



**IAEA**

International Atomic Energy Agency

*Atoms for Peace and Development*

# IAEA Considerations on Decommissioning

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# IAEA Statute : objectives



**Established in 1957**

**171 Member States**

**~ 2,560 multidisciplinary  
professional and support staff  
from more than 100 countries**



**ATOMS FOR PEACE AND DEVELOPMENT**

The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world.

# Main areas of work



Safeguards and Verification



Safety and Security



Science and Technology

Peace

Development

Gather Best Practices, support scientific development  
Publications, Coordinated Research Projects

Disseminate Information and Support Programmes  
Networks, Peer Reviews, Technical Cooperation Projects

# IAEA work aligns with Sustainable Developments Goals





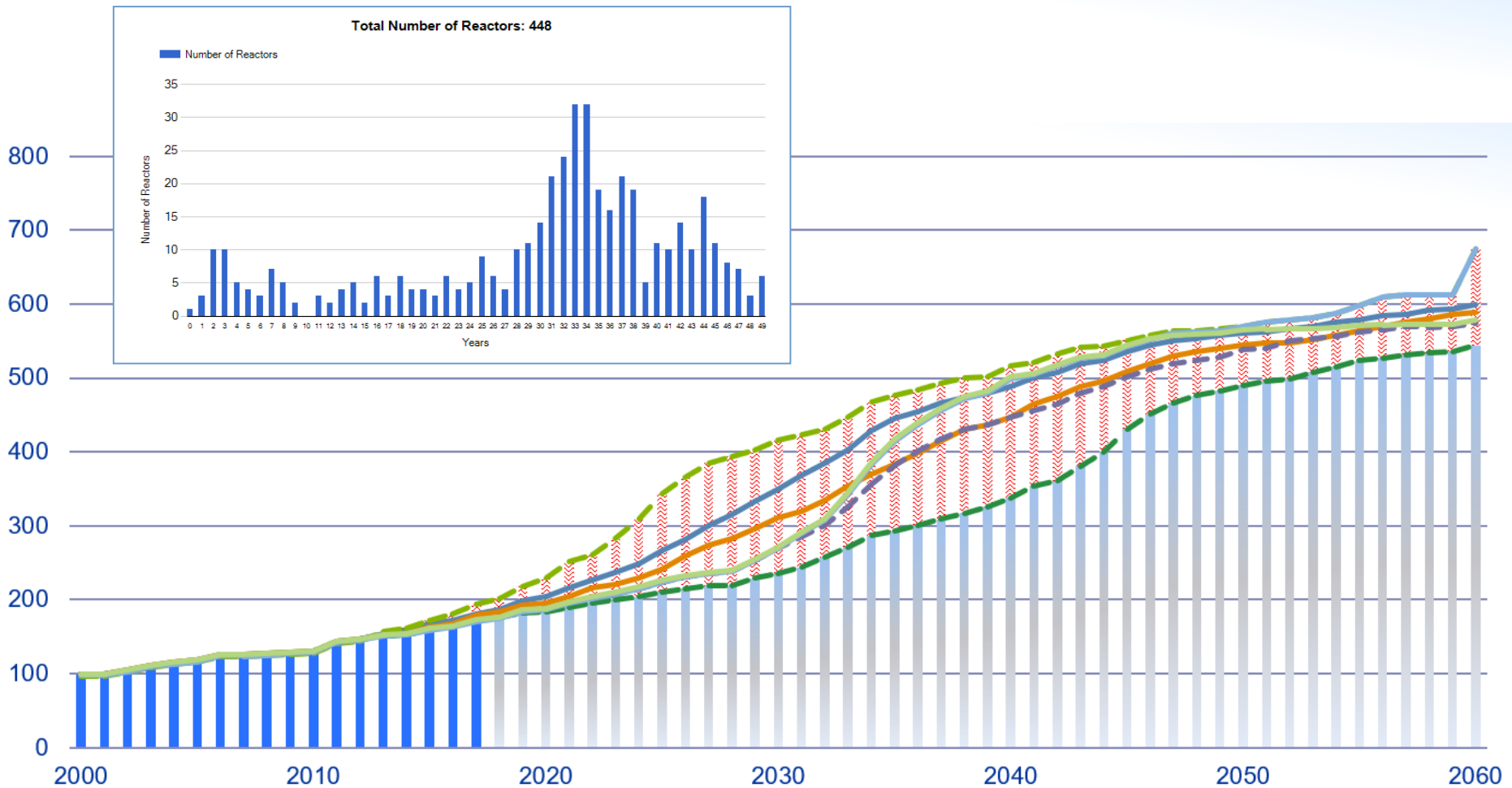
# IAEA Activities in the field of Decommissioning

Two groups within the IAEA deal with decommissioning issues:

- **Decommissioning and Environmental Remediation Section**, Division of Nuclear Fuel Cycle and Waste Technology, Department of Nuclear Energy;
- **Decommissioning and Remediation Unit**, Waste and Environmental Safety Section, Division of Radiation, Transport & Waste Safety, Department of Nuclear Safety and Security.



