



International Atomic Energy Agency

Requirements for Decommissioning Planning

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Lesson Objectives

- **Understand the requirements for the preparation of a decommissioning plan**
- **Understand the importance of early planning**
- **Understand the importance of preparing a decommissioning plan now, if it is not available**
- **Understand the planning for decommissioning and the overall outline of decommissioning plans**
- **Understand the work breakdown structure (WBS)**
- **Understand the need of R²D²P participants to take action on deficits in national situations**



Hierarchy of IAEA Safety Standards (I)

- **Fundamentals**

- Provide basic objectives, concepts and principles of safety
- “The Principles of Radioactive Waste Management” (111-F) 1995
- “Fundamental Safety Principles” (SF-1) 2006

- **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 Facilities Using Radioactive Material” (WS-R-5) 2006



Hierarchy of IAEA Safety Standards (II)

- **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” (GS-G-5.1) 2006

Hierarchy of IAEA Safety Standards (III)

- **Safety Reports**
 - 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) 2004
 - “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
 - “Decommissioning Strategies for facilities Using Radioactive Material” (Safety Report Series No. 50) 2007



International Conventions

- **IAEA Safety Standards are non-binding international recommendations**
- **IAEA Safety Standards are applicable to operations using IAEA support (Statute, Art. III, 6.) !**
- **International Conventions are legally binding to “Contracting Parties”**
- **Conventions are adopted into the legal framework of “Contracting Parties”**
- **Most relevant for Decommissioning:
Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management**

Joint Convention (I)

- **Was developed on the basis of IAEA Safety Standards**
- **Is consistent with IAEA Safety Standards**
- **“Translates” IAEA Safety Standards into national law of Contracting Parties**
- **Includes Decommissioning of nuclear facilities as one major topic**
- **Sets requirements on “Planning”**



Joint Convention (II)

- **Requires a decommissioning plan**
 - **Conceptual plan at design stage**
 - **Update decommissioning plan during operational lifetime; review by regulatory body**
 - **Note: The terms “initial planning”, “on-going planning” + “final planning” are often used to express the development of a ‘final’ decommissioning plan**
 - **Ensure adequate financial resources**
 - **Keep records of information important to decommissioning**
 - **Upgrade existing facilities and past practices**



Messages to countries participating in R²D²P

- **Be “Contracting Party” to the Joint Convention**
- **Comply with IAEA Safety Standards and the Joint Convention**
- **Have a decommissioning plan for each nuclear facility or develop it now**
- **R²D²P would be a failure if decommissioning plans would not be initiated now**
- **Note: Not having decommissioning plans is not consistent with IAEA Safety Standards + the IAEA Statute. Consistency is required for IAEA support!**



General Planning (I)

- **Plan for decommissioning as early as possible**
- **Be consistent with the national legal framework and international recommendations**
- **Extent, content and degree of detail of planning depend on the type, complexity and hazard associated with a facility**
- **Take nuclear and conventional hazards into account**
- **Make a proper cost calculation; periodical review**
- **Ensure funds will be available when needed**

General Planning (II)

- **Three stages of planning are normally used:**
 - Initial Planning
 - On-going Planning
 - Final Planning
- **Again, the degree of detail will vary from facility to facility and will increase from the initial to the final decommissioning plan**
- **Pertinent facility records are critical in the development of a Decommissioning Plan**



Initial Planning

- **An initial decommissioning plan shall be prepared and submitted with each construction application for a new facility**
- **The design and construction of a facility should ease the later decommissioning**
- **Operating facilities without a decommissioning plan should prepare one without undue delay**



Ongoing Planning

- **During on-going facility operations, the decommissioning plan shall be routinely reviewed, updated and made more comprehensive with respect to:**
 - **Technological advances**
 - **Significant changes of systems and structures**
 - **Incidents / abnormal operating events**
 - **Regulations and government policy**
 - **Cost estimates and financial provisions**
- **Also to be incorporated: safety considerations, e.g. normal operations / incidents + accidents**

Final Planning

- Before shutdown of a facility a final + detailed decommissioning plan, including safety assessment, is to be prepared
- This plan has to be submitted to the regulator for review and, if acceptable, approval
- Such an application maybe for a one step project or a stepwise project
- Stepwise projects
 - submit an overall concept with individual steps identified
 - submit plans for individual steps as work progresses
- Decommissioning plans may be amended or refined as work proceeds, subject to approval



Decommissioning Planning: Overview

- **Scope of the project**
- **Decommissioning strategy / option**
- **End state of decommissioning**
- **Technology and equipment**
- **Expertise and qualified staff**
- **Costs and funding**
- **Materials management (fuel, waste, recycling)**
- **Work breakdown structure**
- **Steps in a project execution**
- **Project controls**
- **Release of sites from regulatory control**
- **Communication: local community, decision makers + general public**



