Developing research reactor coalitions and centers of excellence

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Abstract. The IAEA, in line with its statute and mandatory responsibilities to support its member states in the promotion of peaceful uses of nuclear energy in concert with global nuclear non-proliferation, nuclear safety and nuclear material security objectives, is well positioned to provide support for regional and international cooperation involving the research reactor community.

This paper describes activities and progress under the IAEA initiative to promote formation of coalitions of research reactor operators and stakeholders to improve sustainability of research reactors through improved strategic/business planning, collective market analysis and joint marketing of services, increased contacts with prospective customers and enhanced public information.

1. Background

Research reactors continue to play a key role in the development of peaceful uses of atomic energy. They have a variety of roles including education and training, production of medical and industrial isotopes, non-destructive testing, analytical studies, modification of materials, for research in physics, biology and materials science, and in support of nuclear power programmes. The IAEA Research Reactor Data Base lists 248 operational research reactors worldwide with an average age of over 40 years.

It is expected that research reactors will continue to bring substantial benefits to society in the coming decades by contributing to the further development of advanced nuclear power systems, nuclear medicine and biological sciences, material testing, and other applications. However, in order to do so, they need to be financially sound, with adequate income for safe and secure facility operations and maintenance, including planning for eventual fuel removal decommissioning.

The IAEA Research Reactor Data Base lists 248 operational research reactors worldwide. Through both statistical and anecdotal evidence, it is clear that many of these reactors are underutilized, face critical issues related to sustainability, and must make important decisions concerning future operation. Reactors operating at low utilization levels have difficulty providing the service availability and reliability demanded by many potential users and customers, which creates a significant obstacle to increasing utilization.

These challenges are occurring in the context of increased concerns over global non-proliferation and nuclear material safety and security, due to which research reactor operators are increasingly compelled to substantially improve physical security and convert reactors to LEU fuel. Thus, there is a complex environment for research reactors, and one in which underutilized and therefore likely poorly funded facilities invoke particular concern.

Research reactors are challenged to generate income to offset operational costs, often in a context of declining political and/or public support. Many research reactors have limited access to potential

customers for their services and are not familiar with the business planning concepts needed to secure additional commercial revenues or international program funding. This not only results in reduced income for the facilities involved, but sometimes also in research reactor services priced below full cost, preventing recovery of back-end costs and creating unsustainable market norms.

It is clear that the research reactor community possesses the expertise to address these concerns. However, this know-how is not uniformly available to individual facilities. Parochial attitudes and competitive behaviour restrict information sharing, dissemination of best practices, and mutual support that could otherwise result in a coordinated approach to market development, building upon strengths of facilities.

These attitudes are based, in part, on the belief that the markets for research reactor products and services are "zero-sum," with market gains by one research reactor resulting in losses to another "competing" reactor. However, the success of user groups and organizations such as WANO in the nuclear power generation sector show that the benefits of cooperation can be obtained without sacrificing commercial interests.

Further, there is evidence that many markets for research reactor services are supply limited, rather than demand limited:

- Many potential customers do not know how, or where, to contact the research reactor community, and have only limited knowledge or awareness of the range of research reactor services, equipment and locations available.
- Non-uniform standards of quality control and quality assurance at research reactors facilities impede business development and increase customer procurement costs. For example, potential customers need to conduct due diligence and each facility to be used, reducing the enthusiasm and financial rationale for developing additional sources of supply.
- Customers have reported supply deficits, usually associated with operational difficulties at individual reactors, or with the inability of existing sources of supply to meet expanding demand.
- Radioisotopes are produced and sold on a parochial basis, without regard to the optimization of transportation logistics and safety, which results in customer budgets diverted to transportation rather than the research reactors themselves.

The renewed interest in nuclear power, and the worldwide expansion of nuclear medicine for the diagnosis and treatment of disease, presents new opportunities for research reactors – including by countries without such a facility. However, a reactor constructed to meet a specific need might not have sufficient identified utilization to fully occupy the facility, or to be adequately available for its intended purpose. One answer to this dilemma would be the creation of a new multi-national facility rather than a national facility, but this requires an increased level of coordination between current and prospective operators.