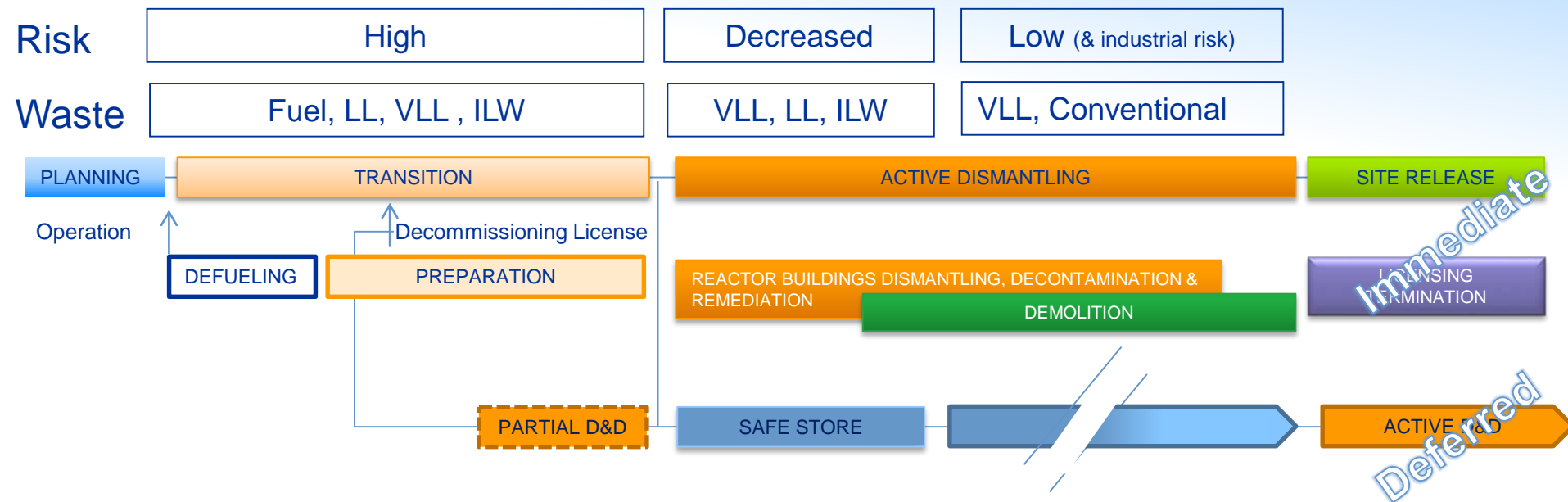
# Illustration of possible future developments in a number of shutdown power reactors depends on various operational lifetimes (40-60 years)



# Key positions

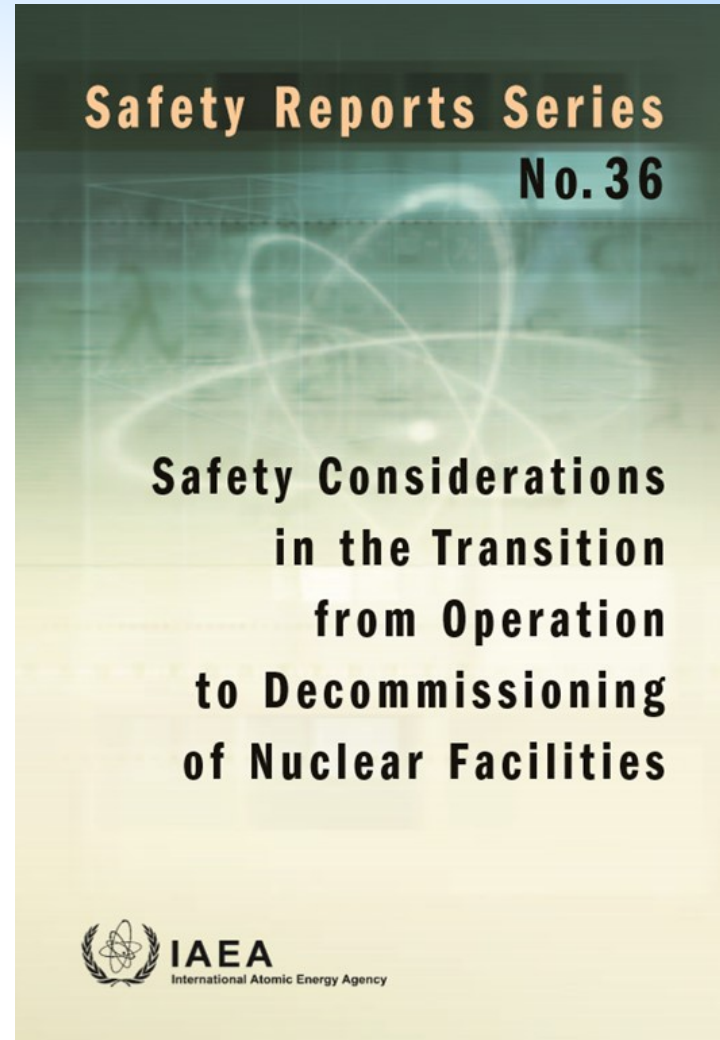
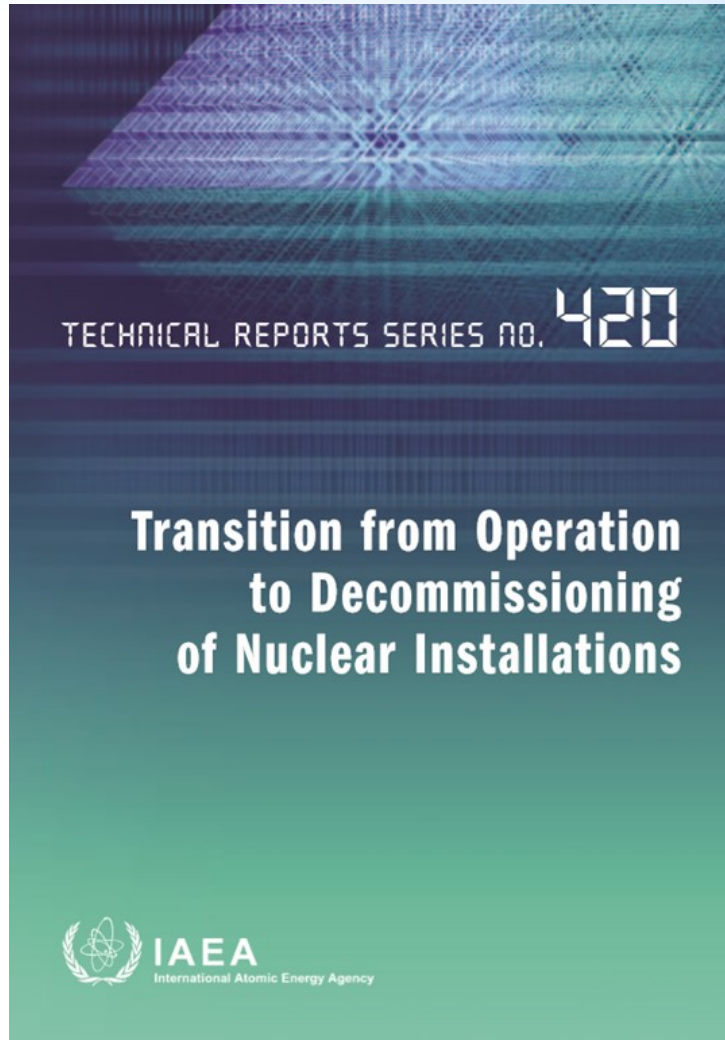
- Safety driven activity, requires authorization (licensing);
- Last phase in the facility lifetime, normal phase which can't be avoided;
- Early planning;
- Fund accumulation (“polluter pays”);
- Spent fuel, liquids and operational waste to be removed prior to decommissioning (during transition);
-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

