IAEA's Cross Cutting Activities on Research Reactors

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NEFW / IAEA

International Conference on Research Reactors: Safe Management and Effective Utilization

14–18 November 2011
Rabat, Morocco

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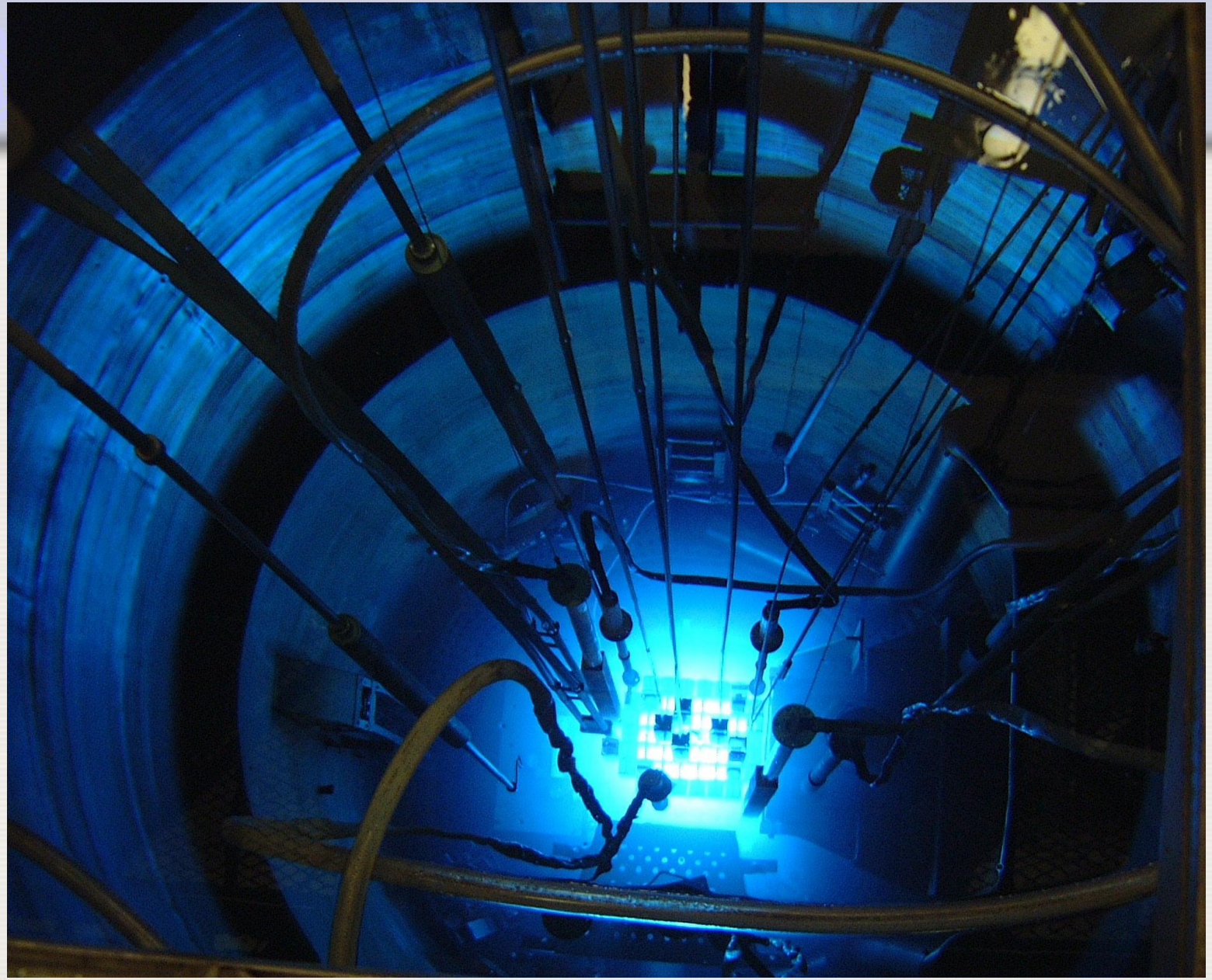
International Atomic Energy Agency

Outline

- Introduction
- Research Reactor Issues and Challenges
- Cross-cutting Coordination
- Some Relevant Cross-Cutting Activities Underway
- Conclusions



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Introduction

- For almost 60 years research reactors have contributed to the development of nuclear science and technology
- We know about 672 research reactors in 69 countries (67 MS) of which about 230 are still operating

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Research Reactor Issues and Challenges

- Underutilization
- Inadequate funding - over-reliance on government / public sector funding
- Ageing materials and equipment, in ageing facilities, run by aged staff
- Non-existent or inappropriate business and /or strategic plans
- Lack of market analysis and marketing skills
- Need for modernization/refurbishment

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Research Reactor Issues and Challenges (cont'd)

- Unavailability of suitable high-density LEU fuels for conversion of some RRs
- Need for enhanced international cooperation as "state of the art" facilities are too expensive for a single country
- Parochial attitudes, resistance to cooperation
- New RRs
- Accumulation of spent fuel
- Deteriorated spent fuel at some storage sites
- Presence of fresh and spent HEU
- Reluctance to decommission

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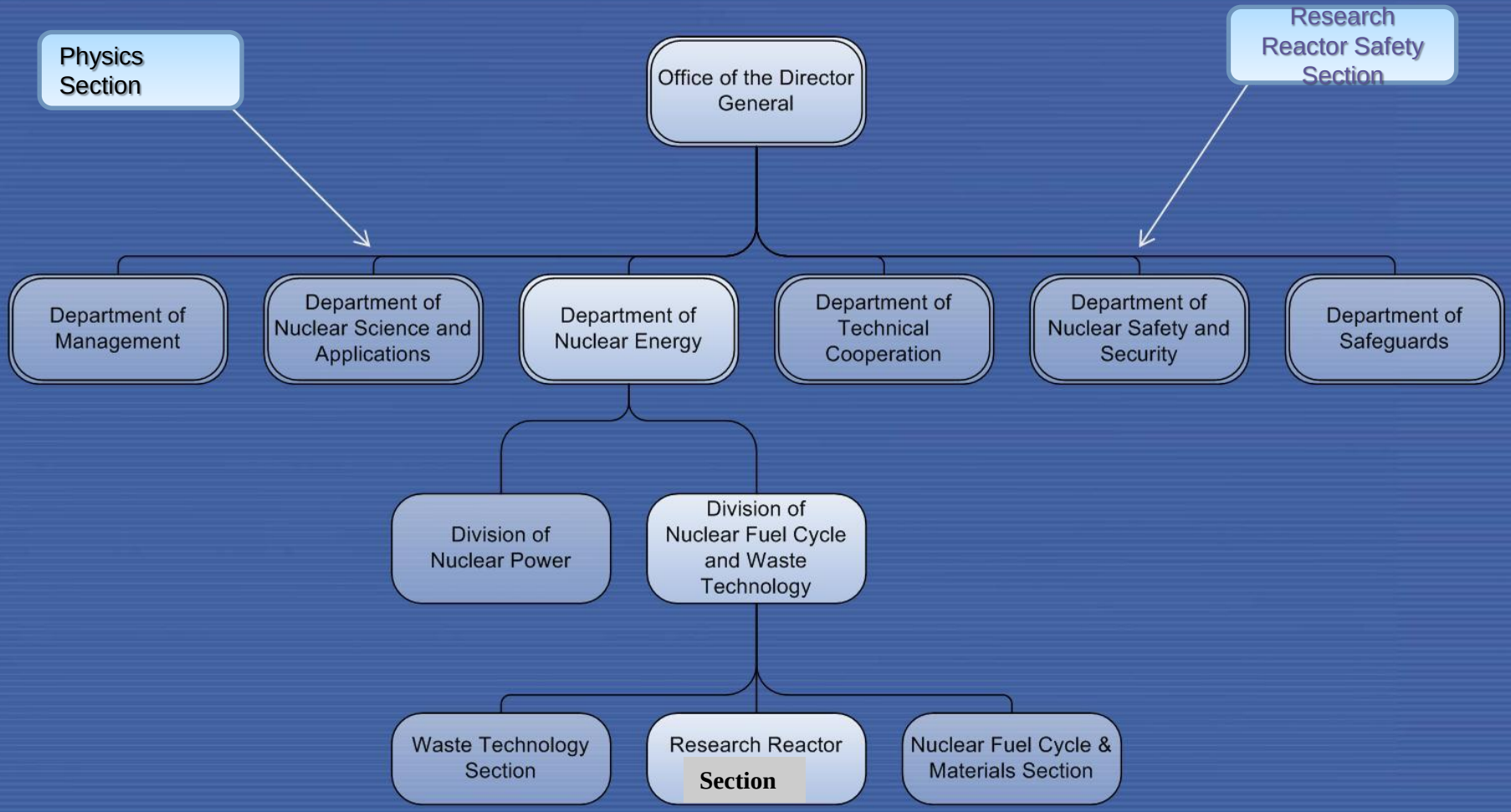
Organization – IAEA / RRS



