Improving Nuclear Safety at International Research Reactors: The Integrated Research Reactor Safety Enhancement Program (IRRSEP)

Authors: David Huizenga, Douglas Newton, Joyce Connery
Affiliation: Office of International Nuclear Safety and Cooperation, National Nuclear Security Administration, U.S. Department of Energy

Nuclear energy continues to play a major role in the world's energy economy. Research and test reactors are an important component of a nation's nuclear power infrastructure as they provide training, experiments and operating experience vital to developing and sustaining the industry. Indeed, nations with aspirations for nuclear power development usually begin their programs with a research reactor program. Research reactors also are vital to international science and technology development. It is important to keep them safe from both accident and sabotage, not only because of our obligation to prevent human and environmental consequence but also to prevent corresponding damage to science and industry. For example, an incident at a research reactor could cause a political and public backlash that would do irreparable harm to national nuclear programs. Following the accidents at Three Mile Island and Chornobyl, considerable efforts and resources were committed to improving the safety posture of the world's nuclear power plants. Unsafe operation of research reactors will have an amplifying effect throughout a country or region's entire nuclear programs due to political, economic and nuclear infrastructure consequences.

With this in mind, the Office of International Nuclear Safety and Cooperation of the U.S. Department of Energy has been involved with the International Atomic Energy Agency (IAEA) initiative to on develop a Code of Conduct on the Safety Research Reactors. The members of that body have recognized the important benefits of research reactors in areas such as research, training, radioisotope production, medical and industrial applications. The IAEA also recognized the potential for accidents at such facilities and the fact that these facilities lie outside the scope of the Convention on Nuclear Safety. Therefore, it was concluded that a Code of Conduct be created to "serve as guidance for the development and harmonization of policies, laws and regulations on the safe management of research reactors."[i]

The Code of Conduct recommends that States review the safety of research reactors, including those in extended shutdown and ensure that all reasonable safety improvements are employed. In the event that safety improvements cannot be implemented, the Code of Conduct suggests that a planning process begin to shutdown and decommission the reactor.[ii]

For these reasons, the U.S. Department of Energy's Office of International Nuclear Safety and Cooperation has initiated a program to improve, where necessary, the safety and security of research reactor facilities. This program is based on ten years of experience that the Department has in cooperative safety and security projects at nuclear power plants in the former Soviet Union.

The mission of the Office of International Nuclear Safety and Cooperation is to enhance the safety and security of nuclear reactors worldwide, prevent nuclear incidents or accidents, mitigate accident consequences, bolster the worldwide safety culture of the nuclear fuel cycle, and enhance emergency preparedness. The flagship of this office has been its Soviet-Designed Reactor Safety Program. For the past ten years, we have been working with operators of Soviet-designed power reactors to improve their safety. We have worked in the areas of operational safety improvements (emergency procedures, operator training, simulators and quality assurance), risk reduction at the oldest and least safe plants, and regulatory assistance. The office supported the safe closure of Chornobyl's final operating unit, unit 3, and continues to support the qualification of an independent US nuclear fuel supplier for Ukraine. Other countries in which we have worked include Armenia, Bulgaria, Czech Republic, Hungary, Kazakhstan, Lithuania, Russia and Slovakia. Our overall safety goal has been to transfer nuclear safety technology, methods and practices to establish a sustainable nuclear safety culture in host countries.

Building on this breadth of experience in Soviet-designed reactor safety and with the bulk of the work completed or near-completion, the Office of International Nuclear Safety and Cooperation is refocusing its efforts toward ensuring the nuclear safety of research reactors. Working in parallel with our counterparts at the IAEA and with other offices within the U.S. Department of

Energy, our program seeks to improve nuclear safety through safety upgrades, transfer of nuclear safety technology, and, drawing on experience at Chornobyl and the Kazakhstan BN350 breeder reactor, with safe shutdown expertise.

Problems Identified by the IAEA[iii] *and Proposed Resolution*

Listed below are some of the problems highlighted by the IAEA that research reactor operators face. Of course, each facility is unique and may face none, some or all of these problems. These problems are illustrative only, as are the proposed solutions presented.

1.) *Aging facilities:* Many of the research reactors worldwide have been operating for over thirty years. Unlike power reactors, research reactors were not designed and constructed for a specific lifetime. The aging process changes the characteristics of component systems gradually. If this process is unchecked, degradation of materials can and will occur under normal operating conditions.

Addressing the issue: For research reactors with on-going mission, the IRRSEP program can help identify, and in some cases, replace components that have been compromised due to aging. In both aging and younger reactors, it is necessary to ensure that the quality assurance programs contain procedures for periodic testing, review and maintenance of components and systems. In aging reactors, safety analysis reports may need to be amended to include methodology for surveillance and in-service testing.

2.) *Deficiencies in regulatory supervision:* Some reactors are located in countries without appropriate regulatory authorities or with weak oversight. It may not be that the regulatory authority lacks competence, it may be that it is under-funded and/or understaffed.

Addressing the issue: In collaboration with the IAEA, the Office of International Nuclear Safety and Cooperation has worked with regulators through its other programs by providing information and in some cases, training. Independent nuclear safety centers have been established in several countries and interface on a regular basis with regulators.

3.) *Research Reactors in extended shutdown:* If not maintained, the safety of a reactor in extended shutdown will deteriorate. Licenses often need to be amended to reflect the shutdown condition. In some cases, the reactors are in a suspended state because the ownership of the reactor or the responsibility for decommissioning is not clear.

