

## Decommissioning of Nuclear Facilities - Discussion and Conclusions -



**Ernst Warnecke; NSRW  
R<sup>2</sup>D<sup>2</sup>Project: Basics of Decommissioning of  
Research Reactors / Manila; 16-20 October 2006**



## Lesson Objectives (1)

- Discuss the requirements that should be in place to support the decommissioning process
- Understand the responsibilities of the State, Regulatory Body and the Operator/Owner
- Discuss the regulatory approval process
- Review available and developing IAEA safety documentation



## Lesson Objectives (2)

- The R<sup>2</sup>D<sup>2</sup>P workshop on “legal & regulatory aspects” was held on 26 - 30 June 2006 in Manila
- A repetition of that information is neither possible nor intended
- A summary of essentials will be provided for completion of a workshop on the “Basics of Decommissioning”



## Factors Affecting the Regulatory Process (1)

- Constitutional & legal system
- Distribution of authority & jurisdiction among government agencies (one or more authorities)
- Ownership, organization & structure of operator (government operation / regulatory independence)
- Availability of technical, personnel & financial resources to the regulatory body (small countries with few experts)



## Factors Affecting the Regulatory Process (2)

- Size of the nuclear programme / national nuclear infrastructure – graded approach concept
- Regardless of regulatory arrangement, the responsibility for safety is assigned to the operator
  - no delegation of responsibility if contractors are involved
  - continuity of responsibility in the case of a sequence of operators



## Regulatory Framework

A legal / regulatory framework for nuclear facilities and activities includes, for example:

- Radiation and environmental protection standards
- Waste management programme, including disposal
- Guidance on the removal of materials, buildings and sites from regulatory control (end point definition / re-use + recycling)
- Provisions for decommissioning, incl. establishment of a funding mechanism for decommissioning activities and materials management



## Responsibilities of the Member State

- Establish & implement a legal framework for the regulation of nuclear activities, incl. decommissioning
- Define clearly the role of the regulatory body [preferably one (or a lead) authority] and the operators
- Ensure continuity of responsibilities, e.g. in the case of a consecutive series of operators
- Make provisions for adequate financial [e.g. government budget], human and technical resources
- Ensure that the regulatory body has an independent and unbiased perspective on activities



## Responsibilities of Regulatory Body - General

- Provide full governmental control with regard to health, safety & environmental protection (during the licensing process and during operations)
- Have a proper organization and adequate resources
- The Authority regulating operation normally regulates decommissioning
- Empowered to enforce legislation and regulations, e.g. suspend or cancel licenses
- Provide general guidance on decommissioning
- Liase with other organizations



## Responsibilities of Regulatory Body – Specific (1)

- Assist in developing legislation and policies regarding decommissioning
- Establish safety criteria for decommissioning, including decisions on acceptable end point conditions
- Develop regulations and guides required to implement the national policy on decommissioning
- Review the selected strategy and approve plans and submissions
- Issue licenses or other authorisations for decommissioning before the implementation of an activity



## Responsibilities of Regulatory Body – Specific (2)

- Assure compliance with regulatory requirements through visits and inspections of operations
- Ensure that decommissioning activities which generate waste will not be started unless there is a waste management strategy and a destination for the waste in place
- Establish limits and conditions for the removal of materials, buildings and sites from regulatory control
- Ensure maintenance of long term records, e.g. on waste and the release of materials, buildings and sites from regulatory control
- Ensure adequate training is available for those involved with decommissioning activities



## Responsibilities of Operator or Owner - General

- Responsible for safety during decommissioning of the facility including actions of contractors
- Submit a license application, including a decommissioning plan to the regulatory body for review and/or approval
- No decommissioning activity shall begin without the appropriate license or other type of authorisation by the regulatory body

**Remember – The operator has overall responsibility!!!**



## Responsibility of Operator or Owner – Specific (1)

- Ensure adequate protection of the worker, general public & the environment
- Prepare a decommissioning plan
  - Conceptual plans and technical provisions should have been made for decommissioning at the design stage
  - Decommissioning plans should have been prepared, updated and reviewed by the regulatory body during operation
  - An up to date decommissioning plan should be available at the end of operation
  - Prepare a (preliminary) decommissioning plan if it is not yet available
- Establish and maintain necessary operational records to support decommissioning
- Characterize the facility after completion of operations so a (final) decommissioning plan can be prepared



