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APPROACHES AND CHALLENGES IN THE MANAGEMENT OF NORM RESIDUES AND WASTES IN IAEA MEMBER STATES

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Some initial figures (1/2)

- **Uranium Mill Tailings**
  - There exist large quantities of mill tailings 200,000,000 tonnes in the United States alone. One of the IAEA TECDOC's indicate the estimate of 186 uranium tailings dams/piles representing 908,000,000 m3 covering an area of 5769 ha.
- **Phosphogypsum (PG)** (phosphate industry)
  - Depending on the source of rock phosphate, about 4.5 to 5 tonnes (dry basis) of phosphogypsum is generated per tonne of phosphoric acid (as P2O5) recovered. Globally the total amount of phosphogypsum generated is 170 million tonnes/a.
- **Red Mud** (Bauxite – Aluminium industry)
  - The aggregate industry-wide generation of red mud wastes in the USA is approximately 2.8 million metric tons per year, yielding a facility average of nearly 564,000 metric tons per year. The sector-wide waste-to-product ratio is 0.69.
  - The impoundments that receive the muds typically have a surface area of between 44.6 and 105.3 hectares (110 and 260 acres). The depth of the impoundments range from 1 to 16 meters (1 to 15 m), with an impoundment average of 7 meters. The quantity of muds accumulated on-site ranged from 500,000 to 22 million metric tons per facility, with an average of 9.7 million metric tons per facility.

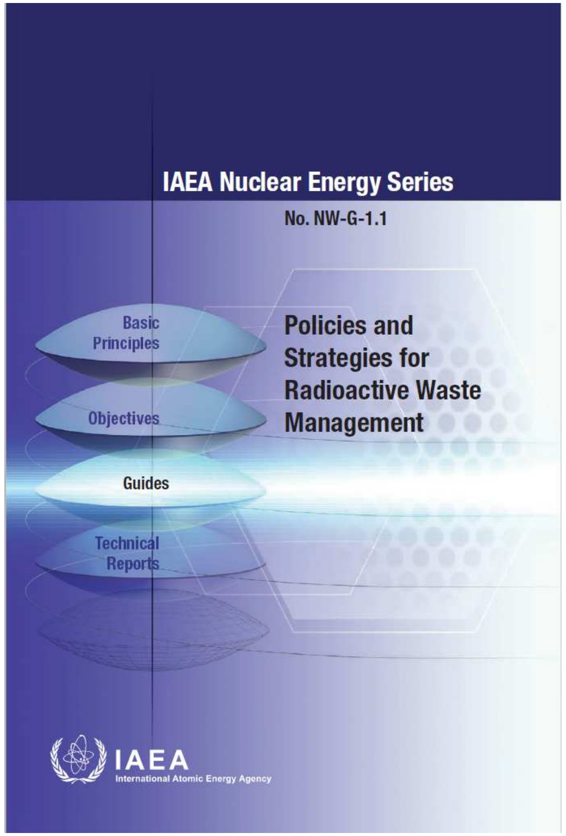
Some figures (2/2)

- **Oil & Gas**
  - **Produced Waters** - The ratio of produced water to oil in conventional well was approximately 10 barrels of produced water per barrel of oil. According to the American Petroleum Institute (API, more than 18 billion barrels of waste fluids from oil and gas production are generated annually in the United States.
  - **Scales** - Approximately 100 tons of scale per oil well are generated annually in the United States. As the oil in a reservoir decreases and more water is pumped out with the oil, the amount of scale increases. In some cases brine is introduced into the formation to enhance recovery; this also increases scale formation
  - **Sludge** - Oil production processes used in conventional drilling generate an estimated 230,000 MT or 141 cubic meters of NORM sludge each year. It has been determined that most sludge settles out of the production stream and remains in the oil stock and water storage tanks.
- **Coal**
  - In 2012, 59 percent of the coal consumed by electric utilities and independent power producers in the United States resulted in the generation of about 68 million tons of fly ash, bottom ash and boile

Policy and Strategies in RWM

- **<u>Policy</u>** is a set of established goals or requirements for the safe management of spent fuel and radioactive waste; it normally **defines national roles and responsibilities**. As such, policy is mainly established by the national government; policy may also be codified in the national legislative system.
- **<u>Strategy</u>** is the means for achieving the goals and requirements set out in the national policy for the safe management of radioactive waste. **Strategy is normally established by the relevant waste owner or operator**, either a governmental agency or a private entity. The national policy may be elaborated in several different strategies. The individual strategies may address different types of waste (e.g. reactor waste, decommissioning waste, institutional waste, etc.) or waste belonging to different owners.

