NEW OPPORTUNITIES FOR ENHANCED RR UTILIZATION THROUGH NETWORKS AND COALITIONS

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Abstract

This paper will give an overview of the IAEA activities related to research reactor (RR) networks and coalitions during the last four years. Both recent achievements and planned actions will be reported with a major emphasis on enhanced RR utilization through facilitated access to neighboring Member States without a RR, the creation of new capabilities leading to potential revenue generation, the revision and implementation of strategic and business plans, as well as self-monitoring and self-evaluation using comprehensive performance indicators. Some new initiatives also will be introduced and described.

1. INTRODUCTION

RRs have played and continue to play an important role in the development of neutron science and related technologies, the generation of radioisotopes for medicine and industry, the provision of multi-elemental analyses of various samples, the improvement of material quality through irradiation by neutrons, and the creation of other products and services for a broad range of applications. RRs can also be useful tools supporting present and future national nuclear power programmes, including the development of human resources and skills. Today's decreasing number of RR facilities faces a number of critical issues and important challenges such as underutilization, nonexistent or inappropriate strategic–business plans, ageing and needs for modernization or refurbishment, the presence of fresh or spent HEU fuel, the unavailability of qualified high density LEU fuels, the accumulation of spent nuclear fuel, advanced decommissioning planning and implementation stages, and in some cases safety and security issues. In addition to this non-exhaustive list of challenges is plans by certain Member States to build new RRs though they possess little or no experience in this domain.

Although the number of RRs is steadily decreasing, more than half remain heavily underutilized [1], without a clear purpose or strategy, and, in many cases, underfunded and understaffed. Keeping in mind that more than 50% of operational RRs are more than 40 years old, the projected decrease in operational RRs from ~240 today [1] to between 100 and 150 is expected in the next 10–15 years. In this context, greater international cooperation and networking is required to ensure broader access to the remaining facilities, thus, increasing

their efficient utilization. These networks will also contribute to upgrading existing RRs, developing new facilities and improving access for Member States without RRs. Indeed, if the benefits from RRs are to be realized, then the premises upon which they are built and operated must be reconsidered and updated to fit today's technical, economic and social situation [2]. In this respect, all aspects of RR utilization, strategy and life cycle management should be re-examined.

Among a number of related efforts, during the last four years the IAEA has been promoting networking, coalitions and regional collaboration to improve the efficient and sustainable utilization of RRs [3]. A number of RR coalitions and networks have been developed with the IAEA's support as a new model to better utilize RRs and facilitate access for Member States without such facilities. The coalition/network concept (see Figure 1) involves putting in place cooperative arrangements among RR operators, user entities, customers and other stakeholders. Ideally, a strong and coordinated partnership is formed, leading to increased utilization of individual RRs through collective efforts, as well as improved self-sustainability and self-reliability. The IAEA acts as a catalyst and facilitator towards self-reliance, assists in preparation of strategic and business plans, and also provides initial support via its technical assistance programmes.

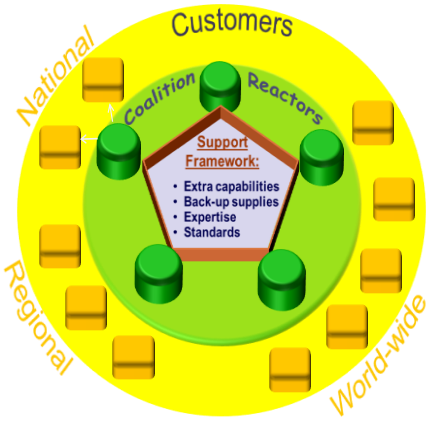

FIG. 1. The schematic concept of RR coalitions and networks.

2. RR COALITIONS AND NETWORKS

The IAEA supported coalitions and networks of RRs continue to enhance cooperation among RR facility managers, existing and potential users, and other stakeholders. Six such networks, with shared RR facilities and competencies, have collectively offered services to regional and international users, secured entrepreneurial interest, supported upgrades to existing or new facilities and improved access to countries without RRs. With the Central Africa RR Network (CARRN), created in July 2011 in Accra (Ghana), the combined efforts of RR coalitions and networks currently involve 42 Member States (25 with RRs and 17 without such facilities) (see Figure 2 and Table 1 for details).

