

# IAEA Perspectives on Radiological Characterisation

Patrick O'Sullivan

Waste Technology Section,  
Nuclear Energy Department,  
International Atomic Energy Agency

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Studsvik, Sweden



**IAEA**

International Atomic Energy Agency

# Agenda

- Role of the IAEA
- Nuclear safety regime applied to radioactive waste management
- Characterisation and phases of facility lifetime
- Concluding remarks

# Background: Mandate

## *Article III*

**Para A.6.** The Agency is authorized to **establish or adopt ... standards of safety** for protection of health and minimization of danger to life and property, and to **provide for the application of these standards ...**”

## *Article VIII*

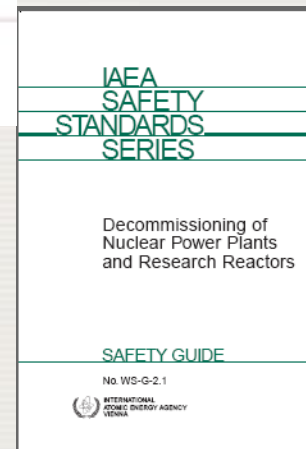
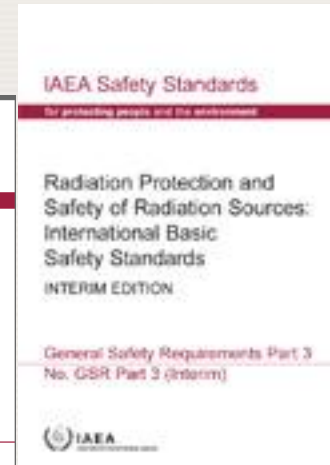
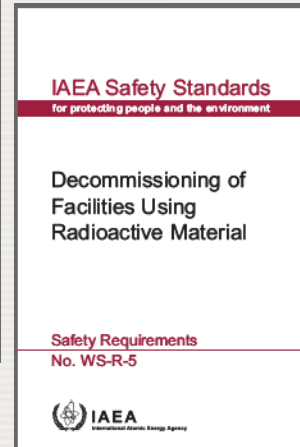
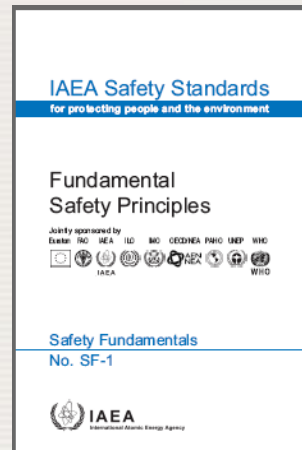
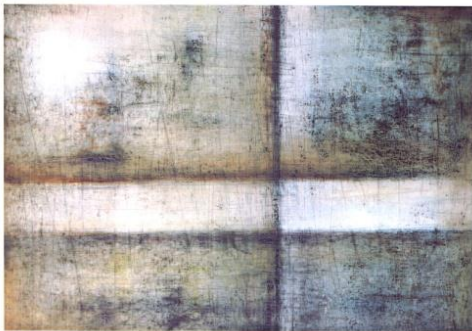
The agency shall take positive steps to encourage the **exchange among its members of information** relating to the nature and peaceful uses of atomic energy and shall serve as an intermediary among its members for this purpose.

*\*\*\*\*\*The IAEA is bound by statute to apply the safety standards to work carried out with IAEA funds.*

# The Nuclear Safety Regime applied to Radioactive Waste Management

## Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

IAEA International Law Series No. 1



☐ National Policy and Strategy



# International Safety Standards

- IAEA Statute:

**1. Develop safety standards**



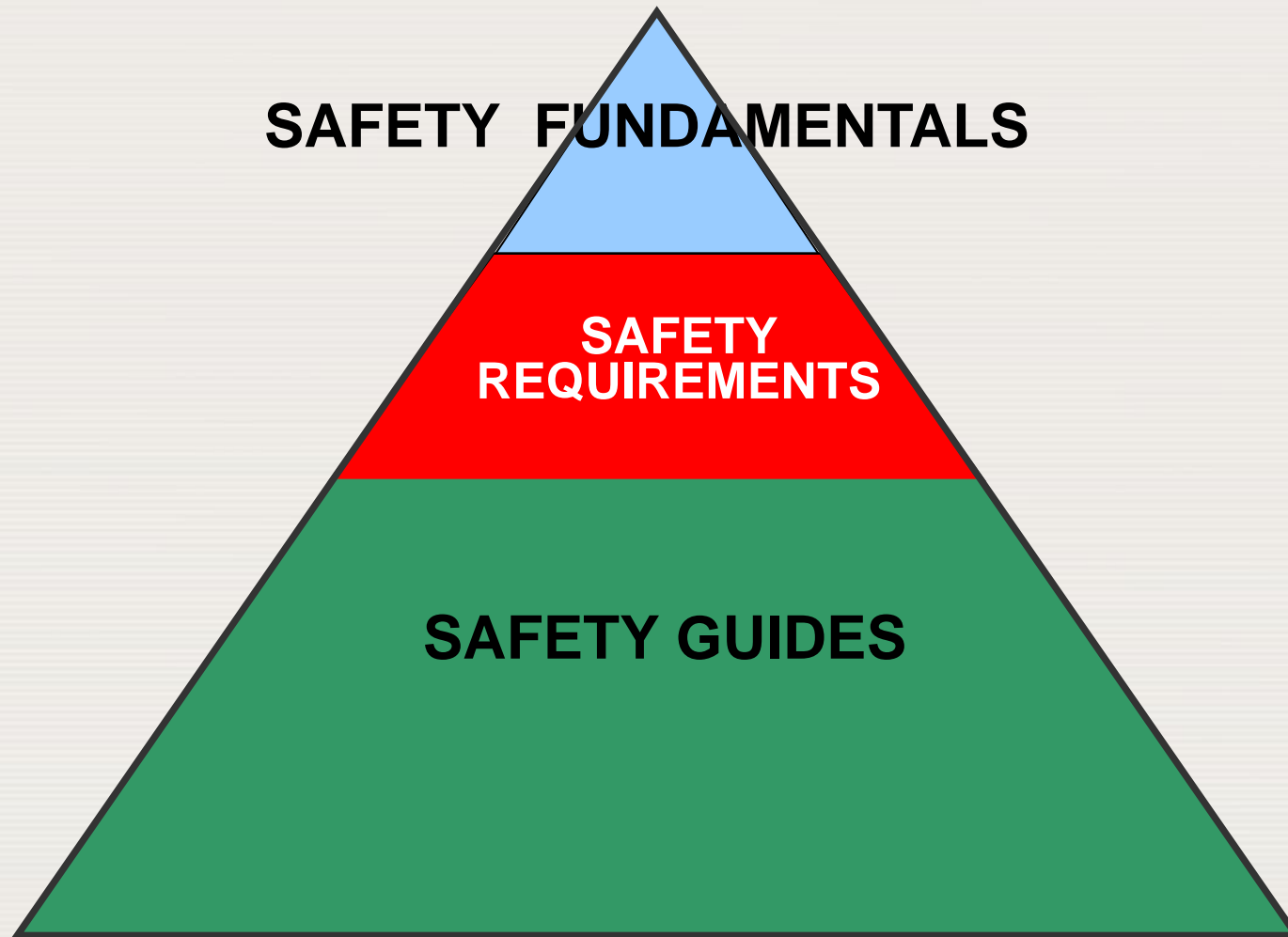
Nuclear safety  
Radiation Safety  
Waste Safety  
Transport Safety