Policy for NORM



Relevant Policy Aspects

- National policy on the management of NORM, i.e. whether NORM is regulated as a radioactive material or as a chemically toxic material;
- In some countries, NORM is regarded as being subject to regulation by the nuclear regulatory authority, while in others it falls within the responsibility of non-radioactive regulators;
- Its radioactive properties are taken into consideration in both cases.
- It is important that national policy should indicate the regulatory regime under which NORM is managed (Article 3.2 of the Joint Convention).
- Tailings from uranium mining and milling may also be included in this category.

This Convention shall also apply to the safety of radioactive waste management when the radioactive waste results from civilian applications. However, this Convention shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of this Convention by the Contracting Party.

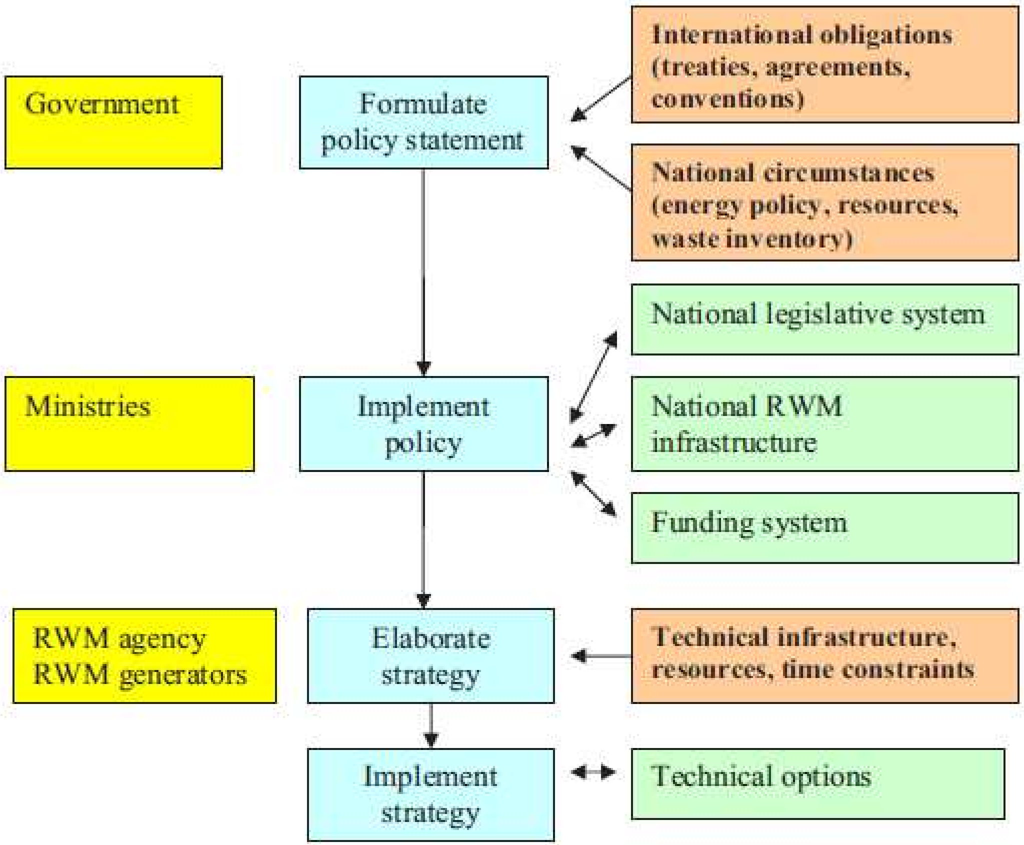
Need for Policy

- As a basis for the preparation, review or revision of related legislation;
- To define **roles and responsibilities** for ensuring the safe management of radioactive waste;
- As a starting point for the development of national radioactive waste management programmes (strategies);
- As a starting point for further developments and modifications to existing national practices;
- To provide for the safety and sustainability of radioactive waste management over generations, and for the **adequate allocation of financial and human resources over time**;
- To **enhance public confidence** in relation to the subject of spent fuel and radioactive waste management.

