

Report on the Technical Meeting on

***Strategic Planning for Sustainability-Mediterranean
Region:
Research Reactor Utilization***

**Action Plan 2008-2010
(Proposal)**

**IAEA Headquarters
Vienna, Austria**

19-22 February 2008

1. INTRODUCTION

The unique properties of neutron (such as neutral charge, large penetration in most of the elements, magnetic moment) make research reactors (RR) a powerful tool in many scientific and engineering fields. RRs offer a diverse range of applications like large scale radioisotope (RI) production for medical and industrial use, neutron beam research for materials studies, neutron irradiation for transmutation doping of silicon and material testing for fusion and fission. Education and training in all nuclear technology areas including for operators and users of nuclear facilities, radiation protection personnel, regulatory personnel, or students and researchers is another important area where RRs have a large contribution.

A large number of RRs are in regular operation and they are fully utilized for large scale RI production, employing neutron beams in research and for industrial applications, neutron irradiation for transmutation doping of silicon in the range of a few tons per annum, material testing, etc. There are a number of new multipurpose RRs and specific utility-based RRs being built for neutron beam techniques and/or RI production.

However, due to various reasons such as lack of funds and trained manpower, and the inability to elicit the support of end users, many RRs are not effectively utilized. Under utilization may result in prolonged planned or unplanned shutdown of the RRs and gradually becoming a concern from the point of view of safety, security or non-proliferation. To resolve these issues and to ensure the sustainability of research reactors and thus their future contribution to science and technology, energy, medicine, industrial and environmental applications and cultural heritage, it is necessary to work out regional strategies for effective and efficient utilization of RRs consistent with their features taking into account the national support and users' profile at national or regional level. Regional collaboration, networking and coalitions of research reactors and their users among Member States (MS) may result in the development of synergies and joint offering of complementary services, leading to better utilization of all involved facilities. This could also contribute towards upgrading existing facilities and/or developing new facilities and making them more accessible to users in countries without research reactors. The present technical meeting (TM) is a follow-up meeting to the workshop held in Vienna in March 2007 for the Mediterranean Region (including the Balkans) and includes both MS with (Appendix 1) or without RR (Appendix 2).

2. PURPOSE OF THE MEETING

There are 12 RRs in the Mediterranean region with potential for applications in various fields. The purpose of the TM was to promote the efficient utilization of the RRs through regional collaboration and sharing of resources in the Mediterranean region with countries having RRs and those who do not have but desire to use the available facilities. The participants presented and discussed their work, facilities available, activities and interest in networking to enhance research reactor utilization. The participants not having RR presented their interests in the use of nuclear techniques and areas where they would like to use RRs. In addition, discussion on following areas took place:

- Follow up the collaboration activities, proposed in the previous (2007) Workshop;
- Possible additional areas for collaborations in RR utilization, for example, neutron beam applications, neutron radiography, materials studies/testing, neutron irradiation, NAA and neutronic calculations;
- Possible mode of operation or steps to be taken for initiating collaboration;

— Create a network of users for research reactors for their effective utilization.

3. OUTPUT

The output of this Technical Meeting is a brief summary of each particular discussion on networking and cooperative arrangements and presentations by the participants that took place during the meeting. The discussion puts forward ideas and proposals to enhance RR utilization and initiates a dialogue and a platform for collaborations among the countries of the region and which are contained in this report.

4. OUTCOME

After implementation of the specified outputs, the participating MS will develop cooperation and collaborations for increased utilization of the RRs among the countries involved in order to improve the sustainability of those facilities. It also examined/examines?? means for providing access to the capabilities of their facilities to the MS not having RRs. If implemented, these proposals will provide MS not having RRs with benefits of peaceful uses of nuclear science and technology through facilitated use of the research reactor facilities available in the neighbourhood (region) and around the world and will assist them to develop expertise in related areas in order to contribute to their sustainable development objectives.

5. MINUTES OF THE TECHNICAL MEETING

The TM on “Strategic Planning for Sustainability – Mediterranean Region: Research Reactor Utilization” was held at the IAEA headquarters in Vienna from 19 to 22 February 2008. Participants from Azerbaijan, Egypt, Greece, Montenegro, Syria and Tunisia attended the TM. The list of participants is attached (Appendix III).

