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COUNCIL DIRECTIVE

of 27 October 1966

amending the 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

(66/45/Euratom)

THE COUNCIL OF THE EUROPEAN ATOMIC ENERGY COMMUNITY,

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

Having regard to the request of the Federal Republic of Germany of 23 March 1960 for the basic standards to be revised and supplemented;

Having regard to the Opinion of the specialist group appointed by the Scientific and Technical Committee from among scientific experts in 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 Parliament¹;

Whereas the basic standards must be adjusted in accordance with the most recent scientific data;

Whereas it is necessary to take account of experience acquired from the practical application of the basic standards by the Member States;

HAS ADOPTED THIS DIRECTIVE:

Article 1

The Council Directives of 2 February 1959 laying down the basic standards for the protection of the health of workers and the general public against the dangers

arising from ionising radiations,² as amended by the Council Directive of 5 March 1962,³ shall be amended in accordance with Articles 2 to 20.

Article 2

In Article 1 (1) the seventh and eighth subparagraphs shall be replaced by the following:

‘Exposure’: any exposure of persons to ionising radiation; a distinction is made between:

- external exposure, where the source is outside the body;
- internal exposure, which is caused by the introduction of radioactive substances into the body; and
- total exposure, which is the sum of external exposure and internal exposure.

‘Planned abnormal exposure’: external and internal (or external or internal) exposure as a result of which a maximum permissible dose is exceeded in occupationally exposed persons, and for which the risk has previously been studied and accepted. It may be authorised only in cases of absolute necessity.

‘Unplanned abnormal exposure’: external and internal (or external or internal) exposure which is of a fortuitous nature and which involves exceeding a maximum permissible dose for occupationally exposed persons.

¹ OJ No 96, 2.6.1965, p. 1696/65.

² OJ No 11, 20.2.1959, p. 221/59.

³ OJ No 57, 9.7.1962, p. 1633/62.

Article 3

The Table in Article 1 (4) shall be replaced by the following:

Radiation	RBE ¹
X- and gamma rays, electrons and beta rays of all energies	1
Neutrons	2 to 10·5 ²
Protons	10
Alpha particles	10
Heavy recoil nuclei	20

¹ In the case of irradiation of the lenses of the eyes, the RBE must be multiplied by:

- a factor of 1 when its value is equal to 1;
- a factor of 3 when its value is higher than or equal to 10;
- a factor between 1 and 3, obtained by interpolation, for RBE values between 1 and 10.

² See Annex 2.

Article 4

(a) The heading of Article 7 shall be deleted.

(b) Article 7 (1) shall be replaced by the following:

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

The maximum permissible dose for a person of a given age, received by the blood-forming organs and the gonads (or by one or other of those organs), shall be calculated in accordance with the basic formula:

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

where D = dose in rem

N = age in years.’

(c) Article 7 (3) shall be amended to read as follows:

‘§ 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 must be avoided wherever possible.’

Subparagraphs (b) to (d) shall remain unaltered.

Article 5

Articles 8 and 9 shall be deleted.

Article 6

Article 10 shall be renumbered Article 8 and be amended to read as follows:

Article 8

Where there is partial exposure of the body, during which the doses received by the blood-forming organs and the gonads or by one or other of those organs do not exceed the limits set by the basic formula, the maximum permissible dose shall be:

- (a) for external exposure of the extremities (hands, forearms, feet, ankles), 15 rem per thirteen weeks and 60 rem per year;
- (b) for external exposure of the skin or bone, with the exception of the extremities specified in (a) above, 8 rem per thirteen weeks and 30 rem per year;
- (c) for exposure of other organs individually, 4 rem per thirteen weeks and 13 rem per year.’

Article 7

Article 11 shall be renumbered Article 9.

Article 8

Article 12 shall be renumbered Article 10. The first sentence of that Article shall be amended to read as follows:

‘For the population as a whole, the maximum permissible genetically significant dose shall be 5 rem per head, accumulated up to thirty years of age.’

Article 9

Article 13 shall be renumbered Article 11. Paragraph 3 of that Article shall be amended to read as follows:

‘The Table in Annex 2 shows the neutron flux as imparting a dose rate of 2·5 millirem/hours as a function of the neutron energy and the corresponding RBE values.’

Article 10

Article 14 shall be renumbered Article 12 and amended to read as follows:

Article 12

§ 1 — "Maximum permissible contamination of persons" means contamination resulting from the inhalation or ingestion of air or water contaminated to the maximum permissible concentrations calculated in accordance with Annex 3.

