IAEA Technical Requirements for Centralized Radioactive Waste Processing and Storage Facilities

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WASTE MANAGEMENT STRATEGY OPTIONS

- Local waste management
  - *Collection*
  - *Segregation*
  - *Characterization*
  - *Storage for decay*
- Centralized waste management
  - *Treatment*
  - *Conditioning*
  - *Storage of waste packages (interim and long term)*
  - *Disposal*

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NEED FOR PROCESSING

Materials with characteristics that make them unsuitable for authorized discharge, authorized use or clearance from regulatory control and for which no further use is foreseen shall be processed as radioactive waste. Processing of waste may yield waste or material that is suitable for authorized discharge, authorized use or clearance from regulatory control.

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WASTE CHARACTERISTICS AND AMOUNTS

- The amounts and characteristics of radioactive waste have a major technical influence on the selection of waste management technologies
- Failure to understand the characteristics of the waste before selecting the technologies will increase the risk of the process not operating successfully

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REQUIREMENTS FOR SELECTION OF PROCESSING TECHNOLOGIES

- Scale of application
- Maturity
- Robustness
- Flexibility
- Anticipation of future needs
- Complexity and maintainability
- Product characteristics
- Secondary waste generation
- Compatibility with existing processes

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SCALE OF APPLICATION

- Some processes may be restricted to small scale applications e.g. those which require manual handling (e.g. preparation of spent radioactive sources for disposal) or new processes for which extrapolation to a large scale application may need more development and evaluation
- Other processes are characteristically large scale, such as supercompaction of solid waste, evaporation of aqueous effluents, etc

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MATURITY

- Is the process an applied technology or still at the R&D stage?
- Has it been demonstrated (with surrogates or real waste)?
- Has it been licensed or is it licensable?
- Is the technology currently in use?
- Are designs available and can suppliers be identified?
- What is the practical operating experience (cost, throughput, reliability, compliance)?
- Is there access to information regarding the current uses of the technology to verify suppliers'
- Were any problems experienced in use?

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ROBUSTNESS

- Sensitivity of the technology to composition and variation in nature of the input waste (e.g. slurries, combustible and non-combustible solids, aqueous waste concentrates, ion exchangers)
- Dependence of the process upon up-front detailed characterization of input materials
- Complexity of start-up, maintenance, shutdown and decommissioning operations

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FLEXIBILITY

- "Range of application" covers the number of waste streams the technology can accommodate
- It represents the difference between a well tuned technology that is very effective for one waste stream and another that is applicable for many waste types

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PRODUCT CHARACTERISTICS

- The product requirements will be influenced by the disposal option, future conditioning steps, storage time, transport regulations, etc
- A specific product definition is the WAC which will be defined against a particular disposal option, for example factors such as package type, dimensions and performance (drop tests, etc.) might be specified

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SECONDARY WASTE GENERATION

- Processes and technologies should not be considered in isolation
- No applied technologies are without their own requirements and few can be operated without secondary waste generation
- The upstream processes, the support services and the secondary waste must all be considered and provision made in planning and selecting technologies either providing additional equipment or utilizing existing equipment

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ANTICIPATION OF FUTURE NEEDS

- The future usage of equipment and facilities will influence the selection of an appropriate technology
- The choice depends on if the technology is driven by a short-term need or is part of a long-term strategy related to the uses of radionuclides or nuclear power
- The use of temporary facilities versus permanent ones should be considered

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COMPLEXITY

- Complex technological processes are not automatically better than simple ones.
- The following should be considered:
  - *few or no moving parts*
  - *commonly available reagents for use*
  - *stable process, easy to control*
  - *Simple operations*
  - *easily accessible components*

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MAINTAINABILITY

- Simplicity
- Radiation resistance (hardening)
- Corrosion resistance
- Wear resistance
- Contamination resistance
- Ageing management

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COMPATIBILITY WITH OTHER PROCESSES

- Processes and technologies should not be considered in isolation
- No applied technologies are without their own requirements
- Upstream and downstream processes should be taken into account

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FUNCTIONAL REQUIREMENTS FOR A CENTRALIZED STORAGE FACILITY

Provisions for:

- Adequate environment by ventilation, control of humidity, condensation and airborne salt, dust and aerosol concentrations, to protect the waste and its packaging from degradation
- Adequate heat removal, if required
- Surveillance and inspection of waste packages
- Inspection of facility components important to safety
- Movement and handling of waste packages
- Retrieval of individual waste packages

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FUNCTIONAL REQUIREMENTS FOR A CENTRALIZED STORAGE FACILITY

Provisions for:

- Identification of individual waste packages
- Implementation of adequate operating and accounting procedures
- Maintenance of the facility
- Prevention of damage to the facility and waste packages resulting from facility operation
- Additional storage capacity for secondary waste from the facility operation, and for packages that are damaged during storage
- Decontamination of package handling and storage areas and equipment after operational incidents

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TECHNICAL FACTORS FOR SITE SELECTION

- Geology
- Hydrogeology
- Seismicity
- Climate
- Availability of physical infrastructure
- Proximity of natural resources (mineral, drinking water, forests, etc.)
- Proximity of raw materials (water, power, personnel, etc.).

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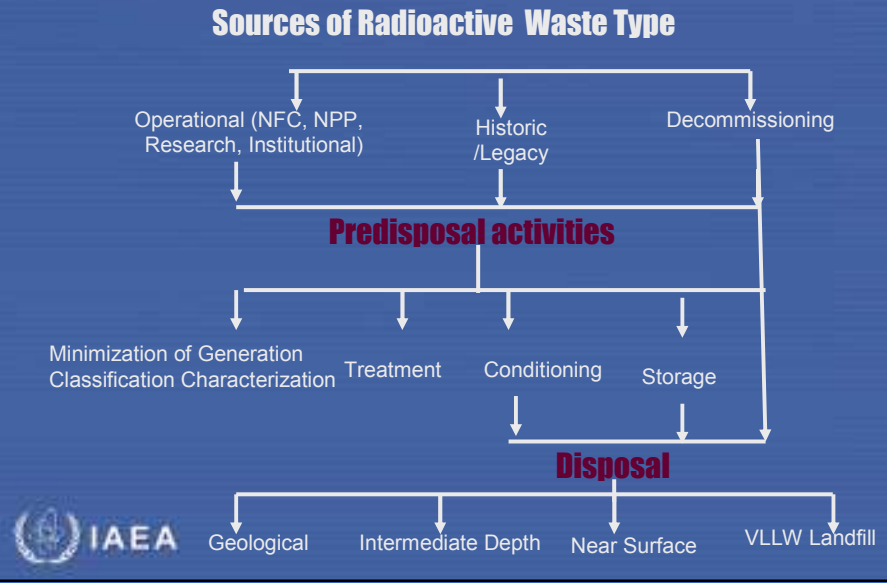
Management of Radioactive Waste



IAEA RELEVANT ACTIVITIES – Policies and strategies

- **Guidance document on radioactive waste management policies / strategies *(ongoing)***
- **Report on "Radioactive Waste Assessment Methodology" *(ongoing)***
- **Report on "Economics of Radioactive Waste Management" *(ongoing)***
- **"Review of the Factors Affecting the Selection and Implementation of Waste Management Technologies", TECDOC-1096**

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RWM Policies and Strategies Document

- Highlights the main elements of national policy and strategy for safe SNF and RW management recognising that policies and strategies vary considerably depending on, among other things, the nature and scale of the generation of radioactive material in a country;

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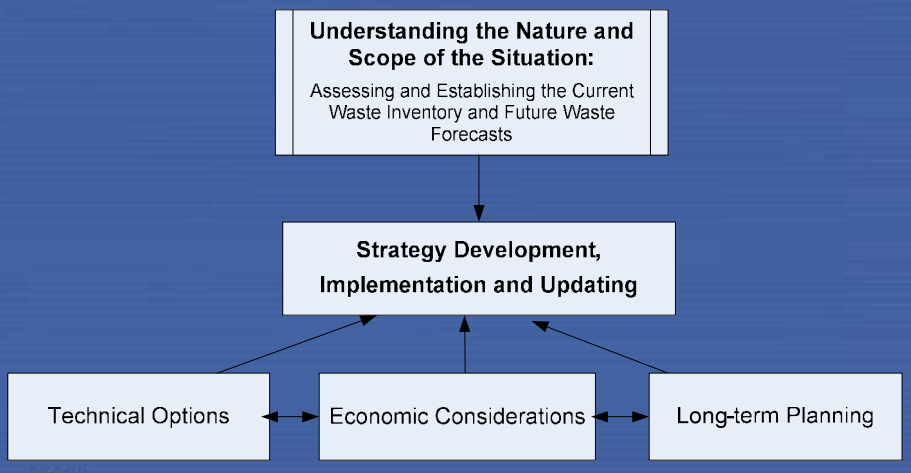
RW Strategy Implementation Linkages