# Decommissioning has following phases and waste arisings



- Phase 1 (Approximately 4+ y) – **PLANNING** (before final shut down)
  - Decommissioning Plan last update, decommissioning scenario, strategy, end state definition, characterization 1
- Phase 2 (Approximately 5+ y) – **TRANSITION** (after final shut down)
  - Defueling, circuit decontamination in-situ, waste removal, first decommissioning works, new constructions, characterization 2 ...
  - After decommissioning license or formal authorization*
    - Continue circuit and buildings decommissioning and new constructions in preparation of, either reactor dismantling or **care and maintenance**.
- *Care and Maintenance / safe store period if deferred strategy applies*
- Phase 3 (Approximately 10+ y) – **ACTIVE DISMANTLING**
- Phase 4 (Approximately 2+ y) – **SITE RELEASE** -> Licensing Termination -> end-state



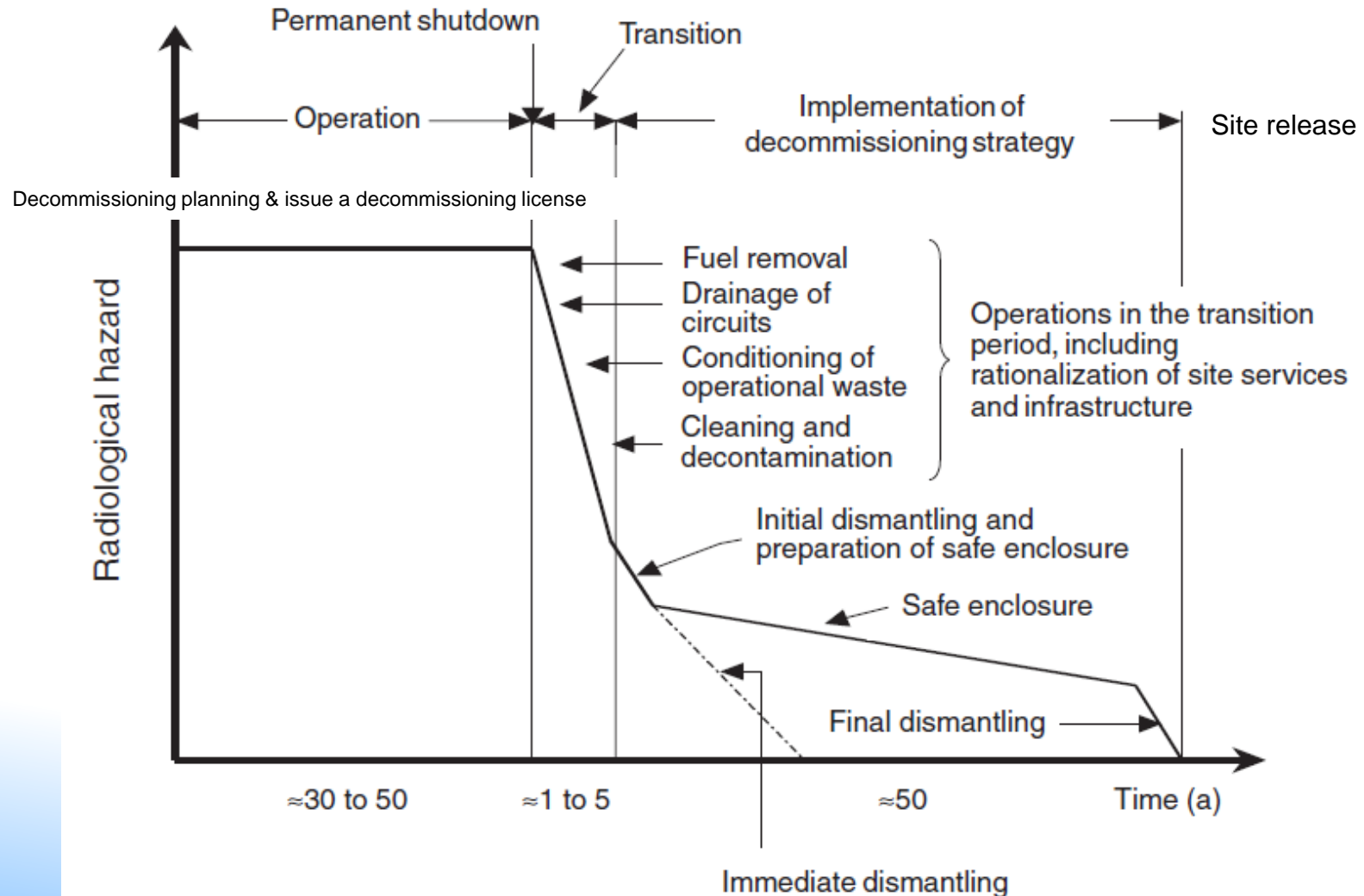


New NE Series report on Management of Transition of Nuclear Power Plants from Operation to Decommissioning ... is under preparation

