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DIRECTIVES

laying down the basic standards for the protection of the health of workers and the general public against the dangers arising from ionising radiations

THE COUNCIL OF THE EUROPEAN ATOMIC ENERGY COMMUNITY,

Having regard to the provisions of the Treaty, and in particular Articles 30 and 31 thereof;

Having regard to the opinion of the group of experts appointed by the Scientific and Technical Committee from among the scientific experts of the Member States;

Having regard to the Opinion of the Economic and Social Committee;

Having regard to the proposal from the Commission;
After consulting the European Parliament;

Whereas basic standards for the protection of the health of workers and the general public against the dangers arising from ionising radiations must, as specified in the Treaty, be laid down in order to enable each Member State, in accordance with Article 33 of the Treaty, to lay down the appropriate laws, regulations or administrative provisions to ensure compliance, to take the necessary measures with regard to teaching, education and vocational training, and to lay down such provisions in harmony with those applicable in this field in the other Member States;

Whereas the protection of the health of workers and of the general public requires that any activity involving a danger arising from ionising radiation must be made subject to rules;

Whereas it is necessary that basic standards be adapted to the conditions governing the use of nuclear energy and that they vary according to whether occupationally exposed persons or persons belonging to special groups of the population are concerned or protection of the population as a whole is envisaged;

Whereas the protection of the health of the general public entails a system of surveillance, inspection and accident procedure;

Whereas procedure for the protection of the health of workers calls for both medical and physical radiation protection surveillance;

HAS ADOPTED THESE DIRECTIVES:

TITLE I

Definitions

Article 1

For the purposes of these Directives, the following terms have the meaning hereby assigned to them:

§ 1 — Physical and Radiological Terms

'Maximum permissible concentration of a radioactive nuclide': the concentration of this nuclide in air inhaled or in drinking water which delivers the maximum permissible dose under conditions of continuous exposure. It is expressed in units of activity per unit volume.

'Contamination': radioactive contamination, i.e. the contamination of any material or any area by radioactive substances.

In the particular case of workers, such contamination includes both external skin contamination and internal contamination irrespective of method of intake (inhalation, ingestion, absorption through the skin, etc.).

'Disintegration': the process of spontaneous breakdown of a nucleus of an atom resulting in the emission of a particle or a photon or of a particle and a photon.

'Natural background radiation': all ionising radiations from natural terrestrial and cosmic sources.

'Uptake': internal contamination in which radioactive substances participate in the metabolism of the body.

'Exposure': any exposure to ionising radiation; a distinction is made between external radiation, where the source is outside the body, and internal radiation, which is caused by the uptake of radioactive substances.

'Planned abnormal exposure': total exposure to ionising radiation of an occupationally exposed person, studied and accepted beforehand as a risk.

'Nuclide': the atom defined by its mass number, atomic number and energy state.

'Ionising radiations': eletromagnetic radiations (X-ray or gamma-ray photons or quanta), or corpuscular radiations (alpha particles, beta particles, electrons, positrons, protons, neutrons and heavy particles) capable of producing ions.

'Radioactivity': spontaneous disintegration of a nuclide, with the emission of a particle or a photon, to form a different nuclide.

'Radiotoxicity': the toxicity attributable to ionising radiations emitted by an incorporated radioactive element; it depends not only on the radioactive characteristics but also on the metabolism of the element in the body or in the organ, and therefore on its chemical and physical state.

'Source': an apparatus or substance capable of emitting ionising radiations.

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

'Unsealed source': a source consisting of radioactive substances in such a form that dispersion of radioactive substances cannot be prevented and risk of contamination cannot be eliminated.

'Radioactive substances': all substances displaying the characteristics of radioactivity.

§ 2 — Other Terms

'Accident': an unforeseen event which entails risk of exposure exceeding the maximum permissible doses.

'Medical surveillance': all the medical examinations and the measures taken by an approved medical practitioner for health surveillance of workers with a view to protecting them against ionising radiations, and to ensure compliance with the basic standards.

'Physical surveillance': all the surveys, monitoring and tests carried out with a view to protecting the health of workers and of the general public against ionising radiations, and to ensure compliance with the basic standards.

'Qualified expert': a person having the knowledge and training needed both to measure ionising radiations and to give advice in order to ensure the effective protection of individuals and the correct operation of protective facilities, and having qualifications recognised by the competent authority.

'Special groups of the population': these groups include:

(a) persons who enter the controlled area occasionally in the course of their duties, but are not regarded as 'occupationally exposed persons';

(b) persons who handle apparatus emitting ionising radiations or containing radioactive substances in quantities such that the radiations emitted do not result in the maximum permissible dose for this category of person being exceeded;

(c) persons who reside in the vicinity of the controlled area and as a result may be subjected to an exposure higher than that laid down for the population as a whole.

'Approved medical practitioner': a medical practitioner responsible for medical control whose qualifications and competence are recognised and approved by the competent authority.

'Occupationally exposed persons': persons who in a controlled area regularly undertake work exposing them to the dangers arising from ionising radiations.

'Controlled area': a specified area in which there is a source of ionising radiations and where occupationally exposed persons are liable to receive a dose higher than 1·5 rem per year; in this area both physical and medical radiation surveillance are applied.

'Protected area': any area surrounding a controlled area where there is a permanent danger of the maximum permissible dose for the general public being exceeded, and where there is physical radiation protection surveillance.

§ 3 — Units and Symbols

'Curie': the quantity of a radioactive nuclide in which the number of disintegrations per second is $3{\cdot}7 \cdot 10^{10}$; it is the unit of radioactivity. One 'kilocurie' equals 10^{3} curies, one 'millicurie' (mc) equals 10^{-3} curie, and one 'microcurie' equals 10^{-6} curie.

'Rad': the unit of absorbed dose: 1 rad equals 100 ergs per gramme of irradiated material at the place of interest.

'Rem': corresponds to the quantity of ionising radiation which, when absorbed by the human body, produces a biological effect identical to that produced in the same tissue by the absorption of one rad of X-radiation.

