

RADIATION SAFETY DIRECTORATE

Pursuant to Article 26-e, paragraph 1, item 20 of the Law on Ionising Radiation Protection and Radiation Safety (Official Gazette of the Republic of Macedonia No. 48/02 and 135/07), the Director of the Radiation Safety Directorate hereby adopts a

RULEBOOK ON THE CATEGORISATION OF IONISING RADIATION SOURCES AND THE CATEGORISATION OF RADIOACTIVE AND NUCLEAR MATERIALS

Article 1

This Rulebook shall prescribe the categorisation of ionising radiation sources and the categorisation of radioactive and nuclear materials.

Article 2

Certain terms used in this Rulebook shall have the following meaning:

“Dangerous source” shall be an ionising radiation source which, if not under control, may result in exposure to ionising radiation sufficient to cause fatal deterministic effects or may be life threatening or may result in a permanent injury that decreases the quality of life of the individual.

“Sealed radioactive source” shall be a source in solid form protected in such a way as to prevent, under normal conditions of use, any dispersion of radioactive substances into the environment.

“Unsealed radioactive source” shall be a source that does not belong in the group of sealed radioactive sources.

“Radiological risk” shall be the potential for the occurrence of considerable effects upon individuals’ health or their offspring as a result of exposure to ionising radiation.

Article 3

The categorisation of ionising radiation sources and of radioactive and nuclear materials shall provide the basis for establishing the appropriate level of control in all operations related to them, in terms of the safety of and physical protection against radioactive sources and radioactive and nuclear materials.

Article 4

The provisions of this Rulebook shall not refer to:

- Ionising radiation-generating devices (X-ray machines, particle accelerators, etc.);
- Radioactive waste and disused sources, and
- Package intended for transport of radioactive materials.

Article 5

The categorisation of ionising radiation sources and radioactive material (hereinafter referred to as: categorisation of radioactive sources) shall be based on the D-value of a given radioactive source which represents the activity value of the radioactive source above which the source shall be considered dangerous.

The determination of whether a source is dangerous or not, and the D-values of individual radionuclides shall be specified in Appendix 1, which is a constituent part of this Rulebook.

Article 6

Assigning a category to a given radioactive source shall be performed on the basis of the ratio between the activity of the radioactive source expressed in terra-becquerels (TB_q) and the lower D-value of the corresponding radionuclide (A/D) listed in the Table attached in Appendix 1 and constituting a part of this Rulebook, as follows:

- 1) Radioactive sources of Category 1 shall be those for which $A/D \geq 1000$;
- 2) Radioactive sources of Category 2 shall be those for which $1000 > A/D \geq 10$;
- 3) Radioactive sources of Category 3 shall be those for which $10 > A/D \geq 1$;
- 4) Radioactive sources of Category 4 shall be those for which $1 > A/D \geq 0,01$, and
- 5) Radioactive sources of Category 5 shall be those for which $0,01 > A/D \geq A_{E,k}/D$, where $A_{E,k}$ is the activity of the radionuclide k which corresponds to the exemption level in accordance with the regulations concerning ionising radiation protection and radiation safety.

Article 7

The assignation of a category to radioactive sources referred to in Article 6 of this Rulebook shall also apply to unsealed radioactive sources and radionuclides with a short half-life, taking into account the activity value of the source when assigning the category.

Article 8

When several radioactive sources are in close proximity to each other at a location where they are used in accordance with the regulations concerning ionising radiation protection and radiation safety, the category of the aggregation of sources shall be determined in accordance with Article 6 of this Rulebook, where the A/D ratio shall be calculated in accordance with the following formula:

$$\frac{A}{D} = \sum_n \frac{\sum_i A_{i,n}}{D_n}$$

where $A_{i,n}$ is the activity of each individual source i of radionuclide n, while D_n is the D-value for radionuclide n.

Article 9

High-activity radioactive sources shall be radionuclides whose activity exceeds the levels referred to in the Table attached in Appendix 2, which is a constituent part of this Rulebook.