§ 2 — The values shown in Annex 3 are applicable for determining the maximum permissible concentrations in inhaled air or in drinking water; they must be considered as average values covering a period of thirteen consecutive weeks.

§ 3 — These values relate to continuous exposure, calculated on the basis of one hundred and sixty-eight hours per week, for occupationally exposed persons. They must be multiplied by a factor of 3 to relate to a working week of forty to forty-eight hours.

§ 4 — The introduction at a single time of a quantity of radioactive nuclides equal to that which would be introduced in thirteen consecutive weeks on the basis of the maximum permissible concentrations as calculated from Annex 3 must be avoided wherever possible.

§ 5 — Outside the controlled areas, for persons belonging to the population group defined in (c) of the fifth subparagraph of Article 1 (2), the maximum permissible concentrations which determine the maximum permissible contaminations shall be laid down as one-tenth of the values shown in the Tables in Annex 3. They must be considered as average values relating to a period of a year.

§ 6 — Where contamination results from a mixture of radioactive nuclides, Table C, D or E in Annex 3, as the case may be, shall apply.

Article 11

Article 15 shall be deleted.

Article 12

The provisions of the new Articles 13, 14 and 15 shall be as follows:

Article 13

TOTAL EXPOSURE

In the case of total exposure, the sum of the doses due to external exposure and internal exposure shall be calculated by an appropriate method and shall be within the maximum permissible doses.

Article 14

ABNORMAL EXTERNAL EXPOSURE

§ 1 — "Planned abnormal external exposure"

- (a) The dose delivered on one occasion or more in the course of a planned abnormal external exposure shall not exceed 12 rem. This dose shall be added to the dose accumulated up to the time of the abnormal exposure.
- (b) If the cumulative dose thus calculated is below the maximum permissible dose calculated according to the basic formula set out in Article 7 (1) and if the quarterly dose exceeds 3 rem, subsequent exposures shall be reduced to a maximum dose of 1.5 rem per quarter until such time as the values derived from applying the provisions of Article 7 (3) are restored.
- (c) If the cumulative dose thus calculated exceeds the maximum permissible dose calculated according to the basic formula set out in Article 7 (1), subsequent exposures shall be reduced to a maximum dose of 2.5 rem per year until such time as the cumulative dose conforms again to the basic formula.
- (d) No woman of reproductive capacity may be subjected to such an exposure.

§ 2 — "Unplanned abnormal external exposure"

- (a) When a dose delivered during an unplanned abnormal external exposure does not exceed 25 rem, paragraph 1 (b) or (c) shall be applicable.
- (b) When the dose exceeds 25 rem, Article 25 (3) shall be applicable.

§ 3 — "Partial planned abnormal external exposure"

- (a) The dose delivered on one or more occasions in the course of a partial planned abnormal external exposure must not exceed:
 - in the case of the extremities (hands, forearms, feet, ankles): 60 rem;
 - in the case of the skin (with the exception of that of the extremities): 30 rem;
 - in the case of the lenses of the eyes: 15 rem.

The doses received shall be added to the doses accumulated in the current year.

- (b) For subsequent exposures of the extremities, the skin (with the exception of that of the extremities) and the lenses of the eyes, the maximum permissible doses to be taken into consideration shall, until such time as the

integrated values derived from applying the provisions of that Article are restored, be reduced to half of the dose laid down in Article 8.

§ 4 — “Partial unplanned abnormal exposure”

(a) When a dose delivered in the course of a partial unplanned abnormal external exposure does not exceed:

— 120 rem in the case of the extremities (hands, forearms, feet, ankles);

— 60 rem in the case of the skin (with the exception of that of the extremities);

— 30 rem in the case of the lenses of the eyes;

paragraph 3 (b) shall be applicable.

(b) When the dose exceeds the values specified in (a), Article 25 (3) shall be applicable.

Article 15

ABNORMAL INTERNAL EXPOSURE

§ 1 — “Planned abnormal internal exposure”

(a) A planned abnormal internal exposure shall be permitted only if it cannot be avoided by taking all the necessary safety measures. Should such exposure prove unavoidable, the quantity of radioactive nuclides introduced into the body at one time or more than once must not exceed the quantity which would result from exposure, over a period of one year, to the maximum permissible concentrations as shown in Annex 3 for occupationally exposed persons.¹

(b) Every planned abnormal internal exposure must be entered in the physical control records (Article 22 (2)) and in the medical file of the worker concerned (Article 26), together with the estimated value of the absorbed dose and of the uptake resulting from that exposure.

