

IAEA Safety Standards on Decommissioning of Facilities

Yulia GORLOVA

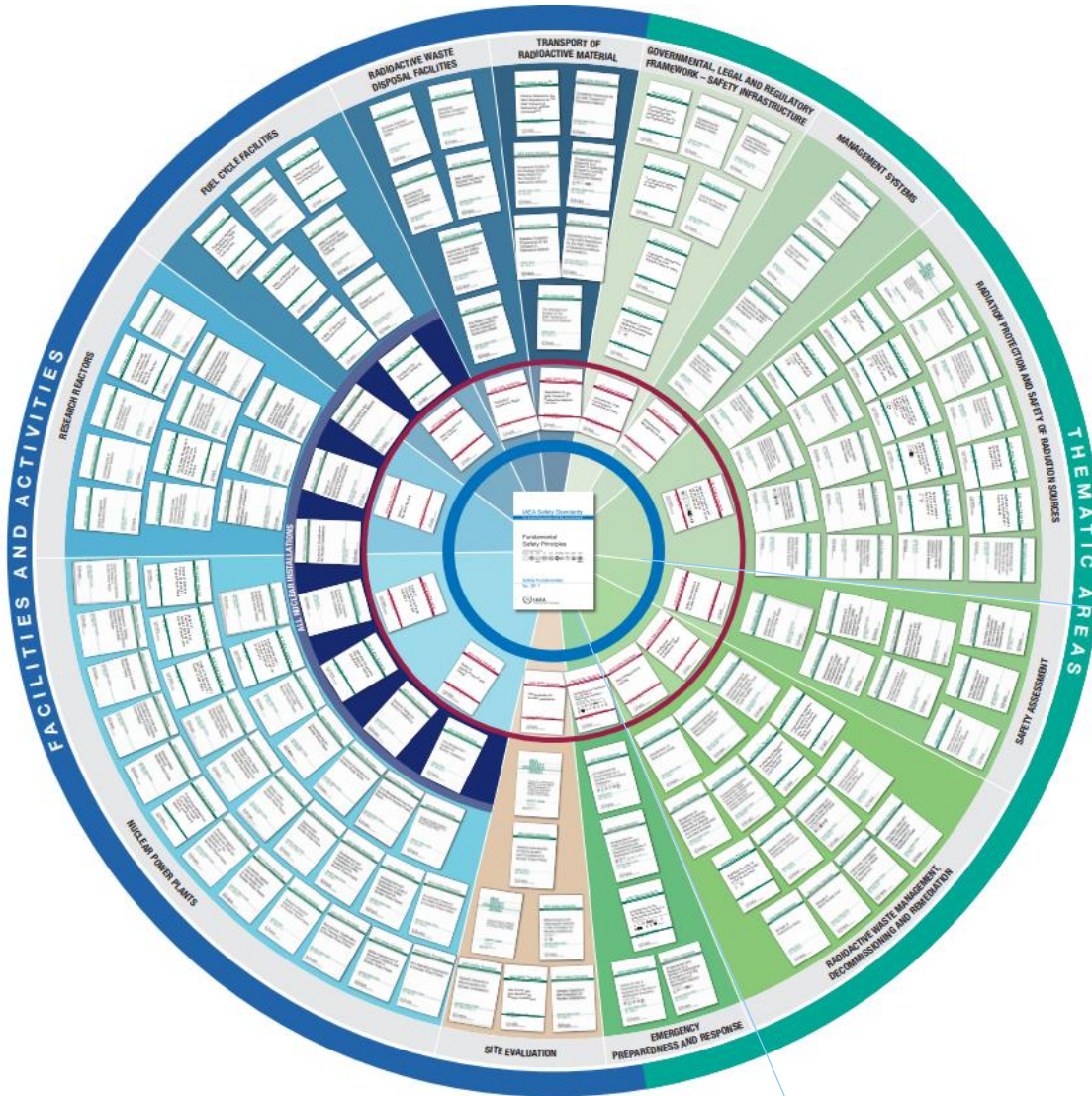
Decommissioning and Remediation Unit |
Waste and Environmental Safety Section |
Division of Radiation, Transport and Waste Safety |
Department of Nuclear Safety and Security



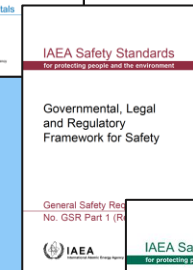
IAEA Safety Standards

Safety means the protection of people and the environment against radiation risks, and the safety of facilities and activities that give rise to radiation risks.

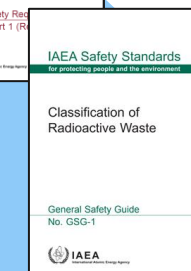
- IAEA Safety Standards reflect an international consensus on what constitutes a high level of nuclear safety
- IAEA Safety Standards serve as a global reference for protecting people and the environment



Safety Fundamentals

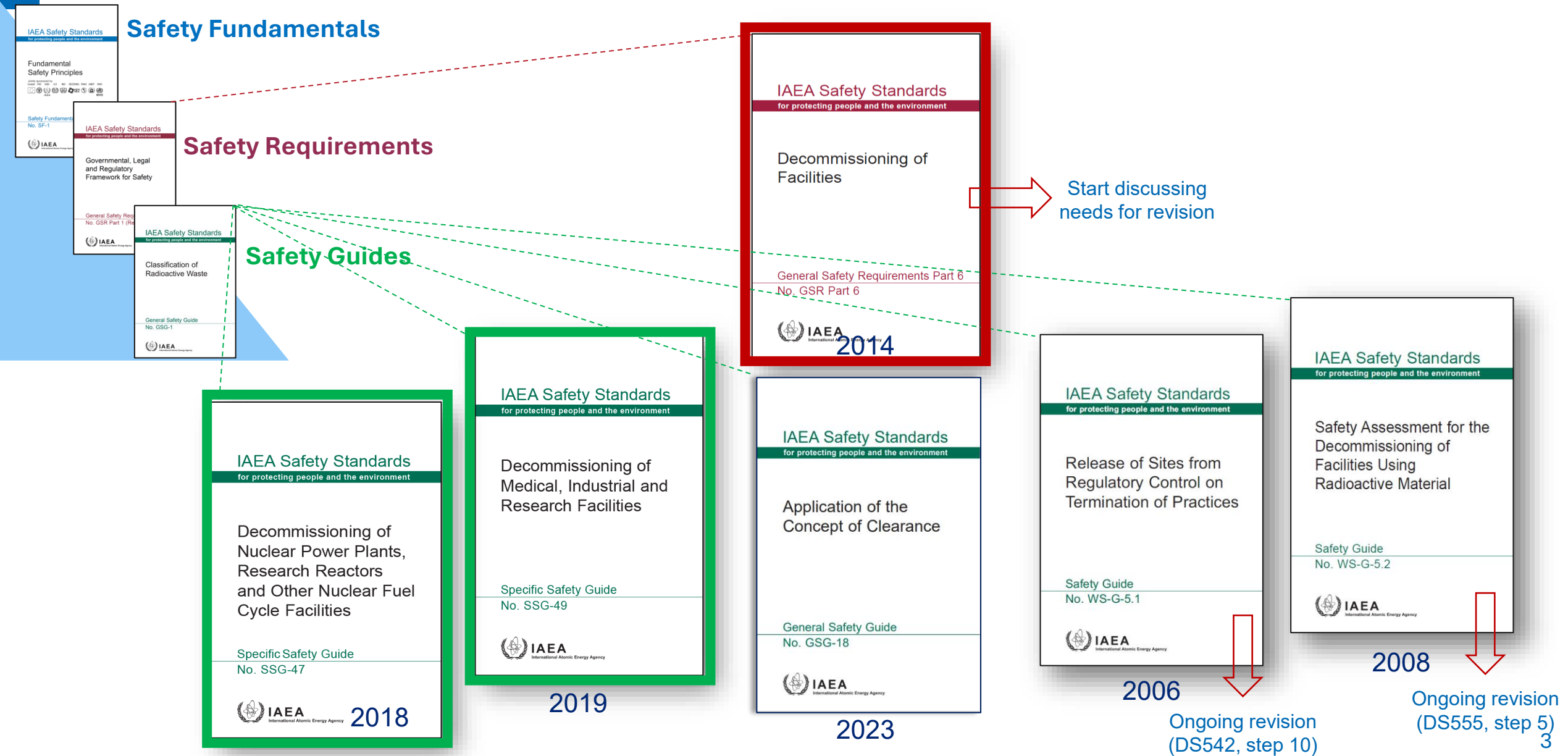


Safety Requirements



Safety Guides

IAEA Safety Standards: Decommissioning



Introduction to decommissioning

*“Decommissioning - Administrative and technical actions taken to allow the **removal of some or all of the regulatory controls** from a facility”*

GSR Part 6 and the IAEA Safety and Security Glossary

*Decommissioning is the **last** phase in the lifetime of a facility. However, **aspects of decommissioning have to be considered throughout the other phases** (siting, design, construction, commissioning and operation).*