Scope of the Project

- **Clarify the scope as early as possible**
- **Be clear of what needs to be done**
 - **Which buildings / facilities are to be decommissioned**
 - **What is the relevant area (inside / outside the fence)**
 - **What is the expected end-state for the buildings / facilities**
 - **What is the expected end-state of the area**
 - **What are the requirements for the release of facilities and the site**
- **Plan properly to be (reasonably) sure that the final goal (expected end-state) can be achieved**
- **Include the licensing needs into all the planning**
- **Communicate (decision makers + the public)**



Decommissioning Strategy / Option

- **Three main strategies / options are considered:**
 - Immediate decontamination and dismantlement
 - Safe storage for a defined period prior to decontamination and dismantlement
 - Entombment of the facility (near surface repository)
- **Many factors have to be considered:**
 - Policy + socio-economic factors (politicians, public ...)
 - Technological + operational factors
 - Long-term uncertainties

IAEA: Selection of decommissioning strategies: Issues and factors

http://www-pub.iaea.org/MTCD/publications/PDF/TE_1478_web.pdf

NEA: Selecting strategies for the decommissioning of nuclear facilities

<http://www.nea.fr/html/rwm/reports/2006/nea6038-decommissioning.pdf>



End State of Decommissioning

- **Three main end states are often considered:**
 - Free release of buildings + sites
 - Reuse of buildings + sites (nuclear or industrial)
 - Restricted release of buildings + sites (institut. control)
- **Factors important to end state decisions**
 - Proper characterisation of buildings + sites
 - Assessment of the decontamination capabilities
 - Comparison to the release requirements
 - Analyses of the costs / financial benefits (land price)
 - Policy + socio-economic factors: politicians, pressure groups, public ... may heavily oppose restricted release
- **Be prepared to deal with scientific and all types of non-scientific matter**

Technology and Equipment (I)

- **Decommissioning is a breakdown of structures to manageable pieces**
- **Cutting (shears), sawing (band saw), demolition (wrecking ball) and others may be used**
- **Trend: Use and, if necessary, adopt standard equipment (from the shelf)**
- **Look at risks associated with equipment, e.g.:**
 - **Thermal techniques (risk of fire)**
 - **Dry techniques (risk of airborne contamination)**
 - **Liquid techniques (risk of waterborne contamination)**
- **Plan to prevent negative impacts, e.g. remove combustibles, use housing / tent, contain liquids**

Technology and Equipment (II)

- **Necessary technology + equipment**
 - Plan well to identify technological and equipment needs
 - Look for similar / comparable project experience
 - Assess costs and licensing in the planning process
 - Look for nationally available equipment
 - Procurement on international market takes time + may be difficult (import rules, foreign currency, spare parts)
 - Plan for IAEA support (e.g. Technical Co-operation)
 - Look for used equipment or share equipment especially in cases of a singular exercises (R²D²P co-operation)

Expertise and Qualified Staff

- **Countries with small nuclear programmes may be short in expertise and qualified staff to serve both operations and independent review (regulation)**
 - Involve expertise from other countries / IAEA assistance
- **Prepare a proper plan for the workforce needs**
- **Plan the transition of existing staff from operation to decommissioning according to workforce need**
- **Assess the work to be done by own staff + decide on the involvement of (specialised) contractors**
- **Provide education and training to the staff**
- **Set up a project management organisation**



Costs and Funding (I)

- **Estimate costs at a very early stage**
 - This is necessary to set up a funding mechanism
 - Research facilities are often Government owned
 - Governments tend to pay from the annual budget
 - A “decommissioning fund” may not be needed
 - Plan in view of Government budgeting, e.g. 5a / 1a plan
- **Estimate costs for decommissioning options**
 - Part of the “optioneering” (decision making) process
- **Calculate detailed costs during the final planning**
 - Total costs and cost breakdown for individual elements
 - Prepare a detailed time table: Time is money!

Costs and Funding (II)

- Manage the programme well to avoid delays: extra cost!
 - Build inflation into the cost calculations: e.g. X% p.a.
 - Allow a margin for uncertainties
 - Include the costs for waste + materials management, e.g. conditioning, storage, disposal of radioactive waste; nuclear fuel; release of materials, buildings, site(s)
 - Plan well to ensure funds are available when needed
- **Please bear in mind: No funds – No safety!**