(c) In the case of subsequent internal exposure, the maximum permissible concentrations to be taken into consideration must be at the most

¹ This quantity X (in curies) may be calculated from the maximum permissible concentrations in air for occupationally exposed persons for forty to forty-eight hours per week by the following formula:

$$X = 2500 \cdot q$$

q being three times the value shown in the Tables in Annex 3. The coefficient 2500 is obtained on the basis of an inhalation of 10 m³ of air per day for five days per week and fifty weeks per year.

equal to half the values calculated in accordance with Annex 3 and must remain so for such time as would be required to accumulate, by continuous exposure under the same conditions, the quantity of radionuclides introduced into the body as a result of the planned abnormal internal exposure.

(d) No woman of reproductive capacity may be subjected to such an exposure.

§ 2 — “Unplanned abnormal internal exposure”

(a) When the quantity of radioactive nuclides introduced into the body during an unplanned abnormal internal exposure is less than double the quantity as laid down in paragraph 1 (a), the provisions of paragraph 1 (c) shall be applicable.

(b) When the contamination exceeds the limit laid down in (a) of this paragraph, Article 25 (3) shall be applicable.

Article 13

Article 16 shall be replaced by the following:

Article 16

The values of maximum permissible exposure and contamination applicable to conditions other than those obtaining in the case of occupationally exposed persons shall be calculated from the maximum permissible doses as laid down in Part III.

Article 14

Article 25 (3) shall be replaced by the following:

§ 3 — *Special surveillance*

(a) Special surveillance shall be arranged in the event of abnormal exposure.

(b) Routine medical examinations shall be supplemented by any examinations, decontamination measures and 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.

Article 15

Annex 1 shall be replaced by the following:

ANNEX 1

§ 1 — Activities below which the requirements for reporting and obtaining prior authorisation may be waived:

Nuclides of very high radiotoxicity: 10^{-7} curies;

Nuclides of high radiotoxicity: 10^{-6} curies;

Nuclides of moderate radiotoxicity: 10^{-5} curies;

Nuclides of low radiotoxicity: 10^{-4} curies;

§ 2 — The principal radioactive nuclides are classified as follows, according to their relative radiotoxicity:

(a) *Very high radiotoxicity:*

Ac²²⁷ Am²⁴¹ Am^{242m} Am²⁴³ Cf²⁴⁹ Cf²⁵⁰ Cf²⁵¹ Cf²⁵² Cf²⁵⁴ Cm²⁴² Cm²⁴³ Cm²⁴⁴ Cm²⁴⁵ Cm²⁴⁶
Cm²⁴⁸ Es²⁵⁴ Es²⁵⁵ Np²³⁷ Pa²³¹ Pb²¹⁰ Po²¹⁰ Pu²³⁸ Pu²³⁹ Pu²⁴⁰ Pu²⁴¹ Pu²⁴² Ra²²³ Ra²²⁶ Ra²²⁸
Th²²⁷ Th²²⁸ Th²³⁰ U²³⁰ U²³² U²³³ U²³⁴

(b) *High radiotoxicity:*

Ac²²⁸ Ag^{110m} Am²⁴² At²¹¹ Ba¹⁴⁰ Bi²⁰⁷ Bi²¹⁰ Bk²⁴⁹ Ca⁴⁵ Cd^{115m} Ce¹⁴⁴ Cf²⁵³ Cl³⁶ Cm²⁴⁷ Co⁵⁶
Co⁶⁰ Cs¹³⁴ Cs¹³⁷ Es²⁵³ Es^{254m} Eu¹⁵² (13 years) Eu¹⁵⁴ Fm²⁵⁵ Fm²⁵⁶ Hf¹⁸¹ I¹²⁴ I¹²⁶ I¹³¹ I¹³³
In^{114m} Ir¹⁹² Mn⁵⁴ Na²² Pa²³⁰ Pb²¹² Pu²⁴⁴ Ra²²⁴ Ru¹⁰⁶ Sb¹²⁴ Sb¹²⁵ Sc⁴⁶ Sr⁸⁹ Sr⁹⁰ Ta¹⁸² Tl¹⁶⁰
Te^{127m} Te^{129m} Th²³⁴ Tl²⁰⁴ Tm¹⁷⁰ U²³⁶ Y⁹¹ Zr⁹⁵

