Australian Government
Australian Radiation Protection and Nuclear Safety Agency

arpansa

Updated Guidance on the Application of Exclusion, Exemption and Clearance of Radioactive Material in Australia Based on International Best Practice

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Concepts: Exclusion, Exemption & Clearance

Exclusion, **exemption** and **clearance** are used as part of the process to determine the nature and extent of regulatory control as it applies to planned exposure situations as part of the optimisation process.

Exclusion exposures deemed not amenable to control, regardless of the exposure magnitude

> a decision that regulatory control is not practically possible.

[SET ASIDE this 'trivial' category]

Exemption a source or practice that need not be subject to some or all regulatory control

> a decision **before** regulated activities commence
> source levels derived via conservative scenario assumptions

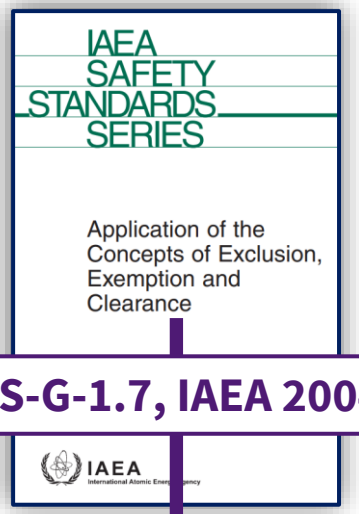
Clearance a source within a regulated practice that is removed from regulatory control

> a decision **after** regulated activities commence
> source levels derived via conservative assumptions **and/or** case-by-case assessment

IAEA Standards for Exemption & Clearance

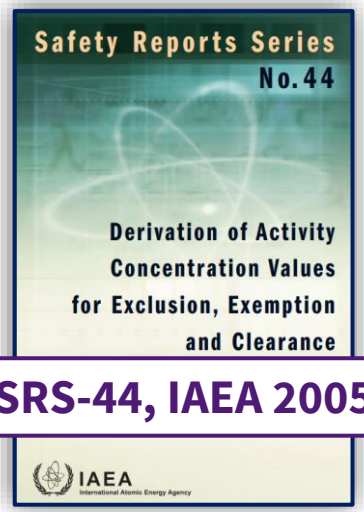
The application of **exemption** and **clearance** concepts are embodied in IAEA publications, including:

APPLICATION GUIDANCE



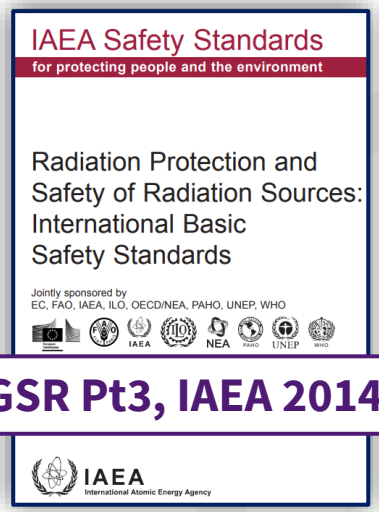
RS-G-1.7, IAEA 2004

DERIVATION OF LEVELS



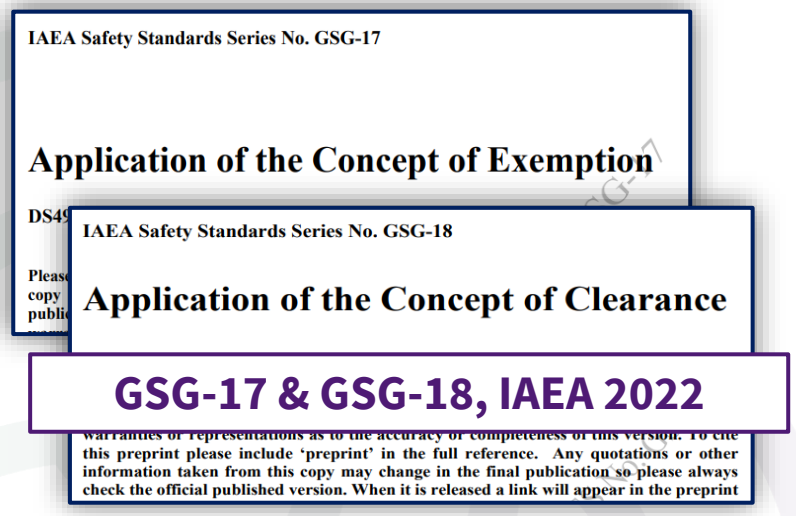
SRS-44, IAEA 2005

CRITERIA + LEVELS



GSR Pt3, IAEA 2014

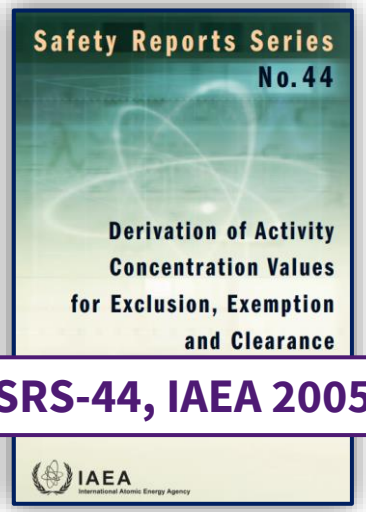
PRE-PRINT (preprint.iaea.org)



GSG-17 & GSG-18, IAEA 2022

REDUNDANT *

Basis of Clearance Levels for Bulk Amounts of Material



SRS-44, IAEA 2005

General approach
- Calculation methods
- Exposure scenarios
- Solid contamination
- Artificial & natural RNs

Realistic parameter values & 10 µSv/year criterion

+

Low probability values & 1 mSv/year criterion

Development of levels
- Dose coefficients
- Limiting pathways
- Parameter values

Bulk activity levels (Bq/g)