IAEA: Financial Aspects of Decommissioning

http://www-pub.iaea.org/MTCD/publications/PDF/te_1476_web.pdf

NEA: Decommissioning Funding: Ethics, Implementation, Uncertainties

<http://www.nea.fr/html/rwm/reports/2006/nea5996-decommissioning.pdf>

NEA: Decommis. Nuclear Power Plants: Policies, Strategies and Costs

<http://213.253.134.43/oecd/pdfs/browseit/6603221E.PDF>

Materials Management

- **What to do with the nuclear fuel**
 - Return to the USA, Russia (or another country)
 - If necessary, receive fresh fuel in return
 - Plan early to get a “slot” + prepare for the fuel transfer
- **Check the needs for materials management**
 - Assess sufficiency of existing decontamination, release measurement, conditioning, storage, disposal facilities
 - If insufficient: plan early for building of new capacities
 - Identify routes for recycle + reuse of materials / equipm.
 - Identify routes for the disposal of non-nuclear waste
- **Some of the waste issues may be controversial**

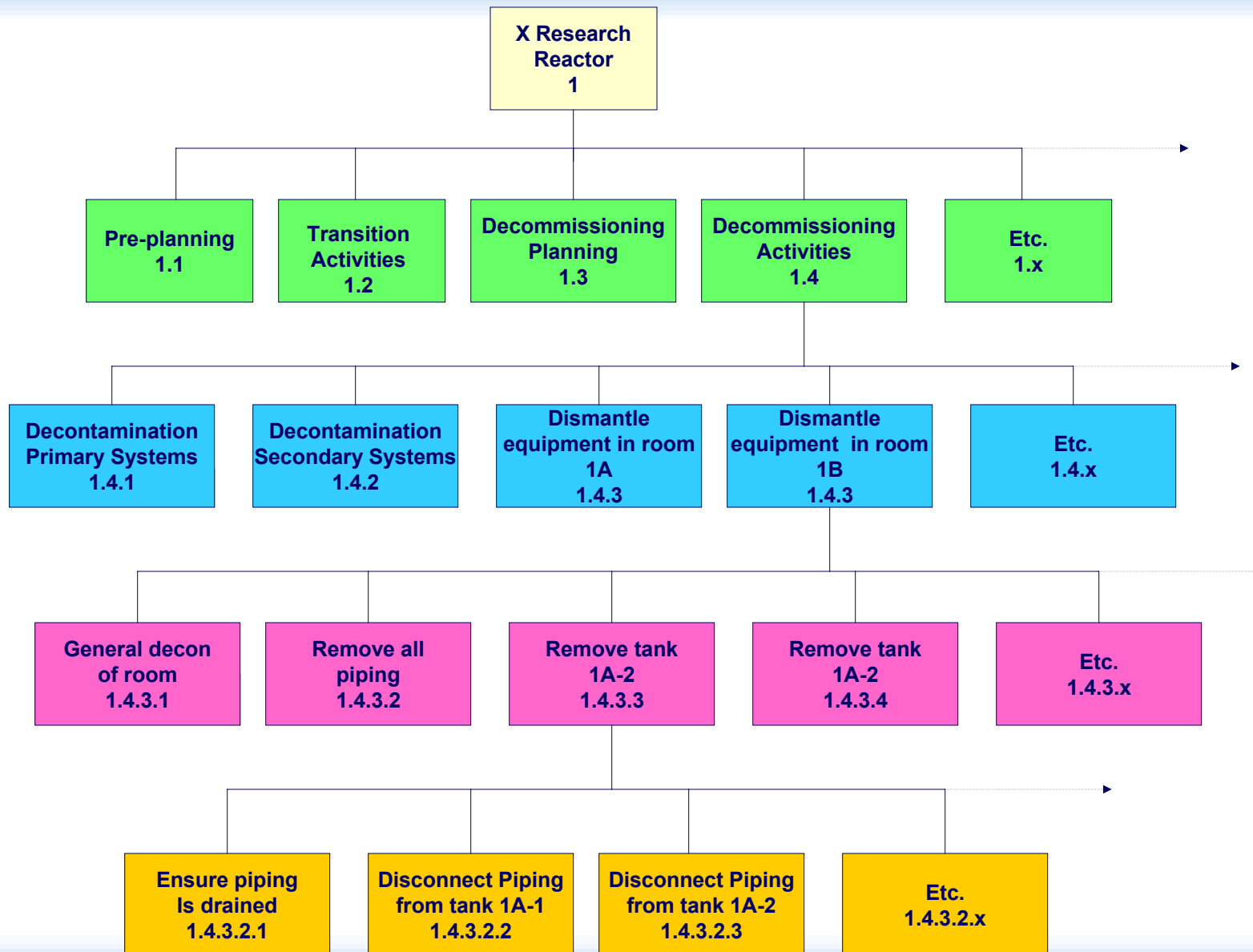
Work Breakdown Structure (WBS); (I)