## Responsibilities of Operator or Owner – Specific (2)

- Prepare the final decommissioning plan including
  - Technical Approach
  - Safety assessment
  - Environmental assessment
  - Radiation protection programme
  - Materials / Waste management plan
  - QA/QC programme
  - etc.
- Ensure suitable staff, equipment and financial resources are available
- Comply with all legal requirements



## Responsibilities of Operator or Owner – Specific (3)

- Propose a concept for the management of materials (clearance, recycling, re-use, disposal as conventional waste)
- Propose a destination for the radioactive decommissioning waste (e.g. storage or disposal)
- Ensure waste can be safely transported, stored & disposed
- Conduct the decommissioning activities
- Carry out a final survey and submit a final report of the project
- Ensure all end point criteria are defined and met
- Plan for contingencies & emergencies  
[Murphy's law: Anything that can go wrong will go wrong]



## Regulatory Approval Process (1)

- The operator needs to make an application for an operating license amendment or issuance of a new license for decommissioning
- Certain conditions may be contained in the new or modified license directing how the facility is now to be operated
- Decommissioning requires approval by the regulatory body before the activities can be implemented (i.e., Decommissioning Plan); overall concept + stepwise license
- The decommissioning organization typically submits these documents formally through official channels to the regulatory body



## Regulatory Approval Process (2)

- The regulatory body reviews the application with independent means and may request further information to clarify points
- Upon resolution of points commented upon, the regulatory body will decide on the application and formally transmit an approval to the operator
- After approval, there may be a need for changes, e.g. because of unexpected contamination. Define the level of flexibility (no action, notification, application for license amendment) regarding deviations from the original plan
- Agreement on flexibility be established by the regulatory body and the operator prior to starting decommissioning



## Regulatory Approval Process (3)

- The regulatory body should formally be request to terminate the operating license upon completion of decommissioning
- The regulatory body should receive a proof that final endpoint conditions have been met
- The regulatory body may carry out an independent assessment that the decommissioning has been successfully completed before a formal response that the license is terminated
- Upon license termination the regulatory body must decide on storage and maintenance of long term records



## Joint Convention: Background

- **Joint Convention (J.C.) on the safety of spent fuel management and on the safety of radioactive waste management**  
<http://www-ns.iaea.org/conventions/waste-jointconvention.htm>
  - International legal instrument: binding to Contracting Parties
  - All States with spent fuel / radioactive waste should become a Party
  - The J.C. formulates requirements on decommissioning in line with IAEA safety standards, e.g.
    - Early planning: during design, construction and operation; § 7,14
    - Establish + maintain legislative and regulatory framework; § 19
    - Establish regulatory body (effective independence); §20
    - Human and financial resources; § 22,26
    - Ensure safety of decommissioning; § 26 (special reference to Radiation Protection; Emergency Preparedness; Records)



## IAEA Safety Standards: Background

- **IAEA Statute:**

- **Develop safety standards**



Nuclear safety  
Radiation Safety  
Waste Safety  
Transport Safety

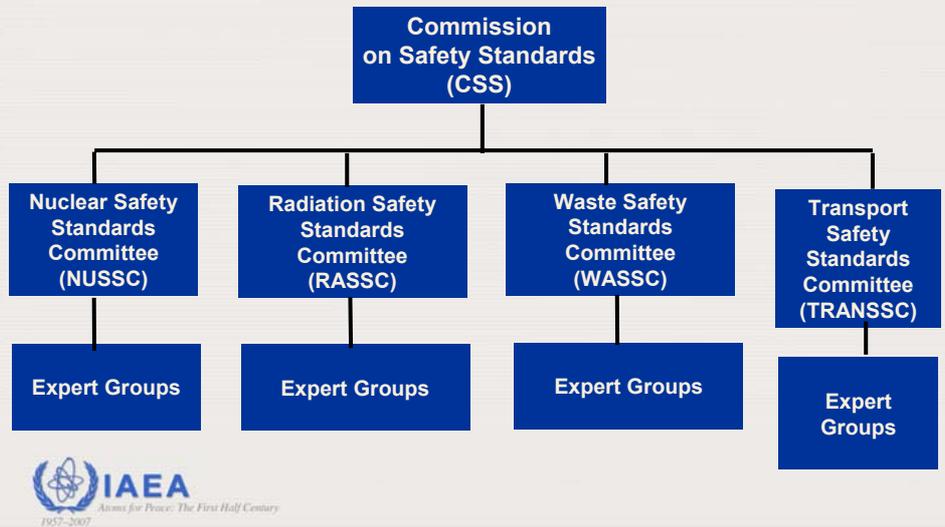
- **Provide for their application (upon request)**