## Operation + transition + decommissioning

Decommissioning strategies: immediate dismantling, deferred dismantling or combination of these two approaches

An option: entombment (in-situ decommissioning)



# Transition Activities

## Licensing Issues

- Allowable under an Operating License
- Submission of Decommissioning Safety Analysis Report for De-fueled Condition and description of the decommissioning scenario(s) (including strategy, end-state etc.)

## Engineering Issues

- Analyses for the Decommissioning (Scenario(s), Safety Bases)
- Development of System Abandonment Criteria
- Prepare revisions to the Maintenance Rule Program

## Staff and Organization issues

- Develop Early Retirement Plans
- Develop Employee Retention Plans
- Develop the Decommissioning Staffing Plans

## Initiate Decommissioning Work

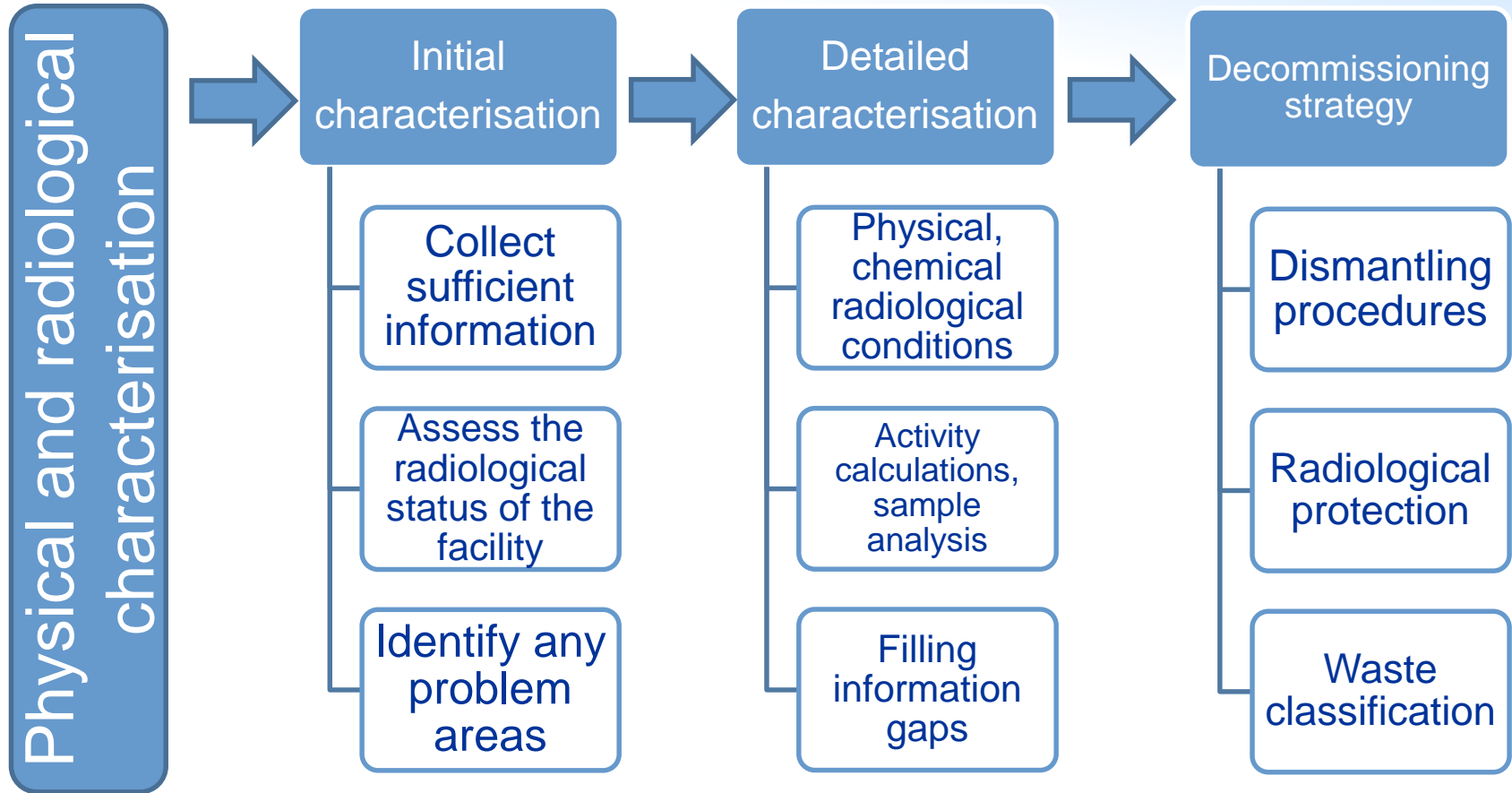
- Develop Contract Strategies and Perform Bid Evaluations
- Perform a Comprehensive Site Characterization
- Preparatory work (e.g. for interim storage, new waste treatment facilities etc.) and some decommissioning authorized activities