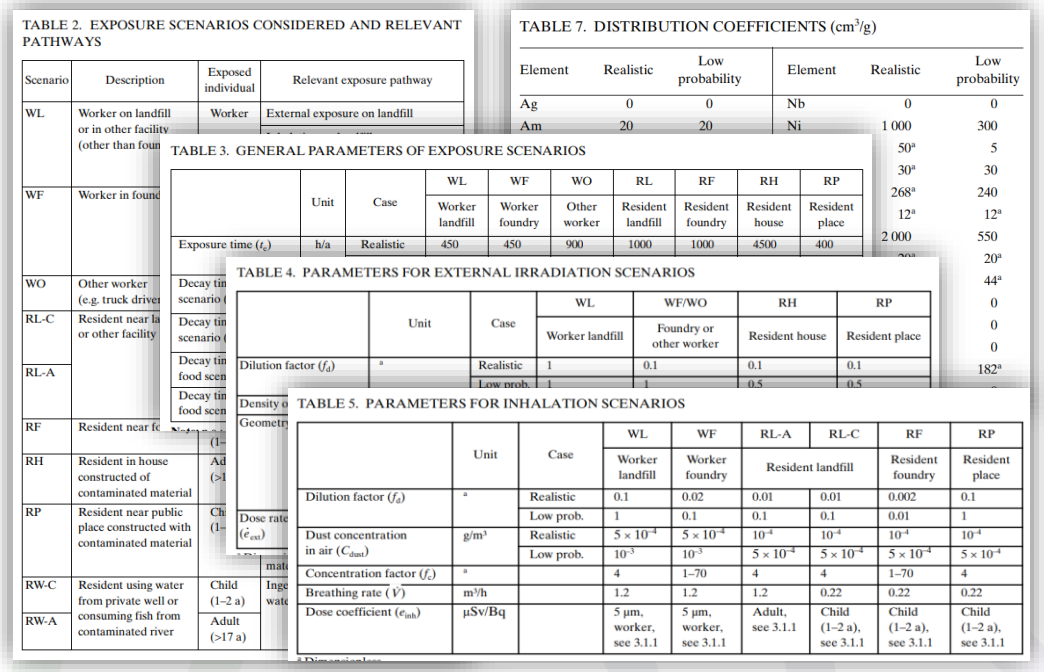


TABLE 2. EXPOSURE SCENARIOS CONSIDERED AND RELEVANT PATHWAYS

Scenario	Description	Exposed individual	Relevant exposure pathway
WL	Worker on landfill or in other facility (other than foun	Worker	External exposure on landfill
WF	Worker in found		
WO	Other worker (e.g. truck driver		
RL-C	Resident near la or other facility		
RL-A			
RF	Resident near fo		
RH	Resident in house constructed of contaminated material		
RP	Resident near public place constructed with contaminated material		
RW-C	Resident using water from private well or consuming fish from contaminated river	Child (1–2 a)	
RW-A		Adult (>17 a)	

TABLE 7. DISTRIBUTION COEFFICIENTS (cm^3/g)

Element	Realistic	Low probability	Element	Realistic	Low probability
Ag	0	0	Nb	0	0
Am	20	20	Ni	1 000	300
				50[a]	5
				30[a]	30
				268[a]	240
				12[a]	12[a]
				2 000	550
					20[a]
					44[a]
					0
					0
					0
					182[a]

TABLE 3. GENERAL PARAMETERS OF EXPOSURE SCENARIOS

	Unit	Case	WL	WF	WO	RL	RF	RH	RP
			Worker landfill	Worker foundry	Other worker	Resident landfill	Resident foundry	Resident house	Resident place
Exposure time (t_e)	h/a	Realistic	450	450	900	1000	1000	4500	400
Decay tin scenario (									
Decay tin scenario (									
Decay tin food scen									
Decay tin food scen									

TABLE 4. PARAMETERS FOR EXTERNAL IRRADIATION SCENARIOS

	Unit	Case	WL	WF/WO	RH	RP
			Worker landfill	Foundry or other worker	Resident house	Resident place
Dilution factor (f_d)	[a]	Realistic	1	0.1	0.1	0.1
		Low prob.	1	1	0.5	0.5
Density o						
Geometry						
Dose rate ($\dot{e}_{ext}$)						

TABLE 5. PARAMETERS FOR INHALATION SCENARIOS

	Unit	Case	WL	WF	RL-A	RL-C	RF	RP
			Worker landfill	Worker foundry	Resident landfill		Resident foundry	Resident place
Dilution factor (f_d)	[a]	Realistic	0.1	0.02	0.01	0.01	0.002	0.1
		Low prob.	1	0.1	0.1	0.1	0.01	1
Dust concentration in air (C_{dust})	g/m³	Realistic	5×10^{-4}	5×10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}
		Low prob.	10^{-3}	10^{-3}	5×10^{-4}	5×10^{-4}	5×10^{-4}	5×10^{-4}
Concentration factor (f_c)	[a]		4	1–70	4	4	1–70	4
Breathing rate ($\dot{V}$)	m³/h		1.2	1.2	1.2	0.22	0.22	0.22
Dose coefficient (e_{inh})	µSv/Bq		5 µm, worker, see 3.1.1	5 µm, worker, see 3.1.1	Adult, see 3.1.1	Child (1–2 a), see 3.1.1	Child (1–2 a), see 3.1.1	Child (1–2 a), see 3.1.1

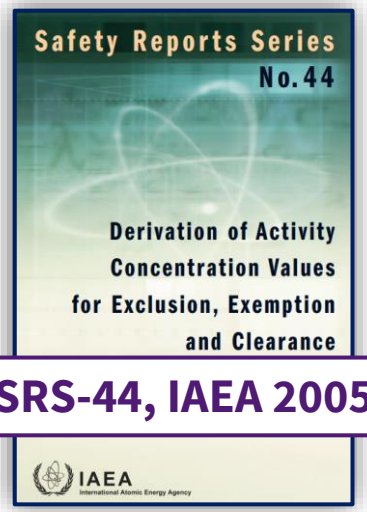
TABLE 15. ACTIVITY CONCENTRATION VALUES FOR BULK AMOUNTS OF RADIONUCLIDES OF ARTIFICIAL ORIGIN