Cross-cutting Coordination

- IAEA's activities on RRs included in a cross-cutting coordinated area
- Activities coordinated through a Cross-Cutting Co-ordination Group for Research Reactors (CCCGRR)
- CCCGRR includes representatives from the Departments of Nuclear Safety, Nuclear Applications, Nuclear Energy, Safeguards and Technical Cooperation

Cross-cutting Coordination

- Primary goals:
  - Make sure that all of the individuals concerned know what each other is trying to accomplish;
  - Facilitate and ensure co-operation and participation of all pertinent staff in Agency's interconnected RR activities;
  - Ensure that duplication is eradicated; and
  - Make sure that potential problems are dealt with before they become real problems

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Cross-cutting Coordination (cont'd)

- To facilitate implementation of the RRs activities (addressing the Issues and Challenges);
- To act as ***focal point*** for RR activities that cut across NA, NE, NS and TC;
- To take the ***lead*** in planning and prioritizing activities that really require Crosscutting co-ordination;
- To ***monitor*** their implementation; and
- To ***report*** on progress on their achievement.

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Cross-cutting Coordination (cont'd)

Focal Point for Activities on RR Safety is the Research Reactor Safety Section (Department of Nuclear Safety)

Specific presentation on:

"IAEA Sub-Programme on Research Reactor Safety"

H. Abou Yehia

Session D on Thursday

Cross-cutting Coordination (cont'd)

Focal Point for Activities on RR Utilization is the

Physics Section

(Department of Nuclear Applications)

Specific presentation on:

"IAEA New Opportunities for Enhanced RR Utilization through Networks and Coalitions"

D. Ridikas

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Session A on Monday

Cross-cutting Coordination (cont'd)

Focal Point for Activities on RR Innovation, Modernization, Operation, Fuel Cycle and New RRs is the

Research Reactor Section

(Department of Nuclear Energy)

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SOME RELEVANT CROSS-CUTTING ACTIVITIES UNDERWAY

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Research Reactor Operation, Maintenance and Ageing Management

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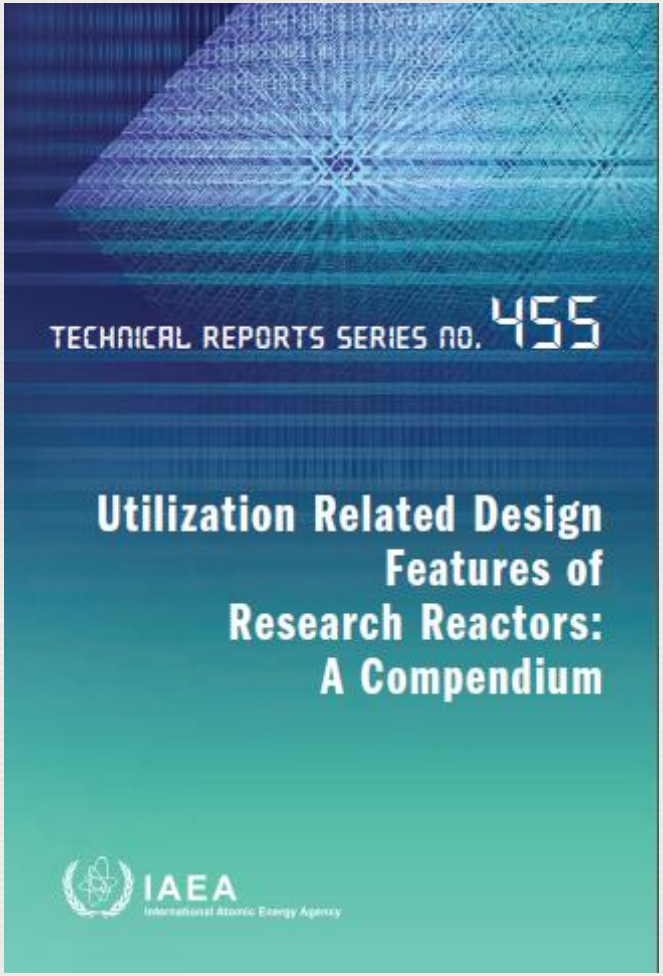
Background

Research Reactor (RR) Operation and Maintenance (O&M) and Ageing activities Focus on the RR / machine **availability** and **reliability** as a **platform** for

- Basic and applied science, research and development
- Production of medical and industrial isotopes and other industrial products
- Education and training



http://www-pub.iaea.org/MTCD/publications/PDF/TRS455_web.pdf

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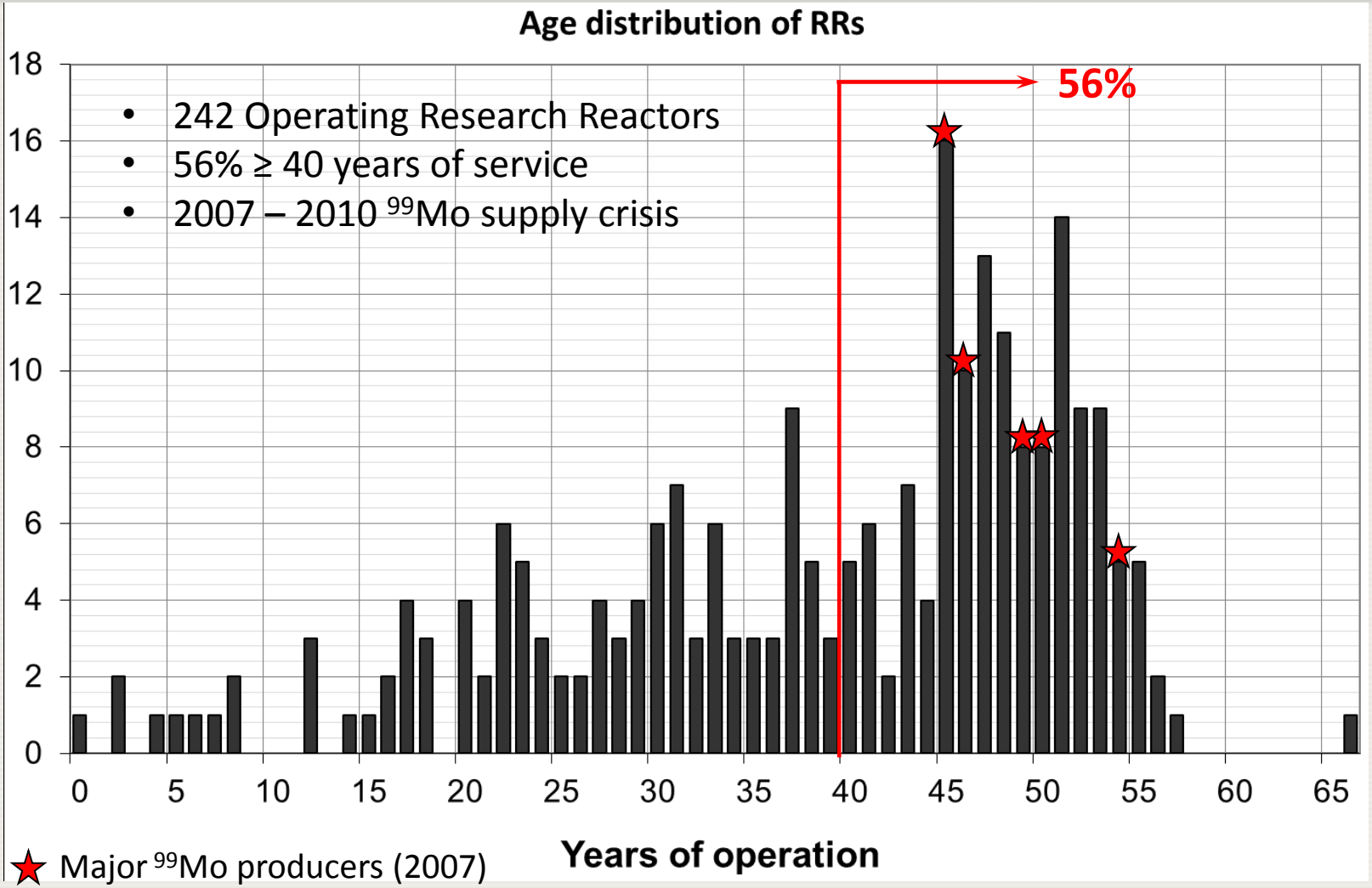
Background