The level of activity of radionuclides not listed in the Table referred to in paragraph 1 of this Article shall be one hundredth part of the corresponding A1 value determined in the regulations concerning the transport of radioactive materials.

Article 10

The categorisation of nuclear materials shall be based on the potential radiological risk of the materials used in nuclear explosives and it shall depend on the type of nuclear material, its composition, physical and chemical form, degree of dilution, level of radiation and quantity of the material.

The categorisation referred to in paragraph 1 of this Article shall be given in the

Table attached in Appendix 3, which is a constituent part of this Rulebook.

Article 11

This Rulebook shall enter into force on the eighth day from the date of its publication in the Official Gazette of the Republic of Macedonia.

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Skopje

Director,

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DETERMINING WHETHER A CERTAIN SOURCE IS DANGEROUS AND THE
D-VALUES OF INDIVIDUAL RADIONUCLIDES

In order to determine whether a certain radioactive source is dangerous, the A/D ratio should be calculated as follows:

- 1) for all materials, the ratio shall be calculated as follows:

$$\frac{A}{D_1} = \sum_i \frac{A_i}{D_{1,i}}$$

where A_i is the activity expressed in terra-becquerels (TBq) of radionuclide i which is out of control due to an exceptional radiation occurrence or another accident, while $D_{1,i}$ is the D_1 value of radionuclide i as given in the Table in this Appendix and refers to external exposure to ionising radiation and is used for dispersing and non-dispersing materials and represents a quantity of material without protection which, if carried in a pocket during 10 hours may cause serious harm, with the exception of material whose quantity is too large for it to be placed in a pocket, in which case the D_1 value of the quantity may jeopardise the life of the individual if s/he has been in its proximity for a longer period of time (for days or weeks).

- 2) for dispersing materials, the ratio shall be calculated as follows:

$$\frac{A}{D_2} = \sum_i \frac{A_i}{D_{2,i}}$$

where A_i is the activity expressed in terra-becquerels (TBq) of radionuclide i which is out of control due to an exceptional radiation occurrence or another accident, while $D_{2,i}$ is the D_2 value of radionuclide i as given in the Table attached in this Appendix and represents the quantity of material which if dispersed (in a fire or an explosion) may cause long-term doses that might result in permanent injuries that decrease the quality of life.

The mobile source or the radioactive material which is out of control shall represent a dangerous source if the following non-formula applies to it:

$$\frac{A}{D_i} > 1 \quad \text{where } i=1,2.$$

Table: D-values of individual radionuclides

Radionuclide	D₁ (TBq)	D₂ (TBq)
H-3	UL ¹⁾	2.0E+03
C-14	2.0E+05	5.0E+01
P-32	1.0E+01	2.0E+01
S-35	4.0E+04	6.0E+01
Cl-36	3.0E+02	2.0E+01
Cr-51	2.0E+00	5.0E+03
Fe-55	UL ¹⁾	8.0E+02
Co-57	7.0E-01	4.0E+02
Co-60	3.0E-02	3.0E+01
Ni-63	UL ¹⁾	6.0E+01
Zn-65	1.0E-01	3.0E+02
Ge-68	7.0E-01	2.0E+01
Se-75	2.0E-01	2.0E+02
Kr-85	3.0E+01	2.0E+03
Sr-89	2.0E+01	2.0E+01
Sr-89(Y-90)	4.0E+00	1.0E+00
Y-90	5.0E+00	1.0E+01
Y-91	8.0E+00	2.0E+01
Zr-95 (Nb-95m/Nb-95)	4.0E-02	1.0E+01
Nb-95	9.0E-02	6.0E+01
Mo-99(Tc-99m)	3.0E-01	2.0E+01
Tc-99m	7.0E-01	7.0E+02
Ru-103(Rh-103m)	1.0E-01	3.0E+01
Ru-106(Rh-106)	3.0E-01	1.0E+01
Pd-103(Rh-106)	9.0E+01	1.0E+02
Cd-109	2.0E+01	3.0E+01
Te-132(I-132)	3.0E-02	8.0E-01
I-125	1.0E+01	2.0E-02
I-129	UL ¹⁾	UL ¹⁾
I-131	2.0E-01	2.0E-01
Cs-134	4.0E-02	3.0E+01
Cs-137(Ba-137m)	1.0E-01	2.0E+01
Ba-133	2.0E-01	7.0E+01
Ce-141	1.0E+00	2.0E+01
Ce-144 (Pr-144m,Pr-144)	9.0E-01	9.0E+00
Pm-147	8.0E+03	4.0E+01
Eu-152	6.0E-02	3.0E+01
Eu-154	6.0E-02	2.0E+01
Gd-153	1.0E+00	8.0E+01
Tm-170	2.0E+01	2.0E+01
Yb-169	3.0E-01	3.0E+01
Re-188	1.0E+00	3.0E+01
Ir-192	8.0E-02	2.0E+01
Au-198	2.0E-01	3.0E+01
Hg-203	3.0E-01	2.0E+00
Tl-204	7.0E+01	2.0E+01