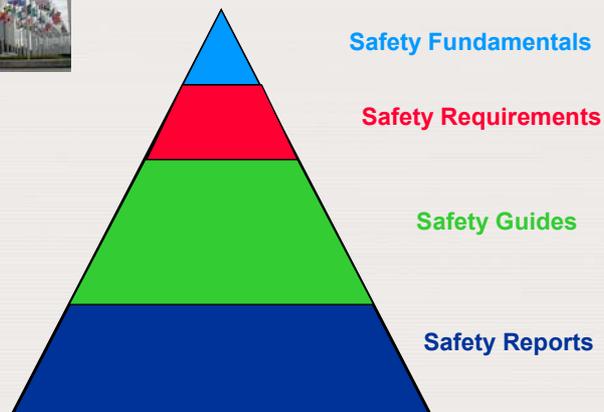
Peer reviews  
Technical cooperation  
Training  
Exchange of information  
Research and development



## Preparation and Review of Safety Standards



## Types of Safety Documents



## IAEA Related Documents (1)

- **Fundamentals**
  - Provide basic objectives, concepts and principles of safety
  - “The Principles of Radioactive Waste Management” (111-F) 1995; New “Joint” Safety Fundamentals (DS 298)
- **Requirements**
  - Establish requirements that must be met to ensure safety - use “shall” statements
  - Governed by objectives and principles in the Safety Fundamentals
  - “Predisposal Management of Radioactive Waste, Including Decommissioning” (WS-R-2) 2000
  - **“Decommissioning of Nuclear Facilities” (DS-333 or WS-R-5) to be issued in 2006 to supersede WS-R-2**



## IAEA Related Documents (2)

- **Safety Guides**
  - Recommend actions, conditions or procedures for meeting requirements - use “should” statements
  - Implication is that recommended methods or equivalent alternative methods should be used
  - “Decommissioning of Nuclear Power Plants and Research Reactors” (WS-G-2.1) 1999
  - “Decommissioning of Medical, Industrial and Research Facilities” (WS-G-2.2) 1999
  - “Decommissioning of Fuel Cycle Facilities” (WS-G-2.4) 2001
  - “Application of the Concepts of Exclusion, Exemption and Clearance” (RS-G-1.7) 2004
  - **“The Release of Sites from Regulatory Control upon Termination of Practices” (DS-332 or WS-G-5.1) to be issued in 2006**



## IAEA Related Documents (3)

- **Safety Report**
  - Describe good practices
  - Give practical examples and detailed methods that can be used to meet safety requirements
  - Do not establish requirements or give guidance
  - “Safe Enclosure of Nuclear Facilities during Deferred Dismantling” (Safety Report Series No. 26) 2002
  - “Safety Considerations in the Transition from Operation to Decommissioning of Nuclear Facilities” Safety Report Series No. 36) 2005
  - “Derivation of Activity Concentration Values for Exclusion, Exemption and Clearance” (Safety Report Series No. 44) 2005
  - “Format and Content for Decommissioning Safety Related Documents” (Safety Report Series No. 45) 2005



## IAEA Related Documents (4)

- **Safety Documents under preparation**
  - Safety Assessment Methodologies for Decommissioning (DS376)
  - Monitoring for Compliance with Exclusion, Exemption and Clearance Values (DD740)
  - Safety Analysis Process for Decommissioning (DD741)
  - Methods for Monitoring for Compliance with Remediation Criteria (DD744)
  - Strategies for Safe Decommissioning of Nuclear Facilities (DD820)



## IAEA Related Documents (5)

- Technical Reports and TECDOCs
  - Provide technical information
  - Over 20 specific topics concerning subject of decommissioning
    - Characterization
    - Record keeping
    - Planning
    - Technologies
- Technical Assistance to Member States
- Coordination with other international organizations
  - OECD Nuclear Energy Agency
  - International Commission on Radiological Protection



## Safety Requirements (DS-333 / new WS-R-5) (1)

- Three strategies have been defined – Immediate dismantling, Deferred dismantling and Entombment
- The dismantling process shall be considered as a practice per BSS
- Safety culture shall be fostered and maintained
- The decommissioning process shall be regulated and appropriate regulatory infrastructure shall be in place
- Preferred strategy shall be immediate dismantling
- A decommissioning plan shall be prepared for each facility (early planning!)
- The implementation of the decommissioning strategy shall not begin until approval has been received by the regulatory body
- The safety impacts of the decommissioning activities shall be assessed and managed so that hazards are mitigated



