Overview of decommissioning and clearance in Sweden from a regulator’s perspective

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In Sweden there are several permanently shut down nuclear facilities were decommissioning is being prepared or is currently on-going. According to current plans, seven nuclear reactors in Sweden will be dismantled within the next 20 years. Also, decommissioning of Ranstad uranium milling facility is currently in progress – a project with presents numerous interesting issues. This is thus a challenging and remarkable time both for the nuclear industry and the nuclear regulators in Sweden. Swedish Radiation Safety Authority (SSM), which was formed by merging the previous authorities for radiation protection and nuclear safety (SSI and SKI) about five years ago, has since its formation worked on building up an organisational structure and developing the legal framework intended to deal with the current and future regulatory requirements in decommissioning and associated waste management. Clearance is an example where the authority has produced new regulations and where some issues remain to resolve, mainly with regard to release of sites. The challenges are not merely technical, but also in respect to how the authority optimises its supervision of decommissioning activities and this is an area SSM is currently developing.

Overview

A few nuclear decommissioning projects have been carried out in Sweden, whereof two major ones are decommissioning of the reactor R1 in Stockholm and the Active Central Laboratory (ACL) in Studsvik. Sweden’s first reactor R1, which was an underground experimental reactor located on a university campus in Stockholm, was decommissioned in the early 1980s. About 20 years later the ACL and the associated filter building was decommissioned. ACL was built for research and development of reprocessing and MOX fuel production, but was also used for other research purposes. A lesson learned from the decommissioning of the ACL is that it is very important to make an adequate radiological characterisation of the facility, as well as having clearly determined clearance levels. There were certain shortfalls in these areas at the decommissioning of the ACL, which led to project delays. In addition to this, a number of other clean-up and smaller decommissioning projects have been carried out in Sweden, mainly at Studsvik.

Currently there are four large nuclear facilities in Sweden that are shut down and undergoing, or awaiting decommissioning; the uranium milling facility in Ranstad, the R2 and R2-0 material test reactors in Studsvik, Ågesta pressurised heavy water reactor and Barsebäck nuclear power plant.

Installations in Ranstad

The uranium mining and milling facility in Ranstad was constructed in the 1960s and about 200 tonnes of uranium were produced in total during its operation. The uranium open-cast mine and the mill tailings deposits were in the 1990s restored and covered. Currently, decommissioning of the
remaining facility is proceeding. Part of the facility was until 2009 used for extraction of uranium from waste originating from nuclear fuel fabrication. This license expired in December 2009 and the associated installations are planned to be decommissioned as a part of the decommissioning project for the leaching and extraction plant. An extensive radiological survey has been performed and detailed plans are being developed for the dismantling of remaining systems, demolition of buildings and restoration of the site. The large sorting facility (author’s translation of “sovringverket”) was demolished in 2013 and the leaching facility is scheduled to be demolished in 2014. The decommissioning activities for the nuclear installations on the site are planned to continue until 2016.

The similarities in the contamination from the processes carried out at Ranstad and the naturally occurring radioactivity in the building material and surrounding environment has presented some interesting challenges, both for the project organisation and for the Swedish Radiation Safety Authority (SSM), related to for example radiological characterisation and waste management. Also, since some of SSM’s fundamental regulations apply to all nuclear facilities and since Ranstad can be seen as a low risk facility compared to, for example, a nuclear power plant, the licensee has applied for exemptions from many of the requirements. This application of graded approach is desirable from a regulator’s perspective as it allows the regulatory supervision to be optimised based on relevant issues. Further, extraction of uranium from waste at the Ranstad facility was conducted by a different company to that which carried out mining and milling. The dividing of responsibilities, including financial, has therefore not been without difficulties.

Studsvik material test reactors

The two material test reactors in Studsvik (R2 is a tank type and R2-0 is a mobile pool type) were permanently shut down in 2005. Preparations for dismantling of the reactors are on-going. Decontamination of two test loops was performed 2008. In 2010, the license according to the Act on Nuclear Activities was transferred from the operator Studsvik Nuclear AB to the decommissioning and waste management company AB SVAFO. AB SVAFO investigates the possibility to use the remaining facilities for other purposes, such as treatment and storage of radioactive waste. Thus, it has not yet been decided if the buildings will be demolished or not.

