Safety Considerations in the Transition from Operation to Decommissioning of Research Reactors

Research Reactor Safety Section
Division of Nuclear Installation Safety

IAEA- EBP Workshop on the Transition Period – R2D2
12-16 November 2007, Australia

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International Atomic Energy Agency

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Introduction(1/2)

- Stages in the lifetime of research reactors are:
  - Siting;
  - Design;
  - Construction;
  - Commissioning;
  - Operation; and
  - Decommissioning.
- The decommissioning is a complex process which involves "Administrative and technical actions taken to allow the removal of some or all of the *regulatory controls* from a *facility*".

IAEA Glossary

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Introduction(2/2)

- The operating organization is responsible for the safety for all stages of research reactors, including decommissioning. This responsibility *"shall be terminated only with the approval of the regulatory body"- NS-R-4.*

- A criteria for the release of decommissioned research reactors from the regulatory control shall be established (Code of Conduct on the Safety of Research Reactors).

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Transition period in the decommissioning process: General (1/3)

- Transition period: time between the permanent shutdown of the facility and the start of implementation of the decommissioning strategy.

- This period involves some routine operations and other activities with safety implications.

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Transition period in the decommissioning process: General (2/3)

- This period normally considered to be part of the operational phase (covered by the operating license conditions).

- The IAEA Safety Standards (SS) require review and approval of the regulatory body of activities performed during the transition period.

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Transition period in the decommissioning process: General (3/3)

- Extended shutdown period should be avoided.
- Significant level of risk is associated with decommissioning activities performed in the transition period during removal of spent fuel.

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Activities and safety issues in the transition period (1/2)

- Activities in the transition period should be aimed at reducing the nuclear and radiological hazards.

- Organizational and administrative activities in the transition period include:

  - Changes to the organization chart, including establishment of decommissioning teams;
  - Establishment of interfaces with different groups involved;
  - Preparation of the final decommissioning plan;
  - Collection of important reactor documentation and establishment of an effective record keeping system.

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Activities and safety issues in the transition period (2/2)

- Main activities of safety concerns during the transition period include:
  - Handling and temporary storage of spent fuel;
  - Drainage of systems;
  - Estimation of the radioactive material inventory;
  - Systems removal or reconfigurations and planning for installation of new systems.

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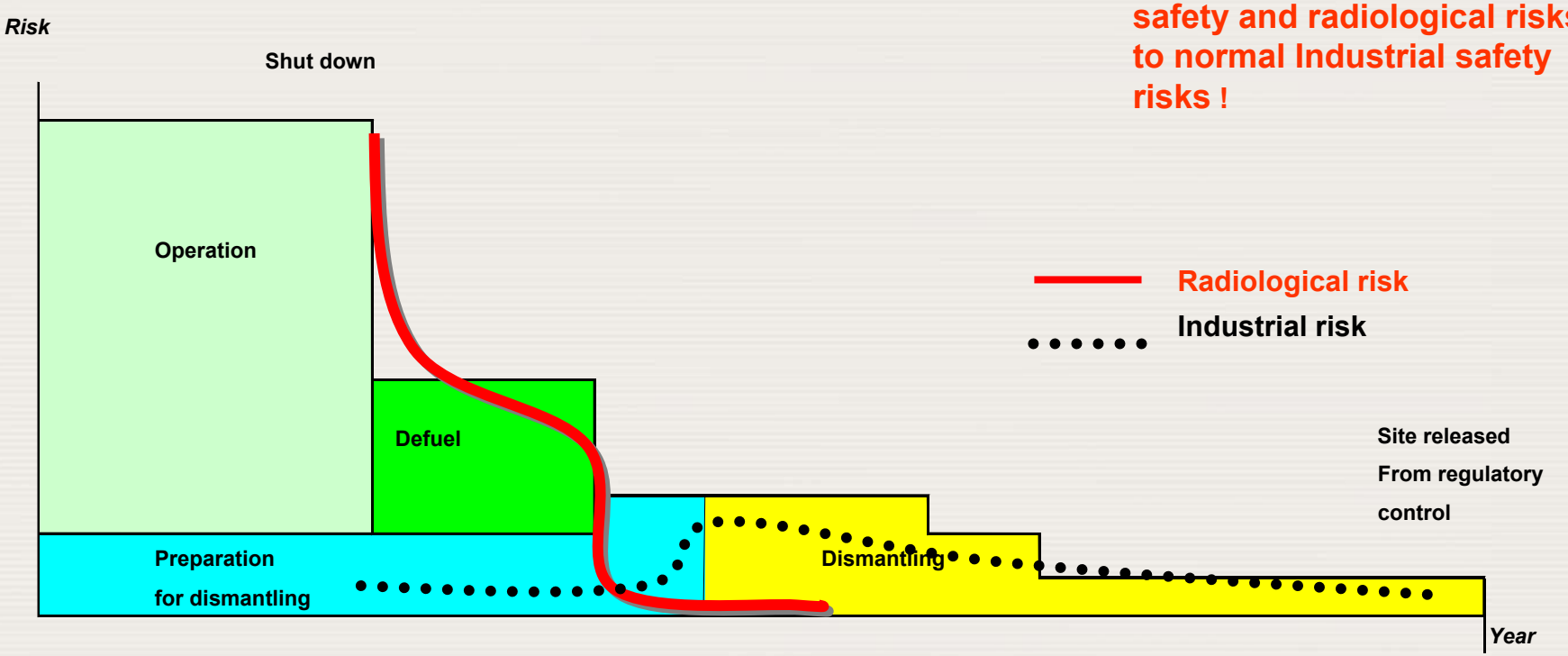
Risks during decommissioning

