IAEA
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ENVIRONET NORM – Work Session Task 1 – Status Report

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9th International Symposium on Naturally Occurring Radioactive Material (NORM IX)

22-27 September 2019

Denver, Colorado, USA

ENVIRONET Project NORM - History

- ENVIRONET meeting participants identified need for assistance in acquiring knowledge and practical experience related to NORM residue/waste/legacy site management NORM Residues Management workshop, The Netherlands, **Oct 2013**
- Consultants meeting, Vienna, Austria, **Jul 2015**: purpose to evaluate need, objectives, scope, and potential activities of a new NORM Project; Draft project ToR presented at ENVIRONET Annual Meeting
- 1st NORM Project Technical Meeting, Stockholm, Sweden **Dec 2016**: held jointly with the 8th EAN_{NORM} Workshop; revised project ToR and identified specific **task 1a** and **task 2**
- 2nd NORM Project Technical Meeting, Vienna, Austria, **Oct 2017**; made progress on existing tasks and established new **task 3**
- 3rd NORM Project Technical Meeting, Katowice, Poland, **Nov 2018**: held jointly with the 1st ENA Workshop; special ENVIRONET/NORM work session – redefine **task 1b Policy & Strategy**
- 4th NORM Project Technical Meeting, Denver, Colorado, USA, **Sep 2019**: parallel and ENVIRONET/NORM work session during the NORM IX Symposium

NORM Residue and Waste Management Issues

*per December 2016 (cf. Table 1 of the NORM Project **Terms of Reference** for complete list)*

1. **Terminology (task 1a)**

2. **NORM Policy & Stakeholder Involvement (task 1b)**
   - Policy, strategy, regulation
   - Exemption levels
   - Conditional clearance
   - Cost, funding, resource requirements
   - Raising MS awareness
   - Stakeholder engagement
   - Import, export, international trade

3. **NORM Characterization & Risk Assessment**
   - **Inventory (task 2 – Wouter Schroeyers)**
   - NORM characterization
   - NORM measurements
   - Risk Assessment

4. **Management Framework**
   - Life-cycle management
   - Integrated safety management
   - Cost assessment (Task 3)
   - National management approach
   - Waste management options
   - Stakeholder involvement
   - Transportation
   - Emergency preparedness
   - Closure or decommissioning
   - Long-term stewardship

5. **Legacy Sites**
   - Identification
   - Characterization
   - Risk assessment
   - Remedial action
   - Costing and funding

Current Tasks under Activity 1 of the NORM Project

Task 1: Definitions / Considerations for Developing Policies and Strategies for NORM Residue and Waste Management

- Develop a document discussing aspects to be considered in developing national NORM policies and strategies

Task 2: Guidance on the Assembly of NORM Inventories

- Develop guidance on the need and process for assembling information regarding NORM management infrastructures and NORM inventories

Task 3: Assessment of Costs Associated with NORM Management

- Develop document providing a roadmap for assessing costs associated with the management and disposal of NORM residues and wastes, across the full lifecycle of activities (including decommissioning).

Aspects to Consider in Developing National NORM Policies & Strategies *(Draft Outline Report – remarks 3rd Project Meeting)*

NORM policies and strategies should be founded by a comprehensive NORM inventory and cost considerations and implications.

I. Introduction and definitions

a. Policy –definition and purpose
b. Strategy – definition and purpose
c. Country-specific drivers and constraints
   - NORM Policy vs Waste Policy

II. General Information about NORM

a. Definition
b. NORM-related industries (define, not just list)
c. NORM waste streams and radionuclides

III. Principles and core values

➢ Core values vs. National responsibility

a. Radiation protection principles (safety objectives)
b. Graded approach
c. Waste management hierarchy
d. Cradle-to-grave (lifecycle management)
e. Sustainability
f. Stakeholder engagement
g. Knowledge management (training, staff development, succession planning, record retention)
h. Integrated Approach

