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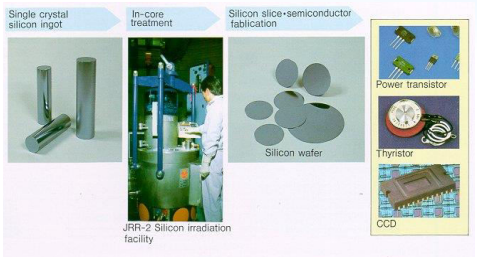
IAEA Activities in Support of Operation and Maintenance of Research reactors

Ram Sharma
Acting Section Head, Research Reactor Section
NEFW, Department of Nuclear Energy, IAEA

Test, Research and Training Reactors Annual Conference
October 28 – November 1, 2018;
Newport Marriott, Newport, Rhode Island

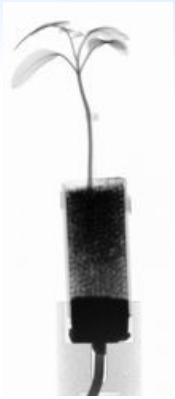
RRs in everyday life

Gemstones coloration

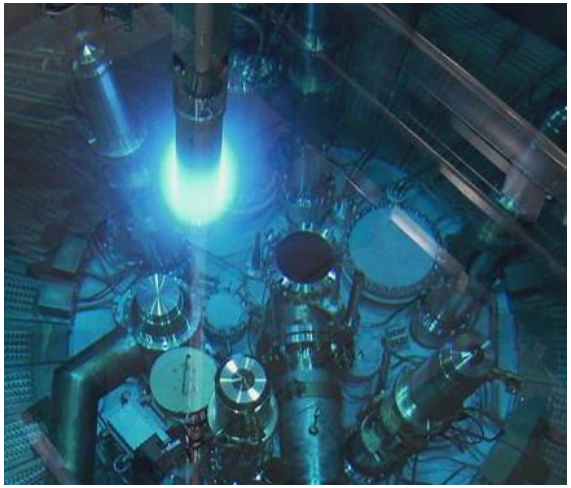


Silicon doping for electronic components

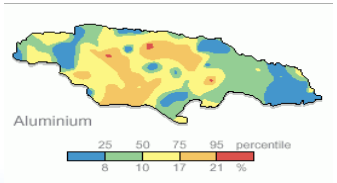
Radioisotopes for medical, industrial and agricultural applications



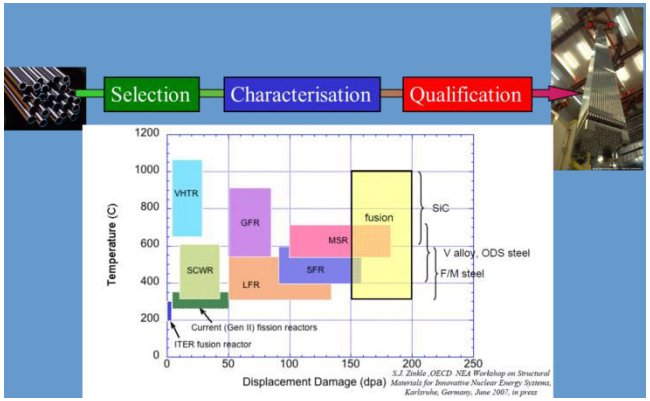
Non-destructive Examination (e.g. neutron imaging)



Education & training in nuclear science & technology



Research in many Scientific Disciplines (e.g. geological & environmental studies)



Support to Nuclear Power Industry (Fuel qualification, NPP life extension, material testing)

