Management of Materials from the Decommissioning of Nuclear Reactors

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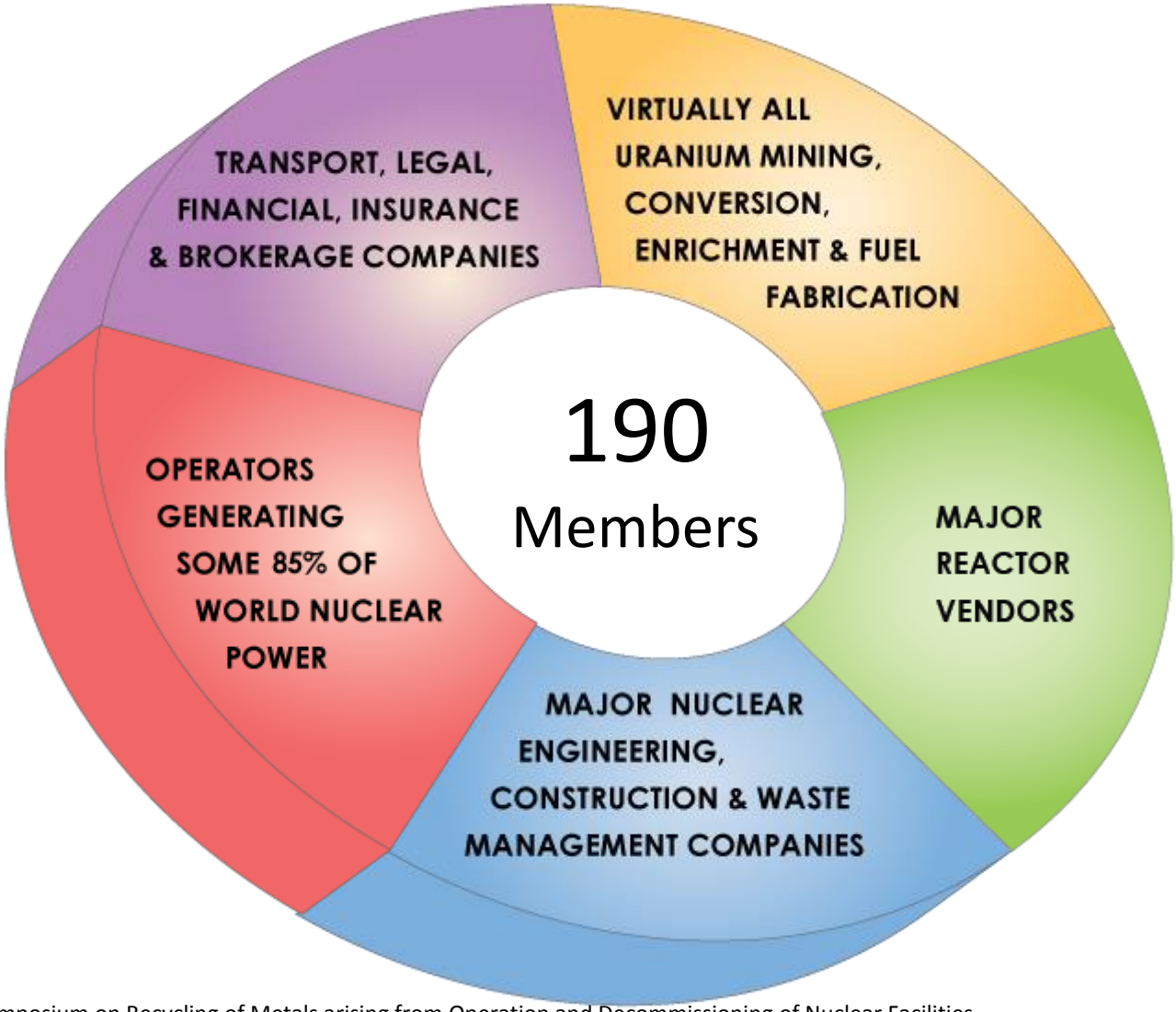