Aspects to Consider in Developing National NORM Policies & Strategies *(2)*

IV. Elements of Policy and Their Implications

a. Responsibilities
   - ➢ Responsible authority (enforcement)
   - i. National government/legislature
   - ii. Operators
   - iii. Regulators
     1. Multiple jurisdictions
     2. Cooperative agreements
     3. Harmonization of requirements
   - iv. Waste management Organizations
   - v. Others

b. Inventory (NORM Policy vs Waste Policy)
   - i. NORM-related industries
   - ii. NORM residues and waste streams generated
   - iii. Future and on-going operations
   - iv. Legacy sites

c. Management Framework (management approaches)
   - i. Decision making
     1. Dose and risk-based (occup. & public)
     2. Cost-benefit analysis
     3. Technological readiness
     4. Environmental impact assessment
   - ii. Waste classification
   - iii. Private versus government
   - iv. Analytical laboratories
   - v. Storage requirements
   - vi. Disposal options
   - vii. Recycle/reuse
   - viii. Transportation
   - ix. Monitoring
   - x. Reporting
   - xi. Infrastructure (compliance)

d. Trans-boundary considerations

e. Provision of resources
   - i. Financial (assurance)
   - ii. Human resources
     1. Knowledge management
   - iii. Infrastructure
   - iv. Long-term stewardship (institutional control, monitoring)

f. Stakeholder engagement

Aspects to Consider in Developing National NORM Policies & Strategies *(3)*

V. Elements of Strategies and Their Implications

a. Level (industry, company, project)

b. Detailed inventory of residues/waste

i. characterisation

c. Management options

i. Decision making

1. Dose assessment (occupational and public)
2. Cost analysis
3. Technology assessment (reliability, readiness, availability)
4. Environmental impact assessment

ii. Storage

iii. Disposal

1. Underground injection
2. Landfill
3. Incineration
4. Smelting
5. Dedicated NORM disposal facility

iv. Recycle/reuse

v. Long-term stewardship

d. Human resource needs

e. Budget and schedule

f. Stakeholder engagement plan

VI. Annexes

a. Terminology

b. Case studies

i. Spain, General, Marta Garcia

ii. Brasil, Oil and Gas, Lucia Neder

iii. Nederland, general, Gert Jonkers

VII. References

Approach & Work in Progress

- Skimmed the internet for relevant reports and checked IAEA "library" (and own library) for relevant documents
- Collected around 200 potentially interesting reports/documents, of which about 70% seem to be relevant for the task 1 document:
  "*Considerations for Developing National Policies and Implementing Strategies for NORM Management*"
- In the mean time three draft reports/documents appeared that were also relevant for the task 1 document, viz.
  - ICRP Task Group 76: "*Radiological Protection from NORM in Industrial Processes, final draft for comments*"
  - IAEA DS459: "*Management of NORM Residues from Uranium Production and Other Activities*"
  - IAEA draft Technical Document: "*Application of Graded Approach to the Safe Management of NORM Residues*"
- From interesting documents relevant paragraphs 'cut' and 'pasted' into a (seemingly) applicable subsection in the outline of the draft task 1 document.
- The current 340 page document is being *c.q*. should be condensed into the essentially relevant information

2 General Information about NORM
Comments - Acronym NORM and its Use

- Not only the interpretation, but also opinions differ what is exactly mentioned by Naturally Occurring Radioactive Material (NORM)
- Term NORM is very often used in our technical vocabulary, but as an acronym for 'Naturally Occurring Radioactive Material' it is a **misnomer**
  - 'naturally occurring' refers to the radionuclide's in the "material" (matrix) and not (necessarily) to the "material" (a [by]product / residue / waste from a physical, chemical or thermal industrial process) itself
  - Radionuclide's of Natural Origin (RNO's) are ubiquitous in our environment, it could be argued that all "materials" are effectively NORM (scientific *vs*. regulatory point of view)

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Key Question: *At what level of activity concentration …*

… will we in our technical vocabulary be referring to NORM?

… does it become necessary to regulate?