Source: IAEA Research Reactor Database
(http://nucleus.iaea.org/RRDB/RR/ReactorSearch.aspx)

The RR Community

Diverse

- Mission
- Power level
- Design
- Operational context
- Regulatory context
- Resource and financial allocation mechanisms

Challenges generic guidance

The ‘Bathtub Curve’

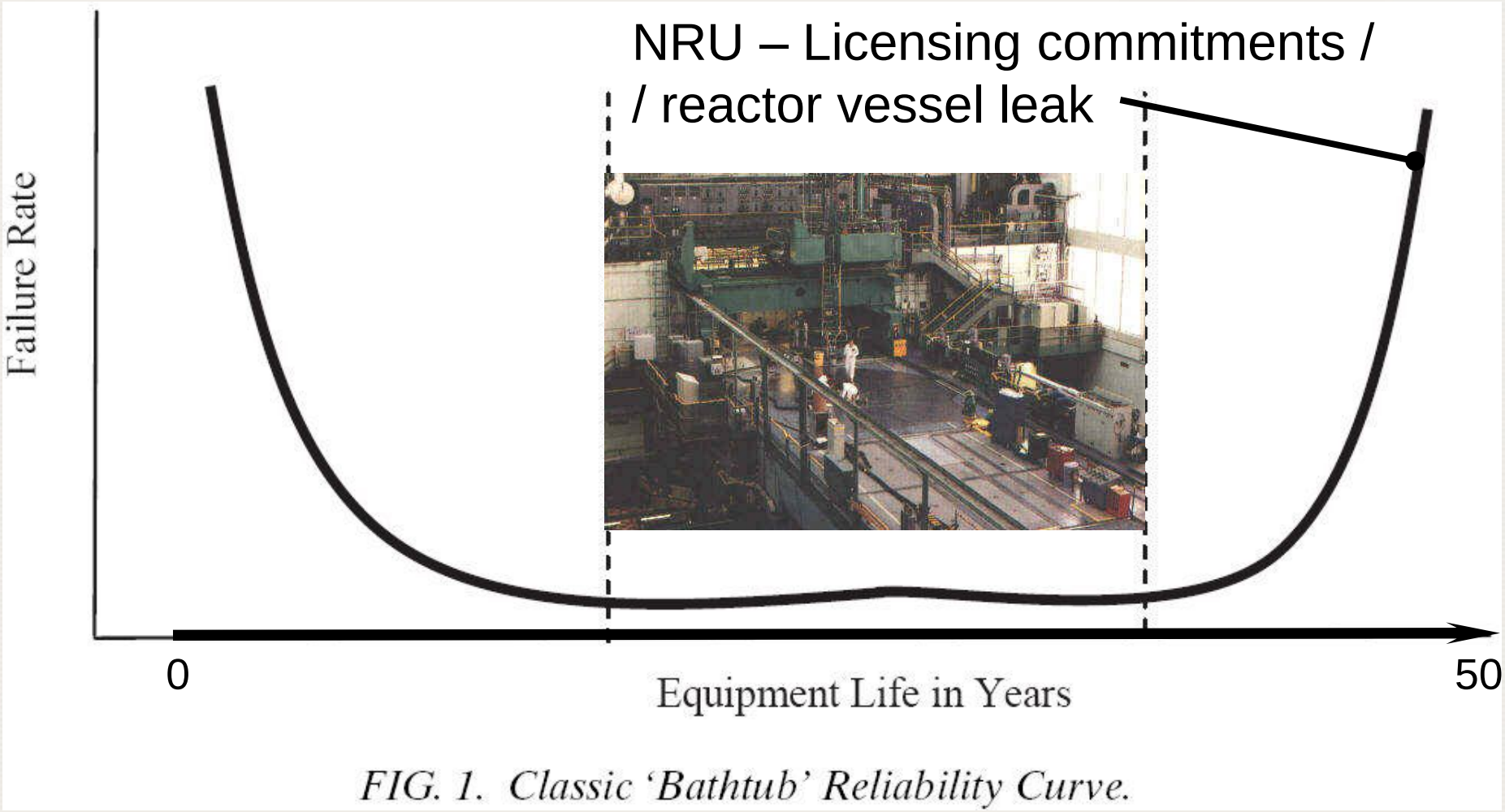


FIG. 1. Classic ‘Bathtub’ Reliability Curve.

Summary of outputs

Publications

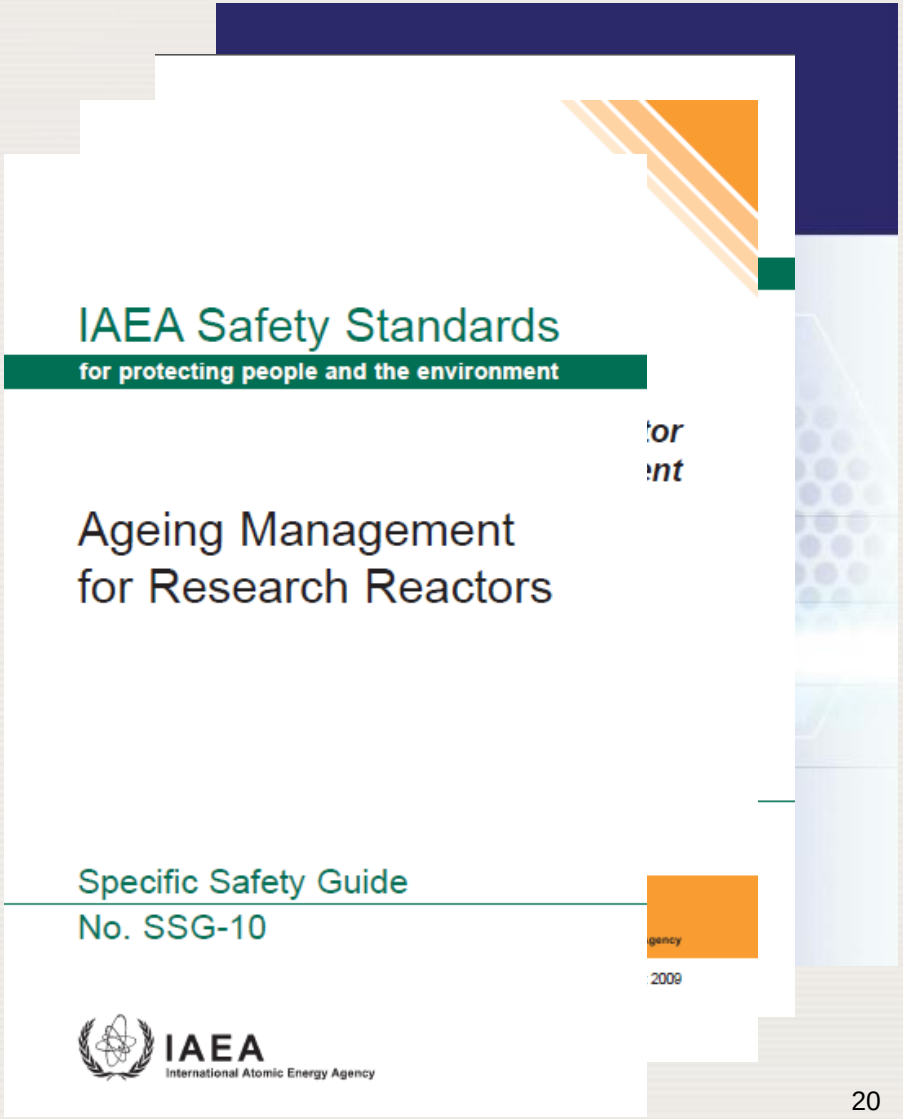
- Optimization and RR Availability and Reliability (2008)
- RR Modernization and Refurbishment (2009)
- RR Management Systems (Expected – 2012)

Database

- RR Ageing Database (2009/2011)
- > 170 submittals

Meetings

- Biannual TM – RR Ageing, Modernization and Refurbishment (NE and NS)
- ~ 50 participants from >30 Member States
  - Operators, regulators, vendors, independent authorities



