

International Safety Standards and their Application to NORM

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IAEA

International Atomic Energy Agency



Overview

1. The International Safety Standards
2. Application of the Standards to NORM
3. Revision of the BSS – possible changes concerning natural sources
4. Regulatory implications of the Standards
 - worker exposure
 - public exposure
5. Report-back from NORM V
6. A few words about NORM residues

International Safety Standards – the IAEA's mandate

The Agency is authorized.....

- To establish or adopt,
in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned,
standards of safety for protection of health and minimization of danger to life and property and to provide for the application of these standards.....

(IAEA Statute 1956 as amended)

Cosponsorship of standards

IAEA Safety Standards

for protecting people and the environment

Fundamental Safety Principles

Jointly sponsored by

Euratom FAO IAEA ILO IMO OECD/NEA PAHO UNEP WHO



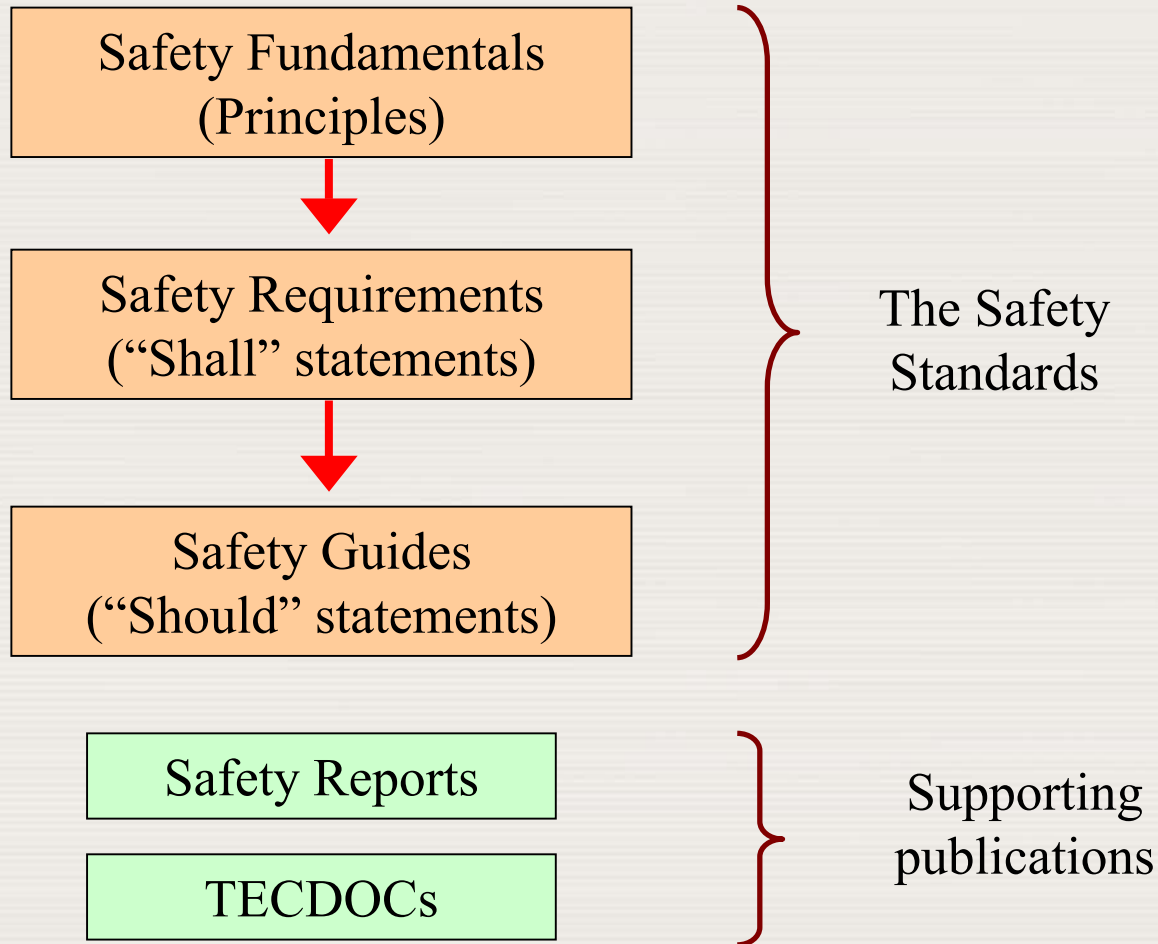
Euratom
FAO
IAEA
ILO
IMO
OECD/NEA
PAHO
UNEP
WHO

