IAEA Perspectives on Preparation for Decommissioning

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ABSTRACT

There are about 160 power reactors in decommissioning phase worldwide. In addition, more than 400 other nuclear facilities, such as research reactors or nuclear fuel cycle facilities, have been shutdown for decommissioning, have been undergoing active decommissioning or have already been fully dismantled.

Planned and systematic preparation for decommissioning is very important for further effective implementation of dismantling activities. While some preparatory activities for decommissioning start early in the facility life-cycle, the main preparatory activities are implemented towards the end of the operational period and during the transition period from operation to decommissioning. These may include a wide range of technical actions, such as physical and radiological characterization, pre-decommissioning decontamination, management of spent fuel and operational waste, establishment of new waste management facilities and modification of safety systems needed to support decommissioning. In parallel, some non-technical tasks are to be completed, e.g. preparation of the final decommissioning plan and its supporting documents, licensing activities, organizational changes, training of personnel for decommissioning, etc. Preparatory activities may be organized in various ways depending on considered decommissioning strategies and physical and radiological status of the nuclear facility after its routine operation is over.

The IAEA published numerous safety and technical reports providing guidance, recommendations, experiences, good practices and lessons learned, fully or to some extent covering the preparatory phase for decommissioning. Many training courses, workshops, seminars etc. were organized to support sharing of good practices among specialists and organizations involved. This paper provides an overview of relevant activities and perspectives of the IAEA in this area. The paper also draws some general conclusions and identifies lessons learned on the basis of the initiatives implemented so far.

Introduction

In general terms, preparation for decommissioning should start well before the final shutdown of a nuclear facility. It is required that an initial decommissioning plan is prepared at the time of the facility's design and construction, and is regularly updated while the nuclear facility is in operation, using the best available information and knowledge of the facility and its operation [1, 2]. This should minimize the need to subsequently track down workers and reconstruct information about operational events from their accounts/experiences.

Planning for decommissioning includes not only preparation of a decommissioning plan and its supporting documents, but also a collection of relevant information and data to facilitate future decommissioning, selection of a decommissioning strategy, conduct of physical and radiological characterization to support the planning process, estimation of decommissioning cost, identification of provision of financial resources for the decommissioning project, etc. [1].

Technical preparatory actions to facilitate further decommissioning are typically implemented during the transition period from operation to decommissioning [3]. Modifications to the facility and its systems, but also organizational modifications are sometimes necessary to be performed during that period. Typical transition activities are implemented under operating license, taking into account all relevant safety and regulatory considerations and requirements [4, 5].

Safety and technical considerations related to the preparation for decommissioning

During the transition period a set of preparatory actions for decommissioning need to be performed in accordance with the authorization (license) for operation of the facility or under a modified operational authorization. The authorization for operation of the facility usually remains in place, unless the regulatory body approves modifications to the authorization on the basis of reduction of hazards associated with the facility [1].

There are important organizational and administrative activities to be performed either prior to the final shutdown or at latest during the transition period as part of preparations for implementation of the decommissioning strategy [5]. These activities include appropriate changes to the structure of the licensee's organization, with the establishment of a decommissioning project team, responsible and accountable for decommissioning planning and operations.

Clear interfaces with all interested parties (stakeholders) have to be established, including information exchange mechanisms to build confidence in, and acceptance of, the selected decommissioning strategy.

Important non-technical activities include also a preparation of the final decommissioning plan with all required supporting documents [2, 6], collection and retention of decommissioning related records and establishment of an efficient record management system. In many cases a program has to be defined for development of working procedures, to detail the use of techniques and equipment required for decontamination, dismantling, demolition and management of decommissioning waste.

Typical technical tasks in preparation for decommissioning include:

- Removal of spent fuel (and other nuclear material) from the facility, but not necessarily from the site;
- Removal of operational waste, unnecessary material and some minor components from the facility;
- Treatment, conditioning and, if possible, disposal of operational waste;
- Enlargement of waste management capacities to deal with large amount of decommissioning waste;
- Draining of circuits and systems – this activity may result in a considerable amount of liquid waste to be treated;
- Post-operational decontamination and cleaning to the extent possible – this activity will produce secondary waste;
- Radiation surveys and radiological control of the work areas;
- Physical and radiological characterization to support decommissioning planning, etc.

