V Congresso PCR-CPLP
Coimbra, 10-12 março 2016

Tópico 6 – Gestão de fontes e resíduos radioativos

GESTÃO DE RESÍDUOS RADIOATIVOS EM AMBIENTE HOSPITALAR

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Gestão sustentável de resíduos hospitalares

Resíduos radioativos

IAEA Classification Scheme

- Very low level waste (VLLW)
- Low level waste (LLW)
- Intermediate level waste (ILW)
- High level waste (HLW)

International Atomic Energy Agency

Resíduos radioativos

Exempt waste

- Levels set in national legislation or regulations for exemption/exclusion and/or clearance
- Suitable for reuse, recycling or unrestricted disposal
- No further regulation or recording

International Atomic Energy Agency

Resíduos radioativos

Very short lived waste (VSLW)

- Only contains radionuclides of short half-life (certainly <30 years)
- Usually from medical or research applications
- Safe and secure storage for several years
- Needs approval by regulator
- May eventually be disposed of as EW or VLLW

TABLE 1. TYPICAL UNSEALED RADIONUCLIDES USED IN MEDICINE AND BIOLOGICAL RESEARCH

Radio-nuclide	Half-life	Principal application	Typical activity per application	Waste characteristics
^{3}H	12.3 a	Radiolabelling, biological research, organic synthesis	Up to 50 GBq	Solvents, solid, liquid
^{11}C	20.4 m	Positron emission tomography, lung ventilation studies	Up to 2 GBq	Solid, liquid
^{14}C	5730 a	Medical diagnosis Biological research Labelling	Less than 1 MBq Up to 50 GBq Up to 50 GBq	(CO_2) Solid, liquid Solvent
^{15}O	122 s	Positron emission tomography, lung ventilation studies	Up to 2 GBq	Solid, liquid
^{18}F	1.8 h	Positron emission tomography	Up to 500 MBq	Solid, liquid
^{24}Na	15.0 h	Biological research	Up to 5 GBq	Liquid
^{32}P	14.3 d	Therapeutic nuclear medicine	Up to 200 MBq	Solid, liquid
^{33}P	25.4 d	Biological research	Up to 50 MBq	
^{35}S	87.4 d	Medical and biological research	Up to 5 GBq	Solid, liquid
^{36}Cl	3.01×10^5 a	Biological research	Up to 5 MBq	Gaseous, solid, liquid
^{45}Ca	163 d	Biological research	Up to 100 MBq	Mainly solid, some liquid
^{46}Sc	83.8 d	Medical and biological research	Up to 500 MBq	Solid, liquid
^{51}Cr	27.7 d	Diagnostic nuclear medicine, biological research	Up to 5 MBq Up to 100 MBq	Solid Mainly liquid effluent
^{57}Co ^{58}Co	271.7 d 70.8 d	Diagnostic nuclear medicine, biological research	Up to 50 MBq —	Solid, liquid effluent
^{59}Fe	44.5 d	Diagnostic nuclear medicine, biological research	Up to 50 MBq	Solid, mainly liquid
^{67}Ga	3.3 d	Diagnostic nuclear medicine	Up to 200 MBq	Solid, liquid

TABLE 2. SEALED SOURCES USED IN MEDICINE, INDUSTRY AND RESEARCH

Application	Radionuclide	Half-life	Source activity	Comments
Bone densitometry	^{241}Am	433.0 a	1–10 GBq	Mobile units
	^{153}Gd	244.0 d	1–40 GBq	
	^{125}I	60.1 d	1–10 GBq	
	^{239}Pu–Be	2.41×10^4 a		
Manual brachytherapy	^{198}Au	2.7 d	50–500 MBq	Small portable sources; being phased out
	^{137}Cs	30.0 a	30–300 MBq	
	^{226}Ra	1600 a	50–500 MBq	
	^{32}P	14.3 d		
	^{60}Co	5.3 a	50–1500 MBq	
	^{90}Sr	29.1 a	50–1500 MBq	
	^{103}Pd	17.0 a	50–1500 MBq	
	^{125}I	60.1 d	200–1500 MBq	
	^{192}Ir	74.0 d		
	^{106}Ru	1.01 a		
Remote after-loading brachytherapy	^{137}Cs	30.0 a	0.03–10 MBq	Mobile units
	^{192}Ir	74.0 d	200 TBq	
Teletherapy	^{60}Co	5.3 a	50–1000 TBq	Fixed installations; phased out but some units in storage pending disposal
	^{137}Cs	30.0 a	500 TBq	
Whole blood irradiation	^{60}Co	5.3 a	50–1000 TBq	Fixed installations
	^{137}Cs	30.0 a	2–100 TBq	
Research	^{60}Co	5.3 a	Up to 750 TBq	Fixed installations
	^{137}Cs	30.0 a	Up to 13 TBq	
Sterilization	^{60}Co	5.3 a	Up to 40 PBq	Fixed installations
Calibration sources, anatomical markers, sources used as standards in instruments	^{63}Ni	100 a	<4MBq	Fixed installations in instruments or mobile sources
	^{137}Cs	30.0 a	<4MBq	
	^{57}Co	271.7 d	Up to 400 MBq	
	^{226}Ra	1600 a	<10 MBq	
	^{147}Pm	2.62 a	<4 MBq	
	^{36}Cl	3.01×10^5 a	<4 MBq	
	^{129}I	1.57×10^7 a	<4 MBq	