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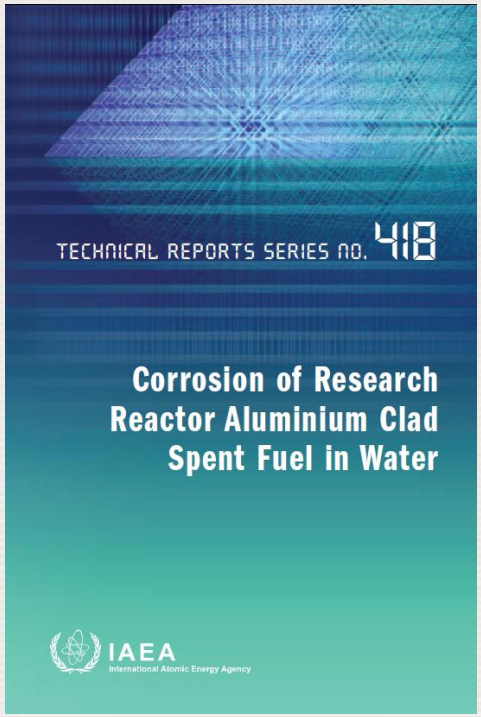
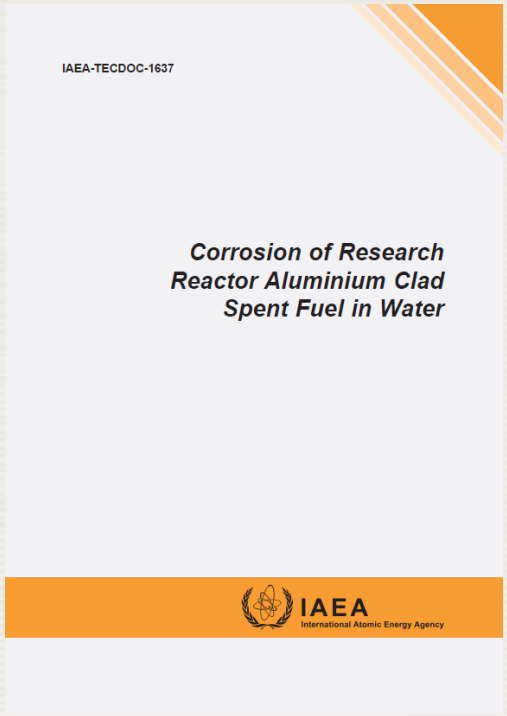
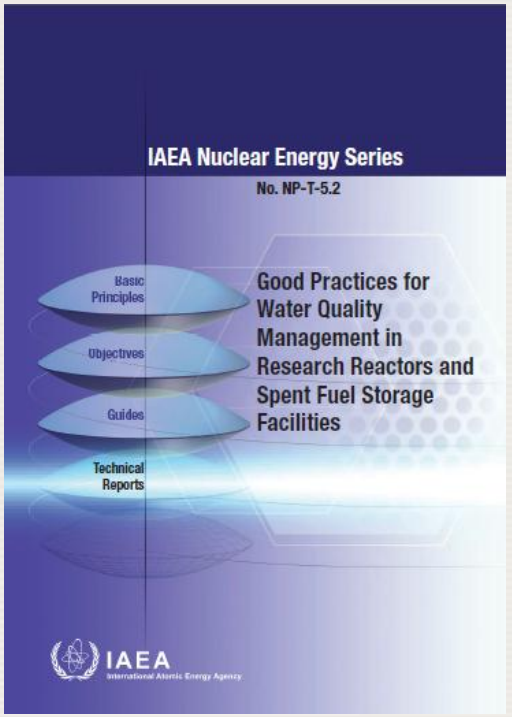
Summary of outputs



Phase I (1996-2002) - CRP



Phase II (2003-2006) – CRP
& Technical Cooperation Regional Project for Latin America (2001-2006)



Final Publication (2011)

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2012-2013 Activities - Ageing

Biannual TMs on Ageing Modernisation and Refurbishment to continue

- TECDOC – capture meeting contributions
- NE Series Report – Good practices in the development and implementation of Ageing Management programmes
- NE Series Report – Technologies and Techniques to inspect and monitor RR Primary System components
- Update of RR Ageing Database

Technical Cooperation – direct assistance

2012-2013 Activities - Ageing

Coordinated Research Project – core structural materials properties database

- Joint NA and NE activity
- Phase I – Assessment of Core Structural Material Programmes of RRs
  - Consultancy Meeting – June 2009
  - Technical Meeting – June 2010
- Phase II – Integrity Assessment of RR Core Components for Lifetime Extensions: Process, Status and Future Perspectives
  - Consultancy Meeting – October 2011
- Phase II – Monitoring and Assessment of RR Core Structural Materials
  - Coordinated Research Project – from 2012

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2012-2013 Activities – O&M

Launch RR O&M Network

- Formulate an IAEA RR O&M peer review service
  - Develop draft methodology – performance based
  - Ensure complimentary to INSARR (minimal overlap)
  - Complete prototypical RR Peer Review
- Publish methodology and make service broadly available to RR operating organisations

Coordinated Research Project – Improved I&C Maintenance Techniques using the Plant Computer

- On-line monitoring techniques and new software with existing computer systems to achieve extended calibration frequencies based on instrument condition as opposed to time in service.

Management of Spent Fuel from Research Reactors

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OUTLINE

- Issues and Challenges
- RRS Activities on RR Spent Fuel Management:
  - Issued Publications
  - Publications in Progress
  - Assistance to MS with RR Spent Fuel Issues

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Specific Back-end Issues and Challenges for RRs

- Accumulation of spent fuel
- Deteriorated spent fuel at some storage sites
- Presence of fresh and spent HEU
- Reluctance to decommission
- Little availability of back-end options for RR spent fuel
- “Take-back” programmes will soon achieve their goals and eventually cease
- As majority of the RRs wish to continue operating using LEU, inventories of LEU SNF will continue to be created

Specific Back-end Issues and Challenges for RRs

- Countries with one or more RRs and no nuclear power programme may have to choose between creating a national final disposition route for relatively small amounts of RR SNF (prohibitive in most cases), or permanently shutting down their RRs before the termination of the SNF take-back programmes
- Finding appropriate, sustainable and cost effective solutions for the management of the back end of the fuel cycle for these countries is critical to the continued use of RRs in these countries

RRS Activities on RR Spent Fuel Management

- Elaboration of documents gathering examples of good practices and lessons learned, with a focus on:
  - Proven technology solutions
  - Direct help to RR managers and operators
  - “How to do” rather than on “What has to be done”
  - Contributions from well operated facilities worldwide
  - Non-proliferation concerns, HEU minimization
- Direct assistance to MS with RR Spent Fuel Issues

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Issued Publications

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In 1996, a new CRP was initiated, to study “Corrosion of research reactor aluminium-clad spent fuel in water”, which resulted in publication of IAEA TRS 418 in 2003. The document includes:

Brief revision of the “state of the art” on Aluminium Corrosion

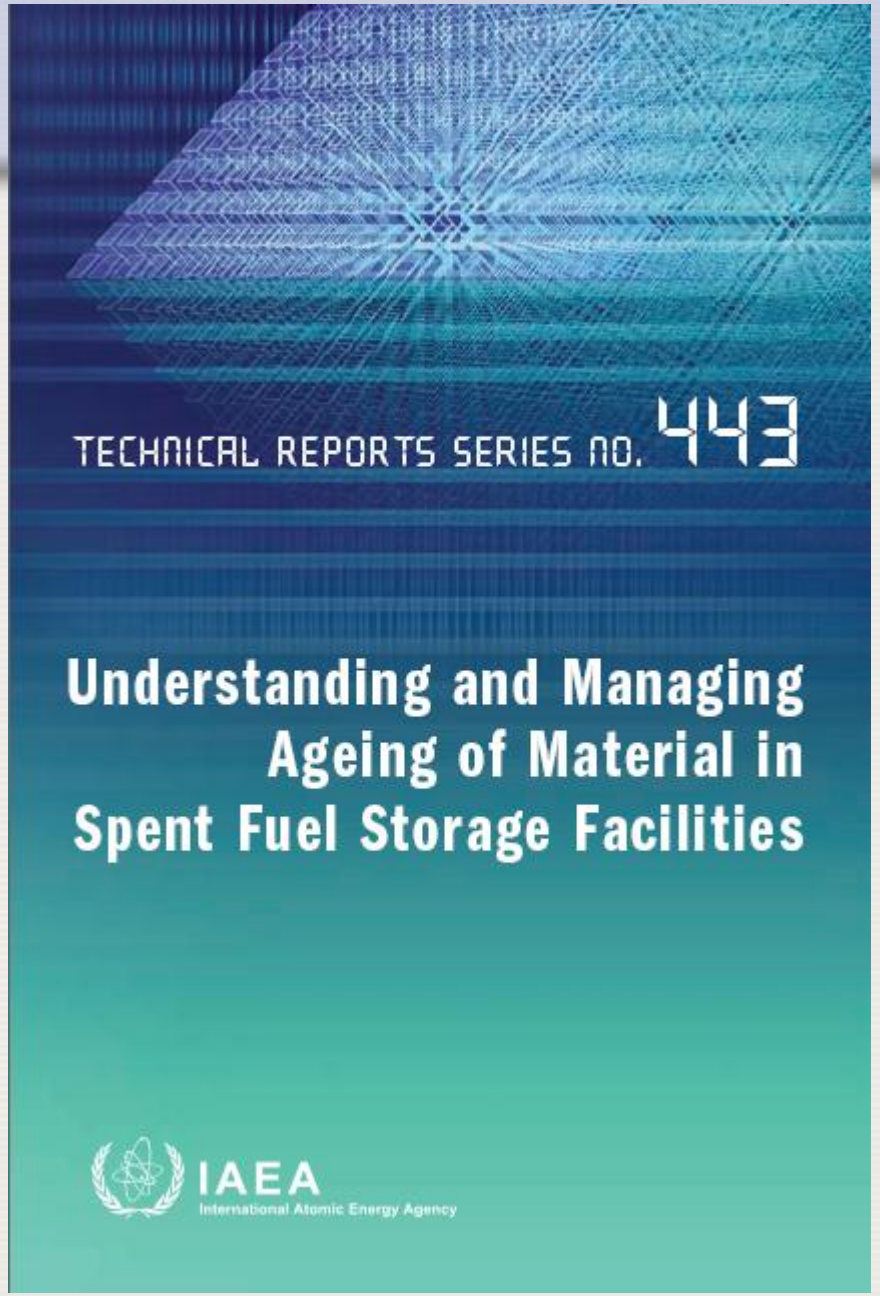
Description of National experiences on corrosion of aluminium clad spent fuel in water at various RR pools and basins

General guidelines for corrosion protection of RR aluminium clad spent nuclear fuel in interim wet storage

In 1999 the Agency started a new CRP, on

"Ageing of Material in Spent Fuel Storage Facilities"

which resulted in the publication of Technical Report Series 443 in 2006 :



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- 2000-2005 Latin American Regional Project Management of Spent Fuel from Research Reactors (RLA/4/018) Argentina, Brazil, Chile, Mexico and Peru.

- Define the basic conditions for a regional strategy for managing spent fuel that will provide solutions compatible with the economic and technological realities of the countries involved

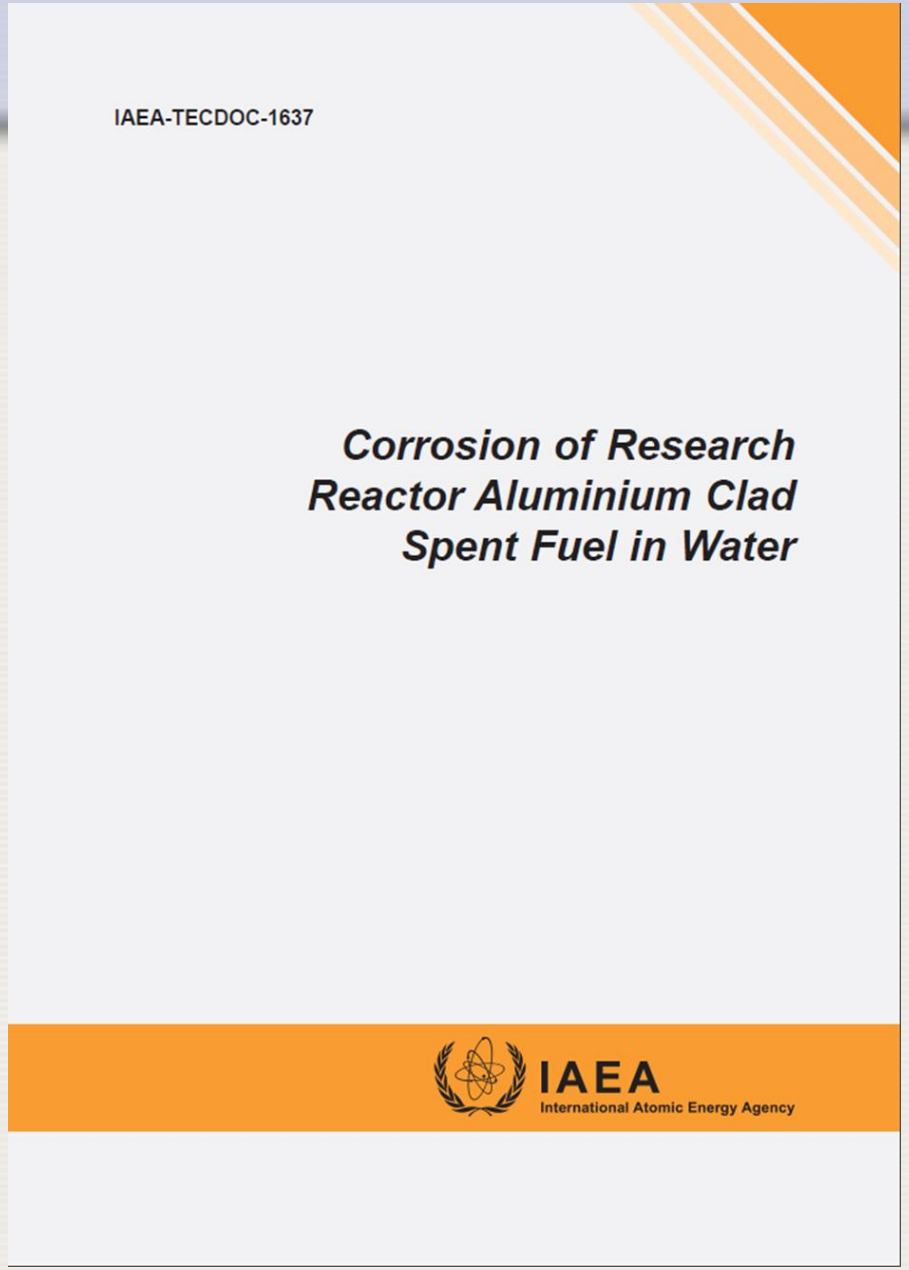
- Determine what is needed for the temporary wet and dry storage of spent fuel from the research reactors in the countries of the Latin American region that participated in the project

- This report documents the work on back-end options carried out within RLA/4/018

2002 a follow up CRP on “Corrosion of Research Reactor Aluminium Clad Spent Fuel in Water” (Phase II)

2001 Technical Cooperation Regional Project for Latin America (RLA/4/018) entitled Management of Spent Fuel from Research Reactors

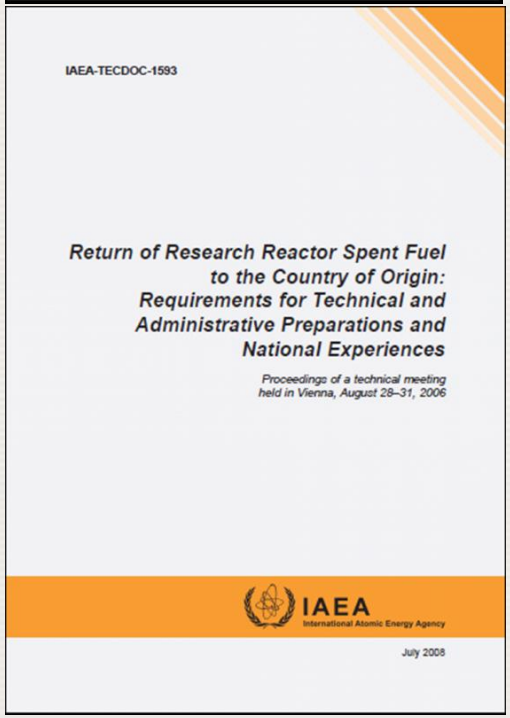
This report documents the work performed in the CRP and in RLA/4/018



