

Technical Working Group Research Reactors

Presentation of P&B Projects

05-February-2008

IAEA, Vienna

NEFW, RR Group



IAEA

International Atomic Energy Agency

Project D.2.02 – Supporting Research Reactor Modernization and Innovation

Category:	Supporting Intergovernmental Decision Making
Activity:	1. Developing Research Reactor Coalitions and Centres of Excellence
Duration:	2007-2009
Participants:	Argentina, Armenia, Azerbaijan, Chile, Colombia, Czech Republic, Egypt, Hungary, Jamaica, Kazakhstan, Mexico, Peru, Poland, Romania, Russia, Ukraine, Uzbekistan, others
Funding:	Project Management 2007-2009 EB (NTI) Project Activities 2007-2008 TC, U.S. DOE, Norway?
Coordination:	NAPC, TC
Meetings:	Investigation of Neutron Scattering Coalition, 11-13 February, Vienna Development of Russian Nuclear Education and Training Coalition, 12-14 March, Moscow Others TBD

Project D.2.02 – Supporting Research Reactor Modernization and Innovation

Research Reactor Coalitions – Objectives

- Support HEU minimization (incentive and reward for conversion)
- Expand utilization of RRs through greatly enhanced cooperation, ultimately/ideally through a subscription-based coalition:
 - Distribution of demand, staging, or methods development for services/research
 - Back-up arrangements for outages
 - Optimize activities based on strengths/features of individual reactors
 - Reduce transport needs by geographical optimization
 - Reduce costs of medical radio-isotope development
 - Complete menu of services, facility/equipment investments, etc. through a single point of access
- Disseminate best practices in operations, QA, safety, security
- IAEA as “**facilitator**” and catalyst: generate and coordinate formulation of ideas/proposals/ventures; provide initial support (studies/analyses, meetings, training, PR materials).

Project D.2.02 – Supporting Research Reactor Modernization and Innovation

Research Reactor Coalitions – Progress/Results

- Training Workshop on Managing Commercial Isotope Sales, Imperial College, UK, May 14-16, 2007
- Exploratory discussions with Russia (agreed protocols), Dmitrovgrad, RF, Sept. 5-6, 2007 and Vienna December 13-14, 2007
- Strategic planning, Kazakhstan-Uzbekistan, Oct. 8-12, 2007
- Cooperative arrangements regarding radioisotopes, Peru, Chile, with MURR and McMaster, Oct. 15-19, 2007
- Preliminary coalition agreement on education and training, Argentina-Atominstitut, Oct. 22-23, 2007
- Preliminary coalition agreement on education and reactor training, Mexico (ININ)-LVNPP-(Atominstitut), Oct. 22-23, 2007
- Agreement on Latin American and Caribbean coalition, Jamaica-Mexico-Colombia, Oct. 30-31, 2007
- Workshop on Advanced Strategic Planning for Research Reactor Coalitions, Vienna, Austria, 17-19 December 2007 (proposals for Eastern European, Central Asian, and other coalitions)

D.2.02 – Supporting research reactor modernization and innovation

Activity 2

Provide advice and assistance as requested to RR planning, modernization or refurbishment

Category

Fostering information exchange and establishing databases

Objectives:

- Optimize the implementation of large engineering projects involving significant facility modification and/or the addition of new systems, capabilities or services,
- Collect and share information relevant to the planning, optimization and implementation of relevant projects,
- Encourage high profile project planning and integration with formal organizational strategic planning,
- Capture and share lessons learned (positive and negative) for the mutual benefit of the RR community and
- Discuss future opportunities and areas of support related to this topic.

D.2.02 – Supporting research reactor modernization and innovation

Provide advice and assistance as requested to RR planning, modernization or refurbishment (continued)

Duration

2006-2009

Participation

Open to any RR organisation. Specifically aimed at those who are planning major facility modification projects, have projects in-progress, or have recently completed major relevant activities.