Aim: to achieve **progressive and systematic reduction of rad. hazards**, so

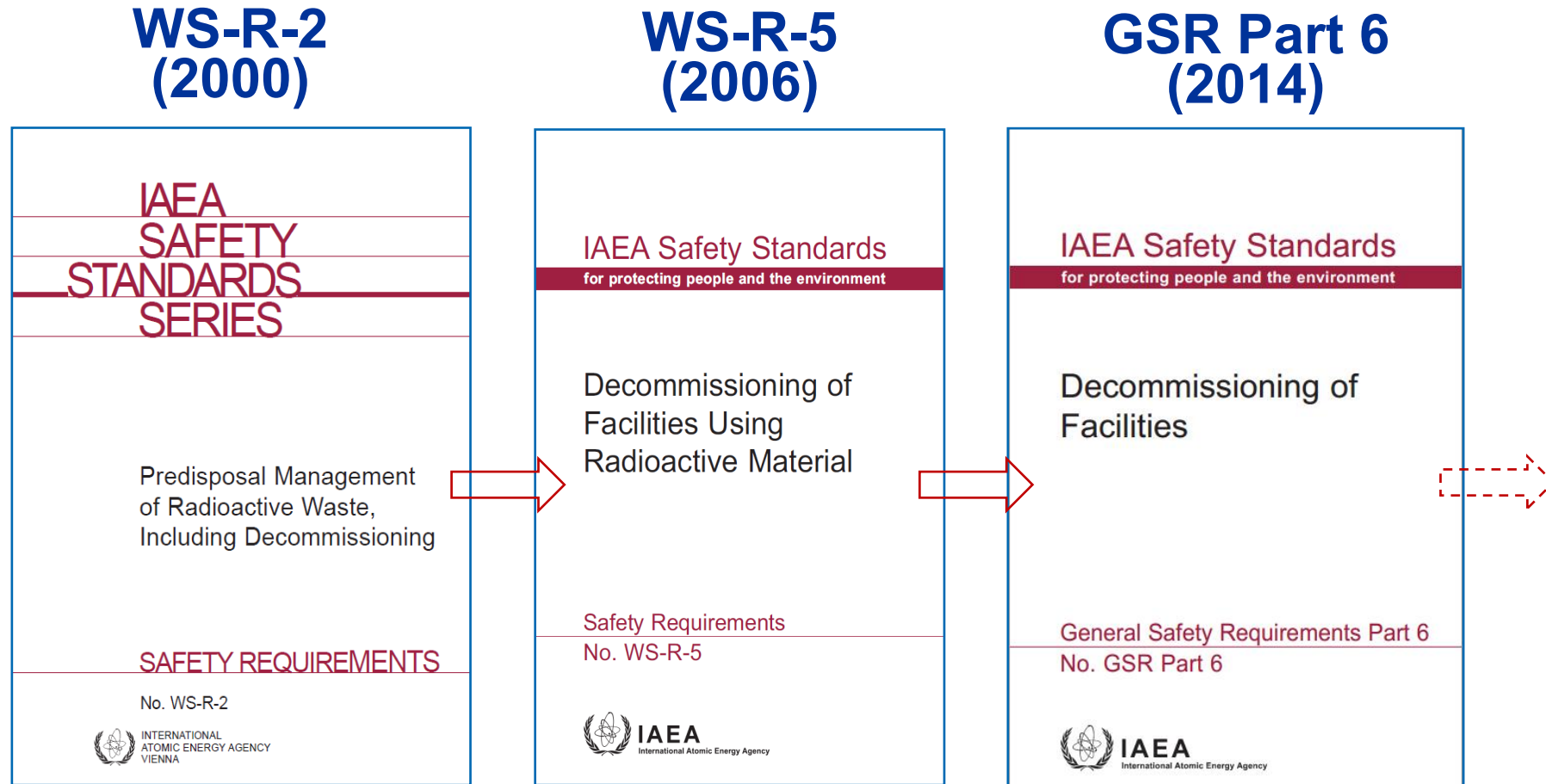
- (1) the site can be **released** from rad regulatory control and
- (2) can subsequently be **safely reused**

Planned: as early as feasible, nowadays recommended to be included in design considerations



SAFETY REQUIREMENTS ON DECOMMISSIONING

History of IAEA safety requirements for decommissioning



Structure of IAEA **GSR Part 6** “Decommissioning of Facilities”

9 sections

15 “overarching” requirements supported by 61 “explanatory” requirements

1. INTRODUCTION

Requirement 1: Optimization of protection and safety in decommissioning
Requirement 2: Graded approach in decommissioning
Requirement 3: Assessment of safety for decommissioning

2. PROTECTION OF PEOPLE AND
PROTECTION OF THE ENVIRONMENT

3. RESPONSIBILITIES ASSOCIATED WITH
DECOMMISSIONING

Requirement 4: Responsibilities of government for decommissioning
Requirement 5: Responsibilities of regulatory body for decommissioning
Requirement 6: Responsibilities of licensee for decommissioning

4. MANAGEMENT OF
DECOMMISSIONING

Requirement 7: Integrated management system for decommissioning

5. DECOMMISSIONING STRATEGY

Requirement 8: Selecting a decommissioning strategy

6. FINANCING OF DECOMMISSIONING

Requirement 9: Financing of decommissioning

7. PLANNING FOR DECOMMISSIONING
DURING THE LIFETIME OF FACILITY

Requirement 10: Planning for decommissioning
Requirement 11: Final decommissioning plan

8. CONDUCT OF DECOMMISSIONING
ACTIONS

Requirement 12: Conduct of decommissioning actions
Requirement 13: Emergency response arrangements for decommissioning
Requirement 14: Radioactive waste management in decommissioning

9. COMPLETION OF DECOMMISSIONING
ACTIONS AND TERMINATION OF
AUTHORIZATION FOR
DECOMMISSIONING

Requirement 15: Completion of decommissioning actions and termination of authorization for decommissioning

Key positions

- Safety driven activity, requires authorization (licensing)
- Last phase in the facility lifetime, normal phase which can't be avoided
- Early planning
- Fund accumulation (“polluter pays”)
- Spent fuel, liquids and operational waste to be removed prior to decommissioning (during transition)
- Strategies - preference to immediate dismantling
- Implemented as a project with multiple phases
- Gradual removal of hazards (changing profile of hazards, surprises, uncertainties)
- Protection of workers, public and the environment
- Technologies available, well developed
- Disposal of RAW, clearance of material (recycling, reuse)
- Non-radioactive waste, hazardous material
- Industrial safety aspects
- Release of the site from regulatory control – preference to unrestricted release



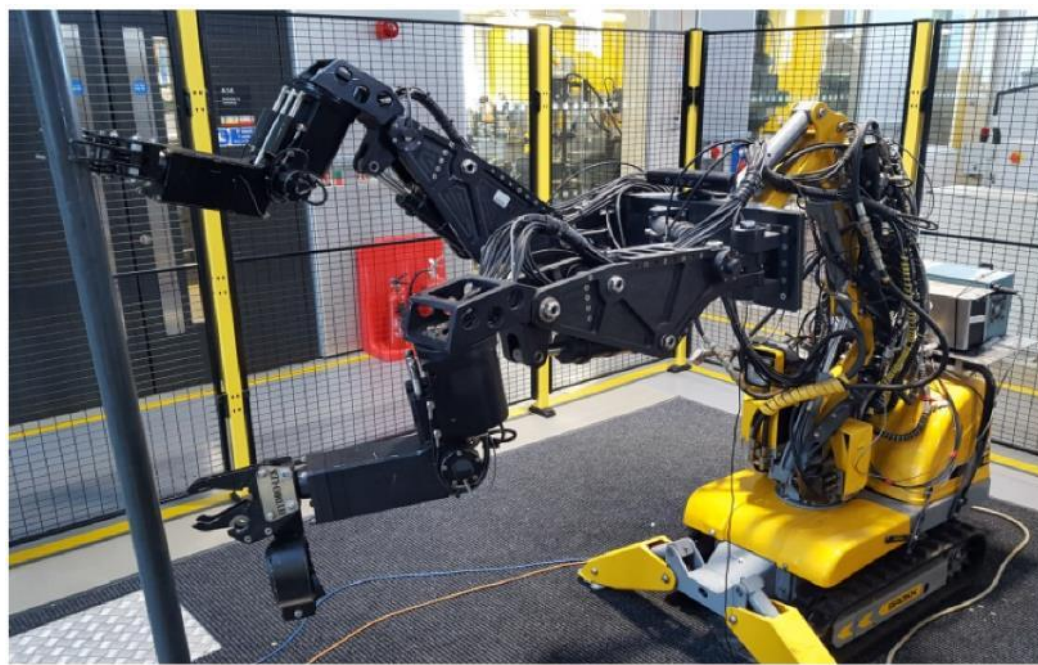
Neckarwestheim I NPP:
Removal of steam generator in
one piece
Image source: EnBW AG



Greifswald NPP: shaving of
concrete surface
Image sources: EWN GmbH



Philippsburg NPP: Blasting of
cooling towers
Image sources: EWN GmbH

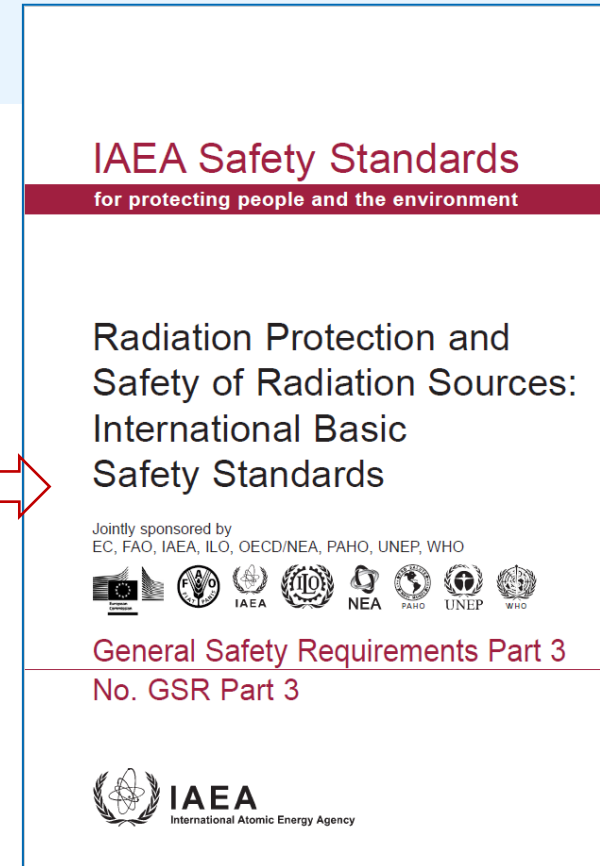


2. Protection of People and Protection of the Environment

Requirement 1: Optimization of protection and safety in decommissioning

*Exposure during decommissioning shall be considered to be a planned exposure situation and the relevant requirements of the **Basic Safety Standards** shall be applied accordingly during decommissioning.*

- Dose limitation
- Protection of workers and the public against exposure during planned activities, but also in case of incidents during decommissioning
- Compliance with environmental protection requirements