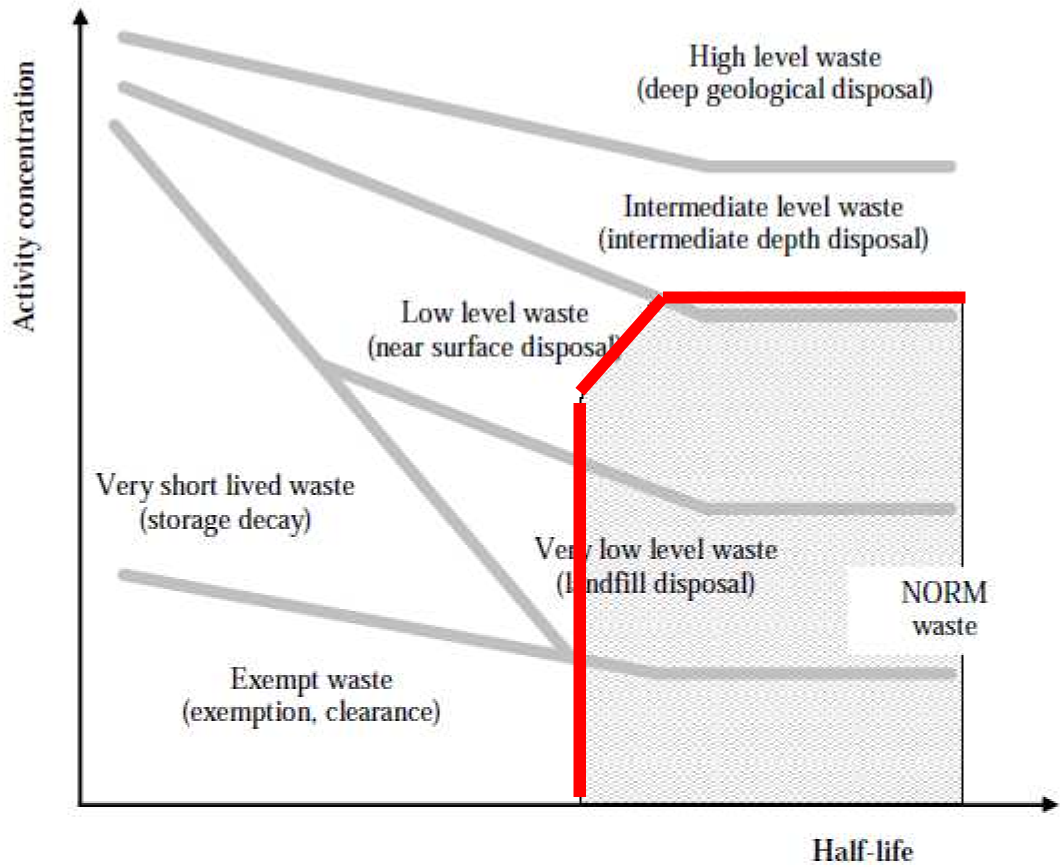
Need for Strategies

- Specify how the national radioactive waste management policy will be implemented by the responsible organizations using the available technical measures and financial resources;
- Define how and when the identified goals and requirements will be achieved;
- Identify the competencies needed for achieving the goals and how they will be provided;
- Elaborate the **ways in which the various types of radioactive waste in the country will be managed** during all phases of the radioactive waste life cycle (from cradle to grave);
- To **enhance public confidence** in relation to radioactive waste management

The principal steps in the development and implementation of a radioactive waste management (RWM) policy and strategy



Classification scheme for radioactive waste — Application to NORM waste.