**2. Provisions for their application and guidance on good practices**



Peer reviews  
Technical cooperation  
Research and development  
Training  
Exchange of information (networks)

# Hierarchy of Safety Standards



# Safety Fundamentals

## Thematic Areas

Legal & governmental infrastructure

Emergency preparedness & response

Management systems

Assessment & verification

Site evaluation

Radiation safety

Radioactive waste management

Decommissioning

Rehabilitation of contaminated areas

Transport of radioactive material

## Facilities & Activities

Nuclear power plants

Research reactors

Fuel cycle facilities

Radiation related facilities & activities

Waste treatment and disposal facilities

# IAEA Safety Standards for decommissioning

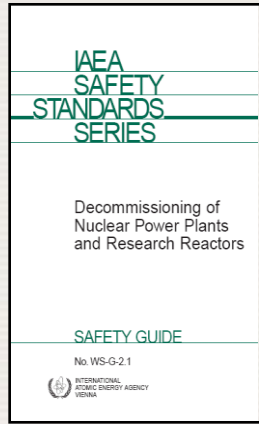
2006, **revision began in 2011**

*Being combined*

1999

1999

2001



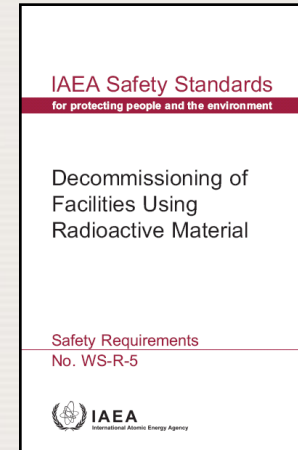
**DS402**



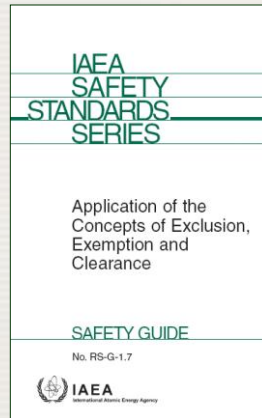
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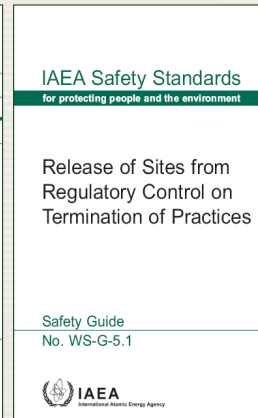
**DS404**



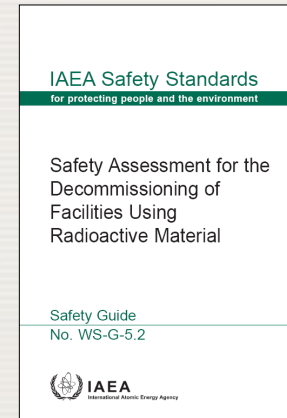
2004



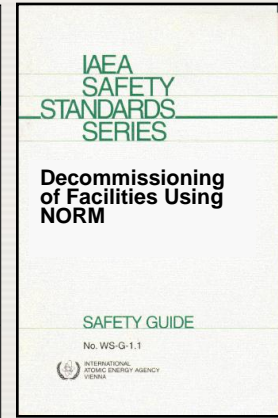
2006



2008



*Planned*



*Under revision*





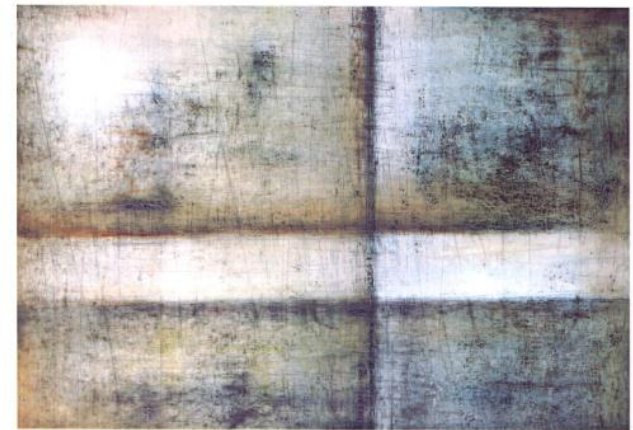
# The Joint Convention on the safety of spent fuel management and the safety of radioactive waste management - 1

