Commissioning Experience for Reactor and Primary Cooing System of Jordan Research and Training Reactor (JRTR)

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KAERI
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- Walk-down and Flushing
- System Performance Test and Reactor Performance Test
- Commissioning of RSA and I&C
Introduction
Objective - Commissioning

- To **install** the RSA and connected systems
- To **prepare** SPT, PSI, IST, and RPT: Walk-down, Flushing
- To **check** the performance of system
  - To measure the system flow rate and pressure drop
  - To check function of pumps, flap valves and siphon break valves
  - To check alarm, lamp and interface
  - To fill the fresh resin
  - To form Initially hot water layer
Reactor Cooling and Connected Systems
System Classification

Classification

- Safety class 3
- Seismic class I
- Quality class: Q

Applicable code: NS-R4 of IAEA

KEPIC MND, 2005 edition and 2006 addenda
ASME Section III, Subsection ND, 2004 edition
Walk-down and Flushing
Walk-down and Closed Loop Flushing

- **Walk-down**

  - PCS room
  - PWMS room

- **Closed Loop Flushing**

  - Water flushing: Strainer mesh, PCS, PWMS, HWLS, EWSS
  - Air flushing: Lint-free cloth, HWS
Open Loop flushing and Preliminary Test

• Open Loop Flushing

• Preliminary Test (Flow rate and Pump Operation)
System Performance Test
Objective

• This test is to measure the system flow rate and pressure drop of Primary Cooling System (PCS) and check function of PCS pumps, flap valves and siphon break valves. This test is also to check alarm, lamp and interface check.
Acceptance Criteria

• PCS Pump Performance – two pump operation
  • Pump performance shall comply with KEPIC MOY (In-Service Test of Pumps)
  • PCS Pumps shall be operated at least 2 hours to measure the operation parameters in order to make the system stable.
  • The NPSH margin (NPSHa/NPSHre)

• PCS Pump Performance – one pump operation
  • PCS pump shall not be rotated in the reverse direction with the anti-reverse rotation device (ARRD) when the reverse flow is occurred.

• PCS Pump Performance – Interlock
  • If any one of isolation valves HCV-001 at the upstream of PCS pump PP-001 and HCV-003 at the downstream of PCS heat exchanger HX-001 is closed, PCS pump PP-001 shall not be started when the hand switch HS-001 is turned to “ON”. This operation status shall be displayed on the OWS.

![Isolation valve](attachment:image)
**Siphon Break Valve**

- **Experiment and CFD analysis for Siphon Break Design**

<table>
<thead>
<tr>
<th>Siphon break line size (inch)</th>
<th>Two phase model</th>
<th>Turbulence model</th>
<th>Numerical Undershooting height (m)</th>
<th>Experimental Undershooting height (m)</th>
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<td>SST model</td>
<td>Siphon break is failed</td>
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</table>

**Experiment**

- **Water volume fraction**
- **Pressure distribution**

**CFD analysis**

- **Undershooting height**

**Camera Region**

1. Region 1
2. Region 2

**Experimental facility**

- Line for 10” pipe break

**Butterfly Valve**

- **Region 1**
- **Region 2**

**10” pipe break**

**Experimental facility**

- **10” pipe break**
Acceptance Criteria

- **Siphon Break valve - interlock**

- Siphon break valves shall be opened automatically by the signal of the RPS Lo-Lo-Lo pool water level.

- These siphon break valves shall be opened when the PCS flow is reduced to the Lo-Lo flow.

- Siphon break valves shall be opened when the supply of compressed air or electricity is failed.

- Each hand switch is used to manually open the valves by an operator in the MCR and SCR.
**Flap valve & Flywheel**

- **Residual heat cooling by natural circulation**

- The coastdown flow rate shall be maintained above the required flow rate after the electrical power supplied to two PCS pumps is cut at the same time.

**QME-1 test**
1. Leakage test
2. End load test
3. Seismic test
4. Flow reversal test

\[ I_p \frac{d\omega}{dt} + M = 0 \quad (M: \text{friction torque} + \text{hydraulic torque}) \]

\[ I_p \frac{d\omega}{dt} + C\omega^2 = 0 \quad \left( C = \frac{M_{ss}}{\omega_{ss}} \right) \]
PWMS & HWLS

- Pump test
- Flow rate
- Storing and refilling of reactor pool water
- Filling of the fresh resin

- Pump and heater test
- Flow rate
- Initial forming of Hot Water Layer
- Makeup flow rate
- Filling of the fresh resin
- Helium leak test, Heavy water filling and chemical property check, Canned pump test, Main and purification flow rate

HWS I/X

Leak test

HWS Pump / Heat exchanger / Expansion tank

HWS expansion/ collection tank level and pressure

HWS pump performance test
Commissioning of RSA / I&C
JRTR Reactor Package

- Reactor Assembly
  - Reactor Structure Assembly
  - Beryllium Reflector Assemblies
  - CRDM
  - SSDM
  - Neutron Detector Housing
  - Gamma Detector Housing
  - Dummy Fuel Assembly

- Beam Port Assemblies
- Thermal Column Assembly
- Special Tools
JRTR Reactor Package

- Pre-service inspection
- Manufacture, installation and Test
- CRDM and SSDM Performance test
- Special Tool Performance test
- Inner shell /Be inspection and measurement

RSA inspection using under water camera

Inner shell /Be inspection and measurement
Operation in MCR

- Simulator development for training
  - Normal Operation
    - Shutdown check, fluid system ON
    - Rx Startup, manual control, and approach to criticality
    - Power ascension, full power operation, and shutdown
  - Abnormality Handling during Operation
    - PCS pump failure
    - Loss of Electric Power
    - Loss of Coolant Accident
    - Loss of Heat-Sink
    - RPS CMF + LOCA
Thank You