Safety Fundamentals

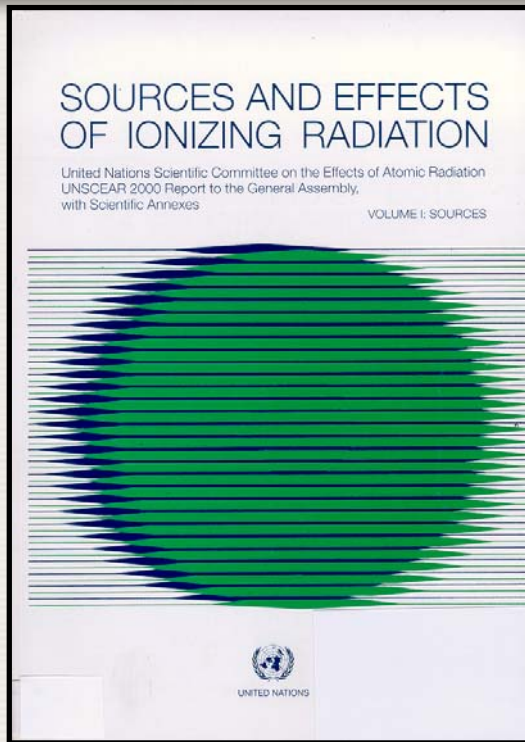
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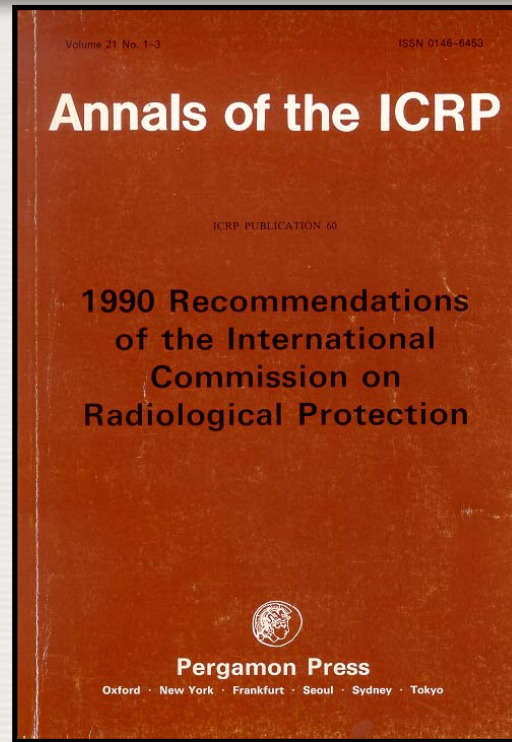
Hierarchy of the safety standards



Standards development process



UNSCEAR
Data on sources
and effects of
radiation



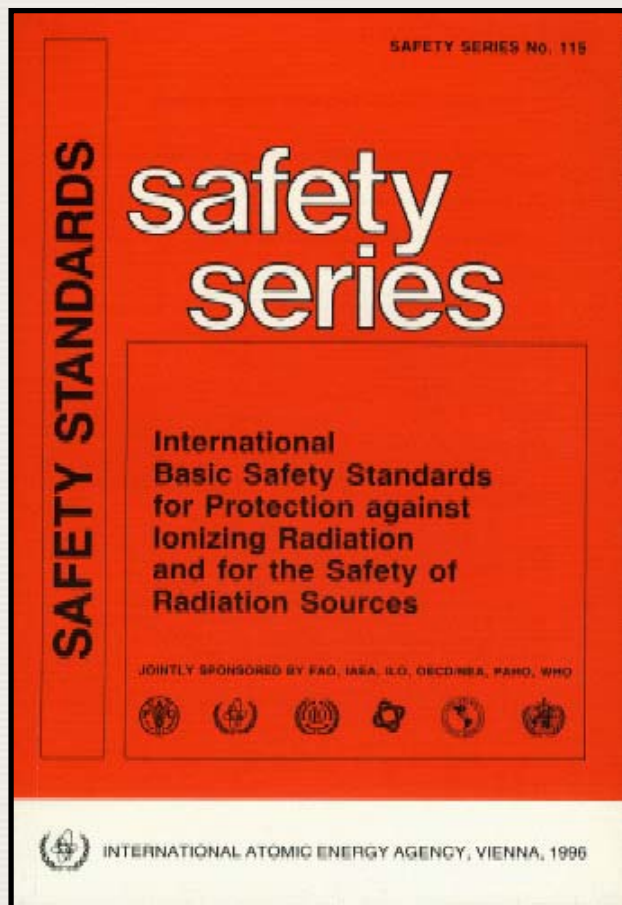
ICRP
Recommendations for
protection



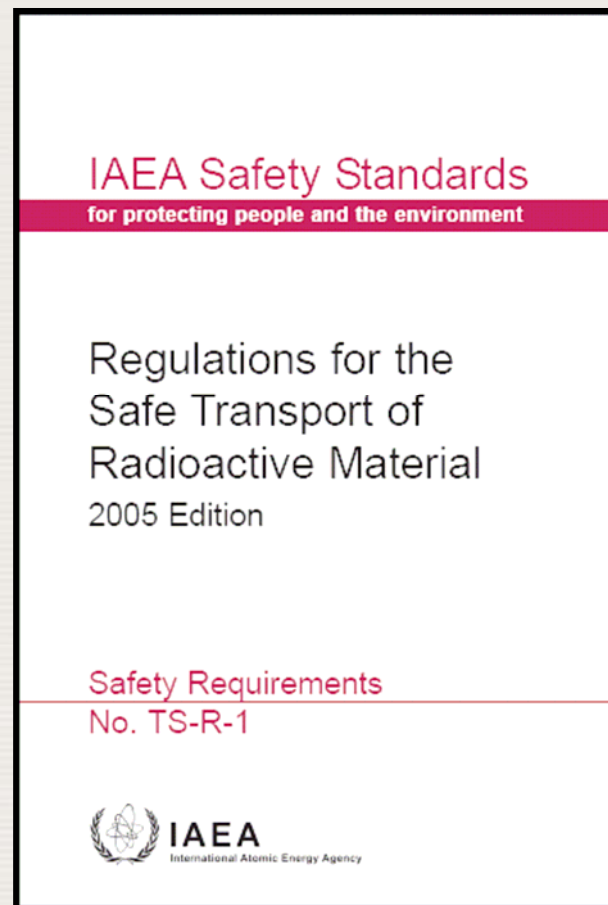
**IAEA + other
intergovernmental
bodies**

