

Safety of Research Reactors: Views of the NEA Committee on the Safety of Nuclear Installations (CSNI)

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The safety of research reactors has received global attention recently due to the forced closures of medical radioisotope reactors. Historically, research reactors have been generally treated by regulators and the international community as a subset of power reactors. They possess many of the same or similar safety issues but on a different scale, such as the reactor physics, radiation protection, and the ageing management of equipment and materials. However, while research reactors involve lower risk than power reactors, many of them are ageing, and they are sometimes located in areas with high population density and due attention should be paid to their adequate safety performance.

There are some unique issues related to the operation of research reactors. The reactor type, configuration, thermal output, and the utilisation can be significantly different from each other and from power reactors. Regulatory guidance and policy varies from country to country. Additionally, the purpose and uses of research reactors tend to be more international in nature. Certainly, the shutdown of the reactors in Canada and the Netherlands has affected more countries and has created a larger global crisis in the supply of medical radioisotopes than ever seen previously.

Following these recent events, the NEA Committee on the Safety of Nuclear Installations (CSNI) has begun to take a keen interest in determining what in particular it can contribute to the current safety or knowledge gaps pertaining to the safe operation of the current fleet of research reactors. CSNI Members made clear that any work undertaken by the Committee should not duplicate but rather should complement the extensive work already carried out over the past number of years by the IAEA on the safety of research reactors. A position paper was established by a sub-group of Members and the NEA staff and discussed extensively in the CSNI meetings held in June and December 2010. A close interaction with the IAEA staff has been maintained all along this work, as well as with the NEA Committee on Nuclear Regulation Activities (CNRA).

The CSNI recognizes that the IAEA is much involved in the safety of research reactors in terms of safety standards, education and training, safety review missions, incident reporting and already initiated some coordinated research projects. The overall conclusion reached by the CSNI is that there are no major safety issues where the lack of data could be considered as an important source of weakness in the regulation and safe operation of research reactors. However, the CSNI identifies some technical areas where it could contribute to improve the knowledge basis on the research reactor safety, subject to the confirmation of a priority interest by the regulatory community.

First of all, the CSNI outlines that a realistic and accurate risk categorization is of utmost importance prior to embarking on technical activities on research reactor safety. The categorization of research reactors is largely based today on their power level. But, as for medium and high power research reactors, the risks involved are dependent upon the type and

the characteristics of the reactors (operation mode, fission product inventory, and criticality). In this regard, the CSNI may consider, in cooperation with the IAEA, the development of guidelines to establish more realistic criteria for risk categorization of different types of research reactors. Such a categorization is a key element when developing an appropriate graded approach in the application of safety requirements for research reactors.

Ageing Management and Long Term Operation are key issues for research reactors. While much attention has been focused by the IAEA on the fundamental elements of an appropriate ageing management program, the CSNI could conduct further research collectively into the specific science and mechanics of ageing applicable to research reactors. An activity has been recently initiated within the CSNI Working Group on Integrity and Ageing of Equipment (WGIAGE) including a survey and an identification of major age-related degradation mechanisms of materials and equipment of power reactors and could be complemented by also addressing materials and degradation mechanisms specific to research reactors.

Another topic of interest is the Accident Analysis Code Review and Validation. Most of the existing research reactors have been designed for a long time with rather simple and conservative methods. In the framework of Periodic Safety Reviews (PSR) of these reactors, when in force in the country, or in case of applications for Long Term Operation (LTO), recent analytical tools are often used to perform safety analyses, as well as for new projects. The question raised by the application of these numerical tools and methods to research reactors deals with their qualification, as most analytical tools available to research reactor operators and researchers were developed and qualified for power reactors. Several NEA member countries operating research reactors of various types have developed analytical tools for safety analysis and applied them to research reactors. Some of their research or safety organizations are in possession of data and experimental results which could be used in a common effort to achieve a better adaptation and validation of analytical tools applied to research reactor analysis. Furthermore, the CSNI could build and evaluate benchmark of analytical tools against data relevant for the qualification of these tools applied to research reactors.

As regards Severe Accident and Management Analysis for research reactors, currently the approach seems to be for most countries to use a simplified bounding analysis type of calculation with large safety margins. While highly conservative, the use of a deterministic bounding analysis approach to severe accidents makes the identification of appropriate accident management strategies difficult. Another related technical area of interest has to do with improvements in the precision of source term calculations for specific types of research reactors. Given the importance for reasonably accurate source term calculations in the overall development of emergency response plans and mitigation measures (particularly given that many research reactors are located in rather densely populated areas), it could be worthwhile for the CSNI to carry out a study into how accident scenarios for research reactors are developed, the analytical tools that are used and the fission product transfer coefficients that are applied with the goal of moving towards some harmonization in these domains.

As research reactors continue to age with some facing potentially no foreseeable end-of-life, the importance of human and organizational factors to their continued safe operation cannot be overstated. While there have been organizational improvements undertaken to support the continued safe operation of power reactors, the operating organizations for research reactors may have not been involved in such improvements and therefore may lag in the implementation of state-of-the-art organizational performance improvements. Among others, knowledge management appears as an extremely important topic for the continued safe

operation of research reactors and also for a good ageing management: if knowledge on the installation is not adequately maintained, ageing management cannot be performed adequately.

Furthermore, lessons learnt from the Fukushima accidents should also be applied to research reactors. In particular, some generic issues should be investigated, such as for instance the risks of core re-criticality in case of core fuel relocation, of criticality in spent fuel pools or of internal explosion due to various reaction products such as the products of metal/water reactions. It is to be outlined in the respect that the most important French research reactors are submitted to “stress tests” as are power reactors.

As the CNRA was setting up a specific Task Group on the Safety of Research Reactors in order to identify knowledge or policy gaps related to regulatory activities, the CSNI decided to provide this task group with its position paper and to contribute to its work. This common effort should lead by the end of 2011 to a consistent position within the NEA to determine if further activity to address knowledge or policy gaps on the safety of research reactors is needed and how CNRA and CSNI working groups could address these gaps, in close cooperation with the IAEA.