Mr. G. Mank, Head of Physics Section welcomed the participants. He talked on the role of RRs in science, particularly in material research and development. He stressed on the need of improving RR utilization for technological needs of the future and regional collaboration for manpower development. Attracting young newcomers in the field should be a matter of particular concern.

Mr. S. Paranjpe, Scientific Secretary of the TM welcomed the participants.

The participants introduced themselves including their field of interest and nature of work in their respective canthers. Mr. S. Jovanovic was nominated to chair the TM. Mr. M. Shaat and Mr. N. Reguigui were the reporters of the meeting. Appendix IV gives the agenda of the TM.

The technical session started with the presentation by Mr. S. Paranjpe. He gave a brief account of the IAEA activities related to RR utilization. He then presented the background of the TM and expectations from the participants.

During the meeting the existing facilities of the countries having RRs were presented and also the needs of the MS not having RRs for having access to RRs and participating in common projects.

6. OVERVIEW OF PRESENTATIONS

Mr. Paranjpe gave presentation on the IAEA role and background and expectations from this technical meeting. He also presented methodology on strategic planning and regional

networking for sustainability using research reactors. The following topics were emphasized: isotope production, Neutron activation analysis, neutron radiography, neutron beam research and, material characterization and testing consistent with research reactor features. He then gave an overview of NAPC activities and the existing RRs in the region and the potential participants with no RR. Also a separate presentation on research reactor utilization through networking in the region of SE Asia and in Africa was given.

Mr. Shaat from Egypt presented Research Reactors Status and Potential Areas of Collaborations in Egypt. He also gave details of numerous facilities that exist in the two reactors and their uses. Mr. Shaat gave presentation on the achievements realized in neutronic calculations in Egypt and cooperation with other countries in this field.

Mr. Gabulov from Azerbaijan talked about current regulatory infrastructure on radiation safety in his country, the collaboration programs, and the role of the Institute of Radiation Problems of Azerbaijan National Academy of Sciences. He also presented plans for the implementation of research reactor in the Republic of Azerbaijan.

Mr. Stamatelatos from Greece had a presentation on the Efficient Utilization of the Greek Research Reactor through Regional Networking in the Mediterranean Region. Current situation with the research reactor was reviewed, including the expectations from refurbishing the reactor and strategic planning [expected to restart by 2009]. He offered to share facilities with institutes from the region, emphasizing a couple of topics of common interest such as cultural heritage preservation and material characterization through neutron beam experiments. Large sample NAA experience in Greece was briefly presented.

Mr. Jovanovic from Montenegro summarized in short the conclusions and the expectations from the 2007 meeting and suggested a number of topics and fields of cooperation, such as k_0 method for neutron activation analysis, semiconductor detector characterization and reactor neutron flux characterization. He reminded the participants about the fact that “ k_0 -kit” was developed within the IAEA and was subject of in-house Team Merit Award in 2005.

Ms. Djurovic from The Ministry of Tourism and Environmental Protection of Montenegro presented the activities of the Ministry and especially those related to ionizing radiation and the establishment of the Environmental Protection Agency which will be in charge of the regulatory functions concerning radiation sources, among other things. She also presented an overview of some of the most important neutron sources in Europe.

Mr. Othman from Syria presented the function and activities of Syrian Atomic Energy Commission (AEC). He gave an overview of most of the activities of the AEC such as isotope production (^{99m}Tc generator, ^{68}Ga , ^{201}Tl ...), radiopharmaceuticals, biotechnology, solar energy, and agricultural applications. Mr. Othman presented the development of instrumental neutron activation analysis at AEC including the cyclic activation and short lived radioisotope production using MNSR. He also gave an overview of the collaboration with the university to run undergraduate and post graduate courses in radiation protection and nuclear engineering.

Mr. Reguigui from Tunisia reviewed the activities of the National Center of Nuclear Sciences and Technology in Tunisia and talked on the need of Tunisia for cooperation in the areas of research reactor utilisation and operation, especially for the upcoming years since Tunisia is in the process of setting up the required infrastructure for the installation of the first nuclear power plant by 2020.

7. DISCUSSION AND CONCLUSIONS

At this stage, three main fields for research reactor utilization of common interest were identified:

- Cultural heritage study and preservation,
- Environmental protection, and
- Nuclear knowledge management.