A safety analysis report for the dismantling of the reactors is being produced at the moment and expected to be submitted to SSM in November 2013. Dismantling of the reactors is scheduled to commence in the second half of 2014 and it is planned that in 2018 the facility will be in such a state that it will be possible to apply for clearance. However, the existing license for dismantling the facility, issued under the Environmental Code, requires the facility to be dismantled by 1 Jan 2017. It will thus be necessary for AB SVAFO to apply for a new license, or alternatively to apply for amendments to the listed requirements associated with the license. The possible future use of the building, as an alternative to demolishing it, also needs to be considered in such an application.

Experience from the R2 decommissioning project shows that the requirement to report to the European Commission (via SSM) in accordance with Article 37 of the Euratom Treaty is a time consuming process which can cause delays to the project, especially if the report is rejected by the Commission and amendments are required.
It has proven difficult to characterise the reactor with respect to induced activity from neutron activation due to short and frequent operating cycles of the reactors coupled with uncertainties with regard to the material composition of the reactor. According to AB SVAFO there are very high dose rates on certain parts, compared to those at a nuclear power plant reactor, due to high neutron flux during operation. Another aspect which needs to be considered is the fact that the R2 reactor tank is made of aluminium, which is of concern both with regard to cutting techniques and waste disposal solutions (aluminium could corrode and cause H2 production). These challenges are not just an issue for the project; SSM also need to ensure that the regulatory supervision adequately address these aspects of the project. Further, AB SVAFO has also discussed with SSM the possibility of carrying out certain work packages (removal of heavy water and certain items in the reactor pool) prior to approval of the Safety analysis report for dismantling and demolition. These questions have to be managed by the SSM on a case by case basis as there is no precise definition of what constitutes “dismantling” in the regulations.

Ågesta PHWR

The underground pressurised heavy water reactor in Ågesta was permanently shut down 1974. A license according to the Environmental Code for continued care and maintenance until 2020 was issued by the local environmental court in November 2008. In December 2009, the company AB SVAFO applied to take over the license according to the Act on Nuclear Activities from the current licensee Vattenfall AB. The application is still under review by the SSM, which shall give its recommendation to the Ministry of Environment. Aspects for SSM to consider in the review of the application include financial security, adequacy of management system and organisational capabilities. AB SVAFO is currently, under contract from Vattenfall AB, involved in the care and maintenance programme as well as in preparations for the future dismantling and demolition. In 2010 Vattenfall AB applied for exemption of certain areas outside the reactor enclosure at Ågesta and this is an on-going matter. The dismantling and demolition of Ågesta is scheduled to be carried out 2020 – 2026 [Ref. 1].

One difficulty with decommissioning the Ågesta reactor is the fact that it has been shut down for almost 40 years and some of the knowledge about the plant therefore is gone. This also includes knowledge within the SSM. Moreover, the long decay time of the remaining inventory may cause challenges for waste characterisation and clearance of materials, since the typical key nuclide Co-60 may no longer be possible to use for estimation of nuclides that are difficult to measure. Another thing which makes decommissioning complicated is that it is located inland, which renders certain options for transportation of the decommissioning wastes impossible. Further, the fact that the reactor is underground presents certain challenges and the SSM is currently looking at Vattenfall AB’s arrangements for ensuring the integrity of the cave structure.

Barsebäck nuclear power plant

Barsebäck nuclear power plant, for which Barsebäck Kraft AB (BKAB) holds the nuclear license, consists of two BWR units which were permanently shut down 1999 and 2005, respectively. The
facility has been prepared for a period of care and maintenance awaiting dismantling (off-site shipment of fuel, downsizing of organization, adjustment of supervision and maintenance, energy saving measures etc.). Primary system decontamination of both units was performed during the winter 2007/08. Processing of the wastes from operation and decontamination is proceeding. An extensive radiological and hazardous substances survey of the site and the buildings has been performed. Full dismantling is planned for 2023, after extension of the existing repository for low- and intermediate level waste in Forsmark (SFR) [Ref. 1]. A project has been launched for dismantling of internal reactor components for storage on site until full dismantling is performed. After interim storage the components are planned to be transferred for continued interim storage in a separate part of the SFR facility. The plans for constructing an interim store on the Barsebäck site was halted in September 2013 as the local authority stopped the plans due to fear that the store will become “permanent”. The local council is in favour of a permit for the store issued on a 5-yearly basis, but Eon, the owner of the power plant, has replied that the risk to the project of such a solution would be too great.

