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Safety of Radioactive Waste and Spent Fuel Management

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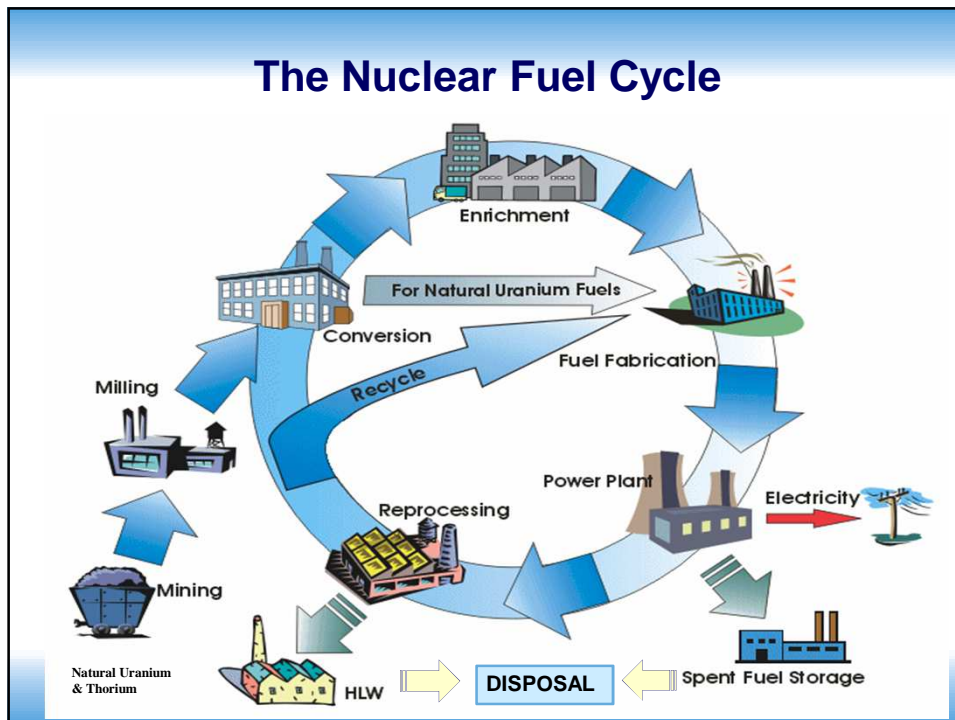
Contents

- **Overview on Waste Management**
- **Safety Standards**
- **Projects and Working Groups**

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The Nuclear Fuel Cycle

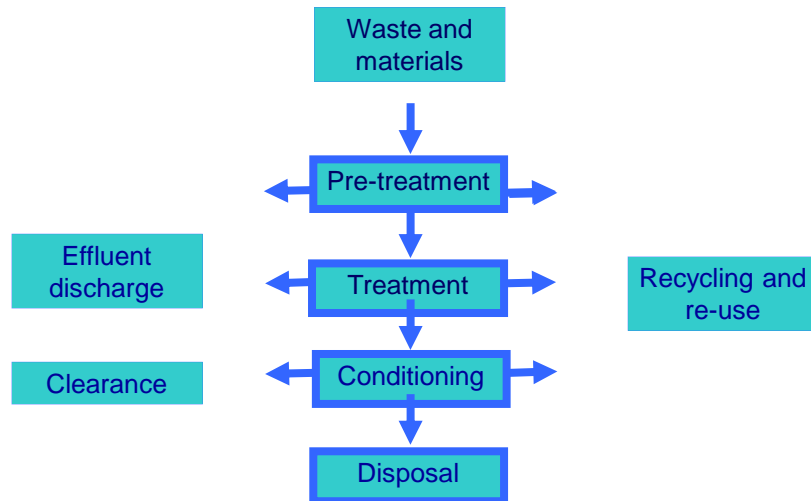


Waste Arisings

Radioactive waste arises from many different activities, for example:

- **Operation and decommissioning of nuclear facilities (e.g. nuclear power plants);**
- Application of radionuclides in industry, medicine, and research;
- Cleanup of contaminated sites; and
- Processing of raw materials containing naturally occurring radionuclides.