TABLE 1. TYPICAL UNSEALED RADIONUCLIDES USED IN MEDICINE AND BIOLOGICAL RESEARCH

Radio-nuclide	Half-life	Principal application	Typical activity per application	Waste characteristics
[redacted]		Radiolabelling, biological research, organic synthesis	Up to 50 GBq	Solvents, solid, liquid
^{11}C	20.4 m	Positron emission tomography, lung ventilation studies	Up to 2 GBq	Solid, liquid
[redacted]		Medical diagnosis	Less than 1	
		Biological research	Up to 50 G	
		Labelling	Up to 50 G	
^{15}O	122 s	Positron emission tomography, lung ventilation studies	Up to 2 GI	
^{18}F	1.8 h	Positron emission tomography	Up to 500 I	
^{24}Na	15.0 h	Biological research	Up to 5 GI	
^{32}P	14.3 d	Therapeutic nuclear medicine	Up to 200 I	
^{33}P	25.4 d	Biological research	Up to 50 M	
^{35}S	87.4 d	Medical and biological research	Up to 5 GI	
[redacted]		Biological research	Up to 5 MI	
^{45}Ca	163 d	Biological research	Up to 100 I	
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	[redacted]		1–10 GBq	
	^{239}Pu–Be	2.41×10^4 a		
	^{198}Au	2.7 d	50–500 MBq	Small portable sources; being phased out
	^{137}Cs	30.0 a	30–300 MBq	
	^{226}Ra	1600 a	50–500 MBq	
	^{32}P	14.3 d		
	^{60}Co	5.3 a	50–1500 MBq	
	^{90}Sr	29.1 a	50–1500 MBq	
	^{103}Pd	17.0 a	50–1500 MBq	
	^{125}I	60.1 d	200–1500 MBq	
	^{192}Ir	74.0 d		
	^{106}Ru	1.01 a		
	^{137}Cs	30.0 a	0.03–10 MBq	Mobile units
	[redacted]		200 TBq	
	^{60}Co	5.3 a	50–1000 TBq	Fixed installations; phased out but some units in storage pending disposal
	^{137}Cs	30.0 a	500 TBq	
	^{60}Co	5.3 a	50–1000 TBq	Fixed installations
	^{137}Cs	30.0 a	2–100 TBq	
	^{60}Co	5.3 a	Up to 750 TBq	Fixed installations
	^{137}Cs	30.0 a	Up to 13 TBq	
	^{60}Co	5.3 a	Up to 40 PBq	Fixed installations
	^{63}Ni	100 a	<4MBq	Fixed installations in instruments or mobile sources
anatomical markers, sources used as standards in instruments	^{137}Cs	30.0 a	<4MBq	
	^{57}Co	271.7 d	Up to 400 MBq	
	^{226}Ra	1600 a	<10 MBq	
	^{147}Pm	2.62 a	<4 MBq	
	^{36}Cl	3.01×10^5 a	<4 MBq	
	^{129}I	1.57×10^7 a	<4 MBq	

IAEA Safety Standards

for protecting people and the environment

Management of Waste from the Use of Radioactive Material in Medicine, Industry, Agriculture, Research and Education

Safety Guide

No. WS-G-2.7

IAEA

International Atomic Energy Agency

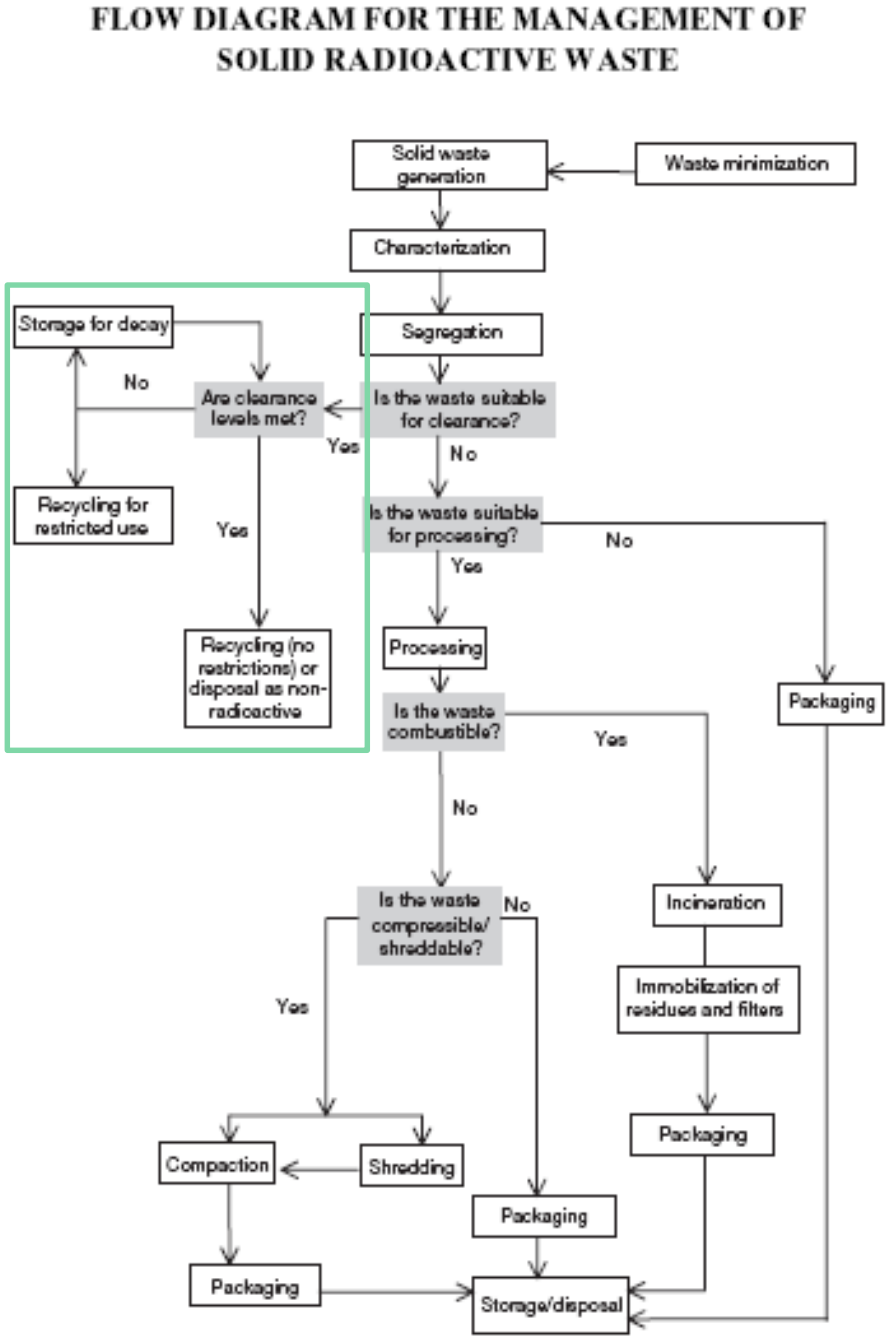


FIG. 1. Flow diagram illustrating the steps in solid radioactive waste management.

