

## **Safety of Decommissioning of Nuclear Facilities**

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### **ABSTRACT**

Ensuring safety during all stages of facility lifecycle is a widely recognised responsibility of the operators, implemented under the supervision of the regulatory body and other competent authorities. As the majority of the facilities worldwide are still in operation or shutdown, there is no substantial experience in decommissioning and evaluation of safety during decommissioning in the majority of Member States. The need for cooperation and exchange of experience and good practices on ensuring and evaluating safety of decommissioning was one of the outcomes of the Berlin conference in 2002. On this basis during the last three years IAEA initiated a number of international projects that can assist countries, in particular small countries with limited resources. The main IAEA international projects addressing safety during decommissioning are: (i) DeSa project on Evaluation and Demonstration of Safety during Decommissioning; (ii) R<sup>2</sup>D<sup>2</sup>P project on Research Reactors Decommissioning Demonstration Project; and (iii) Project on Evaluation and Decommissioning of Former Facilities that used Radioactive Material in Iraq.

This paper focuses on the DeSa project activities on (i) development of a harmonised methodology for safety assessment for decommissioning; (ii) development of a procedure for review of safety assessments; (iii) development of recommendations on application of the graded approach to the performance and review of safety assessments; and (iv) application of the methodology and procedure to the selected real facilities with different complexities and hazard potentials (a nuclear power plant, a research reactor and a nuclear laboratory). The paper also outlines the DeSa project outcomes and planned follow-up activities. It also summarises the main objectives and activities of the Iraq project and introduces the R<sup>2</sup>D<sup>2</sup>P project that is the subject of a complementary paper.

### **1. Introduction**

Ensuring safety during all phases of facilities using radioactive material is the primary focus of regulators and responsibility of operators. Decommissioning experience worldwide is continuously expanding [1, 2] which has contributed to the establishment of a set of internationally agreed safety standards in this field. The Safety Fundamentals [3] was published in 2006, complemented by new Safety Requirements on Decommissioning of Facilities Using Radioactive Material [4]. These requirements are supported by Safety Guides [5-9] that present good practice on demonstrating compliance with the specific safety requirements.

The International Atomic Energy Agency (IAEA), according to its Statute, establishes safety standards and also provides for their application. Based on the increasing number of requests from Member States in the recent years, the IAEA launched several new international projects in the field of decommissioning.

### **2. Main IAEA International Decommissioning Projects**

These projects have common goals that can be summarised as follows:

- To provide forums for exchange of information, experience between Member States;

- To build up competence in experts from different interested parties, e.g. operators, regulators.
- To assist in the establishment of the national infrastructure for decommissioning,
- To assist the adequate planning for and implementation of decommissioning of specific facilities in the country in accordance with international safety standards.

These IAEA decommissioning projects also have specific focus and expectations, and this paper presents three of the current ongoing IAEA projects [10];

- *Safety assessment for decommissioning* through the Evaluation and Demonstration of Safety during Decommissioning of Nuclear Facilities (DeSa) Project;
- *Decommissioning of legacy facilities* through the Decommissioning Project of the Iraq Former Nuclear Complex;
- *Decommissioning of small facilities* through the Research Reactor Decommissioning Demonstration (R<sup>2</sup>D<sup>2</sup>P) Project.

### 3. Evaluation and Demonstration of Safety during Decommissioning (DeSa) Project

The increasing number of facilities that are reaching the end of their lifetime or that have been shutdown as planned or prematurely, as well the large number of operating facilities that are envisaged to be decommissioned in the next ten to twenty years is drawing the attention of operators, regulators and other stakeholders (e.g. public) to the approaches and measures of ensuring safety during decommissioning. Performance of safety assessment is one of the tools and arguments for demonstration of safety and it has been discussed at the international Conference in Berlin 2002 [11]. The outcomes of this conference were reflected in the International Action Plan on Decommissioning of Nuclear Facilities [12]. The Board Of Governors approved the Action Plan in 2004 [13] and requested the IAEA to “establish a forum for the sharing and exchange of national information and experience on the application of safety assessment in the context of decommissioning and provide a means to convey this information to other interested parties, also drawing on the work of other international organizations in this area”.

In November 2004 the new International Project on Evaluation and Demonstration of Safety during Decommissioning of Nuclear Facilities (DeSa) [14] was launched with the aim to (i) harmonise safety assessment approaches, (ii) illustrate the methodology on different types of facilities (e.g. a nuclear power plant (Fig.1), a research reactor (Fig. 2) and a Pu-nuclear laboratory (Fig. 3)), (iii) develop recommendations on the regulatory review of such assessments; and (iv) provide a forum for exchange of information between experts from IAEA Member States.