The X-rays taken as reference are those producing an average specific ionisation of 100 ion pairs per

micron of water. This corresponds to X-rays of about 250 kV.

'Röntgen': the quantity of X- or gamma radiation which the associated corpuscular emission per 0·001293 gramme of air produces, in air, ions carrying a quantity of electricity of either sign equal to one electrostatic unit.

§ 4 — Activity and Doses

'Activity': the number of disintegrations per unit time; activity is expressed in 'curies'.

'Absorbed dose': the amount of energy imparted to matter by ionising particles per unit mass of irradiated material at the place of interest, whatever type of ionising radiation is used. The unit of absorbed dose is the 'rad'.

'Exposure dose': of X- or gamma rays at a given place: the measure of radiation in terms of its ability to produce ionisation. The unit of exposure dose of X- or gamma rays is the 'röntgen' (r).

'Personal dose': the dose of ionising radiations received by any individual during a given period of time.

'Integral absorbed dose': the total quantity of energy imparted by ionising particles to material throughout the region of interest.

The unit of integral absorbed dose is the 'gramme-rad'.

'Relative biological effectiveness' (RBE): the ratio of a dose of X-rays taken as reference to the dose of the ionising radiation in question which produces the same biological effect. The accepted values of the RBE of various types of radiation are given in the following Table:

Radiation	RBE	Biological effect
X- and gamma rays, electrons and beta rays of all energies	1	Whole-body irradiation (blood-forming organs critical)
Fast neutrons and protons up to 10 MeV	10	Whole-body irradiation (cataract formation critical)
Alpha particles emitted by natural radio elements	10	Cancer formation
Heavy recoil nuclei	20	Cataract formation

'Biological effective dose' or 'RBE dose': determined by multiplying the absorbed rad dose by the RBE factor. The RBE dose is expressed in 'rem'.

'Maximum permissible doses compatible with adequate safety': the doses of ionising radiation which, in the light of present knowledge, are not expected to cause bodily injury to a person at any time during his life or to the population as a whole.

Such doses are assessed on the basis of the radiation received by individuals or by the population as a whole, excluding natural background radiation and radiation received in the course of medical examination and treatment.

'Accumulated dose': expresses the sum of all the doses, integrated in time, which an individual has received from any source, with the exception of those due to natural background radiation and to medical examination and treatment.

'Population dose': the dose of ionising radiations received by a population during a given period of time and weighted in relation to demographic data.

TITLE II

Scope

Article 2

These Directives 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 danger arising from ionising radiations.

Article 3

Each Member State shall make the reporting of the activities referred to in Article 2 compulsory and, in cases to be determined by the Member State in relation to the degree of danger arising from such activities, shall make the activities subject to, a procedure for prior authorisation.

Article 4

This procedure for reporting and for obtaining prior authorisation may be waived in the case of:

(a) radioactive substances with a total activity of less than 0·1 microcurie. This value is applied to the most highly toxic radioactive nuclides. Other values are determined in each case by reference to the relative radiotoxicity and the information given in the Tables in Annex I to these Directives;

(b) radioactive substances of a concentration of less than 0·002 microcurie per gramme and solid natural radioactive substances of a concentration of less than 0·01 microcurie per gramme;

(c) apparatus emitting ionising radiations of a type accepted by the competent authorities, provided that the radioactive materials are effectively protected against any contact or leakage and that the dose emitted, at any time and at any external point 0·1 metres from the surface of the apparatus does not exceed 0·1 millirem per hour.

Article 5

Apart from the cases provided for by national legislation, a prior authorisation shall always be required for:

(a) the use of radioactive substances for medical purposes;

(b) the addition of radioactive substances in the manufacture of foodstuffs, and in pharmaceutical goods, cosmetics and products for household use, and in the handling of such foodstuffs, pharmaceutical goods and products;

(c) the use of radioactive substances in the manufacture of toys.

TITLE III

Maximum permissible doses compatible with adequate safety

Article 6

§ 1 — Exposure of persons and the number of persons exposed to ionising radiations must be kept to a minimum.

§ 2 — Persons under the age of eighteen must not be employed in work involving occupational exposure to the risk of ionising radiation.

§ 3 — During pregnancy or the nursing period, women must not be employed in work involving a risk of high exposure.

CHAPTER I

Maximum permissible doses for occupationally exposed persons

Article 7

WHOLE-BODY EXPOSURE

§ 1 — The maximum permissible dose for a person occupationally exposed shall be expressed in rem and shall be calculated by reference to age and to an average annual dose of 5 rem.

The maximum permissible dose for an occupationally exposed person, of a given age, shall be calculated in accordance with the basic formula:

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

where

D = dose in rem

N = age in years.

Dose D is the dose actually received in the blood-forming organs, the gonads and the lenses of the eyes.

§ 2 — Protective devices shall be based on an average weekly dose of 0·1 rem.

§ 3 — The maximum cumulative dose in any period of thirteen consecutive weeks shall not exceed 3 rem. The following shall be taken into account in calculating the dose:

(a) Persons aged eighteen and over may receive a cumulative dose of 3 rem (distributed over thirteen consecutive weeks), provided that the basic formula is complied with and that the dose accumulated over one year never exceeds 12 rem.

A single dose of 3 rem may be permitted only as an exception.

(b) When the dose previously accumulated is known with certainty and is below the dose calculated according to the basic formula, doses may be accumulated at the rate of 3 rem per 13 weeks as long as the maximum permissible dose calculated according to the basic formula has not been reached.

(c) When the dose previously accumulated is not known with certainty, it shall be assumed to be equal to the maximum permissible dose calculated according to the basic formula.

(d) When the dose previously accumulated is known with certainty and corresponds to standards applying at a time when the recommended maximum permissible doses were higher than those derived from the basic formula, the method of calculation shall be as stipulated in (c).

