

Principles of Nuclear Safety

Module 17

MAINTENANCE

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Why must maintenance be strictly controlled?

Review & approval required to ensure:

- system reliability and effectiveness continues to meet safety analysis assumptions
- continued personnel & public safety
- safety and production risks acceptable

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Maintenance OP&P

“Maintenance at the nuclear facility shall be of such a standard that, in the opinion of the Board, the reliability and effectiveness of all equipment and systems as claimed in the Safety Report and the documents listed in the application are assured”

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When is AECB Maintenance Approval Required?

- non-standard work on special safety systems, which does not place components in the safe state, with reactor in GSS
- work on IAEA nuclear safeguard installation

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Operations Manager's Approval Requirements

- maintenance policies
- maintenance on safety related systems, including compliance monitoring equipment
- non-standard maintenance procedures
 - eg, approved work practices
- maintenance requiring AECB involvement

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When is SS Maintenance Approval Required?

- safety related systems (others at SS's discretion)
- SS approval entails review for:
 - adequate priority on maintenance
 - no license/OP&P violations
 - impact on safety (3 C's) and production
 - any required notifications made/approvals obtained
 - any applicable constraints satisfied

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Constraints on SS Maintenance Approvals

- **benefits outweigh risks incurred**
- **Unit/station operating conditions appropriate**
- **system/component placed in preferred state**
- **use of qualified staff**
- **special requirements re SSS channels:**
 - **OP&P constraint**
 - **independence by using different staff**
- **testing prerequisite to return to service**
- **adherence to design specifications**

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Unit & Station Operating Conditions

- **state must be appropriate for the proposed job**
 - **controls in place to maintain that state**
 - **the SS has the overview of the station**
- Examples:**
- **unit stable for discretionary maintenance**
 - **unit in GSS for SDS maintenance**
 - **unit at high power for RRS maintenance**
 - **some SDS parameters cannot be tested under shutdown conditions**

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Place System/component in its safe state where applicable

Examples:

- rejecting a channel on a special safety system
- placing a valve in its fail-safe position
- jumpering contacts to the safe state

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Special Requirements for SSS Channels

- OP&P constraint: *"...put in a safe state, repair, test, and return one channel to service prior to working on another channel."*
- Prevent multiple, common cause failures on channels:
 - use different persons to do same job on each SSS channel
 - » prevent level 2 or 1 impairments resulting from same human error repeated on more than one channel
 - preferably persons from different crews
 - » eliminates supervisor as common source of human error
- Use Special Safety System qualified staff

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Adherence to Design Specifications

- Failure to apply specified codes and standards invalidates the safety analysis

Method of achieving adherence in practice:

- SS confirms appropriate reviews/approvals
- Use qualified staff following approved procedures
- Post-maintenance verification
 - via Supervisory verification and prescribed performance tests
 - Ensures that system performance meets standards credited in safety analysis

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ANO Maintenance Approval

- ANO approves all maintenance on his/her unit
- reviews for possible effects on capability to monitor and control unit under current operating conditions

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Pressure Boundary Maintenance

DEFINITION:

- design pressure > 103 kPa(g)
- includes work on piping, vessels & supports welded thereto
- *not* direct replacement of gaskets, seals, glands, pump shafts or valve stems

SPECIAL REQUIREMENTS to PERFORM:

- special documentation package
- certified welders using approved procedures and materials
- approved testing/inspection by certified QC Technicians

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SS's Pressure Boundary Responsibilities

- to notify MCCR & AECB promptly of rupture
- to ensure all repairs, modifications, examinations and testing done by qualified staff using approved procedures & materials
- to verify regulatory requirements met prior to return to service
- to ensure documents prove compliance

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MCCR Approval Requirements

- to begin *major work* (welding) on a pressure boundary
- to return pressure boundary to service after repairs
- welding and non-standard repair procedures
- non specification component replacement
- hydrostatic or pneumatic testing
- Welder & QC Technician qualifications
- registration of pressure boundary design

MCCR must be notified promptly of any pressure boundary rupture

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Foreign Material Exclusion Controls

- established when critical systems are opened
 - for both safety and economic reasons
 - consist of restricted access, material accounting, internal inspections

Examples:

- HTS, to prevent channel blockage, corrosion or erosion damage
- Generator, to prevent core damage from metallic debris

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Nuclear Code Classified Systems

- Nuclear systems piping and equipment are classified as nuclear class 1, 2 or 3 (NC1, NC2 or NC3)
 - eg, PHT components whose failure would result in a LOCA are NC1
- material requirements per NC1, 2 or 3 *must* be met to preserve integrity of safety analysis
- Materials in classified systems are documented to:
 - prove compliance with material requirements per the classification
 - make them traceable in the event of unforeseen problems with a certain material

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Specially Qualified Systems

- Some systems are qualified to function for a specified mission time under stressful conditions
 - *seismic qualification* refers to ability to function during and after an earthquake
 - *environmental qualification* refers to ability to function in a specified environment, such as LOCA or steam
- If system qualification is not preserved during maintenance, then safety analysis is invalidated and nuclear safety compromised

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