FIG. 1 Nuclear Power Plant

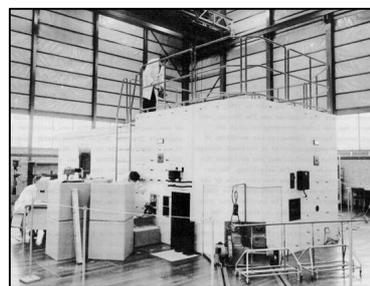


FIG. 2 Research Reactor

During the last three years over fifty experts from operating organisations, regulatory bodies and other interested organisation in over 30 countries are participating in the project. The project has successfully completed two of the three phases and at present is consolidating the work outcomes and developing the conclusions and lessons learned [15].

At present the preliminary outcomes of the DeSa project activities to date can be summarised as follows [15]:



*FIG 3. Nuclear Laboratory*

- a. A harmonised safety assessment methodology has been developed based on the Member States' practice. It has been considered and being implemented in several decommissioning projects in Russia, Ukraine, China, etc.
- b. Safety assessments for three real facilities with different complexity and hazard potential have been developed using the methodology (a). These assessments can be of benefit for Member States, in particular, developing countries in the development and implementation of specific decommissioning projects in their countries.
- c. A review procedures has been developed that can assist regulators and also operators and independent reviewers in the evaluation of safety assessments for decommissioning. This procedure has been based on experience of over twenty regulators as well as on the IAEA safety standards and supporting documents.
- d. Specific recommendations have been developed on the application of the graded approach to development and review of safety assessments for decommissioning. This is of particular importance to the optimisation of efforts of all interested parties and focus on the main safety related issues in decommissioning.
- e. The three year project is the first IAEA project in the field of safety of decommissioning. For this short period it established a network of specialists in this area, a forum for regular meetings and discussion of specific technical aspects, provided a mechanism for exchange of knowledge, experience and good practice between operators and regulators, and also enhanced the dialogues between operators and regulators from the same and other countries.

In addition, the project provided a very useful input to the preparation of the Safety Guide "Safety Assessment for Decommissioning of Facilities Using Radioactive Material" [16] expected to be published in 2008. The project contributed to the preparation of supporting documents through the publication of the outcomes in a four-volume report [15], expected also to be published in 2008. The experience gained through this IAEA initiative has already been applied to ongoing IAEA technical assistance in Congo, Ukraine, Romania, China, Lithuania and other countries of Central and Eastern Europe [17].

On the basis of the outcomes of the project, planned to be presented at the 4<sup>th</sup> Joint DeSa meeting (29 October – 2 November 2007) in Vienna [14], a follow-up project is under consideration to be initiated in 2008-9.

#### **4. Decommissioning of the Iraq Former Nuclear Complex**

There are a number of sites in Iraq which have been used for nuclear activities and which contain potentially significant amounts of radioactive material. Many of these sites suffered substantial physical damage during the Gulf Wars and several have been subject to looting of materials and equipment as a consequence of the challenging security situation in the country. On the principal nuclear site at Tuwaita there were two research reactors, hot cells and fuel fabrication and waste management facilities. All the sites have some degree of contamination and require decommissioning and remediation in order to ensure radiological safety. In December 2004 the Government of Iraq requested IAEA assistance to determine the effort needed to implement this work and to set up plans and programmes for its delivery.

The objective of this international collaboration is to support the provision of legal and regulatory infrastructure, to assess and characterise the current state of the facilities, to develop the decommissioning and waste management strategy and to support the implementation of the overall decommissioning and remediation plan.

There are some particular challenges related to this project which present special difficulty. Many of the physical structures have been very significantly damaged or destroyed, and the orderly characterisation of the facilities (including piles of rubble, scattered waste materials and unsafe structures) is a non-standard activity. Because of the historical context there is no tradition of working under regulatory control. There is no waste disposal site currently available in the country. Historical records have been lost or destroyed. Experienced human resources have been dispersed and are largely unavailable. Security conditions generally in the country present very uncertain working conditions.



*FIG. 4. IRT-5000 Research Reactor in Iraq*

Despite the above challenges, good progress has been made in establishing a legal basis and a regulatory body for the decommissioning activity. Detailed regulations to support the new Nuclear Law are being drafted. Scoping characterisation of many of the sites and facilities has been undertaken, and a prioritised order of work is being derived. Preparatory work to aid the development of a waste management strategy has been undertaken with the aid of visits to US, German and French facilities.