Waste Management Approaches



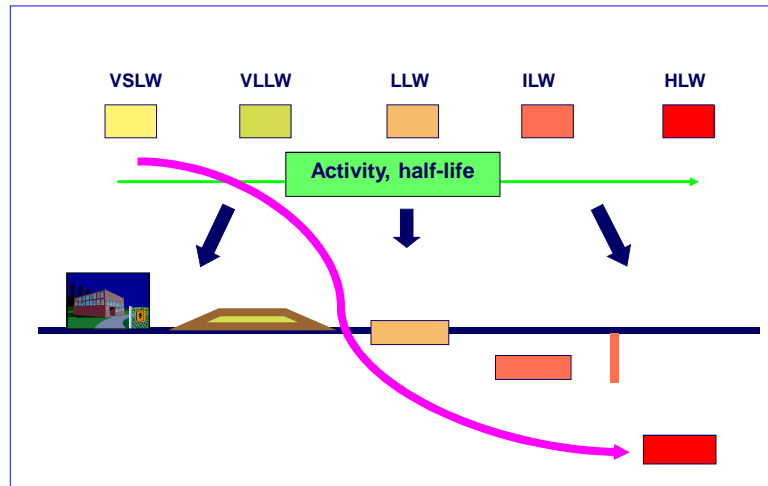
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PREDISPOSAL MANAGEMENT

CHARACTERIZATION		TREATMENT			CONDITIONING
LL	Liquid	LIQUID WASTE	SOLID WASTE	GASEOUS WASTE	Cementation
		Chemical Treatment	Compaction	Scrubbing	Polymerisation
IL	Solid	Ion Exchange	Incineration	Adsorption/Absorption	Bituminisation
		Reverse Osmosis	Size Fragmentation	Prefiltration	
HL	Gaseous	Evaporation	Repackaging	High Efficiency Filtration	Vitrification

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WASTE TYPES & RELEVANT DISPOSAL OPTIONS



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Broad Disposal Options

- Surface and near-surface disposal (with and without engineered barriers) up to 30m
- Underground cavities (natural or engineered) at few m to few 100 m
- Geological disposal (a mined facility) several hundreds of m
- Borehole disposal
- Other “Exotic” disposal options (either not considered credible or legal)

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Cost – get a feeling for it

- EVERY step in RWM expensive
- Decommissioning: several hundred million per NPP
- Near surface disposal: a few thousand or tens thousands Dollar per m³
- Geological disposal: range of Billions
- One Dual-Use-Cask CASTOR: 1.5 mill. Euro
- Calculated Cost ZWILAG (NF-T-3.5)
 - HLW (200 casks), II-ILW (4000 m³), LILW (16500 m³)
 - Investment: 98,3 mill CHF,
 - Operation and maintenance: 4.5 mill. CHF

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Cost – get a feeling for it

Cost of Swedish Program for Radioactive Waste Management

Cost Component	Euro (millions)	% of total project	incurred	future	% Incurred
Reprocessing	970	11.2	970	0	100
Transport	313	3.6	146	167	47
SKB Admin, RD&D	1295	15.0	703	592	54
CLAB	1342	15.5	838	504	62
SFR	357	4.1	257	100	72
Encapsulation plant	770	8.9	29	741	3.8
Deep repository	1903	22.0	161	1742	8.5
Decomm of NPPs	1731	20.0	0	1731	0
Project as a whole	8658	100.2	3080	5578	35.6

Source: E. Segelod, *The cost of the Swedish nuclear waste program*, Progress in Nuclear Energy, Vol 48, pp314-324 (2006).

Source provides costs in SEK – converted to Euro assuming 9 SEK per Euro

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Contribution of IAEA

- **Support to Member States in establishing proper safety framework (regime) for management of spent fuel and radioactive waste:**
 - **Development of Safety Standards (statute)**
 - **Provisions for use and application of Safety Standards**
 - **Joint Convention on the Safety of Spent Fuel and Radioactive Waste Management**
 - **Promote exchange of information (e.g. international projects, meetings...)**
 - **Review Missions**

Basic Facts

The IAEA has responsibilities for the safety of spent fuel and radioactive waste management, and implements a wide range of safety demonstration projects related to:

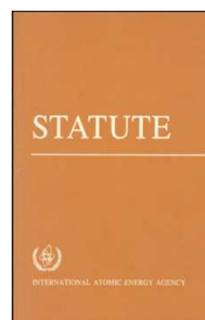
- **Predisposal management and disposal**
- **Decommissioning of facilities;**
- **Remediation of sites;**
- **Control and assessment of radioactive releases.**

The foundation for these projects is the safety standards which the IAEA is authorized,

Statutory Obligations (1957)

Article III, *Functions*, Paragraph A.6.