- ❑ Addresses safety issues concerning spent fuel and radioactive waste management on a global scale
- ❑ Entered into force in June 2001 (currently includes 62 participating countries and Euratom)
- ❑ Main objectives
  - ❑ To achieve and maintain a high level of safety
  - ❑ To ensure that there are effective defences against potential hazards
  - ❑ To prevent accidents with radiological consequences and to mitigate their consequences



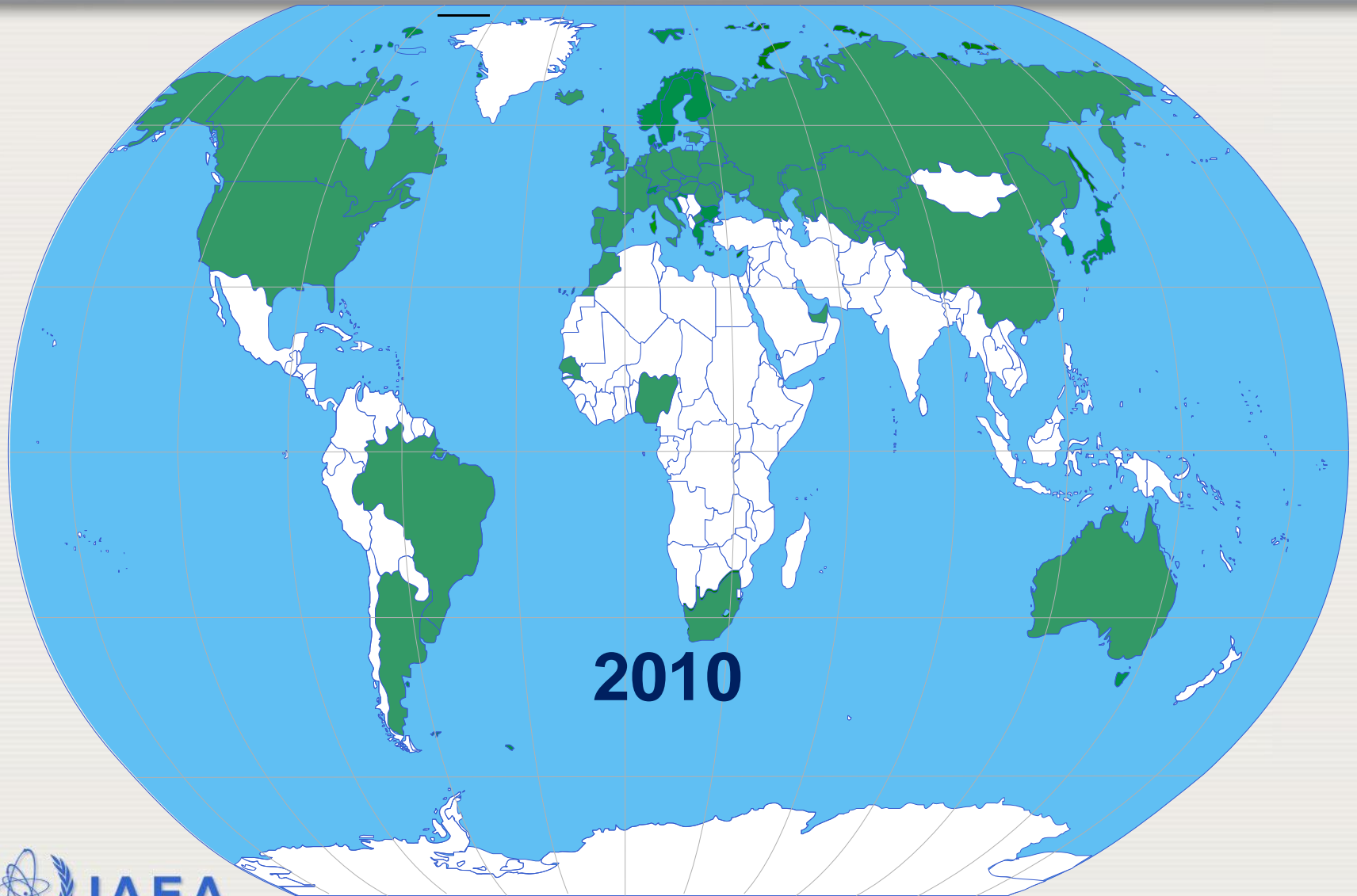
## Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

IAEA International Law Series No. 1



**Contracting Parties: 55 [now 62!]**

**Status: 10 March 2010**



# The Joint Convention on the safety of spent fuel management and the safety of radioactive waste management - 2

## Decommissioning

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- ❑ Article 26 (Decommissioning): steps shall be taken to ensure the safety of decommissioning of a nuclear facility
  - ❑ **Qualified staff** and adequate financial resources are available
  - ❑ Provisions with respect to **operational radiation protection**, discharges and unplanned and uncontrolled releases are applied
  - ❑ Provisions with respect to emergency preparedness are applied
  - ❑ **Records of information** important to decommissioning are kept