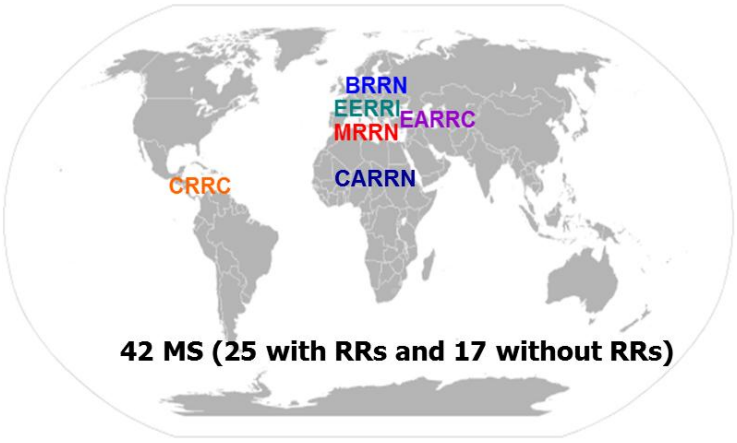

FIG. 2. IAEA supported RR coalitions and networks (also see Table 1).

TABLE 1. REGIONAL MEMBER STATE REPRESENTATION AND MAJOR AREAS OF JOINT ACTIVITIES OF RR COALITIONS

RR coalition/network	Participating Member Sates	Major joint activities
BRRN — Baltic RR Network	Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Norway, Poland, Russian Federation, Sweden	• Education and training • Irradiation services • Neutron beam applications • Waste and decommissioning issues
CRRC — Caribbean RR Coalition	Colombia, Jamaica, Mexico	• NAA
EARRC — EurAsia RR Coalition	Czech Republic, Hungary, Kazakhstan, Ukraine, USA, Uzbekistan	• Radioisotope production, in particular Mo-99 production via neutron capture
EERRI — Eastern European RR Initiative	Austria, Czech Republic, Hungary, Poland, Romania, Serbia, Slovenia	• Education and training • Radioisotope production • Research and applications using neutron beams • Material irradiation and tests
MRRN — Mediterranean RR Network	Algeria, Azerbaijan, Bulgaria, Egypt, France, Greece, Italy, Montenegro, Morocco, Portugal, Slovenia, Syria, Tunisia, Turkey	• Education and training • NAA • Neutron radiography
CARRN — Central Africa RR Network	Algeria, DRC, Ghana, Madagascar, Morocco, Niger, Nigeria, Sudan, Zambia	• Education and training • NAA

In the last few years the above RR coalitions have succeeded in the achievement of very concrete results with some selected examples highlighted below:

— **EERRI:** Since its inception the EERRI, supported by the Agency, has organized and conducted 5 six-week RR Group Fellowship Training Courses to assist Member States interested in initiating their first RR projects. The training courses included hands-on experimental exercises and technical visits to different RRs in Central Europe and provided training on RR utilization and safety, operation and maintenance planning and evaluation, and international cooperation. In total close to 40 fellows from all over the world have been trained. The 6th course has already been scheduled for 2012.

— **CRRC:** In collaboration with the IAEA, a promotional brochure "CRRC: Partnering for Progress" was prepared and published. This publication introduced some of the key peaceful nuclear based technologies, especially in the areas of analytical element determination, production of radioisotopes and radiation protection which the CRRC can provide to governmental and commercial customers in the region while working in partnership for progress.

— **EARRC:** Through a number of meetings and expert missions, supported by the IAEA, the EARRC was able to finalize its strategic and business plan, including concrete actions towards commercial production of Mo-99 via neutron capture. Some of the trial Mo-98 targets were irradiated and shipped to a radioisotope reprocessing company in the USA as part of the QA/QC process.
— **MRRN:** Under coordination of the IAEA, the MRRN has collected most of the partner facility information related to the three major activities of the network (see Table 1 for details). This information will be used to create a comprehensive database on products and services offered by RR facilities in the region and to plan and implement future joint activities such as proficiency tests in NAA, neutron radiography or a regional group fellowship course on specific RR related topics.

In addition to the six existing coalitions and networks, a new RR network in the Asia-Pacific region under the umbrella of the Asia-Oceania Neutron Scattering Association (AONSA) was recently initiated during the IAEA Consultancy Meeting held in October 2010 with 11 Member States from this region. In relation to this development, in 2010 the Australian Nuclear Science and Technology Organisation (ANSTO), with its state-of-the-art neutron beam facilities built around the OPAL RR, was designated an IAEA Collaborating Centre for neutron scattering applications. This will further strengthen international access and help build skills in this region through a variety of mechanisms toward expected improvements in the fields of engineering, health and nutrition, and the environment. It is expected that support for this network will be enabled through a new regional TC project RAS1019 "Enhancing Safety and Utilization of Research Reactors."

Finally, in the Final Project Coordination Meeting of RER4032 on "Enhancing the Sustainability of Research Reactors and their Safe Operation through Regional Cooperation, Networking and Coalitions," held in December 2011 in Vienna, an initiative to create a new RR coalition, involving mainly the Commonwealth of Independent States (CIS), was supported. The official inception of this new network is expected in 2012 within the framework of a new regional TC project RER1007 "Enhancing Utilization and Safety of Research Reactors through Networking, Coalitions and Sharing Best Practices."