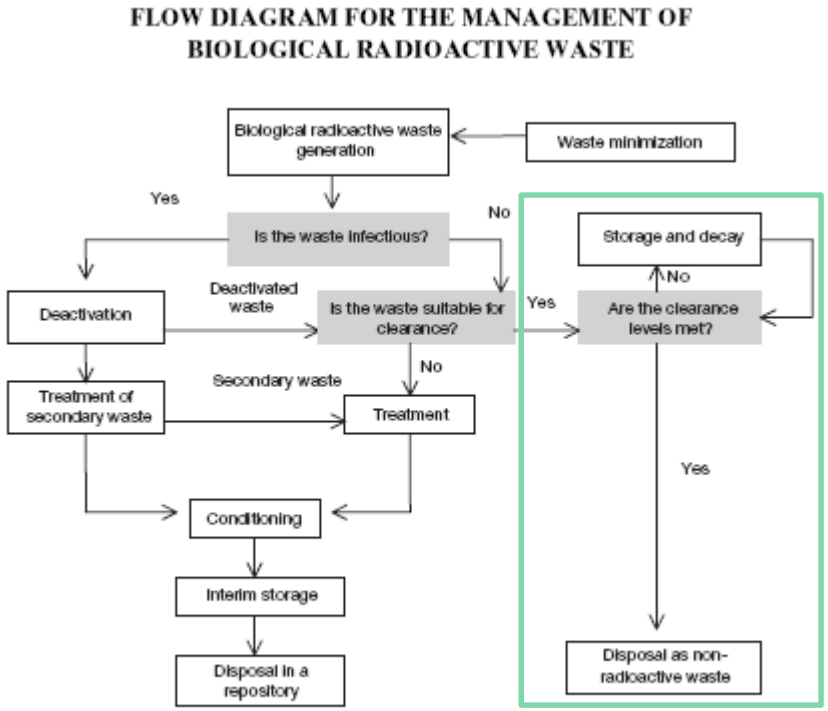


FIG. 2. Flow diagram illustrating the main steps in the management of biological radioactive waste.

Fontes seladas

Categorization of Radioactive Sources

TABLE II.1. CATEGORIES FOR SEALED SOURCES USED IN COMMON PRACTICES

Category	Ratio of activity in the source to activity that is considered dangerous[a] (A/D)	Example of sources[b] and practices
1	$0.01 > A/D$ and $A >$ level for exemption[c]	Low dose rate brachytherapy eye plaques and permanent implant sources;
2		X ray fluorescence devices;
3		Electron capture devices;
		Mossbauer spectrometry sources;
		Positron emission tomography check sources
4	$1 > A/D \geq 0.01$	Low dose rate brachytherapy sources (except eye plaques and permanent implants);
		Industrial gauges not incorporating high activity sources;
		Bone densitometers;
		Static eliminators
5	$0.01 > A/D$ and $A >$ level for exemption[c]	Low dose rate brachytherapy eye plaques and permanent implant sources;
		X ray fluorescence devices;
		Electron capture devices;
		Mossbauer spectrometry sources;
		Positron emission tomography check sources

2005

Fontes seladas

TABLE 3. PLAIN LANGUAGE DESCRIPTIONS OF THE CATEGORIES (cont.)

Category of source	Risk in being close to an individual source	Risk in the event that the radioactive material in the source is dispersed by fire or explosion
4	**Unlikely to be dangerous to the person:** It is very unlikely that anyone would be permanently injured by this source. However, this amount of unshielded radioactive material, if not safely managed or securely protected, could possibly — although it would be unlikely — temporarily injure someone who handled it or who was otherwise in contact with it for many hours, or who was close to it for a period of many weeks.	This amount of radioactive material, if dispersed, could not permanently injure persons.[b]
5	**Most unlikely to be dangerous to the person:** No one could be permanently injured by this source.[b]	This amount of radioactive material, if dispersed, could not permanently injure anyone.[b]

[a] The size of the area to be cleaned up would depend on many factors (including the activity, the radionuclide, how it was dispersed and the weather).

[b] Possible delayed health effects are not taken into account in this statement (see para. II.2).

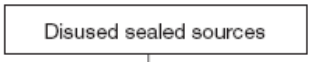
TABLE II-2. ACTIVITY[a] CORRESPONDING TO A DANGEROUS SOURCE (*D* VALUE[b]) FOR SELECTED RADIONUCLIDES, AND MULTIPLES THEREOF

Radionuclide	1000 × *D*		10 × *D*		*D*		0.01 × *D*	
	TBq	Ci[c]	TBq	Ci[c]	TBq	Ci[c]	TBq	Ci[c]
Am-241	6.E+01	2.E+03	6.E-01	2.E+01	6.E-02	2.E+00	6.E-04	2.E-02
Am-241/Be	6.E+01	2.E+03	6.E-01	2.E+01	6.E-02	2.E+00	6.E-04	2.E-02
Au-198	2.E+02	5.E+03	2.E+00	5.E+01	2.E-01	5.E+00	2.E-03	5.E-02
Cd-109	2.E+04	5.E+05	2.E+02	5.E+03	2.E+01	5.E+02	2.E-01	5.E+00
Cf-252	2.E+01	5.E+02	2.E-01	5.E-00	2.E-02	5.E-01	2.E-04	5.E-03
Cm-244	5.E+01	1.E+03	5.E-01	1.E+01	5.E-02	1.E+00	5.E-04	1.E-02
Co-57	7.E+02	2.E+04	7.E+00	2.E+02	7.E-01	2.E+01	7.E-03	2.E-01
Co-60	3.E+01	8.E+02	3.E-01	8.E+00	3.E-02	8.E-01	3.E-04	8.E-03
Cs-137	1.E+02	3.E+03	1.E+00	3.E+01	1.E-01	3.E+00	1.E-03	3.E-02
Fe-55	8.E+05	2.E+07	8.E+03	2.E+05	8.E+02	2.E+04	8.E+00	2.E+02
Gd-153	1.E+03	3.E+04	1.E+01	3.E+02	1.E+00	3.E+01	1.E-02	3.E-01
Ge-68	7.E+01	2.E+03	7.E-01	2.E+01	7.E-02	2.E+00	7.E-04	2.E-02
H-3	2.E+06	5.E+07	2.E+04	5.E+05	2.E+03	5.E+04	2.E+01	5.E+02
I-125	2.E+02	5.E+03	2.E+00	5.E+01	2.E-01	5.E+00	2.E-03	5.E-02
I-131	2.E+02	5.E+03	2.E+00	5.E+01	2.E-01	5.E+00	2.E-03	5.E-02
Ir-192	8.E+01	2.E+03	8.E-01	2.E+01	8.E-02	2.E+00	8.E-04	2.E-02
Kr-85	3.E+04	8.E+05	3.E+02	8.E+03	3.E+01	8.E+02	3.E-01	8.E+00
Mo-99	3.E+02	8.E+03	3.E+00	8.E+01	3.E-01	8.E+00	3.E-03	8.E-02

Atividades usuais após decaimento < 1 MBq

(< 1.E-6)!

Appendix V



Artigo 44.º

Fontes radioativas seladas fora de uso

Sempre que o detentor de uma fonte entender que se encontra esgotada a finalidade para a qual obteve a fonte e solicite a sua recolha, a caução constituída nos termos do Decreto-Lei n.º 38/2007, de 19 de fevereiro, reverte a favor da eliminação da fonte radioativa selada fora de uso como resíduo radioativo.