2 General Information about NORM

2.1 NORM Definition (1)

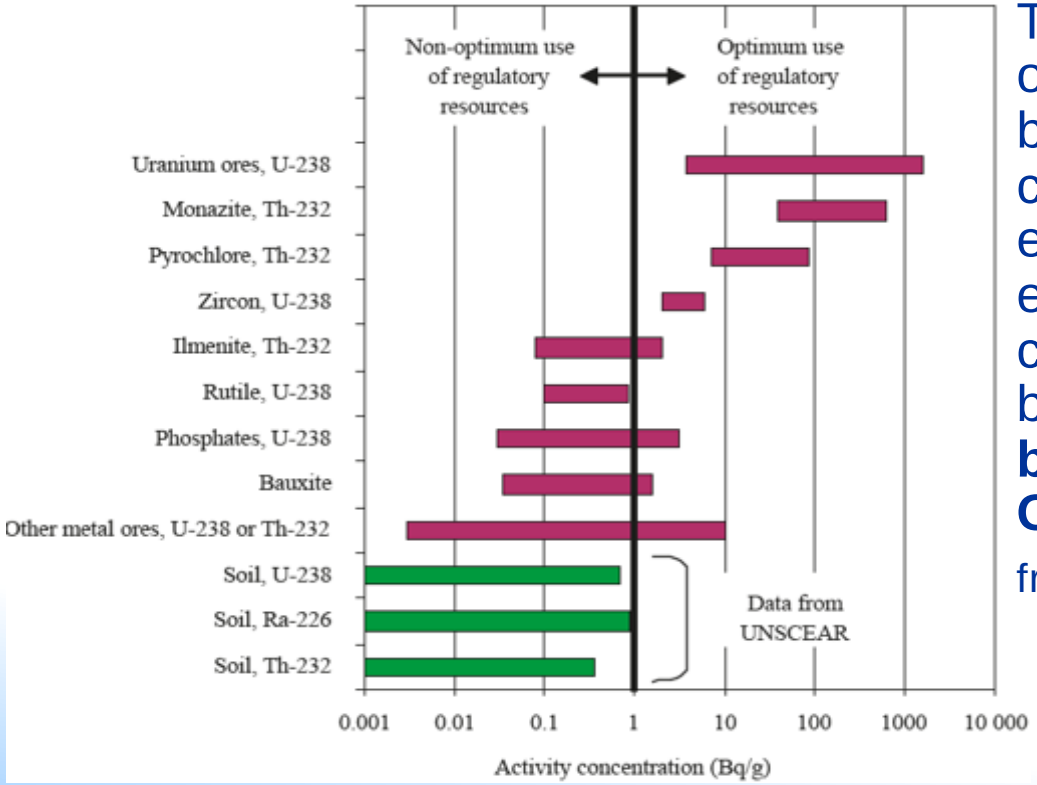
- **NORM**: radioactive material containing no significant amounts of radionuclides other than Radionuclides of Natural Origin (RNO)
- **National regulatory decision**: most nations have implemented the ICRP dose limit of **1 mSv/a** for non-radiation workers and the public at large.

  Dose influencing key parameters are
  - type of handlings with materials containing RNO (*e.g.* mining, crushing, beneficiation, digestion, processing)
  - fate/use of the resulting [by]products after processing ('material' properties change, concentration of Radionuclides of Natural Origin may pop up in process streams)
  - activity concentration in original material (natural resource)
- **Exempt Level**: activity concentration, below which "NORM" need not be subject to some or all aspects of regulatory control
- **Clearance Level**: activity concentration, below which regulatory control may be removed from "NORM" within a notified or authorized practice

2 General Information about NORM

2.1 NORM Definition (2)

"*If, in every process material, the activity concentrations of all radionuclides in the ^{238}U decay series and the ^{232}Th decay series are 1 Bq/g or less and the activity concentration of ^{40}K is 10 Bq/g or less,* ***the material is not regarded as Naturally Occurring Radioactive Material****, the industrial activity is not regarded as a practice and the requirements for existing exposure situations apply*."



