



International Atomic Energy Agency

Decommissioning of Nuclear Facilities

Decommissioning Planning

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Lesson Objectives

- **Understand the overall planning process as it applies to decommissioning including economic inputs and preliminary studies**
- **Understand the key points in the planning process**
- **Understand the cost estimation process including the use of a Work Breakdown Structure (WBS) and its interface with scheduling used in decommissioning planning**
- **Understand the importance of early planning for effective decommissioning**

NOTE: This lesson has been modified to reflect both a summary of 'conceptual' material and practical considerations



Planning Process

Decommissioning of a facility is a PROJECT and should be operated using sound project planning principles and project management techniques

- **General Planning**
 - **General thoughts for the licensee to consider**
- **Initial Planning**
 - **Planning that is conceptual in nature**
- **Ongoing Planning**
 - **Incorporation of details from new information**
- **Final Planning**
 - **Detailed planning prior to conduct of field activities**



General Planning

- **Successful decommissioning depends on careful and organized planning**
- **The planning requirements have to be consistent with regulatory requirements**
- **A detailed project scope is mandatory for initiating even the most general planning**
- **The extent, content and degree of detail of planning depends on the complexity and hazard potential of the installation**
- **One goal of the planning process is the development of a decommissioning plan**



General Planning

- **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 initial to final decommissioning planning**
- **Pertinent facility records are critical in the development of the Decommissioning Plan**



Initial Planning

- **An initial Decommissioning Plan shall be prepared and submitted with each construction application for a new facility**
- **This plan would contain a lower level of detail than that which would be contained in the final Decommissioning Plan**
- **Operating facilities without an initial 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**
 - **Incidents/abnormal operating events**
 - **Regulations and government policy**
 - **Cost estimates and financial provisions**
- **Additionally - to be incorporated into the Decommissioning Plan are:**
 - **Safety considerations, and**
 - **Any significant systems and structural changes**



Details of the Decommissioning Planning Process

- **Project Scope**
- **Selecting the Decommissioning Strategy**
- **Economic Inputs to the Decision Process**
- **Project Initiation**
- **Transition Phase**
- **Project Execution**
- **Project Controls**
- **Project Closeout**



Project Scope

- **Scope for the project is difficult to quantify**
 - **Better the definition of scope, more effective the planning process**
- **Project cost and schedule are affected by answers to the following**
 - **Facilities and area that bounds the project**
 - **Expected end-state for the affected facilities and area**
 - **Type and distribution of contaminants**
 - **Final release criteria to be met**



Selecting the Decommissioning Strategy

- **Once the overall project scope is determined, the decommissioning strategy is selected. Three main approaches are considered**
 - **Immediate dismantlement**
 - **Deferred dismantlement for some defined period**
 - **Entombment**
- **In general, each approach will be evaluated using a cost-benefit analysis methodology**
- **Both economic as well as non-economic inputs are typically used to support a site-specific decision for the optimal method of decommissioning**



Economic Inputs to the Decision Process

- **Cost estimates for each decommissioning strategy is considered**
- **Decommissioning funding approaches**
 - **Fully funded external fund**
 - **Annual budget allocation**
- **The effects of project delays**
 - **timing to begin the project**
 - **delays once the project is in progress**
- **Projections on growth rates for decommissioning funds**
- **Projections on interest rates**
- **Evaluation of the variability in these parameters**



Initial Decommissioning Plan

- **Basic information on the complexity of the facility decommissioning**
- **Establishes a funding mechanism and collection process**
- **Lists assumptions for decommissioning**
- **Describes the procedures and requirements for collection of data during**
 - **Construction**
 - **Operation**
 - **Maintenance**
- **Provides input to engineering design of the facility**
- **Update regularly as changes occur**



Decommissioning Plan- Contents

- **Introduction**
- **Facility Description**
- **Decommissioning Strategy**
- **Project Management**
- **Decommissioning Activities**
- **Surveillance and Maintenance**
- **Waste Management**
- **Cost Estimate and Funding Mechanisms**
- **Safety Assessment**
- **Environmental Assessment**
- **Health and Safety**
- **Quality Assurance**
- **Emergency Planning**
- **Physical Security and Safeguards**
- **Final Radiological Survey**
- **Appendices if necessary**



