

## **U.S. Department of Energy Program of International Technical Cooperation for Research Reactor Utilization**

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### **Abstract**

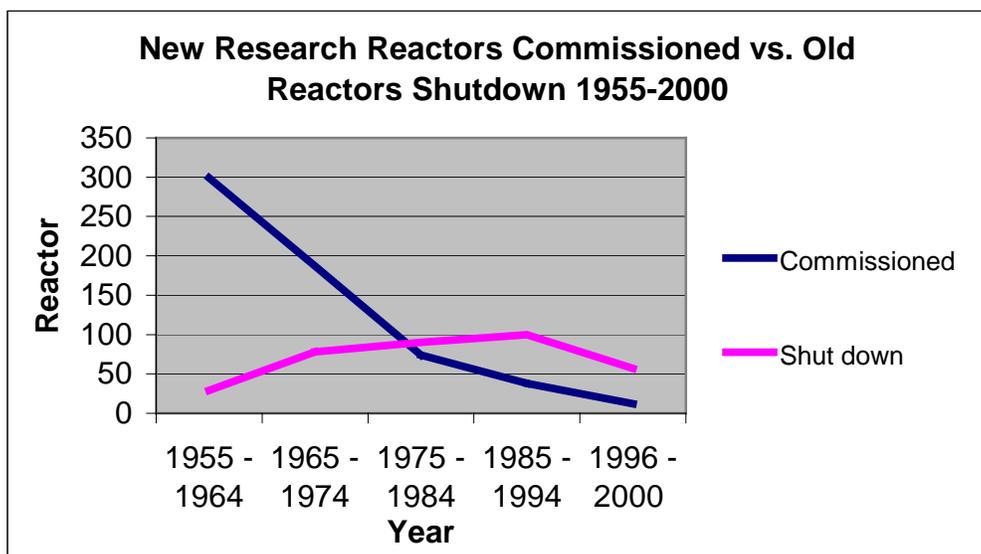
The U.S. Department of Energy, National Nuclear Security Administration (DOE/NNSA) has initiated collaborations with the national nuclear authorities of Egypt, Peru, and Romania for the purpose of advancing the commercial potential and utilization of their respective research reactors. Under its Office of International Safeguards "Sister Laboratory" program, DOE/NNSA has undertaken numerous technical collaborations over the past decade intended to promote peaceful applications of nuclear technology. Among these has been technical assistance in research reactor applications, such as neutron activation analysis, nuclear analysis, reactor physics, and medical radioisotope production. The current collaborations are intended to provide the subject countries with a methodology for greater commercialization of research reactor products and services. Our primary goal is the transfer of knowledge, both in administrative and technical issues, needed for the establishment of an effective business plan and utilization strategy for the continued operation of the countries' research reactors. Technical consultation, cooperation, and the information transfer provided are related to:

- ❑ Identification, evaluation, and assessment of current research reactor capabilities for products and services;
- ❑ Identification of opportunities for technical upgrades for new or expanded products and services;
- ❑ Advice and consultation on research reactor upgrades and technical modifications;
- ❑ Characterization of markets for reactor products and services;
- ❑ Identification of competition and estimation of potential for market penetration;
- ❑ Integration of technical constraints;
- ❑ Estimation of cash flow streams; and
- ❑ Case studies.

The United States engages in bilateral technical cooperation through the Sister Laboratory program to fulfill its obligations under Article IV of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which obligates signatory states "...to develop research, production and use of nuclear energy for peaceful purposes..." and requires member states to facilitate "...further development of the application of nuclear energy for peaceful purposes..." Technical experts of DOE's Los Alamos National Laboratory and Oak Ridge National Laboratory recently began collaboration on research reactors business planning methodologies under the DOE/NNSA Sister Laboratory Program.