2. Protection of People and Protection of the Environment

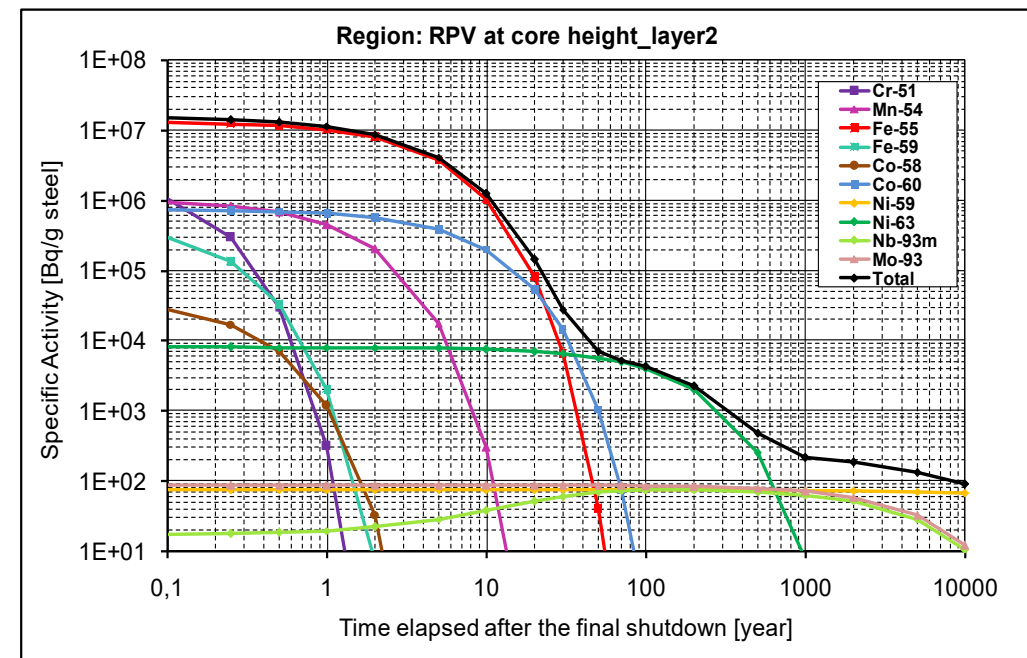
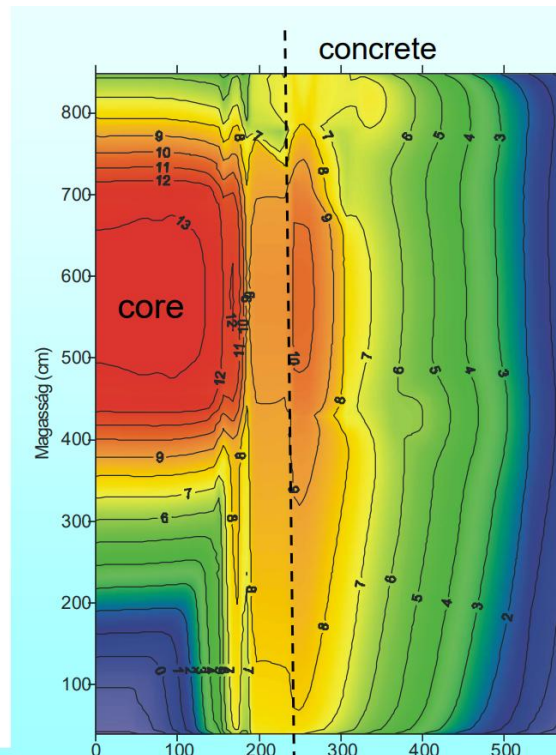
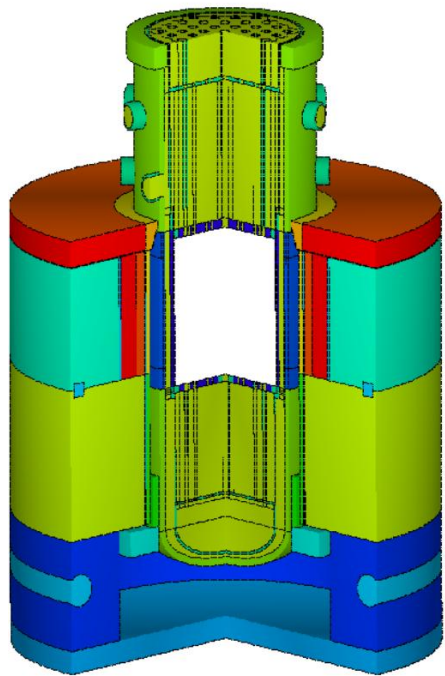
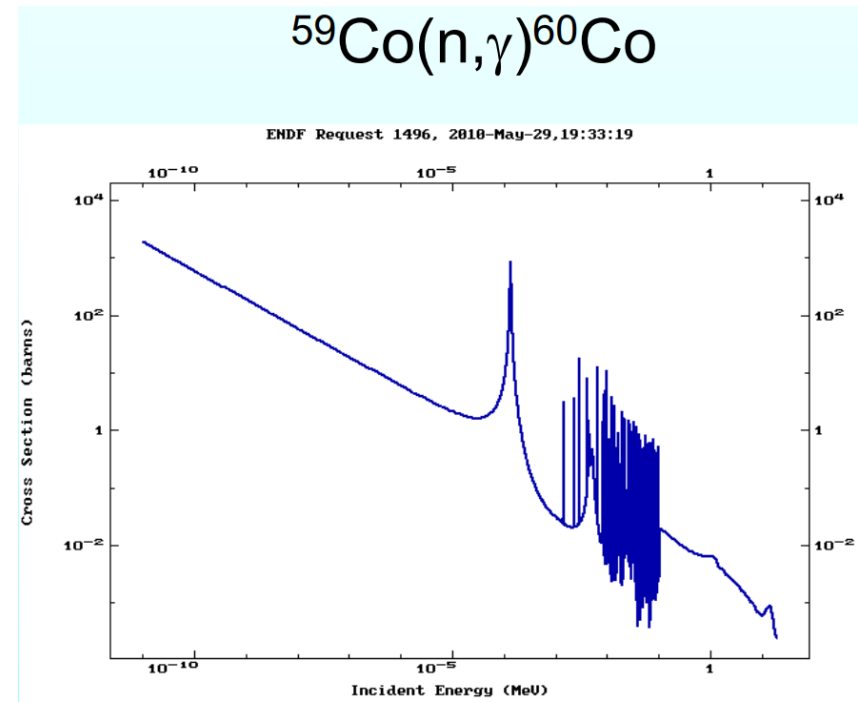
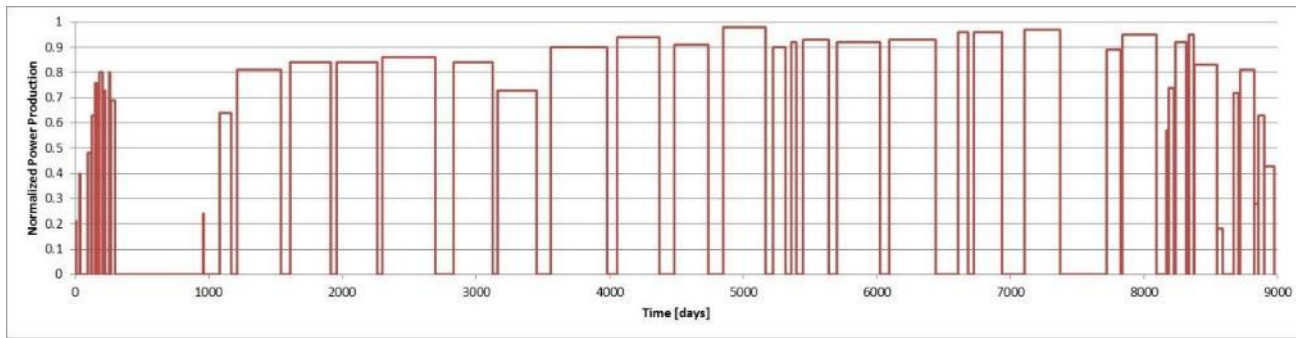
Requirement 2: Graded approach in decommissioning

A graded approach shall be applied in all aspects of decommissioning in determining the scope and level of detail for any particular facility, consistent with the magnitude of the possible radiation risks arising from the decommissioning.