Decommissioning Plan - Decommissioning Strategy

- **Objectives of Project**
- **Decommissioning alternatives considered**
- **Safety principles and criteria for each**
- **Details of alternatives studied**
- **Selection and justification of preferred strategy**



Decommissioning Plan – Decommissioning Strategy

- **Specific information for each strategy considered**
 - **Regulatory**
 - **Safety- radiological and non-radiological**
 - **Schedule**
 - **Cost**
 - **Waste types and volumes**
 - **Dose estimates- worker and public**
 - **Technology**
 - **Social factors**



Decommissioning Plan – Project Management

- **Legal and regulatory requirements**
- **Organization and responsibilities**
- **Safety culture**
- **Training and qualifications**
- **Resources and staffing levels,
Contractor support**
- **Schedules**



Decommissioning Plan – Waste Management

- Identification of individual waste streams
- Characterization of waste streams
- Procedures
 - Waste handling
 - Packaging
- Calculations
 - Correlation factors
 - Waste volume estimates by type
 - Transportation
- Waste disposition



Decommissioning Plan - Cost Estimate and Funding Mechanism

- **Cost Estimate**
 - **Base on Decommissioning Project Work Breakdown Structure activities and schedule**
 - **Includes labour, expense and capital**
 - **Develop appropriate contingency**
 - **Identify all assumptions**
- **Funding Mechanism**
 - **Detail funding collection process throughout life**
 - **Identify contingency funding**
 - **Develop cost estimates for contingency restart**



Project Initiation

- **Project initiation begins when the decision is made to permanently shut down a facility and proceed to implementation of the decommissioning strategy.**



Project Initiation

- **Key tasks for project initiation include:**
 - **Planning the transition of the existing staff from operations to decommissioning**
 - **Setting up a management organization**
 - **Evaluating whether to use outside Contractor or to self-perform the project**
 - **Identifying resources and how to obtain them**
 - **Performing preliminary site characterizations to bound the scope of the work**
 - **Preparing baseline cost and schedule estimates to monitor and control expenditures**
 - **Evaluating fuel disposition options**



Transition Phase Activities

- **Following permanent shutdown of the facility, the activities necessary to prepare the facility for decommissioning are begun. These activities include:**
 - **Site characterization**
 - **Regulatory notifications and any required initial public interactions**
 - **Implementation of revised safety and authorization bases**
 - **Staff reorganization**
 - **Bid specification preparation – as appropriate**



Development of the Work Breakdown Structure (WBS)

- **Categorize cost elements and work activities into logical groupings**
- **Identify direct or indirect relationships**
- **Work groupings**
 - **Typically related to the accounting system used for budgeting**
 - **Track major elements against decommissioning costs**
- **WBS elements**
 - **Generally arranged in a hierarchical format**
 - **Top level of the WBS is the overall project**
 - **Subsequent levels used to track increasing levels of detail in the project**



Work Breakdown Structure

- **WBS element levels**
 - **Six levels may be adequate for a single decommissioning project**
 - **Decommissioning programs with multiple projects may use 8 or more WBS levels**
 - **Costs may be "rolled up" to Level 3 or Level 4 summary costs for management information**
- **Project management/ accounting software**
 - **Usually identifies categories of costs**
 - **Compares to the chart of accounts**
 - **Integrates WBS format for project reporting**



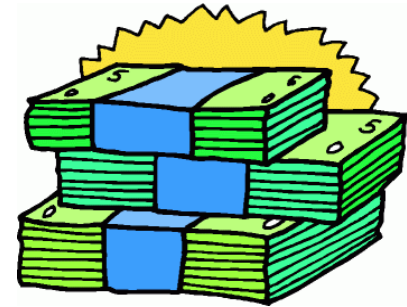
Levels of Cost Estimating

- There are different levels of “Accuracy” used when performing a decommissioning cost estimate
- Typical levels of accuracy in cost estimates are:
 - Order of magnitude -30% to +50%
 - Based on similar project scope
 - Budgetary -15% to +30%
 - Use some drawings but not site specific
 - Definitive -5% to +15%
 - Site specific and very detailed; based on drawings and a detailed review of required activities and their costs