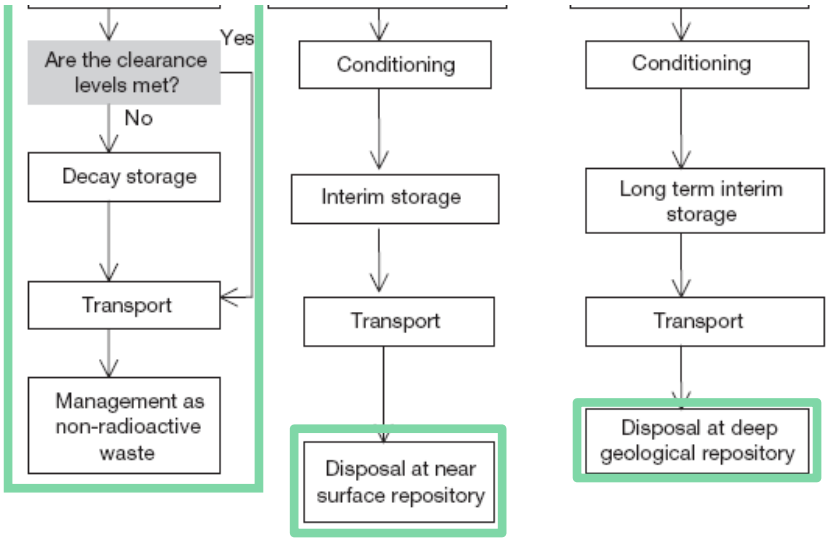


FIG. 3. Flow diagram illustrating the main steps in the management of disused sealed

Decreto-Lei n.º 140/2005

de 17 de Agosto

Artigo 2.º

Dispensa de declaração de exercício

Estão dispensadas de declaração de exercício as práticas referidas no n.º 2 do artigo 3.º da Directiva n.º 96/29/EURATOM, do Conselho, desde que cumpridas as condições e valores aí previstos.

Decreto-Lei n.º 38/2007

de 19 de Fevereiro

Artigo 2.º

Âmbito de aplicação

1 — O presente decreto-lei aplica-se às fontes radioactivas seladas, incluindo fontes de actividade elevada e fontes órfãs.

2 — O presente decreto-lei não se aplica aos pacientes sujeitos a exposição às radiações para fins médicos, os quais se regem por regulamentação específica.

3 — O presente decreto-lei não é aplicável, igualmente, às fontes cuja actividade tenha descido abaixo dos níveis de isenção especificados no Decreto-Lei n.º 140/2005, de 17 de Agosto.

2. No reporting need be required for practices involving the following:

(a) radioactive substances where the quantities involved do not exceed in total the exemption values set out in column 2 of Table A to Annex I or, in exceptional circumstances in an individual Member State, different values authorized by the competent authorities that nevertheless satisfy the basic general criteria set out in Annex I; or

(b) radioactive substances where the concentration of activity per unit mass do not exceed the exemption values set out in column 3 of Table A to Annex I or, in exceptional circumstances in an individual Member State, different values authorized by the competent authorities that nevertheless satisfy the basic general criteria set out in Annex I; or

(c) apparatus containing radioactive substances exceeding the quantities or concentration values specified in subparagraphs (a) or (b), provided that:

(i) it is of a type approved by the competent authorities of the Member State; and

(ii) it is constructed in the form of a sealed source; and

(iii) it does not cause, in normal operating conditions, a dose rate exceeding 1 $\mu Sv\ h^{-1}$ at a distance of 0,1 m from any accessible surface of the apparatus; and

(iv) conditions for disposal have been specified by the competent authorities; or

Classificação de resíduos radioativos

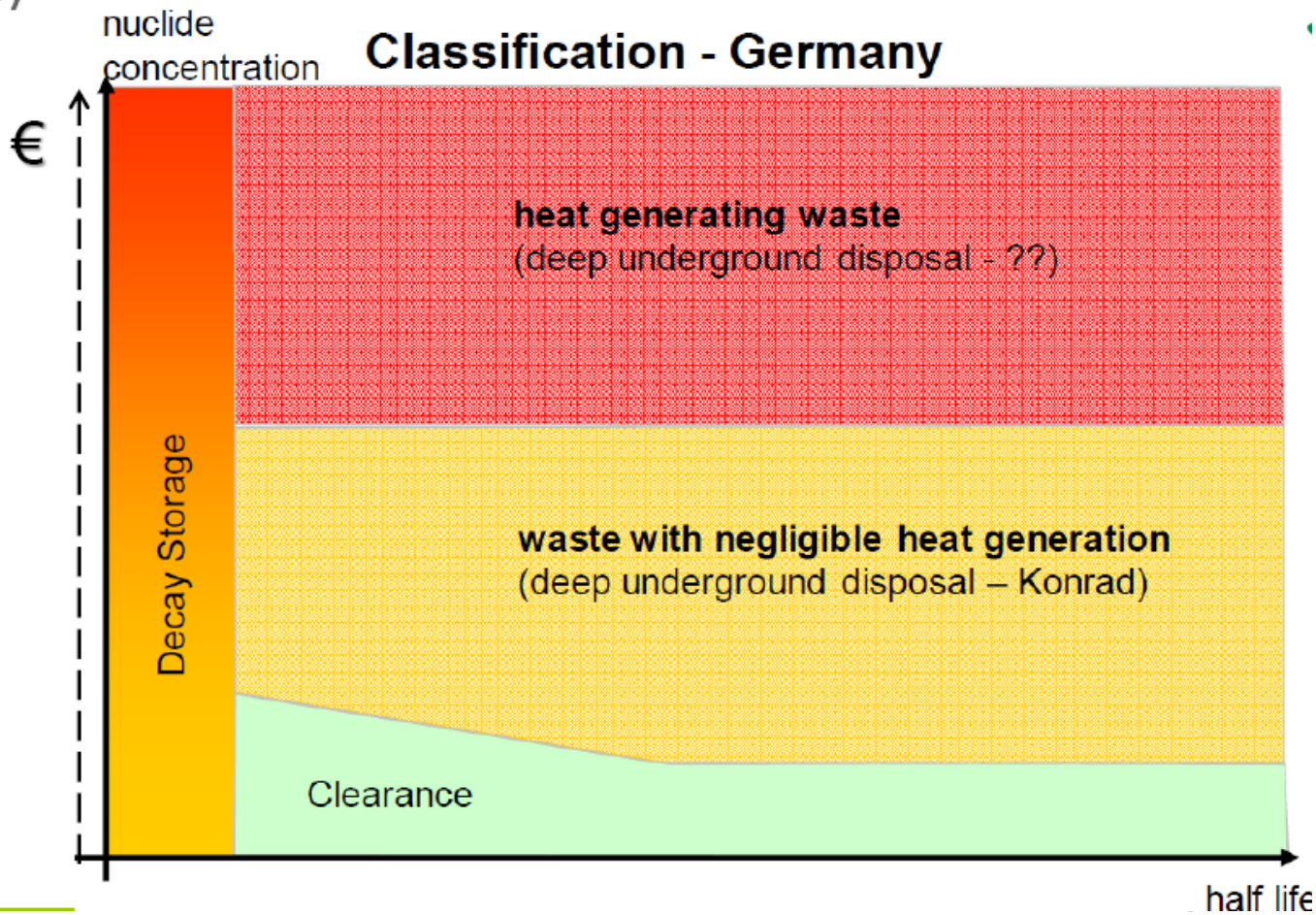
Implementation of clearance in different countries