IAEA RRDB Overview

21 Sep 2018

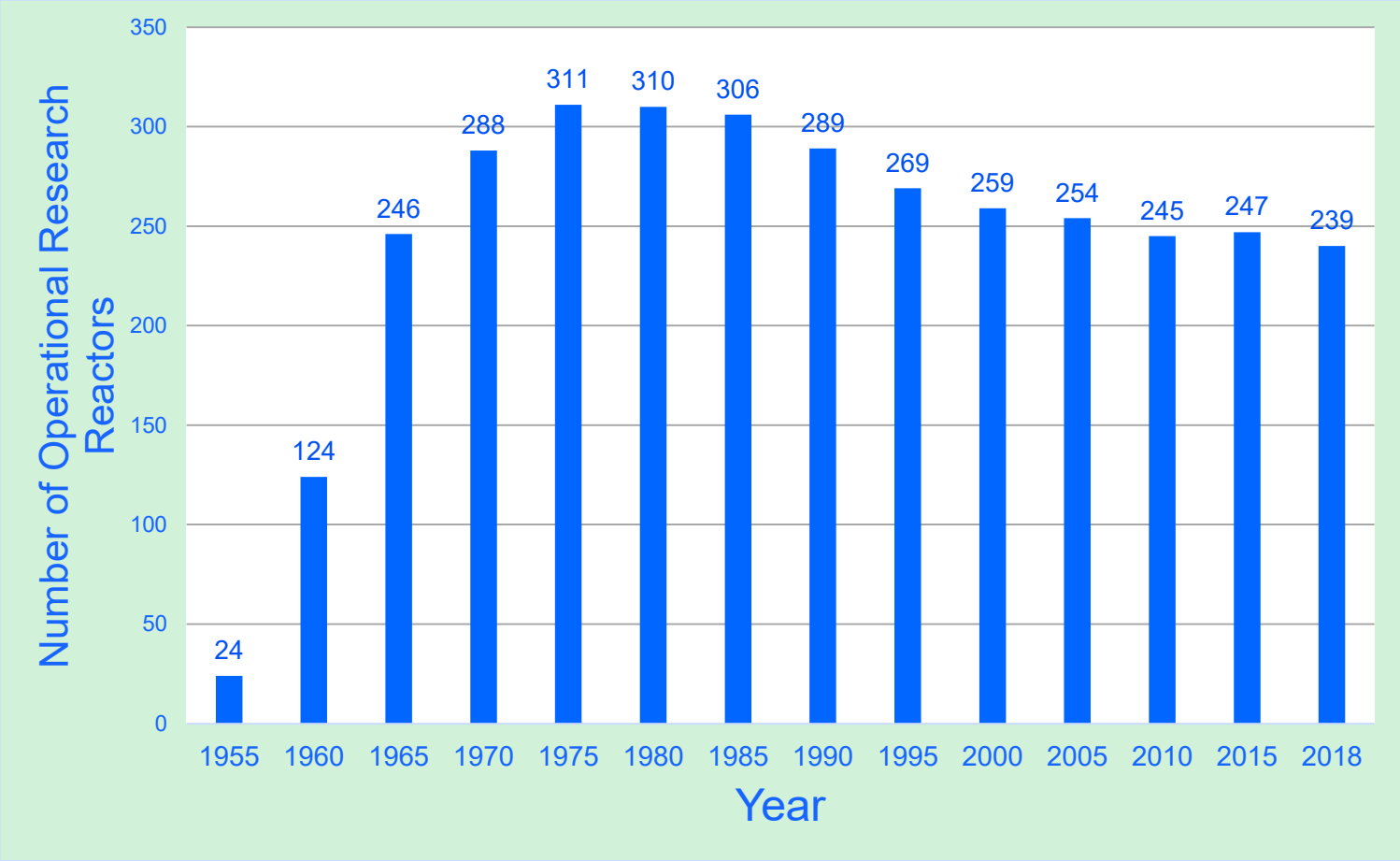
Status	Developed Countries	Developing Countries	All Countries
Planned	2	11	13
Under construction	4	5	9
Operational	140	86	226
Temporary shutdown	8	5	13
Extended shutdown	5	8	13
Permanent shutdown	42	14	56
Under decommissioning	63	4	67
Decommissioned	413	29	443
Total	677	163	840