Figure 1 illustrates the impact of the preparatory (transitional) activities to the general reduction of radiological hazard in case of the two basic decommissioning strategies.

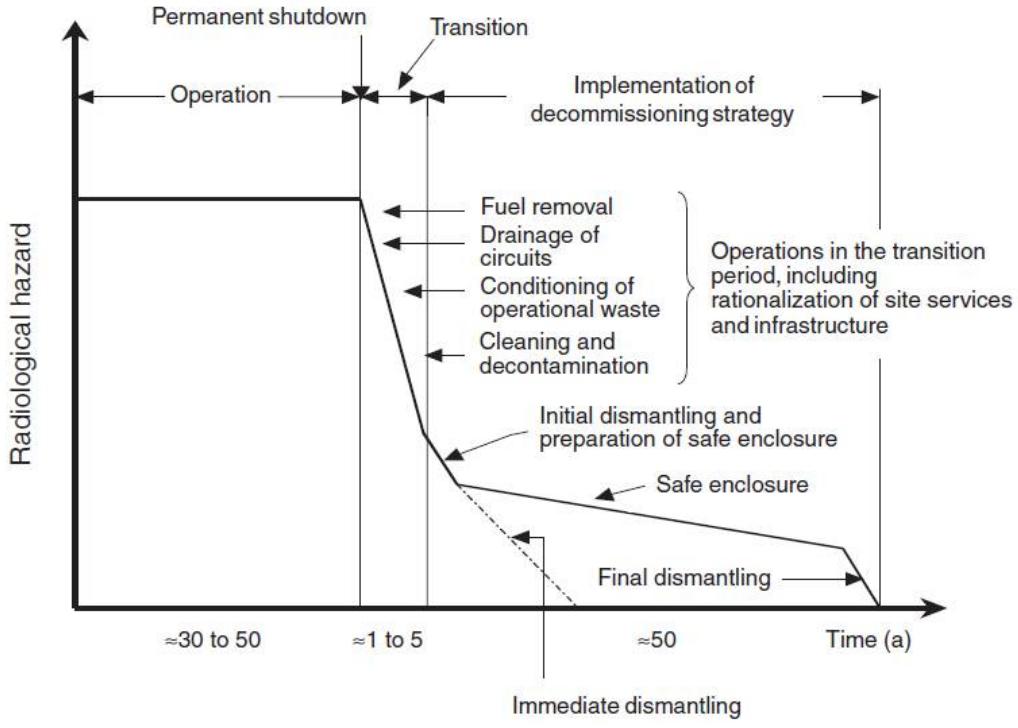

FIG. 1. Transitional activities and their impact on radiological hazard reduction in case of the two basic decommissioning strategies for the 'safe enclosure' option (the full line corresponds to deferred dismantling strategy, the chain line shows the immediate dismantling strategy) [5].

As decommissioning is quite a different activity from routine operation of facilities, as well as involving new hazards and unique kinds of operations in a continuously changing working environment, the IAEA recommends that it is licensed separately from operation. The preparation of the licensing documentation for decommissioning, its submittal to the regulatory body, its regulatory review, amendments that may be necessary, and the issuance of decommissioning license, all occur towards the end of operation and during transition. The planning and licensing process needs to take into account all the preparatory activities performed prior to commencement of decommissioning, as these preparations may strongly influence the starting conditions of the facility at the beginning of the decommissioning process. Some of the preparatory activities performed during transition may require separate authorization, if such or similar activities have never been performed during operation of the facility.

IAEA services related to preparation for decommissioning

The IAEA published numerous safety and technical publications, which provide requirements, guidance, recommendations, experiences, good practices and lessons learned, fully or partly covering preparatory phase for decommissioning [1-7]. Some other reports include collections of national case studies related to preparation for decommissioning [8].

Many group events involving participants from different Member States, such as training courses, workshops and seminars, were organized by the IAEA to support sharing of good practices on preparation for decommissioning among specialists and organizations involved. Representatives of operators, technical support organizations and regulators are typical attendees of the IAEA events. Such events are mainly organized as part of the Technical Cooperation (TC) Programme of the IAEA, often with support from the International Decommissioning Network (IDN), and are mainly hosted by the Member States' organizations responsible for decommissioning. They involve lectures by international experts or by the host organization, discussion sessions, facility visits, practical demonstrations and exercises, and observations of ongoing site activities. Nuclear power plants and research reactors have been the main target facilities for a longer period of time, but recently more events have started to be organized; addressing preparations and implementation of decommissioning of other types of nuclear fuel cycle and radioactive waste management facilities.