(c) *Moderate radiotoxicity:*

A⁴¹ Ag¹⁰⁵ Ag¹¹¹ Am²⁴⁴ As⁷³ As⁷⁴ As⁷⁶ As⁷⁷ Au¹⁹⁶ Au¹⁹⁸ Au¹⁹⁹ Ba¹³¹ Be⁷ Bi²⁰⁶ Bi²¹² Bk²⁵⁰
Br⁸² C¹⁴ Ca⁴⁷ Cd¹⁰⁹ Cd¹¹⁵ Ce¹⁴¹ Ce¹⁴³ Cl³⁸ Co⁵⁷ Co⁵⁸ Cr⁵¹ Cs¹³¹ Cs¹³⁶ Cu⁶⁴ Dy¹⁶⁵ Dy¹⁶⁶
Er¹⁶⁹ Er¹⁷¹ Eu¹⁵² (9 h) Eu¹⁵⁵ F¹⁸ Fe⁵² Fe⁵⁵ Fe⁵⁹ Fm²⁵⁴ Ga⁷² Gd¹⁵³ Gd¹⁵⁹ Hg¹⁹⁷ Hg^{197m} Hg²⁰³
Ho¹⁶⁶ I¹³⁰ I¹³² I¹³⁴ I¹³⁵ In^{115m} Ir¹⁹⁰ Ir¹⁹⁴ K⁴² K⁴³ Kr^{85m} Kr⁸⁷ La¹⁴⁰ Lu¹⁷⁷ Mn⁵² Mn⁵⁶ Mo⁹⁹
Na²⁴ Nb^{93m} Nb⁹⁵ Nd¹⁴⁷ Nd¹⁴⁹ Ni⁶³ Ni⁶⁵ Np²³⁹ Os¹⁸⁵ Os¹⁹¹ Os¹⁹³ p³² Pa²³³ Pb²⁰³ Pd¹⁰³
Pd¹⁰⁹ Pm¹⁴⁷ Pm¹⁴⁹ Pr¹⁴² Pr¹⁴³ Pt¹⁹¹ Pt¹⁹³ Pt¹⁹⁷ Pu²⁴³ Rb⁸⁶ Re¹⁸³ Re¹⁸⁶ Re¹⁸⁸ Rh¹⁰⁵ Rn²²⁰
Rn²²² Ru⁹⁷ Ru¹⁰³ Ru¹⁰⁵ S³⁵ Sb¹²² Sc⁴⁷ Sc⁴⁸ Se⁷⁵ Si³¹ Sm¹⁵¹ Sm¹⁵³ Sn¹¹³ Sn¹²⁵ Sr⁸⁵ Sr⁹¹ Sr⁹²
Tc⁹⁶ Tc⁹⁷ Tc^{97m} Tc⁹⁹ Te^{125m} Te¹²⁷ Te¹²⁹ Te^{131m} Te¹³² Th²³¹ Tl²⁰⁰ Tl²⁰¹ Tl²⁰² Tm¹⁷¹
U²⁴⁰ + Np²⁴⁰ V⁴⁸ W¹⁸¹ W¹⁸⁵ W¹⁸⁷ Xe¹³⁵ Y⁹⁰ Y⁹² Y⁹³ Yb¹⁷⁵ Zn⁶⁵ Zn^{69m} Zr⁹⁷

(d) *Low radiotoxicity:*

A³⁷ Cm²⁴⁹ Co^{58m} Cs^{134m} Cs¹³⁵ Ge⁷¹ H³ I¹²⁹ In^{113m} In¹¹⁵ Kr⁸⁵ Nb⁹⁷ Nd¹⁴⁴ Ni⁵⁹ O¹⁵ Os^{191m}
Pt^{193m} Pt^{197m} Rb⁸⁷ Re¹⁸⁷ Rh^{103m} Sm¹⁴⁷ Sr^{85m} Tc^{96m} Tc^{99m} Th nat.* Th²³² U nat.** U²³⁵
U²³⁸ Xe^{131m} Xe¹³³ Y^{91m} Zn⁶⁹ Zr⁹³

§ 3 — In the case of the nuclides In¹¹⁵, Nd¹⁴⁴, Rb⁸⁷, Re¹⁸⁷, Sm¹⁴⁷ the requirements for reporting and obtaining prior authorisation may be waived, irrespective of the quantities used.