818 built

IAEA RRDB Overview

Numbers of operational research reactors

21 Sep 2018



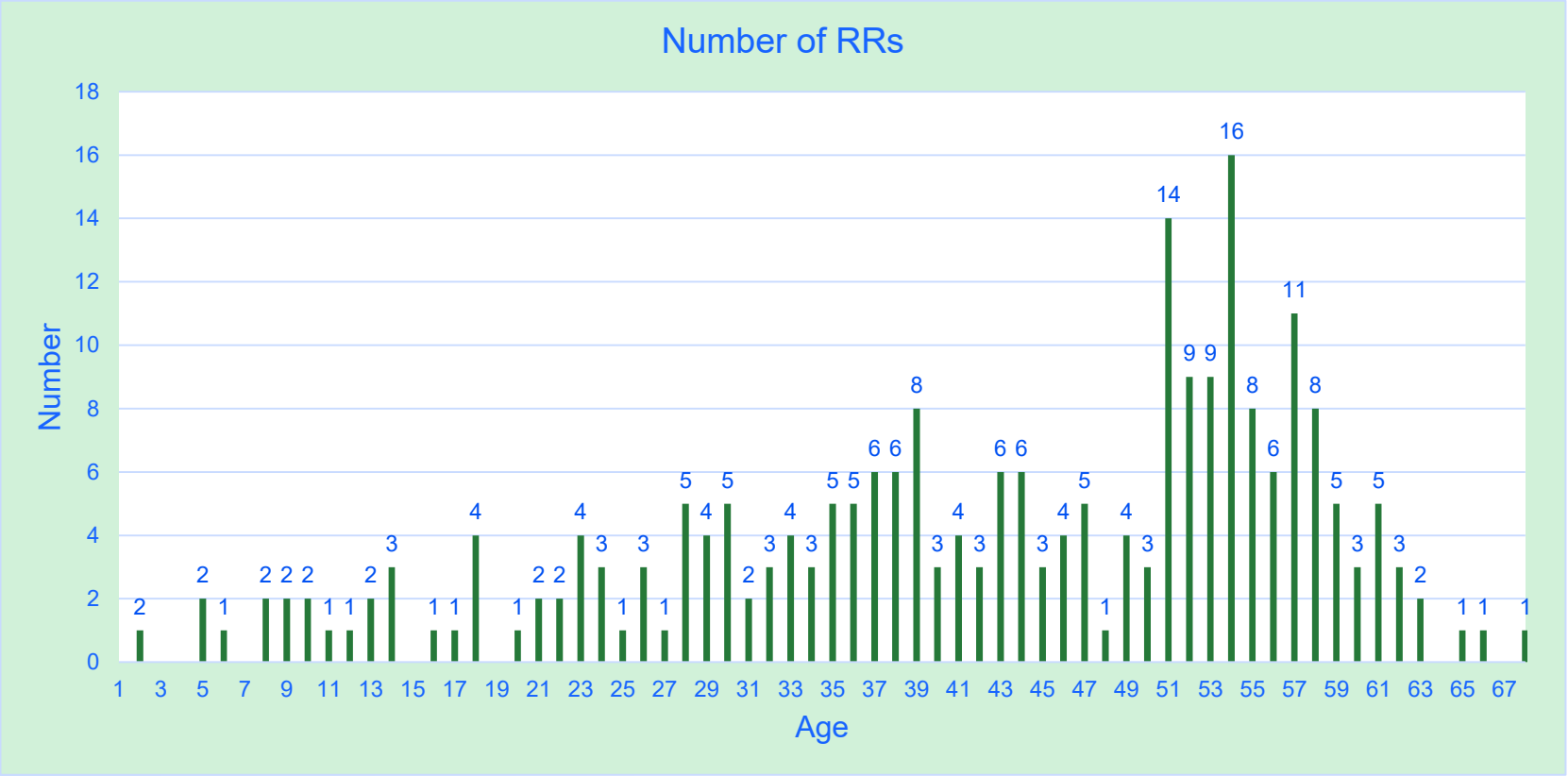
IAEA RRDB Overview

21 Sep 2018

Ageing status

60% of operating RRs are over 40 years old.

43 % of operating RRs are more than 50 years old.



