IAEA Activities in the Operation and Maintenance of Research Reactors

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International Atomic Energy Agency

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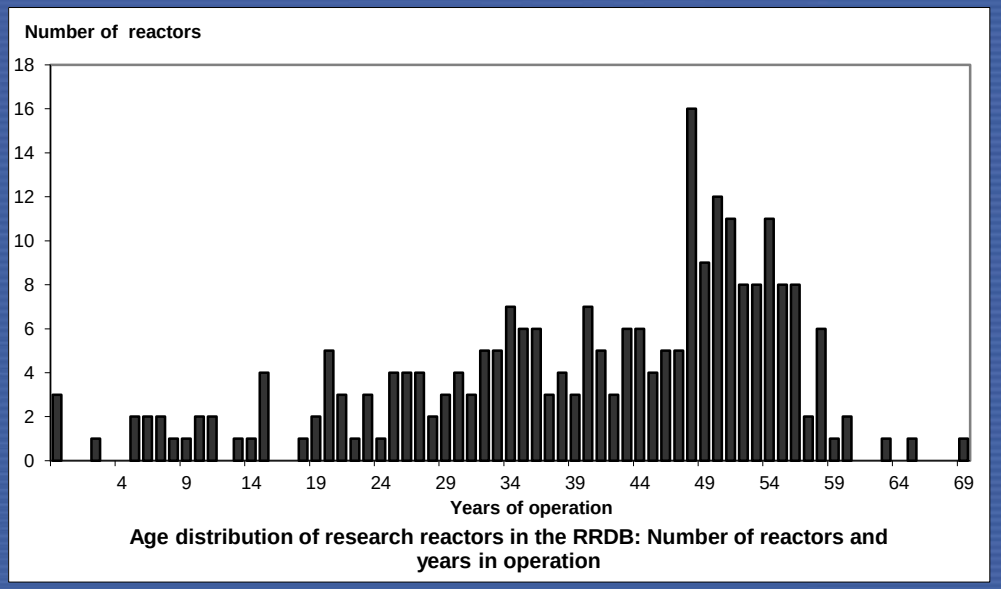
RR O&M Challenges

- Ageing
  - Facilities and equipment
  - Over 50% > 40 years old
  - Human resources
- Obsolescence of Equipment
- Equipment Modernisation
  - New technology
  - Increased reliability
- Changes in Safety and Security Requirements
- Management Considerations and Best Practices



Age distribution of research reactors in the RRDB: Number of reactors and years in operation

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IAEA assistance to Research Reactors

- Peer Review missions
- Meetings and workshops
  - Consultants' Meetings
  - Technical Meetings
  - Technical Cooperation Workshops / Training Courses
  - International Conferences and Symposia
  - International Expert's Missions
  - Coordinated Research Projects (CRP)
- Technical Cooperation (TC) projects
- Publications (standards, guidance, and other documents)
- Mobilisation of international experts

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RR O&M Project

- Focused on Assisting Member States Obtaining and Sustaining High Operational Performance and Reliability at RRs
- RR Ageing Management
- Operation and Maintenance Assessment of RRs (OMARR) Peer Review Missions
- Implementation of Integrated Management Systems to Enhance Availability and Reliability
- Support in Response to Member State Requests

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OMARR (Operations and Maintenance Assessment of Research Reactors)

- OMARR is an IAEA service to provide advice and assistance to Member States to improve their operational and maintenance (O&M) practices by peer to peer reviews
  - Comprehensive review of the facility
  - Compliance with plant procedures
  - Suggest areas of improvement
  - Mutual transfer of knowledge and experience
- OMARR is a way to interface with your peers and exchange ideas with the aim of increasing availability and reliability
- End result is a possible improvement in plant availability and reliability
- OMARR results and recommendations are confidential and are not sent to the regulatory agency