Regulatory style
standards

Safety Requirements containing specific references to natural sources

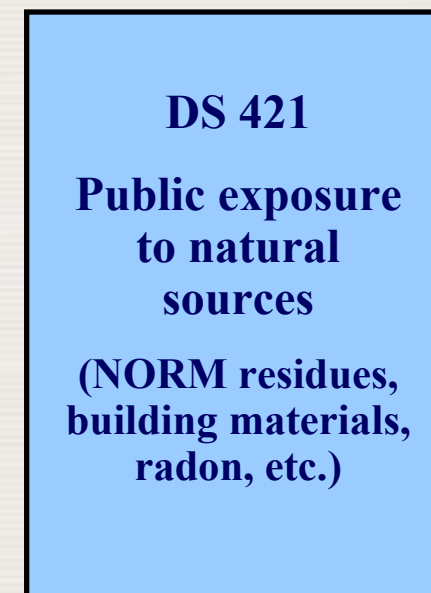
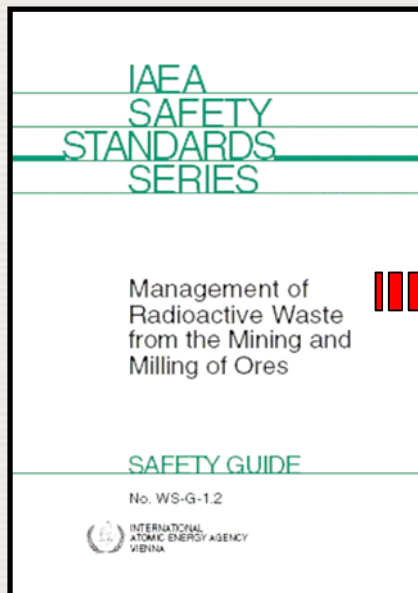
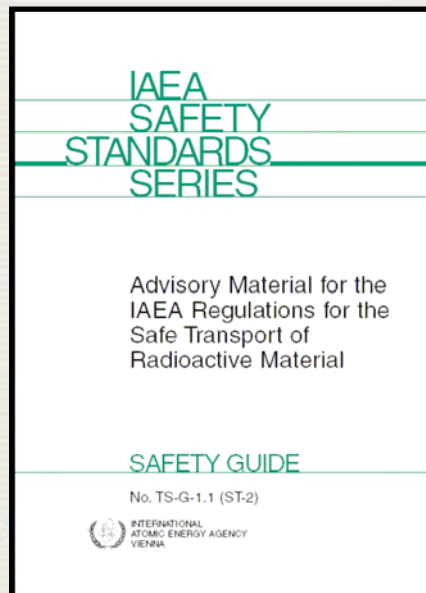
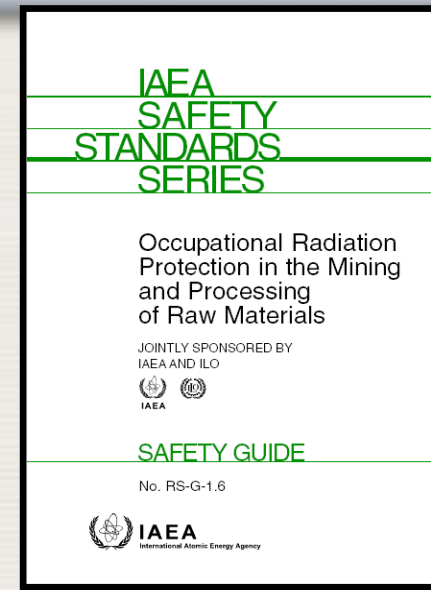
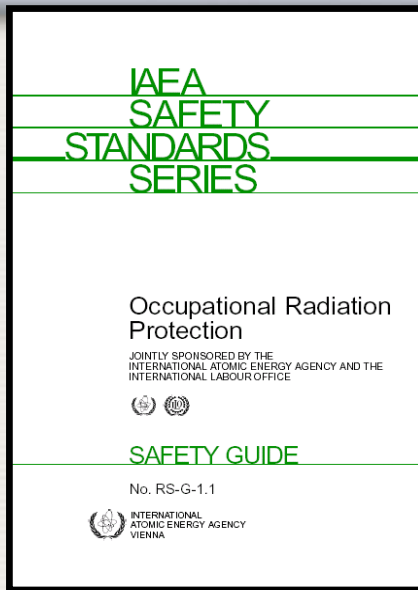
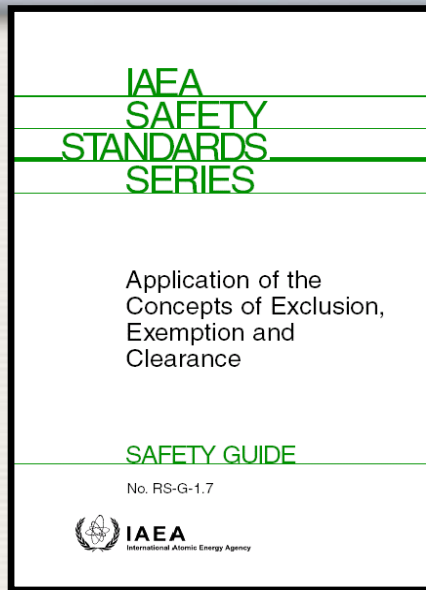