IAEA RRDB Overview

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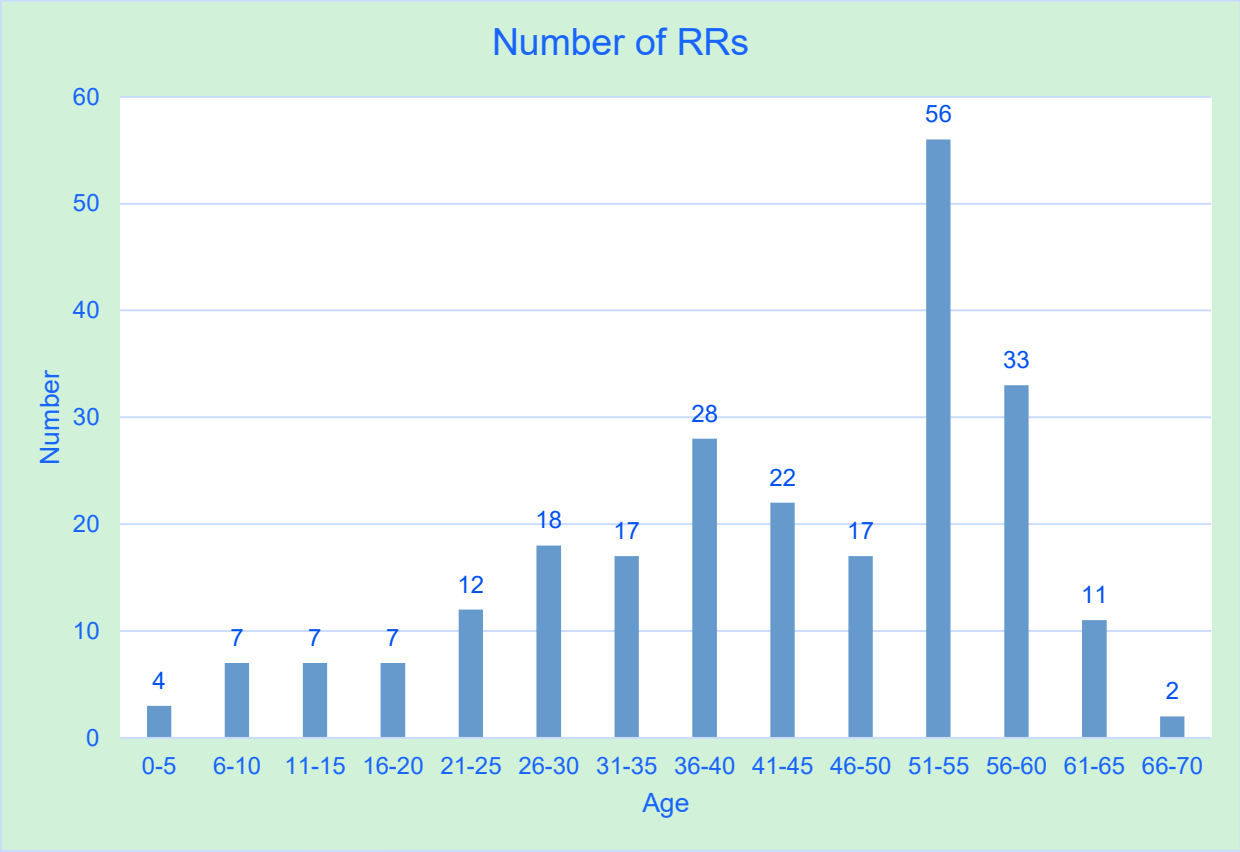
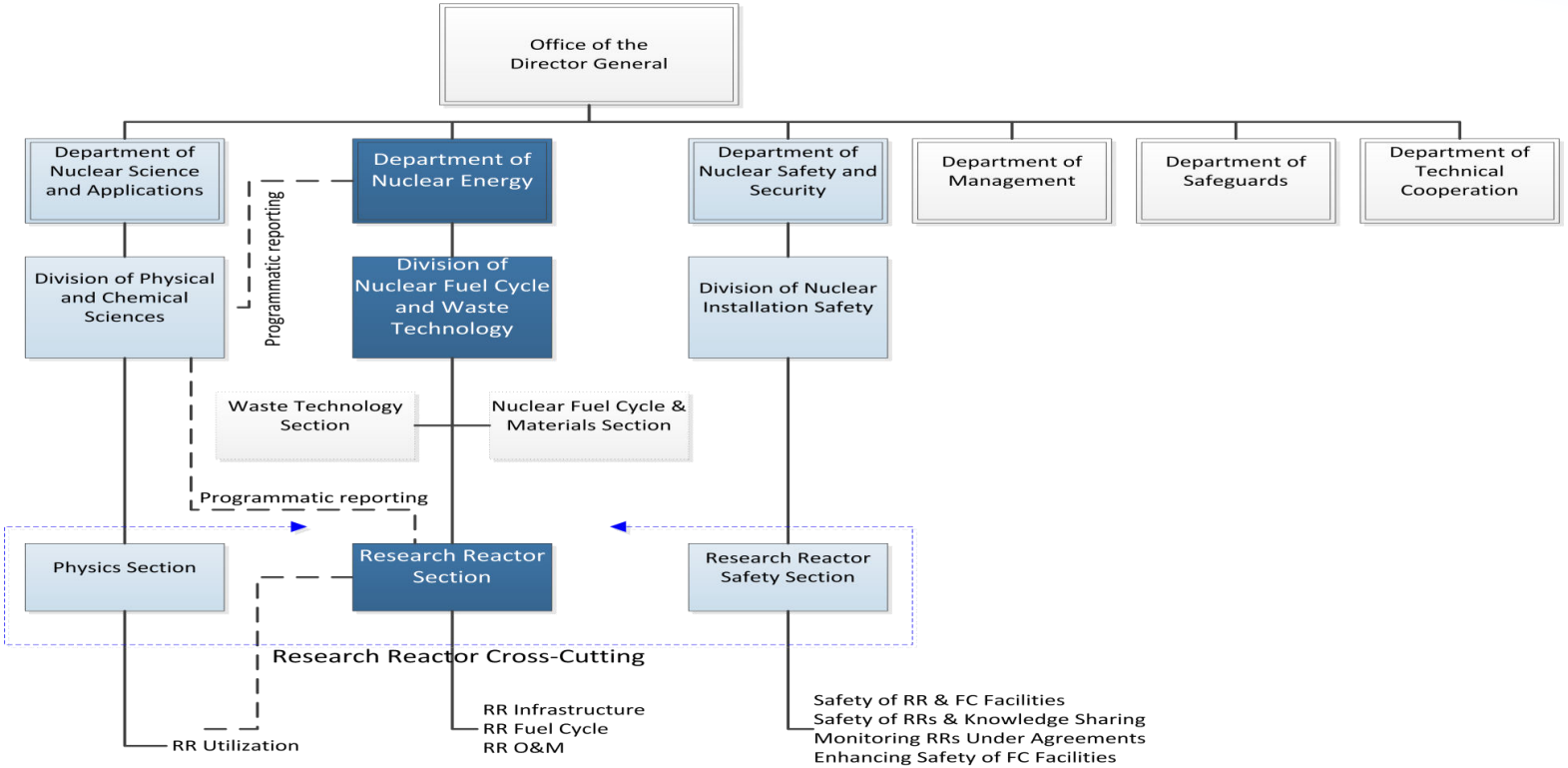