## Introduction

The historic speech delivered by U.S. President Dwight D. Eisenhower on December 8, 1953 at the United Nations General Assembly was a vision preserving the benefits of nuclear research while addressing the danger of proliferating nuclear weapons and technology. In his speech he envisioned, “experts would apply atomic energy to the needs of agriculture, medicine and other peaceful activities.” Research reactors have played a historic role in discovering many beneficial peaceful uses of nuclear technology around the world for over fifty years. Though there have been many research reactors commissioned and built over the years, there has been a sharp decline in operational research reactors in recent times.



The International Atomic Energy Agency (IAEA) has forecasted that in the next 15 years, only 30 to 40 research reactors will be operational compared to the 272 research reactors operational today. This sharp decline in operational research reactors is attributed to various factors such as

- ❑ Aging materials and equipment in aging facilities, run by aged staff;
- ❑ Underutilization: the original mission of some research reactor facilities may have been accomplished, changed, or is no longer needed;
- ❑ Inadequate funding, as fiscal realities, such as fueling costs, force governments to cut back support;
- ❑ Stagnation of nuclear power in many industrialized countries; and
- ❑ Unavailability of suitable high-density low-enriched uranium fuels.<sup>1</sup>

The ramifications of this dramatic change in the research reactor scene has a great impact in developing countries around the world where nuclear technology increases the quality of life by helping to raise the level of available health care, agricultural efficiency, water sources, education, training, and industrial efficiency. The IAEA reports that although there has been significant shutdown and decommissioning of research reactors around the

<sup>1</sup> “New Life for Research Reactors? Bright Future But Far Fewer Projected”, IAEA Staff Report, 8 March 2004, [July04: <http://www.iaea.org/NewsCenter/Features/ResearchReactors/reactors20040308.html>].

world, countries may still utilize their research reactor if they are, "...actively managed, planned, researched, financed and marketed."<sup>2</sup>

In response to the concerns of the developing partner countries, the United States Department of Energy National Nuclear Security Administration's Sister Laboratory Program has initiated workshops and expertise to help Sister Laboratory bilateral partners develop business planning capabilities for their research reactors and cyclotron facilities. The activities of the Sister Laboratory Program initiative complements the IAEA plan to develop strategic plans for sustainability of research reactors. At this time Peru, Romania and Egypt are taking part in the DOE/NNSA Sister Laboratory International Technical Cooperation for Research Reactor Utilization.

### **Business Planning for Research Reactors**

Currently, many reactors are configured for mainly research use; however, reactor use for purely nuclear research is not a sustainable option for many developing countries. The operational costs of running a research reactor are still significant costs for governments. Research institutes and operators will need to embrace the need to commercialize their research reactors and develop utilization strategies to ensure revenue generation in the face of declining governmental support.

An effective plan for reactor commercialization or business planning is based upon projected revenue and cost streams. The basis for commercialization of research reactors is not a new science and many other industry tools can be applied for revenue generation at research reactors and cyclotron facilities. Cost streams are straightforward to define because the cost for operating research reactors falls under general categories such as staffing, equipment, fuel, materials, services, and utilities. Reactor operators are aware of the cost of running their reactors so these cost streams are already identified and tracked. Revenue generating streams on the other hand are much more difficult to assess because many research- focused reactors lack experts with experience in assessing the market for reactor products and services. A general shift from acknowledging the availability of the reactor for use to pro-actively seeking new users and new applications is required for successful commercialization activities. Unlike reactor sciences, market studies include aspects of sociology and psychology – areas in which nuclear experts in research institutes may not have experience.

A common theme within the Sister Laboratory Technical Cooperation for Research Reactor Utilization Projects is the need to bridge and combine effectively experts in both reactor utilization and business. Our bilateral projects are complementary to those of the IAEA and are cognizant of the relevant IAEA documents. The Sister Laboratory Program has developed four-phased projects with Peru, Romania and Egypt to develop a business plan for research reactors. The phases include 1) Utilization Planning, 2) Market Assessments, 3) Integration of Technical Constraints, and a 4) Financial Analysis.

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<sup>2</sup> "New Life for Research Reactors? Bright Future But Far Fewer Projected", IAEA Staff Report, 8 March 2004, [July04: <http://www.iaea.org/NewsCenter/Features/ResearchReactors/reactors20040308.html>].