Waste Technology Publications on NORM

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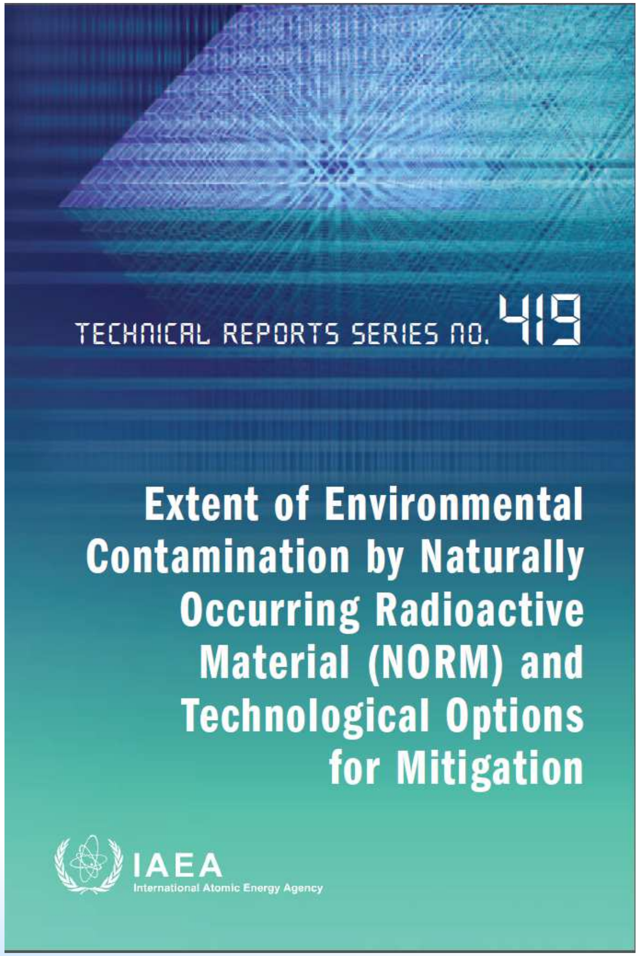

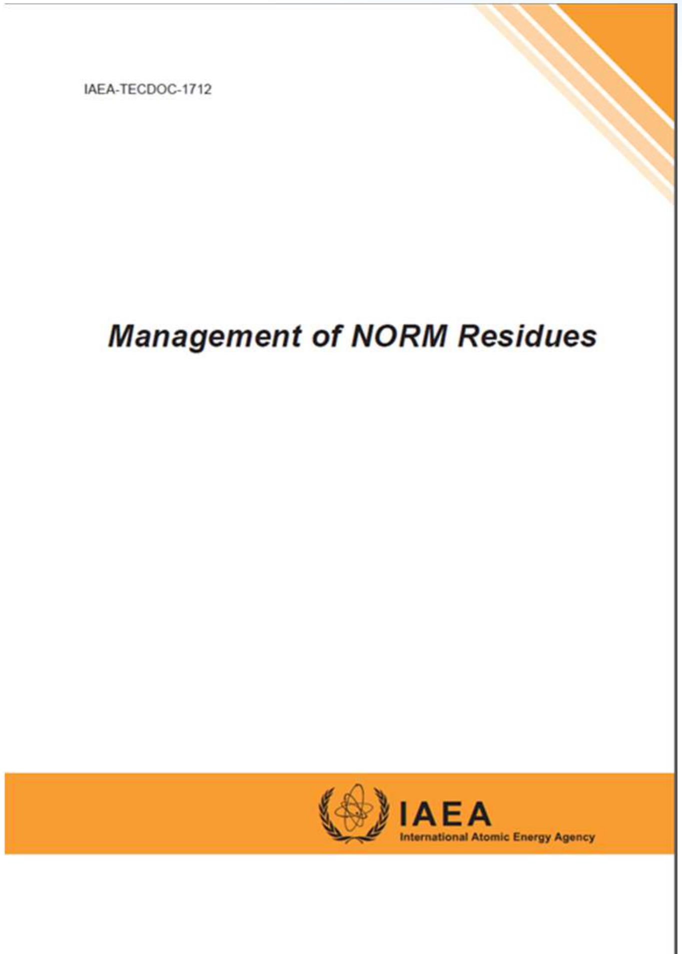

Approach to Waste Management

- Prevention
  - Purchase of natural resources, adjustments in process
- Reuse
  - Mixing with concrete, road constructions, dykes
- Cleaning
  - Contaminated scrap to smelters
- Treatment
  - By Waste Management Organisation (WMO)
- Disposal
  - Land fills for NORM