Funding

Funded through regular budget

Coordination

NEFW



D.2.02 – Supporting research reactor modernization and innovation

Provide advice and assistance as requested to RR planning, modernization or refurbishment (continued)

Progress / Results

- October 2006 – Activity kick-off workshop hosted by TU-Delft, the Netherlands. Based on contributions from contributors, recommendation for Agency to publish technical report.
- December 2007 – Consultancy completed detailed review of the available material, confirmed the value of an Agency technical report and developed an outline of the document as well as letters requesting specific revisions/updates of reports submitted during the initial meeting.

Meetings / Future Activity

- Consultancy meeting possible in the 3rd quarter 2008 if required to review revised contributions and finalize the draft report.

D.2.02 – Supporting research reactor modernization and innovation

Activity 3

Hold international workshops (one every 2 yr) on modernization and refurbishment of RRs (2006 onwards)

Category

Fostering information exchange and establishing databases

Objectives

- Optimize the implementation of large engineering projects involving significant facility modification and/or the addition of new systems, capabilities and services,
- Provide a periodic international forum for discussion of planning and implementation of relevant projects amongst facility representatives,
- Periodically consider and facilitate revision of the technical report on RR Modernization and Refurbishment and
- Discuss future opportunities for Agency collaborative support on this topic.

D.2.02 – Supporting research reactor modernization and innovation

Hold international workshops (one every 2 yr) on modernization and refurbishment of RRs (2006 onwards) - continued

Duration

2006-?

Participation

Open to any RR organisation. Specifically aimed at those who are planning major facility modification projects, have projects in-progress, or have recently completed major relevant activities.

Funding

Funded through regular budget

Coordination

NEFW

D.2.02 – Supporting research reactor modernization and innovation

Hold international workshops (one every 2 yr) on modernization and refurbishment of RRs (2006 onwards) - continued

Progress / Results

October 2006 – Activity kick-off workshop hosted by TU-Delft, the Netherlands. Based on contributions from contributors, recommendation for Agency to publish technical report.

Meetings / Future Activity

Next Workshop to be organized following the release of the technical report on this topic.

D.2.02 – Supporting research reactor modernization and innovation

Innovative Methods in Research Reactors Physics

Background

- Recent developments in computer technology and codes allows for better simulation of the processes taking place during the steady state operation and transients of research reactors.
- Application of these methods and codes provides for improving the design of the research reactors and the associated experiments, and enhancing operational and safety performance.

D.2.02 – Supporting research reactor modernization and innovation

Innovative Methods in Research Reactors Physics (cont'd)

Needs

- **Benchmarks against experimental data to demonstrate the quality of computational methods and codes, through a formal qualification process.**

D.2.02 – Supporting research reactor modernization and innovation

Innovative Methods in Research Reactors Physics (cont'd)

Actions

- **Consultancy Meeting** 10-12 March 2008, Vienna, to discuss the different elements of the development and implementation of a new **Coordinated Research Programme (CRP)**. In particular, the expected research output, the action plan and related activities, and the logical framework of the CRP.

D.2.02 – Supporting research reactor modernization and innovation

Innovative Methods in Research Reactors Physics (cont'd)

CRP's Objectives

- Transfer know-how from leading institutes to the other organizations participating in the CRP;
- Establish procedures for the qualification of the computational tools for operation and safety analysis of research reactors;
- Apply the available codes to different research reactor cases, making detailed comparison of results between different organizations and codes
- Evaluate the user effects on the results predicted by different computer codes.

D.2.02 – Supporting research reactor modernization and innovation

Activity – (future)

Coordinated Research Project on LEU fuelled, aqueous, homogenous reactor (AHR) utilisation for the production of ^{99}Mo and other isotopes

Category

Not yet categorized

Objectives

- Support HEU minimization
- Help satisfy increasing demand for ^{99}Mo and other isotopes through the development and utilization of solution reactor technology,
- Address identified challenges associated with solution reactor based production of ^{99}Mo and other isotopes,
 - complete and share research on the further optimization of the fuel base, especially the use of LEU instead of HEU,
 - analyze fission product effects on the process and final products,
 - determine long term operational effects including corrosion and
 - complete feasibility studies.
- Results from different organizations and codes will be reviewed and shared so the accuracy and precision of different approaches can be properly evaluated and
- Discuss future opportunities for Agency collaborative support on this topic.