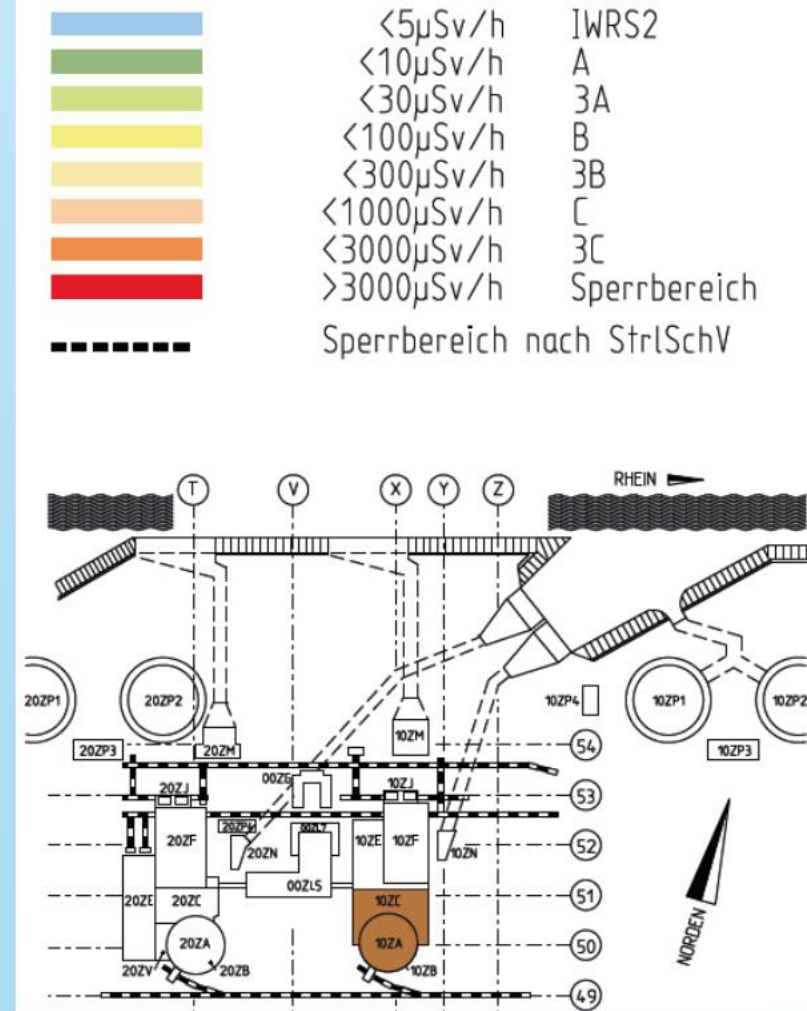
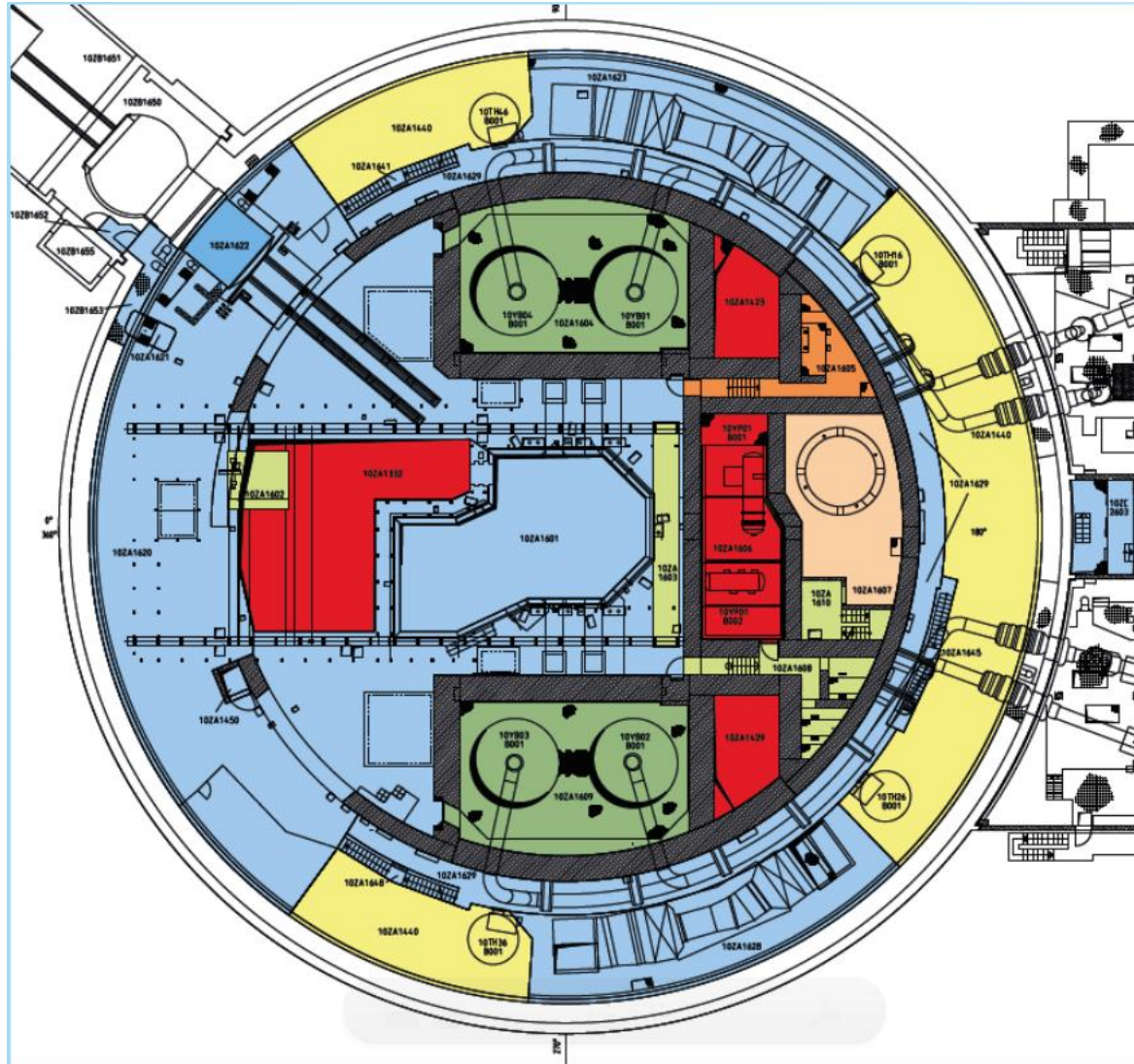
Requirement 3: Assessment of safety for decommissioning

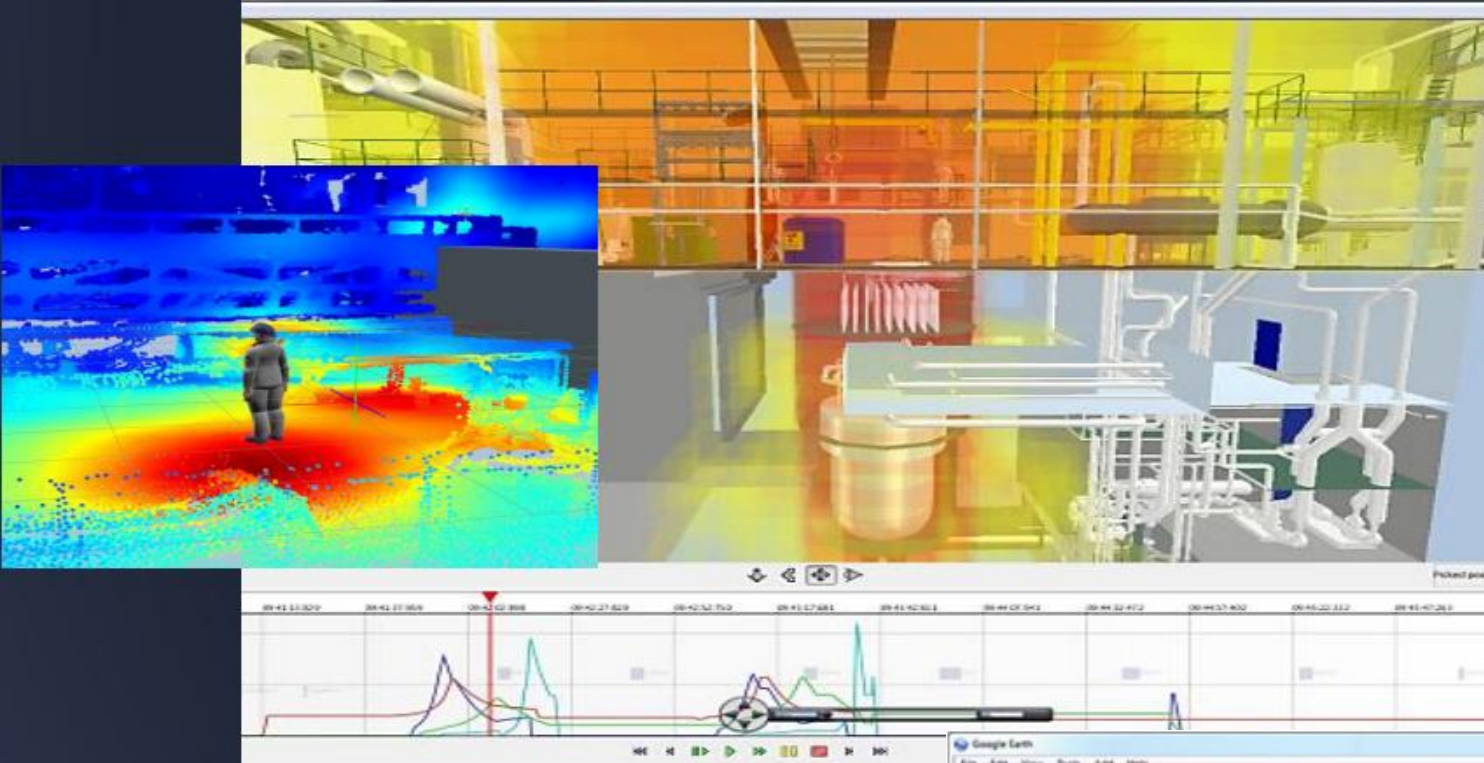
Safety shall be assessed for all facilities for which decommissioning is planned and for all facilities undergoing decommissioning.

- The FDP shall be supported by a safety assessment addressing the planned decommissioning actions and potential incidents, including accidents, that may occur or situations that may arise during decommissioning.

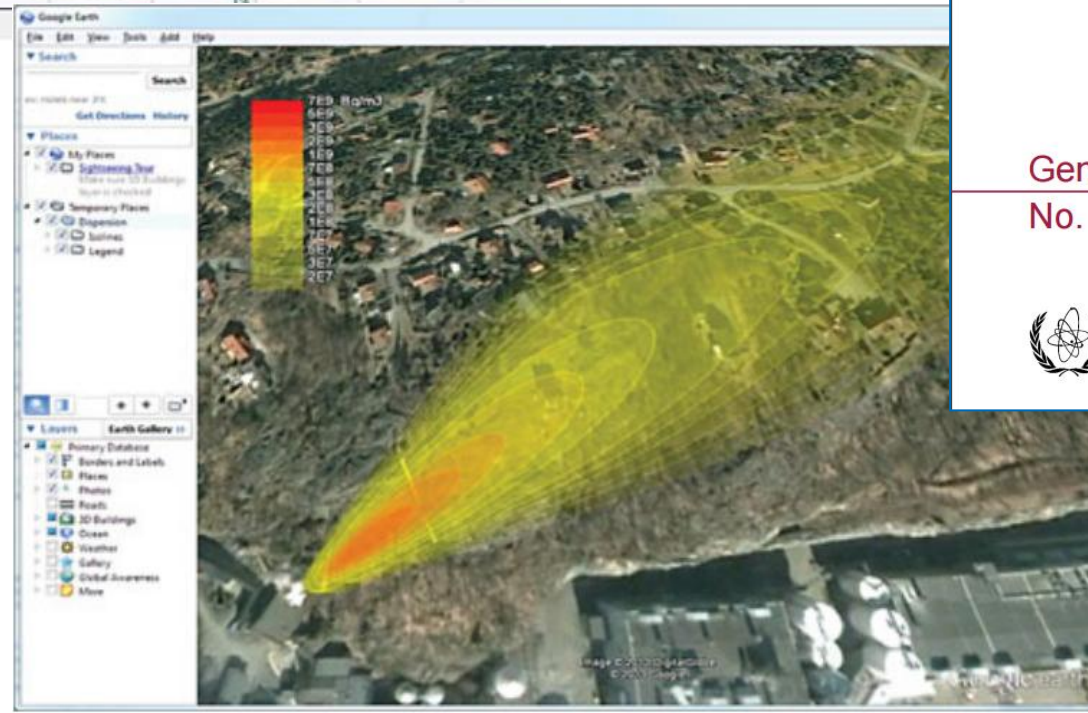


IAEA RER9120 Workshop on Management of Waste from Decommissioning, November 2015, Karlsruhe





Planning: Simulation / modeling / visualization of the radiation fields and the environmental dispersion



IAEA Safety Standards for protecting people and the environment

Safety Assessment for Facilities and Activities

General Safety Requirements
No. GSR Part 4 (Rev. 1)



(2016)

3. Responsibilities Associated with Decommissioning

Requirement 4: Responsibilities of the government for decommissioning

The government shall establish and maintain a governmental, legal and regulatory framework within which all aspects of decommissioning, including management of the resulting radioactive waste, can be planned and carried out safely. This framework shall include a clear allocation of responsibilities, provision of independent regulatory functions and requirements in respect of financial assurance for decommissioning.