In summary, although some noticeable results have been obtained during the initiation and support of RR coalitions, much more effort is required to collectively achieve the objective of increased and self-sustainable RR utilization. In addition to their individual strategic plans, coalition partners need to put in place coalition-based common strategic and management plans. They also need to pursue more detailed market analysis and business development to identify specific profitable opportunities through sustainable commercial activities such as complementary marketing and delivery of irradiation products, services and education and training, among other revenue generating applications of RRs.

3. CONCEPT OF RESEARCH REACTORS AS INTERNATIONAL CENTRES OF EXCELLENCE OR REGIONAL HUBS

Even though some RR facilities have already been established as regional centres of excellence or global providers of products and services, most RR managers still focus their strategy on responding to national needs and serving national customers and stakeholders. As a matter of fact, more than half of the world's RRs have very low utilization, and many are challenged to obtain appropriate funding. On the other hand, many countries do not have access to RR services and would certainly take advantage if access to these facilities could be arranged. In this context, there is a clear potential for increased international cooperation for both existing and new RR projects. This should result in increased access for international community, common research and development programmes on a collaborative or

commercial basis and more available financial resources for the RRs involved. In addition, being in close contact with the wide user community, a shared RR would better understand its needs and be able to tailor services or develop additional capabilities as user requirements evolve. As a result, RRs with a regional or international perspective have access to a much wider user base and diversified funding opportunities. This can be translated into improved sustainability as well as options for increased capabilities or equipment. Non-host countries that subscribe to such RRs would benefit from access to improved capabilities at a lower cost than what could be achieved by constructing their own national facility. To access these benefits, a number of issues at the technical, financial, regulatory and intergovernmental levels must be addressed. There is a need to envisage and develop good practices for the sharing of RR facilities between countries regionally and internationally. The IAEA Technical Meeting on "Access and Utilization of RR by Non-Host Member States," held in May 2011 in Vienna, was the first step in defining these issues and developing guidelines to address them. This meeting provided a forum to identify existing good practices at international RR facilities and to collate practical experience with both successes and obstacles to such international cooperation as well as other relevant matters through presentations and brainstorming discussions.

Another similar initiative targets very high flux RRs, also as multi-user international facilities, but with potentially shared ownership. Indeed, a number of such powerful RRs are expected to be brought into service within the next decade (e.g., CARR in China, PIK and MBIR in the Russian Federation, MYRRHA in Belgium, RJH in France, PALLAS in The Netherlands). Each of these facilities has the potential to be an important international centre of excellence and a scientific hub for cutting edge research and materials investigations, though only few currently have implemented such an organizational structure for management and operation (e.g., ILL in France and HBWR in Norway). The applications of these future research centres include innovative reactor concepts and fuel studies, material testing both for fission and fusion technologies, burning of long-lived actinides from present reactor fuels, production of medical and industrial radioisotopes or neutron science and applications using neutron beams. The benefits of developing an International Centre of Excellence on the basis of very high flux RRs are twofold:

1) Such infrastructures are expensive, and they are most effective when they are supported intellectually and financially by a broader global community. With multilateral support they may be able to complete needed studies more quickly and cost effectively, avoiding the duplication of R&D investments and fragmentation of scientific efforts.
2) Each new well-functioning RR International Centre of Excellence builds confidence in the supra-national approach in which a few well-equipped, well-utilized, well-funded safe and secure facilities can substitute for many comparatively isolated facilities challenged by low utilization and limited funding.

These issues will be addressed in another IAEA Technical Meeting on "Options for Using High Flux Research Reactor Facilities as International Centres of Excellence/Regional Hubs" planned to take place in early 2012. As a result of this event and the follow up activities through 2012-2013, a dedicated Technical Document or guideline will be prepared.

4. STRATEGIC AND BUSINESS PLANNING FOR RRS

RRs face increasing pressures to become more commercially responsive and above all to increase their utilization. Whatever the reasons, there is in general a need for a change in the mindset of an RR facility from just "being available" to taking control of the facility's destiny by proactively seeking out new users and applications. Therefore, facility managers

need a straightforward and cost-effective approach to both increasing utilization and efficient management. In that respect, development and implementation of a strategic and business plan is crucial in order to achieve increased utilization, while helping to create a positive safety culture, a motivated staff, a clear understanding of real costs and a balanced budget. The IAEA strongly recommends preparation of such plans for each RR facility and assists in their creation, revision or improvement.

The justification, conceptual structure and implementation of RR strategic plans has also now been introduced in the RR Group Fellowship Training Courses organized by the IAEA in cooperation with the EERRI, as part of the lecture series given by the IAEA . Based on IAEA-TECDOC-1212 "Strategic Planning for RRs [4]," the IAEA has also developed a specific template with explanatory guidelines to facilitate the creation or revision of such a strategic plan by RR facilities. Furthermore, this material was complemented by expert lectures and dedicated training workshops. It is used to elaborate strategic and business plans for newcomer Member States interested in introducing their first RR (e.g., Azerbaijan, Lebanon, Sudan, Tunisia and six GCC Member States).