Article 8

PLANNED ABNORMAL EXPOSURE

In the case of a planned abnormal exposure, a dose of 12·5 rem may be permitted for occupationally exposed persons. This dose may be received only once in a lifetime; it shall be included in the maximum permissible total dose calculated according to the basic formula. Any excess in relation to that maximum permissible total dose calculated according to the basic formula shall be disregarded.

Women of reproductive age may not be subjected to a planned abnormal exposure.

Article 9

ACCIDENTAL WHOLE-BODY EXPOSURE

Where there is accidental exposure of an occupationally exposed person, a dose between 3 and 25 rem, provided that it is received only once in a lifetime, shall be included in the maximum permissible cumulative dose corresponding to the age of the individual and calculated in accordance with the basic formula. Any excess in relation to that maximum permissible total dose shall be disregarded.

Article 10

PARTIAL EXPOSURE

Where there is partial exposure of the body, during which the doses received by the blood-forming organs, the gonads and the lenses of the eyes together do not exceed the limits set by the basic formula, the maximum permissible dose shall be laid down as follows:

(a) for external exposures of the extremities (hands and forearms, feet and ankles), 15 rem per 13 weeks and 60 rem per year;

(b) for external exposures of the whole skin, 8 rem per 13 weeks and 30 rem per year;

(c) for exposures of internal organs with the exception of the blood-forming organs, the grounds and the lenses of the eyes, 4 rem per 13 weeks and 15 rem per year.

CHAPTER II

Maximum permissible doses for special groups of the population

Article 11

(a) For persons belonging to the special groups of the population within the meaning of (a) and (b) of the fifth subparagraph of § 2 of Article 1, the maximum permissible dose shall be laid down as 1·5 rem per year; the dose in question is the dose actually received by the blood-forming organs, the gonads and the lenses of the eyes.

(b) For persons belonging to the special group of the population within the meaning of (c) of the fifth subparagraph of § 2 of Article 1, the maximum permissible dose shall be laid down as 0·5 rem per year; the dose in question is the dose actually received by the blood-forming organs, the gonads and the lenses of the eyes.

CHAPTER III

Maximum permissible dose for the population as a whole

Article 12

For the population as a whole, the maximum permissible dose shall be 5 rem per head, accumulated up to thirty years of age. This dose shall take into account, by weighting, the doses received by occupationally exposed persons and by special groups of the general public. It shall not take into account exposure to natural background radiation and exposure in the course of medical examination and treatment.

TITLE IV

Maximum permissible exposure and contamination

Article 13

§ 1 — 'Maximum permissible exposure' means the external exposure distributed in the body over a period of time and which imparts, in the light of present knowledge, the maximum permissible dose to the individual or to the general public.

§ 2 — Exposures shall, according to the case, be expressed in terms of exposure dose, dose measured in the air, or in particle flux.

§ 3 — The Table in Annex 2 to these Directives shows the corresponding neutron flux in respect of the maximum permissible dose for occupationally exposed persons.

Article 14

§ 1 — 'Maximum permissible contaminations' means such contaminations that the quantities of radioactive nuclides present in air inhaled or in drinking water do not exceed the maximum permissible concentrations laid down in the Table in Annex 3 to these Directives.

§ 2 — Concentrations shall be expressed in activity per unit volume.

§ 3 — The Table in Annex 3 gives the concentrations which correspond to the maximum permissible dose for occupationally exposed persons.

§ 4 — Where there is contamination resulting from the uptake in the same organs of a mixture of radioactive nuclides the nature of which is known, the cumulative action of the exposures which the radioactive nuclides cause shall be taken into account.

§ 5 — Where there is contamination of a single organ by a mixture of radioactive nuclides the nature of which is known, the sum of the exposures from the different nuclides shall be taken into account in calculating the maximum permissible concentrations.

§ 6 — Where there is contamination of different organs by the uptake of a mixture of radioactive nuclides, this shall be regarded as total exposure.

§ 7 — Where there is contamination by a mixture of radioactive nuclides of unknown composition, the values to be used are those shown in the Table in Annex 3 for any mixture of beta and gamma emitters and for any mixture of alpha emitters.

Article 15

Where the exposure of occupationally exposed persons is limited to forty hours per week, the concentrations shown in the Table in Annex 3 for air inhaled may be multiplied by 3. Where persons remain for a limited period in an atmosphere contaminated by a radioactive substance, the conversion factor may be higher than 3, according to the exposure time; however, the conversion factor shall never exceed 10.

Article 16

The values of maximum permissible exposure and contamination applicable to conditions other than those obtaining in the case of whole-body exposure of occupationally exposed persons shall be calculated from the maximum permissible doses as laid down in Part III. Outside controlled areas, the maximum permissible concentrations which determine the maximum permissible contaminations shall be laid down as one-tenth of the values shown in the Table in Annex 3.

Article 17

In order to ensure that the health of the population is protected having due regard to the maximum permissible doses laid down in Articles 11 and 12 and to the maximum permissible exposures and contaminations referred to in Articles 13, 14, 15 and 16, each Member State shall take surveillance, inspection and intervention measures in the event of an accident.

§ 1 — Surveillance shall comprise all the arrangements and surveys for the detection and elimination of factors which, in the production and use of ionising radiations or in the course of any operation involving exposure to their effects, may cause a radiation hazard for the population. The extent of the precautions taken shall depend on the magnitude of the radiation hazards, especially in the event of an accident, and on density of the population.

§ 2 — Surveillance shall be carried out:

(a) in 'protected areas', that is, the areas in which protection is based on observance of the maximum permissible dose of 0·5 rem per year laid down in Article 11 (b), for persons belonging to the special group of the population residing in the vicinity of the controlled area;

(b) in the whole territory for which the maximum permissible dose is that laid down for the population as a whole.

§ 3 — Surveillance shall comprise examination and checking of protective devices, and dose determinations to be effected for the protection of the population.