3. Responsibilities Associated with Decommissioning

Requirement 5: Responsibilities of the regulatory body for decommissioning

The regulatory body shall regulate all aspects of decommissioning throughout all stages of the facility's lifetime, from initial planning of decommissioning during the siting and design of the facility, to the completion of decommissioning actions and the termination of authorization for decommissioning.

The regulatory body shall establish the safety requirements for decommissioning, including requirements for management of the resulting radioactive waste, and shall adopt associated regulations and guides. The regulatory body shall also take actions to ensure that the regulatory requirements are met.

3. Responsibilities Associated with Decommissioning

Requirement 6: Responsibilities of the licensee for decommissioning

The licensee shall plan for decommissioning and shall conduct the decommissioning actions in compliance with the authorization for decommissioning and with requirements derived from the national legal and regulatory framework. The licensee shall be responsible for all aspects of safety, radiation protection and protection of the environment during decommissioning.

4. Management of Decommissioning

Requirement 7: Integrated management system for decommissioning

The licensee shall ensure that its integrated management system covers all aspects of decommissioning.

- An IMS shall provide a single framework for the arrangements and processes necessary to address all the goals of the operating organization, including goals relevant to decommissioning. These goals shall include safety, health, security, environmental, quality and economic elements.
- The prime responsibility for safety shall remain with the licensee.

IAEA Safety Standards

for protecting people and the environment

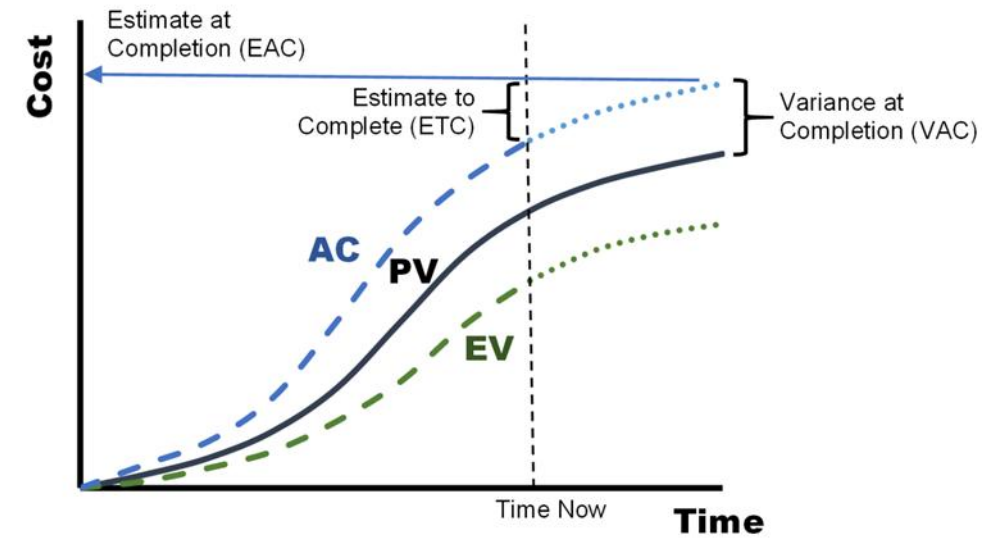
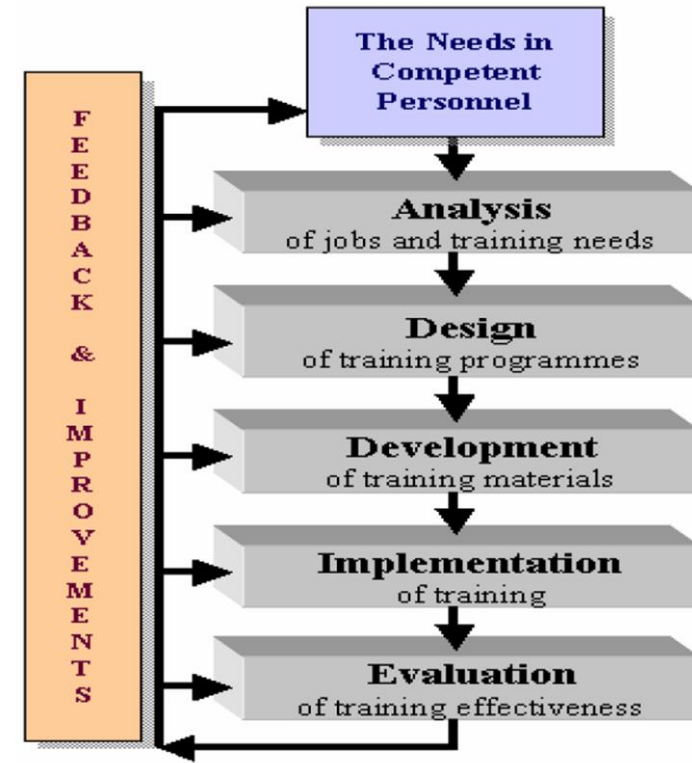
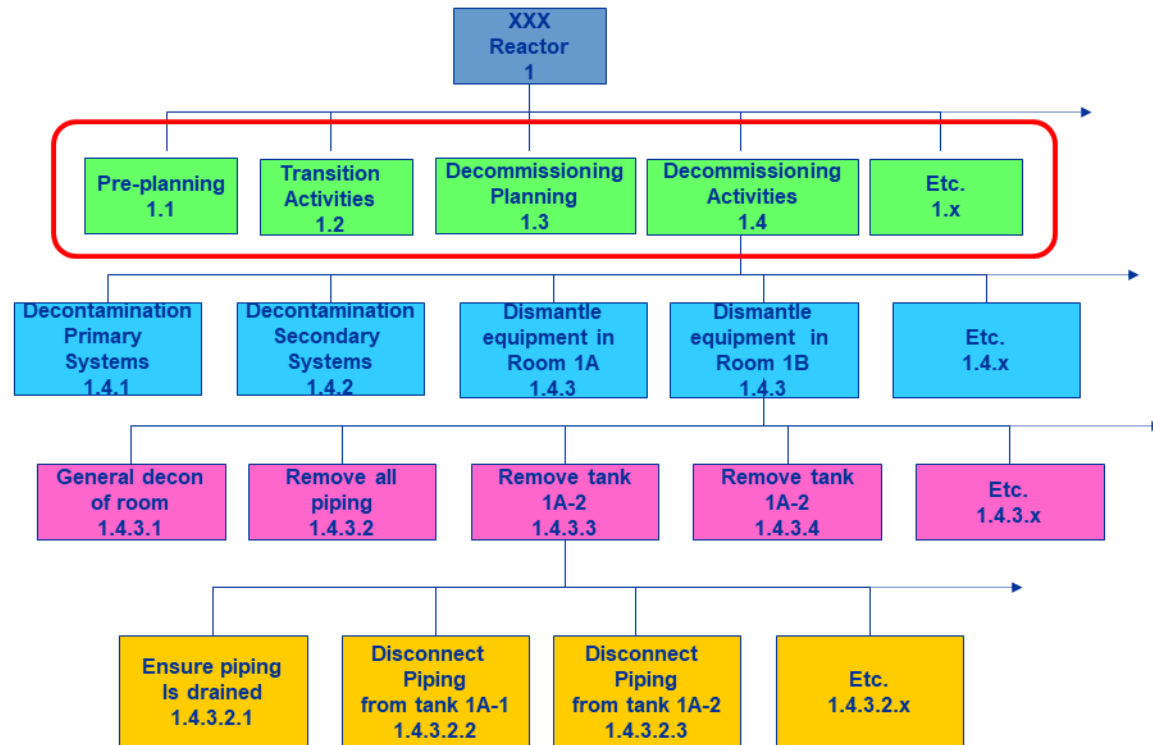
Leadership and
Management for Safety

General Safety Requirements

No. GSR Part 2



IAEA
International Atomic Energy Agency



5. Decommissioning Strategy

Requirement 8: Selecting a decommissioning strategy

The licensee shall select a decommissioning strategy that will form the basis for the planning for decommissioning. The strategy shall be consistent with the national policy on the management of radioactive waste.

- The preferred decommissioning strategy shall be immediate dismantling.
- For sites with more than one facility, a site strategy for decommissioning shall be developed to ensure that interdependences between the facilities are taken into account in the planning for individual facilities that will lead to final decommissioning plans for each facility.

options:

Immediate dismantling

Advantages

- Facility history and process knowledge
- Economic effects for the region and workers
- Security of funding
- Potential early reuse of site
- Potential for reduced effort for radiological assessment
- Minimized future uncertainties

Disadvantages

- Potential for higher occupational radiation dose exposures
- Higher RW volumes
- More complex decontamination and dismantling activities
- Need for waste management capabilities

Deferred dismantling

Advantages

- Lower radiation exposure
- Lower volume of RW
- Use of simpler dismantling techniques
- Allows for decommissioning fund growth
- Allows to develop RW management capabilities
- Option for multiunit facility or multifacility site

Disadvantages

- Increased efforts for radiological assessment
- Loss of knowledge about the facility
- Loss of qualified staff
- Maintenance costs of safe enclosure rise as facility ages
- Reduced availability of spare parts and components to maintain critical systems

6. Financing of Decommissioning

Requirement 9: Financing of decommissioning

Responsibilities in respect of financial provisions for decommissioning shall be set out in national legislation. These provisions shall include establishing a mechanism to provide adequate financial resources and to ensure that they are available when necessary, for ensuring safe decommissioning.

- It shall be ensured that adequate financial resources to cover the costs associated with safe decommissioning, including management of the resulting waste, are available when necessary.
- The cost estimate for decommissioning shall be updated on the basis of the periodic update of the initial decommissioning plan or on the basis of the final decommissioning plan.