Radionuclide	Concentration		Radionuclide	Concentration	
H-3	100		Sc-48		
Be-7	10		V-48		
C-14	1		Cr-51		
F-18	10	[a]	Mn-51		
Na-22	0.1		Mn-52		
Na-24	1	[a]	Mn-52m		
Si-31	1 000	[a]	Mn-53	100	
P-32	1 000		Mn-54	0.1	

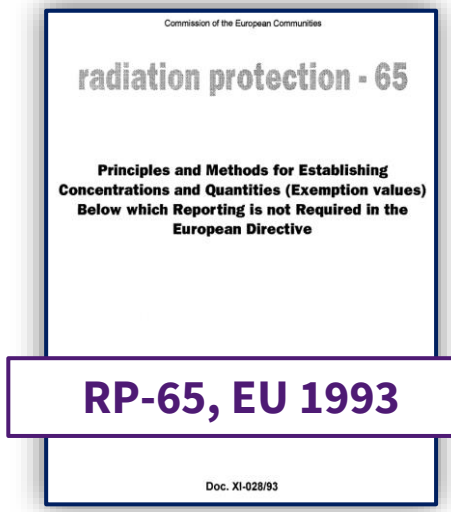
TABLE 16. ACTIVITY CONCENTRATION VALUES (Bq/g) FOR RADIONUCLIDES OF NATURAL ORIGIN

Radionuclide	Concentration
K-40	10
All other radionuclides of natural origin	1

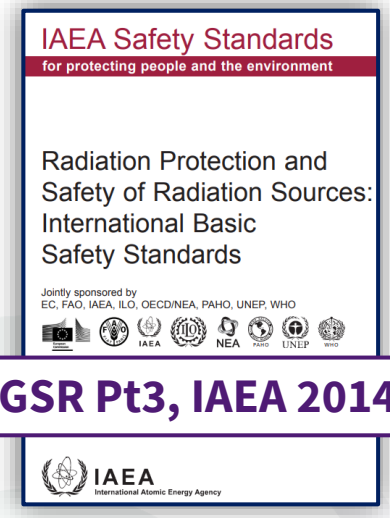
Reference Exemption & Clearance Levels



SRS-44, IAEA 2005



RP-65, EU 1993



GSR Pt3, IAEA 2014

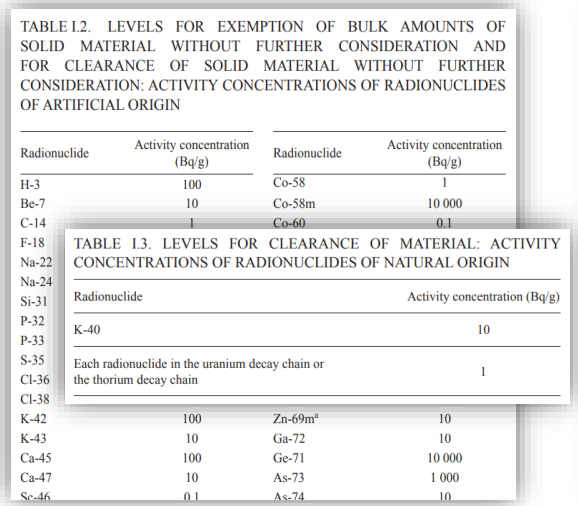


TABLE I.2. LEVELS FOR EXEMPTION OF BULK AMOUNTS OF SOLID MATERIAL WITHOUT FURTHER CONSIDERATION AND FOR CLEARANCE OF SOLID MATERIAL WITHOUT FURTHER CONSIDERATION: ACTIVITY CONCENTRATIONS OF RADIONUCLIDES OF ARTIFICIAL ORIGIN

Radionuclide	Activity concentration (Bq/g)	Radionuclide	Activity concentration (Bq/g)
H-3	100	Co-58	1
Be-7	10	Co-58m	10 000
C-14	1	Co-60	0.1
F-18	1	Co-60m	1 000
Na-22	0.1	Co-61	100
Na-24	0.1	Co-62m	10
Si-31	1 000	Ni-59	100
P-32	1 000	Ni-63	100
P-33	1 000	Ni-65	10
S-35	100	Cu-64	100
Cl-36	1	Zn-65	10
Cl-38	10	Zn-69	1 000
K-42	100	Zn-69m[a]	10
K-43	10	Ga-72	10
Ca-45	100	Ge-71	10 000
Ca-47	10	As-73	1 000
Sc-46	0.1	As-74	10

TABLE I.3. LEVELS FOR CLEARANCE OF MATERIAL: ACTIVITY CONCENTRATIONS OF RADIONUCLIDES OF NATURAL ORIGIN

Radionuclide	Activity concentration (Bq/g)
K-40	10
Each radionuclide in the uranium decay chain or the thorium decay chain	1

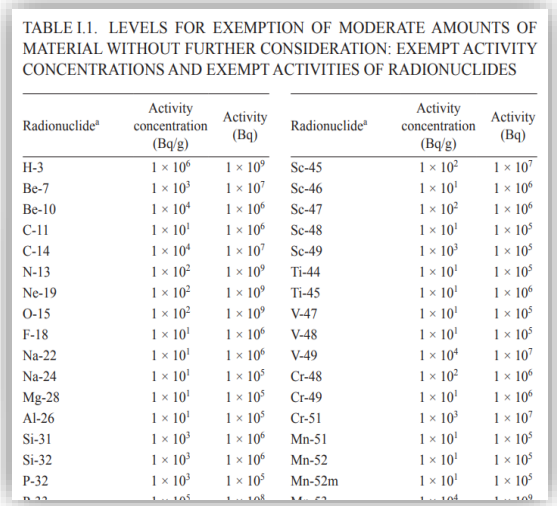


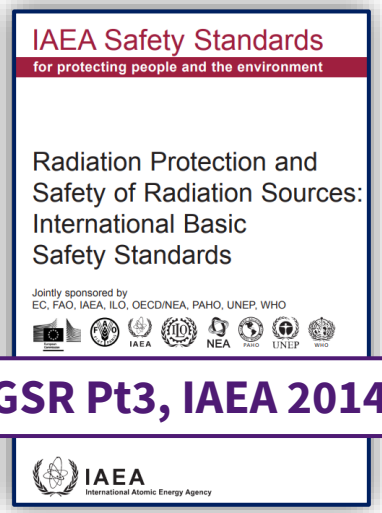
TABLE I.1. LEVELS FOR EXEMPTION OF MODERATE AMOUNTS OF MATERIAL WITHOUT FURTHER CONSIDERATION: EXEMPT ACTIVITY CONCENTRATIONS AND EXEMPT ACTIVITIES OF RADIONUCLIDES