The current priorities of the programme are as follows:

- To implement the revised and strengthened regulatory regime;
- To develop the project organisation and infrastructure and build the overall plan;
- To dismantle a low-contaminated facility at Tuwaitha to provide early and safe learning experiences in characterisation survey work, decommissioning activities and regulatory interactions, and to develop confidence and pride;
- To bring order to the scattered waste and unsafe structures at Tuwaitha;
- To plan for the waste management and disposal requirements.

Despite the above conditions, recent assessments at Tuwaitha and the surrounding area have shown that there are currently no radiological conditions which require urgent and immediate intervention.

Continued review is essential, with particular emphasis on oversight of the current on-site storage of liquid waste and other wastes contained in drums. It is therefore appropriate to move forward with a controlled approach to decommissioning based on a properly developed plan with sound data, which has been subject to regulatory review.

### **Research Reactor Decommissioning Demonstration Project (R<sup>2</sup>D<sup>2</sup>P)**

The Research Reactor Decommissioning Demonstration Project (R<sup>2</sup>D<sup>2</sup>P) was established by the IAEA in 2005 [18] in order to support countries with ‘small’ nuclear programmes in the decommissioning of research reactors. Such countries often do not have trained experts for planning, regulating and executing the decommissioning of research reactors. As many research reactors are approaching the end of their normal lifetime, they are facing decommissioning. The IAEA has been requested to help member states in managing their decommissioning needs.

The R<sup>2</sup>D<sup>2</sup>P objective was established to provide ‘hands-on’ experience and to train and educate experts from ‘small’ nuclear countries in the decommissioning of research reactors in order to prepare them for the decommissioning of the respective national facilities. The project became operational in 2006 and was joined by 13 countries. The Philippines agreed to offer the decommissioning of their research reactor (PRR-1) as the model for R<sup>2</sup>D<sup>2</sup>P. This approach will ensure both, that (a) the Philippines will receive international support for their decommissioning project (equipment and expertise, as necessary) and that (b) the participating countries will receive training in order to be prepared for the decommissioning of their own research reactor.

The actual work on this project was started in 2006 by two workshops [18], one on the legal and regulatory framework and the other one on the ‘basics’ for decommissioning. The purpose of these two workshops was to give an overview over the whole scope of decommissioning projects from planning to final release of buildings and sites, including the regulatory and operational aspects, in order to set the scene for the project. The experts from the participating countries were requested to check the respective national situations against the internationally recommended approach, to make an effort to improve national situations and to report on achievements and progress to the R<sup>2</sup>D<sup>2</sup>P meetings.



*FIG. 5. TRIGA Research Reactor in the Philippines*

After the ‘theoretical’ start of the project the future focus will be on ‘practical’ aspects of decommissioning, including the actual demonstration on how to carry out the various decommissioning steps. The actual plan for the 6 years project includes workshops on the following subjects:

- Characterisation;

- Decommissioning technologies;
- Cost estimates;
- Preparation and review of decommissioning plans;
- Decontamination and dismantling exercises;
- Final radiological survey (buildings and site);
- Final decommissioning report.

The course of action and the scheduling of workshops will be a matter of the progress in the execution of the decommissioning project by the Philippines.

The PRR-1 decommissioning is a special case. The reactor had been upgraded and converted to a TRIGA. Soon after the re-start a leak occurred in the liner. The reactor was shut down for repair in 1988 and actually never taken back into operation. That means that the radionuclide inventory is relatively low and that the transition from operation to decommissioning cannot be demonstrated. Furthermore, other types of research reactors, i.e. heavy water reactors, are also in operation and they are associated with specific decommissioning requirements (e.g. accommodating higher H-3 levels). From this point of view it would be desirable to complement the PRR-1 case with other research reactors if agreement can be found with the respective host country. One such example is the High Flux Australian Reactor (HIFAR) that was shut down at the beginning of 2006. It is in the transition phase to safe enclosure and later decommissioning and is being considered to complement the PRR-1 activities very well.

## **5. Conclusions**

The IAEA has established almost a complete set of safety standards on decommissioning of all types of facilities using radioactive material. At present the main focus of IAEA is to assist Member States in the application of the safety standards in practice and also to review the safety standards and recommendations (and where necessary revise) them in accordance with the Member States practice and feedback from the application of these standards (e.g. WENRA, Athens conference). International initiatives, such as the DeSa, Iraq and R<sup>2</sup>D<sup>2</sup>P projects proved to be a very useful mechanism for providing specific technical assistance and also improving the cooperation between countries at regional and international level.

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