Addressing the issue: IRRSEP will endeavor to ensure the safety of a reactor in extended shutdown. Once the decision is taken to permanently shutdown a reactor and go to either immediate or delayed decommissioning, the Office of International Nuclear Safety and Cooperation can provide technical assistance in certain areas. For instance, the office is working with the IAEA and the BN-350 nuclear power plant in Kazakhstan to develop a decommissioning plan for international peer review. It was also involved in the Chornobyl closure. Expertise can be brought to plan system dismantling and/or mothballing, radiation safety and fire protection upgrades, and surveillance and maintenance planning.

4.) *Inadequacies in Operational Organization Management:* Research reactor management deficiencies can consist of various elements including loss of expertise and corporate memory, inadequate quality assurance programs, lack of a safety culture, insufficient financial support, inadequate emergency planning, lack of strategic long-term planning, and lack of periodic safety reviews.

Addressing the issue: In reactors that continue to operate, the Office of International Nuclear Safety and Cooperation can provide reactor facilities with necessary safety upgrades, continued training for safety personnel, assistance with quality assurance programs and a program for periodic safety reviews. IRRSEP can also assist in the development of an emergency policy and preparedness infrastructure. This includes, the development of emergency operations facilities and the development of emergency procedures to ensure that health and safety of workers, the public, and environment are protected. A needs assessment will indicate the most effective use of resources to support the safe operation of the reactor.

5.) *Inadequate international cooperation:* The IAEA has noted a lack of information exchange, international standards and guides, peer reviews, and regional reactors.

Addressing the issue: While this issue is best addressed by the International Atomic Energy Agency, IRRSEP can facilitate and strengthen networks among research reactor operators. Indeed many of those networks already exist thanks to the excellent work of our colleagues in

the RERTR program. The research reactor Code of Conduct is one mechanism by which international norms and standards are established.

The Program

The program is envisaged to be a five- to seven-year program funded initially between two and three million dollars per year. The program is comprised of three phases: self-evaluation, site visits with a technical evaluation and finally, corrective measures. Corrective measures would range from safety enhancements for operational reactors to shutdown safety assistance and decommissioning technical cooperation. For research reactors that are scheduled for shutdown or decommissioning, the program may provide technical assistance in areas such as decommissioning plan development, final de-fueling, interim fuel storage and some decontamination and closure or dismantling of systems. For research reactors that will continue to operate, technical assistance may be provided to improve safety in areas such as reactor control and protection systems, fire protection, modern safety analyses, training, emergency procedure development, emergency preparedness and spent fuel storage safety upgrades.

The criteria for safety assistance are threefold: the impact on safety, cost-effectiveness and host-country commitment (sustainability). While considering the impact on safety, the project is evaluated against available independent safety reviews and risk assessments to verify that it improves safety. Regulatory involvement, technology transfer and sustainability also are factored into the evaluation. The cost-effectiveness evaluation is done by a comparative assessment of projects to determine the relative investment in safety. Projects that can be done in conjunction with other projects and those that enhance indigenous safety capabilities are favored. Finally, the host country's commitment to the project, its willingness to collaborate and its willingness to commit funds and personnel are also weighed.

At the moment, facilities in Kazakhstan, Uzbekistan and Romania are in the third phase of the program. They have each done a self-evaluation followed by a technical team visit by our office and its contractors. Several tasks have been identified for each facility and contracting for those

tasks will begin in the nearest future. Several other countries have completed the self-evaluation phase and technical visits are being scheduled. These countries include Latvia, Poland and Bulgaria. Others, such as Ukraine, are in the process of completing self-evaluations.

The WWR-M research reactor in Tashkent is involved currently in a core conversion project with the Department of Energy's Office of Nonproliferation and International Security. The Office of International Nuclear Safety and Cooperation recently evaluated the safety of the reactor and will work collaboratively with the RERTR project to address nuclear safety issues. One of the primary needs of the reactor from a safety perspective is an upgrade of its instrumentation and control system. Work is being done to support that upgrade now. Other areas include fire suppression, radio communications, and pipe corrosion. Safety enhancements for the WWR-K Research Reactor in Alatau, Kazakhstan were also identified. These measures include an uninterruptible power supply, a neutron monitoring system, non-destructive examination equipment and training and upgrades to fire detection and fire suppression systems.

In Maguerele, Romania, the WWR-S research reactor is no longer operating. We are working closely with the reactor operator and the regulatory body in Romania to provide assistance with the safe shutdown and decommissioning planning. For example, we will review the decommissioning plan, upgrade radiation detection equipment and replace the HEPA filtration system in the spent fuel storage area and throughout the reactor facility.

The U.S. Department of Energy is working to develop an integrated safety enhancement program for research reactors aimed at addressing the issues of nuclear safety and security. We propose to work closely with the international research reactor community to solve its common problems and improve nuclear reactor safety.

[i] Preamble to the *Draft Code of Conduct on the Safety of Research Reactors*, 17 May 2002. Vienna, Austria.
[ii] *Draft Code of Conduct on the Safety of Research Reactors,* Section V.B.16, 17 May 2002. Vienna, Austria,.
[iii] From *Issue Paper for the International Conference on Topical Issues in Nuclear Safety,* 3-6 September 2001. Vienna, Austria.