Maintaining the sustainability of research reactors

Helmuth Boeck
Associate Professor for Reactor Safety at the Vienna University of Technology's Institute of Atomic and Subatomic Physics. Boeck has over 45 years of experience in research reactor utilization and operation. He has also served as an expert on more than 80 IAEA-supported missions.

Research reactors continue to be an indispensable means of providing radioisotopes for medicine and industry, neutron beams for material research and non-destructive testing, and analytical and irradiation services for both the private and public sectors. Their use also plays a strategic role in educating and training a new generation of scientists and engineers to support nuclear science and technology programmes.

Of the 841 research reactors built to date, many have already been decommissioned, or are awaiting decommissioning, and, out of the 224 research reactors still in operation, over 50% are over 40 years old. While there are currently 9 research reactors under construction worldwide and about 30 new research reactors in different stages of planning, many research reactors have been shut down owing to a lack of funding, a lack of utilization or a lack of strategic planning, all of which were not previously considered to be important issues. With proper management and utilization, a research reactor can operate for 60 years or more. However, it is of paramount importance that adequate life management programmes, including those related to safety, security and utilization, are established well in advance.

Collaborating to reduce costs and increase utilization

The main challenges faced by research reactor operators today are issues concerning funding and utilization. Research reactors are not usually supported financially by the state, industry or the private sector if there is no visible benefit. The benefits could involve academic research within a national university programme, the production of medical radioisotopes or materials research within a national or an international cooperation programme. Depending on the research reactor's power level — which influences how it is used — a multipurpose research programme would be the optimal solution.

One possibility to reduce operational costs while increasing utilization is to form regional research reactor partnerships among two or more research reactor facilities, which can then share operation time and/or expensive equipment. Over the past decade, several such partnerships have been initiated and financially supported through the IAEA's group fellowship training (GFT) courses.

One example of this is the Eastern European Research Reactor Initiative (EERRI), which was established by four countries, Austria, the Czech Republic, Hungary and Slovenia, which, in total, operate six research reactors of various designs. Through this network, 15 GFT courses lasting 6 weeks and with more than 120 participants in total have been carried out since 2009. The participants were trained on at least 5 research reactors with power levels of between 100 kW and 10 MW and were educated about topics such as reactor physics, instrumentation and control systems, radiation protection and activation analysis.

Similar initiatives are, for example, the Global TRIGA Research Reactor Network (GTRRN), which was created to discuss and address common issues of TRIGA-type research reactors — of which more than 30 are in operation worldwide — including supply of fuel, technical support and enhanced utilization.

Ageing, shutdown and decommissioning

According to the IAEA's Research Reactor Database, several research reactors across the world are in extended shutdown for reasons such as the absence of a utilization plan or because the technical status does not meet internationally accepted safety standards and would otherwise require extensive refurbishment or modernization. In some cases, refurbishment or modernization may be so costly that it is cheaper to keep the reactor in shutdown; however, even in this state, maintenance costs continue. Consequently, there are several research reactors sleeping their way into an undecided future, which, in the long run, could raise real safety and security questions.

This situation is exacerbated by the question of how to deal with the reactors' spent fuel, which must be effectively managed, including storage at a national storage facility, reprocessing, final disposal, or shipping back to the country of origin. Such options are usually expensive and must be handled in a timely manner while also observing international safety standards and ensuring the necessary financial investment at an early stage.

Management systems for strategic planning

For long term research reactor operation, an effective ageing management programme should be established and should typically include, among others, a detailed safety assessment for long term operation and adequate plans for refurbishment and modernization in order to bring the facilities into line with up-to-date safety standards.

For many research reactors, there is a lack of decommissioning plans that should have been developed at the beginning of the reactor's operational lifetime and subsequently kept up-to-date. Several IAEA safety standards have been developed to provide guidance on establishing ageing management programmes, decommissioning and managing research reactors in extended shutdown.

These issues related to shutdown, ageing and decommissioning can be addressed when establishing an overall management system. These systems also need to be developed in such a way as to address important goals, including safety, health, security and related issues, in order to improve a research reactor's continued operation and services, as outlined in the IAEA safety standards. The system should provide generic guidance that aids the establishment, implementation and assessment of a research reactor and provides specific guidance on operation that complies with international standards.

To set up a management system, a detailed strategic plan tailored to a particular facility should be established and should involve all partners, such as national authorities, industry, users and facility managers, in order to streamline available funds and operational expenses. This strategic plan must be periodically revised to account for changes to the research reactor's mission over time. The IAEA has developed many documents to assist countries in developing and implementing strategic plans.

In conclusion, these topics indicate how research reactors can be maintained and/or improved to ensure sustainability. Depending on the particular status of a specific research reactor, the operating organization may decide on actions for improvement using, in particular, the IAEA's experience and support so as to maintain the sustainability of its research reactor.