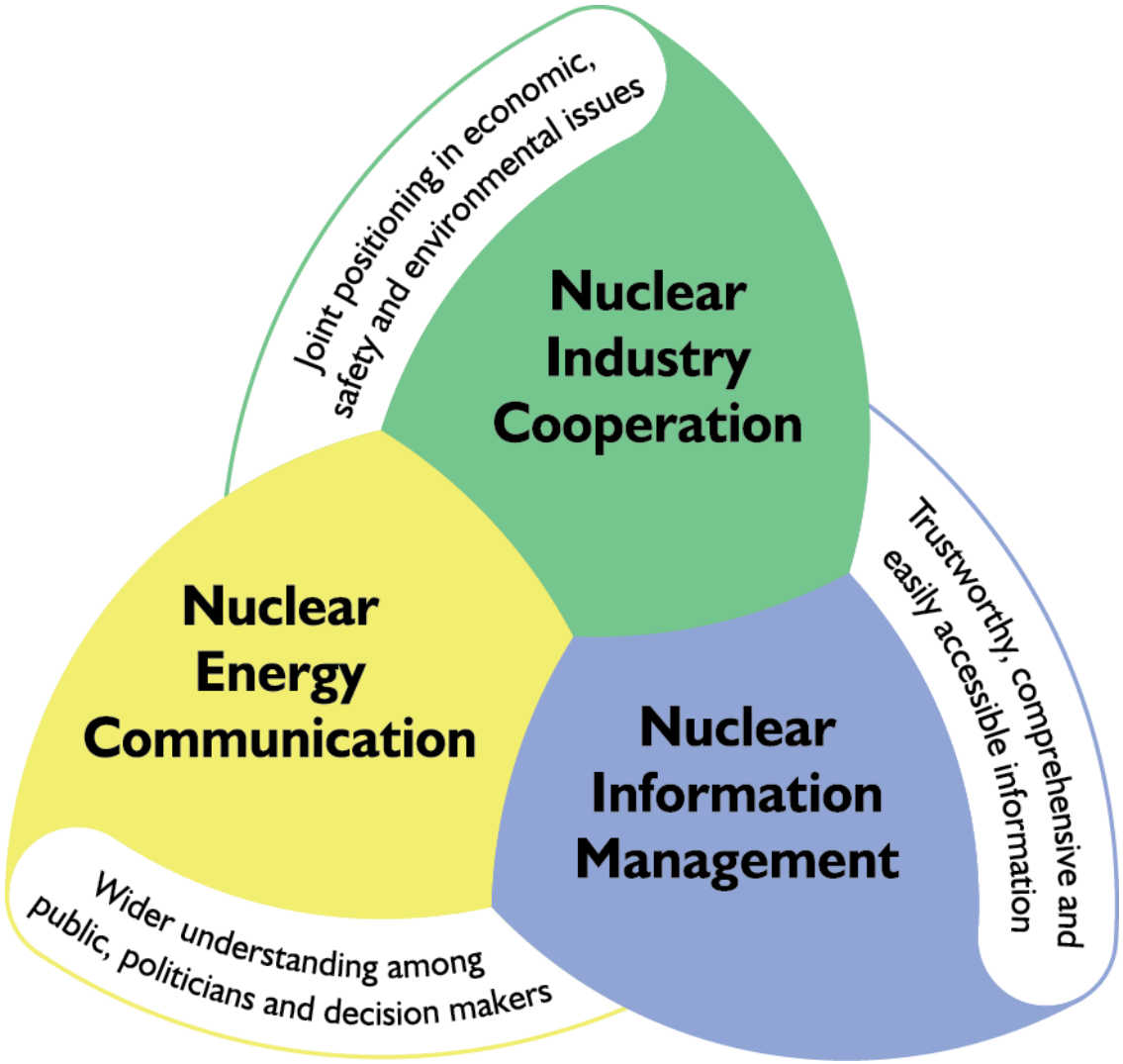
Symposium on Recycling of Metals arising from Operation and Decommissioning of Nuclear Facilities
8th – 10th April 2014