# Fundamental safety objective and principles for protecting people and environment



## IAEA Safety Standards

for protecting people and the environment

### Fundamental Safety Principles

Jointly sponsored by



Safety Fundamentals

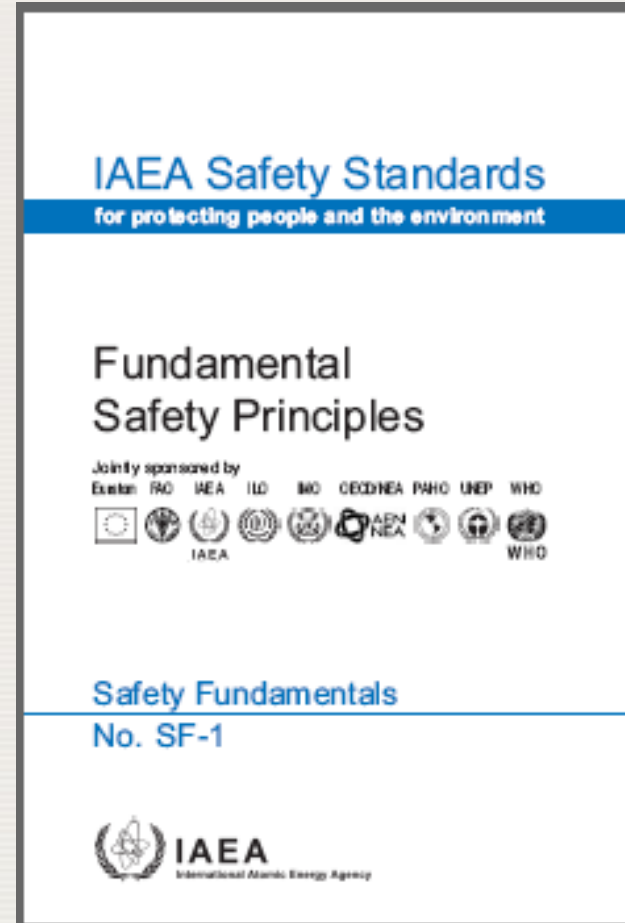
No. SF-1



# Fundamental Safety Principles (SF-1) - 1

## Fundamental Safety Objective

- ❑ To protect people and the environment from the harmful effects of ionizing radiation
- ❑ To achieve the highest standards of safety that can reasonably be achieved, measures have to be taken:
  - ❑ To **control exposure** of people and releases to the environment
  - ❑ To **restrict the likelihood of events** that might lead to a loss of control
  - ❑ To **mitigate the consequences** of such events if they were to occur



# Fundamental Safety Principles (SF-1) - 2

## No. 7 Protection of present and future generations

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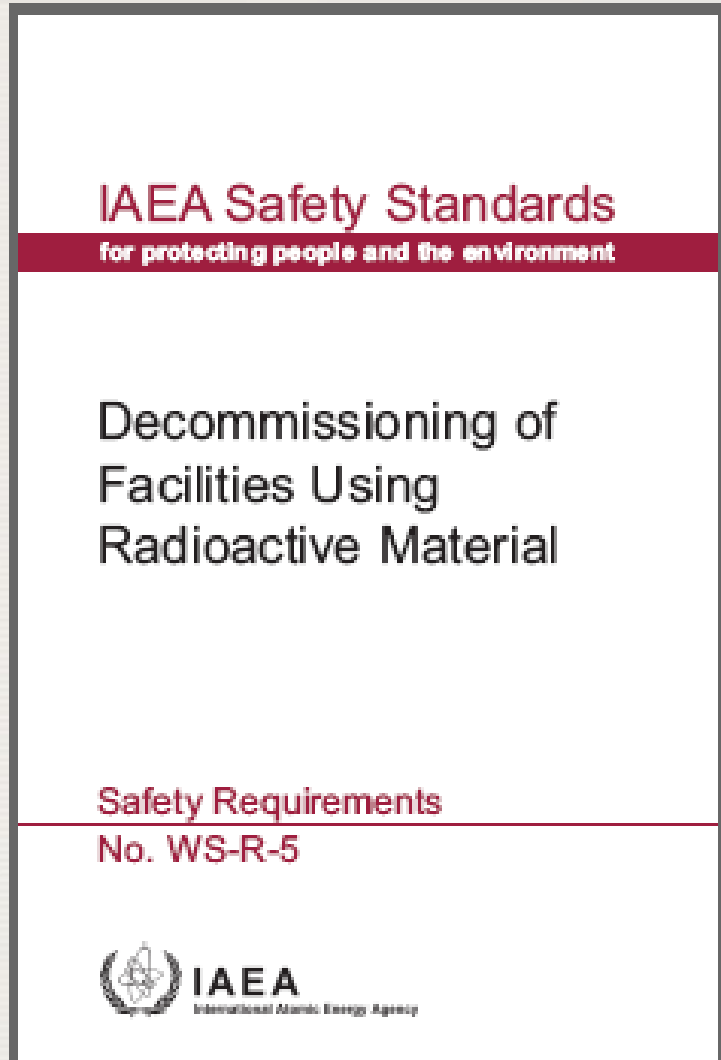
- ❑ **People and the environment, present and future, must be protected against radiation risks**
  - ❑ Safety standards apply not only to local populations but also to populations remote from facilities and activities
  - ❑ Subsequent generations should be protected without the need for them to take significant protective actions
  - ❑ **Generation of waste must be kept to a minimum** by means of design measures and procedures, such as the recycling and reuse of material

# Decommissioning of Facilities using Radioactive Material (WS-R-5)

## Objective

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- ❑ To establish the basic safety requirements that must be satisfied during the planning and implementation of decommissioning for the termination of practices and for the release of facilities from regulatory control
- ❑ [http://www-pub.iaea.org/MTCD/publications/PDF/Pub1274\\_web.pdf](http://www-pub.iaea.org/MTCD/publications/PDF/Pub1274_web.pdf)