Applications in the fields of health, agriculture, biology, material science and geology were also discussed and are envisaged for further cooperation in the future.

Within the above mentioned three common fields of interest, the participants identified several methodologies which might be a subject of cooperation. The following possible areas of cooperation were prioritized:

- Neutron Beam Utilization, including Small Angle Neutron Scattering (SANS) and Neutron diffraction.
- Neutron radiography.
- Analytical techniques: INAA, PGNAA, k_0 -method, large sample NAA...
- Reactor neutronics.
- Neutron flux calculations.
- Thermohydraulic calculations.
- Shielding Calculations for Nuclear Reactors, and Radioactive sources.
- Semiconductor detector efficiency calculations.

In addition, it was mentioned that the possibilities exist for the cooperation in:

- Radioisotope Production.
- Materials science and research development for commercial applications.
- NTD technology and quality control of industrial products.
- Neutron Irradiation Services.
- Reactor operation and nuclear safety culture.
- Reactor core fuel management strategy.
- Contribution to the development of new analytical techniques, like large sample NAA.

These areas are more beneficial/useful to participants with medium and high flux research reactors.

8. PROPOSED ACTION PLAN

8.1. Creation of a RR Mediterranean Portal

A web site will be installed/launched and maintained in a partner's server (Demokritos, Greece by April 2008, Mr. I.E. Stamatelatos to coordinate). The aim of the portal is to have a forum and to present the different facilities and activities of the partners. In particular, the portal will include:

- General Information about the potential/applications of RR.
- Documentation, reports, papers, etc.
- Links to the various RR facilities: description, contact information, etc.
- Project ideas.
- Overview of research groups.
- Announcements of scientific events (conferences, WS, meetings, ...).
- News.

8.2. Organization of Workshops

A Workshop on neutron activation analysis of cultural heritage objects will be held in Egypt sometime during the 4th quarter of 2008 (Mr. Shaat to coordinate).

A Workshop on neutronics calculation will be held in Egypt sometime during the 1st quarter of 2009 (Mr. Shaat to coordinate).

A Workshop on neutron scattering techniques is foreseen in one of the Mediterranean countries by mid 2010. Mr. Messoloras from Greece will look on the possibility of venue and dates.

8.3. Organization of Inter-comparison Exercises

8.3.1. *On marine sediment characterization*

The exercise consists of demonstrating the capabilities of the various institutions involved in analysing marine sediments. In a later stage, a comparison of the various analytical methods used can be made. Samples will be sent to various participants by the end of May 2008. Results are expected by the end of 2008 (Mr. Reguigui to coordinate).

8.3.2. *On semiconductor gamma detector efficiency calculations*

This inter-comparison will test different approaches being used for the calculation of full energy peak efficiencies for semiconductor gamma detectors (i.e., Monte Carlo methods and semi-empirical methods). Inter-comparison input data (Detector-sample geometries and specifications) will be defined by Mr. Jovanovic and sent to participants by the end of May 2008. Results are expected by mid 2009. The results may be tested on real environmental samples (Mr. Othman from Syria to coordinate).

8.4. Innovation and Development

8.4.1. *Shielding and flux optimization for neutron generators*

The use of neutron generators is becoming an attractive option for countries with no RR and even for countries with RR desiring to have a turn key machine for neutrons. However, a lot of work needs to be done to come up with an optimum design for the activation chamber and the NG shielding in terms of flux optimization and radiation risk minimization. The participants in this project will work on a specific situation (to be given by Mr. Reguigui during this meeting). A coordination meeting will be organized in Tunisia by October 2008 to compare results.

8.4.2. Assessment of large sample NAA in the region

Participants expressed their desire in conducting an assessment of the possibilities of applying large sample NAA in their respective facilities. A coordinated effort in this respect would include exchange of theoretical and experimental data for their irradiation and counting facilities (Mr. Stamatelatos to coordinate).

8.5. Summer School on RR Utilization

Within nuclear knowledge management, education is an issue of primary concern. Making young scientists aware and interested in this subject is very important to attract them to this field. It is the overall opinion of the participants that the organization of a summer school on reactor operation and utilization (by 2nd quarter of 2009) will lead to the desired results. Special attention will be paid to applications in the fields of archeology and environment (Mr. Othman from Syria to coordinate).