These criteria represent (in order of magnitude terms) the upper bounds of the activity concentrations in normal soil. It is evident that many commercially exploited minerals contain activity concentrations of ^{238}U and ^{232}Th below 1 Bq/g and **may not need to be regulated** as **Naturally Occurring Radioactive Material**.

from: IAEA Occupational Radiation Protection (GSG-7)

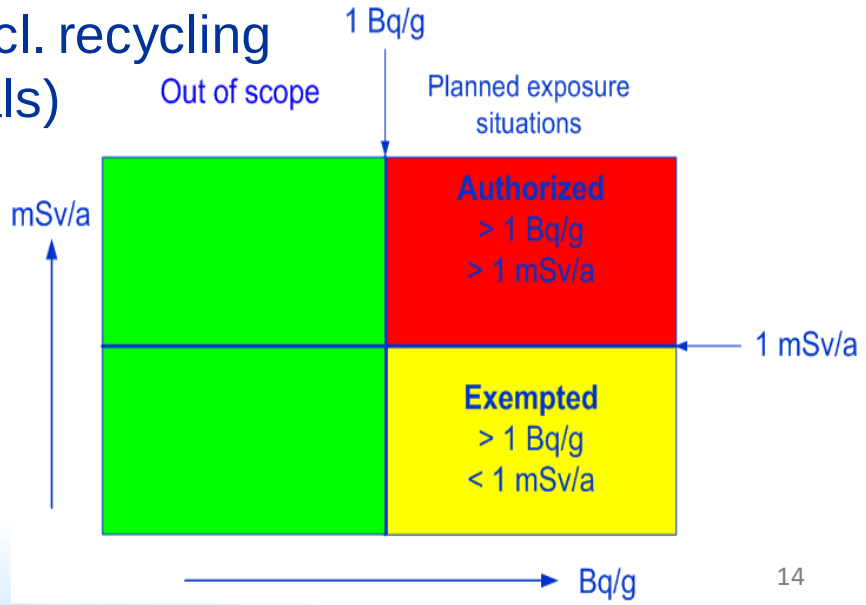
2 General Information about NORM

2.1 NORM Definition (3)

- ✓ **Existing exposure** due to any matrix/material containing RNO of the ^{232}Th or ^{238}U decay series less than 1 Bq/g
  - incl. NORM residues in fertilizers, soil amendments or construction materials, or NORM residues that exist as residual radioactive material in the environment, even if > 1 Bq/g
- ✓ **Planned exposure** due to any matrix/material containing RNO of the ^{232}Th or ^{238}U decay series exceeding 1 Bq/g;
  - incl. public exposure due to discharges or due to the management of radioactive waste arising from a planned exposure situation
  - incl. recycling NORM residues (incl. recycling residues into construction materials)

Material that is designated as being subject to regulatory control in this regard is referred to as NORM.

from: IAEA Occupational Radiation Protection GSG-7



2 General Information about NORM

2.2 NORM related industries (1)

- strongly driven by economic viability, when profit margins are small the pressures to keep costs low are large
- multiple regulatory authorities
- multi-hazards situations
- radiological risk generally not dominant
- doses always below thresholds for deterministic effects
- NORM residues are almost always long-lived
- RP culture not at the same level as nuclear industry

- A graded approach is needed.