Radionuclide[a]	Activity concentration (Bq/g)	Activity (Bq)	Radionuclide[a]	Activity concentration (Bq/g)	Activity (Bq)
H-3	1×10^6	1×10^9	Sc-45	1×10^2	1×10^7
Be-7	1×10^3	1×10^7	Sc-46	1×10^1	1×10^6
Be-10	1×10^4	1×10^6	Sc-47	1×10^2	1×10^6
C-11	1×10^1	1×10^6	Sc-48	1×10^1	1×10^5
C-14	1×10^4	1×10^7	Sc-49	1×10^3	1×10^5
N-13	1×10^2	1×10^9	Ti-44	1×10^1	1×10^5
Ne-19	1×10^2	1×10^9	Ti-45	1×10^1	1×10^6
O-15	1×10^2	1×10^9	V-47	1×10^1	1×10^5
F-18	1×10^1	1×10^6	V-48	1×10^1	1×10^5
Na-22	1×10^1	1×10^6	V-49	1×10^4	1×10^7
Na-24	1×10^1	1×10^5	Cr-48	1×10^2	1×10^6
Mg-28	1×10^1	1×10^5	Cr-49	1×10^1	1×10^6
Al-26	1×10^1	1×10^5	Cr-51	1×10^3	1×10^7
Si-31	1×10^3	1×10^6	Mn-51	1×10^1	1×10^5
Si-32	1×10^3	1×10^6	Mn-52	1×10^1	1×10^5
P-32	1×10^3	1×10^5	Mn-52m	1×10^1	1×10^5

- **Exemption**: moderate mass; any solid RNs
- **Exemption**: bulk mass; artificial solid RNs
- **Clearance**: any mass; artificial solid RNs
- **Clearance**: any mass; natural solid RNs

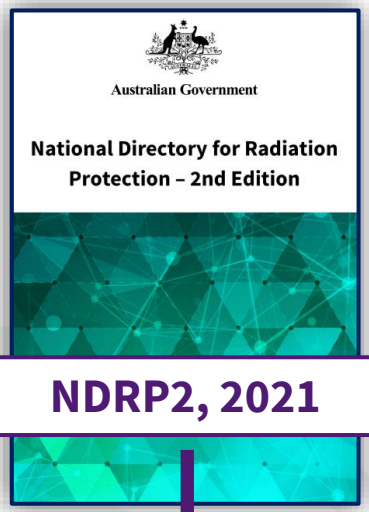
? Clearance of moderate vs bulk amounts of solids ? (later)

Australian Implementation of Exemption & Clearance

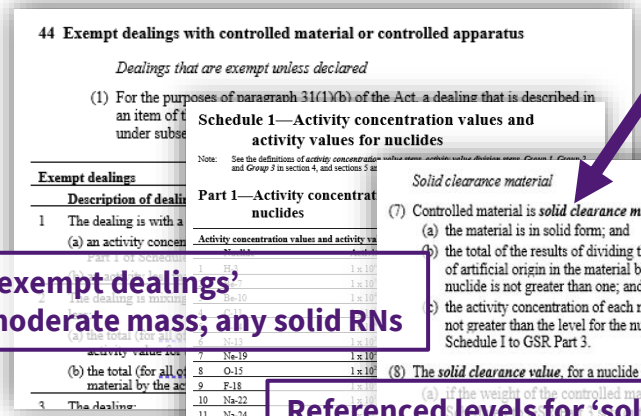


GSR Pt3, IAEA 2014

ARPANS Regs, 2018

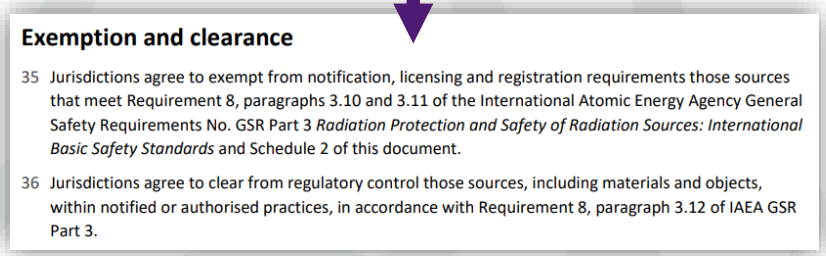


NDRP2, 2021



Tabulated levels of 'exempt dealings'
- **From GSR Pt3: moderate mass; any solid RNs**

Referenced levels for 'solid clearance materials'
- **any mass; artificial solid RNs > GSR Pt3**
- **any mass; natural solid RNs > GSR Pt3**



Reference to all GSR Pt3 exemption & clearance levels

Australia – Further Work on Exemption & Clearance

IRRS 2018: The IAEA conducted their 2nd Integrated Regulatory Review Service mission.

Objective: Review Australia's arrangements for radiation protection and nuclear safety.

Recommendation #22: Commonwealth to adopt and implement uniform **clearance** levels.

No.	Recommendations	Responsible committee	Key Stakeholders	Proposed Actions
R22	The Commonwealth Government, in conjunction with the state and territory Governments, should progress the adoption and implementation of uniform clearance levels.	enHealth	ARPANSA, S/T regulators, Commonwealth Department of Health, S/T policy agencies	• NDRP2 to be updated with the requirement for jurisdictions to adopt the clearance levels in Schedule 1 of GSR Part 3. • enHealth will provide guidance on the application of clearance levels in accordance with Schedule 1 of GSR Part 3.