During decommissioning risk changes from reactor safety and radiological risks to normal Industrial safety risks !



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Handling and storage of spent fuel (1/4)

- As a first priority, the core should be unloaded and the spent fuel is stored at the spent fuel storage.
- Fuel handling Postulated Initiating Events (PIEs) that were considered for the normal operation phase should be re-assessed.
- The safety analysis should be revised to include any PIEs involving spent fuel that were not previously considered.
- PIEs involving spent fuel include:
  - Criticality;
  - Loss of spent fuel storage cooling;
  - Loss of water from the storage pool;
  - Transfer cask or heavy load dropping accidents;
  - Loss of off-site electrical power.

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Handling and storage of spent fuel (2/4)

- Prior to transfer of the spent fuel to storage pool:
  - Verification of the fuel storage capacity (storage racks, criticality, cooling capacity, etc.);
  - Inspection of the spent fuel pool and storage racks (to check existence of cooling channels and acceptable geometrical tolerances for storage racks);
  - Approved operational procedures (and operators trained in their use) should be in place.

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Handling and storage of spent fuel (3/4)

- During storage in the spent fuel pool:
  - Water chemistry parameters should be kept within specifications.
  - Periodic verifications, by inspection, of the status of the spent fuel.
  - Sub-criticality features and devices, criticality monitors, and radiological protection monitors should be kept operational.
  - Specific procedures should be established if a fuel element becomes stuck in the storage rack.
  - Movements of the crane and its speed should be limited.

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Handling and storage of spent fuel (4/4)

- Fresh fuel should be stored and handled according to the procedures used for the normal operation phase.
- For fresh fuel, Inspection and transport procedures similar to those of spent fuel should be used.
- Significant reduction of safety concerns is achieved when the fuel is evacuated from the reactor facility.

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Systems drainage and isolation(1/2)

- Partial drainage or isolation of a SSC should not affect the function and operability of the other remaining systems.

- Assessment is needed to ensure that system drainage will not result in increase of radiological exposure (e.g. caused by loss of shielding).

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Systems drainage and isolation(2/2)

- Attention should be given to the management of radioactive waste generated from drainage of systems.
- The drainage sequence should be carefully analyzed to ensure that there is no impact on the systems to be kept operational.
- Updating of facility and system drawings, operating procedures.

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Reactor systems in the transition period (1/3)

- Three categories:
  - Systems to be kept operational or need to be modified to support decommissioning;
  - Systems to be removed from service;
  - New systems to be installed to support decommissioning (waste management facilities, handling facilities, etc.).
- A system for categorization of the reactor modifications according to their safety significance should be established.