Cross-cutting Activity on RRs Coordination Group



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NAPC-PS

NEFW Research Reactor Section

9 (2) P-staff
3 G-staff
2 SSAs

R. Sharma

R. Thottakkara

N. Hakimy-Sadiq

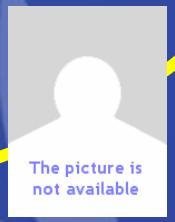
K. Milosovicova

F. Marshall

P. Chakrov

Y. G. Cho

Vacant Position



U. Salikhbaev

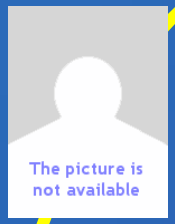
N. Peld

A. Zhukova

T. Hanlon

A. Sitnikov

Vacant Position



N. Pessoa Barradas

I. P. Swainson

RR sub-programme (1.4.2.)

The **sustainability of RRs life-cycle** is an issue of major concern, also considering that the majority of the existing RRs have reached 40 years of operation MS are increasingly seeking Agency's assistance in addressing the main challenges related to **RR sustainable operation and effective utilization** as well as in **building new and accessing existing RRs** for developing their national nuclear programmes and strategies, including for development of human capital

Objectives

- To support Member States in ensuring sustainable operation and effective utilization of existing research reactors on long term basis with enhanced availability and reliability
- To support Member States in nuclear capacity building based on the use of and access to RRs
- To support Member States in planning and implementing new research reactor projects, including the development of their national infrastructure

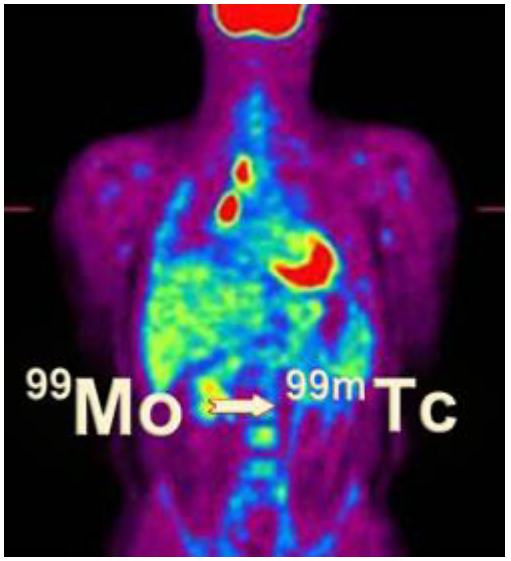
RR sub-programme (1.4.2.)