## Utilization Planning

The first phase of cooperation between the U.S. and its sister laboratory partners involves the assessment of research reactor capabilities and development of domestic capacities to survey product and service opportunities in both their home economy and those in neighboring countries. Oak Ridge National Laboratory has expertise that it plans on sharing on identification of various uses and applications of reactors for commercial purposes, followed by an assessment of research facilities for products and services in their current configuration as well as other capabilities that can be enhanced or added with modifications. There are many viable commercial uses for of the research reactors, partitioned into either products or services, which can service domestic and regional needs. Examples of commercial uses developing countries may want to explore are numerous; some are included in the include following:

Products	Services
<ul style="list-style-type: none"> <li>• “Web-based virtual reactor”</li> <li>• Radioisotopes production               <ul style="list-style-type: none"> <li>Radiopharmaceuticals</li> <li>Isotopic tracers                   <ul style="list-style-type: none"> <li>Atmospheric studies</li> <li>Emergency planning</li> <li>Environmental studies</li> <li>Isotope hydrology</li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Neutron Therapy</li> <li>• Teaching hospital/environmental facility</li> <li>• Teaching and training facility</li> <li>• Use of hot cell facilities</li> <li>• Neutron radiography</li> <li>• Insect sterilization</li> <li>• Gem clarification and color change</li> <li>• Neutron activation applications</li> <li>• Materials analysis and studies               <ul style="list-style-type: none"> <li>Archaeology projects</li> <li>Forensic sciences</li> <li>Work for licensing authorities</li> <li>Textiles industries</li> <li>Electronics materials</li> <li>Fishing Industries</li> <li>Shore contamination</li> <li>Veterinary sciences</li> </ul> </li> <li>• Material irradiation               <ul style="list-style-type: none"> <li>Food irradiation</li> <li>Seeds irradiation</li> </ul> </li> </ul>

Oak Ridge National Laboratory experts plan to assist our foreign counterparts in identifying products and services for the current configuration of the research reactor and also providing advice and consultation on research reactor upgrades and technical modifications, that can enhance the production or service capabilities of the reactor, in order of costs.

Los Alamos National Laboratory is prepared to provide consultations with our international counterparts on developing capabilities in market assessments, marketing, and other business related fields. Building human resources in economic studies will focus on use of higher education and industry. A developed team of experts in commercial activities can then move forward towards identifying product/service opportunities in key industries and economic sectors for both existing products and

services used and potential new products and services. The identification of possible product/service opportunities will utilize the assessment of research facilities capabilities.

### **Market Assessment**

The second phase of the cooperation on business planning will primarily focus on assessing domestic and regional markets for key industries and economic sectors. The IAEA as part of their support for sustainable research reactors is encouraging facilities to develop into “regional centers of excellence.” These centers would be able to provide products and services for a number of neighboring countries. The assessment of markets both domestically and regionally will provide information on how to develop research reactor operations so they may develop into a sustainable facility that can support both domestic and regional needs.

Los Alamos experts are prepared to provide consultations and expertise in quantifying the market needs and potential constraints to reactor product and services both domestically and regionally. Activities in the phase include the conversion of industry or economic sector requirements to quantities identified in the utilization planning phase. The quantification of market needs will be followed by estimations of future markets for potential new reactor products and services that may result from possible modifications to the reactor configurations. Competition for reactor products and services in the markets will be identified through studies, which include: existing and potential future market entrants; capability of the competition to serve identified markets; and competitive costs. These studies will identify areas of the market in which the reactor facility can provide a comparative advantage over its competitors.

### **Integration of Technical Constraints**

During this phase, technical constraints such as limitations of the research reactor and configurations will be identified. Also included in this assessment are the limitations that transportation and other constraints such as product radioisotope half-lives that may impose a limitation on the geographical distance of markets. These constraints can be a major roadblock for developing countries that may lack electricity, water and transportation infrastructure.