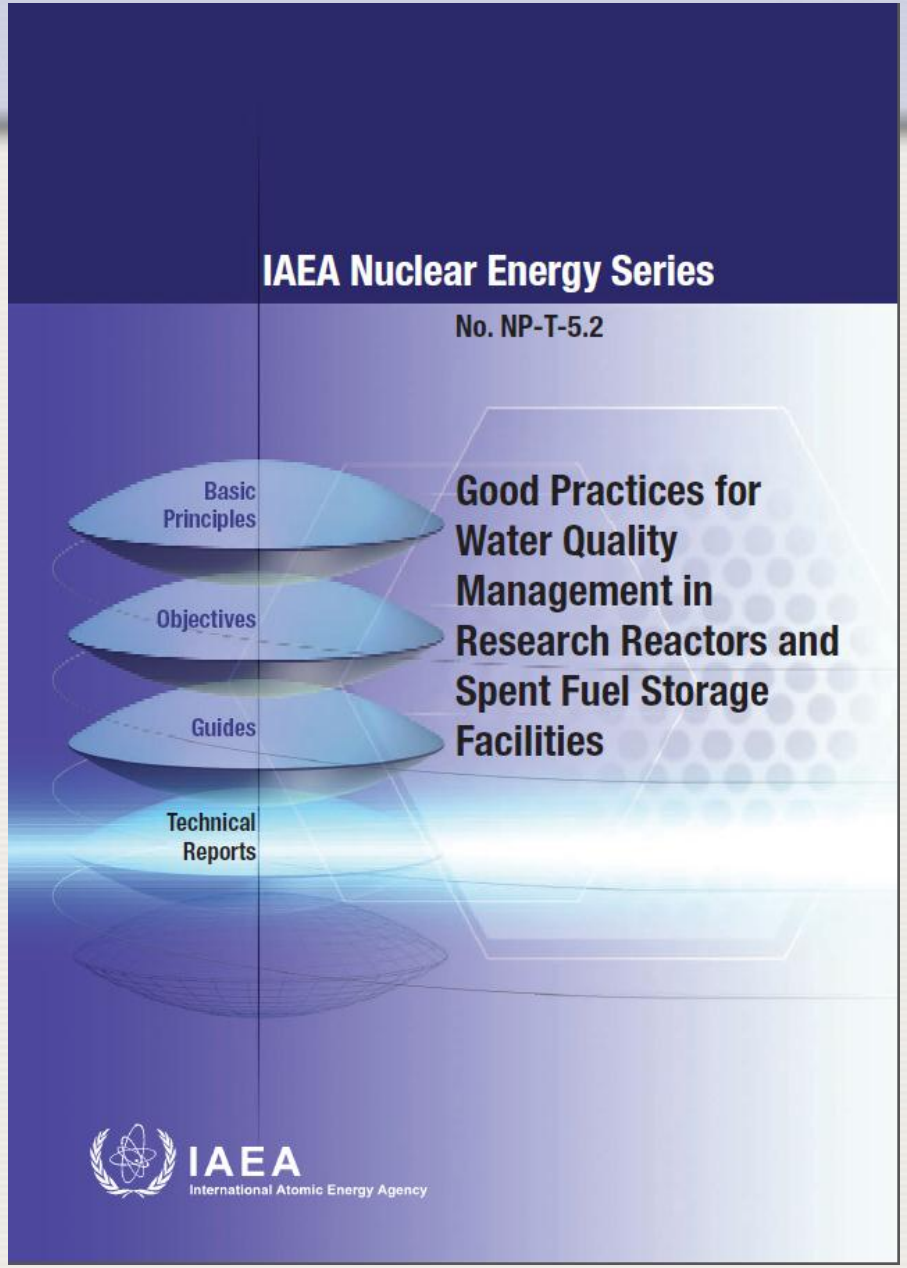
Guidelines for adminsitrative and technical preparations for shipping RR spent fuel back to the country of origin

Capture lessons learned from previous successful spent fuel shipments

Determine actions to be taken by IAEA and others to facilitate future shipments



- 2011 – Comprehensive report on water quality management in research reactors
- Catalogue of good practices
- Corrosion process that affects components
- Understanding of water chemistry and its influence on the corrosion process
- Requirements and operational limits for water purification systems of RRs
- Describes good practices for water chemistry control in research reactors
- Application: primary cooling system, spent fuel storage basins, secondary cooling system, emergency cooling systems, make-up system sand water reservoirs of RRs



Publications in Progress

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Publications in Progress

… on SNF storage and back-end solutions (1/3)

- **Subject:** cover long term interim storage and back-end solution of the RRSNF.
- **Rationale:**
  - **Disseminate good practices for long term interim storage:** Wet storage can be extended over long period (~50 years), then it may be transferred to dry storage for even longer periods. Thus, the continued safe, secure, reliable and economic handling, management and storage of RRSNF of all types, is a serious issue.
  - **Study commercial available back-end options:** the major goal of the take-back programmes supported by the US DOE GTRI is to eliminate inventories of HEU. Eventually, when these programmes have achieved their goals they will cease. Appropriate, sustainable and cost effective solutions for the management of the back end of the fuel cycle for LEU SNF will be a must for RR willing to continue operating.
- **Publications:** three publications are under preparation to support these objectives.

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Publications in Progress

… on SNF storage and back-end solution (2/3)

1) **Good practices for the management and storage of research reactor spent nuclear fuel (Proceedings Series):** Proceedings of a technical meeting held in Thurso, UK, October 19-22, 2009.
   - ✓ **Objective:** review of standard practices, criteria for SNF management and national programmes; wet and dry storage practices and experience.
   - ✓ **Status:**
     - Editorial work completed, IAEA's DCT approved for publication on Aug 31, 2011. **to be issued soon**

2) **Good Practices for Interim Wet and Dry Storage of RRSNF (NE Series)**
   - ✓ **Objective:** comprehensive document addressing all aspects of interim storage of SNF with a focus on dry storage (facility design, disposal options, regulatory body and safeguards requirements, as well as water chemistry ageing management, etc.)
   - ✓ **Status:**
     - 3rd CM in May'11: Document contents approved contributors identified.
     - Issuing Schedule: mid 2012.

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Publications in Progress

… on SNF storage and back-end solution (3/3)

3) **"Available Commercial Options for Back-end Management of Research Reactor Spent Nuclear Fuel" (NE Series)**

- ✓ **Objective:** elaborate a service description that would:
  - ✓ Introduce available service suppliers (reprocessing facilities) with country specific legislative background including possible back-end options, transport package requirements and licensing issues; time frame of a project implementation.
  - ✓ Give an overview on managerial and logistic support provided (package available, shipment mode supported, selection criteria, contraction and licensing support, as well as preparation and operation support.
  - ✓ outline benchmark rates for cost estimation
- ✓ **Status:**
  - ✓ 1st (kick-off) CM took place in the 1st week of May'11 with the participation of experts of (1) RR operating organization, (2) service provider (reprocessing) facilities, and (3) managerial support provider companies.
  - ✓ Table of contents accepted chapter contributors identified;
  - ✓ Schedule: to be issued by end of 2012

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Assistance to MS with RR Spent Fuel Issues

- Russian Research Reactor Fuel Return Program" (RRRFR)
- Foreign Research Reactor Spent Nuclear Fuel (FRRSNF) Acceptance Program

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Supporting International Efforts to Enhance the Security of Mo-99 supply

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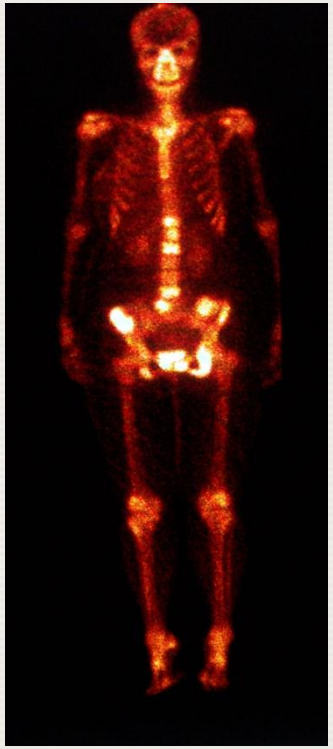
Security of Mo-99 supply

Since 2005, the Research Reactor Section (RRS) – in very close cooperation with the Division of Physical and Chemical Sciences and with the significant support of key, external partners – has supported international efforts to enhance the security of Mo-99 supply using every available IAEA implementation mechanism.