Project 1.4.2.001 Enhancement of utilization and applications of research reactors

RRs remain indispensable in the provision of radioisotopes for medicine and industry, neutron beams for material research and non-destructive testing, analytical and irradiation services both for private and public sectors

Equally, the contribution of RRs to the education and training of the new generation of scientists and engineers in support of nuclear science and technology programmes remains a strategic role for their utilization

As the ageing RR fleet continues to decrease, the remaining and new facilities need to be efficiently utilized, well managed with the aim for sustainable long term operation



Objectives

- To assist MS in enhancing RR utilization for many applications, such as isotope production, use of neutron beams, irradiation and analytical services, material characterization and testing consistent with RR features, nuclear education and training
- To increase cooperation and resource sharing between different RR centres, promote and strengthen both regional and thematic networking, including interested Member States without RRs
- To assist RR centres in development of user communities and industrial partnership for enhanced and sustainable RR utilization by offering products and services

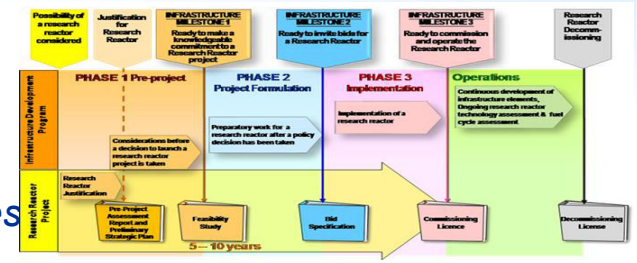
RR sub-programme (1.4.2.)

Project 1.4.2.002 Research reactor infrastructure development and capacity building

Several Member States (MS) have started planning or building their first research reactor as a key national facility for the development of their nuclear science and technology programmes, including nuclear power

However, the introduction of the first research reactor in a country requires the establishment of an adequate national infrastructure which covers a wide range of technical areas to ensure that national and international commitments and obligations, particularly regarding safety, security, safeguards and emergency preparedness, are met during the construction, operation and decommissioning phases

Several MS developing nuclear science and technology programmes, including nuclear power programmes, are also seeking opportunities to access RR to achieve their national capacity building objectives



Objectives

- To assist MS in planning and implementing new RR projects, including the assessment and development of their national nuclear infrastructure
- To assist Member States in building and/or preserving national nuclear capacity, including human resources development, through the use of research reactors and procurement of specific equipment and services
- To increase access to research reactors for all MS developing nuclear science and technology programmes, including nuclear power

RR sub-programme (1.4.2.)

Project 1.4.2.003 Addressing research reactor fuel cycle issues

Assurance of new fuel supply is a concern for research reactors (RRs); cooperation between RR organizations and Member States (MS) can be fostered to leverage supply options

Back-end options for the RR nuclear fuel cycle need to consider non-proliferation, national policy, economics, and environmental concerns as well as technical issues

The continued safe, reliable, and economic handling, management and storage of RR Spent Nuclear Fuel (SNF) of all types is a serious issue for most MS with RRs

Ongoing, international programmes seek to convert RR fuel and targets from High Enriched Uranium (HEU) to Low Enriched Uranium (LEU). Many RRs have been converted to LEU fuel and targets, with significant quantities of fresh and spent HEU repatriated to the country of origin. Development and qualification of very high density fuels are necessary to convert the remaining RRs from HEU to LEU

Objectives

- To assist MS in strengthening the capability to deal with all fuel cycle issues, including fuel supply, development, fabrication and qualification of new fuels, vulnerabilities related to SNF management and the back end of the fuel cycle
- To assist MS, upon request, with the conversion of research reactors and targets for radioisotope production from HEU to LEU and repatriation of SNF to its country of origin

RR sub-programme (1.4.2.)