(a) The examination and checking of devices shall include:

1. Examination and prior approval of plans for installations which involve radiation danger and of the proposed siting of these installations;

2. Acceptance of new installations as regards protection against any radiation or contamination liable to extend beyond the perimeter of the establishment, taking into consideration the demographic, meteorological, geological and hydrological conditions;

3. Checking the effectiveness of technical protective devices;

4. Acceptance, as regards physical surveillance, of facilities for measuring radiation and contamination;

5. Checking that measuring instruments are serviceable and correctly used.

(b) Dose determinations to be made for the protection of the population shall include:

1. Assessment of external exposure, indicating the quality of the radiations concerned and, according to the case, determination of the exposure dose, the dose measured in the air, or the flux;

2. Assessment of radioactive contamination, indicating the nature and the physical and chemi-

cal state of the radioactive contaminants, and the determination of their activity and their concentration (per unit volume in air and in water, per unit area on the ground, and per unit weight in biological and food samples);

3. Assessment of the 'population dose', taking into consideration the conditions of exposure, and weighted in relation to demographic data. In particular, doses due to exposure to various sources of radiation must be added together whenever possible.

(c) The frequency of assessments shall in each case be such as to ensure compliance with the basic standards.

(d) Records relating to measurements of external exposure and contamination together with the assessments of any dose received by the population shall be preserved in archives.

§ 4 — Each Member State shall establish a system of inspection to supervise the protection of the health of the population and to initiate any surveillance and intervention measures whenever they prove necessary.

§ 5 — (a) Member States shall, in case an accident occurs:

1. plan the measures to be taken by the competent authorities;

2. lay down 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.

(b) Member States shall communicate to the Commission the arrangements made pursuant to 1 and 2 of subparagraph (a).

(c) Any accident involving exposure of the population to radiation must, where the circumstances so require, be notified as a matter of urgency to neighbouring Member States and to the Commission of Euratom.

TITLE V

Fundamental principles governing health surveillance of workers

Article 18

§ 1 — Health surveillance of workers in the controlled areas shall consist of physical surveillance for protection against radiation and of medical surveillance.

§ 2 — A system or systems of inspection shall be established by each of the Member States to supervise such surveillance and to initiate measures for surveillance and intervention wherever necessary.

CHAPTER I

Physical surveillance for protection against radiation

Article 19

Physical surveillance shall be undertaken by qualified experts whose qualifications are accepted by the competent authority. The scope of the resources used must depend on the size of the installations and the nature and type of such resources must depend on the hazards associated with the work involving exposure to ionising radiations.

Article 20

Physical surveillance shall include:

§ 1 — Specifying and marking out controlled areas, that is, areas in which the maximum permissible dose of 1·5 rem per year, laid down in Article 11 (a) for special groups of the population, may be exceeded and in which protection is based on compliance with the maximum permissible doses laid down in Chapter I of Part III for occupationally exposed persons.

§ 2 — Examination and checking of protective devices, including:

(a) the examination and prior approval of plans for installations which involve radiation danger and of siting of these installations in the establishment;

(b) the acceptance of new installations as regards physical surveillance;

(c) checking the effectiveness of technical devices for protection;

(d) checking that measuring instruments are serviceable and correctly used.

§ 3 — The following assessments:

(a) assessment of exposures in the localities concerned, indicating the nature and, where necessary, the quality of the radiations in question, in order to be able to take into account the relative biological effectiveness of the ionising radiations (RBE) and, according to the case, determination of the exposure dose, the dose measured in the air, or the flux;

(b) 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 per unit volume and unit area;

(c) assessment, based on exposure conditions, of the personal whole-body dose received according to how exposure occurred. The accumulated personal dose of persons exposed to external radiation must be assessed by one or more individual radiation detectors continuously carried on the person; the personal dose of those exposed to internal radiation must be assessed by any physical or medical method which enables the uptake to be evaluated.

Article 21

The frequency of assessments shall be laid down in such a way as to ensure compliance with the basic standards in each case.

Article 22

§ 1 — Records relating to the assessment of personal doses shall be preserved during the lifetime of the person concerned and in any case for at least thirty years after the cessation of work which involved exposure to ionising radiation.

§ 2 — Results of assessments of exposures and radioactive contaminations, and the action taken, shall be recorded and preserved.

CHAPTER II

Medical surveillance

Article 23

Medical surveillance of workers shall be carried out by approved medical practitioners.

Article 24

§ 1 — No worker may be placed or retained in work involving exposure to ionising radiation if the medical findings are unfavourable.

§ 2 — Member States shall lay down the procedure for appeal against findings mentioned in § 1.

Article 25

Medical surveillance of workers shall include:

§ 1 — *Pre-employment medical examination*

(a) This examination shall include a thorough enquiry into the medical history of the person, which must take into consideration any previous exposures to radiation, and a general clinical examination together with all the investigations necessary to judge the condition of the organs and functions liable to be most affected by exposure to radiation.

(b) The medical practitioner conducting the examination shall be informed of the initial duties and of any change in the duties of the worker, and of the exposures which these involve.

(c) Member States shall draw up a list, for the information of approved medical practitioners, showing the criteria which determine unsuitability.

§ 2 — *Routine or special medical examinations* to determine the condition of the most radiosensitive organs and functions

(a) The frequency of these examinations shall depend on the working conditions and the worker's state of health. Not more than one year shall elapse between two successive examinations, and this interval shall be reduced whenever necessary on account of exposure conditions or the worker's state of health;

(b) The approved medical practitioner shall continue health surveillance after cessation of work for as long as he considers it necessary to safeguard the health of the person concerned;

(c) The following medical classification shall be adopted for work involving radiation hazards:

1. workers unsuitable for their duties, who must be moved away from the hazard;
2. workers placed under observation, whose ability to withstand the hazard must be proved;
3. suitable workers, able to continue to withstand the hazard which their duties involve;
4. workers under health surveillance after cessation of work which involved exposure to ionising radiations.