Management of NORM Residues as Waste

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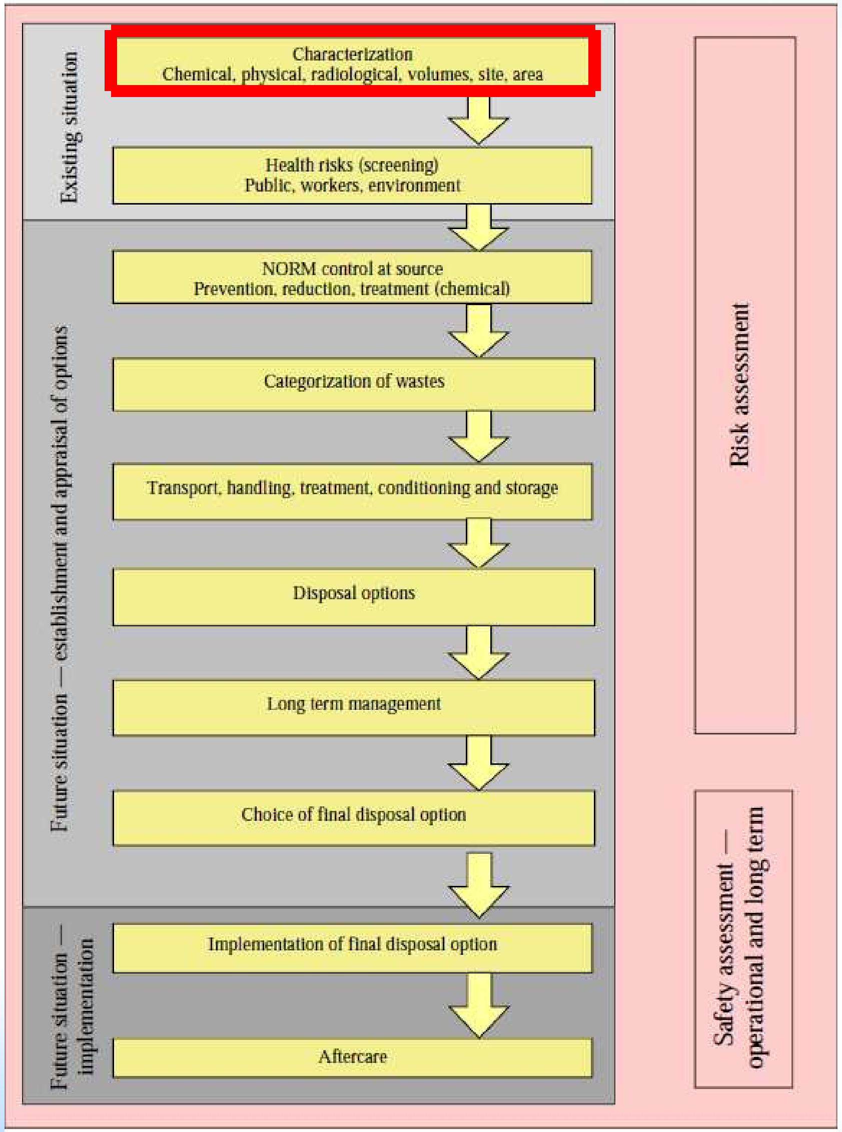

- **Phase 1**: Evaluation of the current situation
- **Phase 2**: Selection of the optimum NORM waste management option
  - (a) The cost–benefit effectiveness over the entire waste life cycle;
  - (b) Technological considerations, including long term performance and the extent to which the technology is proven and used internationally;
  - (c) Safety implications:
    - (i) Exposures of workers and members of the public (during facility operation) and ALARA considerations;
    - Transport safety;
    - Operational safety;
  - (d) Social and environmental factors:
    - Long term impacts on public safety;
    - Sustainability considerations;
    - Perceived risk and societal acceptability;
    - For legacy sites, the benefit to the community in relation to the ‘no action option’;
    - Environmental impact;
    - Potential for on-going improvement
- **Phase 3**: Implementation of the optimum NORM waste management option

EXAMPLES OF NORM WASTE MANAGEMENT

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- **Waste rock from mining operations**
  - It may remain in place as rock piles or, where the opportunity exists, may be backfilled into mining voids such as open pits
- **Tailings from the dry separation of heavy minerals**
  - Usually mixed with other low activity residues, returned to the mining void and covered with non-radioactive sand or overburden. If high thorium concentration is high it may be required that they be blended with (non-radioactive) mine sand tailings to dilute the radionuclide content before disposal in the mine pit.
- **Bauxite tailings**
  - Usually disposed of as a slurry (10–30% solids) in large engineered containments that are lined with clay and/or polymeric material. Other disposal options include disposal in the sea and, after dewatering, dry disposal by land spreading.
- **Tailings and phosphogypsum from phosphate fertilizer production**
  - Usually returned to the mining void as a slurry. Phosphogypsum disposal is usually performed in situ by converting existing large containment structures ('stacks') into permanent disposal facilities Less commonly, phosphogypsum is disposed of by discharging it to water bodies, usually large rivers, river estuaries or the sea. Stacking of phosphogypsum is carried out by wet deposition (as a slurry) or dry deposition.