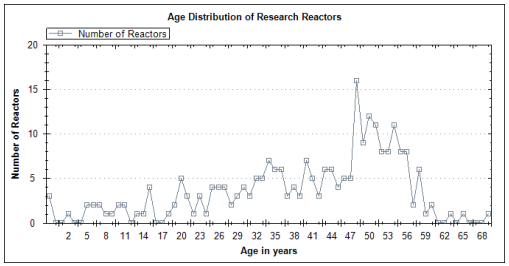
Project 1.4.2.004 Research reactor operation and maintenance

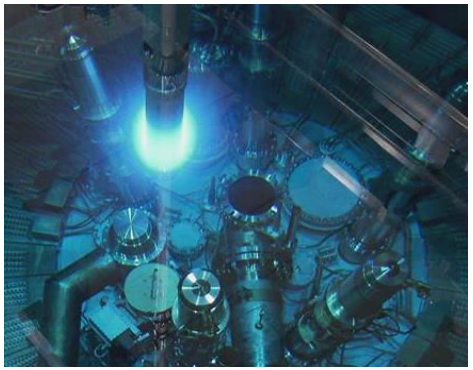
Approximately 60% of the operating research reactors (RR) in the world are more than 40 years old. Although the life of such facilities could reach 60 years and beyond, it is of paramount importance that adequate life management programmes (ageing and refurbishment/upgradation programmes) are established well in time

Adequate operation and maintenance (O&M) plans, as well as management system, need also to be in place to ensure optimization of operational performances of existing research reactors

Considering the general trend of funding reduction for such facilities and limited succession planning, development and implementation of sound O&M as well as life management programmes are vital to ensure for these facilities a cost-effective completion of their assigned missions

Another very relevant issue is related to the fact that two thirds of the research reactors ever built, are currently in permanent shut-down state and need to be decommissioned





Objectives

- To assist Member States in developing and implementing operation and maintenance plans to improve facility's operational performances and in establishing integrated management systems
- To assist Member States in developing and implementing ageing management and renovation/upgradation programmes for facility's life management
- To contribute to IAEA cross-cutting activities on research reactors' decommissioning

RRS (O&M) - Major Activities

- Technical Meetings
- Training Workshops
- Peer Review and Expert Missions
- Coordinated Research Projects
- RR Information Resources
- Publications

Technical Meetings

- Ageing Management, Refurbishment and Modernization of research reactors (every two-years, held in Oct 2017, next in 2019)
- Upgrades to Digital Instrumentation and Control Systems for Research Reactors (every two years, held in Jul 2017, next in 2019)
- Good Operating Practices and sharing of experience (planned in Oct, 2018)

Training Workshops

- ISI, NDE and On Line Monitoring (OLM) techniques (every two-year; June 2018)
- Integrated Management Systems (IMS) (every two-year; planned in 2019)
- Planning for decommissioning / Managing transition from permanent shut down to decommissioning

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Operation and Maintenance Assessment for Research Reactors (OMARR) - Objectives

- Provide advice and assistance to Member States in enhancing the performance of research reactors
- Identify areas for improvement
- Address specific operational challenges
- Create a space for sharing experiences and good practices

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Scope

- Performance oriented and focuses on good practices
- Operational plans, procedures and practices, including operational performance indicators;
- Maintenance plans, procedures and practices, including non-destructive examination and in-service inspections;
- Ageing management plans and practices;

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Scope

- Human resources development including for technical services
- Quality assurance and integrated management system
- Plant asset and configuration management
- Plant modification and/or refurbishment

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Approach

- On request of RR operating organization only
- Addresses the topical areas described in IAEA Nuclear Energy Series No. NP-T-5.4, " **Optimization of Research Reactor Availability and Reliability"**

- ➢ Pre-OMARR - A preparatory Mission of *2–3 days*
- ➢ Main OMARR - main mission of *5–7 days*
- ➢ Post-OMARR - follow up mission of 3-5 days if required by the facility

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Pre-OMARR

- One IAEA staff and 2-3 international experts, Facility staff
- Self-assessment by facility - facility documents
- Review of current status and future plans
- Identify areas needing attention.
- Identify the scope and methodology of the main OMARR Mission with the operating organization
- Provide report to the operating organization