- Coordinated Research Projects
- Technical Cooperation Projects
- Regular Program and Budget activities
  - Networks and Coalitions
  - Participation in complimentary, international activities
  - Meetings
  - Missions
  - Publications
  - General Conference Side-events



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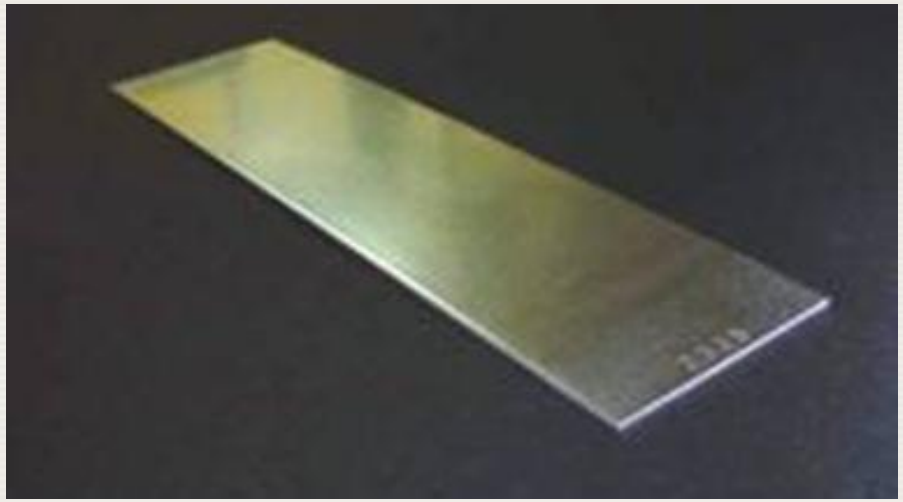
Security of Mo-99 supply

The transition of Mo-99 production away from the use of Highly Enriched Uranium (HEU) is a fundamental component of RRS Mo-99 projects. This objective enhances long-term Mo-99 supply security by:

- Minimising proliferation and security concerns
- Equalising production costs (OECD)
- Facilitating back-up or small-scale, regional production via the deployment of non-HEU technologies



LEU Mo-99 Target (CNEA, Argentina)

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Security of Mo-99 supply

Small-scale, indigenous or regional production

- CRP on Small-scale indigenous production using LEU fission or neutron activation from 2005 & supported by US DOE/NNSA
  - 7 Contract holders, 8 Agreement holders
  - November 2010 meeting on Waste and Quality Issues (Santiago, Chile)
- Regional TC project (ARCAL) in Latin America assessing feasibility of production for regional facilities (current project commenced in 2009)
  - 2011 – background study and reference plan.
- EURASIA Research Reactor Coalition – cooperating to produce low specific activity, Mo-99 via neutron capture of Mo-98 (launched in 2008)
  - Working to address availability of enriched Mo-98 and low activity generator technology
  - Implemented using a regional TC project and Regular Budget mechanisms (EB support from NTI)

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Security of Mo-99 supply

Small-scale, indigenous or regional production (cont'd)

- Expert Missions
  - Mo-99 production project progress review Mission to Egypt (2010)
  - Mission to Malaysia to assess Mo-99 production infrastructure readiness (2011)
  - IAEA and project counterpart Missions to US facilities and laboratories (2011 - ANL, Y-12, MURR)
- Interregional TC project – to deploy demonstrated, non-HEU production technologies in Member States seeking small-scale, or back-up production capability.
  - Proposal submitted for PUI funds, project planned and ready to commence in 2012

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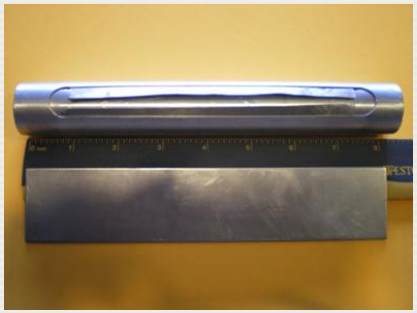
Security of Mo-99 supply

The transition away from HEU

- Supported by US DOE/NNSA and the Government of Norway
- Conversion planning for Mo-99 production facilities from HEU to LEU
  - Series of working group meetings for key stakeholders to review progress, exchange information and explore opportunities for mutually beneficial collaboration
  - August 2010 (kick-off), 2010 RERTR (update|), December 2011
- Report on the demonstrated status of development for non-HEU Mo-99 production technologies (2012)
  - Small to large scale
  - Basic concept to fully deployed
  - To be used as an input to the Interregional TC project
  - Since 2010 RERTR
    - February 2011 CM – draft report
    - 2 rounds of review complete



Annular metal foil target

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Security of Mo-99 supply

International cooperation

- Initially implemented via the Small-scale CRP and related mechanisms
- Pre-crisis: Contributions to seminars, symposia and relevant reports
  - Oslo, Norway Symposium on the Minimisation of HEU in the Civilian Nuclear Sector, June, 2006
  - Sydney, Australia Global Initiative to Combat Nuclear Terrorism, December 2007
  - Contributed to preparation and review of US National Academy of Science study, Medical Isotope Production without HEU, 2009
  - WOSMIP - 2009

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Security of Mo-99 supply

International cooperation

- During the Supply Crisis
  - Resources redirected to address immediate supply emergency
  - Invited to join OECD/NEA HLG-MR
    - Supported efforts to introduce new irradiation facilities (reactors) in Poland and Czech Republic
    - Support to address transportation related challenges
  - 53rd and 54th GC side events
- Since 3rd Quarter 2010 (immediate supply crisis abated)
  - Resumption of all activities to transition away from HEU
  - Remain involved in on-going supply security work of OECD/NEA
    - Economic study of HEU to LEU conversion (OECD)
  - WOSMIP - 2011
  - 55th GC side event

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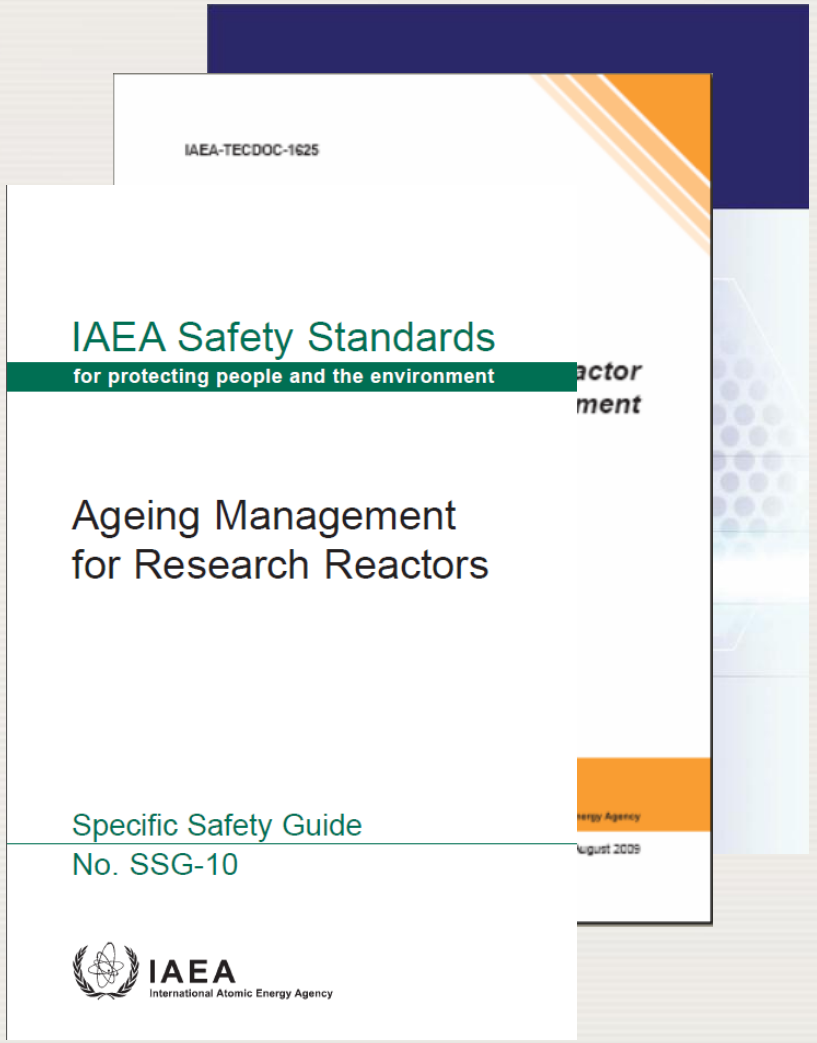
Security of Mo-99 supply