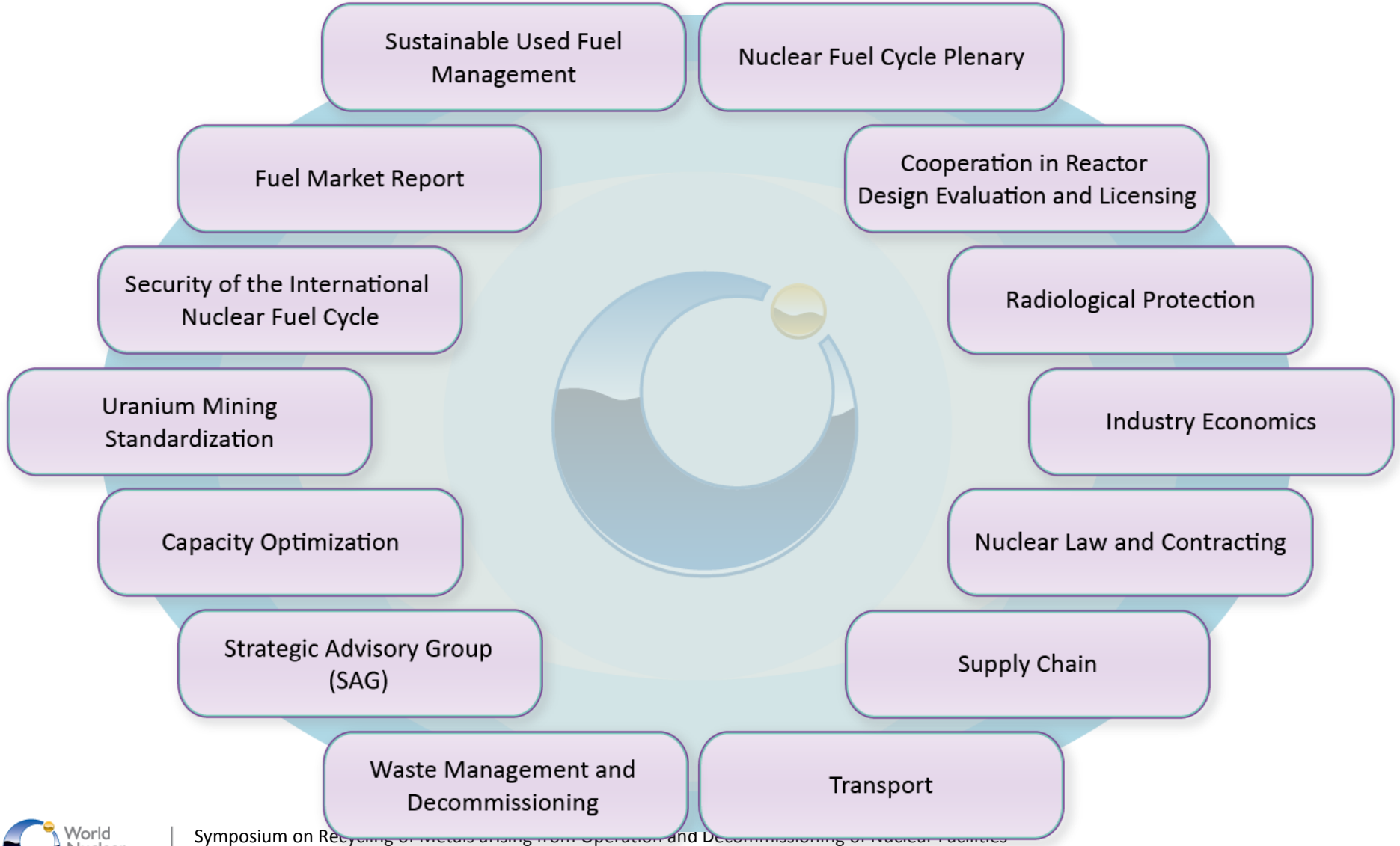
World Nuclear Association



Strategic Overview



Members' Groups



Representation in key international forums

International Atomic Energy Agency

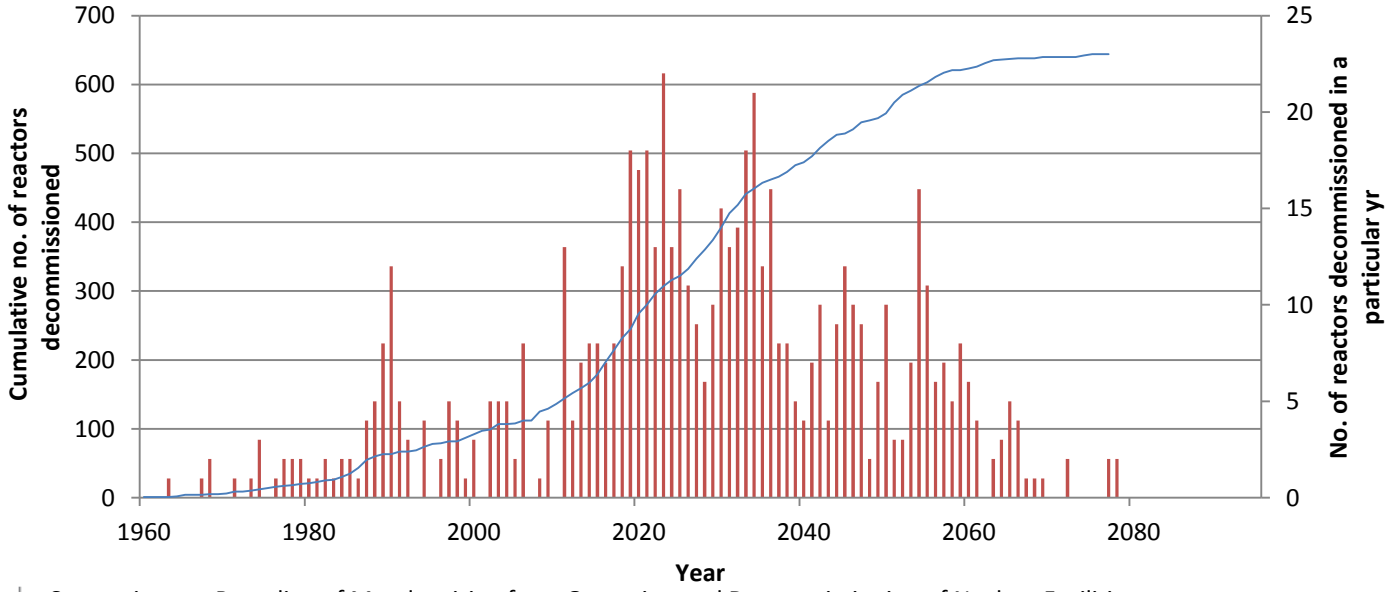
Nuclear Energy Agency of the OECD

UN Framework Convention on Climate Change

International Commission on Radiological Protection

Decommissioning Prospects Worldwide

- More than 400 reactors in operation worldwide
- By 2060, most of them will reach end of operation
- Within controlled area each reactor provides :
  - 200,000t concrete
  - 20,000t steel
  - 2,000t copper
- Only 4,000t are activated (i.e. must go to final disposal)