EXAMPLES OF NORM WASTE MANAGEMENT (cont.)

- **Scale deposits**
  - The main options for the disposal of scale after its removal are:
    - Burial at a site that will remain under institutional control after closure, for instance at a mine site or in engineered earthen trenches or concrete silos;
    - Disposal at a hazardous waste disposal facility;
    - Disposal at a low/intermediate level radioactive waste disposal facility.
- **Sediments and sludge**
  - Some sediments and sludge have to be treated in a similar manner to high activity scale and disposal in engineered shallow ground burial facilities such as earthen trenches or concrete silos is often the preferred management option. Lower activity sediments and sludge (typically of the order of 10 Bq/g or less) are generally suitable for disposal at landfill facilities for normal industrial waste.
- **Furnace dust**
  - Disposal as industrial waste in a controlled landfill facility. Another option is to store it for about 100 years, after which it can be disposed of as non-radioactive waste.
- **Liquid NORM waste**
  - Aqueous waste streams that cannot be recycled are generally treated to remove contaminants and then discharged to the environment in accordance with the authorized discharge limits for the facility concerned

What are IAEA Member States Requesting? (1/2)

- Improvement and upgrade of the analytical and technical capabilities
- Design and implementation of monitoring programmes
- Establishment of administrative and standard operating procedures by the oil industry and assessing possible NORM contamination and its impact to the workers and environment
- Establishment of good operational practices in oil production in relation to the radiological safety of the workforce and the environment
- Establishment of a policy and strategy for NORM and establishment of an appropriate regulatory framework associated with NORM industry operations
- Discussion and identification of concepts in NORM waste management, NORM risk assessment. Review and discussion of relevant regulations, national policies and strategy for NORM waste

What are IAEA Member States Requesting? (2/2)

- Training on the identification of NORM generating industries, NORM generation estimates, decontamination techniques, radon measurements and NORM waste treatment and storage
- Advice on plans for NORM disposal, techniques for conditioning and storage, long term storage design and cost (design+facilities+operations)
- Training on technical works required for waste treatment, storage, radiological measurements and disposal options
- Provide and discuss examples of technical documents and procedures for decontamination, conditioning and pre-storage and calculation of the cost of disposal facilities
- Build regional capacities of specialists to carry out comprehensive NORM waste management options
- Programme of action to minimize the impact of radioactive residues on populations and to create a favourable conditions for the sustainable development of the affected territories
- Long-term stability and associated safety challenges of existing NORM disposal practices (pits, landfills, trenches, dams, etc.) – **WATEC recommendation**

Some situations of NORM Waste Requiring Attention – Extension of the Problem Worldwide?

Copper slag

Mixed contamination

Copper Slag disposal
Site in Zambia

Charcoal enriched in Ra-226 - Azerbaijan

Scrap Metals Contaminated with NORM

- Detection
- Decontamination Procedures
- Costs
- Disposal Routes for the Generated Wastes
- Transboundary Issues

Technical Cooperation Projects on NORM

- ANG9005 - Ongoing Managing Naturally Occurring Radioactive Material Waste
- CMR9007 - Establishing a National Radioactive Waste Management System
- LIB9013 - Building Capacity for Naturally Occurring Radioactive Material Waste Management
- YEM9005 - Improving Decision Making on Naturally Occurring Radioactive Materials (NORM) Pollution of Water and Soil in Oil and Gas Fields
- ZAM9010 - Assessing Radioactive Contamination of Surface, Groundwater and other Resources in Mining Areas

Review Missions

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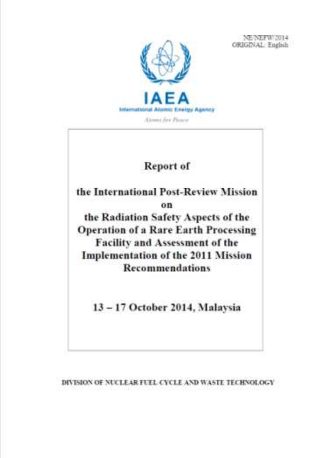
Report of the
International Review Mission
on the

Radiation Safety Aspects of
a Proposed Rare Earths
Processing Facility
(the Lynas Project)