2 General Information about NORM

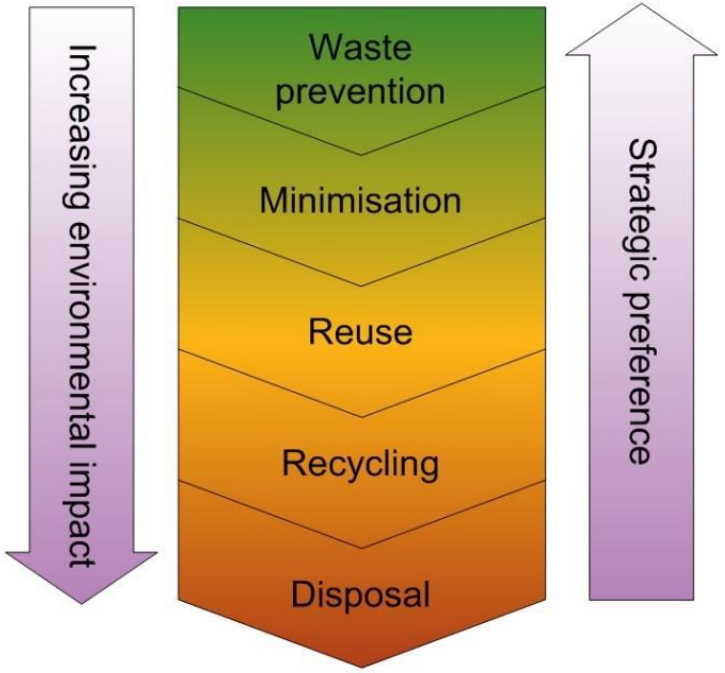
2.2 NORM related industries (2)

Mining/Beneficiation	bulk tailings liquids		Processing/Use	description	bulk solids / slag	bulk ponds/ effluents	small/moderate scale / deposit	small/moderate sludge / filter	small/moderate dust	comments
U Ore	X	(Inter)National Transportation			X			X		tailings < 30 Bq/g or 2‰
Th ore	X		Th: Bastnaesite				X	X		Th concentrate
Mineral Sands			Th: Monazite		X	X				
			Zr/ZrO_2: Zircon			X			X	fused ZrO_2
			TiO_2: Ilmenite/Rutile	$TiCl_4$ route	X	X	X	X		
				sulphate route		X		X		
			RE from Monazite	various processes	X	X				
Rare Earth's (RE)	X		RE from Bastnaesite		X	X	X	X		
			Fe-Nb			X				
Ta, Nb, FeNb	X		Metal Refining		X			X	X	pyrochlore
Sn, Cu, Zn, Pb, Fe ore	X		Metal Refining	hydro-/pyro-metallurgy	X	X	X	X	X	tailings: heavy metal
bauxite (Al)	X		Al production	electrometallurgy		red mud		slime		
Phosphate ore			Phosphoric Acid	wet acid route	phospho-gypsum		X	X		
			NPK Fertilisers							
			Phosphor	thermal route			X	X	X	
Coal Mining	X		Coal Fired Power Plant	combustion	bottom ash				fly ash	
Gas/Oil Production	X / X	no	Oil Refining	refining				X		Ni.V in sooth ash
Geothermal Energy	X / X		Geothermal Heating	closed loop			X	X		
Water			Drinking Water					X		

3 Principles and Core Values

3.3 Waste Management Hierarchy

Concept is central to the development of plans requiring potential waste producers to consider in order of preference the various waste management options, starting with waste prevention and with disposal as the option of last resort



- **Prevent/minimise** (*e.g.* supersaturation – scale inhibitors / electrochemical deposits – material specifications, *etc.*)
- **NORM residue**
  - ✓ **Reuse**: matrix itself has physical/ chemical properties for certain applications (soil amendments, dike enforcements, additive in building materials)
  - ✓ **Recycle**: other valuable elements present (*e.g.* Hg in sludge from gas production, Ta and/or Nb in slags from Sn-production)
- **NORM waste** – no further use other than waste disposal is foreseen

Evaluation up till now

- Apparent overlap between the contents of the task 1 document and the two draft IAEA documents, DS459 "*Management of NORM Residues from Uranium Production and Other Activities*" and the draft TecDoc "*Application of Graded Approach to the Safe Management of NORM Residues*". However, these document mainly represent the view of the regulator and not necessarily the view of the NORM impacted industry.
- 'Reading' through 200 reports/documents quite time consuming, especially when a large portion of these reports/documents were over 100 pages.
- The 340 page outline 'cut and paste' document may be a good start, but it will take still quite some time before a 'readable' draft document will be available

Personal Notes

- Keeping track of all the information read is virtual impossible
- The amount of work has been underestimated
- Too big for one person, work to be subdivided over volunteers

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Thank you!