In order to address the complex of issues related to sustainability, security, safety, and non-proliferation aspects of research reactors, and to promote international and regional cooperation, the Agency has undertaken new activities to promote Research Reactor Coalitions and Centres of Excellence. This activity integrates Agency regular and extra-budgetary funded program activities related to research reactors, relevant national and regional IAEA Technical Cooperation projects, including "Enhancement of the Sustainability of Research Reactors and their Safe Operation Through Regional Cooperation, Networking, and Coalitions" (RER/4/029) and "Nutritional and Health-Related Studies Using Research reactors" (RAF/4/020; AFRA IV-12). It is also supported by a two-year grant from the Nuclear Threat Initiative (NTI).

The aim of this effort is to promote concrete examples of enhanced regional cooperation, to form networks of research reactors conducting joint research or other shared activities, and to form a voluntary, subscription-based, self-financed coalition of research reactor operators (which may include other participants, sponsors, etc.) which may serve as a model or example for additional coalitions.

2. Concept outline

From the operational perspective, coalitions will facilitate peer group sharing of best practices, improve information availability to their members, and reinforce/develop the operating disciplines of safety and quality control.

From the business perspective, coalitions will provide improved market analysis and support for strategic and business planning. Where appropriate, the coalitions may jointly market services and increase contacts between research reactor operators and prospective customers. By so doing, the coalitions will help increase reactor utilization, generate additional revenues and provide the justifications for additional governmental support that could pay for operational improvements.

From a public perspective, coalitions will have the opportunity to enhance the information available to help retain and build confidence in reactor operation.

There is not a "one size fits all" solution, coalitions can take several different forms according to the needs and capabilities of their members. Possible coalition variants include bilateral sub-contracting, joint venture or other supply arrangements between pairs of research reactors; informal peer group networks that can share best practice information;, and broad, formal coalitions that are capable of effectively marketing their members' services and representing their interests in common, as well as setting standards for all members. It is expected that formal coalitions will also facilitate access by non-reactor owning countries/members, with financial subscriptions paid in return for access to reactor services, thus avoiding the new construction or operation of marginally supported reactors.

In most cases, it is envisaged that the coalitions will not start with a full scope implementation, but rather will develop from relatively modest starting points (e.g. involving two or three reactors/partners), and will evolve by expanding their scope of implementation as the confidence of the members, and their governments, increases. For example, a simple, bilateral backup supply arrangement may grow into an informal network, and eventually become a subscription-based coalition.

3. Concept benefits

A coalition is expected to have both specific and general benefits to participating research reactors.

The specific benefits of a coalition will derive from improved strategic and business planning (using IAEA-TECDOC-1212 "Strategic Planning for Research Reactors" as a guide) and joint marketing of the services of its participant reactors (commercial products and scientific/research), which would be expected to have the following benefits, with the coalition thus able to:

- Optimize the services offered (possibly including education and training, production of isotopes, industrial irradiation services such as transmutation doping, neutron activation analysis and other analytical services for industry and government) on a geographical basis, and reduce operational costs.
- Make maximum use of expertise or equipment at a particular facilities, and perhaps enable particular facilities to specialize in services in which they could have a "comparative advantage."
- Use the combined expertise of the participant facilities to best advise and serve their customers. This would help increase customer knowledge of, and access to, the radiation services, and support the customer with a more reliable and comprehensive customer service.
- Improve the utilization and sustainability of individual research reactors, and increase overall levels of demand to the mutual benefit of all market participants (suppliers and customers). Additional reactor utilizations would generate revenues, or help make the necessary justifications for additional local governmental support, thus improving sustainability. The additional funding could assist individual reactors to pay for operational, safety and security improvements.

- Develop a common methodology for calculating costs of reactor services to include spent fuel management and eventual decommissioning liabilities.
- Provide assistance to reactors planning or undergoing conversion from Highly Enriched Uranium to LEU including sharing of experience and planning expertise.
- Address the needs of user groups that do not have access to a research reactor in their Member State(s).