The “BSS”

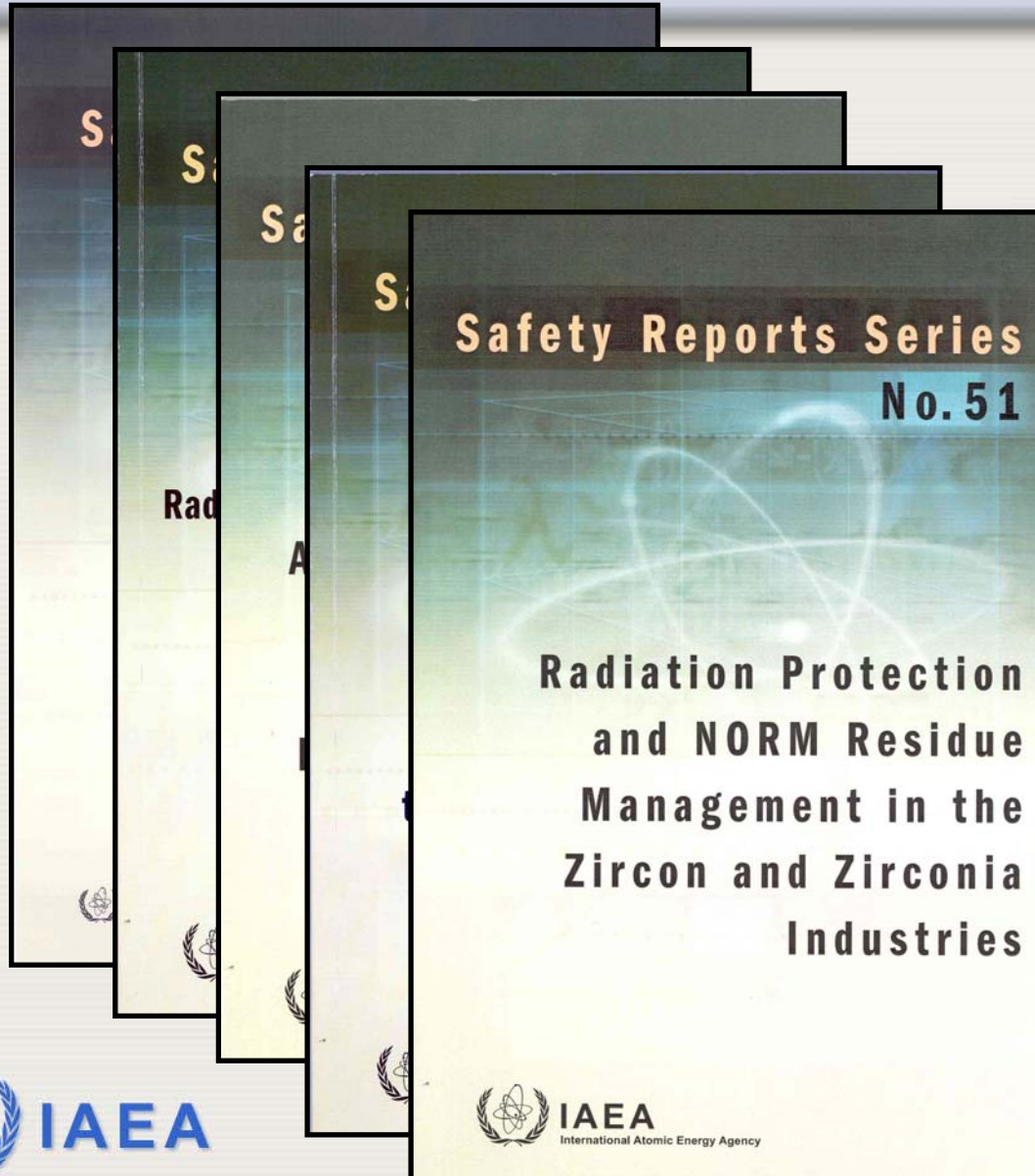


The “Transport Regulations”

Safety Guides containing specific recommendations on natural sources



Safety Reports concerning exposure to natural sources



Under development:

- Phosphate industry
- TiO₂ pigment production
- Monazite and rare earths extraction
- Industrial uses of thorium
- etc. ????

Application of the Standards to NORM

- but, first of all, what is NORM?