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Main OMARR

- Two IAEA staff, 3-4 international experts and Facility Staff
- Size of the team and the duration of the main Mission depend on the complexity of the facility and topics to be reviewed
- Observers from organizations receiving a future OMARR Mission may be invited to participate with the consent of the hosting organization

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Post-OMARR

- Undertaken if facility needs advise for mid-course correction in action plan proposed in main OMARR
- One IAEA staff and 1-2 international experts, Facility staff
- Review implementation progress and identify areas needing attention
- Suggest modifications to the implementation plan.
- Provide report to the facility including additional recommendations

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Outcomes

- A more efficient and reliable long-term operation of a research reactor
- Better performance
- Improved safety and safety culture
- Optimized utilization of human and financial resources.
- Sharing of experience and good practices

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Beneficiaries

- A research reactor under commissioning or in operation
- Assist an operating organization carrying out a major refurbishment or modernization of their facilities in identifying the structures, systems and components to be replaced or refurbished
- Also useful after a major refurbishment or modernization of a research reactor facility in identifying ways to improve O&M programs and procedures

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Missions undertaken

- Initiated in 2012 with first mission to 20 MW RR at the National Institute of Standards and Technology (NIST), in the United States of America
- Second at the 250 kW RR at the Applied Nuclear Energy Laboratory (LENA) at the University of Pavia, in Italy

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Missions undertaken

- Third in June,2017 : WWR-SM, Uzbekistan
- Fourth in Sept., 2017: RPI, Portugal - NDE
- Fifth in March, 2018: BTRR, Bangladesh
- Sixth in May, 2018: Kinshasa, DR Congo
- Seventh in January, 2019: Bandung TRIGA 2000 Research Reactor, Indonesia
- Many member states (8) showing interest

ISI and NDE support mission

- Radiation Resistant underwater camera systems – “Proton” and “D40M” from Diakont for inspection of core components
- USM 36 ultrasonic tester
- Service on member states request.
- RPI in Portugal and BTRR in Bangladesh

Coordinated Research Projects (CRP)

- CRP on “Improved Instrumentation and Control (I&C) Maintenance Techniques for Research Reactors” has been completed – TECDOC-1830

- CRP on establishment of “Material Properties Database for Irradiated Core Structural Components for Continued Safe Operation and Lifetime Extension of Ageing Research Reactors” completed – TECDOC under publication

- CRP on “Condition monitoring and incipient failure detection of rotating equipment at research reactors” completed (final RCM 15-19 April, 2018) – TECDOC on benchmark results from member states under preparation

- New CRP on “Risk Based ISI and Decision Making for RRs”

IAEA RR Information Resources

RRDB (https://nucleus.iaea.org/RRDB/)

- Contains information on more than **775 RRs worldwide** - technical characteristics, purpose, availability, capability, and facility managers' contacts.
- Being regularly updated with assistance from Member States (MSs) to share and collect information in one place

RRADB (https://nucleus.iaea.org/sites/rramp/)

- Repository of the worldwide experience in **managing ageing of structures, systems and components** (SSCs) at research reactors
- Comprised of about **300 reports** with examples of affected systems, ageing issues faced, ageing mechanisms identified and remedial actions taken - serve as meta data and allow for searching/filtering of the list of reports
- Updated on biennial basis; next cycle – 2019.

RR-MPDB (TBD)

- Material Properties Database for Irradiated Core Structural Components for Continued Safe Operation and Lifetime Extension of Ageing Research Reactors
- Developed on the SharePoint platform – a document collection (RRADB type)
- Currently contains 5 groups of different meta data; about 150 reports uploaded with attributed meta data.
- Launched on trial basis to get feedback from users

Publications under preparation

Title	Type	Status
Application of non-destructive testing and in-service inspection to research reactors	TECDOC 1263 (2001)	Revision initiated
Optimization of Reliability and Availability of RRs	NP-T-5.4 (2008)	Revision initiated
Digital Instrumentation and Control Systems for new facilities and modernisation of existing Research Reactors	NES	First draft under preparation
Ageing Management, Refurbishment and Modernization for Long Term Operation of Research Reactors	NES	TECDOC (2014) being upgraded to NES
Guidelines to conduct OMARR mission	TECDOC	First draft under preparation

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Thank you!