Ageing Management and SSC’s Improvements at IRR1

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Israeli Research Reactor-1

- First criticality: July, 1960
- Reactor type: MTR, HEU (93%), Swimming Pool type
- Power: 5 MW
- Moderator + Coolant: H₂O
- Utilization: Industrial neutron radiography; Neutron diffraction; Activation analysis; Nuclear physics and health physics research; Students educating, public education and awareness.
“In practice, the ageing management program at a research reactor is accomplished by coordinating existing programs, including maintenance, periodic testing and inspection programs” [IAEA SSG-10]
Management system (RMCP-Reactor Management Computerize Tool)

- Monitoring staff training, authorizations, enrichment activities etc.
- Special equipment monitoring: calibration of measurement equipment and equipment status.
- Quality assurance (management system) of documentation (procedures, drawings etc.).
- Maintenance management and equipment data base.
- Analyzing database and help in planning future actions.
RMCP maintenance module examples

- Annual preventive maintenance reminders
- Equipment database
- Statistics

corrective maintenance by system
Maintenance and periodic testing

Operational status

- Maintenance
- Periodic testing
  - Routine
    - Monthly
    - Quarterly
    - Annually (per sys)
  - Non-Routine
    - Corrective maintenance
    - System Upgrade
    - System Replacement

Operation engineer
- Periodic testing
  - Pre-operational
  - Monthly check-up
  - Quarterly check-up
  - Semi-annual check-up
  - Annual check-up

Maintenance supervisor
- Reactor manager’s approval
“In practice, the ageing management program at a research reactor is accomplished by coordinating existing programs, including maintenance, periodic testing and inspection programs” [IAEA SSG-10]
Inspection and peer reviews

- Safety Division of SNRC
- IAEA INSARR
- Domestic peer reviews
- Safety Committee
- Nuclear Regulatory Body

- Organizational: Twice a year
- National: ~once every two years
- International: quarterly
"In practice, the ageing management program at a research reactor is accomplished by coordinating existing programs, including maintenance, periodic testing and inspection programs” [IAEA SSG-10]

- Safety infrastructure upgrades
- Systems and components improvements
- Revision of procedures
Lessons learned from Fukushima Daiichi accident

Fukushima accident has catalyzed interface-procedures in reactor licensing process. Major benefit to aging-management is an agreed-upon action-plan, involving both the regulator and the facility, based on IAEA SRS-80:

- Complementary operational procedures.
- Installation of accelerometer for triggering automatic shutdown.
- Dynamic analysis of key systems.
- Upgrade of Electrical and Water-Supply system.

* Int. Conf. on RR Safe Management and Effective Utilization, Vienna, Nov. 2015.
Implementation - Example #1
Renewal of flow regulating system (1/3)

- Several 10" butterfly valves regulate the flow rate of the primary cooling system (installed 40 years ago).
- Degradation (difficulties in operation, leaks) and obsolescence (lack of spare parts) necessitated renewal of this safety related system.

*Old diaphragm actuator*  
*Old butterfly valve*
Renewal of flow regulating system (2/3)

The new system is based on:

- Fail Safe actuator (normally closed).
- Electro-pneumatic control instead of full pneumatics.
- Electronic and electro-mechanic component – approved according to IEC-61508 with SIL 2/3.
- No change in valve location nor valve size.

**Principle of operation**
Renewal of flow regulating system (3/3)

Valves system: Installation and commissioning

- Characterization and plan
- Present to the safety committee
- Off-line test
- Work permit granted
- Installation
- On-line test
- Final approval and report

off-line commission testing

old system (right) vs new (left)
Implementation – Example #2
Control Room Renovation

- Control console
- Chart recorders
- New fire detection and extinguishing system
- Upgrade the UPS units
- Data acquisition (DAQ) and HMI systems

control room view- 2007

control room view- 2017
Implementation - Example #3
Replacement of servo power regulating unit (1/4)

**Servo unit objective:** to convert the output of the Wide Range Monitor (voltage) to the input of the regulating rod controller (resistance)
Replacement of servo power regulating unit (2/4)

- CIC
- WRM
- Chart recorder
- PID controller
- M
- DAQ
- galvanic isolator
- low current
- voltage
- demand

Replacement of servo power regulating unit (2/4)
Replacement of servo power regulating unit (3/4)

low current

WRM
galvanic isolator

voltage

DAQ
demand

PID controller

CIC

WRM Signal Converter

Signals

Adjustments

0.10Vdc

26.5Vdc

230Vac
Replacement of servo power regulating unit (4/4)

New “servo” unit – commissioning tests

Stabilization time and overshoot – step power demand response

Steady-state example

new “servo” unit

old servo unit
Implementation - Example #4

Upgrading the Rabbit’s Control System

- Obsolescence of the system
- Malfunctions of the electronic and electro-mechanic devices
- Controlled by PLC
- Advanced safety features
- Standard components
The old mechanism: an electromagnet with a mechanical latch.

The new concept is based only on the electromagnetic coupling:

• “Fail safe“ design.
• “Off the shelf" products, which are used in safety systems for fire protection doors (UL listed).

**Implementation - Example #5 updrading the confinement isolation mechanism**

- Material strength calculations
- design special adapters
- "mock-up"
- commissioning tests
Conclusions

• In recent years, IRR1 underwent major upgrades and improvements as part of an ageing management program.

• Obsolete SSC’s are updated by modern state-of-the-art solutions.

• Existing programs and lessons learned from special occasions were integrated into the ageing management program.

• We will be happy to share our experience and knowledge with other RR groups.
Thank You!