			Labor Category 1 Title: Laborer \$25.00			Labor Category 2 Title:			Total Activity			
Activity Description =====	Activity Duration PLF =====		Adjusted Duration =====	# of Workers =====	Man Hours =====	Base Cost =====	# of Workers =====	Man Hours =====	Base Cost =====	# of Workers =====	Man Hours =====	Base Cost =====
Prepare area	10	1.52	15.2	2	0.51	12.67				2	0.51	12.67
Remove insulation	15	2.09	31.4	2	1.05	26.25				2	1.05	26.25
Remove pipe hangers	10	1.52	15.2	1	0.25	6.33				1	0.25	6.33
Cut pipe	5	1.52	7.6	2	0.25	6.33				2	0.25	6.33
Load pipe in container	2	1.52	<u>3.0</u>	1	0.05	1.25				1	<u>0.05</u>	<u>1.27</u>
Total duration	72.4 min/ 2 meter piece						Craft Labor			2.11	52.85	
	or	1.21 hr/piece			Supervisor ratio 5:1 rate \$45.00/hr			<u>0.42</u>			<u>18.90</u>	
	or	0.60 hr/meter			Subtotal labor			2.53			71.75	
	Total Man-hours 2.53 man-hours/piece			Overhead & profit @ 0%			<u>0</u>			<u>0</u>		
				Total Labor Cost			2.53			71.75		
	or	1.27 man-hours/meter			Equipment Costs:							
				Consumables/Materials (Herculite) 4 sq m @ \$2.00/sq m							8.00	
				Saw Blades .1 @ \$1.00/blade							0.10	
				Absorbent material 2 sq m@ \$5.00/sq m							10.00	
				Bag for insulation 1 @ \$0.25 each							<u>0.25</u>	
				Subtotal							18.35	
				Overhead & Profit on equipment @ 10%							<u>1.84</u>	
				Total equipment cost							20.19	
Total Task Cost to Remove Pipe											\$91.94 /piece	
or											\$45.97 /meter	

7. Planning for Decommissioning During the Lifetime of the Facility

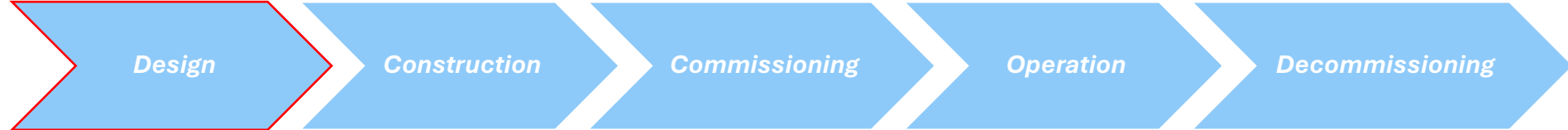
Requirement 10: Planning for decommissioning

The licensee shall prepare a decommissioning plan and shall maintain it throughout the lifetime of the facility, in accordance with the requirements of the regulatory body, in order to show that decommissioning can be accomplished safely to meet the defined end state.

- The regulatory body shall ensure that the licensee takes decommissioning into account in the siting, design, construction, commissioning and operation of the facility.

Initial planning for decommissioning

Start of decommissioning planning



Licensee: radiological survey, designing of facility taking into account future decommissioning, submission of an initial decommissioning plan (with the application for the operation), updating of decommissioning plan, record keeping

Periodically
/ when specific
circumstances warrant

Regulatory Body:
Review

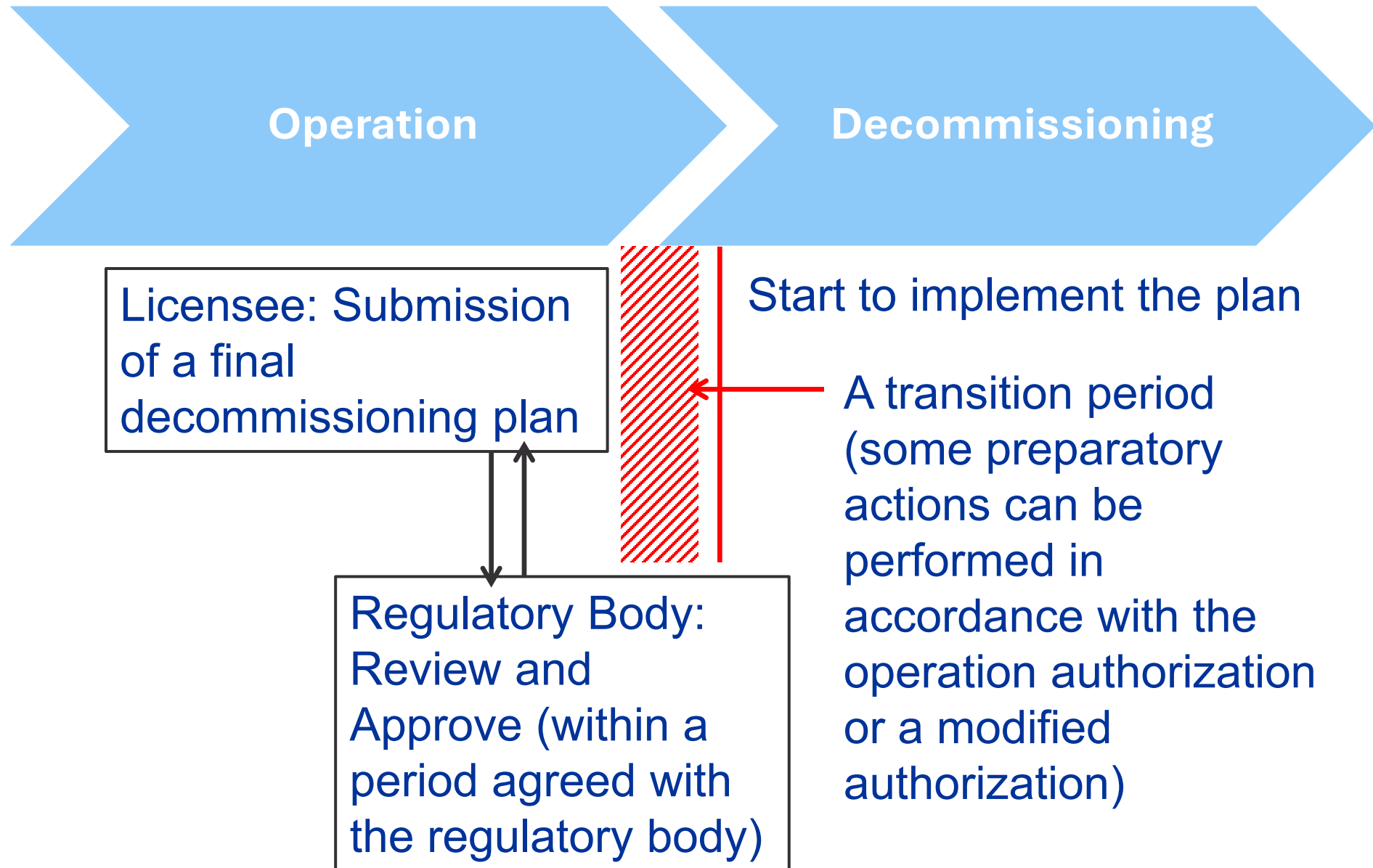
7. Planning for Decommissioning During the Lifetime of the Facility

Requirement 11: Final decommissioning plan

Prior to the conduct of decommissioning actions, a final decommissioning plan shall be prepared and shall be submitted to the regulatory body for approval.

- The final decommissioning plan and supporting documents shall cover the following: the selected decommissioning strategy; the schedule, type and sequence of decommissioning actions; the waste management strategy applied, including clearance, the proposed end state and how the licensee will demonstrate that the end state has been achieved; the storage and disposal of the waste from decommissioning; the timeframe for decommissioning; and financing for the completion of decommissioning.

Final planning for decommissioning





3D laser scanning
3D modelling technologies

Effective alternative to replace
missing as-build documentation
and drawings

Demonstration of technical
feasibility

Optimisation of processes,
development and testing of specific
technologies and devices

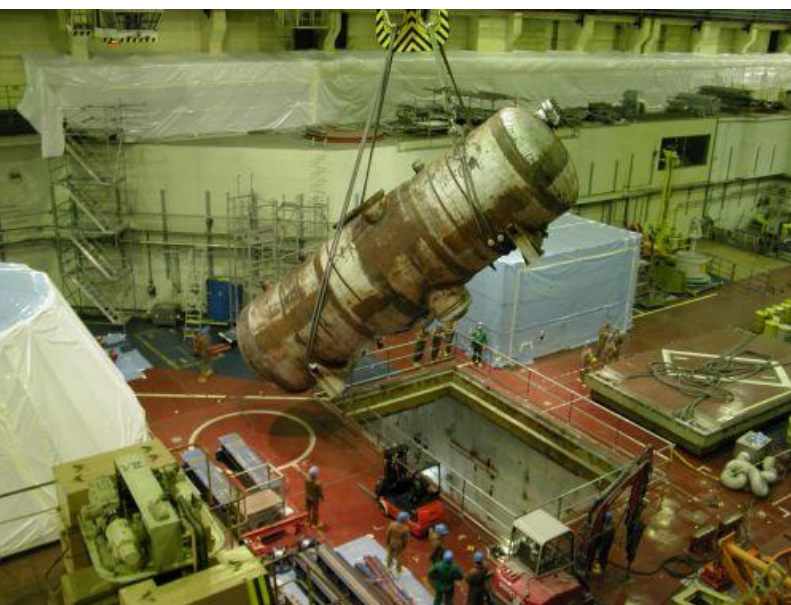


8. Conduct of Decommissioning Actions

Requirement 12: Conduct of decommissioning actions

The licensee shall implement the final decommissioning plan, including management of radioactive waste, in compliance with national regulations.

- The licensee shall implement the final decommissioning plan once the regulatory body has approved it.
- In the case of deferred dismantling, the licensee shall ensure that the facility is maintained in a safe configuration so that subsequent decontamination and/or dismantling can be performed. An adequate programme for maintenance, monitoring and surveillance, which shall be subject to approval by the regulatory body, shall be developed to ensure safety throughout the period of deferral.



8. Conduct of Decommissioning Actions

Requirement 13: Emergency response arrangements for decommissioning

Emergency response arrangements for decommissioning, commensurate with the hazards, shall be established and maintained, and events significant to safety shall be reported to the regulatory body in a timely manner.

IAEA Safety Standards for protecting people and the environment

Preparedness and Response for a Nuclear or Radiological Emergency

Jointly sponsored by the
FAO, IAEA, ICAO, ILO, IMO, INTERPOL,
OECD/NEA, PAHO, CTBTO, UNEP, OCHA, WHO, WMO



General Safety Requirements No. GSR Part 7



8. Conduct of Decommissioning Actions

Requirement 14: Radioactive waste management in decommissioning

Radioactive waste shall be managed for all waste streams in decommissioning.