§ 3 — *Special surveillance*

(a) Special surveillance shall be arranged in the event of severe external exposure and in the event of contamination of the worker;

(b) Routine medical examinations shall be supplemented by any examinations, decontamination measures and all urgent remedial treatment considered by the medical practitioner to be necessary.

(c) The medical practitioner shall decide whether the worker should remain at work, be moved away, or be isolated and whether urgent medical treatment should be given.

(d) Any worker receiving accidental external radiation in excess of 25 rem or accidental internal contamination must be placed under health surveillance.

Article 26

§ 1 — A medical record shall be opened for each worker, kept up to date and be preserved in archives during his lifetime and in any case for at least thirty years after the cessation of the work which involved exposure to ionising radiation.

§ 2 — The medical record shall include information regarding the duties to which the worker has been assigned, the personal doses received by the worker and the results of medical examinations.

§ 3 — Member States shall determine the practical arrangements to enable the medical record for each worker to be kept up to date. They shall also ensure that within the Community all relevant information concerning the duties performed by the worker and the doses received shall have free circulation.

Article 27

Every worker who is liable to be exposed to radiation danger shall be informed about the hazards which the work involves for his health, the techniques of the work, the precautions to be taken and the importance of complying with the medical requirements.

Article 28

These Directives are addressed to all Member States.

Done at Brussels, 2 February 1959.

For the Council

The President

COUVE DE MURVILLE

ANNEX 1

1. Relative radiotoxicity of nuclides

The accepted classification of radioactive nuclides according to relative radiotoxicity is as follows:

A. *Very high radiotoxicity*

Sr^{90} + Y^{90}, Po^{210}, At^{211}, Ra^{226} + daughter products, Ac^{227}, Pu^{239}, *Am^{241}, Cm^{242}

B. *High radiotoxicity*

Ca^{45}, *Fe^{59}, Sr^{89}, Y^{91}, Ru^{106} + Rh^{106}, I^{131}, *BA^{140} + La^{140}, Ce^{144} + *Pr^{144}, Sm^{151}, *Eu^{154}, *Tm^{170}, Pb^{210} + Bi^{210} (Ra D + E), *U^{233}, *Th^{234} + *Pa^{244}

C. *Moderate radiotoxicity*

*Na^{24}, P^{32}, S^{35}, Cl^{36}, *K^{42}, *Sc^{46}, Sc^{47}, Sc^{48}, *V^{48}, *Mn^{56}, Fe^{55}, *Co^{60}, Ni^{59}, *Cu^{64}, *Zn^{65}, *Ga^{72}, *As^{76}, *Rb^{86}, *Zr^{95}, *Nb^{95}, *Mo^{99}, Tc^{96}, *Rh^{105}, Pd^{103} + Rh^{103}, *Ag^{105}, Ag^{111}, Cd^{109}, *Ag^{109}, *Sn^{113}, *Te^{127}, *Te^{129}, Cs^{137} + *Ba^{137}, Pr^{143}, Pm^{147}, *Ho^{166}, *Lu^{177}, *Ta^{182}, *W^{181}, *Re^{183}, *Ir^{190}, *Ir^{192}, *Pt^{191}, *Pt^{193}, *Au^{196}, *Au^{198}, *Au^{199}, *Tl^{200}, *Tl^{202}, Tl^{204}, *Pb^{203}

D. *Slight radiotoxicity*

H^3, *Be^7, C^{14}, F^{18}, *Cr^{51}, Ge^{71}, *Tl^{201}

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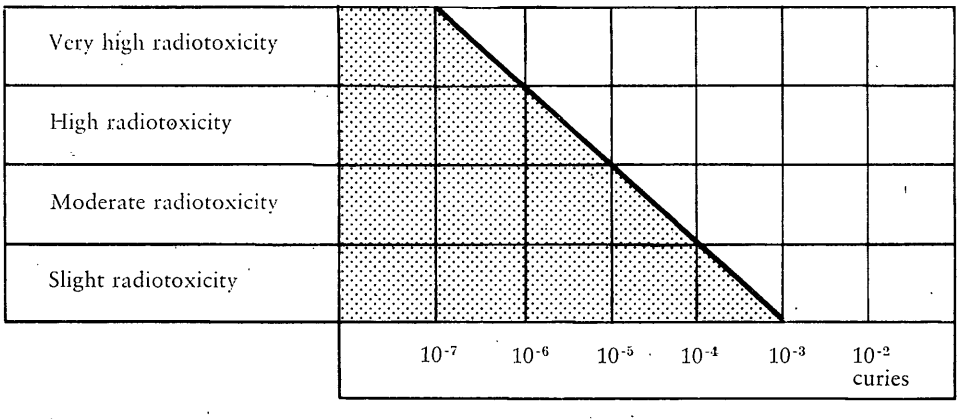
* = gamma emitter.

2. Activity below which official authorisation may be waived

The requirement with regard to official authorisation may be waived insofar as the activities corresponding to the shaded area are concerned.



(Ordinate shows relative radiotoxicity of nuclides, and abscissa the activity in curies)

ANNEX 2

Table showing corresponding neutron fluxes for the maximum permissible dose in respect of occupationally exposed persons

(40 hours per week)

Neutron energy	Neutron flux (neutrons/cm² sec)
0·025 eV	700
10 eV	700
10 KeV	350
0·1 MeV	70
0·5 MeV	30
1 MeV	20
2 MeV	12
3–10 MeV	10

ANNEX 3

Maximum permissible concentration of a radionuclide in air inhaled and in drinking water for continuous exposure of occupationally exposed persons

(Table based on Recommendations issued by the International Commission on Radiological Protection on 1 December 1954)[a]