Po-210	8.0E+03	6.0E-02
Ra-226(progeny)	4.0E-02	7.0E-02
Th-230	9.0E+02	7.0E-02
Th-232	UL ¹⁾	UL ¹⁾
U-232	7.0E-02	6.0E-02
U-235(Th-231)	8.0E-05 ⁷⁾	8.0E-05
U-238	UL ¹⁾	UL ¹⁾
U Natural	UL ¹⁾	UL ¹⁾
U Depleted	UL ¹⁾	UL ¹⁾
U Enriched>20%	8.0E-05	8.0E-05
U Enriched >10%	8.0E-04	8.0E-04
Np-237(Pa-233)	3.0E-01	7.0E-02
Pu-238	3.0E+02	6.0E-02
Pu-239	1.0E+00	6.0E-02
Pu-239/Be²⁾	1.0E+00	6.0E-02
Pu-240	4.0E+00	6.0E-02
Pu-241(Am-241)	2.0E+03	3.0E+00
Pu-242	7.0E-02	7.0E-02
Am-241	8.0E+00	6.0E-02
Am-241/Be²⁾	1.0E+00	6.0E-02
Cm-242	2.0E+03	4.0E-02
Cm-244	1.0E+04	5.0E-02
Cf-252	2.0E-02	1.0E-01

* UL - Unlimited quantity

Appendix 2

Table: Activity levels of individual radionuclides above which they shall be considered high-activity radioactive sources

Element (Atomic number)	Radionuclide	Activity level (Bq)
Iron (26)	Fe-55	4x 10 ¹¹
Cobalt (27)	Co-60	4x 10 ⁹
Selenium (34)	Se-75	3 x 10 ¹⁰
Krypton (36)	Kr-85	1 x 10 ¹¹
Strontium (38)	Sr-90 ^(a)	3x 10 ⁹
Palladium (46)	Pd-103 ^(a)	4x 10 ¹¹
Iodine (53)	I-125	2 x 10 ¹¹
Caesium (55)	Cs-137 ^(a)	2x 10 ¹⁰
Promethium (61)	Pm-147	4x 10 ¹¹
Gadolinium (64)	Gd-153	1 x 10 ¹¹
Thulium (69)	Tm-170	3 x 10 ¹⁰
Iridium (77)	Ir-192	1 x 10 ¹⁰
Thallium (81)	Tl-204	1 x 10 ¹¹
Radium (88)	Ra-226 ^(b)	2x 10 ⁹
Plutonium (94)	Pu-238 ^(a)	1x 10 ¹¹
Americium (95)	Am-241 ^(b)	1x 10 ¹¹
Californium (98)	Cf-252	5 x 10 ⁸

^(a) The activity level includes the contribution of progeny with a half-life of less than 10 days.

^(b) Includes neutron beryllium sources.