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Economics of RWM

- Outlines a methodology for estimating the costs of RW management activities;
- Assess the liability for specific WM strategy; and
- Provides examples of application of this methodology in a typical end-to-end evaluation of life cycle WM costs for alternative strategies

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Economics of RWM

Develop a waste management plan

Note: May include several alternative scenarios

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Develop cost estimates for each scenario

Note: In planning phase, before scenarios are chosen, indicative cost estimates can be used, based on benchmarking information

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Select one or two scenarios for detailed costing/analysis

Note: For costing selected scenarios, detailed cost estimates are recommended, utilizing a well developed & detailed work breakdown structure

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Estimate liabilities and annual funding needed for each selected scenario

Inputs:
- Detailed cost estimates for each process/life cycle cost estimates by waste management stream, including fixed and variable costs; Labour & material escalation rates; Discount rates to be used (can be prescribed by regulation);
- Current status of funding (if established)

Outputs:
- Present value or current value of liability; Annual funding requirement by waste stream
- Financial guarantees needed (if any).

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Perform risk assessment

Key inputs:
- Cost estimates uncertainty (i.e. ranges); Economic indices uncertainty (i.e. ranges); Strategy uncertainty (e.g. in-service dates of facilities)

Output:
- Confidence in scenario(s) chosen as an input to decision making

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Select preferred waste management strategy

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RW Assessment Methodology

- Provides practical guidance for longer-term planning of technical options for waste management activities by use of standardized, comprehensive considerations and methodologies for performing an assessment of local, national and regional waste inventories and forecasts, and the resulting waste management needs.

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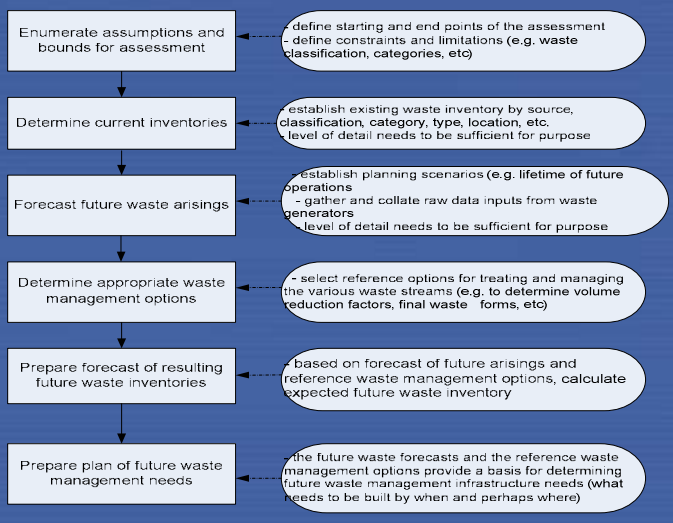
Assessment of Waste Management Needs

Basic Methodology for Assessing Waste Management Needs



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Pre-Disposal RELEVANT ACTIVITIES
Centralized facility

Current

- Reference Design for a Centralized Spent Sealed Sources Facility, TECDOC-806
- Reference Design for a Centralized Waste Processing and Storage Facility, TECDOC-776-

On-going new activities

- Reference design for a processing / conditioning / storage facility for RW from nuclear applications
- Modular design of low level waste processing and storage facility

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Pre-Disposal RELEVANT ACTIVITIES
Long term (Extended) storage

On-going new activities

- Provide guidance on " Technical Conditions for Long-term Storage of Radioactive Waste "
- Coordinated Research Project on "Performance and Behaviour of Cementitious materials in long term storage and disposal of radioactive waste"