The potential benefits are summarized in Table 1.

Table 1: Summary of coalition benefits.

Community Benefit	**Reactor Operator Benefit**	**Customer Benefit**
Disseminate and Encourage Best Practices • Control and Accounting • Non-proliferation • Nuclear Security/Physical Protection (including conversion to LEU) • Operational Safety • Radiation Safety	*Improve Sustainability* • Strategic Planning • Business Planning • Facilitate acquisition of new business and/or funding	*Better Awareness of Available* Capabilities • Customer less reliant on own expertise
Reduce Nuclear Terrorism Risk • Rationalize **radioisotope** supply geography • Reduce Activities Shipped • Reduce Distances Shipped • Improve nuclear material security • Improve spent fuel management	*Increase Market Access for Individual Reactors* • Some products/services via the Network • Improve utilization factors	*Reduced Costs and Complexity* • Rational matching of needs and capabilities/locations • One-stop shop
Build Trust and Confidence in mutual support networks • Promote Regional/International Cooperations • Improve access to the peaceful uses of nuclear technology.Precursor to Centers of Excellence • Additional resources/capabilities • Establish peer group leaders	*Increase Professional Opportunities* • Closer peer group interaction • Access to equipment and expertise at other facilities • Access to different types of irradiation facility	*Improve Service Level* • Standardized Quality Assurance • More available facilities • Improved Reliability • Back-up options

4. IAEA Activities and current status

The Agency's role is to serve as a catalyst and a facilitator of ideas and proposals. A Consultancy Meeting on Developing Proposals for Research Reactor Coalitions and Centres of Excellence" was held in Vienna from 31 August – 5 September 2006 which reviewed existing cooperative arrangements involving research reactors, discussed the general concept of research reactor coalitions, potential subject areas for coalitions, and reviewed and revised a draft concept paper. This concept paper formed the basis of a grant request submitted by the IAEA to Nuclear Threat Initiative (NTI) which was approved in October 2006.

From October-December 2006, the IAEA conducted informal consultations with a wide number of research reactor operators, commercial entities, research reactor irradiation services users, and other stakeholders. These informal discussions identified a number of promising, concrete opportunities for possible coalitions.

At a project planning consultancy meeting in Vienna in January 2007, approximately fifteen "notional proposals" for coalitions covering a range of subjects and virtually all geographic areas were initiated and discussed. These became the basis of the Agency's initial activities in 2007. A core group of advisers was formed and a weekly conference call has been held to execute the work plan, through an action item list. Following initial discussions with possible coalition participants, several of the notional proposals were further elaborated in specific papers as the basis for exploratory meetings and discussions. Recent developments related to these notional proposals are described below.

A. IAEA as "Matchmaker"

As a result of the project development consultancy meeting in fall 2006 and informal contacts made by the IAEA in late 2006 and early 2007, the IAEA identified several "matchmaker" opportunities.

The first was between a well-utilized research reactor and another less-well utilized but state of the art research reactor in the same geographic region. In this case, the well-utilized reactor was seeking additional irradiation capacity for its commercial irradiation business. In the second, the Agency brought together an existing research reactor supplier of industrial isotopes, a commercial user of industrial isotopes/tracers, and a research reactor in a region where the commercial firm had a growing demand for industrial isotopes.

In both cases, the Agency's initial contacts led to direct meetings and negotiations between the various partners without the Agency's involvement, and commercial contracts were discussed and/or concluded.

In the first case, the well-utilized reactor will serve as the "lead reactor," sub-contracting work to the second reactor based on the first reactor's order inventory. The lead reactor will ensure that quality control and quality assurance procedures and standards are adhered to by the sub-contracting reactor so that product delivered to the lead reactor's customers are equivalent to products irradiated in its own facility.

In the second case, the reactor is projected to be a direct contractor/supplier to the industrial entity, based on a non-exclusive contractual arrangement. The IAEA conducted a training workshop at Imperial College U.K. from May 14-16, 2007 to assist staff of the research reactor in understanding regarding the management of isotope sales.