Total Mass of Materials to be Managed

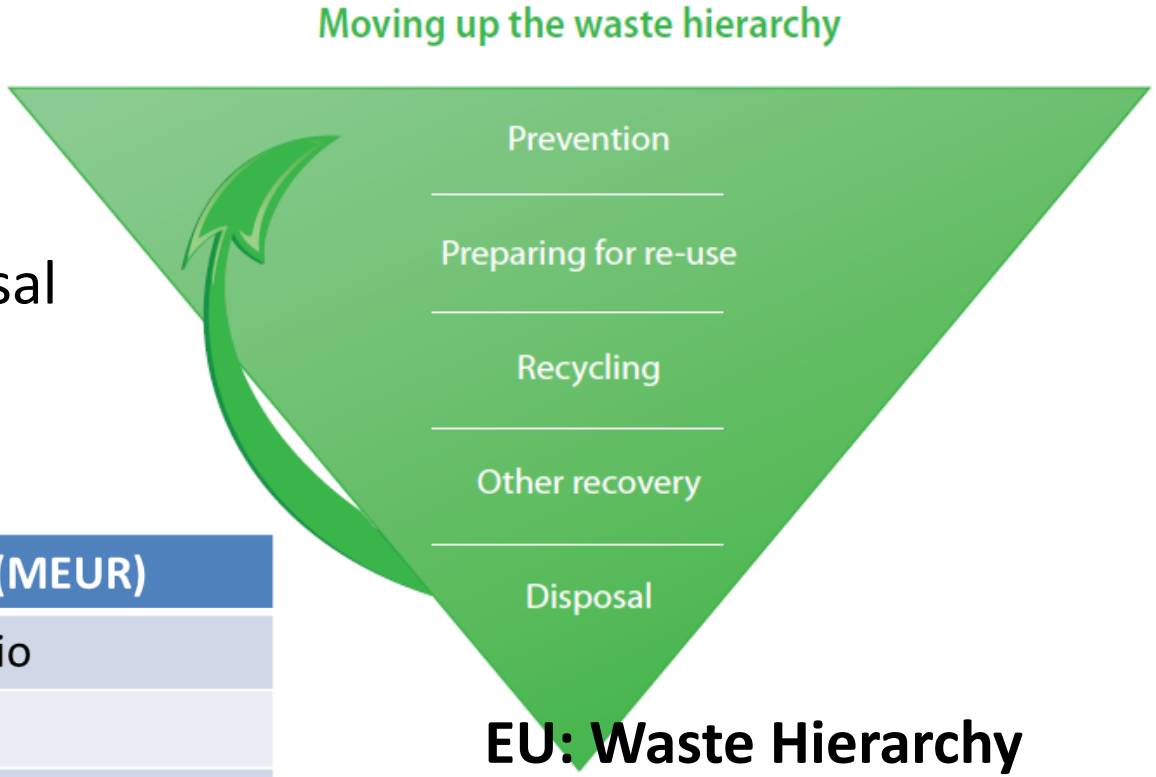
Material	Total mass from reactors worldwide (Mio t)	Annually recycled mass (Mio t)
Concrete	80	2,000
Steel	8	400
Copper	0.8	8

Why Recycling?

Reasons:

- Saving resources
- Reducing use of disposal sites
- Economic arguments

Material	Value (MEUR)
Concrete	800 Mio
Steel	1 Bln
Copper	4 Bln



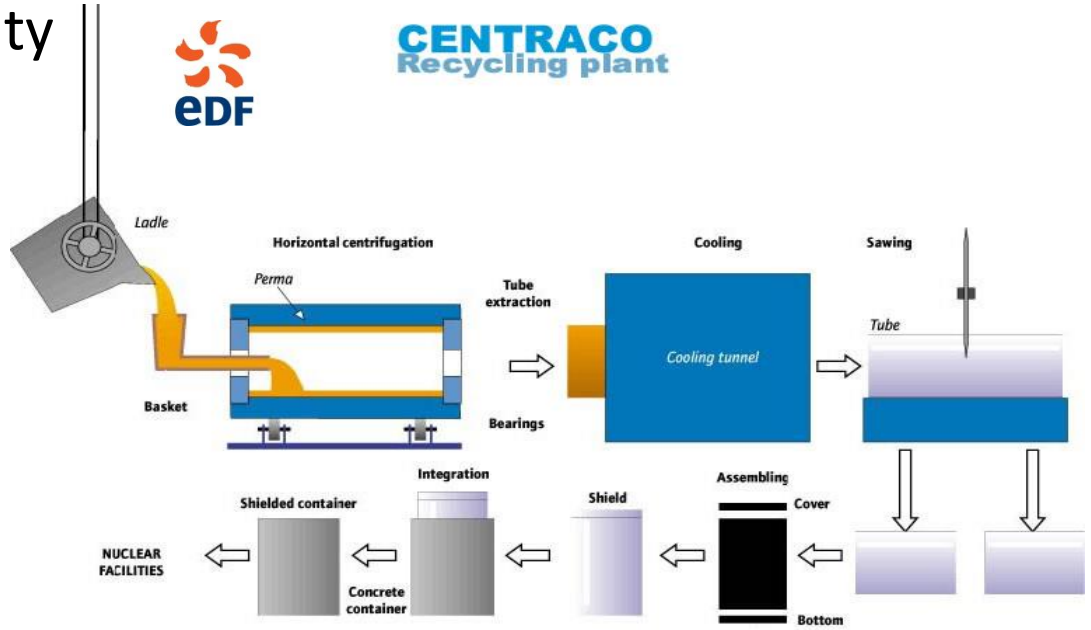
EU: Waste Hierarchy

- Legal obligation in several countries (not for radioactive materials)

Two Recycling Routes

Inside nuclear industry

- Higher level of radioactivity
- Concrete: not possible
- Steel: limited masses for shielding & disposal containers



Outside nuclear industry

- Lower level of radioactivity
- Unlimited mass

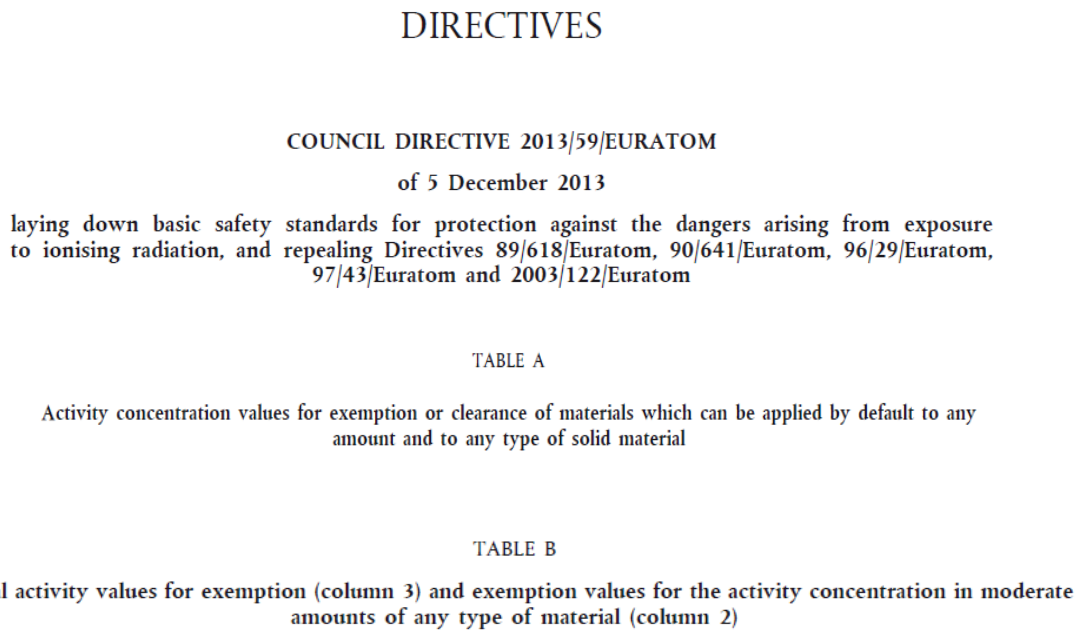
Full Recycling - what does it need?

- Legal basis
- Public acceptance
- Recipient
- Decontamination technologies
- Free release measurement
- Logistics

Legal Basis

- Availability of clearance values
- Good feedback from operating countries
- Different by country