# Decommissioning of Facilities using Radioactive Material (WS-R-5)

## Decommissioning plan

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- ❑ A **baseline survey of the site**, including obtaining information on radiological conditions, shall be performed prior to construction and updated prior to commissioning of a new facility
- ❑ During the preparation of the final decommissioning plan, the extent and type of radioactive material (irradiated and contaminated structures and components) at the facility shall be determined by means of a **detailed characterization survey** and on the basis of **records collected during the operational period**



# Decommissioning of Facilities using Radioactive Material (WS-R-5)

## Completion of decommissioning

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- A final decommissioning report shall be prepared that documents, in particular, the end state of the facility or site, and this report shall be submitted to the regulatory body for review
- Records to be retained in accordance with the records retention requirements of the quality assurance system

# Decommissioning of Nuclear Power Plants and Research Reactors (WS-G-2.1)

## Objective

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- ❑ **To provide guidance** to national authorities, including regulatory bodies, and operating organisations to ensure that the decommissioning process for nuclear power plants and research reactors is conducted in a safe and environmentally acceptable manner
- ❑ [http://www-pub.iaea.org/MTCD/publications/PDF/P079\\_scr.pdf](http://www-pub.iaea.org/MTCD/publications/PDF/P079_scr.pdf)



# Decommissioning of Nuclear Power Plants and Research Reactors (WS-G-2.1)

## Initial Characterization of the Installation

- ❑ **Undertaken during the transition from operation to decommissioning under operational licence**
  - ❑ A survey of radiological and non-radiological hazards is an important **input for the safety assessment** and for **implementing a safe approach during the work**
  
- ❑ **Purpose**
  - ❑ Sufficient radiation and contamination surveys should be carried out to determine the radionuclides, maximum and average dose rates and contamination levels of inner and outer surfaces of structures and components
  - ❑ Results will assist in the preparation of radiation and contamination maps and to assist in selection of procedures for decontamination or dismantling
  - ❑ For activated components calculations should be used together with selective verification sampling

# Decommissioning of Nuclear Power Plants and Research Reactors (WS-G-2.1)

## Final Radiological Survey

- ❑ **Undertaken on completion of the decontamination and dismantling activities**
  - ❑ A survey of the residual radionuclides at the facility site
- ❑ **Purpose**
  - ❑ To demonstrate that the residual activity complies with the regulator criteria and thus enable the site, or parts of it, to be released from regulatory control

# Decommissioning of Nuclear Power Plants and Research Reactors (WS-G-2.1)

## Radiological Characterization

- ❑ **Cases where special care should be taken during characterization**
  - ❑ Unplanned cessation of operations
  - ❑ Failures of spent fuel elements
  - ❑ Buried waste
  - ❑ Previous decontamination/remediation occurred and facilities were reused
  - ❑ Underground or buried piping and liquid storage and drain collection systems

# Characterization and Phases of Facility Lifetime

- Siting: Baseline survey of the site
- Construction: Samples of construction materials
- Operation: Regular surveys during operation, additional in case of incidents → operating records
- Transition: Detailed characterisation survey after the final shutdown → decommissioning plan
- Decommissioning: Monitoring of working areas/ personnel/pathways/materials/waste/environment
- Site release: Final survey of the site and remaining structures