§ 4 — In the case of a mixture of radioactive nuclides belonging to different radiotoxicity groups, the requirements for reporting and obtaining prior authorisation may be waived if the sum of the ratios between the activity of each of the radioactive nuclides and the limit laid down in paragraph 1 for the group to which it belongs is less than 1.

* By custom, one curie of natural thorium corresponds to:

3.7 . 10¹⁰ dis/sec of Th²³² and
3.7 . 10¹⁰ dis/sec of Th²³⁰.

** By custom, one curie of natural uranium corresponds to:

3.7 . 10¹⁰ dis/sec of U²³⁸,
3.7 . 10¹⁰ dis/sec of U²³⁵ and
1.7 . 10⁹ dis/sec of U²³⁵.

§ 5 — The radionuclides not shown in the radiotoxicity groups in paragraph 2 and the radiotoxicity of which is uncertain or unknown must be considered as belonging to the highest radiotoxicity category.¹

Article 16

Annex 2 shall be replaced by the following:

'ANNEX 2

Table showing the neutron flux as delivering a dose-rate of 2.5 mrem per hour as a function of the neutron energy and the corresponding RBE values

Neutron energy	RBE ¹	Neutron flux (neutrons/cm ² sec)
Thermal	3	670
100 eV	2	500
5 keV	2.5	570
20 keV	5	280
100 keV	8	80
0.5 MeV	10	30
1 MeV	10.5	18
2.5 MeV	8	20
5 MeV	7	18
10 MeV	6.5	17

¹ In the case of neutrons of unknown energy the RBE is taken as being 10.¹

Article 17

In Annex 3, Table A shall be amended to read as follows:

(a) The title shall be worded as follows:

'A. Maximum permissible concentration (MPC) of identified radionuclides in drinking water and in air inhaled for continuous exposure of occupationally exposed persons'

The sentence after the title—'(Table based on values recommended in 1959 by the International Commission on Radiological Protection) (ICRP)'—shall be deleted.

The column headings shall be as follows:

Element (Atomic number)	Radionuclide	Form (b)	MPC in water (c)	MPC in air (c)
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(b) In Note (c) the words 'Article 14 (4), (5) and (6)' shall be replaced by the words 'Article 12 (3)'.

(c) The data concerning the elements americium, berkelium, californium, curium, plutonium, strontium and uranium shall be replaced by the following:

Element (Atomic number)	Radionuclide	Form <i>b</i>	MPC in water <i>c</i>	MPC in air <i>c</i>
Americium (95)	Am ²⁴¹	sol. insol.	4 . 10 ⁻⁵ 3 . 10 ⁻⁴	2 . 10 ⁻¹² 4 . 10 ⁻¹¹
	Am ^{242m}	sol. insol.	4 . 10 ⁻⁵ 9 . 10 ⁻⁴	2 . 10 ⁻¹² 9 . 10 ⁻¹¹
	Am ²⁴²	sol. insol.	10 ⁻³ 10 ⁻³	10 ⁻⁸ 2 . 10 ⁻⁸
	Am ²⁴³	sol. insol.	4 . 10 ⁻⁵ 3 . 10 ⁻⁴	2 . 10 ⁻¹² 4 . 10 ⁻¹¹
	Am ²⁴⁴	sol. insol.	0.05 0.05	10 ⁻⁶ 8 . 10 ⁻⁶
Berkelium (97)	Bk ²⁴⁹	sol. insol.	6 . 10 ⁻³ 6 . 10 ⁻³	3 . 10 ⁻¹⁰ 4 . 10 ⁻⁸
	Bk ²⁵⁰	sol. insol.	2 . 10 ⁻³ 2 . 10 ⁻³	5 . 10 ⁻⁸ 4 . 10 ⁻⁷
Californium (98)	Cf ²⁴⁹	sol. insol.	4 . 10 ⁻⁵ 2 . 10 ⁻⁴	5 . 10 ⁻¹³ 3 . 10 ⁻¹¹
	Cf ²⁵⁰	sol. insol.	1 . 10 ⁻⁴ 3 . 10 ⁻⁴	2 . 10 ⁻¹² 3 . 10 ⁻¹¹
	Cf ²⁵¹	sol. insol.	4 . 10 ⁻⁵ 3 . 10 ⁻⁴	6 . 10 ⁻¹³ 3 . 10 ⁻¹¹
	Cf ²⁵²	sol. insol.	7 . 10 ⁻⁵ 7 . 10 ⁻⁵	2 . 10 ⁻¹² 1 . 10 ⁻¹¹
	Cf ²⁵³	sol. insol.	10 ⁻³ 10 ⁻³	3 . 10 ⁻¹⁰ 3 . 10 ⁻¹⁰
	Cf ²⁵⁴	sol. insol.	10 ⁻⁶ 10 ⁻⁶	2 . 10 ⁻¹² 2 . 10 ⁻¹²
Curium (96)	Cm ²⁴²	sol. insol.	2 . 10 ⁻⁴ 2 . 10 ⁻⁴	4 . 10 ⁻¹¹ 6 . 10 ⁻¹¹
	Cm ²⁴³	sol. insol.	5 . 10 ⁻⁵ 2 . 10 ⁻⁴	2 . 10 ⁻¹² 3 . 10 ⁻¹¹
	Cm ²⁴⁴	sol. insol.	7 . 10 ⁻⁵ 3 . 10 ⁻⁴	3 . 10 ⁻¹² 3 . 10 ⁻¹¹
	Cm ²⁴⁵	sol. insol.	4 . 10 ⁻⁵ 3 . 10 ⁻⁴	2 . 10 ⁻¹² 4 . 10 ⁻¹¹
	Cm ²⁴⁶	sol. insol.	4 . 10 ⁻⁵ 3 . 10 ⁻⁴	2 . 10 ⁻¹² 4 . 10 ⁻¹¹
	Cm ²⁴⁷	sol. insol.	4 . 10 ⁻⁵ 2 . 10 ⁻⁴	2 . 10 ⁻¹² 4 . 10 ⁻¹¹
	Cm ²⁴⁸	sol. insol.	4 . 10 ⁻⁶ 10 ⁻⁵	2 . 10 ⁻¹³ 4 . 10 ⁻¹²
	Cm ²⁴⁹	sol. insol.	0.02 0.02	4 . 10 ⁻⁶ 4 . 10 ⁻⁶

Element (Atomic number)	Radionuclide	Form <i>b</i>	MPC in water <i>c</i>	MPC in air <i>c</i>
Plutonium (94)	Pu ²³⁸	sol. insol.	5 . 10 ⁻⁵ 3 . 10 ⁻⁴	7 . 10 ⁻¹³ 1 . 10 ⁻¹¹
	Pu ²³⁹	sol. insol.	5 . 10 ⁻⁵ 3 . 10 ⁻⁴	6 . 10 ⁻¹³ 1 . 10 ⁻¹¹
	Pu ²⁴⁰	sol. insol.	5 . 10 ⁻⁵ 3 . 10 ⁻⁴	6 . 10 ⁻¹³ 1 . 10 ⁻¹¹
	Pu ²⁴¹	sol. insol.	2 . 10 ⁻³ 1 . 10 ⁻²	3 . 10 ⁻¹¹ 1 . 10 ⁻⁸
	Pu ²⁴²	sol. insol.	5 . 10 ⁻⁵ 3 . 10 ⁻⁴	6 . 10 ⁻¹³ 1 . 10 ⁻¹¹
	Pu ²⁴³	sol. insol.	3 . 10 ⁻³ 3 . 10 ⁻³	6 . 10 ⁻⁷ 8 . 10 ⁻⁷
	Pu ²⁴⁴	sol. insol.	4 . 10 ⁻⁵ 10 ⁻⁴	6 . 10 ⁻¹³ 10 ⁻¹¹
Strontium (38)	Sr ^{85m}	sol. insol.	7 . 10 ⁻² 7 . 10 ⁻²	1 . 10 ⁻⁵ 1 . 10 ⁻⁵
	Sr ⁸⁵	sol. insol.	1 . 10 ⁻³ 2 . 10 ⁻³	8 . 10 ⁻⁸ 4 . 10 ⁻⁸
	Sr ⁸⁹	sol. insol.	1 . 10 ⁻⁴ 3 . 10 ⁻⁴	1 . 10 ⁻⁸ 1 . 10 ⁻⁸
	Sr ⁹⁰	sol. insol.	4 . 10 ⁻⁶ 4 . 10 ⁻⁴	4 . 10 ⁻¹⁰ 2 . 10 ⁻⁹
	Sr ⁹¹	sol. insol.	7 . 10 ⁻⁴ 5 . 10 ⁻⁴	2 . 10 ⁻⁷ 9 . 10 ⁻⁸
	Sr ⁹²	sol. insol.	7 . 10 ⁻⁴ 6 . 10 ⁻⁴	2 . 10 ⁻⁷ 1 . 10 ⁻⁷
Uranium (92)	U ²³⁰	sol. insol.	2 . 10 ⁻⁵ 5 . 10 ⁻⁵	10 ⁻¹⁰ 4 . 10 ⁻¹¹
	U ²³²	sol. insol.	8 . 10 ⁻⁶ 3 . 10 ⁻⁴	3 . 10 ⁻¹¹ 9 . 10 ⁻¹²
	U ²³³	sol. insol.	4 . 10 ⁻⁵ 3 . 10 ⁻⁴	2 . 10 ⁻¹⁰ 4 . 10 ⁻¹¹
	U ²³⁴	sol. insol.	4 . 10 ⁻⁵ 3 . 10 ⁻⁴	2 . 10 ⁻¹⁰ 4 . 10 ⁻¹¹
	U ²³⁵	sol. insol.	4 . 10 ⁻⁵ 3 . 10 ⁻⁴	2 . 10 ⁻¹⁰ 4 . 10 ⁻¹¹
	U ²³⁶	sol. insol.	5 . 10 ⁻⁵ 3 . 10 ⁻⁴	2 . 10 ⁻¹⁰ 4 . 10 ⁻¹¹
	U ²³⁸	sol. insol.	6 . 10 ⁻⁶ 4 . 10 ⁻⁴	3 . 10 ⁻¹¹ 5 . 10 ⁻¹¹
	U nat.*	sol. insol.	6 . 10 ⁻⁶ 2 . 10 ⁻⁴	3 . 10 ⁻¹¹ 2 . 10 ⁻¹¹