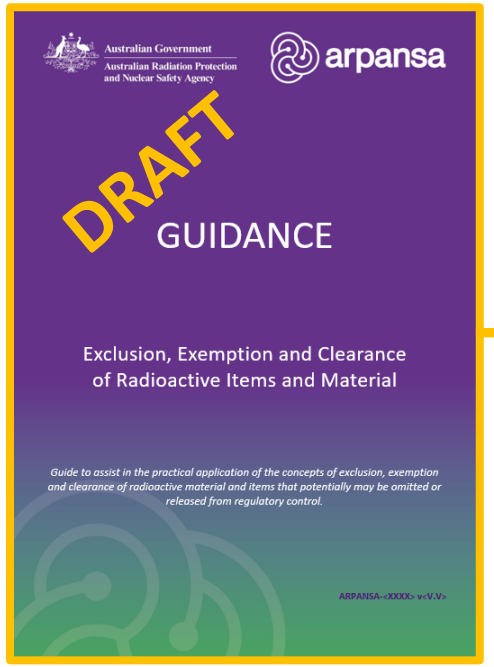
Action Remaining: Provide guidance on clearance levels in accordance with GSR Pt3.

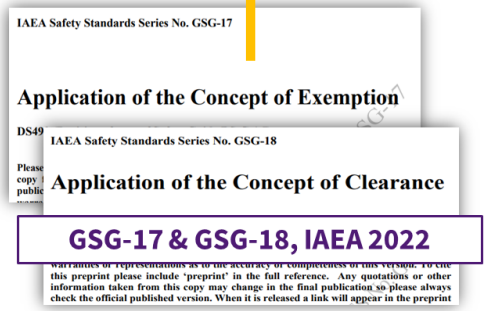
Intent: Develop exclusion, exemption & clearance guidance for Australian jurisdictions.

Guidance Source: GSR Pt3 + GSG-17/18 (new guidance) + local context + experience.

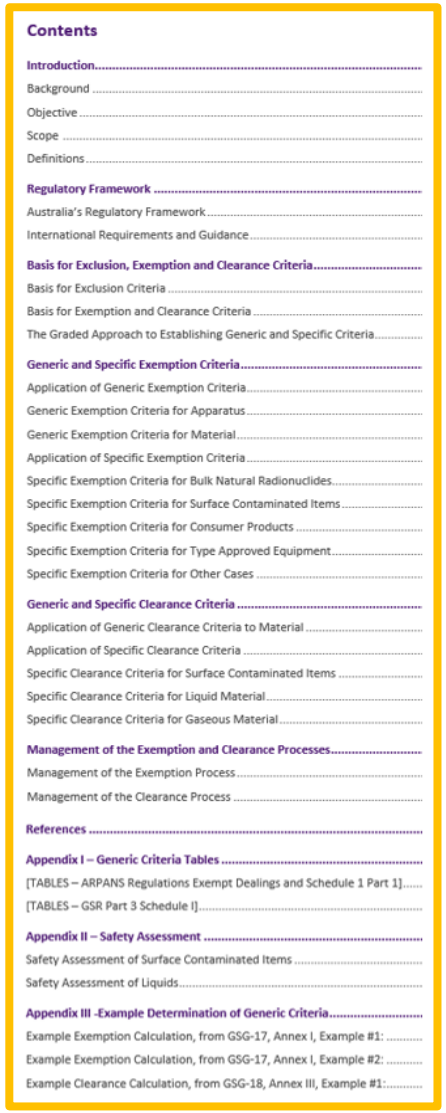
Status: Project commenced via enHealth & Radiation Health Committee (RHC).

Aspects of Guidance on Exemption & Clearance





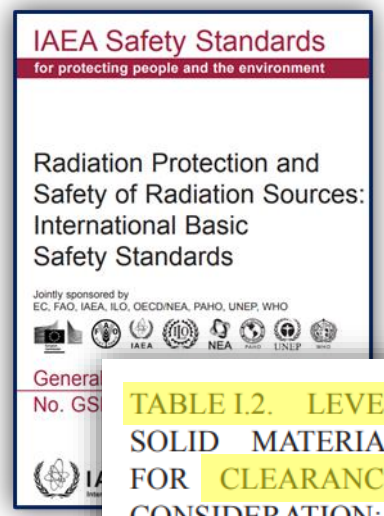
GSG-17 & GSG-18, IAEA 2022



Contents

- Basis for exclusion, exemption & clearance criteria
- Graded approach to generic & specific criteria
- Generic exemption criteria for material & apparatus
- Specific exemption criteria for other sources including:
  - Surface-contaminated objects (SCO's)
  - Consumer products
  - Type-approved equipment
- Generic clearance criteria for solid material
- Specific clearance criteria for other sources including:
  - Surface-contaminated objects (SCO's)
  - Liquid material
  - Gaseous material
- Management of the exemption & clearance process
- Safety assessment of SCO's, liquids
- Example determination of criteria:
  - Exemption & clearance
  - Solids, SCO's, liquids, gases
  - Specific scenarios and material of interest

Example Guidance on Application of ‘Generic’ Levels



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Radionuclide[a]	Activity concentration (Bq/g)	Activity (Bq)	Radionuclide	Activity concentration (Bq/g)	Activity (Bq)
H-3	1×10^6	1×10^9	Sc-45	1×10^2	1×10^7
Be-7	1×10^3	1×10^7	Sc-46	1×10^1	1×10^6
Be-10	1×10^4	1×10^6	Sc-47	1×10^2	1×10^6
C-11	1×10^1	1×10^6	Sc-48	1×10^1	1×10^5
				10^3	1×10^5
				10^1	1×10^5
				10^1	1×10^6
				10^1	1×10^5
				10^1	1×10^5
				10^4	1×10^7

TABLE I.2. LEVELS FOR EXEMPTION OF BULK AMOUNTS OF SOLID MATERIAL WITHOUT FURTHER CONSIDERATION AND FOR CLEARANCE OF SOLID MATERIAL WITHOUT FURTHER CONSIDERATION: ACTIVITY CONCENTRATIONS OF RADIONUCLIDES OF ARTIFICIAL ORIGIN