Facility

Stage

Design,  
Construction &  
Start-up Phase

Operating  
Phase

Shutdown

Safe Enclosure  
Preparation

Safe  
Enclosure  
Period

Final Phase

Decommissioning

Activity

Prepare Initial  
Decommissioning  
Plan

Prepare  
Shutdown  
Plan

Update  
Decommissioning  
Plan

1. Source  
Term  
Reduction  
2. De-fueling  
3. Waste  
Conditioning

1. Site  
Preparation  
2. Initial  
Dismantling

Update Final  
Decommissioning  
Plan

Surveillance &  
Maintenance

1. Final  
Dismantling  
2. Final Survey  
3. License  
Termination

Monitoring

Activity

Background  
Monitoring

1. Routine  
Monitoring  
2. Maintenance  
Support

Characterization  
& Surveillance

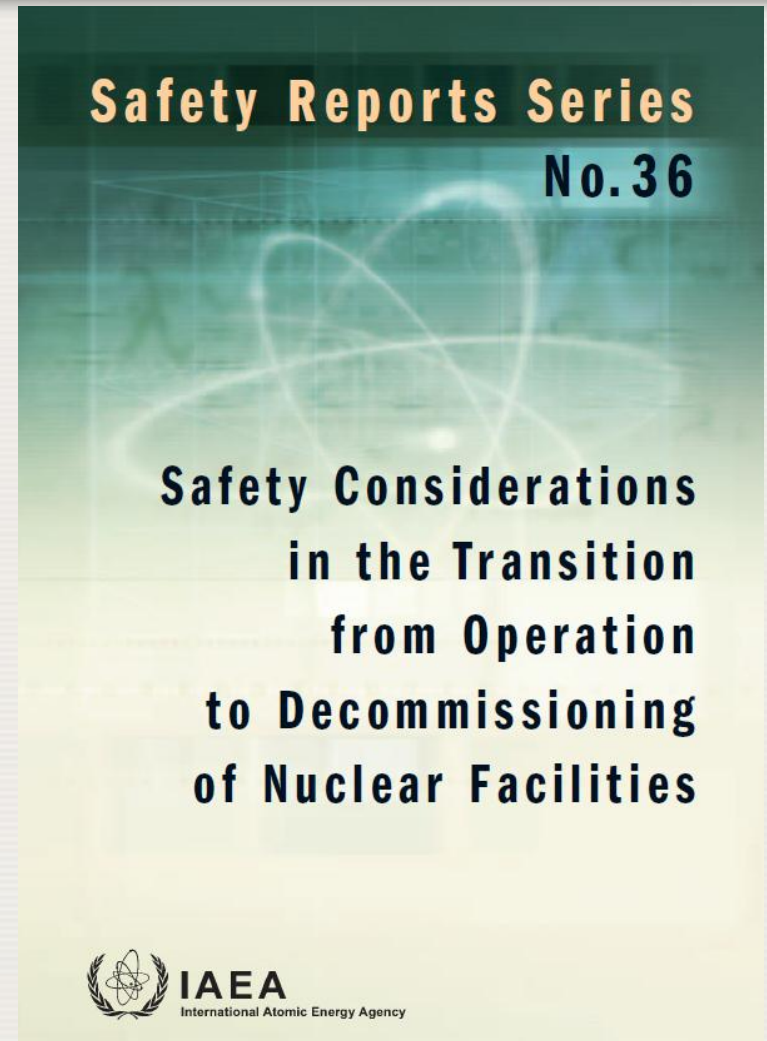
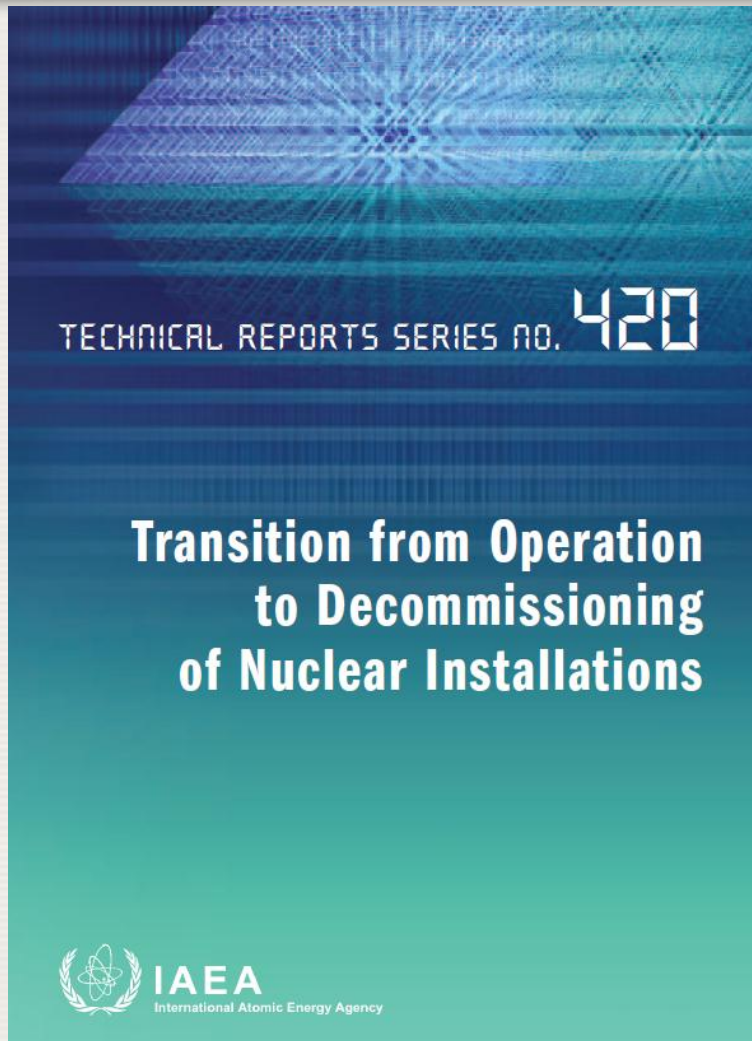
Support & Continued  
Characterization

Support &  
Verification

Post  
Decommissioning  
Surveillance



# Transition period



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**TRS 420 (2004) and SRS 36 (2004)**



# Characterization, organization and management

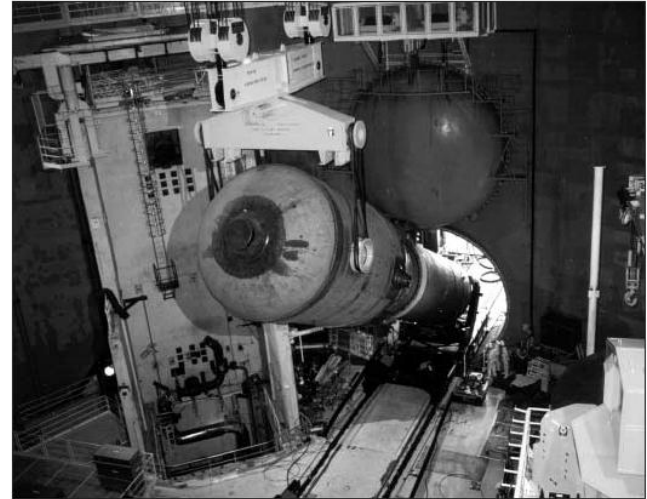


TECHNICAL REPORTS SERIES No. **389**

**Radiological Characterization  
of Shut Down Nuclear Reactors  
for Decommissioning Purposes**



INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1998



TECHNICAL REPORTS SERIES No. **399**

**Organization and Management  
for Decommissioning of  
Large Nuclear Facilities**



INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 2000

# Radiological Characterization of Shut Down Nuclear Reactors for Decommissioning Purposes (TRS-389/1998)

## Characterization objectives

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- ❑ Provide a reliable database of information on quantity and type of radionuclides, their distribution and their physical and chemical states
  - ❑ Survey of existing data, calculations, in situ measurements and/or sampling and analyses
- ❑ Facilitates assessment of options and their consequences
  - ❑ Operating techniques (decontamination and dismantling procedures and tools required)
  - ❑ Radiological protection of workers, general public and the environment
  - ❑ Waste classification
  - ❑ Resulting costs