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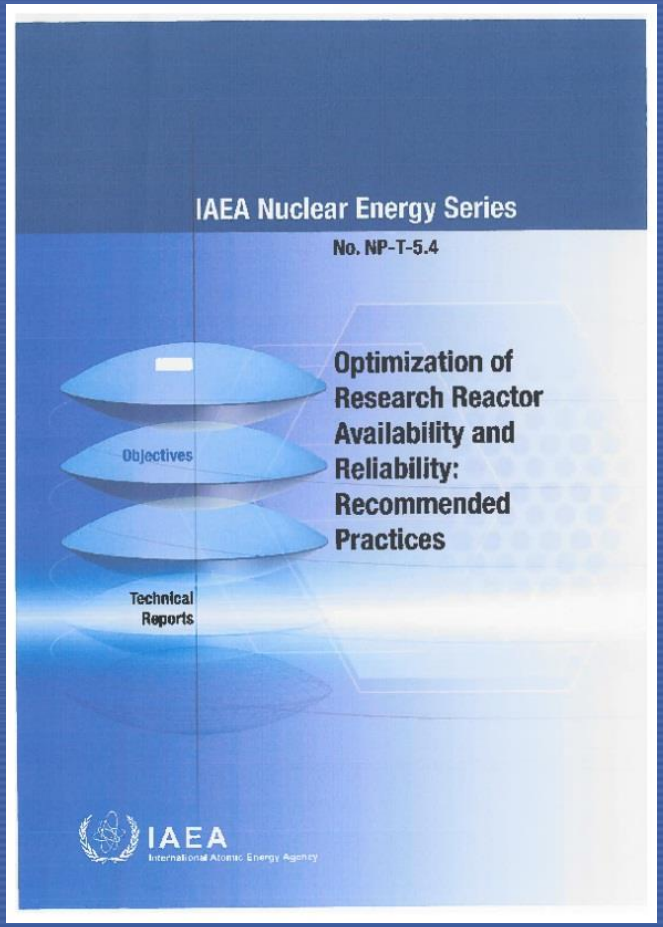
OMARR (Operations and Maintenance Assessment of Research Reactors)

OMARR topics are based on, but not limited to, the IAEA Nuclear Energy Series document NP-T-5.4 entitled Optimization of Research Reactor Availability and Reliability: Recommended Practices

- CUSTOMER/USER EXPECTATIONS
- FUEL CYCLE AND CORE MANAGEMENT
- MAINTENANCE
- DESIGN CONSIDERATIONS
- CONFIGURATION MANAGEMENT
- REGULATORY INTERFACE
- HUMAN RESOURCE MANAGEMENT
- MANAGEMENT INITIATED IMPROVEMENTS
- PUBLIC RELATIONS
- PERFORMANCE MONITORING



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OMARR (Operations and Maintenance Assessment of Research Reactors)

- OMARR missions consist of a pre-meeting at the facility, assessment visit, and a follow-up mission if requested
- Two Facilities Have Had an OMARR Review, Another Expected in 2016
  - Large RR (20MW) NIST USA
    - Pre-meeting in April 2012,
    - Main mission in December 2012
    - Follow-up in November 2013
  - Small RR (Less than 1MWth) LENA Italy
    - Pre-meeting in October 2012
    - Main mission in March 2013

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In service inspection equipment to enable member states to address aging issues

- During the lifetime of a research reactor, structures, systems and components are subjected to environmental conditions such as stress, temperature and irradiation.
- In order to assess changes which may occur in materials and components during operation of a research reactor, it is necessary to establish a baseline of properties (materials properties, thickness, etc.) so that changes can be determined.
- It is necessary to examine on a regular basis the structures, systems and components of the reactor facility for potential degradation to assess its effect on safety, on availability or to avoid high cost of repair or replacement.

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In service inspection equipment to enable member states to address aging issues

- Necessary to Examine RR Systems, Structures, and Components for Potential Degradation to Evaluate Effects on Safety and Availability, or to Avoid High Cost of Repair or Replacement
- IAEA Procured Necessary Equipment for use by Expert Teams in Order to Perform Component Inspections
  - Underwater Cameras
  - Ultrasonic Tester
  - Dental putty
- IAEA Provides Experts to Train Local Staff, & Improve Ageing Management and Surveillance Programs.
- Developing MSs may request NDT/ISI training through IAEA Technical Cooperation
- On request, IAEA Will Assemble Expert Teams to Inspect Mechanical SSCs of MS RRs:
  - Fuel assemblies, core internals, reactor vessels, pool liners, thermal shields, beam tubes, piping, pumps, valves, heat exchangers, and any other equipment as required

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RR O&M Coordinated Research Projects