Case II : Germany

Waste classification :

– Clearance

– No VLLW



Classificação de resíduos radioativos

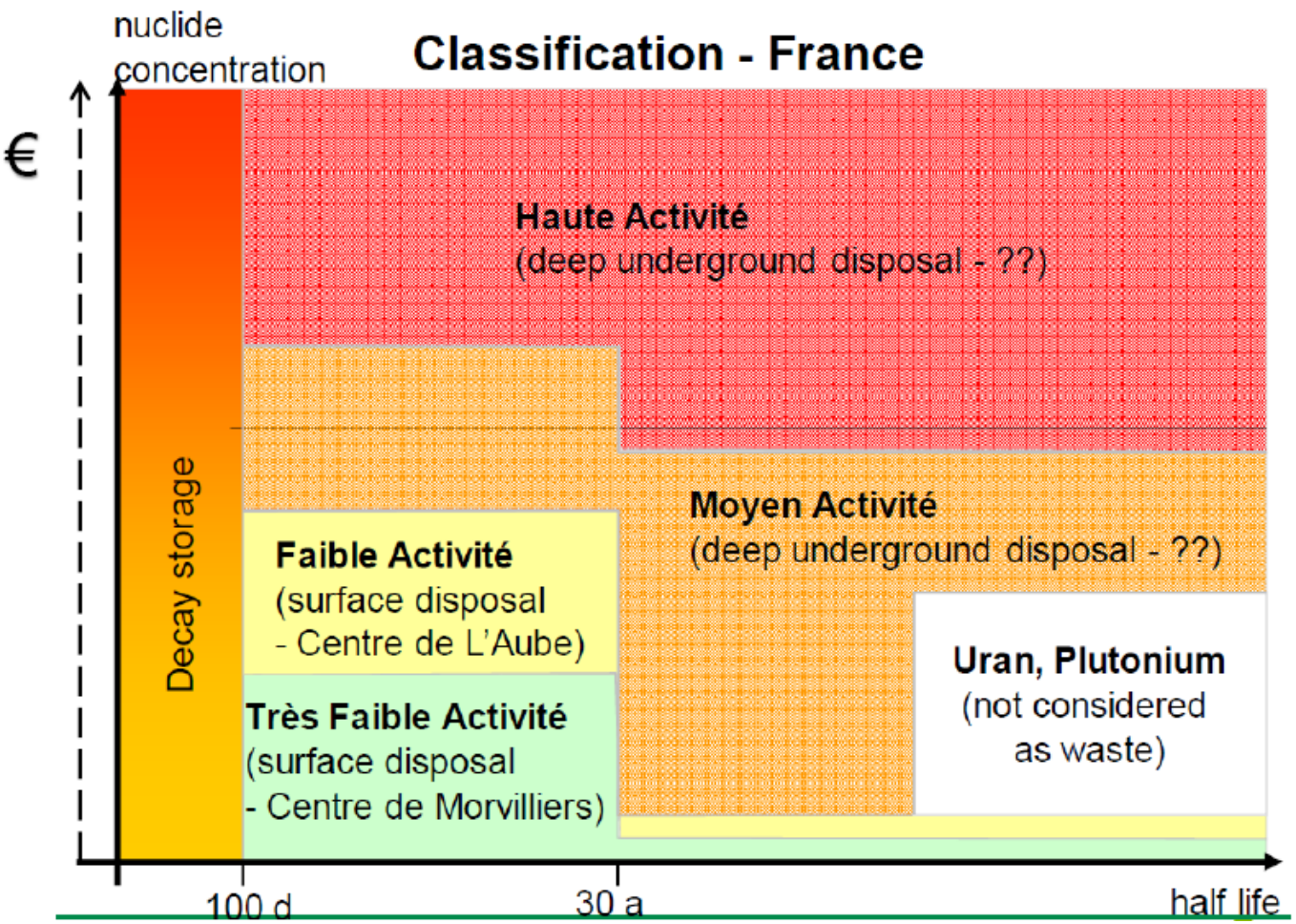
Implementation of clearance in different countries

Case I : France

Waste classification :

– No clearance

– VLLW (TFA)



Classificação de resíduos radioativos

O que significa
"**Descargas autorizadas**"
com valores inferiores
aos de
isenção/liberação?!