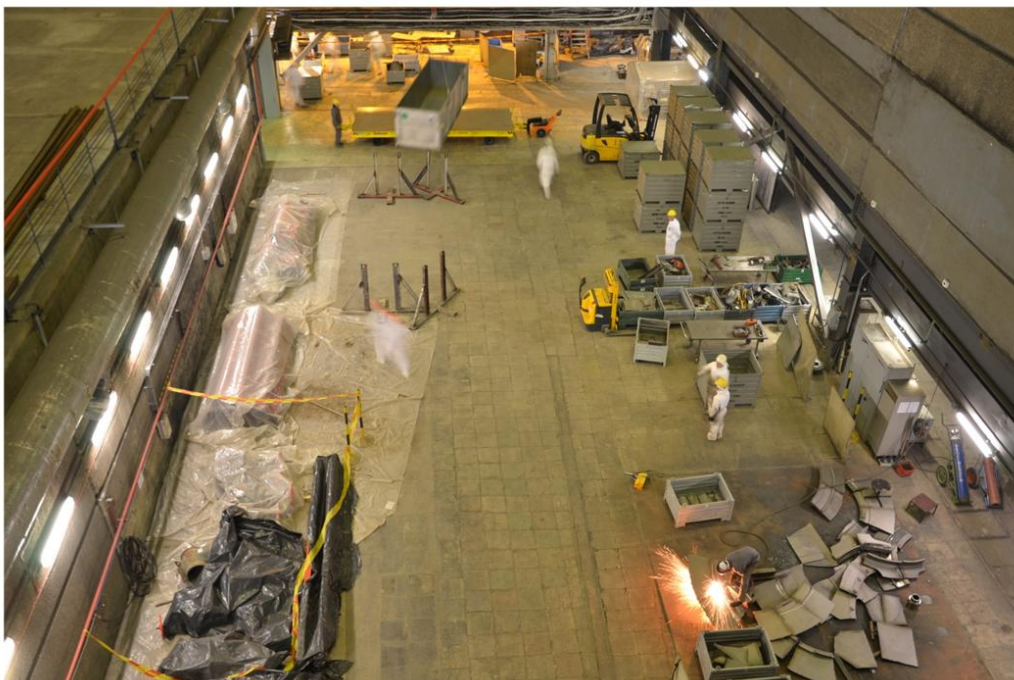
- Radioactive waste arising from operational activities that remains at the facility and radioactive waste that is generated during decommissioning shall be disposed of properly. If disposal capacity is not available, radioactive waste shall be stored safely in accordance with the relevant requirements.

IAEA Safety Standards
for protecting people and the environment

Predisposal
Management of
Radioactive Waste

General Safety Requirements Part 5
No. GSR Part 5





Source: Ignalina NPP, Lithuania





Source: SE RAW, Bulgaria



Source: Cyclife Sweden AB

9. Completion of Decommissioning Actions and Termination of the Authorization for Decommissioning

Requirement 15: Completion of decommissioning actions and termination of the authorization for decommissioning

On the completion of decommissioning actions, the licensee shall demonstrate that the end state criteria as specified in the final decommissioning plan and any additional regulatory requirements have been met. The regulatory body shall verify the compliance with the end state criteria and shall decide on termination of the authorization for decommissioning.

- A final decommissioning report shall be prepared by the licensee to demonstrate that the end state of the facility as specified in the approved final decommissioning plan has been reached.
- The regulatory body shall review the final decommissioning report ... and decide on the termination of the authorization for decommissioning and on the release of the facility and/or the site from regulatory control.



Humboldt Bay NPP, CA, USA



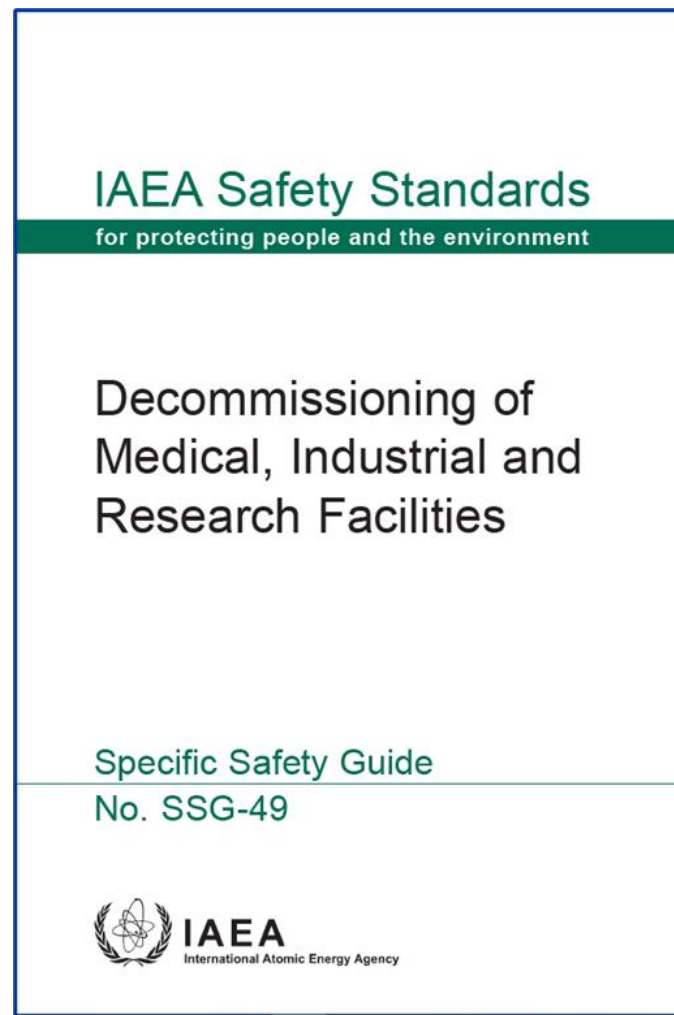
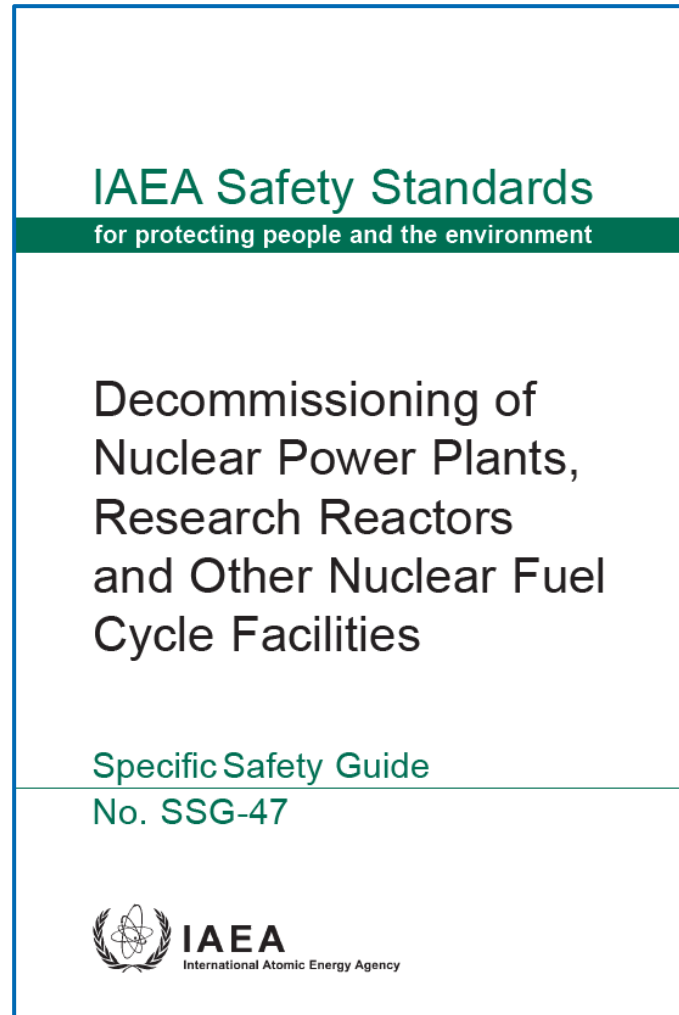
Dry spent fuel storage of the Jose Cabrera NPP, Spain



Jose Cabrera NPP site, Spain – as of May 2023

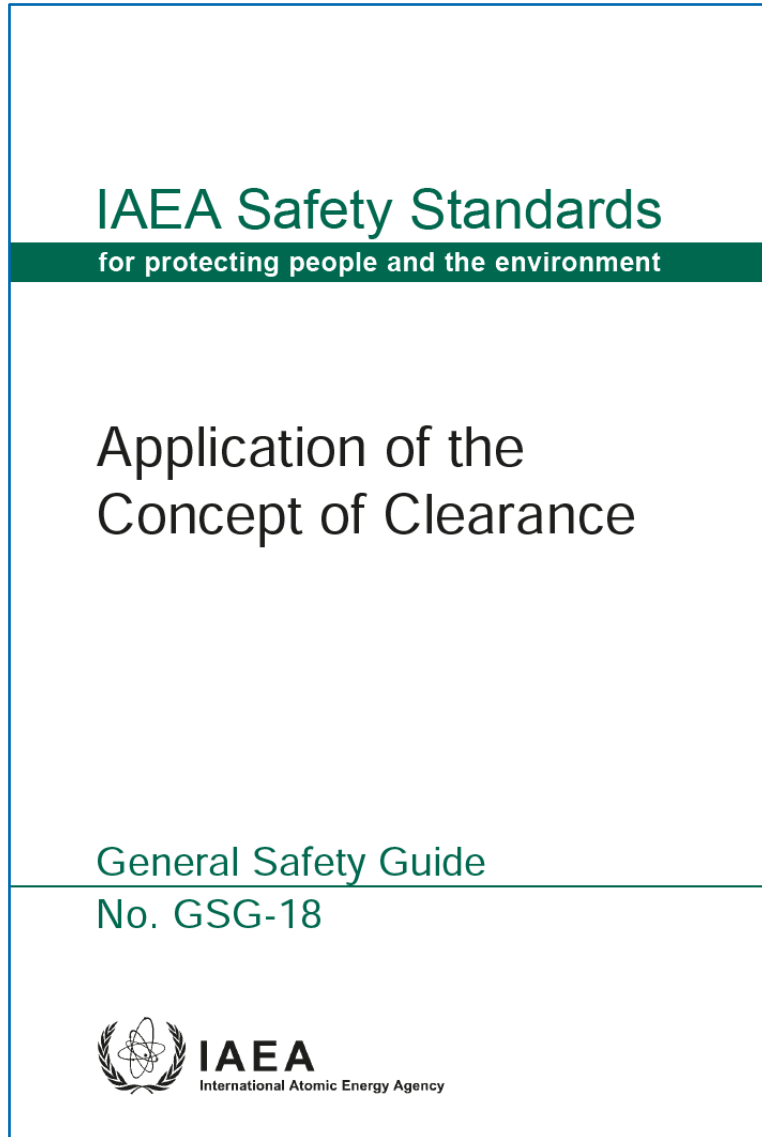
SAFETY GUIDES ON DECOMMISSIONING

Decommissioning Guides (SSG-47, SSG-49)