The IAEA is also encouraging periodic revision and update of the strategic plans of operational RRs by organizing expert review missions or assignments. Such missions were conducted during 2010 and 2011 in Bulgaria, Egypt, Ghana, Morocco and Ukraine. Last but not the least, in addition to their individual strategic plans, the RR coalition and network partners need to put into place coalition-based common strategic and management plans as a group. As it was already mentioned above, in the past the IAEA has already assisted the EARRC in preparation of their strategic and business plan for radioisotope production and commercialization. Similar actions will continue in the new TC cycle of 2012–2013 in Africa, Asia and the Pacific, Europe, and Latin America.

Finally, the need for a strategic and business plan is an inseparable part of the new IAEA document in print on "Specific Considerations and Milestones for a Research Reactor Project", where the primary emphasis is given to assess the Member State's status with regard to justification and resourcing for a RR and the development of the necessary supporting infrastructure [5]. This publication describes the four phases of the implementation programme and provides guidance on the timely preparation of a RR project through an easy to understand sequential development process. It includes a detailed description of the range of infrastructure issues that need to be addressed and the expected level of achievement (or milestones) at the end of each phase. The document will enable Member States to prioritize the activities that they need to order, license, construct and then safely operate a RR. This guidance aims to help them to understand their commitments and obligations associated with the RR programme and clarifies that the responsibility for safe implementation of a RR project rests with the Member State and its organizations and cannot be subcontracted or avoided. Other organizations such as donors, suppliers, nuclear energy agencies and utility organizations may also find this publication useful as a basis for project assessment and follow up. Such assessments could build confidence that a country has the ability to legislate, regulate, construct, efficiently utilize and manage, and safely and securely operate a RR.

5. PERFORMANCE INDICATORS FOR RR FACILITIES

As mentioned in the previous section, the continued operation of many RRs around the world depends on the development and implementation of an effective strategic and business plan. To assist in the implementation and monitoring process, the IAEA has recently proposed a set of performance indicators to monitor utilization of RR facilities. The needs for self-monitoring and self-evaluation are numerous with the main objectives to:

— Provide a quantitative baseline of the actual status of a RR facility;

— Monitor the performance of the facility on a periodic basis and compare the changes with respect to the baseline or the previous year's results;
— Measure the effectiveness and impact of different actions taken on a results-based analysis;
— Measure performace against objective metrics detailed in the strategic plan;
— Provide guidance for future actions and direct input in a revised strategic plan;
— Presently proposed RR performance indicators include the following main areas to be assessed and monitored:
    - Operation data — 14 variables (e.g., neutron scattering operation, hours/year);
    - Operation results — 16 variables (e.g., NAA, number of samples analysed);
    - Shutdown and maintenance data — 9 variables (e.g., number of unscheduled shutdowns);
    - Quality and safety control — 16 variables (e.g., number of QA/QC audits);
    - Radioactive dose records — 6 variables (e.g., average dose per staff member);
    - Radioactive discharge records — 9 variables (e.g., iodine release to atmosphere);
    - Financial records — 10 variables (e.g., revenue generated from E&T activities);

It is intended that numerical values of various variables will allow implementing semi-automatic analysis according to pre-designed criteria, which can be based on specific priorities and objectives of each facility. Certainly, some of the information included in the table of performance indicators will be commercially sensitive and intend for internal use only. Hence it should be stated that the IAEA does not expect public disclosure of all information contained therein. The main purpose here is to assist Member States to develop sound methodologies for self-monitoring and self-evaluation based on quantitative, periodic and comparative analysis.

6. SUMMARY

In summary, the concept of well a utilized and "healthy" RR facility can be built on the following stepping stones[1]: Strategic planning, international cooperation and sustainability through provision of products and services (see Figure 3). This paper has addressed at least partially all these items and has aimed to provide a brief overview of the IAEA's activities in these particular areas.

FIG. 3. Three major issues to be addressed by the RR manager in order to enhance RR utilization and contribute to its sustainability.

[1] RR safety is a fundamental prerequisite that must be considered within each stepping stones [7].

On the other hand, the IAEA's efforts related to the support of RR coalitions and networks, promotion of shared user and shared ownership facilities, assistance in preparation and revision of strategic and business plans for RRs as well as help in design and implementation of performance indicators for RRs are only a few examples among other on-going activities [6] to address the issues and challenges RRs are facing worldwide. Although some noticeable results have been obtained in initiating and supporting RR coalitions, much more work needs to be done to achieve increased, self-reliant and sustainable utilization of individual RRs through regional and international cooperation and collaboration.

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