Definition of NORM for the purposes of the Standards:

Material (irrespective of whether processed or not)

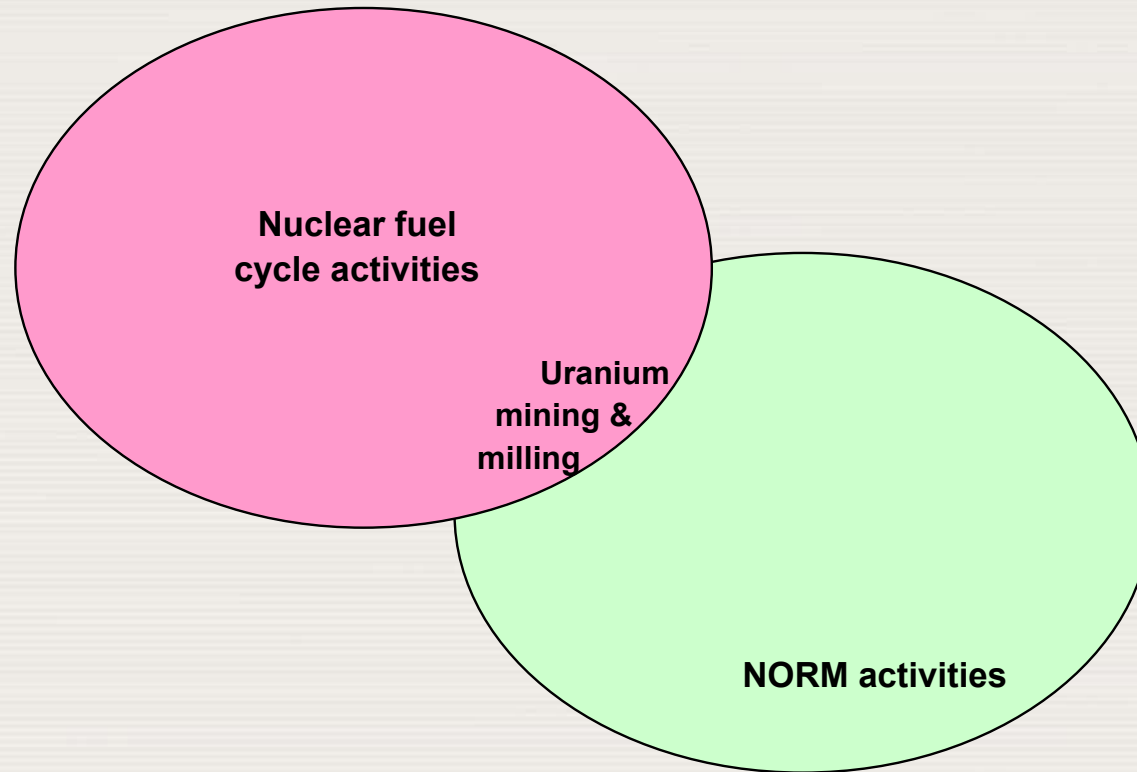
- that contains no significant amounts of radionuclides other than naturally occurring radionuclides and
- is designated in national law or by a regulatory body as being ***subject to regulatory control*** because of its radioactivity

Note:

- Regulatory control as a practice includes the option of exemption
- Regulatory control may also mean control as an existing exposure situation, e.g. building code, land remediation plan
- Although not explicitly stated, NORM does not include material in nuclear facilities, e.g. enrichment plants

NORM and the nuclear fuel cycle

- the overlap



Practice or intervention?

Planned exposure situations

Existing exposure situations

BSS, para. 2.5:

“Exposure to natural sources shall normally be considered as a chronic [existing] exposure situation and, if necessary, shall be subject to the requirements for intervention

except that.....”

Some exposures are, by exception, subject to the requirements for practices

Practice or intervention? (contd)

What are the exceptions?

- Radon
 - some occupational exposures
- NORM
(including public exposure to discharges and waste from NORM facilities)
 - as specified by the regulatory body