Atomic number	Radionuclide	Critical organ	Maximum permissible concentrations	
			in drinking water microcuries/cc	in air inhaled microcuries/cc
1	H^3 (HTO or H^3_2O)	Whole body (GI)[b]	0·2 0·2	10^{-5} 10^{-5}
4	Be^7	Bone (GI)	1 $2 . 10^{-2}$	$5 . 10^{-6}$ $3 . 10^{-6}$
6	C^{14} (CO_2 in the air)	Fat (GI)	$3 . 10^{-3}$ $6 . 10^{-2}$	10^{-5} 10^{-5}
9	F^{18}	Bone (GI)	0·2 $> 0·2$	$3 . 10^{-5}$ $> 3 . 10^{-5}$
11	Na^{24}	Whole body (GI)	$8 . 10^{-3}$ $8 . 10^{-3}$	$2 . 10^{-6}$ 10^{-6}
15	P^{32}	Bone (GI)	$2 . 10^{-4}$ $8 . 10^{-4}$	10^{-7} 10^{-7}
16	S^{35}	Skin (GI)	$5 . 10^{-3}$ $6 . 10^{-3}$	10^{-6} 10^{-6}
17	Cl^{36}	Whole body (GI)	$4 . 10^{-3}$ 10^{-2}	$6 . 10^{-7}$ $2 . 10^{-6}$
19	K^{42}	Muscle (GI)	10^{-2} $3 . 10^{-3}$	$2 . 10^{-6}$ $6 . 10^{-7}$
20	Ca^{45}	Bone (GI)	10^{-4} $2 . 10^{-2}$	$8 . 10^{-9}$ $3 . 10^{-6}$
21	Sc^{46}	Spleen Liver (GI)	0·4 0·3 $4 . 10^{-4}$	$7 . 10^{-8}$ $5 . 10^{-8}$ $7 . 10^{-8}$
21	Sc^{47}	Spleen Liver (GI)	4 3 $9 . 10^{-4}$	$9 . 10^{-7}$ $6 . 10^{-7}$ $2 . 10^{-7}$
21	Sc^{48}	Spleen Liver (GI)	3 1 $4 . 10^{-4}$	$6 . 10^{-7}$ $3 . 10^{-7}$ $7 . 10^{-8}$

a *General Note:* This Table is provisional: it is due to be revised shortly in the light of new conclusions reached by the International Commission on Radiological Protection. It should be borne in mind, when using the Table, that the values contained in it have been calculated on the basis of the old standard of 0·3 rem/week. Hence, in the case of radio-elements distributed throughout the body, the values for maximum permissible concentrations should be divided by 3 in order to accord with the new standards laid down in Part III of these Directives.

b (GI) denotes gastro-intestinal tract.

Atomic number	Radionuclide	Critical organ	Maximum permissible concentrations	
			in drinking water microcuries/cc	in air inhaled microcuries/cc
23	V^{48}	Bone (GI)[b]	0·3 $3 \cdot 10^{-4}$	$6 \cdot 10^{-7}$ $5 \cdot 10^{-8}$
24	Cr^{51}	Kidneys (GI)	0·7 $2 \cdot 10^{-2}$	10^{-5} $4 \cdot 10^{-6}$
25	Mn^{56}	Kidneys Liver (GI)	0·15 0·4 $3 \cdot 10^{-3}$	$4 \cdot 10^{-6}$ $4 \cdot 10^{-6}$ $5 \cdot 10^{-7}$
26	Fe^{55}	Blood (GI)	$5 \cdot 10^{-3}$ 0·1	$7 \cdot 10^{-7}$ $2 \cdot 10^{-5}$
26	Fe^{59}	Blood (GI)	10^{-4} $3 \cdot 10^{-3}$	$2 \cdot 10^{-8}$ $5 \cdot 10^{-7}$
27	Co^{60}	Liver (GI)	$2 \cdot 10^{-2}$ $4 \cdot 10^{-4}$	10^{-6} $8 \cdot 10^{-8}$
28	Ni^{59}	Liver (GI)	0·3 $4 \cdot 10^{-3}$	$2 \cdot 10^{-5}$ $7 \cdot 10^{-7}$
29	Cu^{64}	Liver (GI)	$6 \cdot 10^{-2}$ $5 \cdot 10^{-3}$	$5 \cdot 10^{-6}$ $9 \cdot 10^{-7}$
30	Zn^{65}	Bone (GI)	$6 \cdot 10^{-2}$ $2 \cdot 10^{-3}$	$2 \cdot 10^{-6}$ $4 \cdot 10^{-7}$
31	Ga^{72}	Bone (GI)	3 $5 \cdot 10^{-4}$	10^{-6} 10^{-7}
32	Ge^{71}	Kidneys (GI)	10 $2 \cdot 10^{-2}$	$4 \cdot 10^{-5}$ $3 \cdot 10^{-6}$
33	As^{76}	Kidneys (GI)	0·2 $2 \cdot 10^{-4}$	$2 \cdot 10^{-6}$ $4 \cdot 10^{-8}$
37	Rb^{86}	Muscle (GI)	$3 \cdot 10^{-3}$ $3 \cdot 10^{-3}$	$4 \cdot 10^{-7}$ $4 \cdot 10^{-7}$
38	Sr^{89}	Bone (GI)	$7 \cdot 10^{-5}$ $7 \cdot 10^{-4}$	$2 \cdot 10^{-8}$ 10^{-7}
38	$Sr^{90} + Y^{90}$[h]	Bone (GI)	$8 \cdot 10^{-7}$ 10^{-3}	$2 \cdot 10^{-10}$ $2 \cdot 10^{-7}$
39	Y^{91}	Bone (GI)	$4 \cdot 10^{-2}$ $3 \cdot 10^{-4}$	$9 \cdot 10^{-9}$ $5 \cdot 10^{-8}$
40	$Zr^{95} + Nb^{95}$	Bone (GI)	0·4 $6 \cdot 10^{-4}$	$8 \cdot 10^{-8}$ 10^{-7}
41	Nb^{95}	Bone (GI)	$2 \cdot 10^{-3}$ $2 \cdot 10^{-3}$	$2 \cdot 10^{-7}$ $3 \cdot 10^{-7}$

b (GI) denotes gastro-intestinal tract.

h Values in microcuries and microcuries/cc are given for the parent element. The daughter products are assumed to reach the appropriate fraction of equilibrium with the parent after it is taken into the body.