Contents of a Cost Estimate

- **Description of the overall facility**
 - Portions included in the cost estimate
- **All assumptions**
- **Summary of information by major task**
 - **Cost**
 - **Man-hours and labor categories**
 - **Staffing levels**
 - **Waste volumes**
 - **Uncertainties**
 - **Contingencies**
 - **Backup details on development of cost to allow independent review**
 - **Funding mechanisms**



Project Scheduling

- **Project schedule**
 - **Developed during project planning**
 - **Based on a WBS approach**
 - **Integrates resources, cost and activity duration**
 - **Requires graphical output**
- **Critical activities**
 - **Plan and coordinate lead time for resources**
 - **Schedule budget to ensure activity success**
- **Identify key elements (i.e. waste shipments)**
 - **Make a detailed list of tasks for each key element**
 - **Tie each line item in the schedule to resources and duration to complete the task**

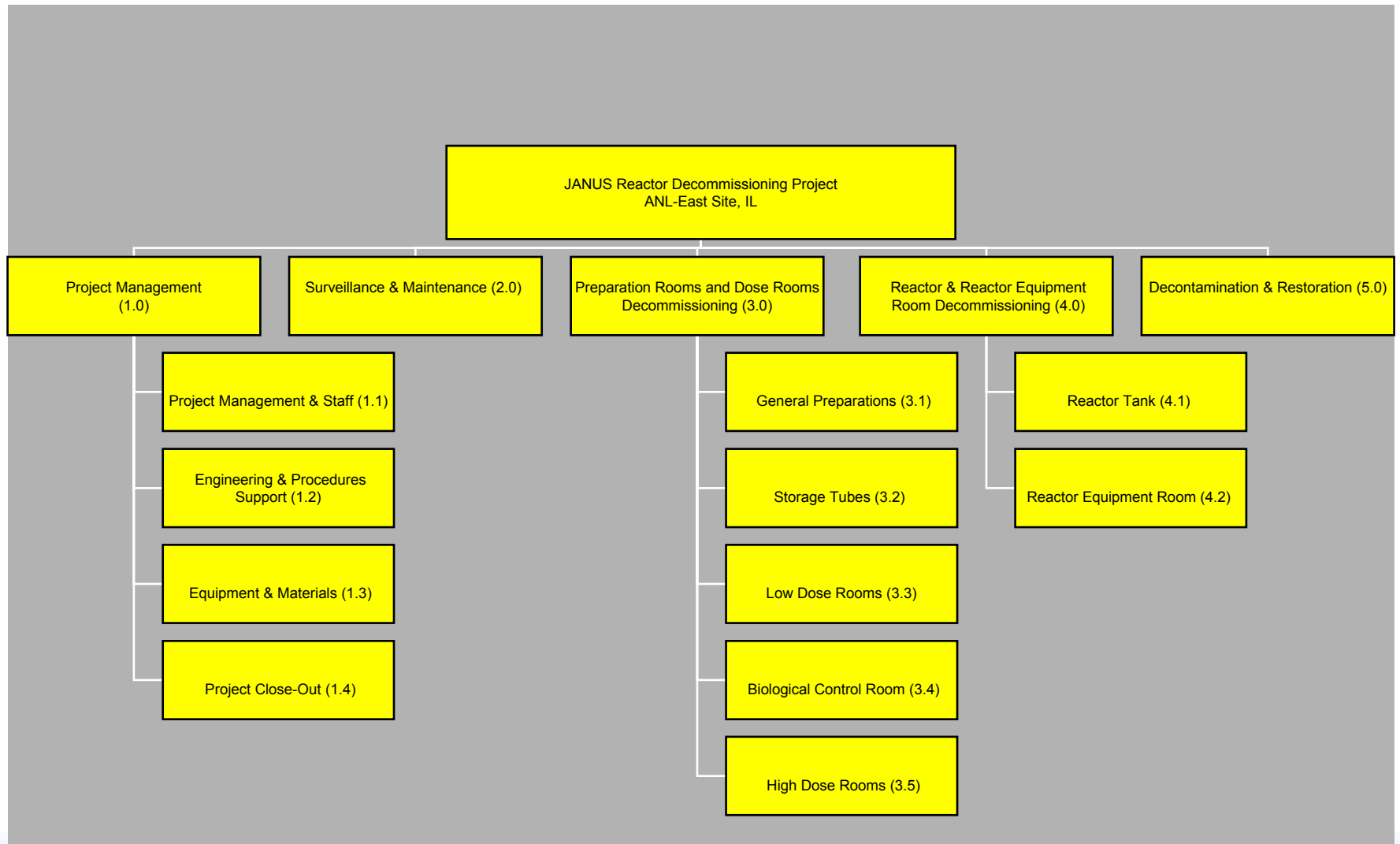


Project Scheduling

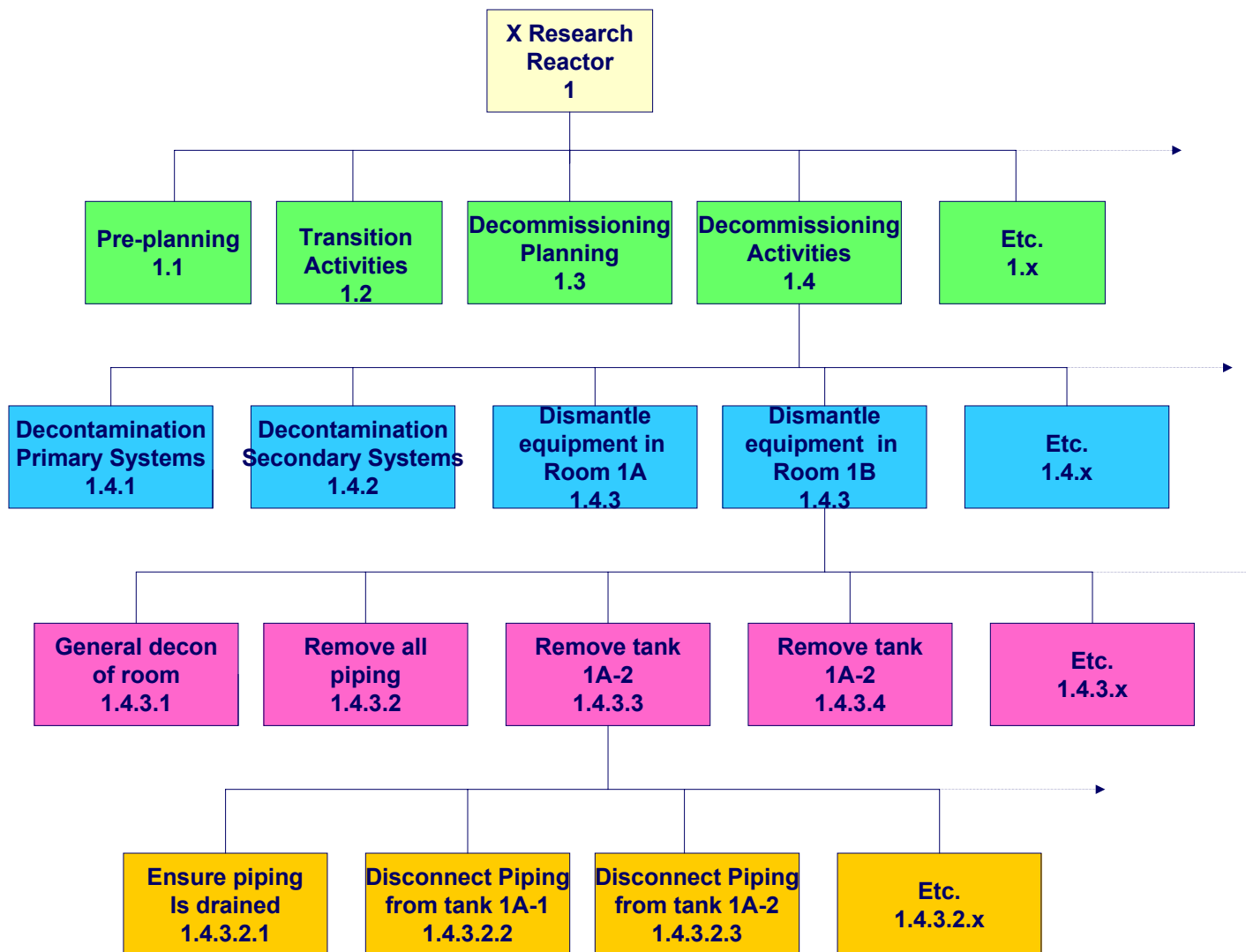
- **Specific elements in a project schedule may include:**
 - **Preliminary site characterization**
 - **Safety assessment and licensing documentation**
 - **Preparation of the Decommissioning Plan**
 - **Obtaining required permits and approvals**
 - **Facility design/ engineering/ modifications to support decommissioning**
 - **Decontamination**
 - **Dismantlement and demolition**
 - **Waste management**
 - **Final radiological survey**
 - **License termination actions**