* By custom, one curie of natural uranium corresponds to:

3.7 . 10¹⁰ dis/sec of U²³⁸
3.7 . 10¹⁰ dis/sec of U²³⁴ and
1.7 . 10⁹ dis/sec of U²³⁵.

Element (Atomic number)	Radionuclide	Form <i>b</i>	MPC in water <i>c</i>	MPC in air <i>c</i>
Uranium (Cont'd) (92)	U ²⁴⁰ + Np ²⁴⁰	sol. insol.	3 · 10 ⁻⁴ 3 · 10 ⁻⁴	8 · 10 ⁻⁸ 6 · 10 ⁻⁸

(d) The following data concerning the elements einsteinium and fermium shall be inserted in the Table:

Element (Atomic number)	Radionuclide	Form <i>b</i>	MPC in water <i>c</i>	MPC in air <i>c</i>
Einsteinium (99)	Es ²⁵³	sol. insol.	2 · 10 ⁻⁴ 2 · 10 ⁻⁴	3 · 10 ⁻¹⁰ 2 · 10 ⁻¹⁰
	Es ^{254m}	sol. insol.	2 · 10 ⁻⁴ 2 · 10 ⁻⁴	2 · 10 ⁻⁹ 2 · 10 ⁻⁹
	Es ²⁵⁴	sol. insol.	10 ⁻⁴ 10 ⁻⁴	6 · 10 ⁻¹² 4 · 10 ⁻¹¹
	Es ²⁵⁵	sol. insol.	3 · 10 ⁻⁴ 3 · 10 ⁻⁴	2 · 10 ⁻¹⁰ 10 ⁻¹⁰
Fermium (100)	Fm ²⁵⁴	sol. insol.	10 ⁻⁸ 10 ⁻⁸	2 · 10 ⁻⁸ 2 · 10 ⁻⁸
	Fm ²⁵⁵	sol. insol.	3 · 10 ⁻⁴ 3 · 10 ⁻⁴	6 · 10 ⁻⁹ 4 · 10 ⁻⁹
	Fm ²⁵⁶	sol. insol.	9 · 10 ⁻⁶ 9 · 10 ⁻⁶	10 ⁻⁹ 6 · 10 ⁻¹⁰

(e) The note concerning natural thorium shall be replaced by the following:

'By custom, one curie of natural thorium corresponds to:

3·7 · 10¹⁰ dis/sec of Th²³² and

3·7 · 10¹⁰ dis/sec of Th²³⁰.'