### **Financial Analysis**

Utilizing the results from the previous project phases, U.S. experts will assist international partners to develop tools to chart revenue and cost streams using worksheet tools that assemble data from the previous studies. The result of this analysis will provide net revenue and internal rate of return as well as other figures that will identify current and future products and services for the reactor. Comparing these figures along with qualitative pros and cons will provide a more profitable road towards commercializing research reactors. The final product of these studies is to build a case study for each country that will provide a baseline for future business planning activities.

### **U.S. Expertise**

The Sister Laboratory International Technical Cooperation for Research Reactor Utilization projects will not exchange any information of business confidential nature. Domestic and regional market studies will only incorporate open sources and data that are collected by the reactor operator. The focus of these cooperative projects is to

provide the necessary tools and methodology through expert consultations and workshops for our international counterparts to ensure they can assess their reactor capabilities as well as market conditions in a sustainable manner. Just recently, DOE/NNSA-sponsored a Technical Workshop on Research Reactor Business Planning at ORNL in August 22-27, 2004 with participants from Romania, Peru, Egypt, Morocco, and Portugal. This workshop provided an effective first step towards developing methodologies on business concepts for research reactors.

### **IAEA Activities**

To complement our bilateral activities, we recommend our international counterparts to actively participate on research reactor issues at the IAEA and to utilize IAEA resources. We encourage our partners to follow IAEA (International Atomic Energy Agency) publications such as "Applications of Research Reactors" and "Strategic Planning for Research Reactors". We also strongly encourage participation in IAEA IGORR (International Group on Research Reactors) Meetings. Utilizing bilateral and IAEA resources, it is our hope that research reactor facilities in our partner countries will shift their focus to ensure sustainability of their reactors in today's political, social, and economic environment.

# SISTER LABORATORY PROGRAM

DEPARTMENT OF ENERGY  
NATIONAL NUCLEAR SECURITY ADMINISTRATION  
OFFICE OF INTERNATIONAL SAFEGAURDS

When the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) entered into force in 1970, it marked an important step in the global effort to stop the proliferation of nuclear weapons and control the raw material for their production. Today the NPT is the cornerstone of the worldwide nuclear nonproliferation regime. Virtually all countries have signed the Treaty, with the exception of Pakistan, India, and Israel, making it the most inclusive of all international treaties.

Technical Cooperation activities mandated under NPT Article IV obligates signatory states – “to develop research, production and use of nuclear energy for peaceful purposes...” and requires member states to facilitate, “...further development of the application of nuclear energy for peaceful purposes...”

The International Atomic Energy Agency (IAEA) provides the primary multilateral means for providing assistance in nuclear-related technologies to developing countries through its technical cooperation program. The technology provided primarily addresses fundamental developmental needs such as food and water supplies, health services, education, and environmental management.

Bilaterally, the United States engages in technical cooperation through the Sister Laboratory Program to fulfill its obligations to NPT Article IV. In the early 1980's, the United States launched an initiative to establish cooperative institutional relationships between its own National Laboratories and counterpart laboratories in developing nations that support the NPT. Mexico's National Institute of Nuclear Research (ININ) entered into a Memorandum of Understanding with Los Alamos National Laboratory in March 1982 becoming the first Sister Laboratory partner. Since then, further Sister Laboratory arrangements have been signed between partner country institutions and DOE/NNSA through the U.S. national laboratories. The US-Romania sister Laboratory arrangement signed in 1999 between Romania and DOE was the first arrangement with two active U.S. national laboratories, ORNL and LANL.

These non-binding arrangements provide U.S. technical experts to interact at the working level for civil nuclear technology and energy applications. Programs undertaken by sister laboratories include: training; fellowships; business planning and exchanges of equipment materials and instruments for radioactive waste management; research and power reactor applications; radiopharmaceutical research; and environmental evaluation and surveillance.

The Office of International Safeguards of the United States Department of Energy, National Nuclear Security Administration currently sponsors Sister Laboratory arrangements in Argentina, Egypt, Mexico, Morocco, Peru, Romania, and Thailand.