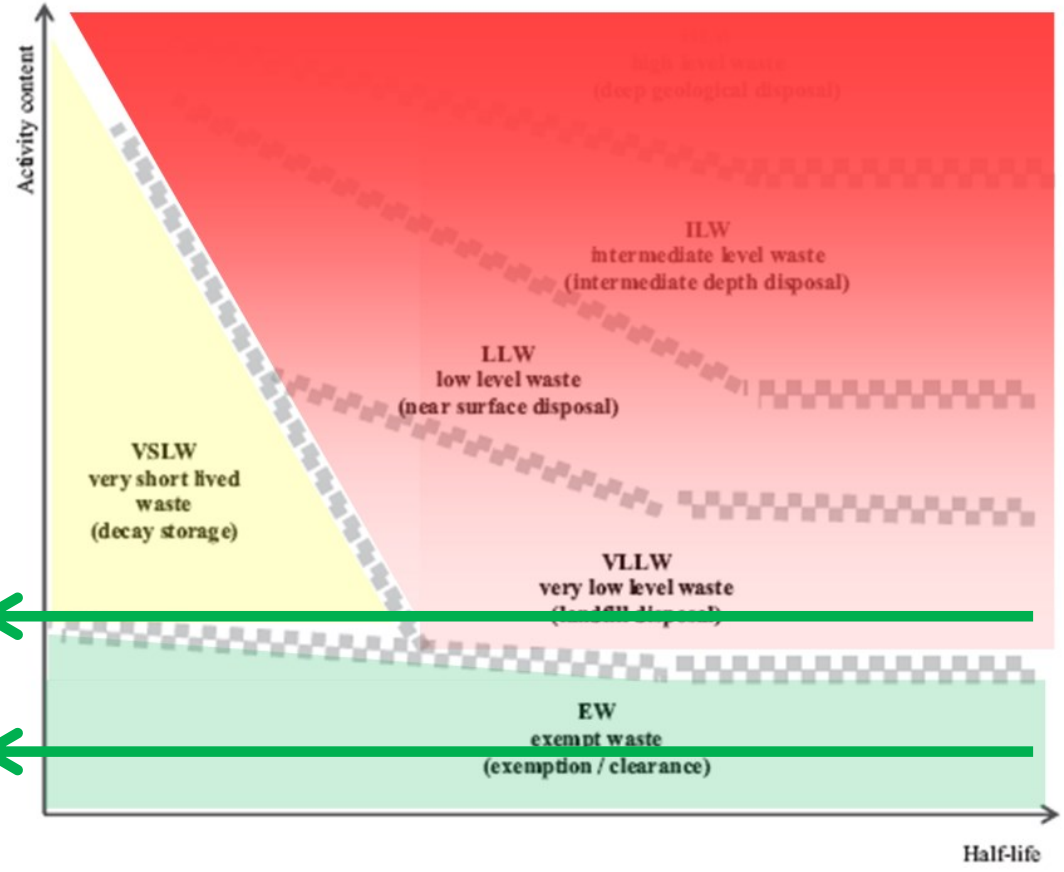


FIG. 1. Conceptual illustration of the waste classification scheme.

Decreto-Lei n.º 156/2013

de 5 de novembro

2 — O presente diploma não se aplica a:

a) Resíduos das indústrias extrativas que sejam radioativos, abrangidos pelo disposto no Decreto-Lei n.º 10/2010, de 4 de fevereiro, alterado pelo Decreto-Lei n.º 31/2013, de 22 de fevereiro;

b) Descargas autorizadas de resíduos radioativos gasosos, líquidos ou sólidos.

Artigo 9.º

Licenciamento

1 — As atividades e as instalações de gestão do combustível irradiado e de gestão de resíduos radioativos, em qualquer uma das suas fases, de escolha de local, projeto, construção, entrada em funcionamento, exploração ou desmantelamento, estão sujeitas a licenciamento, nos termos e condições definidas na secção V do presente capítulo.

2 — Excetua-se do disposto no número anterior a atividade de armazenagem de resíduos radioativos pelo produtor para descarga autorizada, bem como a armazenagem por um período não superior a 30 dias.

Classificação de resíduos radioativos

Exempt waste (EW)

2.8. Exempt waste contains such small concentrations of radionuclides that it does not require provisions for radiation protection, irrespective of whether the waste is disposed of in conventional landfills or recycled. Such material can be cleared from regulatory control and does not require any further consideration from a regulatory control perspective.

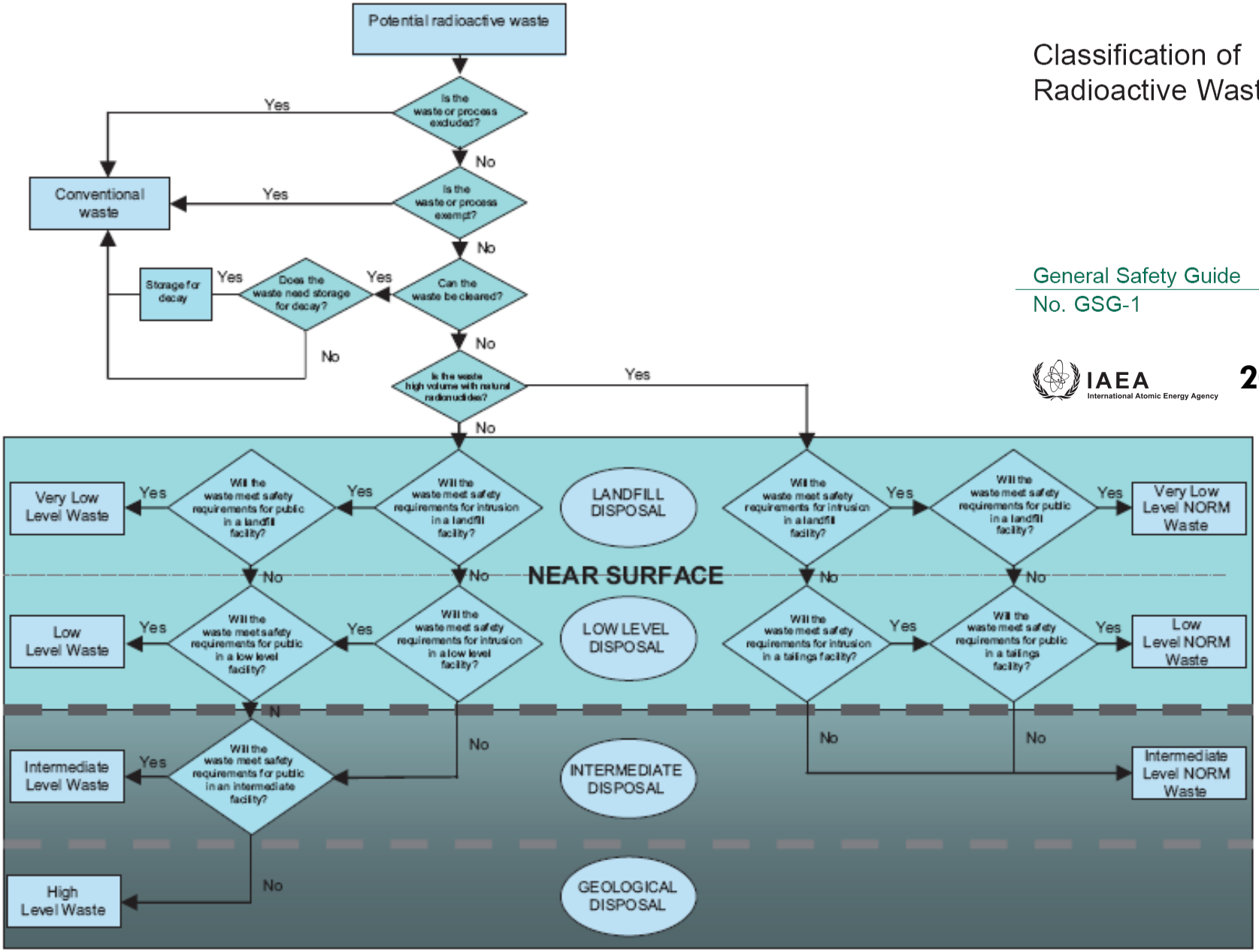
III–21. Sources may be described according to the activity and half-life of the radionuclide they contain. Sources containing radionuclides with half-lives of less than 100 days (e.g. ^{90}Y, ^{192}Ir, or ^{198}Au used in brachytherapy) may be stored for decay and eventually disposed of as exempt waste. Other sources such as

IAEA Safety Standards
for protecting people and the environment

Classification of Radioactive Waste

General Safety Guide
No. GSG-1

IAEA International Atomic Energy Agency
2009



★ **Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom**

ANNEX VII

Exemption and clearance criteria as referred to in Articles 24, 26 and 30

3. **General exemption and clearance criteria**

(a) The general criteria for the exemption of practices from notification or authorisation or for the clearance of materials from authorised practices are as follows:

(i) the radiological risks to individuals caused by the practice are sufficiently low, as to be of no regulatory concern; and **< 10 µSv**

(ii) the type of practice has been determined to be justified; and

(iii) the practice is inherently safe.