Atomic number	Radionuclide	Critical organ	Maximum permissible concentrations	
			in drinking water microcuries/cc	in air inhaled microcuries/cc
42	Mo^{99}	Bone (GI)[b]	5 $3 \cdot 10^{-3}$	$6 \cdot 10^{-4}$ $5 \cdot 10^{-7}$
43	Tc^{96}	Kidneys (GI)	$3 \cdot 10^{-2}$ 10^{-3}	$3 \cdot 10^{-6}$ $2 \cdot 10^{-7}$
44	$Ru^{106} + Rh^{106}$[b]	Kidneys (GI)	0·1 10^{-4}	$3 \cdot 10^{-8}$ $2 \cdot 10^{-8}$
45	Rh^{105}	Kidneys (GI)	0·4 10^{-3}	$2 \cdot 10^{-6}$ $2 \cdot 10^{-7}$
46	$Pd^{103} + Rh^{103}$[b]	Kidneys (GI)	10^{-2} $5 \cdot 10^{-3}$	$8 \cdot 10^{-7}$ $9 \cdot 10^{-7}$
47	Ag^{105}	Liver (GI)	2 $4 \cdot 10^{-4}$	10^{-5} $7 \cdot 10^{-8}$
47	Ag^{111}	Liver (GI)	5 $5 \cdot 10^{-4}$	$3 \cdot 10^{-5}$ $8 \cdot 10^{-8}$
48	$Cd^{109} + Ag^{109}$[b]	Liver (GI)	$7 \cdot 10^{-2}$ 0·7	$7 \cdot 10^{-8}$ 10^{-4}
50	Sn^{113}	Bone (GI)	0·2 $2 \cdot 10^{-3}$	$6 \cdot 10^{-7}$ $3 \cdot 10^{-7}$
52	Te^{127}	Kidneys (GI)	$3 \cdot 10^{-2}$ $7 \cdot 10^{-4}$	10^{-7} 10^{-7}
52	Te^{129}	Kidneys (GI)	10^{-2} $2 \cdot 10^{-4}$	$4 \cdot 10^{-8}$ $4 \cdot 10^{-8}$
53	I^{131}	Thyroid (GI)	$6 \cdot 10^{-5}$ $> 6 \cdot 10^{-5}$	$6 \cdot 10^{-9}$ $> 6 \cdot 10^{-9}$
54	Xe^{133}	Whole body	$4 \cdot 10^{-3}$	$4 \cdot 10^{-6}$
54	Xe^{135}	Whole body	10^{-3}	$2 \cdot 10^{-6}$
55	$Cs^{137} + Ba^{137}$[b]	Muscle (GI)	$2 \cdot 10^{-3}$ $2 \cdot 10^{-3}$	$2 \cdot 10^{-7}$ $2 \cdot 10^{-7}$
56	$Ba^{140} + La^{140}$[b]	Bone (GI)	$5 \cdot 10^{-4}$ $3 \cdot 10^{-4}$	$2 \cdot 10^{-8}$ $6 \cdot 10^{-8}$
57	La^{140}	Bone (GI)	0·3 $3 \cdot 10^{-4}$	$4 \cdot 10^{-7}$ $5 \cdot 10^{-8}$
58	$Ce^{144} + Pr^{144}$[b]	Bone (GI)	$8 \cdot 10^{-3}$ 10^{-4}	$2 \cdot 10^{-9}$ $2 \cdot 10^{-8}$

[b] (GI) denotes gastro-intestinal tract.

[b] Values in microcuries and microcuries/cc are given for the parent element. The daughter products are assumed to reach the appropriate fraction of equilibrium with the parent after it is taken into the body.

Atomic number	Radionuclide	Critical organ	Maximum permissible concentrations	
			in drinking water microcuries/cc	in air inhaled microcuries/cc
59	Pr^{143}	Bone (GI)[b]	$8 . 10^{-2}$ $5 . 10^{-4}$	$2 . 10^{-7}$ $9 . 10^{-8}$
61	Pm^{147}	Bone (GI)	0·2 $2 . 10^{-3}$	$4 . 10^{-8}$ $4 . 10^{-7}$
62	Sm^{151}	Bone (GI)	$5 . 10^{-2}$ $8 . 10^{-3}$	$3 . 10^{-9}$ 10^{-6}
63	Eu^{154}	Bone (GI)	10^{-2} $4 . 10^{-4}$	$2 . 10^{-9}$ $8 . 10^{-8}$
67	Ho^{166}	Bone (GI)	5 $5 . 10^{-4}$	$8 . 10^{-7}$ $8 . 10^{-8}$
69	Tm^{170}	Bone (GI)	$6 . 10^{-2}$ $5 . 10^{-4}$	10^{-8} $8 . 10^{-8}$
71	Lu^{177}	Bone (GI)	6 10^{-3}	10^{-6} $2 . 10^{-7}$
73	Ta^{182}	Liver (GI)	10^{-1} $5 . 10^{-4}$	$2 . 10^{-8}$ $9 . 10^{-8}$
74	W^{181}	Bone (GI)	0·1 $7 . 10^{-4}$	$5 . 10^{-6}$ 10^{-7}
75	Re^{183}	Thyroid Skin (GI)	$9 . 10^{-2}$ 0·3 $2 . 10^{-3}$	$9 . 10^{-6}$ $3 . 10^{-5}$ $4 . 10^{-7}$
77	Ir^{190}	Kidneys Spleen (GI)	10^{-2} 0·2 $3 . 10^{-3}$	$8 . 10^{-7}$ 10^{-6} $6 . 10^{-7}$
77	Ir^{192}	Kidneys Spleen (GI)	$9 . 10^{-4}$ $6 . 10^{-3}$ $5 . 10^{-4}$	$5 . 10^{-8}$ $3 . 10^{-8}$ $9 . 10^{-8}$
78	Pt^{191}	Kidneys (GI)	$6 . 10^{-3}$ $7 . 10^{-4}$	$2 . 10^{-7}$ 10^{-7}
78	Pt^{193}	Kidneys (GI)	$5 . 10^{-3}$ $9 . 10^{-4}$	$2 . 10^{-7}$ $2 . 10^{-7}$
79	Au^{196}	Liver Kidneys (GI)	$5 . 10^{-2}$ $5 . 10^{-3}$ $2 . 10^{-3}$	$2 . 10^{-7}$ $2 . 10^{-7}$ $4 . 10^{-7}$
79	Au^{198}	Liver Kidneys (GI)	$4 . 10^{-2}$ $3 . 10^{-3}$ $6 . 10^{-4}$	$2 . 10^{-7}$ 10^{-7} 10^{-7}
79	Au^{199}	Liver Kidneys (GI)	$9 . 10^{-2}$ $8 . 10^{-3}$ $2 . 10^{-3}$	$4 . 10^{-7}$ $3 . 10^{-7}$ $3 . 10^{-7}$