Subject to the requirements for practices

Guidance now available from Safety Guide RS-G-1.7

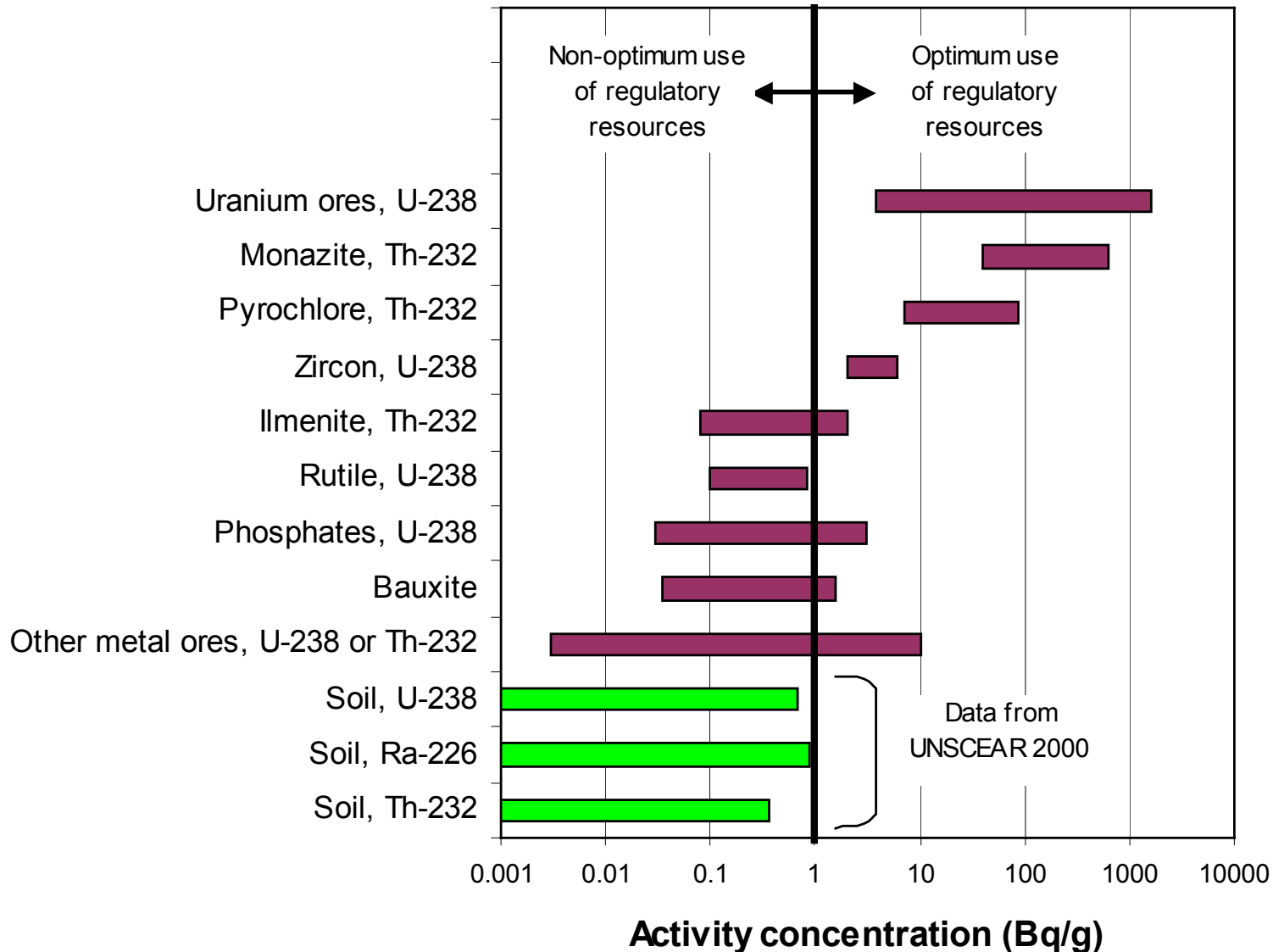
Safety Guide RS-G-1.7 – criteria for regulation of NORM as a practice

- It is usually unnecessary to regulate material below:
 - 1 Bq/g -- U, Th series
 - 10 Bq/g -- K-40
- These values can also be used as **clearance** levels for release of NORM residues from practices
- These criteria do NOT apply to:
 1. Material that is subject to the requirements for existing exposure situations.....
 - Radon
 - Drinking water, foodstuffs, building materials
 - Existing residues in the environment

} Apply the requirements for existing exposure situations
 2. Material in one particular type of planned exposure situation (practice).....
 - Material in transport

Use, instead, the criteria in the Transport Regulations

The rationale for 1 Bq/g



Implementation of the 1 and 10 Bq/g criteria

IAEA Board of Governors, September 2004:

- Approved the use of the criteria in the application of the BSS

IAEA General Conference Resolution GC(48)/RES/10, September 2004:

- Welcomed the approval by the Board of Governors
- Encouraged IAEA Member States “to make use of the criteria, for example to facilitate trade”
- Encouraged the IAEA Secretariat “to take account of the criteria in the forthcoming review and revision of the BSS”

Revision of the BSS – implications for natural sources

1. New terminology in latest ICRP draft recommendations

Planned exposure situation instead of practice

- These are not the same – a practice is an activity or operation, whereas a planned exposure situation is a “situation”
- The new term has been introduced into draft 0.5 of new BSS, but not sure yet whether we can do away with the term “practice”, as this is what is regulated

Existing exposure situation instead of chronic exposure situation

- These are the same – direct substitution
- The term “intervention” can be avoided if necessary by referring to “remedial or protective actions”

For existing exposure situations, reference level instead of action level

- These are not the same
- A reference level is a sort of upper bound, whereas
- An action level can be seen as a sort of lower bound – a “non-action” level, below which further remedial or protective action is deemed to be not justified
- ICRP still mentions the possibility of a “non-action” level for radon in homes, but the emphasis has shifted

Revision of the BSS – implications for natural sources

2. Reference levels for radon

- The numerical value of the present upper bound on the range of action levels is now used by ICRP as the maximum value of the national reference level
- This approach has been adopted in the current draft of the revised BSS (version 0.5)
- The IAEA Safety Committees have recommended to add a footnote on radon reference levels typically used by Member States – these are generally lower than the maximum reference level recommended by ICRP

Revision of the BSS – implications for natural sources

3. Criteria for regulating NORM as a practice (1 and 10 Bq/g)

- The numerical criteria have been incorporated into version 0.5 in accordance with the General Conference Resolution
- In line with the recommendations of Safety Guide RS-G-1.7, these criteria do not apply to:
 - Radon, foodstuffs, drinking water, building material and residues in the environment
 - Exposures from these materials continue to be controlled, where necessary, in accordance with the requirements for existing exposure situations
 - For commodities, e.g. building materials, the maximum reference level is similar to the public dose limit, so the level of control is similar to that for a practice
 - Material in transport
 - Exposures to these materials continue to be controlled in accordance with the IAEA Transport Regulations, where applicable