# Start of decommissioning



- Final shutdown following official decision to permanently discontinue operation;
- Start of decommissioning is not necessarily linked to spent fuel removal, but its removal before the decommissioning is recommended by the IAEA;
- Decommissioning-related activities should start well before final shutdown (e.g. planning, preparation of licensing documentation, pre-decommissioning characterization, HR development plan etc.);
- Transition from operation to decommissioning has to be used for careful preparation of decommissioning activities;
- Decommissioning license shall be issued by national nuclear regulator.

# Characterization objectives

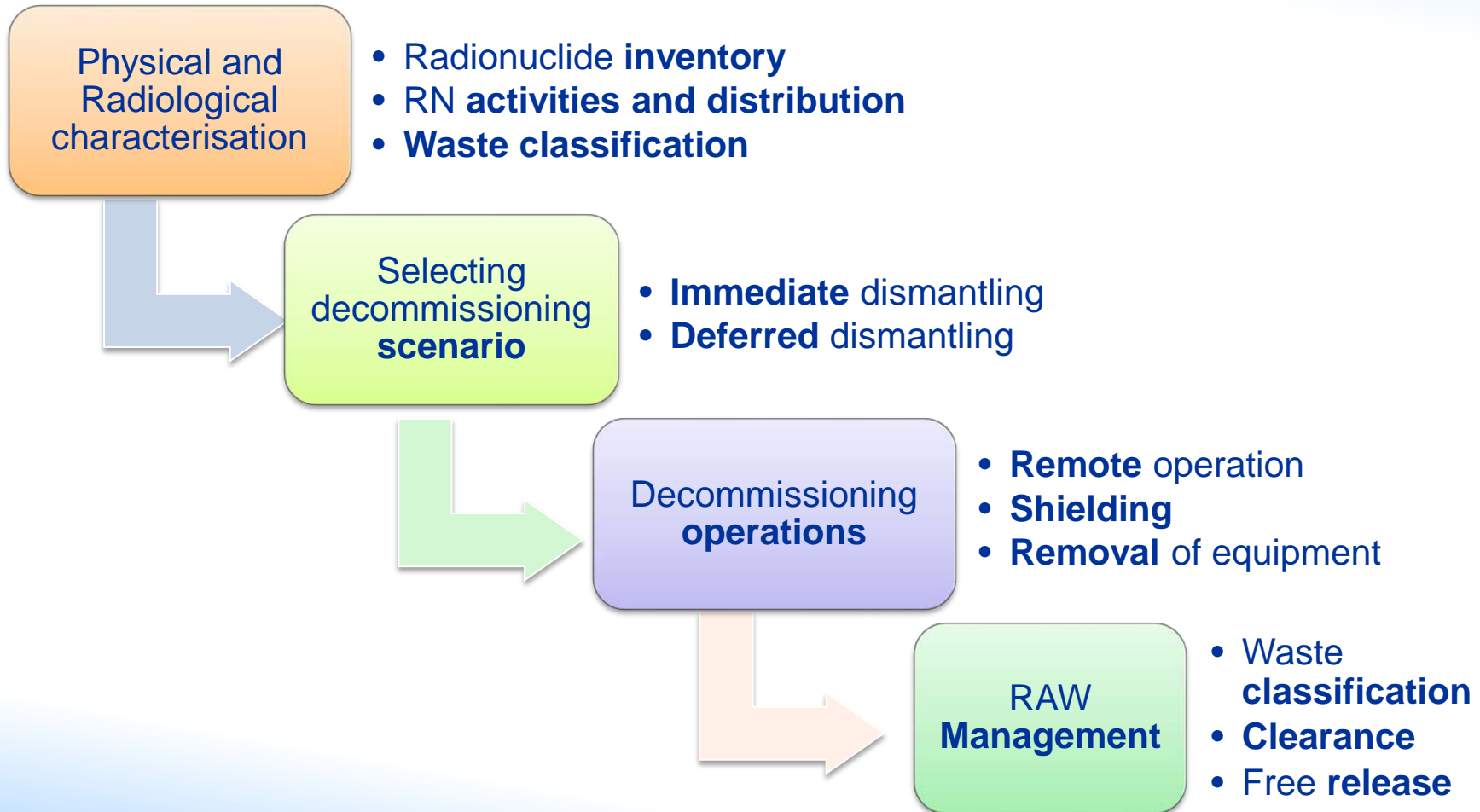


Physical (structural) characterization includes aspects of long-term deterioration, load bearing, acquisition of undocumented or wrongly described details, poorly accessible areas and remote characterisation ...



