}Cf may be disregarded (*)	$4.8 \cdot 10^{-3}$	$4.8 \cdot 10^{-4}$
Any mixture in which ^{227}Ac , ^{230}Th , ^{231}Pa , ^{238}Pu , ^{239}Pu , ^{240}Pu , ^{242}Pu , ^{244}Pu , ^{248}Cm , ^{249}Cf and ^{251}Cf may be disregarded (*)	$1.0 \cdot 10^{-2}$	$1.0 \cdot 10^{-3}$
Any mixture in which alpha emitters can be disregarded and in which ^{227}Ac , $^{242\text{m}}\text{Am}$ and ^{254}Cf may be disregarded (*)	$9.5 \cdot 10^{-2}$	$9.5 \cdot 10^{-3}$
Any mixture in which alpha emitters can be disregarded and in which ^{210}Pb , ^{227}Ac , ^{228}Ra , ^{241}Pu , $^{242\text{m}}\text{Am}$ and ^{254}Cf may be disregarded (*)	1.0	$1.0 \cdot 10^{-1}$
Any mixture in which alpha emitters can be disregarded and in which ^{90}Sr , ^{129}I , ^{210}Pb , ^{227}Ac , ^{228}Ra , ^{230}Pa , ^{241}Pu , $^{242\text{m}}\text{Am}$, ^{249}Bk , ^{253}Cf , ^{255}Es and ^{256}Fm may be disregarded (*)	9.5	$9.5 \cdot 10^{-1}$

(*) 'may be disregarded' implies that the intake of these nuclides represents a negligible fraction of the annual intake limit given in the table in paragraph 1.

2.2. Ingestion of mixtures of radionuclide mixtures of unknown or partly unknown composition

Type of mixture	Members of public
	Limits of annual intake by ingestion μCi
Any mixture for which no information is available as to its composition	$9.6 \cdot 10^{-3}$
Any mixture in which ^{226}Ra and ^{228}Ra may be disregarded (*)	$9.6 \cdot 10^{-2}$
Any mixture in which ^{129}I , ^{210}Pb , ^{226}Ra , ^{228}Ra and ^{254}Cf may be disregarded (*)	$3.2 \cdot 10^{-1}$
Any mixture in which ^{90}Sr , ^{126}I , ^{129}I , ^{131}I , ^{210}Pb , ^{210}Po , ^{211}At , ^{223}Ra , ^{226}Re , ^{228}Ra , ^{227}Ac , ^{230}Th , ^{232}Th , natural Th, ^{231}Pa , ^{232}U , ^{238}U , natural U, ^{248}Cm , ^{254}Cf and ^{256}Fm may be disregarded (*)	1.8

(*) 'may be disregarded' implies that the intake of these nuclides represents a negligible fraction of the annual intake limit given in the table in paragraph 1.

ANNEX IV

Establishments and plants referred to in the second paragraph of Article 16 (a)

1. Establishments and plants including reactors and critical assemblies,
 2. Establishments and plants including accelerators and X-ray generators,
 3. Establishments and plants including sealed sources used in radiotherapy, gammagraphy, and industrial irradiators,
 4. Industrial plants involving work with thorium and natural or enriched uranium:
 - uranium refining plants,
 - ore concentration plants,
 5. Plants for manufacturing fuel elements,
 6. Plants for processing irradiated fuels,
 7. Uranium and thorium mine workings,
 8. Radioactive waste processing plants and storage sites,
 9. High activity laboratories and plants.
-