Research Reactor Decommissioning – WBS Example



Example of a WBS to Level 5



Example WBS Based Schedule

WBS #	Task Name	Labor Hours (x 1000)	Budget (includes labor) (x 1000€)	T = - 3 Months	T = 0	T = 3 Months	T = 6 Months	T = 9 Months	T = 12 Months	T = 15 Months	T = 18 Months	T = 24 Months	
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=3 to T=18]									
1.4.1.1	Decon/Remove Auxiliary Systems		870			[Gantt bar from T=6 to T=15]							
1.4.1.2	Decon/Remove Reactor Systems		870				[Gantt bar from T=9 to T=18]						
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=24]	
1.5.1	Non-radiological remediation		25									[Gantt bar from T=24 to T=24]	
1.5.2	Demobilization		5									[Gantt bar from T=24 to T=24]	
1.5.3	Closeout Documentation		5									[Gantt bar from T=24 to T=24]	



Cost Estimating Considerations

- Provisions to protect the workers
- Provisions to protect the environment
- Regulatory framework within which the decommissioning must be performed
- Project management staff of both the licensee & the decommissioning contractor (if one is used)
- Radioactive waste disposal or storage sites
 - Low, intermediate and high-level wastes
 - Transportation

Black box / general cost estimates do not work !!!



Some Practical Considerations

- **You will likely encounter**
 - **Different fabrication techniques and materials of construction than shown in records**
 - **Inaccurate and missing drawings**
 - **Different radiological conditions and/or other hazards**
 - **Accessibility issues (structural obstructions, radiological hazards, etc)**
- **Have a plan and work the plan**
- **Evaluate alternative approaches to undertake the work – self-perform or contract out**
- **Poor planning often leads to major schedule and funding issues for the management staff – scope, cost and schedule**



Some Practical Considerations

- Consider select staff augmentation or use of independent experts to support the work even if contracting or self-performing
- Don't 'under characterize' the site or facility
- Don't overlook any regulatory hold or reviews in scheduling work
- Don't 'rush to action' – sometimes 'to go fast you need to go slow'
- **Review project specific examples from two decommissioning project sites**



Summary

- Decommissioning is an orderly, phased final step in the life of a nuclear facility
- Focus on the shutdown/ transition is a key step in the decommissioning process
- Planning for decommissioning is an ongoing process
- The Decommissioning Plan is the single document that captures information for the project
- Project schedule, controls and execution were discussed with respect to project planning
- Numerous IAEA reference documents are available

Failing to plan is planning to fail!



References

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