- Follow the structure of the GSR Part 6
- Provide guidance and examples on how to fulfil the requirements for “large” and for “small” facilities

GSG-18: Application of the concept of clearance



- Radiological basis
- Regulatory framework, roles and responsibilities of parties involved
- Different options – generic and specific clearance
- Derivation and application of clearance levels
- Organization and management of the clearance process
- Initial characterization of material to be cleared, scaling factors
- Final monitoring for demonstrating compliance with CLs
- Considerations related to surface contamination
- Sampling, homogeneity, hot spots, mixing
- Treatment of radionuclides of natural origin
- Technical details on measurements and uncertainties of results
- Specificities of clearance of liquids and gases
- Graded approach, conservatism
- Applicability to existing exposure situations (post-accident situations, remediation)
- Involvement of interested parties and confidence building
- Numerous appendices and annexes with practical examples

WS-G-5.2: Safety assessment for the decommissioning

IAEA Safety Standards

for protecting people and the environment

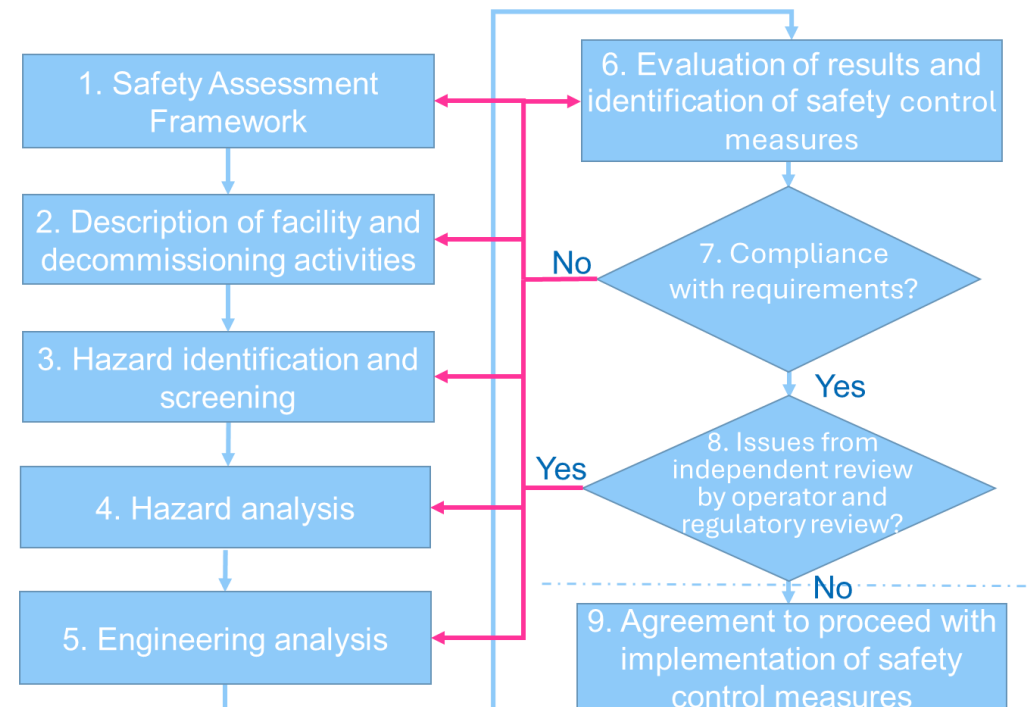
Safety Assessment for the Decommissioning of Facilities Using Radioactive Material

Safety Guide
No. WS-G-5.2

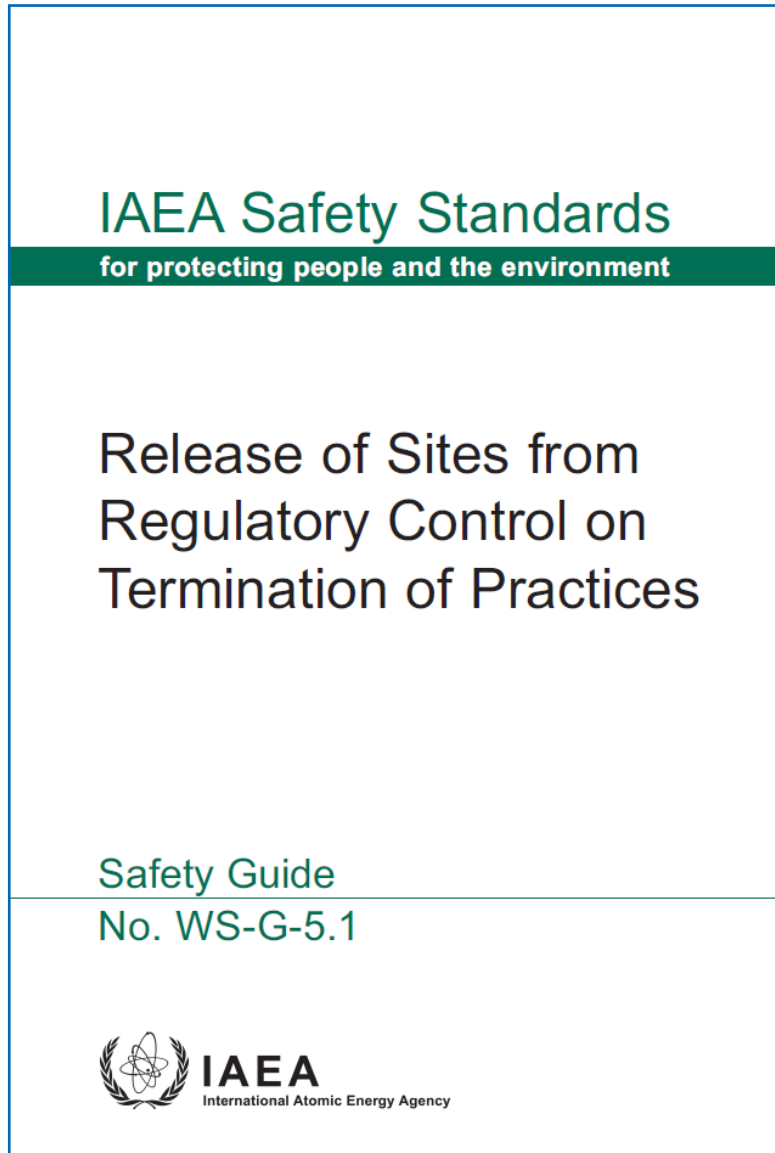


Published in 2008

- Specific to decommissioning
- Applicable to all types of facilities (with consideration of graded approach)
- Ongoing revision (DS555, Step 5)

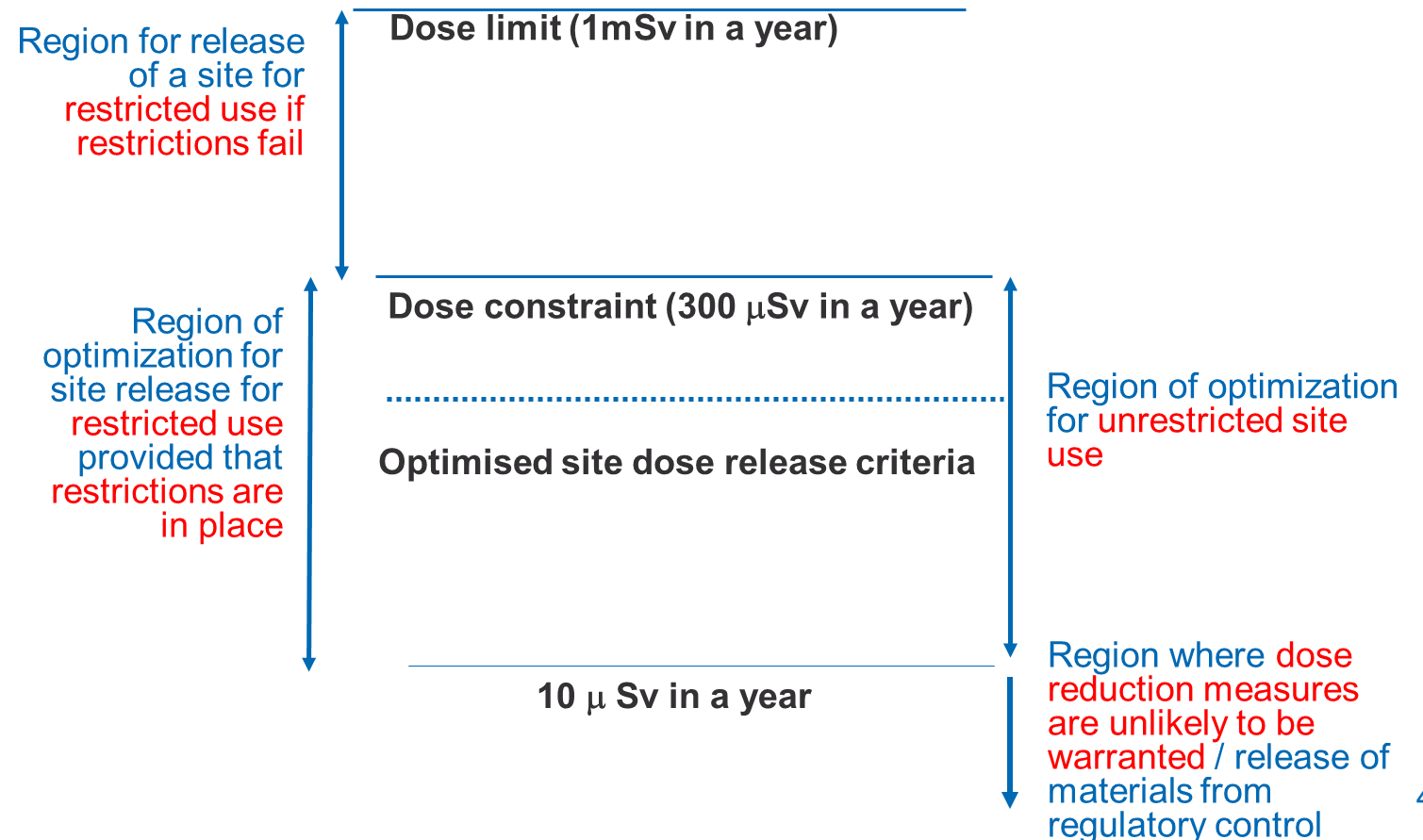


WS-G-5.1: Release of sites from regulatory control



Published in 2006

- Ongoing revision (DS542, Step 10)



**Thank you for your
kind attention!**