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Pre-Disposal RELEVANT ACTIVITIES
Waste characterization

Current and on-going

- Report on "Determination and Use of Scaling Factors in Waste Characterization".
- Strategy and Methodology for Radioactive Waste Characterization, TECDOC-1537
- Characterization of Radioactive Waste Forms and Packages, TRS No. 383
- Categorizing Operational Radioactive Wastes, TECDOC-1538

Initiative for next budget cycle

- Promote network of laboratories for RW characterization
- CPR on waste characterization methods and techniques

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Pre-Disposal RELEVANT ACTIVITIES
Waste minimization

Current

- Considerations for Waste Minimization at the Design Stage of Nuclear Facilities, TRS No. 460

On-going new activities

- TECDOC on "Organization and Technical Options for Waste Minimization during Operation and Maintenance"
- TECDOC on "Liquid and Gaseous Effluents from Nuclear Reactors"
- PROJECT: International benchmarking project on " Minimization of liquid and solid RW generated at NPP sites (WWER Reactors)"

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Pre-Disposal RELEVANT ACTIVITIES
Waste acceptance

Current

- Development of Specifications for Radioactive Waste Packages, TECDOC-1515

On- going

- "Characterization and management of "mixed" waste

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Pre-Disposal RELEVANT ACTIVITIES
Innovative technologies

On-going new activities

- "Processing of waste from innovative types of reactors and fuel cycles"
- "Mobile Processing Technologies and Systems for Radioactive Waste Management"
- Best practices for the processing and conditioning of HLW, including SNF encapsulation

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Pre- Disposal Initiatives beyond 2009

- Maintain focus on human resources capability development

Promote and develop networking at the regional or interregional level

- network of laboratories for RW characterization
- network of L&ILW management centres to promote excellence in RW pre-disposal

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Pre- Disposal Initiatives beyond 2009
Training of waste operators

- Sharing of practical experience, and use of best practices, will continue to be developed and promoted through regional training courses and workshops
- Regional TC Projects provide the best mechanism for uniformed, standardized training for the waste operators.
- The training modules on waste management technologies for waste operators could be further developed based on standardized training syllabus already in use for operators from Russian speaking countries
- The chain of regional Centres of Excellence could be established as part of international networks in RWM to provide exposure to on the job training at the operating waste management facilities

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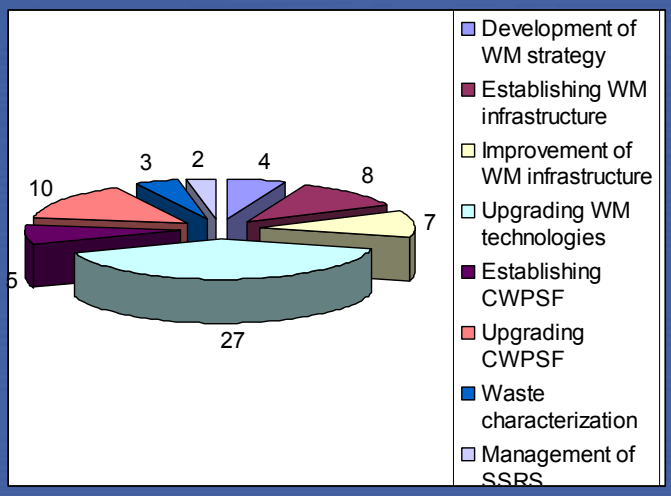
TC projects in IAEA Member States



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Pre- Disposal Initiatives beyond 2009
Focus on HLW

- The extent of the general knowledge in a MS on treatment and conditioning of HLW to stable disposal ready waste forms is very limited
- There are no recent IAEA publications on treatment and conditioning of HLW. The last publication on the subject matter is from 1992.
- The future work should provide an overview of the current technological state of art, and the better understanding on the extent and responsibilities required for management of high level toxic waste, implications to the environment and its economic parameters

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Pre- Disposal Initiatives beyond 2009
Focus on HLW

- Some other older publications related to the HLW management especially for durability of the waste packages and institutional framework should be updated systematically.
- The first CRP on new advanced technological solutions for treatment and conditioning should be planned to provide linkage with on-going work on waste management from innovative reactors.

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IAEA RW Pre-Disposal

Thank you for your attention !

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