(b) Practices involving small amounts of radioactive substances or low activity concentrations, comparable to the exemption values laid down in Table A or Table B are deemed to fulfil criterion (iii).

★ **Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom**

TABLE A

Activity concentration values for exemption or clearance of materials which can be applied by default to any amount and to any type of solid material

TABLE A PART 1

Artificial radionuclides

Radionuclide	Activity concentration (kBq kg^{-1})
H-3	100
Be-7	10
C-14	1
F-18	10

Radionuclide	Activity concentration (kBq kg^{-1})
K-43	10
Ca-45	100

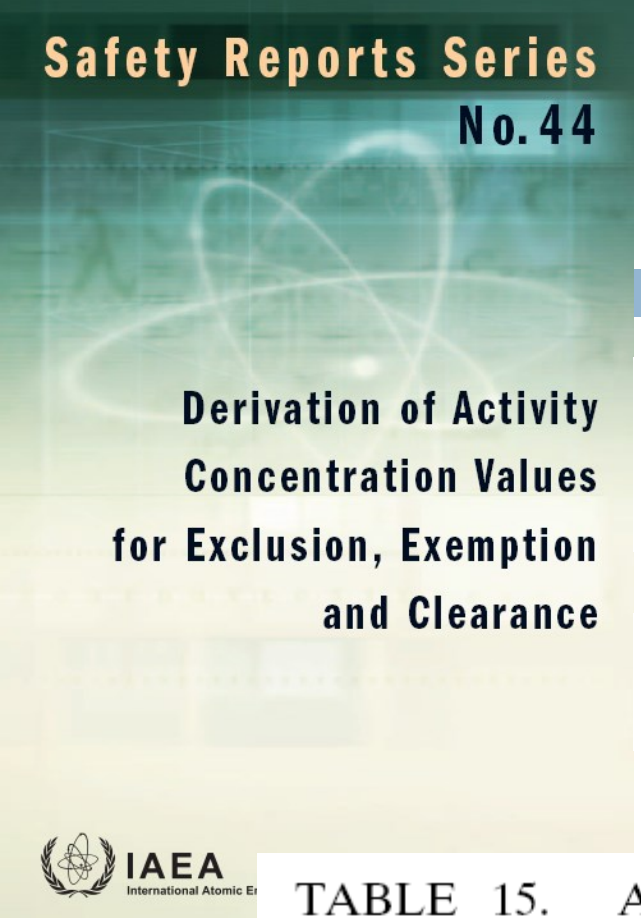
Radionuclide	Activity concentration (kBq kg^{-1})
Mn-56	10
Fe-52 [a]	10

TABLE B

Total activity values for exemption (column 3) and exemption values for the activity concentration in moderate amounts of any type of material (column 2)

Radionuclide	Activity concentration (kBq kg^{-1})	Activity (Bq)
H-3	1×10^6	1×10^9
Be-7	1×10^3	1×10^7
C-14	1×10^4	1×10^7
O-15	1×10^2	1×10^9
F-18	1×10^1	1×10^6

Radionuclide	Activity concentration (kBq kg^{-1})	Activity (Bq)
Ni-65	1×10^1	1×10^6
Cu-64	1×10^2	1×10^6
Zn-65	1×10^1	1×10^6
Zn-69	1×10^4	1×10^6
Zn-69 m	1×10^2	1×10^6



. This Safety Report supports the Safety Guide [2] and provides the basis for the activity concentration values for exclusion and exemption of bulk[1] amounts of material, which can also be used for clearance.

[1] Any amount of material that is greater than a moderate quantity. Moderate quantities are defined in Ref. [3] as being quantities that "are at the most of the order of a tonne" of material.

TABLE 15. ACTIVITY CONCENTRATION VALUES FOR BULK AMOUNTS OF RADIONUCLIDES OF ARTIFICIAL ORIGIN

Radionuclide	Concentration	
H-3	100	
Be-7	10	
C-14	1	
F-18	10	[a]

Radionuclide	Concentration	
Sc-48	1	
V-48	1	
Cr-51	100	
Mn-51	10	[a]

MINISTÉRIOS DO AMBIENTE, ORDENAMENTO DO TERRITÓRIO E ENERGIA, DA SAÚDE E DA EDUCAÇÃO E CIÊNCIA

Portaria n.º 44/2015

de 20 de fevereiro

Artigo 2.º

Valores de liberação

1 — Os valores de concentração indicados no Quadro A, Parte 1, ou no Quadro A, Parte 2, aplicam-se para a liberação de materiais sólidos destinados a reutilização, reciclagem, eliminação convencional ou incineração.

QUADRO A: Valores de concentração de atividade para efeitos de liberação de materiais que podem ser aplicados por defeito a qualquer quantidade e a qualquer tipo de material sólido.

QUADRO A Parte 1: Radionuclídeos artificiais

Radionuclídeo	Concentração de atividade (kBq/kg)
H-3	100
Be-7	10
C-14	1
F-18	10

Falta transpor a tabela B da diretiva!