# Characterization objectives

## Application to decommissioning operations



# Decontamination, dismantling and demolition

- Activities typically involved during nuclear decommissioning;
- Nuclear island: special focus on radiation protection & safety in addition to the industrial safety;
- Non-nuclear island: conventional dismantling and demolition technologies can be used, but waste and materials management has to follow procedures in place for the nuclear site;
- Special challenge: decommissioning of nuclear facility after an accident and decommissioning of 'legacy' facilities;
- Several IAEA reports (+ IDN decommissioning wiki) address relevant technologies and case studies.

# Radioactive Waste Management during decommissioning

- Waste classification in decommissioning is not different from the operation (VLLW, LLW, ILW) however repartition is different due to the high volume of VLLW and LLW;
- Small volume of HLW might be also generated;
- Some waste streams are problematic, e.g. graphite, contaminated sodium etc.;
- Precise radiological characterization of material is needed to determine its potential for release/reuse, storage and/or disposal;
- Availability of enough interim storage capacity for empty and filled radioactive waste packages – potential for reuse of some buildings or structures;

# Radioactive Waste Management during decommissioning

- The need for storage space for decommissioning material, whether it is to be recycled, reused or conventionally disposed of;
- Treatment of radioactive waste – facilities for segregation, cutting, decontamination and final treatment of solid, liquid or gaseous waste, e.g. super-compaction, incineration, evaporation, solidification (drying or cementation), melting, plasma treatment;
- Reduction of volume of the waste, thus limiting the space needed in the interim storage facility and in the final repository.
- ISDC Principal Activity 05: Waste processing, storage and disposal – typically the highest cost estimation among other PAs.

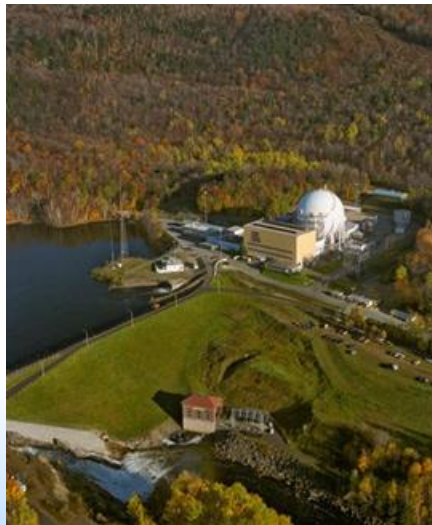
# Exemption vs. Clearance

- **Exemption:** Practices and sources within a practice may be, a priori, exempted from the requirements of standards (not from legal framework) if exposures or risks will be sufficiently small (trivial);
- **Clearance:** Removal of radioactive materials or objects from within authorised practices without any further control by the regulatory authority;
- Exempt materials / sources do not enter the regulatory regime – they remain outside of regulated practices;
- Cleared materials are released from the regulatory regime;
- Trivial amounts of radionuclide / trivial exposures;
- Clearance of bulk amounts of material may require particular regulatory consideration.





Niederaichbach



Yankee Rowe





JPDR



Grenoble



From Nuclear Research Centre to Energy and Material Research Centre

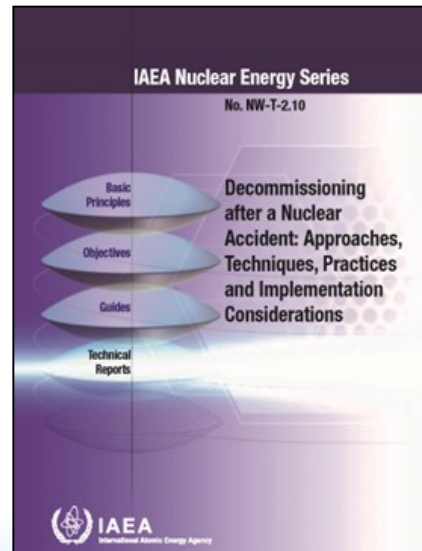
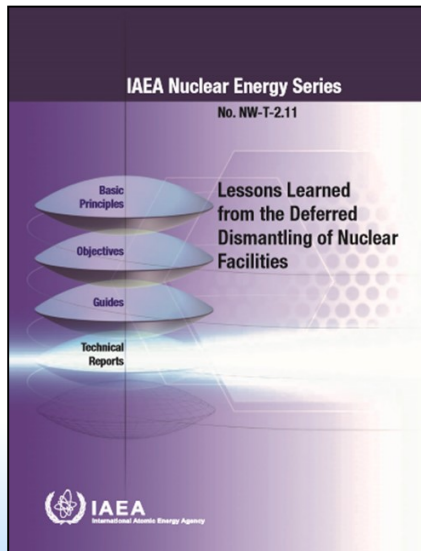
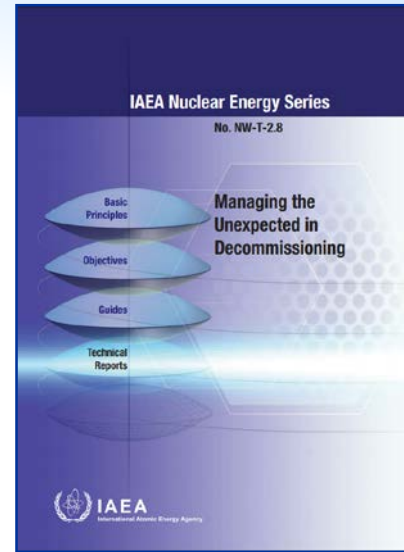
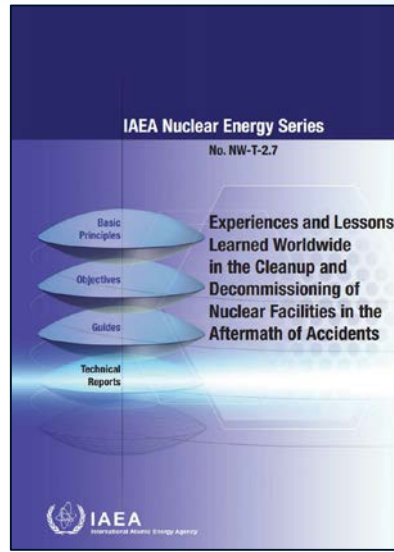
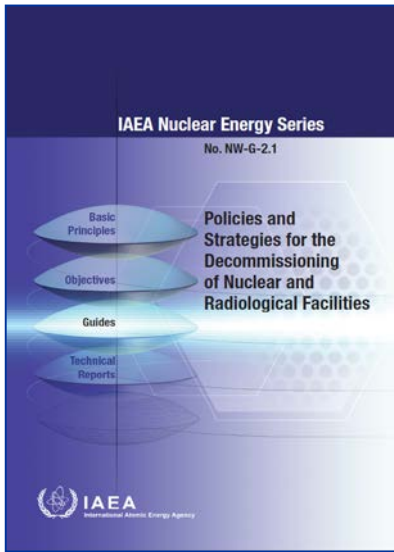
# International Decommissioning Network (IDN)



