



International Atomic Energy Agency

Overview of Safety Considerations in Extended Shutdown

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Background

- **In the last 20 years, some 367 research reactors have been shutdown. Of these, around 110 have undergone or started decommissioning. The rest are in extended shutdown with no clear decision having been made regarding either their return to operation or decommissioning.**

Issues Arising

- **Loss of corporate memory**
- **Personnel qualification**
- **Maintenance of components and systems (including obsolescence)**
- **Preparation and maintenance of documentation.**

Reasons for Extended Shutdown

- **Need to carry out modifications**
- **Need to refurbish as part of life extension**
- **Need to repair structures, systems or components**
- **Need to remedy technical problems**
- **Regulatory or public concerns**
- **Local conflicts (wars)**
- **Political requirements**
- **Lack of resources**

Preservation for Future Operation

- **There are two basic options available preserving the facility ready for return to operation at some time in the future:**
 - **If the foreseen duration is short, continue to perform the usual maintenance and inspections as stated in the OLCs.**
 - **If the duration of shutdown is not clear, mothball the facility.**
 - **If the foreseen duration is neither**

Planning: General Considerations

- **What systems will be taken out of operation or temporarily dismantled?**
- **What procedures are needed to disconnect, dismantle and repair these systems?**
- **What modifications are needed to the SAR?**
- **What are the staff and shift needs?**
- **What are the requirements for periodic testing and maintenance?**
- **What arrangements are needed for updating documentation (drawings, operating procedures, etc)?**
- **What changes are required to the emergency planning arrangements?**

Planning: Preventing Criticality

- **Prevention of inadvertent criticality during extended shutdown is perhaps more important than during normal operation as the fuel may be in a non-normal configuration with reduced safety system availability.**
- **Safety measures include rearranging the core, inserting additional neutron absorbers, disabling the reactivity control system, and adopting new administrative measures.**

Planning: Preparation for Extended Shutdown

- The aim is to establish a safe extended shutdown period with some relief from the normal operating regime
- Determine what systems are going to be affected and how they will be affected

Planning: Potentially Affected Systems

- **Ventilation**
- **Site utilities (electricity, water, air, heating)**
- **Radioactive liquid waste discharge**
- **Water purification**
- **Radiation monitoring (on and off site)**
- **I&C systems**
- **Emergency power**
- **Fire protection**
- **Communication and physical protection**

Planning: Maintenance and Periodic Testing

- **During an extended shutdown, changes can be made to certain maintenance activities and periodic testing where the activity is based on operating time or power generated.**
- **Modification of the programme and related procedures will be necessary.**
- **Additional inspections not included in the original OLCs may be possible.**
- **Inspections should ensure they are able to identify degradation of mechanical and electrical systems.**

Planning: Human Resources

- **Staff will need to be trained in the activities to be undertaken as part of the extended shutdown.**
- **Measures need to be in place to ensure that there is minimal loss of operating experience and knowledge of the reactor facility.**
- **The operating organisation needs to ensure that it has a sufficiently well trained workforce available to restart the reactor at the end of the extended shutdown.**

Planning: Preparation of Documentation

- **A report needs to be prepared for the local safety committees and the regulatory body.**
- **The report should include:**
 - **The plan for the extended shutdown and its projected duration**
 - **An overview of the facility's present status**
 - **An evaluation of the facility's status during the extended shutdown demonstrating its continuing safety**
 - **A list of systems to be disconnected together with the measures to be implemented to protect against deterioration**

Planning: Quality Assurance

- **The planning of the extended shutdown must include appropriate QA requirements. These demonstrate and ensure that adequate arrangements are in place to maintain the reactor in a safe state over the course of the extended shutdown**

Planning: Regulatory Aspects

- **The regulatory framework must be reviewed to determine the implications for licensing.**
- **For some Member States, existing regulations may not specifically address extended shutdown.**
- **A early dialogue with the regulator should take place.**

Implementation: General Considerations

- **Systems taken out of service are identified and removed from service in a logical manner.**
- **The status of the system is clearly indicated to all personnel.**
- **Appropriate instructions are available for all actions.**

Implementation: (No implications for OLCs)

- **The simplest management system for extended shutdown is to maintain compliance with all applicable OLCs.**
- **Equipment continues to be maintained in accordance with the requirements of the OLCs.**
- **Personnel retain their operating qualifications by maintaining their training and re-training programme.**

Implementation: (Implications for OLCs)

- **Revision of any OLCs will require justification and approval from the regulatory body.**
- **Changes to the safety analysis report are therefore likely to be needed.**
- **Operating and maintenance personnel will require re-training to use the modified instructions.**

Implementation: Reassessment Review

- **During the period of extended shutdown, the safety of the measures implemented needs to be periodically assessed.**
- **A review might take place annually, similar to that used during normal operation.**
- **If the extended shutdown is likely to significantly overrun its initial schedule, an additional review should be undertaken.**

Implementation: Documentation

- **All documentation necessary to demonstrate that the work has been properly carried out, that the disconnected systems have been properly looked after, and that the facility is ready to return to normal operation on completion of the work should be kept.**

Implementation: Radiation Protection

- **A radiation monitoring and control programme must remain in place during the period of extended shutdown.**
- **The programme should be modified to ensure the safety of staff carrying out their modified duties and take into account unavailability of disconnected systems (including installed radiation protection and monitoring systems).**

Implementation: Physical Protection

- **During all times when fresh or spent fuel is stored within the facility, adequate physical protection measures must be maintained.**
- **These measures must take into account the activities of the extended shutdown.**
- **If fuel is transported to another facility, adequate physical protection measures must be in place.**

Implementation: Regulatory Aspects

- **The regulator should make regular inspections of the work being undertaken as part of the extended shutdown.**
- **The purpose of these inspections is to confirm that the approved extended shutdown plan is being implemented and the necessary safety requirements are being met.**

Return to Operation: (No implications for OLCs)

- **Prior to returning to normal operation, the operating organisation submits to the regulator a report describing:**
 - **The extended shutdown (work carried out, systems disconnected)**
 - **The provisions put in place for the maintenance of adequate personnel skills and knowledge.**

Return to Operation: (Implications for OLCs)

- **When OLCs are modified for the duration of the extended shutdown, additional information needs to be provided to the regulator showing that all relevant systems and components have been subject to a level of re-commissioning and testing equivalent to that carried out during initial commissioning of the reactor.**

Return to Operation : Responsibilities of Operating Organisation

- **The operating organisation should provide:**
 - **A review of the operational status of the reactor systems, particularly those that may have been modified during the extended shutdown**
 - **Verification of the adequacy of the staff including qualification and training**
 - **A safety evaluation which includes the return to normal operational conditions**
 - **A re-commissioning plan**
 - **A report containing the results of the work that necessitated the extended shutdown.**

Return to Operation : Regulatory Aspects

- **The return to normal operation may require formal approval or authorisation from the regulatory body.**
- **The decision to permit return to normal operation will depend on the documentation supplied by the operating organisation.**