8.6. Education and Training on Reactor Simulation

Young scientists and reactor operators can be trained to use simulators in the region on

- (i) RR operation
- (ii) The steady and transient analysis for reactor performance
- (iii) Compact hardware simulator for NPP.

(Mr. Shaat to coordinate)

8.7. Scientific Visits and Expert Missions

In order to exchange information and to benefit various institutions from the expertise in the region, it is envisaged to carry out scientific visits by senior staff (individually or in groups) to prominent centers in the region and elsewhere and to invite prominent experts to participate in the activities envisaged by this project.

8.8. Participation in Agency CRP's

Participants expressed their interest in participating in CRP's on relevant subjects concerning RR utilization. In particular, NAA of large samples was mentioned, having on mind previously identified common fields of cooperation (e.g. cultural heritage objects).

8.9. Follow up Coordination Meeting

So as to evaluate the progress and the outcome of the various activities that have been proposed here, the participants agreed to organize a follow-up coordination meeting in Montenegro during the second half of 2009 (Ms. Tamara Djurovic to coordinate).

8.10. Summary of the Proposed Action Plan

Activity	Theme	Technique	Venue/date	Coordinator
Web site	Information	HTML	Greece by April 2008	Mr. Stamatelatos
Workshop	Cultural heritage	NAA	Egypt by 4 th Quarter 2008	Mr. Shaat
	Information	Neutronics	Egypt by 1 st Quarter 2009	Mr. Shaat
	Information	Neutron beams	Greece by mid 2010	Mr. Messoloras
Inter-comparison	Environment/sediments	Nuclear Analytical Methods	Tunisia by end of 2008	Mr. Reguigui
	Information/Environment	Gamma Spec	Syria by mid 2009	Mr. Othman Mr. Jovanovic
Innovation	Information	Neutron sources/MC	Tunisia October 2008	Mr. Reguigui
	Information	NAA	Greece by end of 2009	Mr. Stamatelatos
Training	Information/archeology/environment.	Reactor operation and utilization	Syria by 2 nd quarter of 2009	Mr. Othman
	Information	Simulation of Reactor operation and utilization	Egypt by 4 th Quarter 2009	Mr. Shaat
Coordination Meeting	Information	Follow up	Montenegro by 2 nd half of 2009	Ms. Tamara Djurovic

9. EXPECTED BENEFITS TO THE COUNTRIES

- Better utilization of the facilities for the countries having RR;
- Access to new techniques for the countries not having RR;
- Contribution to sustainability of research facilities;
- Dissemination of technological and scientific knowledge;
- Development of trained manpower;
- Contribution to nuclear culture and background information necessary as a basis for introducing nuclear power in several Mediterranean countries.

10. RECOMMENDATIONS TO THE IAEA

- The participants recommend that the Agency inform other Mediterranean countries about the outcome and conclusions of this meeting.
- The participants indicate that limited funds for the proposed activities can be found at national level. However, it is strongly recommended that the Agency consider supporting these activities, so as to enable access to neutron sources (RR in particular) to MS not having such ones, and to benefit from them.
- The participants recommend that the Agency support scientific visits by senior staff (individually or in groups) to prominent centers in the region and expert missions by prominent experts in the various fields.
- The participants recommend that Egypt, having a well operational and high performance research reactor, act as “host-reactor” country in further activities within this project.
- The participants recommend that the Agency support the initiation of a new CRP on large sample NAA.
- The participants recommend that one member of the group should coordinate with the IAEA the implementation and the follow-up of the various activities proposed under this project. It is agreed that Mr. N. Reguigui (Tunisia) will be the coordinator.

11. RECOMMENDATIONS TO MEMBER STATES

- The participants recommend MS to further encourage participation of the relevant institutions in the activities of this project.
- The participants recommend that MS encourage the group activities and provide financial and in-kind support.
- The participants recommend that MS enter into bilateral agreements in this particular field of cooperation.
- The participants recommend that MS participate in the activities of CRPs and inter-regional projects that exist or which will be initiated related to the subject at hand.