- Joint initiative of the IAEA's Departments of Technical Cooperation, Nuclear Energy, Nuclear Safety & Security;
- Launched in 2007 as a forum to improve the exchange of information and organization of practical / “hands-on” decommissioning training;
- Annual meetings, Steering Group, network members;
- Many events offered to the IAEA TC programme;
- CONNECT – SharePoint web platform to facilitate interactions between individuals and organizations involved in all aspects of RWM:
  - Working Group on ‘Knowledge Management in Decommissioning’ – Decommissioning Wiki, E-Learning material.

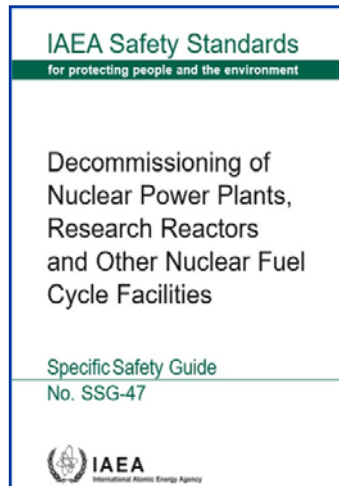


# IAEA Nuclear Energy Series

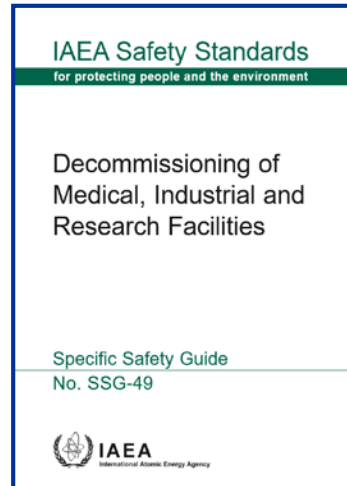


# Safety Standards for decommissioning

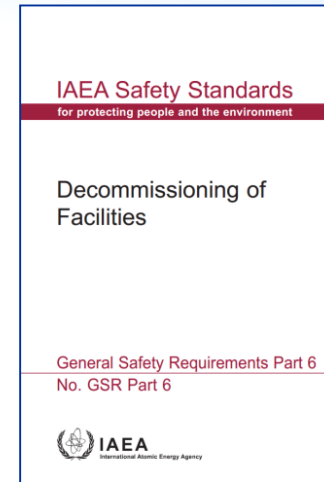
2018



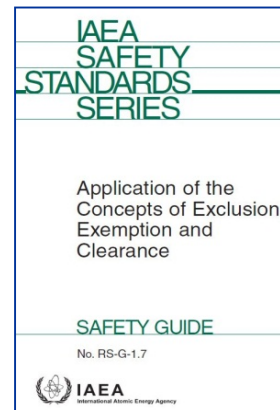
2019



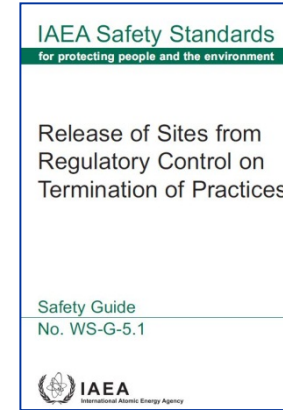
2014



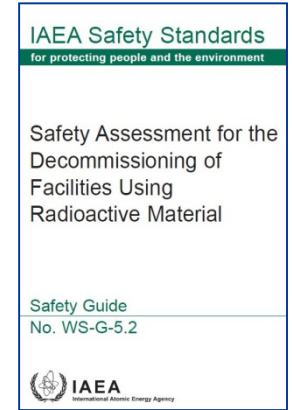
2004



2006



2008



**DS499/DS500**  
**Ongoing revision**



# Examples of International Projects and Communities of Practice

- R2D2P – Research Reactor Decommissioning Demonstration Project
- DACCORD – Decommissioning Cost Estimation for Research Reactors
- MIRDEC – Decommissioning of Medical, Industrial and Research Facilities
- DAROD – Decommissioning and Remediation of Damaged Nuclear Facilities
- COMDEC – Completion of Decommissioning
- Collaborative project on Global status of decommissioning



# ARTEMIS Peer Review

- Main objectives: to provide independent expert opinion and advice to MS;
- Intended for facility operators and other implementing organizations, regulators, government agencies, policy makers;
- May include facilities and activities related to:
  - Spent nuclear fuel and RWM,
  - Decommissioning,
  - Environmental remediation.