“ 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 (including such standards for labour conditions), and **to provide for the application of these standards** to its own operation as well as to the operations making use of materials, services, equipment, facilities, and information made available by the Agency ...; “



IAEA Safety Standards - Overview

- The IAEA maintains about 120 safety standards.
- Program initiated 31 March 1960 (INFCIRC/18).
- Covers nuclear, radiation, transport and waste safety.
- Not legally binding on the Member States, but they can adopt them at their own discretion.
- Legally binding on the activities of the IAEA Secretariat.
- Published in the “IAEA Safety Standards Series”, and can be purchased as hardcopy, or downloaded free-of-charge.

Status of Safety Standards

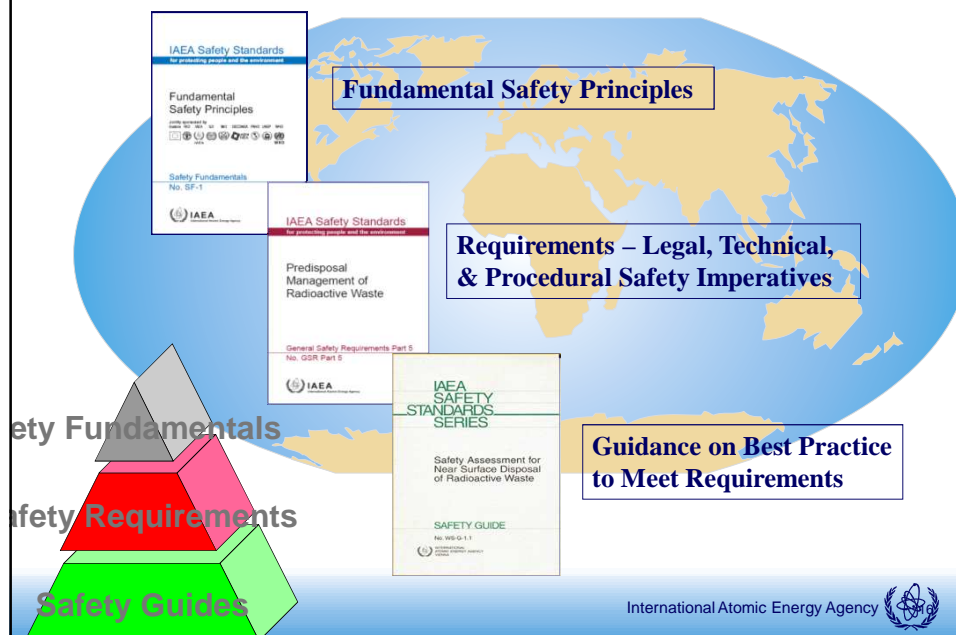
IAEA Safety standards are

- Binding for IAEA's own activities
- Not binding on the Member States (but may be adopted by them) EXCEPT in relation to operations assisted by the IAEA:
 - Integrated Regulatory Review Service
 - Technical Cooperation Fund work
 - States wishing to enter into project agreements with the IAEA

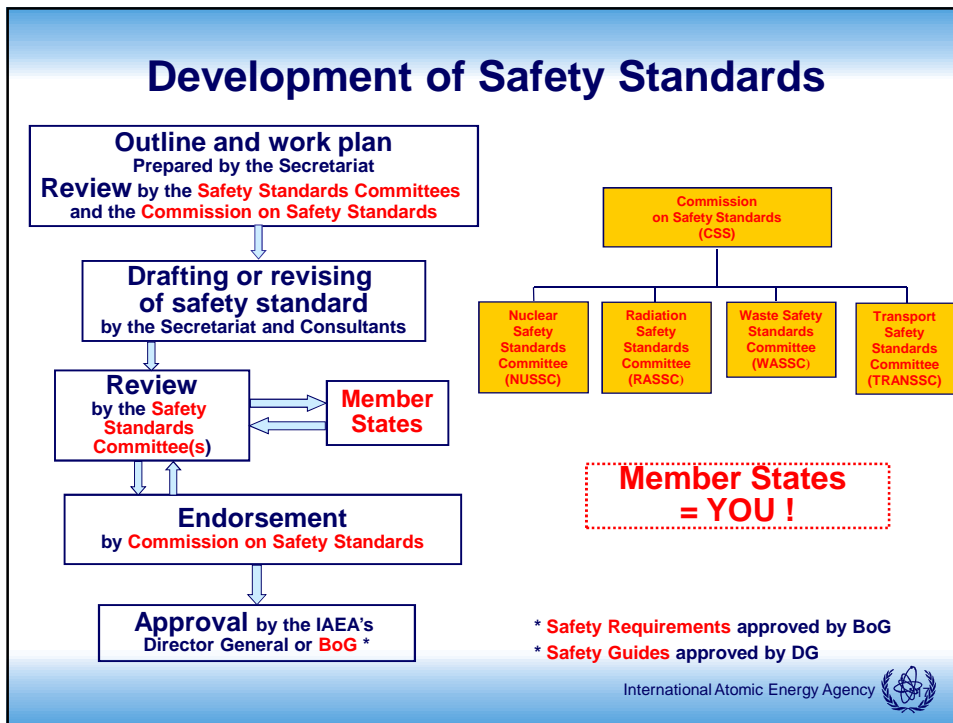
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Safety Standards Categories