D.2.02 – Supporting research reactor modernization and innovation

CRP on LEU fuelled, AHR utilisation for the production of ^{99}Mo and other isotopes
(continued)

Duration

2008-2012

Participation

- First priority is organisations with advanced AHR projects
- ^{99}Mo separation / production operations or technology experience and interest in AHR technology

Funding

Funding being organized through combination of regular budget and extra-budgetary funds

Coordination

NEFW, NAPC and possibly NSNI

D.2.02 – Supporting research reactor modernization and innovation

CRP on LEU AHR utilisation for the production of ^{99}Mo and other isotopes (continued)

Progress / Results

June 2007 consultancy meeting in Vienna met to assess the current state of the relevant technologies (solution reactor and ^{99}Mo separation) and make recommendations to the IAEA. Participants included China (MIPR-NPIC), France (CEA), Netherlands (Tyco International), Russia (RRC Kruchatov Institute and IPPE), USA (BWXT and DOE). The proposed CRP is one of the group's recommendations.

Meetings / Future Activity

First coordination meeting planned for the end of 2008.

D.2.03 – Addressing research reactor fuel cycle issues

Activity 1

Maintain a database on spent fuel from RRs, publish summary statistics periodically

Category

Supporting intergovernmental decision making

Objectives

- Collect RR fuel cycle information to assist in the management of related programmes (HEU shipment and conversion to LEU),
- Assist in the development and implementation of RR related Agency activities and
- Facilitate customized support to individual facilities.

D.2.03 – Addressing research reactor fuel cycle issues

Maintain a database on spent fuel from RRs, publish summary statistics periodically (continued)

Duration

1993-?

Participation

Value of the database is directly proportional to quantity and quality of participation.

Funding

Funded through regular budget

Coordination

NEFW, NAPC

D.2.03 – Addressing research reactor fuel cycle issues

Maintain a database on spent fuel from RRs, publish summary statistics periodically (continued)

Progress / Results

- Two RR databases merged (~2005)
- Very low input from last update request (2006)
- In the 3rd quarter 2007 a project was initiated to enable secure, web-based updates from individual facilities.
- Initial programming completed in 4th quarter 2007
- Internal testing is in-progress

Meetings / Future Activity

- Beta testing to begin in 2nd quarter 2008
- Release in 2008 depending on beta participation and performance

Project D.2.03 – Addressing Research Reactor Fuel Cycle Issues

Category:	Providing Services to Member States
Activity:	3. Support Activities Related to Research Reactor Core Conversion
Duration:	2008-2009
Participants:	Various – U.S., Japan, Norway, Russia, NGOs
Funding:	2008 (EB – Norway)
Coordination:	NSNS
Meeting:	Status Report on Pulse Reactors and Critical Assemblies, 16-18 January 2008, Vienna

Project D.2.03 – Addressing Research Reactor Fuel Cycle Issues

Pulse Reactors/Critical Assemblies – Objectives

- Present, compare, discuss, and review available data regarding PR and CA facilities worldwide and their status in IAEA RRDB.
- Discuss future civil uses, applications, and requirements for PRs/CAs.
- Discuss opportunities to optimise operation/utilization of PRs/CAs, including feasibility of collaborative efforts
- Discuss possible international user facilities and/or centres of excellence
- Gather information for recommendations on “optimization” of existing facilities based on anticipated civil requirements, including possibility of converting facilities with substantial quantities of HEU to LEU.
- Discuss challenges (HEU utilization) and opportunities related to desired technical capabilities (computer modeling).
- Plan future activities, including the necessary financial and other resources, to carry out programmes

Project D.2.03 – Addressing Research Reactor Fuel Cycle Issues

Pulse Reactors/Critical Assemblies – Results

- A status report including updated list of facilities was prepared.
- Recommendations for further IAEA meetings/activities:
 1. Develop ideas on how to establish and operate a fund for projects:
 - to facilitate the conversion of operating facilities, or shut down and de-fueling of unneeded HEU and Pu-fuelled PRs and CAs and,
 - for establishing and strengthening centres of excellence involving PRs and CAs
 2. Study means for minimizing the use of HEU and/or level of enrichment in PRs and CAs, including CAs related to fast-neutron reactors.
 3. Develop guidelines for establishing, financing, and operating centres of excellence, including ensuring physical protection and nuclear security.