• <https://www.iaea.org/artemis/>



The graphic is a blue-themed informational poster for the ARTEMIS peer review service. It features the IAEA logo at the top right and the word 'ARTEMIS' in large white letters. The text describes the service as an integrated review for radioactive waste and spent fuel management. It includes contact information for the ARTEMIS Review Coordinator and a QR code. The background has a subtle pattern of small white dots.

Agency Peer Reviews

The IAEA has organized numerous peer reviews of facilities or activities pertaining to radioactive waste or spent fuel management, radiological impact assessments, and management of residues arising from uranium production, decommissioning and remediation.

**ARTEMIS**

An integrated review service for radioactive waste and spent fuel management, decommissioning and remediation programmes

Do you want to learn more about ARTEMIS for your facility, organization or programme?

To inquire about inviting an independent expert peer review tailored to your needs, email the ARTEMIS Review Coordinator: [ARTEMIS@IAEA.ORG](mailto:ARTEMIS@IAEA.ORG)

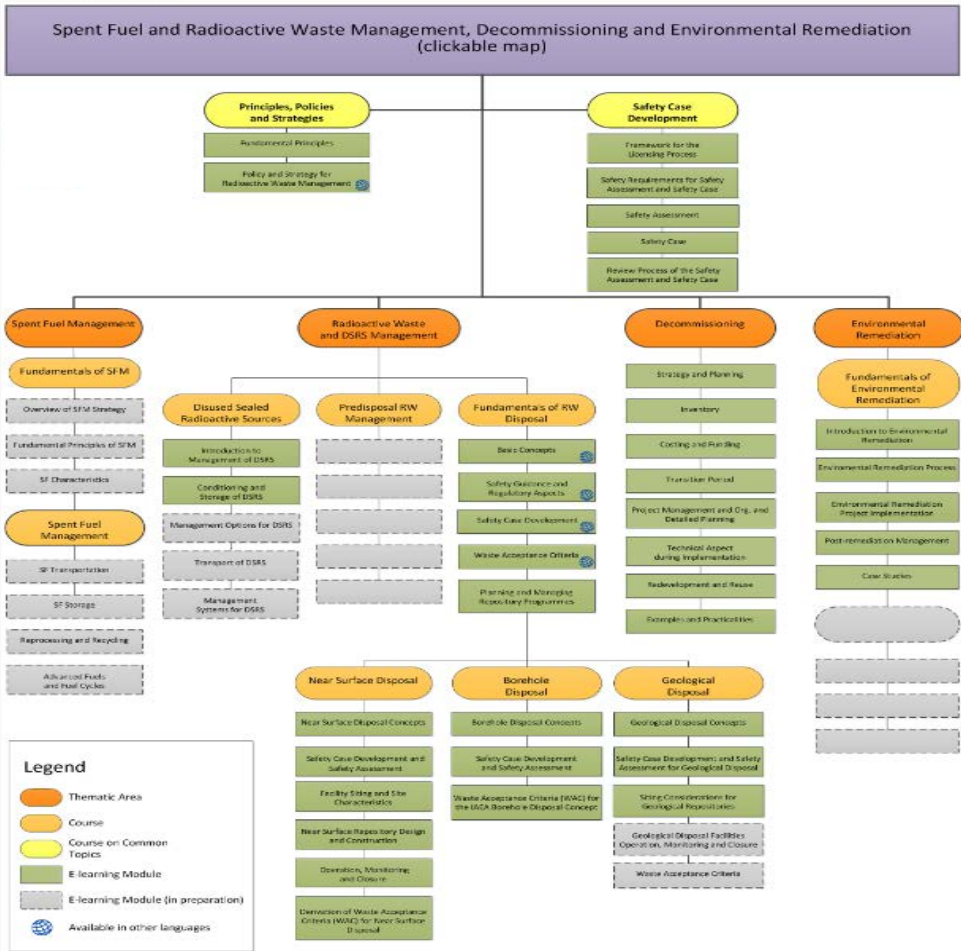
To learn more about the process, search previous mission reports, and more, visit [www.iaea.org/artemis](http://www.iaea.org/artemis)

Reports of all past reviews are available at [www.iaea.org/artemis](http://www.iaea.org/artemis)

Internationally recognized experts in radioactive waste management convened by the IAEA to provide independent review and advice tailored to the specific needs of your government and organization.

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# E-tools



## Decommissioning wiki



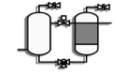
Case Studies



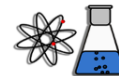
Materials



Technologies



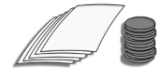
Structures, Systems Components



Characterisation



Waste



Cost



Countries



Management



International Decommissioning Network

# Some additional activities implemented or under preparation

- National and regional Technical Cooperation projects;
- Fukushima Daiichi decommissioning peer reviews;
- Collaborating centers on decommissioning (IFE, Sogin);
- Safeguards considerations on decommissioning;
- Decommissioning by design (e.g. for SMR);
- Sustainability and circular economy in the context of decommissioning;
- Development of human resources for decommissioning;
- Preparation for and implementation of research reactors decommissioning (UZB, Norway etc.);
- Etc.





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*at your service for 60+ years ...*