Development of Safety Standards



Networks

- IDN, ENVIRONET, LABONET, DISPONET and URF Networks (+ IMMUNET):
 - workshops / technical meetings and training courses,
 - Annual Forums of Networks,
 - Active at international conferences (e.g. WM Phoenix).
- Projects under umbrella of IDN and ENVIRONET:
 - CIDER, DACCORD and DRiMa (+ new project DAROD).

International Projects & Working Groups

- Integrated Safety Case for Dual Purpose Casks for SNF
- HIDRA Project: Human Intrusion in the context of Disposal of Radioactive Waste
- Follow up project on Demonstration of Safety of Geological Disposal (GEOSAF)
- Prisma: Follow up of Prism on demonstration of safety of near surface disposal (SC and SA)
- International WG on Disposal of ILW
- CRAFT Project : Demonstration of Safety for predisposal management
- MODARIA: Modelling and Data for Radiological Impact Assessment, launched in Nov. 2012
- RSLs: Regulatory supervision of Legacy Sites
- CGULS: Coordination Group for Uranium Legacy Sites
- R2D2: International Research Reactor Decommissioning Demonstration Project

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Technical Co-operation Programme

- TC-cycle 2014-2015;
- WTS Technical Officers are recently involved in about 40 national, 8 regional and 4 interregional projects;
- WES Technical Officers are involved in about 50 national, regional and interregional projects;
- In most cases TC projects are co-managed by WTS and WES Technical officers;
- New TC-cycle 2016-2017 under preparation.

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Review Missions in 2014/2015

• Malaysia



The screenshot shows a news article on the IAEA website. The article title is "Malaysian Rare Earth Plant Complies with IAEA Recommendations, Report Concludes" by Rodolfo Quevenco. It features a photo of IAEA experts at the Lynas rare earth processing facility. The article text states that the Malaysian government has implemented all recommendations from a 2011 IAEA-led review mission. A "Related Resources" sidebar lists links to the full report, 2011 mission report, 2014 press release, and follow-up review.

26
June 2015

Malaysian Rare Earth Plant Complies with IAEA Recommendations, Report Concludes

By Rodolfo Quevenco, IAEA Office of Public Information and Communication

Members of an IAEA international expert team visit Lynas rare earth processing facility near Kuantan in Malaysia on 14 October 2014. (Photo: G. Tador IAEA)

The Malaysian government has implemented all recommendations put forward by an IAEA-led review mission in 2011 on radiation safety at the Lynas Advanced Materials Plant (LAMP), a rare earths processing facility completed in 2012 near Kuantan, Malaysia. This is one of the main conclusions of a report recently made public by the IAEA on the request of the Malaysian government. The release of the report in itself complies with recommendations to ensure maximum transparency over the project.

Related Resources

- Full Report of the 2014 Safety Review Mission
- Report of the 2011 Review Mission
- 2014 Press Release: IAEA Concludes Follow-up Review of Malaysia Rare Earth Plant
- IAEA Department of Nuclear Energy
- IAEA Department of Nuclear Safety and Security



Review Missions in 2014/15

- 14 May 2015 Third IAEA-led Expert Visit to Collect Marine Samples Offshore Fukushima
- 30 March 2015 IAEA Experts to Visit Fukushima for Additional Information on Contaminated Water Management
- 17 February 2015 IAEA Team Completed Third Review of Japan's Plans to Decommission Fukushima Daiichi
- 3 February 2015 IAEA Experts to Review Japan's Decommissioning Work at Fukushima Daiichi Site
- 31 October 2014 IAEA Experts to Visit Japan to Present Results of Fukushima Seawater Analysis Comparison, Take New Samples



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