- T34002 - Establishment of Material Properties Database for Irradiated Core Structural Components – Part of Ageing Management Strategy
  - Initiated in July 2013
  - 14 Participants: Algeria, Argentina, Australia, Brazil, Egypt, India, Indonesia, Japan, Kazakhstan, Korea - Republic of, Netherlands, Russian Federation, South Africa, United States of America
  - Objective is to develop a material properties Database for irradiated core structural components.
  - Compilation of data from research reactor operator input, comprehensive literature reviews and experimental data from research reactor.
  - Part of the aging management work to assist RRs in identifying possible areas for increased surveillance by in service inspections, to minimize unpredicted failures of core components and to mitigate lengthy and costly shutdowns.
  - The present status is evaluation of the research proposals for the CRP
  - Expected Completion in 2016

RR O&M Coordinated Research Projects

- T34003 - Condition Monitoring and Incipient Failure Detection of Rotating Equipment in Research Reactors
  - The second in a series of CRPs involving on-line monitoring techniques
    - It follows CRP T34001 “Improved Instrumentation and Control (I&C) Maintenance Techniques for Research Reactors using the Plant Computer”
  - First RCM held in January 2016 in Vienna
  - Objectives
    - To compile technologies, procedures, standards, regulations, and guidelines on condition monitoring and failure detection of rotating equipment
    - To obtain relevant data and operating experience not only from research reactors using OLM technologies on rotating equipment but also from industrial applications which are presently available
    - To compile an evaluated, reviewed and assessed database that can be used for sharing relevant information on OLM technologies among interested Member States

Research Reactors Ageing Database

- Initiated in 2006, First Data Loaded 2009
- Information Requested
  - Brief RR details / data / description
  - No enrichment conversions & no photographs
  - Classification of the ageing issue / experience (13 mechanisms, 76 systems in 9 groups)
  - Description of issue and corrective actions
  - Targeted questions on the ageing issue
    - Safety relevance
    - Budget impact
    - Support from outside the RR
    - Government/regulator involvement
  - Contact information at facility for the ageing issue

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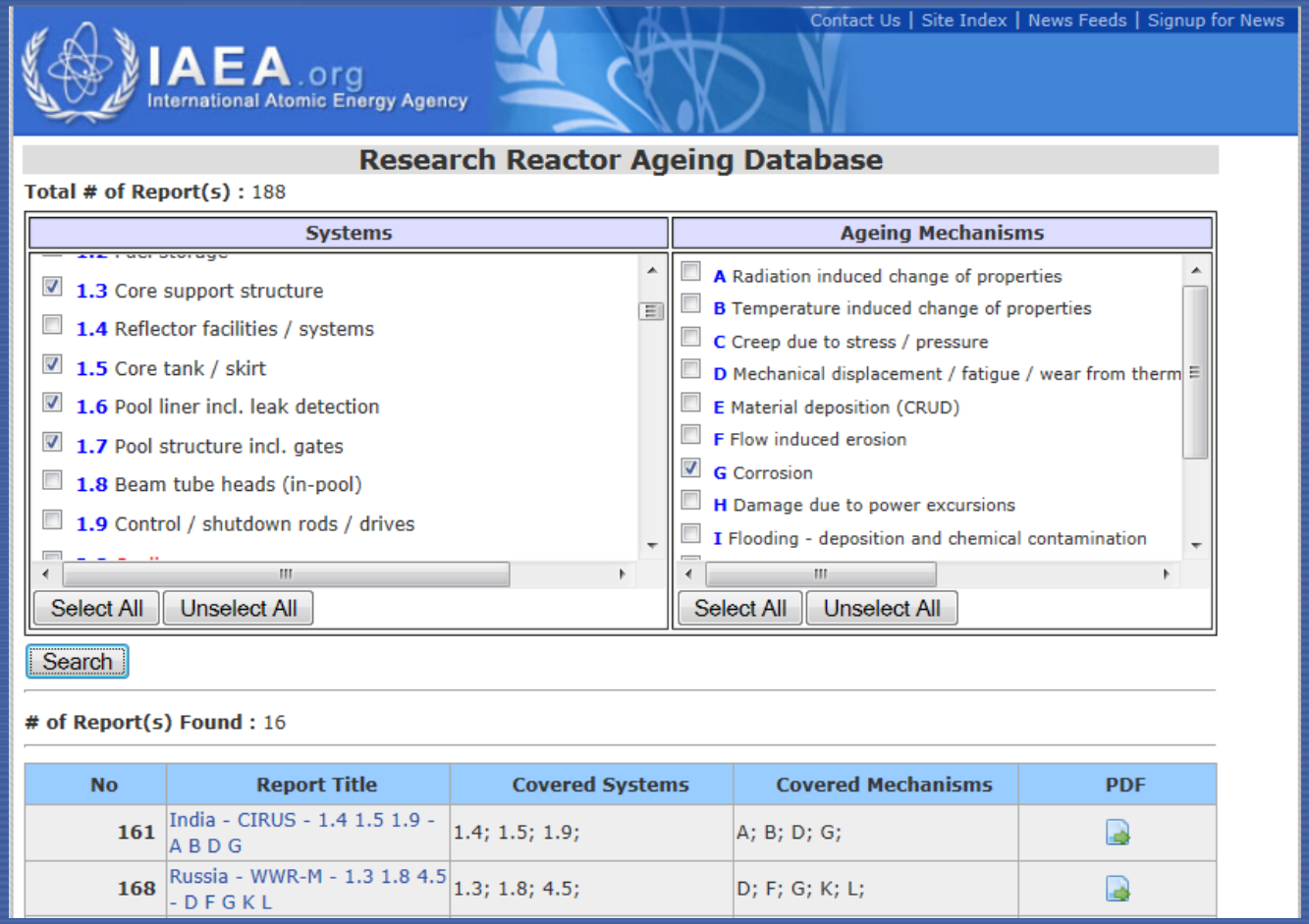
Research Reactors Ageing Database