Focused support to address specific needs of particular Member States is provided within the national TC projects or through national projects financed by extra-budgetary contributions to the IAEA. Assistance in planning for decommissioning, including safety assessment and estimation of decommissioning costs, or support to characterization activities are typical examples of aspects covered within such kind of projects.

Some topics related to preparation for decommissioning are of common interest for many Member States, especially in the area of research reactor decommissioning. In such cases the IAEA organizes topical international projects to provide longer-term platforms for cooperation, training, exchange of knowledge and experience, and for promotion of good practices. Examples of such projects are the Research Reactor Decommissioning Demonstration Project [9] and the International Project on Data Analysis and Collection for Costing of Research Reactor Decommissioning (DACCORD) [10].

The IAEA also provides support to several Member States with nuclear facilities damaged in accidents [11] or with legacy facilities. Preparation for decommissioning in these cases is very complex due to the variety of technical, safety, regulatory, financial and socioeconomic issues. Decommissioning

plans need to be prepared on the basis of incomplete information available, or information associated with large uncertainties, which may include evaluation of alternative strategies, need for application of novel technologies or adaptation of standard technologies. It also may be subject to new safety requirements for conducting activities, ensuring protection and safety under specific post-accident conditions and managing large volumes or non-standard types of radioactive waste.

There are typically three phases associated with a post-accident situation on nuclear facilities: (1) emergency phase, (2) stabilization or recovery phase, and (3) decommissioning phase. Emergency phase refers to the immediate aftermath of a nuclear accident and it implies responding to the consequences of the accident, establishing control of the facility's conditions so that impacts to the environment and general public are limited. Stabilization (recovery) entails the planning and implementation of activities to limit and to reduce the extent of abnormal conditions, and preparing the plant for the achievement of a longer term safe configuration for further decommissioning.

An example of this kind of focused support is the IAEA assistance to Japan in preparing for decommissioning of the damaged Fukushima Daiichi NPP Units 1-4, provided under the International Peer Review of Japan's Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1-4 [12]. The photo shown in Figure 2 was made during the first mission to Japan in April 2013. Other examples are the on-going national Technical Cooperation projects in Slovakia for decommissioning of the A1 NPP and in Ukraine for decommissioning of the Chernobyl NPP, as well as the International Project on Managing Decommissioning and Remediation of Damaged Nuclear Facilities (DAROD) [13], which was launched in January 2015.

FIG. 2. IAEA experts depart Unit 4 of TEPCO's Fukushima Daiichi Nuclear Power Station as part of a mission to review Japan's plans to decommission the facility, Photo Credit: Greg Webb / IAEA.

Aspects related to preparation for decommissioning will be addressed during the International Conference on Advancing the Global Implementation of Decommissioning and Environmental

Remediation Programmes [14], which will be organized by the IAEA in Madrid, Spain, from 23 to 27 May 2016.

Conclusions

The IAEA recognizes great importance of the preparation for decommissioning of nuclear facilities. Many activities have been initiated and organized so far to adequately address related aspects and issues and to support Member States. On this basis the following general lessons learned can be proposed:

- Early planning is the key to a smooth preparation for decommissioning before the final shutdown and during the transition period;
- Safety related considerations have to be addressed by the operator (licensee) based on the regulatory requirements;
- Numerous actions can be taken prior to or during the facility transition period to prepare for and to optimize eventual dismantling;
- Preparatory activities should be evaluated to ensure that they are allowable under the operating license and are not pre-determining decommissioning options available for the nuclear facility (regulator to be involved in such considerations);
- The facility has to be placed in a safe shutdown condition and safety has to be maintained during implementation of preparatory activities, until the decommissioning activities are initiated.

Many valuable technical lessons learned are available in the Member States with advanced nuclear decommissioning programmes, and should be shared with others. Good examples include timely and effective planning of preparatory and transition activities to reduce expenditures and hazards, simplify waste and material management and help to keep the workforce motivated.

Significant cultural and organizational changes that will occur during the transition period and during implementation of decommissioning also need appropriate consideration and management. In this regard a good communication and involvement of all relevant stakeholders should be emphasized, which is essential for a successful preparation for decommissioning.

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