Management of NORM in Australia

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Naturally Occurring Radioactive Materials

- The system of radiation protection was developed with the primary aim of controlling risks from man-made sources
- Naturally Occurring Radioactive Materials (NORM) may be more of a problem when considering the number of people exposed and the levels of exposure
- Imposing the same risk and dose criteria on NORM sources as on man-made sources could result in a significant burden on society

NORM in Australia

- **Australia has developed a Safety Guide on the *Management of Naturally Occurring Radioactive Material (NORM)***

- **The Safety Guide describes the broad regulatory decision-making framework of exclusion and exemption and is based on the system set out in IAEA Safety Report 49**

NORM in Australia

- Many industries in Australia process materials with enhanced levels of NORM

- Depending on the industry and the process involved, enhanced levels may be found in
  - products
  - by-products or
  - waste streams

NORM in Australia

- Mining and mineral processing
  - mineral sand industry, alumina production, tantalum mining,
  - tin smelting, copper production
- Downstream processing of heavy minerals,
  - titanium pigment production, zirconium products
- Phosphate ores
  - production of phosphoric acid and fertiliser
  - Phosphogypsum: fertiliser; soil conditioner; building materials
- Fossil fuels use
  - oil and gas, coal-fired power stations
- Metal smelting industries
  - tin smelting, pig iron production
- Ceramics and building materials
- Water treatment and purification

NORM in Australia

Radionuclide Content ($Bq\ kg^{-1}$)	Quantity Produced Annually		
	Small (< 1 kt)	**Moderate (1 kt - 100 kt)**	**Large (> 100 kt)**
0 – 1000	Oil (sands and sludge)	Synthetic rutile	Alumina residues (red mud)
			Coal ash (bottom ash & fly ash)
	Oil (hard scales and films)	Ceramics	Titanium dioxide pigment, slurries & solids
		Sand blasting materials	Tantalum and Copper tailings
			Ores (coal, bauxite, iron ore)
		Oversize from secondary mineral sands separation	Heavy minerals (concentrate, ilmenite, rutile, zircon)

NORM in Australia

Radionuclide Content ($Bq\ kg^{-1}$)	Quantity Produced Annually		
	Small (< 1 kt)	**Moderate (1 kt - 100 kt)**	**Large (> 100 kt)**
0 – 1000			Furnace and metal smelter slags
			Phosphogypsum
			Phosphate fertilisers
			Water treatment sludge
			Building materials & building/demolition waste

NORM in Australia

Radionuclide Content (Bq kg^{-1})	Quantity Produced Annually		
	Small (< 1 kt)	**Moderate (1 kt - 100 kt)**	**Large (> 100 kt)**
1000 – 5000	Oil (sands and sludge) Oil (hard scales and films)	Tantalum products Oversize from secondary mineral sands separation Dust from secondary mineral sands separation Phosphoric acid	Heavy minerals (concentrate, ilmenite, rutile, zircon) Superphosphate & phosphate rock Alumina residues (red mud) Solids from effluent treatment (titanium dioxide pigment production)
5000 – 20000	Oil (sands and sludge) Oil (hard scales and films)	Dust from secondary mineral sands separation. Tantalum concentrate	Tails from secondary mineral sands separation
> 20000	Zircon dusts Copper smelter dusts Oil hard scales and films	Monazite concentrates Monazite tailings Tantalum concentrate	Tails from secondary mineral sands separation

System of Radiation Protection

- ICRP 60 (1990) imposed controls on activities that changed radiation exposure:

  practices or interventions

- In 2007 ICRP revised its recommendations

- The new system now applies to all conceivable circumstances of exposure
  - Planned Exposure Situations
  - Emergency Exposure Situations
  - Existing Exposure Situations

System of Radiation Protection

- Exposures to NORM should be treated as Planned or Existing situations

- Applies to industries that enhance NORM in their product streams or their waste streams, resulting in potential or actual exposures to workers and members of the public.

System of Radiation Protection

- Exposures that are unamenable to control are generally excluded from the radiation protection system
- Sources that are not excluded may however be exempted from some or all requirements of the system of protection
- Exemption levels for man-made radionuclides in BSS 115 are based on a an annual dose of $10\mu Sva^{-1}$
- NORM exposures are often one hundred times higher
- For NORM in bulk materials the IAEA (RS-G 1.7) determined activity concentration
  - 1 Bq/g for alpha emitters and
  - 10 Bq/g for beta emitters

System of Radiation Protection

- NORM will be managed at exposures approximately one hundred times higher than man-made sources

- This presents a major difficulty in developing a system to regulate exposures from NORM and explaining it to members of the public.

System of Radiation Protection

- Within the new system the principle of optimisation of protection is now considered as the primary tool in radiation protection.

- The principle is stated as: the likelihood of incurring exposures, the number of people exposed, and the magnitude of their individual doses should all be kept as low as reasonably achievable, taking into account economic and societal factors.

System of Radiation Protection

- The level of protection should be the best under the prevailing circumstances, maximising the margin of benefit over harm.