- Restricted – Request Access through RRS



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Research Reactors Ageing Database

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Division of Nuclear Fuel Cycle and Waste Technology
Research Reactor Group

Ageing Management

Reactor Details

Name	HIFAR	Brief supplier / design information (Ex. TRIGA, WWR, SUR, ARGONAUT Pool, MTR, etc.)
Operator	ANSTO	1956 UKAEA DIDO class, D2O cooled and moderated, graphite reflector, operated for 49 years.
Country	Australia	
Power (kW)	10000	

Affected system(s) (see lists on following pages)

2.1 - Primary Cooling

Ageing Mechanism(s) (see lists on following pages)

D, E, G, K, L

Description of issue(s) (PLEASE limit facility descriptions and details to the minimum required to explain the issues / events.)

Fatigue failure from flow induced vibration - Causing weld cracks in small bore D2O pipe flanges, failure of D2O main pump bolts & loosening of D2O NR valve flap (due to split pin failure). These were identified thru D2O leaks or MSD inspections & had only limited potential impact on safety. D2O leaks generally caused extended shutdowns. These issues were reasonably anticipated in the design.

Crud - Causing loss of heat transfer plus high gamma from D2O storage tank & heat exchangers. These were identified thru plant performance monitoring and routine HP surveys & had limited impact on safety. Reasonably anticipated in the design.

Corrosion - Causing failure of D2O CCT bellows seals, leakage of FE seating surfaces and sacrificial plate sealing surfaces and seizing of shield plugs. Identified thru routine inspections and during shield plug changes & had limited impact on safety. Were foreseeable failures during 49 years of operation. The D2O bellows leaks caused a 9 month shutdown due to lack of spare parts, indicating a lack of maintenance planning.

Obsolescence - Causing increased maintenance costs and mainly affecting instrumentation. Identified thru monitoring of maintenance costs and loss of reliability. Were generally anticipated thru the plant's life-time and plant was periodically replaced.

Changes in Standards - Causing a need to upgrade old plant, install new plant and upgrade documentation. These were identified from the publication of new Standards & Codes and potentially had significant impact on safety, like the installation of an emergency core cooling system, by-pass flow pipe, FE sparge cooling holes and core flooding system. These issues were poorly anticipated in the design.

Description of mitigating or corrective action(s) (technical, administrative, programmatic, organisational, etc.)

The fatigue failures were resolved by repair/replacement of components immediately after discovery. Regulators were kept informed & some approvals required. Existing maintenance and inspection programs were improved. Similar issues had occurred at other DIDO reactors and some interaction was carried out.