Following initial implementation and consolidation of these two separate contractual arrangements, the IAEA will encourage the respective partners to add additional members to the contractual arrangements, at a minimum to ensure back-up production arrangements in the case of non-availability of the research reactors.. This could also serve to expand the "menu" of technical capabilities offered by the coalition.

B. Strategic planning for coalitions

Strategic planning is essential to achieve sustainability of research reactor operations. Through a strategic planning process, research reactors can better understand their strengths and weaknesses, their stakeholders and stakeholder needs, and to adjust their activities to better address national development priorities as well as the commercial marketplace. Strategic planning can also assist research reactors in developing ideas for alliances or coalitions with other research reactors on a regional or topical basis depending upon complementary strengths and weaknesses.

The IAEA organized an expert mission to Kazakhstan and Uzbekistan from 8-12 October 2007 to assist research reactors at the respective Institutes of Nuclear Physics to begin to develop strategic plans and to consider formation of cooperative ties between research reactors in the region. Ideas for such potential coalitions will be examined in more detail at a Workshop on Advanced Strategic Planning for Research Reactor Coalitions (Europe region), Vienna, 17-19 December 2007. Officials from Armenia, Austria, Azerbaijan, Czech Republic, Italy, Kazakhstan, Romania, and Russia are expected to participate, both research reactor institutions and countries that do not operate research reactors but which need access to irradiation services.

C. Exploratory discussions on forming research reactor coalitions

As noted above, preliminary discussions took place in fall 2006 and through the first half of 2007 in Vienna and at international research reactor conferences such as the European Nuclear Society's Research Reactor Fuel Management (RRFM) meeting and the Reduced Enrichment for Research and Test Reactors (RERTR) international meetings. A number of missions and meetings were subsequently organized to more fully explore the possibility of forming specific coalitions:

- Russian Federation experts and institutions, Dmitrovgrad, Russian Federation, 5-6 September 2007 (five possible notional proposals agreed for further discussions);
- Peru, Chile, with 2 North American university research reactors, Lima, Peru and Santiago, Chile, 15-19 October, 2007 (on medical and industrial radioisotope research, development, and production);
- CNEA (Argentina) and Technical University Vienna/Atominstitut, Buenos Aires, Argentina, 22-23 October, 2007 (education and practical reactor operations training);
- ININ (Mexico) -Technical University Vienna/Atominstitut, Mexico City, 29 October 2007 (practical reactor operations training);
- Caribbean region research reactor coalition (Jamaica-Mexico-Colombia), Mexico City, 30-31 October 2007 (neutron activation analysis and training services).

The meeting with Russian experts in September resulted in agreement on a meeting protocol that cited five possible areas for coalitions among Russian research reactors and/or with research reactors outside Russia. Further informal discussions on several of these notional proposals was held on the margins of the RERTR meeting in Prague 24-27 September 2007, and additional meetings will be held either in Moscow or Vienna later in 2007 to agree on an implementation plan.

The other missions above (which were just concluded, being conducted, or to be conducted in the next weeks, at the time of this writing) were expected to result in agreements for formation of coalitions.

The IAEA is also currently planning a meeting to explore the formation of a Neutron sciences/scattering coalition in Vienna, 11-13 February 2008.

Several other proposals related to other coalitions in Africa, Latin America, and East Asia and the Pacific are still in the formulation stage and it is expected that exploratory meetings on these concepts will be held in the first quarter of 2008.

5. Conclusion

The IAEA has had a promising start during the first nine months of formal activity on the research reactor coalitions initiative. The IAEA has successfully played the role of "matchmaker" in introducing and facilitating discussions between two sets of partners that led to new commercial arrangements for increased utilization of specific research reactors. It is hoped that these arrangements may form the basis for broader research reactor coalitions in the future.

In addition, a significant number of promising concepts have been developed, exploratory missions and discussions held, and initial agreements for coalitions have been developed. While further discussions and arrangements are still required, it is expected that one or more formal research reactor coalitions will come to fruition in 2008 as a result of these activities.