-> Revised EC Directive may help



DIRECTIVES

COUNCIL DIRECTIVE 2013/59/EURATOM

of 5 December 2013

laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom

TABLE A

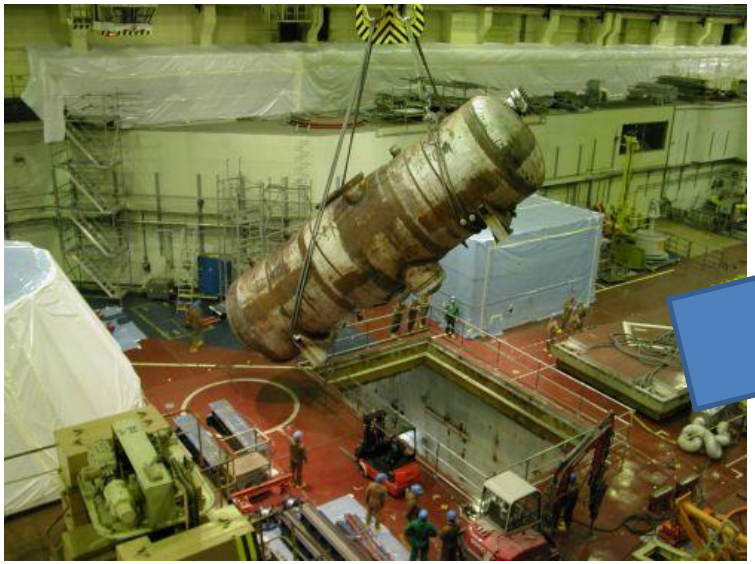
Activity concentration values for exemption or clearance of materials which can be applied by default to any amount and to any type of solid material

TABLE B

Total activity values for exemption (column 3) and exemption values for the activity concentration in moderate amounts of any type of material (column 2)

Public Acceptance

The toughest challenge…



Recipients

Concrete:

- Road construction
- Backfill of underground mines

Steel

- Foundry

Copper

- Refining

D&D Technologies

Any contamination (not activated) can be removed

- Decontamination prior to cutting
- Measurement prior to cutting
- Chirurgical cutting (to keep activated material separate)
- Dry, wet, laser, etc decontamination of cut pieces
- Melting for further decontamination
  [not Co-60! But interesting half-life (5 - 7yr) allows other possibilities, e.g. temporary storage,…]

Free Release

- Measurement of significant mass at low activities
- Continuous measurement
- Qualification & acceptance by authorities and recipient
- Melting to increase share of free release material

Studsvik

Siempelkamp
Nukleartechnik

Logistics

- No long distance transport for bulk/low value material (concrete) -> expensive
- Preparedness for blockage of nuclear transports (local treatment?)
- Intermediate/buffer storage capacities
- Transport of huge metallic components for decay and centralized treatment

Messages

- Huge amounts of materials from D&D

  BUT: recycling market is much bigger, hence no disturbance
- Recycling is most believable/affordable process to minimize environmental impact (preservation of natural resources, reduced storage capacities, waste management…)
- Legal, technical basis to be set
  - Common analysis of environmental & human impact among nuclear operating countries could reinforce nuclear industry credibility
- **ACCEPTANCE** is the **MOST** important/challenging issue

RADIOACTIVE WASTE MANAGEMENT

Treatment Technologies Facilities

evaporation · concentration · cementation
vitrification · nuclide separation · pyrolysis ·
pyrohydrolyse · biological treatment of waste water ·
sorting/segregation · compaction · incineration

- For all types of waste generated in nuclear installations
- From concept development to turn-key construction
- Full toolbox of technologies and systems
- Monitoring systems

References:

- Ignalina NPP, Lithuania
- Chernobyl NPP, Ukraine
- Leningrad NPP, Russia
- Kola NPP, Russia
- EU Research Center Ispra, Italy

NUKEM Technologies –

Expert in Waste Management and Decommissioning

Dr. Georg Braehler, CTO

Presentation on behalf of WNA

DECOMMISSIONING

Segmentation Decontamination Site Remediation

under water milling machines · under water shear and compaction ·
manipulator systems · flame cutting ·
water jet cutting · plasma-arc cutting ·
mechanical cutting tools
remote handling techniques

- Concept development to demolition
- Full toolbox of segmentation techniques
- Decontamination technologies
- Facility upgrading
- Site characterisation and remediation

References:

- Kahl NPP, Germany
- Brennilis NPP, France
- Fuel Fabrication Facility Hanau, Germany
- NECSA, South Africa
- Belgonucleaire, Belgium

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