29 May - 3 June 2011, Malaysia

DIVISION OF NUCLEAR FUEL CYCLE AND WASTE TECHNOLOGY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Report of
the International Post-Review Mission
on
the Radiation Safety Aspects of the
Operation of a Rare Earth Processing
Facility and Assessment of the
Implementation of the 2011 Mission
Recommendations

13 – 17 October 2014, Malaysia

DIVISION OF NUCLEAR FUEL CYCLE AND WASTE TECHNOLOGY

Mission Scope

- Relevant legal and Regulatory Framework
- Radiation protection (occupational, public and environment) including monitoring systems
- Decommissioning and Environmental Remediation
- Transport
- Safety Assessment
- Public Communication

Recommendations on Waste Management

The AELB should require Lynas to submit, before the start of operations, a plan setting out its intended approach to the long term waste management, in particular management of the water leach purification (WLP) solids after closure of the plant, together with a safety case in support of such a plan. The safety case should address issues such as:

(a) Future land use (determined in consultation with stakeholders);
(b) The dose criterion for protection of the public;
(c) The time frame for the assessment;
(d) Safety functions (e.g. containment, isolation, retardation);
(e) The methodology for identification and selection of scenarios – this must include the scenario in which the residue storage facility at the Lynas site becomes the disposal facility for the WLP solids;
(f) Any necessary measures for active and/or passive institutional control.

As the safety case is developed, the RIA for the facility as a whole should be updated accordingly.

Recommendations on Decommissioning and Environmental Remediation

The AELB should require Lynas to submit, before the start of operations, a plan for managing the waste from the decommissioning and dismantling of the plant at the end of its life. The RIA and decommissioning plan should be updated accordingly.

The AELB should implement a mechanism for establishing a fund for covering the cost of the long term management of waste including decommissioning and remediation. The AELB should require Lynas to make the necessary financial provision. The financial provision should be regularly monitored and managed in a transparent manner.

The Environet NORM-Project

Objective: To provide target and practical assistance to MS's in the management of NORM waste

- NORM Policy and Regulation
  - Determination of regulatory authority and scheme
  - Coordination with national radioactive waste management policy and regulation
- Raising Member State NORM Awareness, including technical training and education
- Stakeholder engagement/public awareness
- Cost estimation and funding requirements
- Inventory
  - Identify NORM industries and processes
  - Volumes
  - Activity concentrations or exposure rates
  - Other constituents of concern
  - Current management

- NORM Characterization
  - Residue/waste characterization
  - Legacy site characterization
  - Appropriate sampling methodologies
  - Analytical methodologies
  - Laboratory
  - In situ measurements (mobile lab)
  - Quality assurance and quality control (QA/QC)
  - Infrastructure and equipment
- Management Framework
  - Exemption level based on either Activity concentration, Dose
  - Establish waste management organization (WMO)
    - Private vs. state-owned
    - Centralized vs. multiple facilities
    - NORM-dedicated vs. multiple types of wastes
  - Cost and risk assessment
  - Conditional clearance
  - Storage
  - Transportation

The Environet NORM-Project

- Management options for residues/wastes not exempted or conditionally cleared
  - Prevention
  - Minimization
  - Reuse (i.e., using the NORM in its current form)
  - Recycle (i.e., reprocessing of the NORM into a new form), including NORM-contaminated scrap metal
  - Disposal
- Selection of management options
  - Cost/benefit analysis
  - Risk assessment
  - Stakeholder concerns
  - Other considerations (e.g., economic impacts)
  - Safety assessment of selected disposal option(s)
  - Site selection criteria
  - Design criteria
  - Waste acceptance criteria
- Consideration of non-radiological regulatory requirements
- Long-term stewardship
  - Monitoring
  - Institutional controls
- Legacy Site
  - Identification
  - Characterization
  - Risk assessment
  - Remedial action selection, if needed
- Decommissioning of NORM Facilities
  - Decontamination technologies
  - Dismantling technologies
  - Decommissioning funds

The Environet NORM-Project

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Deliverables

- Activity 1
  - Assembly of Relevant NORM Information by Member State
- Activity 2
  - Best Practices Handbook
- Activity 3
  - Transfer of Knowledge and Best Practices
- Activity 4
  - Direct Assistance to Member States

Join us

- Kick-off Meeting
- Stockholm 5 – 9 December 2016
- In cooperation with the EAN-NORM Network

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Thank you!