In 2012 SSM reviewed the safety analysis report for care and maintenance of the Barsebäck facility and found certain shortfalls in the safety analysis. SSM found that the analysis did not adequately address the risks to personnel. This may be due to the safety analysis being founded on that for the reactors at their operational phase, when the risks to the general public from nuclear accidents were the focus of the safety analysis. As the fuel is removed from the site the risk to the public is greatly reduced, but certain risks to personnel, which were not presented in the safety report for the operational phase, remain and may even increase. An example is risks associated with waste management on site. BKAB has submitted an updated version of the safety analysis report where they have addressed this and SSM are currently reviewing this.

**Other facilities**

Decommissioning of minor old nuclear installations in Studsvik is being performed by the licensee AB SVAFO. Two old underground silos for liquid intermediate level waste have now been decontaminated and partially dismantled. AB SVAFO has applied to the SSM for clearance of the remaining underground structures and the foundation of the earlier building.

The ten reactors in operation at the three nuclear power plants in Sweden are scheduled to be decommissioned in 2025-2045 (the dates refer to the commencing of the dismantling & demolition phases). The first two to be decommissioned are the two oldest reactors at Ringhals nuclear power plant, R1 (BWR) and R2 (PWR), which are scheduled to be fully decommissioned in 2032 and 2030, respectively [Ref. 1]. An application for extension of the existing repository for short-lived low- and intermediate level waste (SFR) so that it also can include decommissioning waste is scheduled for 2014 [Ref. 1]. The extension is being designed to facilitate disposal of one-piece reactor pressure vessels (without internals). Also, part of the extension is planned to be used for intermediate storage of long-lived waste (mainly reactor internals) awaiting
the construction of SFL. A special transport package is being developed for reactor internals. The first decommissioning waste is planned to be received at SFR in 2023 [Ref. 1].

**Swedish Radiation Safety Authority (SSM)**

With the on-going and imminent decommissioning projects in Sweden, as described above, this is an interesting and challenging time both for the nuclear industry and the nuclear regulators in Sweden. SSM which was formed by merging the previous authorities for radiation protection and nuclear safety (SSI and SKI) about five years ago, has since its formation worked on building up an organisation and developing existing regulations to deal with the current and future regulatory requirements in decommissioning and associated waste management. The authority has continually grown in size since the merge and it now has more than 300 employees. In the area of waste management and decommissioning, the number of staff has even doubled since the merge. Although considerable work has been carried out in developing the regulations, there is still work to be done. Clearance is an example where the authority has produced new regulations, but where some issues remains to be resolved, mainly with regard to release of sites. There is in Sweden currently no specified dose criterion for release of sites, and there is no agreed methodology for demonstrating that sites are in compliance with a release criterion (e.g. MARSSIM in the USA). The SSM, as well as the Swedish nuclear industry, is currently working on this issue.

Facilities undergoing decommission are much less static compared to operating facilities, which mean that the arrangements for regulatory supervision differs in the two cases. Also, in the regulatory supervision of operating nuclear facilities there is typically a focus on the effect of changes made on safety of the operation of the facility (e.g. effect on facility of changing from one type of pumps to another), while for decommissioning the focus is on that the task is being carried out in a safe way (e.g. safety of the operator while removing the pump). Furthermore, the experience from SSM’s perspective is that the general concept of the decommissioning being carried out step by step in a certain predetermined manner is typically not realistic. Examples are that new unforeseen issues often arise, that the projects want to carry out certain dismantling activities early to save time, or that only partial decommissioning is to be carried out, if the building is to be used for other purposes. SSM’s experience shows that an open, frequent dialog between the regulator and the licensee is required to manage supervision of the fast changing situation during a decommissioning project. SSM also consider it appropriate that larger decommissioning projects are regulated by a set team of regulators with a responsible team leader to ensure that the regulators are up to speed on the project and have adequate background knowledge. The SSM is developing its supervision of decommissioning activities and intend to look at how this is done in other countries.

SSM believes that collaborations and exchange of experiences between the licensees in regard to finding practicable ways to implement SSM’s regulations is of great importance as this is likely to enable high quality submissions to SSM, make regulatory supervision easier and lead to a safer decommissioning.
References