Article 18

In Annex 3, Table C, the words:

'K = 10 for a continuous exposure (one hundred and sixty-eight hours per week) outside the controlled area'

shall be replaced by the following words:

'K = 10 for a continuous exposure outside the controlled area in the case of persons belonging to the group defined in (c) of the fifth subparagraph of Article 1 (2).'

Article 19

Annex 3, Table D shall be replaced by the following:

'D. Maximum permissible concentration of a mixture of unidentified radionuclides in drinking water for continuous exposure of occupationally exposed persons

Types of mixture	MPC in $\mu\text{Ci/ml}$
— Any mixture of alpha, beta, gamma emitters	$1 \cdot 10^{-7}$
— Any mixture of alpha, beta, gamma emitters, if the Ra^{226} and the Ra^{228} can be disregarded*	$1 \cdot 10^{-6}$
— Any mixture of alpha, beta, gamma emitters, if the Sr^{90} , I^{129} , Pb^{210} , Ra^{226} , Ra^{228} , U^{238} , U nat. , Cm^{248} and Cf^{254} can be disregarded*	$7 \cdot 10^{-6}$
— Any mixture of alpha, beta, gamma emitters, if the Sr^{90} , I^{126} , I^{129} , I^{131} , Pb^{210} , Po^{210} , At^{211} , Ra^{223} , Ra^{226} , Ra^{228} , Rl^{228} , Pa^{231} , Th nat. , U^{232} , U^{238} , U nat. , Cm^{248} , Cf^{254} and Fm^{256} can be disregarded*	$2 \cdot 10^{-5}$
— Any mixture of alpha, beta, gamma emitters, if the Sr^{90} , I^{126} , I^{129} , I^{131} , Pb^{210} , Po^{210} , At^{211} , Ra^{223} , Ra^{226} , Ra^{228} , Ac^{227} , Ra^{228} , Th^{230} , U^{230} , Pa^{231} , Th^{232} , Th nat. , U^{232} , U^{238} , U nat. , Cm^{248} , Cf^{254} and Fm^{256} can be disregarded*	$3 \cdot 10^{-5}$

* "Can be disregarded" implies that the concentration of these radionuclides in water represents only a negligible fraction of the maximum permissible concentration shown in Table A in Annex 3.

Article 20

Annex 3, Table E shall be replaced by the following:

'E. Maximum permissible concentration of a mixture of unidentified radionuclides in inhaled air for exposure of occupationally exposed persons

Types of mixture	MPC in $\mu\text{Ci/ml}$
— Any mixture of alpha, beta, gamma emitters	$2 \cdot 10^{-13}$
— Any mixture of alpha, beta, gamma emitters, if the Pa^{231} , Pu^{239} , Pu^{240} , Pu^{242} , Pu^{244} , Cm^{248} , Cf^{249} and Cf^{251} can be disregarded*	$7 \cdot 10^{-13}$
— Any mixture of alpha, beta, gamma emitters, if the Ac^{227} , Th^{230} , Pa^{231} , Pu^{238} , Pu^{239} , Pu^{240} , Pu^{242} , Pu^{244} , Cm^{248} , Cf^{249} and Cf^{251} can be disregarded*	$1 \cdot 10^{-12}$
— Any mixture of beta and gamma emitters, if alpha emitters can be disregarded and if Ac^{227} , Am^{242} and Cf^{254} can be disregarded*	$1 \cdot 10^{-11}$
— Any mixture of beta and gamma emitters, if the alpha emitters can be disregarded and if Pb^{210} , Ac^{227} , Ra^{228} , Pu^{241} , $\text{Am}^{242\text{m}}$ and Cf^{254} can be disregarded*	$1 \cdot 10^{-10}$
— Any mixture of beta and gamma emitters, if the alpha emitters can be disregarded and if the Sr^{90} , I^{129} , Pb^{210} , Ac^{227} , Ra^{228} , Pa^{230} , Pu^{241} , $\text{Am}^{242\text{m}}$, Bk^{249} , Cf^{253} , Cf^{254} , Es^{255} and Fm^{256} can be disregarded*	$1 \cdot 10^{-9}$

* "Can be disregarded" implies that the concentration of these radionuclides in the air represents only a negligible fraction of the maximum permissible concentration shown in Table A in Annex 3.

Article 21

This Directive is addressed to the Member States:

Done at Brussels, 27 October 1966.

For the Council
The President
J. M. A. H. LUNS