Activity 7

Low Enriched Uranium (LEU) Fuel Utilization in Accelerator Driven Sub-Critical Assembly (ADS) Systems

Objectives

- To study the feasibility of converting the present ADS HEU Facilities into LEU and to promote the utilization of LEU in all future ADS systems.
- TECDOC planed for 2ndQ 2010

LEU Fuel Utilization in ADS Systems (continued)

Background

- At present, more than twenty Member States have activities in ADS.
- HEU or LEU can be used for the sub-critical assembly fuel in ADS Systems. Proliferation concerns encourage the use of LEU.
- In 2005 IAEA organized a TM, in 2006 a first meeting was held and a 3 years collaborative work was initiated.

LEU Fuel Utilization in ADS Systems (continued)

Background (cnt'd)

- 40 researchers from 15 Member States are participating. Extra budgetary funds from USA DOE
- Seven facilities included in the working plan: 2 from Belarus; 1 from Ukraine; 1 from Brazil, 1 from Italy; 1 from Serbia, and 1 from India.
- For each facility the participants defined its area of interest and proposed supporting activity.

LEU Fuel Utilization in ADS Systems (continued)

How it works (data)

- Each participant upload its results, for access to other participants, to a password protected web data base: www-nfcis.iaea.org.
- Results are discussed in an annual meeting held in November. (Next Madrid Nov. 2008)
- Some results shared with existing NE's CRP on ADS Benchmarking.

LEU Fuel Utilization in ADS Systems (continued)

How it works (funding)

- Participants from developed countries: cost free basis.
- Others: Yearly Consultant Service Agreements (CSA) paid upon completion of services to the satisfaction of the Agency.

Project D.2.03 – Addressing Research Reactor Fuel Cycle Issues

LEU Fuel Utilization in ADS Systems (continued)

	Yalina - Thermal - Belarus	Yalina-Booster - Conversion - Belarus	Kharkov Facility Ukraine	ADS IPEN/MB-01 Brazil	RC-1 TRIGA - Italy -7	H5B Serbia	AHWR India
Argentina	SbM - SbD - K			SbD - SbM			
Belarus	S - SbM - K	S - SbM - K	SbM ?	SbM ?			
Brazil - IPEN	SbM - SbD - K	K		S - SbM - SbD - K	K		
China		SbD		SbD			
Germany - FZK	SbM - SbD - K				SbD - SbM - K		
Germany - FZD							
Hungary	SbM			SbM ?		SbM ?	
India	SbM - SbD - K	SbM - K					S - SbM - SbD?
Italy-ENEA	K	K		K	S - SbM - SbD - K		
Italy-Torino	K	K		K	K		
Korea	SbM	SbM	SbM	SbM			
Poland	SbM	SbM	SbM - SbD				
Serbia	SbM	SbM		SbM ?		N - S - SbM	
Spain		SbM		SbM		N	
Sweden		SbM - K			SbM - K		
Ukraine	SbM	SbM	N - S - SbM - K - Ex				
USA	SbM - SbD - K	SbM - SbD - K	N - S - SbM - K - Ex		K - SbD	N	SbM

Nomenclature

- N - Neutron Source
- S - Specification
- SbM - Subcritical Assembly-Monte Carlo
- SbD - Subcritical Assembly - Deterministic
- K - Kinetic Parameters
- Ex- Experimental Program