# Radiological Characterization of Shut Down Nuclear Reactors for Decommissioning Purposes (TRS-389/1998)

## Phased approach during decommissioning

- Initial planning phase of decommissioning
  - Assess radiological status of the facility and nature and extent of problem areas
  
- Detailed planning phase
  - Detailed data on physical, chemical and radiological conditions, including activity calculations, sampling and inspections
  - Estimation of cost, risk and waste generation
  - Technical basis for selection of decommissioning scenario and for project planning
  - Supports detailed decommissioning plan

# Radiological Characterization of Shut Down Nuclear Reactors for Decommissioning Purposes (TRS-389/1998)

## Application to decommissioning operations

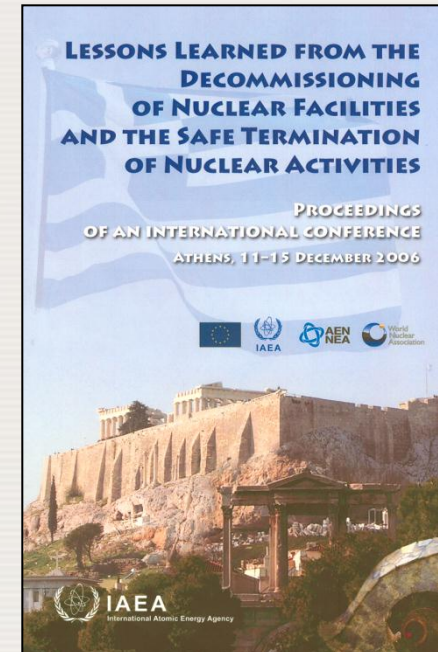
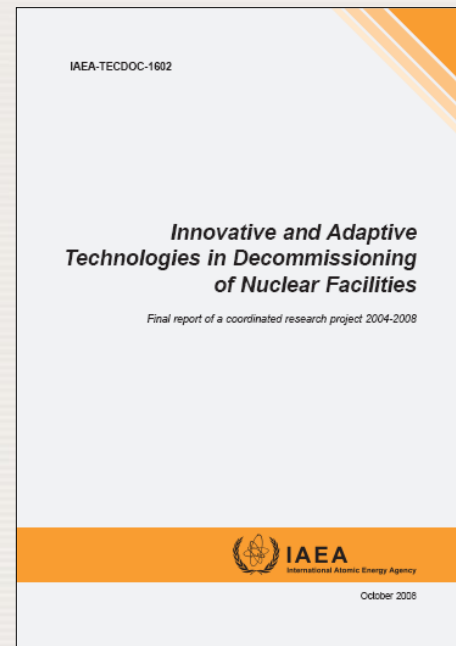
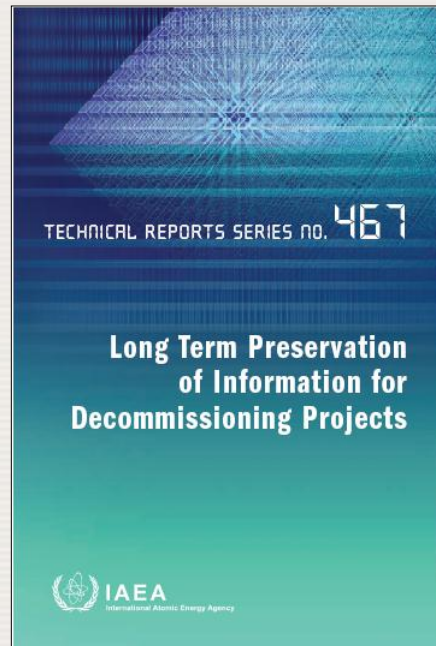
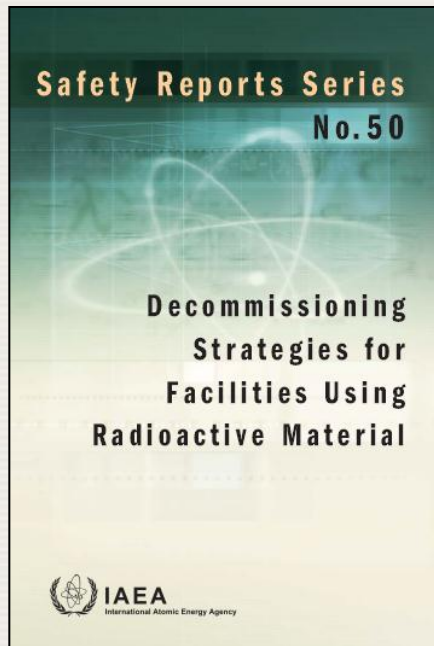
- Decommissioning strategy
  - Partial vs. full decontamination
  - Shielding
  - Partial removal of equipment
  - Waste classification
  - Project schedule and costs
  
- Extent and phasing of characterisation
  - Immediate dismantling – extensive campaign to support decisions of radiological protection and waste disposal
  - Deferred dismantling – rigorous assessments delayed until close to actual dismantling work
  - Detailed characterisation of certain nuclides may be unnecessary
    - Short-lived, in case of deferred dismantling
    - Alpha-emitting, where no fuel damage