- **The WBS is used to categorize work activities and cost elements into a logical structure**
- **This is the basis for a time table / work schedule**
- **The work groupings are usually related to the accounting system used for budgeting and tracking major decommissioning cost elements**
- **It is also of use for project control, e.g. time table**
- **The WBS elements are generally arranged in a hierarchal format that may reflect a company's organization chart**
- **The topmost member or level of the WBS would be the overall project. Subsequent levels are used to track increasing levels of project detail**



Work Breakdown Structure (WBS); (II)

- **The WBS goes down several hierarchical levels, rarely exceeding the sixth level**
 - such detail is usually unnecessary for cost + reporting purposes
 - In many cases the costs are "rolled up" to level 3 or level 2 for management information
- **Project management or accounting software is available**
- **Most project management and accounting software packages are capable of relating cost information directly to the WBS format, e.g. for project reporting purposes**



Example WBS Based Schedule

WBS #	Task Name	Labor Hours (x 1000)	Budget (includes labor) (x 1000€)	T = - 3 Mon	T = 0	T = 3 Mon	T = 6 Mon	T = 9 Mon	T = 12 Mon	T = 15 Mon	T = 18 Mon	T = 24 Mon	
1	Decommission Research Reactor		2000	[Gantt bar from T=-3 to T=24]									
1.1	Pre-shutdown planning		30	[Gantt bar from T=-3 to T=0]									
1.2	Final Shutdown		===		Milestone								
1.3	Preliminary Studies		30		[Gantt bar from T=0 to T=3]								
1.4	Project Execution		1905		[Gantt bar from T=3 to T=18]								
1.4.1	Decommissioning Activities		1740			[Gantt bar from T=6 to T=15]							
1.4.1.1	Decon/Remove Auxiliary Systems		870				[Gantt bar from T=9 to T=12]						
1.4.1.2	Decon/Remove Reactor Systems		870				[Gantt bar from T=12 to T=15]						
1.4.2	Final Status Surveys		150							[Gantt bar from T=18 to T=24]			
1.4.3	Confirmatory Surveys		15								[Gantt bar from T=18 to T=24]		
1.4.4	License Termination		===									Milestone	
1.5	Closeout Actions		35									[Gantt bar from T=24 to T=27]	
1.5.1	Non-radiological remediation		25									[Gantt bar from T=24 to T=27]	
1.5.2	Demobilization		5									[Gantt bar from T=24 to T=27]	
1.5.3	Closeout Documentation		5									[Gantt bar from T=24 to T=27]	

Steps in a Project Execution

- **Decommissioning activities**
 - Emptying the facility
 - Transfer, storage, ... of nuclear fuel
 - Draining and decontamination of pipes, tanks etc.
 - Decontamination of other systems
 - Removal of equipment, components + structures
 - Materials management: incl. conditioning, storage, transport and disposal of waste; recycle / reuse; decontamination / disposal of non-radioactive waste
 - Surveillance and maintenance (S&M)
- **Final surveys and then license termination**
- **Confirmatory surveys, as necessary**



Project Controls

- **Quality Assurance**
- **Control of actual data**
- **Check actual data against planned (baseline) data**
 - **Costs**
 - **Progress of work versus timetable / schedule**
 - **Exposures**
 - **Other control parameters**
- **Take action in the case of deviations from plan**
- **Programme Evaluation and Review Technique (PERT)**

Release of Sites from Regulatory Control

- **When radiological and hazardous material have been removed in accordance with “clearance levels”, the site license may be terminated by the regulatory body**
- **Monitoring needs or institutional controls have to be developed + implemented, if necessary**
- **At the end appropriate project reporting and documentation is to be completed**
- **A decision on the responsibility + location for storage and maintenance of the documentation has to be made**

Communication

- **Communication to the local community, decision makers + the general public is important**
- **Communication is the responsibility of the highest managerial level**
- **Always be correct + never try to fool or cheat**
- **Do not make promises that cannot be fulfilled as this will deteriorate trust + good relations**
- **Listen to or work with “stakeholders” + try to accommodate, if possible, their views in the planning process**
- **Keep “stakeholders” informed (before the press)**
- **Decommissioning end state is a sensitive issue**

NEA: Stakeholder Involvement in decommissioning of nuclear facilities

<http://www.nea.fr/html/rwm/reports/2007/nea6320-stakeholder.pdf>

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Summary

- Decommissioning is an orderly, phased final step in the life of a nuclear facility
- Early planning for decommissioning is required
- Planning is an ongoing process
- A final plan should be available at shutdown
- Planning of the entire decommissioning process must be carried out thoroughly + with great care
- Roles + responsibilities must be clearly defined
- Good planning will save money and will ease the carrying out of the decommissioning activities
- Failing to plan is planning to fail!



THANK YOU