Revision of the BSS – implications for natural sources

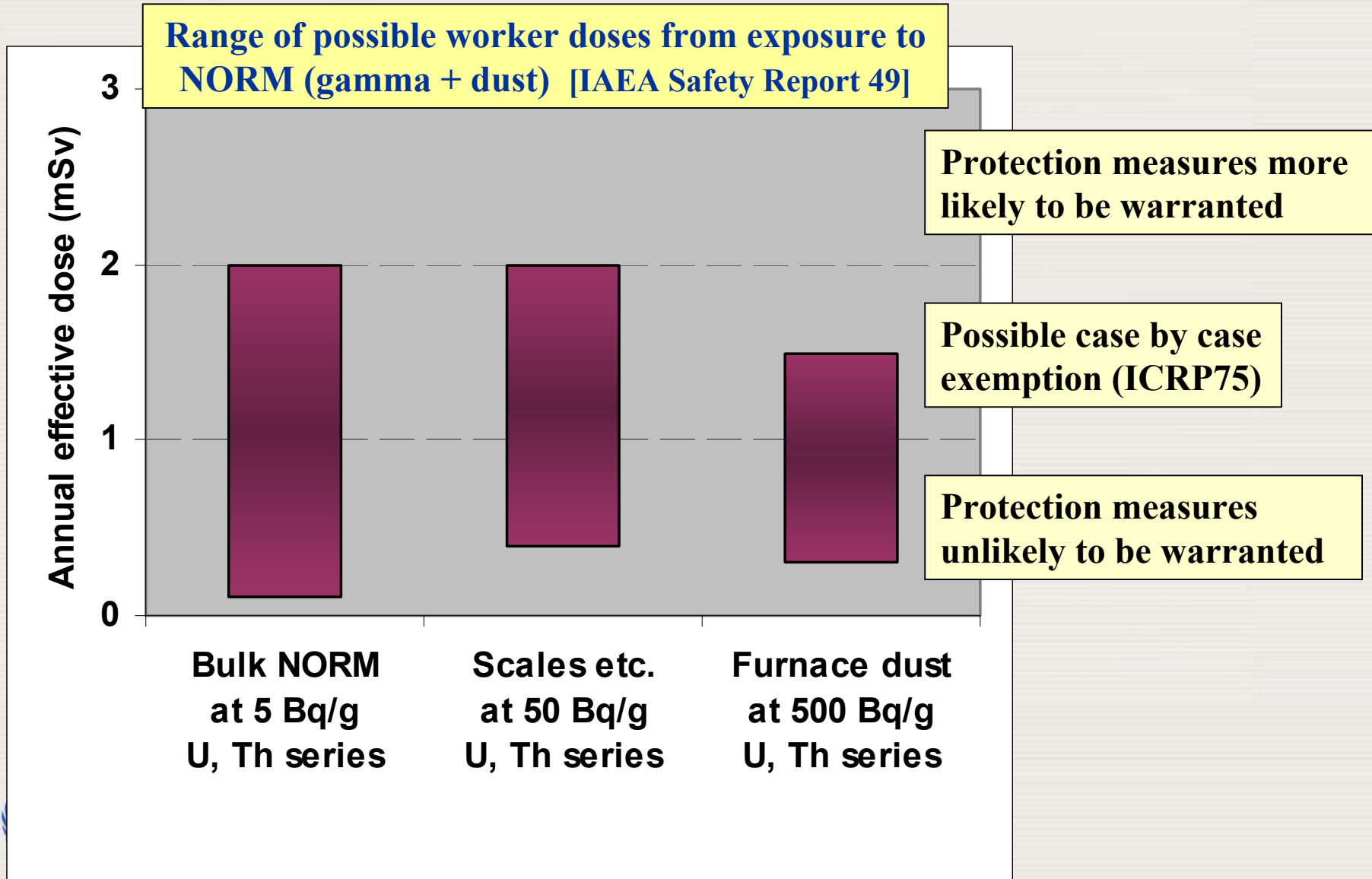
4. Timetable for the next 12 months

- Next drafting meeting with existing and potentially new cosponsors
26–30 November 2007
- Draft version 1.0 to be completed by May/June 2008
 - This will be the first complete “clean” draft
- Review of version 1.0 by IAEA Safety Committees November 2008

Regulatory implications

Question: What if 1 or 10 Bq/g is exceeded?

Answer: Consider exemption as 1st option in graded approach to regulation



Regulatory implications
Exposure of workers to NORM rich in ^{40}K
[IAEA Safety Report 49]

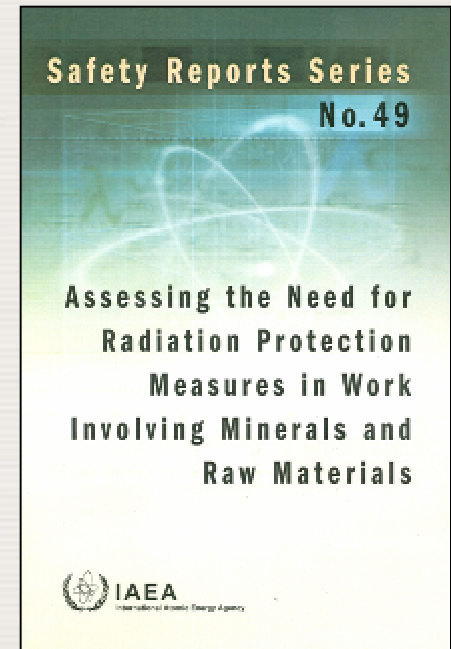
	^{40}K activity concentration (Bq/g)	Annual effective dose (mSv)
K fertilizer	≤ 9.6	≤ 0.17
PK fertilizer	≤ 6.2	≤ 0.15
NPK fertilizer	≤ 5.9	≤ 0.18
Hypothetical fertilizer, pure K	30.6	0.6—0.9

Annual dose is always less than 1 mSv !!