Radionuclide	Activity concentration (Bq/g)	Radionuclide	Activity concentration (Bq/g)
H-3	100	Co-58	
Be-7	10	Co-58m	
C-14			
F-18			
Na-22			

TABLE I.3. LEVELS FOR CLEARANCE OF MATE… CONCENTRATIONS OF RADIONUCLIDES OF NATURA…

Radionuclide	Activity concentration (Bq/g)
K-40	10
Each radionuclide in the uranium decay chain or the thorium decay chain	1

TABULATED GENERIC LEVELS

1 **Exemption**: moderate mass; any solid RNs
2 **Exemption**: bulk mass; artificial solid RNs
2 **Clearance**: any mass; artificial solid RNs
3 **Clearance**: any mass; natural solid RNs

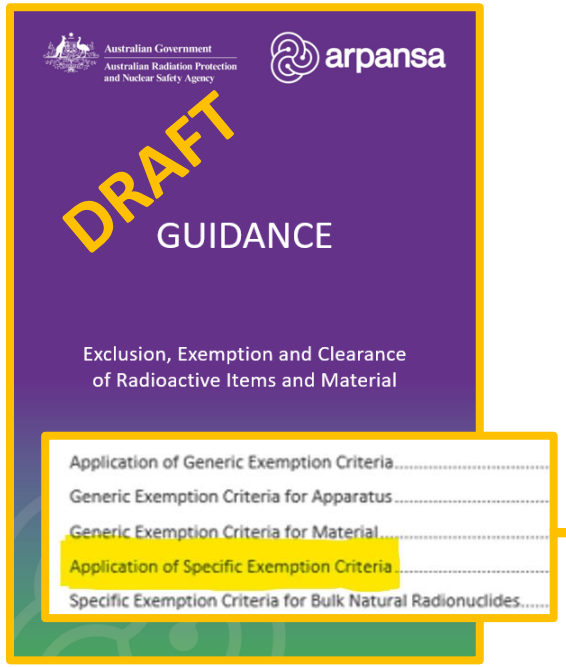
? Clearance of moderate vs bulk solids ?

GUIDANCE FROM GSG-18

4.10. When direct handling of moderate quantities of material after clearance is considered without significant decay, the exemption levels given in Table I.1 of GSR Part 3 [1] are also applicable for clearance, since no decay or waiting time was assumed when deriving these exemption levels, and the same dose criteria were applied for both exemption and clearance [1].

Use Table 1 for clearance of moderate amounts of solid artificial and natural

Application of Specific Exemption & Clearance Levels



Application of Specific Exemption Criteria

In case a practice or source within a practice does not comply with generic **exemption** requirements, or they cannot be applied, the regulator will consider a case-by-case (specific) **exemption**. Examples of specific **exemption** cases include, but are not limited to, bulk amounts of solid materials with radionuclides of natural origin, bulk amounts of liquids and gases with radionuclides of any origin, surface-contaminated commodities, and certain consumer products.

To qualify for specific **exemption**, a person or organization should demonstrate that the intended practice:

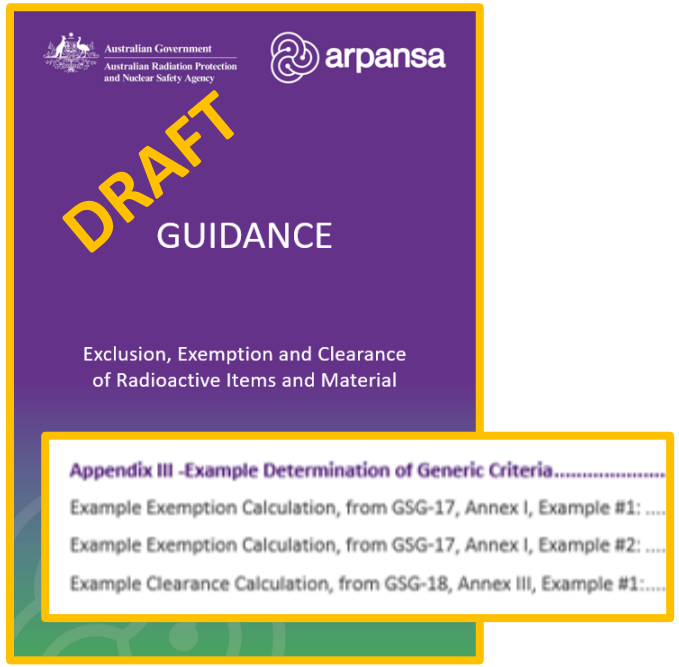
- is justified, and
- complies with the general criteria for **exemption** as per GSR Part 3 paragraph I.1 (i.e. radiation risks are sufficiently low, and regulatory control would yield no benefit), and
- complies with other relevant general criteria for **exemption** of GSR Part 3 Schedule I, such as dose criteria specified in paragraphs I.2 (10 µSv per year for all cases) and I.4 (1 mSv per year for bulk amounts of material containing natural radionuclides).

To be granted a specific **exemption**, planned activities must be analysed via an appropriate safety assessment for compliance with these general criteria for **exemption**. See [Appendix II – Safety Assessment] for general guidance on safety assessments.