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Reactor systems in the transition period (2/3)

- Examples for systems to be kept operational or modified include:
  - Instrumentation and control,as needed;
  - Radiological protection systems;
  - Electrical power supply;
  - Ventilation system;
  - Radioactive liquid discharge systems;
  - Solid waste packaging and handling systems;
  - Handling facilities (e.g. crane);
  - Fire protection system;
  - Emergency signs and lights;
  - Lightening protection system;
  - Physical security system.

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Reactor systems in the transition period (3/3)

- I&C for the removed systems should be disconnected from the control room panel (to avoid confusion).
- Special considerations should be given to those devices to be taken out of operation containing fissionable material (e.g. fuel testing rigs), and highly radioactive samples.
- The OLC should be modified (to focus on surveillance and maintenance).
- The operating procedures and maintenance schedules need to be revised to reflect the actual status of the facility.

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Estimation of the radioactive material inventory

- Earlier evaluation of radiation sources of the facility should be validated. This inventory will be the base for:
  - Revising the radiological protection programmes;
  - Radioactive waste classification;
  - Selection of dismantling techniques;
  - Commencement of decommissioning activities;
  - Estimation of the cost.
- Validation methods include sampling, measurements of radiation fields, and calculations.

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Other operational activates in the transition phase

- Other operational activities include:
  - Cleaning and decontamination of reactor systems and structures;
  - Conditioning and removal of operational waste;
  - Development of safety analysis for decommissioning period.

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Safety documentations for the transition period

- Safety documentation that need revision include:
  - SAR;
  - Decommissioning plan;
  - OLCs;
  - Radiological protection programme;
  - Emergency plan;
  - Environment Impact Assessment
- These documents need to be revised to reflect the actual status of the reactor facility during the transition period and decommissioning phase.

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Decommissioning plan (1/2)

- A decommissioning plan should be developed early in the research reactor operation phase.
- This plan should be revised and amended, as necessary during the reactor life time.
- Before commencement of decommissioning activities, the final version of the plan should be developed. It should be reviewed by the reactor safety committee before submitting it to the regulatory body for review and approval.
- The plan should include evaluation of one or more decommissioning options.

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Decommissioning plan (2/2)

- Typical decommissioning plan includes (IAEA SR 45):
  - Introduction
  - Description of the facility
  - Decommissioning strategy
  - Project management
  - Decommissioning activities
  - Surveillance and maintenance
  - Waste management
  - Cost estimate
  - Safety assessment
  - Environmental assessment
  - Health and safety
  - Quality assurance (Integrated management system)
  - Emergency planning
  - Physical security
  - Final radiological survey

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OLCs

- The OLCs for operation phase need to be kept during the transition period (except those that only apply for operation at power).
- The OLCs that involve spent fuel need to be kept as long as the spent fuel is stored in the reactor facility.
- Some of OLCs used for operation phase may need to be kept (e.g. dose limits, action levels, discharge limits, etc.)
- Limits and conditions (LC) for the transition phase should be developed based on results of the revised safety analysis.
- Limits and Conditions involving non-radioactive material need to be revised or established).

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Radiological protection programme

- Items to be revised to conform the transition period and decommissioning period include:
  - Working area classification;
  - Workplace air sampling programme;
  - Contamination programme control;
  - Internal and external exposure monitoring;
  - Radiological protection procedures (use of protective equipment, procedures for new activities).

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Emergency plan

- The emergency plan which exists at the end of operation phase can be used as a basis.

- Potential items for revision:

  - Modifications in operational arrangements concerning emergency response due to specific activities of the transition period;
  - Procedures for emergency response;
  - Emergency equipments and their maintenance schedules;
  - Requirements for operators training and emergency exercises.

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Conclusion

- From the safety point of view, the transition phase is an important step in the decommissioning of Research Reactors.

- The duration of the transition period should be optimized taking into account the activities to be carried out and the associated safety issues.

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THANK YOU FOR YOUR ATTENTION!

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