# Concluding Remarks

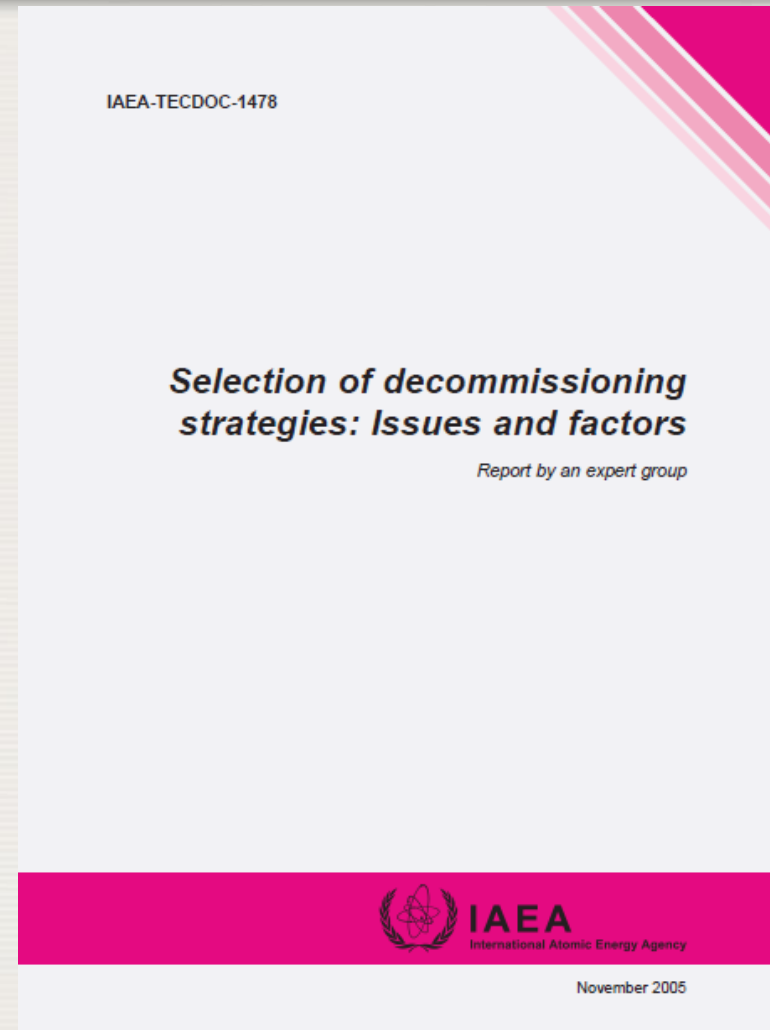
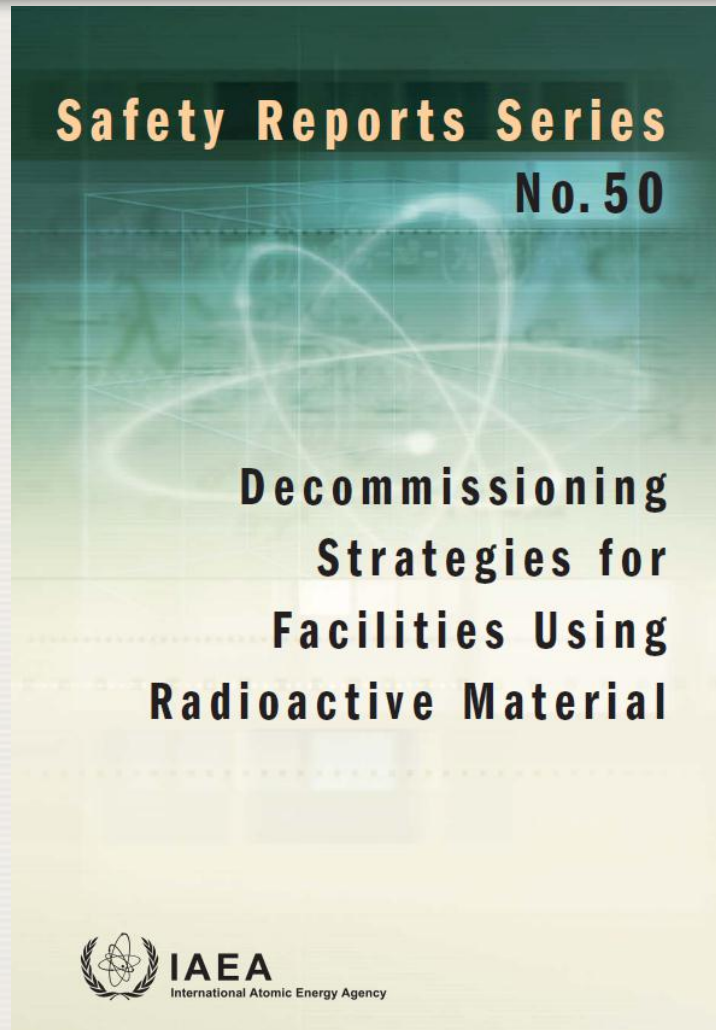
- ❑ Performed during different phases of the facility lifetime
  - ❑ Different purposes (with different objectives)
  - ❑ Physical (structural) and chemical characterization
- ❑ Provides key information for decommissioning planning and for safe and effective implementation of decommissioning activities
- ❑ Requires careful planning and implementation to ensure objectives are met
- ❑ Expensive/requires significant resources
  - ❑ Knowledgeable and trained personnel, sampling equipment, adequate instrumentation, laboratory capabilities, simulation/calculation codes, proper data management and record keeping
- ❑ Safety issues related to characterization
  - ❑ Hazards for workers performing characterization



# Supporting Documents



# Decommissioning strategies



**IAEA**

**SRS 50 (2007) and TECDOC-1478 (2005)**



# Decommissioning technologies



TECHNICAL REPORTS SERIES No. **395**

**State of the Art Technology  
for Decontamination  
and Dismantling  
of Nuclear Facilities**



INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1999



IAEA-TECDOC-1602

## ***Innovative and Adaptive Technologies in Decommissioning of Nuclear Facilities***

*Final report of a coordinated research project 2004-2008*



**IAEA**  
International Atomic Energy Agency

October 2008