When GENERIC levels are not suitable, case-by-case SPECIFIC levels may be developed:

- **Compliance with general criteria of GSR Pt3**
- **Activities must be analysed via a Safety Assessment**
- **Derive levels from first principles / best-practice examples / regulatory guidance**
- **Such as – (i) exemption of bulk naturals (ii) surface contaminated objects**

Example Specific SCO Clearance Levels from GSG-18



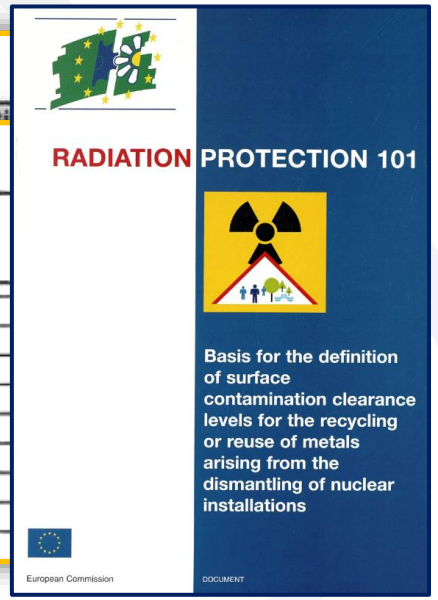
Example #5: Specific Clearance Criteria, SCOs, Multiple Natural Nuclides

Remediation under regulatory control of a historical mineral sand processing facility identified significant quantities of steel infrastructure contaminated with naturally occurring radionuclides: Th-232 and Th-234 (from U-238). Segregation of metal scrap was proposed in order to minimise waste volumes and allow recycling of cleared material. Measurements of surface contamination (Bq/cm^2) would be used to efficiently identify material suitable for clearance and subsequent recycling. This example applies similarly to a process leading to the disposal of the material in normal waste streams.

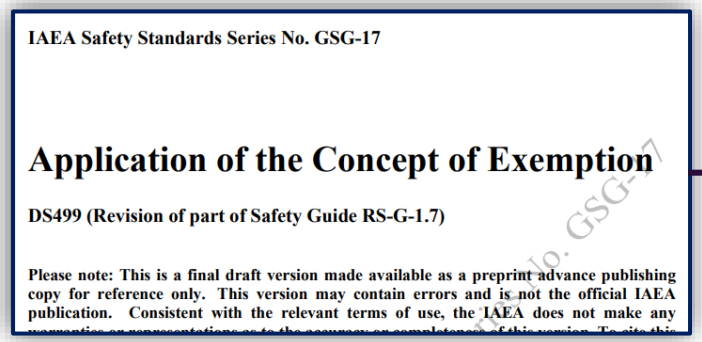
Table 7-1: Radionuclide specific doses from 1 Bq/cm^2 for automated scrap processing.

Table 7-2: Radionuclide specific doses from 1 Bq/cm^2 for manual scrap processing.

Radionuclides	Ingestion Dose µSv/a	β-Skin Dose µSv/a	External Exposure µSv/a	Inhalation Doses Thermal µSv/a	Inhalation Doses Saw µSv/a
Th 232	5.5E-1	4.1E-6	5.8E-2	8.7E+1	5.3E+0
Pa 231	1.8E+0	1.5E-4	2.3E-2	2.7E+2	1.6E+1
U 232	8.3E-1	6.8E-6	1.9E-1	7.8E+1	4.8E+0
U 233	1.3E-1	1.6E-6	3.2E-4	2.1E+1	1.3E+0
U 234	1.2E-1	4.8E-6	6.5E-4	2.0E+1	1.2E+0
U 235	1.2E-1	2.5E-4	8.0E-2	1.8E+1	1.1E+0
U 236	1.2E-1	4.3E-6	6.0E-4	1.9E+1	1.2E+0
U 238	1.2E-1	3.7E-6	1.1E-2	1.7E+1	1.0E+0



More Examples of Specific Exemption from GSG-17


IAEA Safety Standards Series No. GSG-17

Application of the Concept of Exemption

DS499 (Revision of part of Safety Guide RS-G-1.7)

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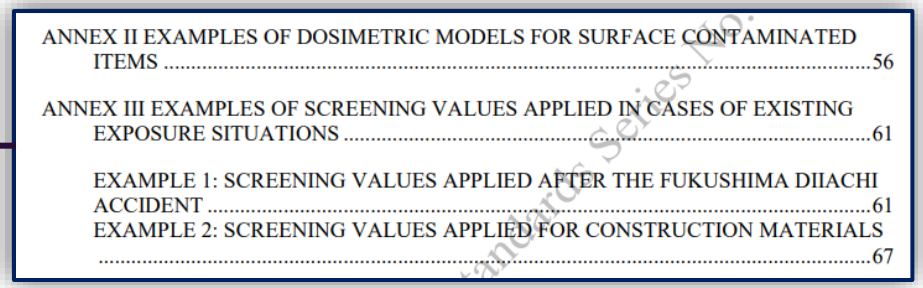

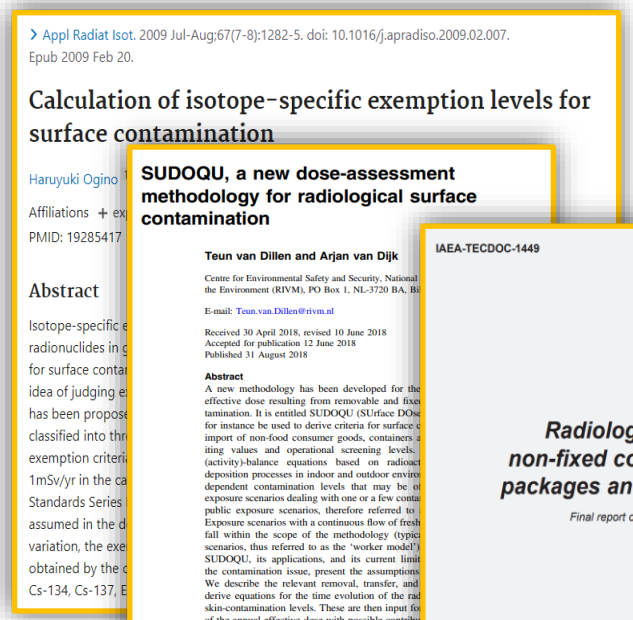
Appl Radiat Isot. 2009 Jul-Aug;67(7-8):1282-5. doi: 10.1016/j.apradiso.2009.02.007. Epub 2009 Feb 20.