ACTIVITIES MATRIX

Project D.2.03 – Addressing Research Reactor Fuel Cycle Issues

- Category:** Promoting Research and Development
- Activity:** 9. Coordinated Research Project on Developing Techniques for Small-Scale Indigenous Production of Mo-99 Using LEU or Neutron Activation (T.1.20.18)
- Duration:** 2005-2009/10
- Participants:** Contracts – Chile, Egypt, Kazakhstan, Libya, Pakistan, Romania (2)
Agreements – Argentina, India, Indonesia, Korea, Poland, U.S. (2)
- Funding:** 2005 (EB – US DOE); 2006 (RB, TC, EB); 2007 (EB – US DOE, Norway, Libya NC, NTI); 2008 (EB); various in-kind
- Coordination:** Joint with NAPC
- Meetings:** 3rd Research Coordination Meeting, 13-16 October 2008, Colombia, Missouri

Project D.2.03 – Addressing Research Reactor Fuel Cycle Issues

Mo-99 CRP - Objectives

- Support HEU minimization
- Foster capacity building for local/regional self-sufficiency and access to nuclear medicine, sustainable development.
- Assist member states with adoption of LEU-Modified Cintichem (foil targets) or neutron activation (gel generators) technology.
- Provide technical and material assistance to perform trial irradiations, bench-scale separation of Mo-99, meeting purity specifications, and prepare TECDOC.
- NOT aimed at conversion of large-scale commercial producers (but they are participating/contributing)

Project D.2.03 – Addressing Research Reactor Fuel Cycle Issues

Mo-99 CRP – Progress/Results

- Aluminum tubing (ANL) and glassware (IAEA) (2006/early 2007)
- Two workshops (Indonesia, March 2006; Vienna, December 2006)
- ANSTO target safety documentation (early 2007)
- 2nd RCM Bucharest and visits to Pitesti & Magurele (April 2007).
- LEU foils from KAERI to Chile, Indonesia, MURR, Poland, Romania (Fall 2007)
- Project website; technical reports ANL, Chile, Libya, MURR, Pakistan
- Preparation of national safety analysis reports; modifications of facilities/hot cells.
- SVs/training – Indonesia (Korea, Fall 2007); Chile, Libya (Indonesia, March 2008) and Libya (Chile, July 2008)
- R&D activity on foil target thermal contact resistance and foil/plate target
- IAEA participation in NAS study (Feb/June 2007) and Global Initiative (December 2007) meetings
- Pakistan decided to pursue LEU-based production.
- Chile - trial irradiation amounts same as weekly national requirements
- MURR - possible production 30 – 50% U.S. market

Project D.2.03 – Addressing Research Reactor Fuel Cycle Issues

Category: Promoting Research and Development

Activity: 10. Coordinated Research Project on Conversion of MNSRs to LEU (T.1.20.20)

Duration: 2006-2009

Participants: Contracts – China (3), Ghana, Nigeria, Pakistan, Syria

Agreements – U.S.

Funding: Extrabudgetary (U.S. DOE), some RB

Coordination: NSNS, NSNI

Meetings: 2nd Research Coordination Meeting, 13-15 May 2008, Vienna

MNSR Conversion CRP - Objectives

- Support HEU minimization
- Assist member states to perform calculations to support eventual conversion of HEU cores to LEU (preparation of safety cases, OLA, etc.)
- Achieve consensus on candidate conversion fuel
- Establish a model conversion project
- Interface with donors on funding for LEU core procurements
- Prepare arrangements for removal of spent HEU cores

Project D.2.03 – Addressing Research Reactor Fuel Cycle Issues

MNSR Conversion CRP – Progress/Results

- 1st RCM Vienna (December 2006); Workshop on core calculations (Vienna, June 2007)
- Project website with all meeting materials and reports:
 1. China - HEU core characterization and conversion core analyses
 2. Ghana - core conversion analyses; comparison of candidate fuels
 3. Nigeria - core conversion analyses; safety analysis
 4. Pakistan - neutronic and thermohydraulic analyses; amendments to SAR
 5. Syria - characterization of HEU core, initiating events, OLC
- Possible conversion fuel - UO₂, 4.2mm meat pellet, 5.1mm O.D clad, 12.5% (or 5.5mm OD fuel rod with 4.3mm meat pellet, 12.5%)

D.2.03 – Addressing research reactor fuel cycle issues

Activity 15

Provide RR support needed for the innovative nuclear power reactors and fuel cycles

Category

Other / uncategorized

Objectives

- Assure the availability of technical capabilities required to support innovative (next generation) nuclear reactors and fuel cycles,
- Define RR capability 'needs' required to support innovative fuel cycle development (principally advanced fuel and materials research),
- Identify available capabilities,
- Quantify and qualify capability gaps and
- Discuss future opportunities for Agency collaborative support on this topic.