b (GI) denotes gastro-intestinal tract.

Atomic number	Radionuclide	Critical organ	Maximum permissible concentrations	
			in drinking water microcuries/cc	in air inhaled microcuries/cc
81	Tl^{200}	Muscle (GI)[b]	$2 . 10^{-2}$ 10^{-3}	$2 . 10^{-6}$ $2 . 10^{-7}$
81	Tl^{201}	Muscle (GI)	$8 . 10^{-2}$ $9 . 10^{-3}$	$7 . 10^{-6}$ $2 . 10^{-6}$
81	Tl^{202}	Muscle (GI)	$2 . 10^{-2}$ $5 . 10^{-3}$	$2 . 10^{-6}$ $9 . 10^{-7}$
81	Tl^{204}	Muscle (GI)	$8 . 10^{-3}$ 10^{-3}	$8 . 10^{-7}$ $2 . 10^{-7}$
82	Pb^{203}	Bone (GI)	0·1 $2 . 10^{-3}$	$7 . 10^{-6}$ $4 . 10^{-7}$
82	Pb^{210} + dr[h]	Bone (GI)	$2 . 10^{-6}$ $3 . 10^{-3}$	$8 . 10^{-11}$ $4 . 10^{-7}$
84	Po^{210} (sol)	Spleen (GI)	$3 . 10^{-5}$ $3 . 10^{-6}$	$5 . 10^{-10}$ $5 . 10^{-10}$
84	Po^{210} (insol)	Lungs	—	10^{-10}
85	At^{211}	Thyroid (GI)	$3 . 10^{-6}$ $> 3 . 10^{-6}$	$5 . 10^{-10}$ $> 5 . 10^{-10}$
86	Rn^{220} + dr	Lungs	—	10^{-7}
86	Rn^{222} + dr	Lungs	—	10^{-7}
88	Ra^{226} + 55% dr[h]	Bone	$4 . 10^{-8}$	$8 . 10^{-12}$
89	Ac^{227} + dr[h]	Bone (GI)	$3 . 10^{-6}$ $6 . 10^{-5}$	$4 . 10^{-12}$ 10^{-8}
90	Th-natural[r]	Bone (GI)	$5 . 10^{-7}$ 10^{-6}	$3 . 10^{-11}$ $2 . 10^{-10}$
90	Th-natural (insol.)	Lungs	—	$3 . 10^{-11}$
90	Th^{234} + Pa^{234}[h]	Bone (GI)	$5 . 10^{-2}$ $2 . 10^{-4}$	10^{-8} $3 . 10^{-8}$
92	U natural[r] (sol.)	Kidneys (GI)	10^{-4} $2 . 10^{-6}$	$3 . 10^{-11}$ $3 . 10^{-10}$
92	U natural (insol.)	Lungs	—	$3 . 10^{-11}$

b (GI) denotes gastro-intestinal tract.

h Values in microcuries and microcuries/cc are given for the parent element. The daughter products are assumed to reach the appropriate fraction of equilibrium with the parent after it is taken into the body.

r The curie of natural uranium is considered to correspond to $3·7 . 10^{-10}$ dis/sec from U^{238}, to $3·7 . 10^{-10}$ dis/sec from U^{234} and $9 . 10^{-8}$ dis/sec from U^{235}. The curie of natural thorium is considered to correspond to $3·7 . 10^{-10}$ dis/sec from Th^{232} and $3·7 . 10^{-10}$ dis/sec from Th^{228}. It is considered that none of the other daughter products of U^{238} or Th^{232} are present at the time of ingestion or inhalation.

Atomic number	Radionuclide	Critical organ	Maximum permissible concentrations	
			in drinking water microcuries/cc	in air inhaled microcuries/cc
92	U^{233} (sol.)	Bone (GI)[b]	$1{\cdot}5 \cdot 10^{-4}$ $3 \cdot 10^{-6}$	$3 \cdot 10^{-11}$ $5 \cdot 10^{-10}$
92	U^{233} (insol.)	Lungs	—	$3 \cdot 10^{-11}$
94	Pu^{239} (sol.)	Bone (GI)	$6 \cdot 10^{-6}$ $3 \cdot 10^{-6}$	$2 \cdot 10^{-12}$ $2 \cdot 10^{-12}$
94	Pu^{239} (insol.)	Lungs	—	$2 \cdot 10^{-12}$
95	Am^{241}	Bone (GI)	$2 \cdot 10^{-4}$ $3 \cdot 10^{-6}$	$4 \cdot 10^{-11}$ $5 \cdot 10^{-10}$
96	Cm^{242}	Bone (GI)	10^{-3} $2 \cdot 10^{-6}$	$2 \cdot 10^{-10}$ $4 \cdot 10^{-10}$
Any fission mixture (beta, gamma)			10^{-7}	10^{-9}
Any mixture of alpha emitters			10^{-7}	$5 \cdot 10^{-12}$

b (GI) denotes gastro-intestinal tract.