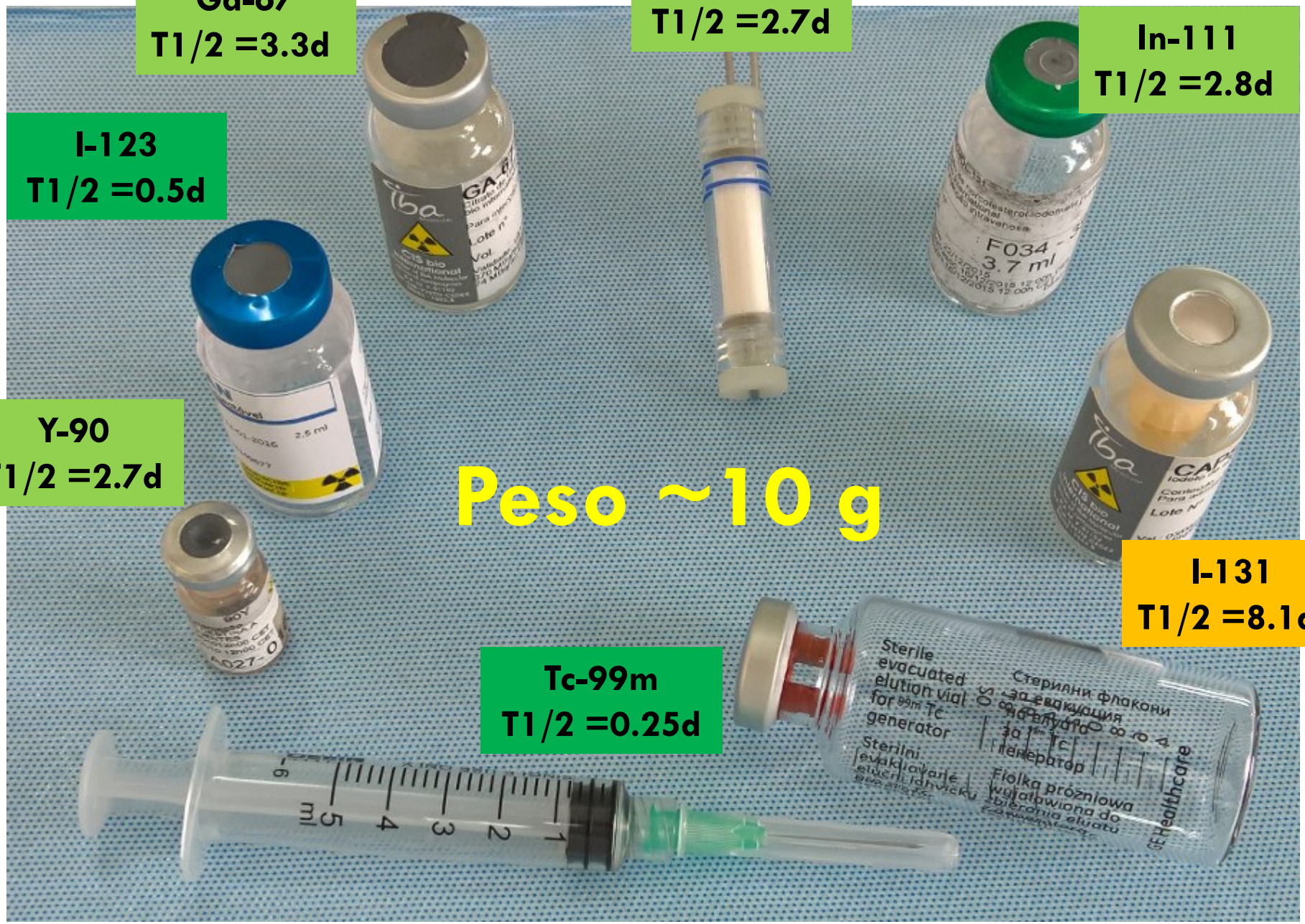
Exemplos: *« To Clear, or not to Clear? »*

TABLE 2. CATEGORIES FOR SOURCES USED IN SOME COMMON PRACTICES (cont.)

I	II	III	IV	V	VI	VII	VIII	IX
Source	Radionuclide		Quantity in use (A)		D value (TBq)	Ratio of A/D	Category	
			Ci	TBq			A/D based	Recommended
PET check sources	Ge-68	Max	1.0E-02	3.7E-04	7.E-01	5.3E-04	5	
	Ge-68	Min	1.0E-03	3.7E-05	7.E-01	5.3E-05	5	5
	Ge-68	Typ	3.0E-03	1.1E-04	7.E-01	1.6E-04	5	
Brachytherapy sources — low dose rate	Cs-137	Max	7.0E-01	2.6E-02	1.E-01	2.6E-01	4	
	Cs-137	Min	1.0E-02	3.7E-04	1.E-01	3.7E-03	5	4
	Cs-137	Typ	5.0E-01	1.9E-02	1.E-01	1.9E-01	4	
	Ra-226	Max	5.0E-02	1.9E-03	4.E-02	4.6E-02	4	
	Ra-226	Min	5.0E-03	1.9E-04	4.E-02	4.6E-03	5	4
	Ra-226	Typ	1.5E-02	5.6E-04	4.E-02	1.4E-02	4	
	I-125	Max	4.0E-02	1.5E-03	2.E-01	7.4E-03	5	
	I-125	Min	4.0E-02	1.5E-03	2.E-01	7.4E-03	5	4
	I-125	Typ	4.0E-02	1.5E-03	2.E-01	7.4E-03	5	
	Ir-192	Max	7.5E-01	2.8E-02	8.E-02	3.5E-01	4	
	Ir-192	Min	2.0E-02	7.4E-04	8.E-02	9.3E-03	5	4
	Ir-192	Typ	5.0E-01	1.9E-02	8.E-02	2.3E-01	4	
Diagnostic isotope generators	Mo-99	Max	1.0E+01	3.7E-01	3.E-01	1.2E+00	3	
	Mo-99	Min	1.0E+00	3.7E-02	3.E-01	1.2E-01	4	4
	Mo-99	Typ	1.0E+00	3.7E-02	3.E-01	1.2E-01	4	
Medical unsealed sources	I-131	Max	2.0E-01	7.4E-03	2.E-01	3.7E-02	4	
	I-131	Min	1.0E-01	3.7E-03	2.E-01	1.9E-02	4	[illegible]
	I-131	Typ	1.0E-01	3.7E-03	2.E-01	1.9E-02	4	

Atividades usuais após decaimento < 1 MBq

(< 1.E-6)!


Ga-67
T1/2 =3.3d
Mo-99
T1/2 =2.7d
In-111
T1/2 =2.8d
I-123
T1/2 =0.5d
Y-90
T1/2 =2.7d
Peso ~10 g
I-131
T1/2 =8.1d
Tc-99m
T1/2 =0.25d

Mo-Tc Generator
(store for decay & dismounting)

Assume a generator with 20 GBq Mo-99 at reference time. The half-life of Mo-99 is 2.75 d and the exemption activity is 1 MBq (BSS). The time for interim storage should then be 40 d.

The dose rate at 1 m from the unshielded column will then be 0.04 µSv/h. Hence, the external exposure will be very small when dismounting the generator.

The dismounted column is exempted waste and the sign of its previous radioactivity should be removed. The column can now be discharged together with similar waste from the hospital.

Dismounting Mo-Tc Generator

1. Check for radiation

2. Remove the plastic cover

3. Check for radiation

4. Remove the column

Dismounting Mo-Tc Generator

5. Remove the lead shield

6. Separate the different materials

7. Check if the column can be classified as exemted waste

Qual é o risco associado ao Mo-99?

- INGESTÃO DA COLUNA DE ALUMINA (Mo-99)!!!

Limites	Atividade ingerida de Mo-99	Dose (µSv)
Isenção	**1 MBq**	**600**
Descarga autorizada	3.7 kBq	2.2

Limite de dose efectiva anual par o público: 1000 µSv

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IAEA POSITION STATEMENT ON RELEASE OF PATIENTS AFTER RADIONUCLIDE THERAPY

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