Crud build-up was minimised through control of the D2O purity and chemistry. Crud sediments in tank bottoms was left in situ due to difficulty of removal, awaiting final decommissioning. Regulators were informed and warning signs erected. Similar issues had occurred at other DIDO reactors but only limited interaction was carried out.

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Ageing Management

Corroded items were promptly replaced & Regulator approvals obtained. Similar issues had occurred at other DIDO reactors but only limited interaction was carried out.

Obsolete systems were replaced within fairly reasonable timescales, mostly as part of an overall HIFAR refurbishing program. Independent reviews and Regulator approvals were obtained. Interaction with other DIDO class reactors occurred.

Changed Standards resulted in some entirely new systems being installed (ECCS) within reasonable timescales, as part of overall HIFAR refurbishing programs. Independent reviews and Regulator approvals were obtained. Interaction with other DIDO class reactors occurred.

Contact detail

If someone is available to discuss and/or share additional information with staff of other research reactors, please provide their contact information below.

Name.....Pertti Sirkka Phone.....0297173778

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Comments

Thank you for your support of this effort. If you have any additional comments or related information to share regarding the IAEA's work on research reactor Ageing Management, please use the field below. (In particular, descriptions of specific Ageing Management practices (inspections, tests, proactive maintenance programmes, etc.) would be very valuable. If copies of Ageing Management procedures or programmes can be shared, electronic copies may be mailed to the responsible officer listed in the footer of this template.)

A reactor like HIFAR which operates for 49 years is required to undergo at least 1 major refurbishing program during its life-time (plus other minor replacements and upgrades along the way) in order to upgrade its existing systems and install new systems, so that the facility can be, as much as practicable, in-line with the latest design Standards and Codes. HIFAR refurbishing was carried out in the 1980s, after approximately 25 years of operation. Following the 2nd 25 years of operation the new refurbishing that is required, to meet the Standards and Codes, as well as the replacement of plant which is often past its economically usable normal life-time, is so extensive and costly that it is a better option to shut-down.

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Department of Technical Cooperation (TC)

- Delivers National and Regional Projects to Promote Peaceful Uses of Nuclear Applications
  - Includes education, electric power, agriculture, medical, etc.
- TC Projects Typically Cross-Cutting – focus on safety, capacity-building, and can include procurement
- TC Programme Products and Services
  - Peer reviews
  - Networks
  - Databases
  - Summaries of experience, new knowledge, best practices, standards and guidelines
  - Training, distance learning (e.g., EERRI)
- Biannual Planning Cycle

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O&M Related Research Reactor Publications

- IAEA TECDOC 1762, 'Operating Experience from Events Reported to the IAEA Incident Reporting System for Research Reactors', 2015
- IAEA TECDOC 1748, 'Project Experiences in Research Reactor Ageing Management, Modernization, and Refurbishment', 2014
- IAEA TECDOC 1740, ‘Use of a Graded Approach in the Application of the Management System Requirements for Facilities and Activities’, 2014
- IAEA Safety Reports Series No. 75, 'Implementation of a Management System for Operating Organizations of Research Reactors', 2013
- IAEA Safety Standards Series No SSG-10, 'Ageing Management for Research Reactors', 2010
- IAEA Nuclear Energy Series No. NP-T-5.4, 'Optimization of Research Reactor Availability and Reliability: Recommended Practices', 2008
- IAEA Safety Standards Series No. NS-G-4.2, 'Maintenance, Periodic Testing and Inspection of Research Reactors Safety Guide', 2007
- IAEA TECDOC 1263, 'Application of Non-Destructive Testing and In-service Inspection to Research Reactors', 2001

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Concluding Remarks - Future O&M Activities

- The IAEA has consistently supported the operation and maintenance programs of research reactors in order to improve plant availability, reliability and safety.
- Digital Upgrade Document - capture newly applied techniques to RR digital systems and to address maintenance and aging concerns
- Integrated Management Systems Workshop every 2 year event (2016)
- Continued Support to MS for ISI and NDT
- RR I&C Training - a series of training workshops on the fundamentals of I&C for knowledge transfer from experienced I&C engineers and technicians to new I&C personnel
- Integrate the OMARR Mission Statement (after 2 more missions) into the NE series document NP-T-5.4 ‘Optimization of Research Reactor Availability and Reliability: Recommended Practices’

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Thank You For Your Attention!

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