The 12 NORM industries that need to be considered for regulation as practices

1. Mining and processing of uranium ore
2. Rare earths extraction
3. Thorium extraction & use
4. Niobium extraction
5. Non-uranium mines
6. Oil and gas
7. Phosphate industry
8. Zircon & zirconia
9. TiO₂ pigment production
10. Metals production (Sn, Cu, Al, Fe, Zn, Pb)
11. Burning of coal etc.
12. Water treatment (Rn, solid residue)

More details in IAEA
Safety Report 49



Worker doses in some of the 12 NORM industries (mSv/a)

1.	Mining and processing of uranium ore	3 – 4 (av.) ←
2.	Production of rare earth elements	
	— Separation of monazite from mineral sands	1.5 – 7 ←
	— Chemical extraction of REEs	3 – 9 ←
3.	Thorium extraction & use	
	— Production of thorium compounds	~ 10 (max.) ←
	— Gas mantle production	1 – 10 ←
	— Other uses of thorium	0 – 0.3
4.	Niobium extraction	
5.	Non-uranium mines	0.1 – 8.5 (av.) ←
6.	Oil and gas	0 – 1.6
7.	Phosphate industry	0.02 – 1
8.	Zircon & zirconia	
	— Thermal zirconia production	0.7 – 3.1
	— Other	0.01 – 1
9.	TiO₂ pigment production	0.03 – 1
10.	Metals production (Sn, Cu, Al, Fe, Zn, Pb)	
11.	Burning of coal etc.	0.15 (max.)
12.	Water treatment (Rn, solid residue)	

Public doses from some of the 12 NORM industries (mSv/a)

1.	Mining and processing of uranium ore	0.02 – 0.04
2.	Rare earths extraction	
3.	Thorium extraction & use	
4.	Niobium extraction	
5.	Non-uranium mines	0 – 0.2
6.	Oil and gas	0.002
7.	Phosphate industry	0.001 – 0.2
8.	Zircon & zirconia	0 – 0.1
9.	TiO₂ pigment production	0
10.	Metals production (Sn, Cu, Al, Fe, Zn, Pb)	
	— Iron and steel production	0.01
	— Red mud disposal	0.01
11.	Burning of coal etc.	0.01
12.	Water treatment (Rn, solid residue)	

NORM V Symposium, Seville, March 2007

- Organized by the University of Seville, in cooperation with the IAEA, the Spanish Nuclear Safety Council and the University of Huelva
- 200 participants, 40 countries
- 37 oral presentations, 50 posters
- Proceedings to be published by the IAEA late 2007 or early 2008
- NORM VI will be held in Marrakech, March 2010

NORM V – some conclusions

- Most industrial uses of Th, some of which could give rise to significant worker doses, are disappearing as non-radioactive substitutes become available
- This leaves the following as almost the only NORM industries with potential for significant worker doses, provided good work practices such as control of dust levels and occupancy time are applied:
 - Processing of Th rich minerals (e.g. monazite)
 - Mining and processing of U ores
 - Some underground mines and similar workplaces with high Rn levels

NORM V – some conclusions (contd)

- Doses to the public are consistently $\ll 1$ mSv/a if normal environmental protection measures are applied, e.g. effluent treatment
- Unrealistic modelling assumptions can give rise to overestimates of up to 2 or 3 orders of magnitude when calculating doses. This could lead to false conclusions on the need for regulation

NORM V – some conclusions (contd)

Harmonization of standards and regulation:

- There is a growing acceptance of the 1 and 10 Bq/g criteria for regulation of NORM as a practice, as per the General Conference Resolution
- 1 mSv/a is now commonplace as a de facto exemption criterion for NORM in practices
- However, harmonization still remains a prospect rather than a reality, resulting in a growing number of incidences of disruptions to trade

NORM V – some conclusions (contd)

Management of NORM residues:

- Bulk wastes stored in engineered surface impoundments have limited radiological impact (often significantly overestimated), but their environmental, safety and financial liability aspects have often been underestimated
- For other NORM residues that have to be disposed of as waste, there is now considerable knowledge on methods for conditioning, storage and disposal, but the facilities and regulatory provisions are generally lacking
- Use, reuse and recycling of NORM residues – with dilution where necessary – is starting to become recognized as a legitimate and desirable alternative to disposal as waste

More on NORM residues



Trial road built with PG –
comparison with normal road

Fertilizer plant viewed from
PG stack



NORM residues – uranium mining has received much attention



....and other NORM residues are not so different



Recreativo de Huelva

Huelva

Palos de La Frontera

Puerto de Palos de Moguer

Image © 2005 DigitalGlobe

© 2005 Google

Pointer 37°15'06.64" N 6°55'29.16" W

Streaming 100%

Eye alt 23291 ft

.....or are they?



Mixed waste



Asbestos lining

Radium scale

Thankyou for your attention!

Radioactive coal residue (iodine extraction from formation water)