12. SUMMARY

This meeting is a follow-up to the previous workshop held in Vienna in 2007. During this meeting, possible additional areas of collaborations in RR utilization were discussed. Three main fields for research reactor utilization of common interest were identified:

- (i) Cultural heritage study and preservation,

- (ii) Environmental protection, and
- (iii) Nuclear knowledge management.

The participants identified several tools and methodologies which might be a subject of cooperation: neutron beam utilization, including small angle neutron scattering, neutron diffraction, neutron radiography, analytical techniques (including INAA, PGNAA, k_0 -methods), reactor neutronics, neutron flux calculations, thermohydraulic calculations, shielding calculations for nuclear reactors, and radioactive sources, semiconductor detector efficiency calculations, radioisotope production, materials science and research development for commercial applications, NTD technology and quality control of industrial products, Neutron irradiation services, reactor operation and nuclear safety culture, reactor core fuel management strategy.

Also, possible modes of operation or steps to be taken for initiating collaboration were presented. It was decided to create a network of users for research reactors for their effective utilization. A detailed action plan for various activities that extend through 2010 was prepared. Further assistance from the Agency is expected.

APPENDIX I. REGIONAL STATUS OF RESEARCH REACTORS IN OPERATION

—	Algeria (2)	1 MW/15 MW
—	Bulgaria (1)	Shut down/refurbishment
—	Egypt (2)	2 MW and 22 MW
—	Greece (1)	5 MW
—	Libya (1)	10 MW
—	Morocco (1)	2 MW
—	Romania (1)	14 MW/500 kW (dual core)
—	Slovenia (1)	250 kW
—	Syria (1)	30 kW
—	Turkey (1)	300 kW

For more detailed information: <http://www.iaea.org/worldatom/rrdb/>

(The IAEA Nuclear Research Reactor Data Base)

APPENDIX II. POTENTIAL PARTICIPATING MS NOT HAVING RESEARCH REACTORS

- Albania
- Azerbaijan
- Bosnia-Herzegovina
- Croatia
- Cyprus
- Lebanon
- FYROM
- Malta
- Serbia
- Montenegro
- Jordan
- Tunisia

APPENDIX III. LIST OF PARTICIPANTS

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***IAEA Technical Meeting on
Strategic Planning for Sustainability-Mediterranean Region: Research Reactor Utilization
19-22 February 2008
Meeting Room: A-2774
IAEA Headquarters, Vienna***

Agenda

Tuesday, 19 February 2008

09:30-10:00	Registration
10:00-10:30	Welcome and Opening Remarks G. Mank, Head, Physics Section S. Paranjpe, Scientific Secretary Introduction of participants Selection of the Chair and Rapporteur
10:30-11:00	Shriniwas Paranjpe RR utilization: IAEA role and background of and expectations from the Technical Meeting
11:00-11:30	Break

Session I (Presentations by the Participants)

11:30-12:30	Ibrahim Gabulov (Azerbaijan) Mohamad K. Shaat (Egypt)
12:30-14:00	Lunch Break
14:00-14:30	Discussion
14:30-15:00	Ion Stamatelatos (Greece)
14:30-15:00	Slobodan Jovanovic (Montenegro)
15:00-15:30	Break
15:30-16:00	Tamara Djurovic (Montenegro)
16:00-17:00	Discussion

Wednesday, 20 February 2008

Session II (Presentations by the Participants)

09:30-11:00 Ibrahim. Othman (Syria)
Nafaa Reguigui (Tunisia)

11:00-11:30 Break

Session III (Discussion on the Areas of Collaboration)

11:30-12:30 Mohamad K. Shaat (Status of proposal on collaboration
Neutronic calculations)

Slobodan Jovanovic (NAA)

12:30-14:00 Lunch Break

14:00-14:30 Neutron Beam applications in Greece

15:30-16:00 Break

16:00-17:00 Discussion on the development of proposals for the first
common program

Thursday, 21 February 2008

09:00-11:00 Discussion on creating Users Portal

11:00-11:30 Break

11:30-12:30 Activities under collaborations, trainings,
recommendations

12:30-14:00 Lunch Break

14:00-16:00 Discussion on collaborations and data input for the Report

Friday, 22 February 2008

09:00-11:00 Preparation of the Report and discussion

11:00-11:30 Break

11:30-12:30 Finalizing the Report

14:00 Wrap-up Session