Closely related projects

- RR Availability & Reliability (2008)
- RR Modernisation and Refurbishment (2009)
- RR Ageing Management (2010)
  - Recurring bi-annual TM
  - Joint activity NS/NE
  - Ageing related operating experience database
    - Comprehensive update in 2011



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OMARR
Operations and Maintenance Assessment for Research Reactors

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OMARR Objective

The main objectives of OMARR missions are to conduct a comprehensive O&M review of the research reactor facility, verify compliance with existing plant procedures, suggest areas of improvement, and mutual transfer of knowledge and experience, between mission experts and reactor personnel

Mission Planning Details

Pre-OMARR Missions have the duration of usually 2 to 3 days and should occur 4 to 12 months before the Main Mission. The Pre OMARR team will consist of usually two IAEA staff members

The duration of the Main Mission varies from 1 to 2 weeks depending on the reactor complexity and topics to be reviewed. The Review team will usually consist of a minimum of two IAEA staff members, and 3 industry experts

The Follow-up Mission will take place 12 to 18 months after the Main Mission. The mission duration and required team composition, will be defined by the IAEA technical officer who conducted the Main Mission

Pre OMARR Mission

The following is an example of what a Pre OMARR Mission would most likely want to have available **:**

(a) the facility O&M documentation including: procedures, instructions, surveillance and calibration instructions, daily logs, and reporting processes;
(b) the quality assurance programme (with the focus on procedures and record-keeping);
(c) the configuration management programme (drawing and document control, engineering change control, vendor document control);
(c) the conduct of operations, the maintenance programme and control of modifications;
(d) procedures related to operational performance monitoring (performance indicator programme)
(e) personnel training and qualification; and
(f) the organization of O&M staff arrangements

OMARR

The OMARR Mission Scope

A probable scope of an OMARR mission is as follows:

(a) conduct an entry meeting to review the Mission objectives,
(b) examines O&M documentation of the reactor facility to compare programme implementation with procedural guidance;
(c) reviews operational records and performance of the reactor, if possible observing operations such as start-up and shutdown;
(d) reviews maintenance records, computer based systems for routine maintenance and breakdown maintenance support, if possible observing maintenance practises and reporting such as routine calibrations, and breakdown servicing of major equipment;
(e) reviews training records and, if possible, observes classroom, simulator or on-the-job training in practice.
(f) discuss technical and procedural details with the responsible personnel, operational engineering and maintenance staff.
(g) At the end of the mission, the team conveys its preliminary conclusions and recommendations according to the operating organisation request at a final, exit meeting. Subsequently, a mission report is submitted through official channels to the Facility Management concerned

OMARR Follow-up Mission

A suggested scope of the Follow-up Mission is:

1. Evaluation of the O&M improvements based on the recommendations provided at the final report

2. Feedback from counterparts on the OMARR service and the means to improve it

3. The preparation of a Follow-up Report

Assisting Newcomer Countries Pioneer-Endurable-Controllable-Easy-care and Safe (PECES) Research Reactor

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Assisting Newcomer Countries

Specific presentation on:

"Considerations and Infrastructure Milestones for a Research Reactor Project"

A. M. Shokr

Session C on Wednesday

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PECES Research Reactor

- A number of MS have informed the IAEA of their interest in a first research reactor
- Need of safety and technical infrastructure to support the reactor as well as new technical and managerial capabilities.
- The research reactor project will create long-term obligations
- The decision to proceed with a new research reactor should be based upon a comprehensive justification

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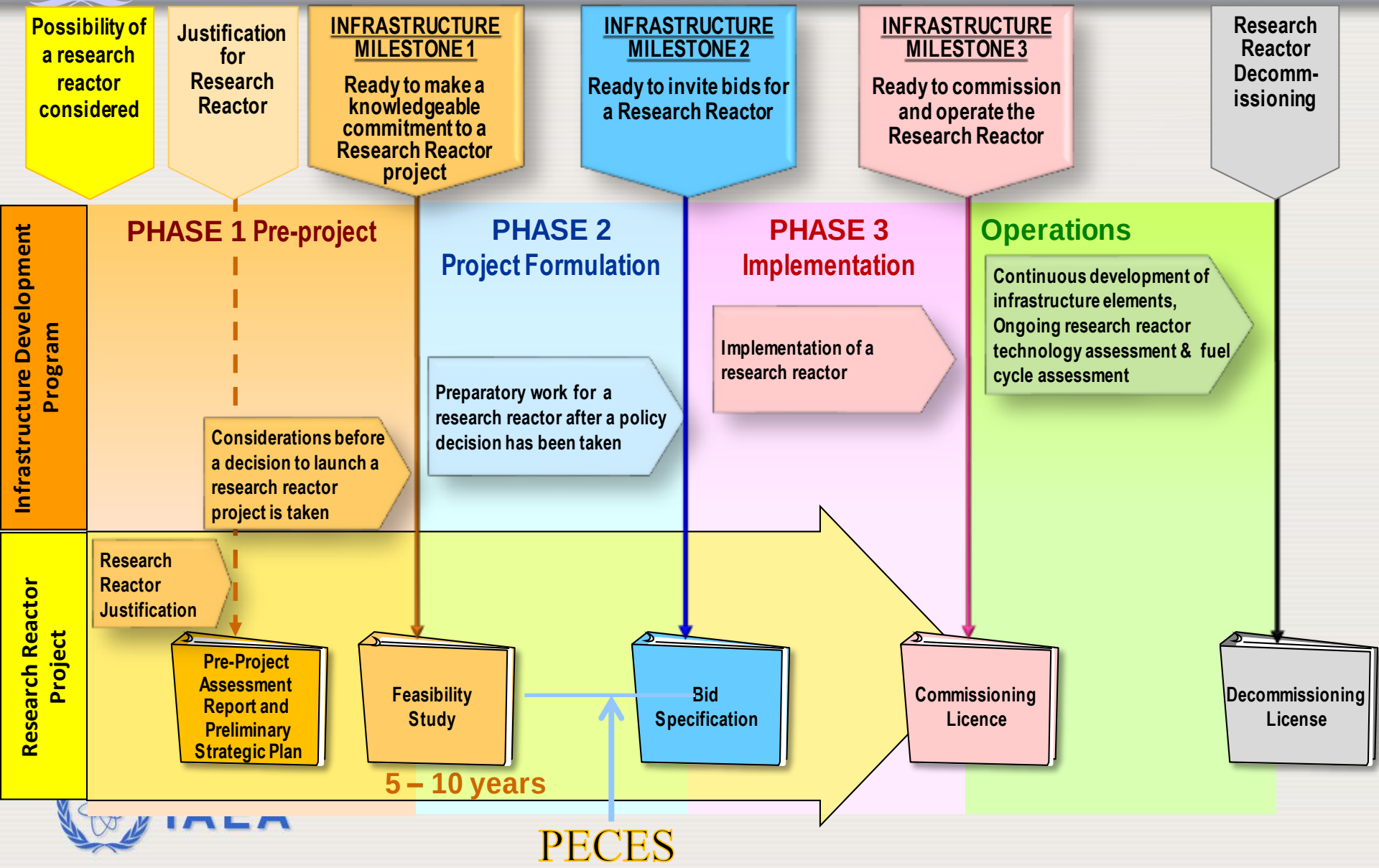
PECES Research Reactor



PECES Research Reactor

- *Phase 2* define the reactor technical specifications in order to be ready to invite bids from vendors

- Need for a technical document, assisting newcomers defining specifications of an ***"ideal RR"*** featuring (among other attributes) the following:
  - An extremely user friendly and flexible operating systems, which will be suited for training activities
  - A design that can tolerate malfunction without irreversible damage
  - A reprocessable and economic fuel (commercial type)
  - A limited direct access to the core
  - Etc….

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PECES Research Reactor

- Kick-off Consultancy meeting October 2011
  - Discussed need for PECES specifications
  - Prepared outline of the document
  - Drafted a synopsis of each chapter
  - Planned a follow-up activities
  - Defined writing responsibilities
  - Prepared a time schedule for the publication

Conclusions

IAEA's Cross Cutting Activities :

- Are designed to address RR issues and challenges
- Focus on the different facets of RRs for their effective utilization and management
- Promote international collaboration to assess projected needs over the long term for RRs on a global and regional basis

Conclusions (cont'd)

IAEA's Cross Cutting Activities :

- Address RR operation, maintenance, availability and reliability
- Address RR Modernization and Refurbishment
- Support New RR projects

Thank You for your attention!

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