- In order to avoid severely inequitable outcomes of this optimisation procedure, there should be restrictions on the doses or risks to individuals from a particular source using dose or risk constraints and reference levels.

System of Radiation Protection

- Constraints and reference levels will ensure appropriate levels of protection under the prevailing circumstances and should not be used or understood as prescriptive regulatory limits.

- The optimisation process is an iterative process requiring regular review.

- Where optimisation becomes a part of the regulatory process, the focus should not be on specific outcomes for a particular situation, but rather on processes, procedures, and judgements.

Management of NORM

NORM can be classified as:

Planned Exposure Situation

- Dose constraints for public exposure should be set in the less than 1mSv band
- Dose constraints for occupational exposures should be set in the 1 - 20mSv band.

Existing Exposure Situations

- Situations that exist when a decision on control has to be taken.

Management of NORM

- Exposures from NORM should be reduced to levels that are close or similar to situations considered as ‘normal’ and
- Whenever practicable, values for the reference levels should be set at the lower end of the 1 to 20 mSv band.

Graded approach to the Management of NORM

- Regulation of NORM requires a graded approach
  - regulatory effort should be proportional to radiological risk
  - screening assessment of the potential radiological impact
- Regulator may grant
  - unconditional exemption or
  - require that a more detailed environmental impact assessment and safety assessment be carried out
- Regulator may then grant conditional exemption or require registration or licensing of the operation.

Notification

- Regulatory Authority may contact a new or existing industry and request a screening assessment if there is a potential for radiation impacts.
- Should be the responsibility of the operator to notify the regulator that an operation involves naturally occurring radioactive materials.
- Notification provides a record for the Regulatory Authority of the intended operation and any decision to either exempt the operation, where it is clear that exposures and activity concentrations will not exceed the relevant exemption criteria, or to proceed with a screening assessment.

Screening assessment

- Upon receiving a notification, the Authority may require an initial screening risk assessment to be made to estimate:
  - the magnitude doses to workers or members of the public;
  - the level of optimisation of radiation protection;
  - the long term impact of any residues on the environment in the case of disposal;
  - the impact of residues that may be recycled;
  - the impact of manufactured items containing NORM.

- Due to the wide variability of NORM operations
  - screening assessment should be specific to the particular operation
  - should be negotiated between the operator and regulator
  - assessment may be based on existing information relating to the operation, its processes and waste/residue management methods,
  - or be based on an agreed monitoring program to provide more data

- Possible outcomes of screening include
  - unconditional exemption, conditional exemption plus periodic review
  - registration, licensing and
  - requirement to develop a NORM management plan

Unconditional exemption

- Where doses are below the exemption criteria, and any other impacts are considered acceptable, the Authority may exempt the operation from further any requirements.

- This would apply to those cases where it is clear that the potential for significant exposures is negligible even if there are changes to the process or the materials being handled.

Conditional exemption

- Where the screening assessment confirms that the criteria for unconditional exemption cannot be met
  - but doses to the workforce and public are well below dose limits,
  - a conditional exemption may be appropriate.

- Ongoing requirements for
  - monitoring and reporting and/or
  - periodic re-assessment against reference levels or dose constraints being applied as conditions of the exemption.
- Operator may be required to develop a NORM management plan, including re-assessment.

Registration/Licensing

- If exemption is not granted, regulation may require the operator to hold an appropriate licence or registration to
  - assign responsibilities
  - require a NORM management plan including
  - a radiation management plan
  - a radioactive waste management plan
  - ongoing monitoring and reporting
  - frequency of re-assessment

NORM management plan

- NORM Management Plan should cover all aspects of the management of radiation exposures and radioactive waste.
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- The plan should include:
  – description of all processes particularly where doses may arise
  – demonstration of compliance with relevant radiation protection standards
  – relevant elements of a plan to manage radiation exposures
  – relevant elements of a radioactive waste management plan

NORM management plan

- NORM Management Plan
  - assessment of the current or projected use of a material that may be recycled
  - assessment of the potential impact of manufactured items containing NORM
  - appropriate monitoring and review programs
  - the relevant occupational health and safety issues
  - the relevant environmental protection issues
  - the definition of responsibilities for the operator/employer and employees
  - a process of review of the status of the operation in relation to continuing controls

Conclusions

- For NORM practices activity concentrations are generally low but volumes are often high

- A graded approach to regulation is required
  - Unconditional or conditional exemption might be appropriate
  - A graded approach places emphasis on the need for optimisation
  - The costs and benefits of introducing regulatory requirements need to be considered and compared with other options that would achieve the same objective.
  - Development of a NORM management plan is important in determining the level of regulation required
    - characterisation of materials, monitoring of radionuclide concentrations, and ongoing risk/dose assessments

Conclusions

- Public perception is important in any issue involving radioactive materials
- Involvement of stakeholders is an important consideration when assessing the optimisation of protection when utilising NORM, or disposing of NORM residues and wastes
- There is a clear need for communication of the potential risks and benefits associated with proposals of this nature.