Calculation of isotope-specific exemption levels for surface contamination

Haruyuki Ogino

Affiliations + ex

PMID: 19285417

Abstract

Isotope-specific e
radionuclides in g
for surface contar
idea of judging e
has been propose
classified into thr
exemption criteri
1mSv/yr in the ca
Standards Series
assumed in the d
variation, the exe
obtained by the c
Cs-134, Cs-137, E

SUDOQU, a new dose-assessment methodology for radiological surface contamination

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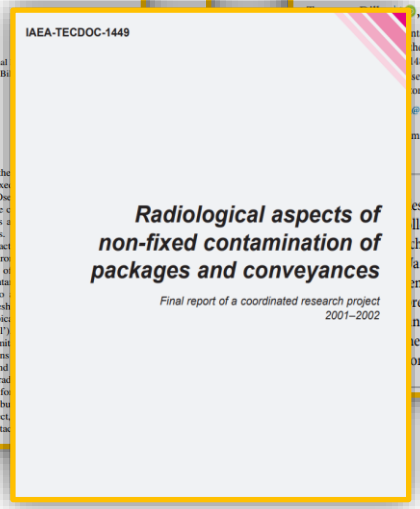
Published 31 August 2018

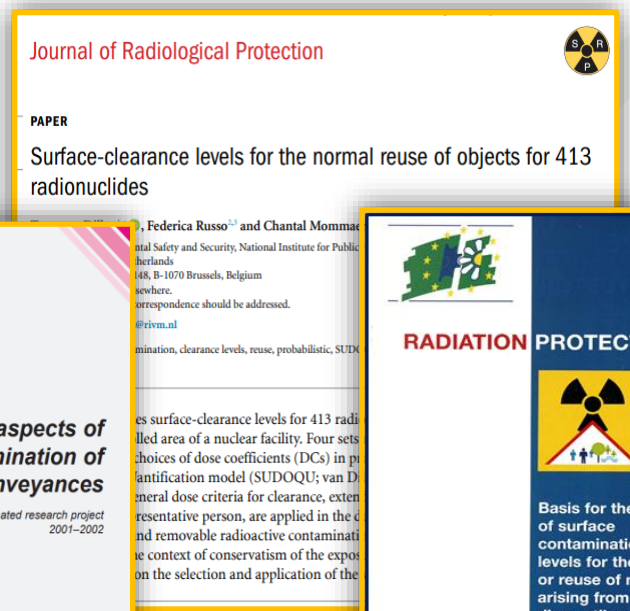
Abstract

A new methodology has been developed for the
effective dose resulting from removable and fixe
tamination. It is entitled SUDOQU (SUrface DOse
for instance be used to derive criteria for surface c
import of non-food consumer goods, containers a
iting values and operational screening levels,
(activity)-balance equations based on radioact
deposition processes in indoor and outdoor enviro
dependent contamination levels that may be o
exposure scenarios dealing with one or a few conta
public exposure scenarios, therefore referred to
Exposure scenarios with a continuous flow of fresh
fall within the scope of the methodology (typic
scenarios, thus referred to as the 'worker model').
SUDOQU, its applications, and its current limit
the contamination issue, present the assumptions
We describe the relevant removal, transfer, and
derive equations for the time evolution of the rad
skin-contamination levels. These are then input fo
of the annual effective dose with possible contribu
radiation, inhalation, secondary ingestion (indirect
contamination, direct ingestion and skin-contac


IAEA-TECDOC-1449

Radiological aspects of non-fixed contamination of packages and conveyances

Final report of a coordinated research project 2001–2002


Journal of Radiological Protection

PAPER

Surface-clearance levels for the normal reuse of objects for 413 radionuclides

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mination, clearance levels, reuse, probabilistic, SUD

es surface-clearance levels for 413 radi
lled area of a nuclear facility. Four sets
choices of dose coefficients (DCs) in pr
antification model (SUDOQU; van D
eneral dose criteria for clearance, exten
resentative person, are applied in the c
nd removable radioactive contaminati
e context of conservatism of the expos
on the selection and application of the

RADIATION PROTECTION 101

Basis for the definition of surface contamination clearance levels for the recycling or reuse of metals arising from the dismantling of nuclear installations

European Commission

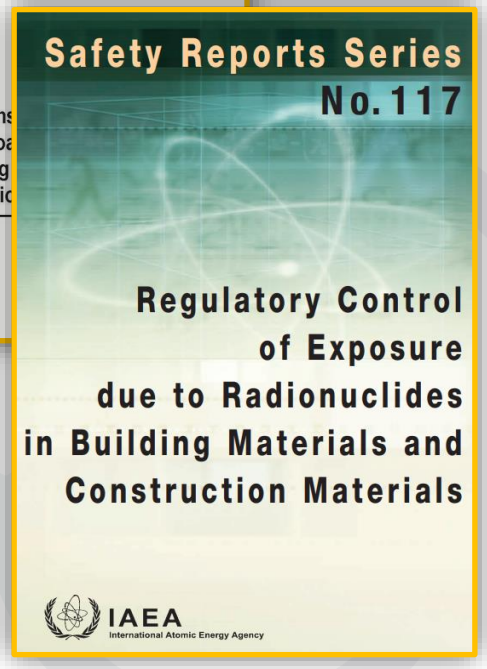
DOCUMENT


Argonne NATIONAL LABORATORY

ANL/EVS/TM/11-3

Potential Dose Distributions
at Proposed Surface Radioa
Clearance Levels Resulting
from Occupational Scenaric

Environmental Science Division


Safety Reports Series No. 117

Regulatory Control of Exposure due to Radionuclides in Building Materials and Construction Materials

IAEA International Atomic Energy Agency

More Examples of Specific Clearance from GSG-18

Further Considerations & Limitations

Emphasis of the Australian context

- Mining & milling operations
- Decommissioning of facilities

Commonwealth vs State & Territory

- 2 guidance documents required ?
- State disposal of material cleared by C'wealth

> Importance of national uniformity

'Cost' to develop SPECIFIC levels

- Finding balance
- Optimisation vs ease of GENERIC levels
- Encourage sustainable practices
- Minimise disposal volumes

DRAFT GUIDANCE SOON
FEEDBACK WELCOME

Thank you

 ARPANSAGovernment

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