D.2.03 – Addressing research reactor fuel cycle issues

Provide RR support needed for the innovative nuclear power reactors and fuel cycles (continued)

Duration

2006-2009

Participation

Algeria, Belgium, Canada, Chile, Czech Republic, France, Hungary, India, Indonesia, Italy, Japan, Korea, the Netherlands, Russia and USA contributed to a November 2006 Technical Meeting.

Funding

Regular P&B

Coordination

NEFW, with input from NAPC and NSNI

D.2.03 – Addressing research reactor fuel cycle issues

Provide RR support needed for the innovative nuclear power reactors and fuel cycles (continued)

Progress / Results

- First TM produced a comparative matrix of ‘needed’ technical capabilities vs. those currently available at different facilities.
- Foreseen capabilities were also listed (from new/proposed facilities or significant, planned modifications)
- Recommendation to further develop the topic and issue an agency technical report

Meetings / Future Activity

Next meeting being planned for 2nd quarter 2008

D.2.05 – RR Operation, Maintenance, Availability and Reliability

Activity 1

Prepare a technical report on the optimization of research reactor availability and reliability

Category

Developing methodologies and guidelines

Objectives

- Achieve RR performance excellence,
- Optimize RR O&M resource management (financial, human, equipment, etc.),
- Identify good practices which have resulted in demonstrated operational excellence within highly utilised RRs sensitive to inadvertent operational events,
- Share these practices with RRs seeking improved RR performance,
- Foster an international forum for discussion and peer networking in a context of RR O&M management and
- Discuss future opportunities for Agency collaborative support on this topic.

D.2.05 – RR Operation, Maintenance, Availability and Reliability

Prepare A&R document (continued)

Duration

2006 – 2008

Participation

Australia, Austria, Canada, Hungary, Japan, Korea, the Netherlands, South Africa and the USA either participated in meetings or otherwise contributed to the document.

Funding

Regular programme and budget

Coordination

NEFW (with reviews from NAPC and NSNI)

D.2.05 – RR Operation, Maintenance, Availability and Reliability

Prepare A&R document (continued)

Progress / Results

- First consultancy in September 2006 formulated document and set scope for the remainder of the effort.
- Second consultancy April 2007 hosted by AECL in Mississauga, Canada; drafted all sections of document.
- Final draft was developed at IAEA during 3rd quarter 2007.
- All internal IAEA technical reviews were completed and the final draft was sent for publication in January 2008.

Meetings / Future Activity

Participating in existing RR collaborative groups as an observer to develop related activities if/as needed.

D.2.05 – RR Operation, Maintenance, Availability and Reliability

Activity 2

Prepare report on RR management system development

Category

Developing methodologies and guidelines

Objective

- Improve RR management and performance (error reduction, consistent and predictable outcomes, process optimization, etc.),
- Report on activities and status of work within different facilities to develop integrated management systems,
- Share examples of management systems and
- Discuss future opportunities for Agency collaborative support on this topic.

D.2.05 – RR Operation, Maintenance, Availability and Reliability

Prepare report on RR management system development (continued)

Duration

2008 – 2009

Participation

Interested organizations / Member States are invited to participate.

Funding

Regular programme and budget

Coordination

NENP, NEFW and NSNI

D.2.05 – RR Operation, Maintenance, Availability and Reliability

Prepare report on RR management system development (continued)

Progress / Results

Existing document preparation in progress within NENP.

Meetings / Future Activity

- Support the completion of the document being prepared by NENP.
- 2009 - possible management system Workshop based on the final document (final date dependent on document issue date).

Thank You

For your attention