## Safety Requirements (DS-333 / new WS-R-5) (2)

- Appropriate means shall be in place for managing materials that are generated during the decommissioning process
- Decontamination and dismantling techniques shall be chosen which minimize waste
- An environmental impact assessment shall be prepared for decommissioning activities.
- All decommissioning tasks shall be controlled through the use of written procedures
- A funding mechanism shall be in place at an early point in time to ensure proper resources are available when needed
- The operator shall show the end state has been reached and the regulator shall confirm this before terminating the license or authorization



## Safety Requirements (DS-333 / new WS-R-5) (3)

- A system shall be established to ensure all records are stored and maintained per the records retention requirements of the QA system
- The concept of clearance shall be used to release any material from regulatory control
- A comprehensive QA programme shall be applied to all decommissioning phases
- A decommissioning organization shall be established early and be responsible for safety
- All individuals shall be trained as appropriate for their job



## Specific Safety Guidance (WS-G-2.1) (1)

- A characterization survey should be performed to determine hazards
  - Both radiological and non-radiological hazards
  - Tailored to type of facility
- The decontamination and dismantling activities should be optimized taking into account exposures, cost, safety of technique and waste
- Dismantling may create new hazards, e.g. due to the removal of barriers, that should be considered
  - Techniques should be simple and reliable
  - Minimize the generation of liquids and secondary waste
  - Technology should be proven
  - Minimize adverse impact on surrounding areas and systems



## Specific Safety Guidance (WS-G-2.1) (2)

- A final radiation survey approach should be included in the decommissioning plan
- Staffing and training
  - Personnel should be competent to perform their assigned work safely
  - Appropriate levels of control, supervision and training should be provided
  - Staff may be supplemented with outside contractors



## Specific Safety Guidance (WS-G-2.1) (3)

- Organizational and administrative control
  - Need clear delineation of authorities and responsibilities
  - Use knowledge and experience of operational staff to develop the decommissioning plan
  - If contractors are used, all license conditions apply to them
  - Operator is responsible!



## Specific Safety Guidance (WS-G-2.1) (4)

- Radiation Protection
  - Optimize approaches to minimize exposure
  - Maintain exposures as low as reasonably achievable
  - Plan tasks in advance and estimate doses
  - Periodically review the radiation protection programme
  - Ensure appropriate radiation monitoring
  - Ensure appropriate resources are made available for safety functions (equipment, personnel, funds)
  - Establish and maintain records
  - Follow good radiation protection practices



## Specific Safety Guidance (WS-G-2.1) (5)

- On- and off-site monitoring will be required
- A waste management plan is required
  - Optimize waste management and reduce waste
  - Balance minimisation of waste with exposure to workers and the public
- The decommissioning plan should include provisions for responding to all emergencies. These might be different than during operation



## Specific Safety Guidance (WS-G-2.1) (6)

- Physical protection should be provided as necessary (Note that hazards may decrease)
- Completion of decommissioning
  - Verify end state conditions have been met
  - Final report should be prepared
  - Appropriate records retained and maintained
  - Site should be controlled until approval is received from regulatory body



## Summary

- A strong and independent regulatory regime is required for safe and efficient decommissioning
- Regulatory body provides requirements and guidance
- Operator is ultimately responsible for ensuring safety and that all requirements are met
- An on-going process of dialoguing between the regulatory body and operator is critical for a timely and successful decommissioning project



## Websites

### **SAFETY STANDARDS**

<http://www-ns.iaea.org/standards>

### **WASSC (PUBLIC):**

<http://www-rasanet.iaea.org/committees/wassc.asp>

### **DRAFT SAFETY STANDARDS:**

<http://www.iaea.org/ns/committees/drafts/inclSStandardsDrafts.htm>

### **PUBLISHED DOCUMENTS:**

<http://www-pub.iaea.org/MTCD/publications/series1.asp>

### **WASTE TECHNOLOGY**

<http://www.iaea.org/OurWork/ST/NE/NEFW/index.html>



## References

- IAEA WS-R-2
- IAEA Safety Fundamentals 111-F
- IAEA Fundamental Safety Principles, DS298 – approved to be published, 2006
- IAEA Safety Guides WS-G-2.1, WS-G-2.2 and WS-G-2.4
- IAEA RS-G-1.7 (Exclusion, Exemption, Clearance)
- IAEA DS 332 – Release of Sites from Regulatory Control on Termination of Practices (to be published as WS-G-5.1)
- IAEA DS 333 – Decommissioning Safety Requirements (to be published as WS-R-5)