

Licensing review process of the European Spallation Source (ESS) research facility

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Introduction

On 3 January 2012 a license application under the Radiation Protection Act (SFS, 1988b) for the European Spallation Source research facility was submitted to the Swedish Radiation Safety Authority. The European Spallation Source research facility will be the site of a new and quite unusual kind of neutron source, based on a large proton accelerator that bombards a heavy material with protons. The Swedish Radiation Safety Authority is now reviewing the application.

The European Spallation Source (ESS)

The proposed European Spallation Source (ESS) is to be a multi-scientific research facility which might be described as an enormous microscope for examining molecular structures. The ESS will generate a very powerful long-pulse source of low-energy neutrons (rated at 5 MW) 30 times more intense than achieved with similar sources in operation today. These neutron beams will enable scientists to analyse and understand basic atomic structures and forces of a variety of different materials. There are applications in disciplines such as medicine, chemistry, physics and engineering.

Today, 17 European countries are engaged in the ESS project, with Sweden and Denmark acting as host nations for the facility. The Swedish company European Spallation Source ESS AB (ESS AB) was established in 2010 with the aim of constructing and operating the ESS facility. The company's main shareholder is the Swedish government (75%) and the Danish government is the main co-owner (25%). According to ESS AB's current plan the ESS facility should be in operation in 2025. It is envisaged that the ESS will be in operation for about 40 years.

The ESS research facility will be located in southwest Sweden, on the outskirts of the city of Lund. In addition, a supercomputing data management and software development centre will be located in Copenhagen. It is expected that 2 000-3 000 guest researchers will carry out experiments at ESS each year. Easy access to the facility and to the data produced for university and research laboratory users all over Europe will be a high priority, just as maximising industrial access will be.

The design and construction of the ESS facility includes three main components: a superconducting particle accelerator, about 580 metres long, where protons are accelerated using high-voltage equipment (klystrons) and cryogenically cooled equipment; a target station where the protons hit a target material (tungsten) leading to generation of neutrons; and, finally, the instruments located at different distances from the target (15-300 metres) to which the neutrons are guided in tubes to the samples surrounded by investigation

detectors. The ESS facility will not be a nuclear facility, but it will house considerable quantities of radioactive material on par with that of a research reactor. More information on the ESS facility can be found in the ESS Technical Design Report (ESS, 2013).

In conjunction with ESS, the Max IV Laboratory (MAX IV) is being constructed. MAX IV will be a synchrotron light facility for studies of molecules and atoms. MAX IV is to be run under the auspices of Lund University. The layout of the facility surrounds a big electron accelerator. From the perspective of radiation safety, the risks and problems posed are smaller for MAX IV than those related to ESS. The application for MAX IV was submitted in 2011 and will be reviewed by SSM in co-ordination with the ESS application.

Figure 1: A conceptual model of the ESS research facility



Source: Used with permission from ESS AB.

Radiation generated by ESS

The ESS research facility must have protective barriers in order to shield the surroundings against radiation. The source of radioactivity is to be equipped with radiation absorbers that reduce radiation as well as containment systems that prevent radioactive substances from spreading to the surroundings. When the accelerator produces a high-energy proton beam, this also involuntarily generates neutron and gamma radiation. Direct prompt radiation is only generated when the accelerator is running. In addition, radioactivity is generated in the materials hit by high-energy direct radiation. The highest level of radioactivity is generated in the target, but also to a lesser extent elsewhere, such as the air and soil surrounding the accelerator.

The review process

SSM has drawn up routines for the review process and preparation of licenses concerning nuclear facilities and other complex facilities/activities involving ionising radiation. The review process for the ESS application is in compliance with these routines and will take place in several steps according to the following:

- 1) A license is issued for activities involving ionising radiation.
- 2) A license is issued for commencement of the construction phase (installation).

- 3) A license is issued for test operation.
- 4) A license is issued for regular operation.
- 5) A license is issued for decommissioning.

ESS AB submitted a license application under the Radiation Protection Act (SFS, 1988b) for the ESS research facility to SSM on 3 January 2012. On 15 March 2012 ESS AB supplemented the application with a preliminary safety analysis report, PSAR (ESS, 2012b) and an environmental impact assessment (EIA) (ESS, 2012a). Thus the first step of the review process could be initiated. Also in March 2012, ESS AB submitted an application under the Swedish Environmental Code (GOS, 1988) to the Land and Environmental Court.

When the application from ESS AB was received, the first thing done was an initial acceptance review. The aim was to conduct a general assessment regarding the completeness of the application documents. This initial acceptance review took around three months, during which time SSM consulted on the ESS application with various stakeholders nationally and also in Denmark.

The application was viewed as being insufficiently complete to enable SSM to begin its technical review work. On 26 July 2012 SSM requested ESS AB to supplement the application with documents concerning most aspects of the construction: preliminary risk analysis, construction of structures and facilities, technical system design, radioactive waste management, decommissioning, radiation protection of workers, financial liabilities, the EIA, etc.

By 31 December 2012 SSM had received some of the required supplements from ESS AB. Still pending are documents on radioactive waste management, decommissioning and financial liabilities. According to ESS AB these last supplements will be delivered at the end of March 2013.

In April 2013 the technical review work is planned to start, where the first phase is a broad review of the application to determine whether the application is now sufficiently complete and of sufficient quality to enter the extensive main review phase. SSM anticipates that this first phase is finished by the end of April 2013 and that the main review can begin after that.

As mentioned above, the licensing of the ESS facility is also done in accordance with the Swedish Environmental Code, handled by the Swedish Land and Environmental Court. However, by praxis in Sweden, SSM will handle the regulatory questions regarding radiation safety and radioactive waste. The environmental impact assessment will thus be reviewed and considered by both SSM and the Land and Environmental Court.

In addition to the two license review processes under the Radiation Protection Act and the Environmental Code, the Swedish government might also consider the permissibility of the ESS facility. Whether this will be the case or not remains to be decided.

Legal requirements

SSM will examine the ESS application for compliance with current legislation, which in this case will be the Radiation Protection Act and the Radiation Protection Ordinance (SFS, 1988a, 1988b). The main purpose of the Radiation Protection Act and Ordinance is to protect people, animals and the environment from the harmful effects of radiation.

In addition to the Radiation Protection Act and Ordinance, SSM has issued a large number of regulations supplementing the Act and Ordinance. Due to the unique character of the ESS facility – it is not a nuclear facility but it will house considerable quantities of radioactive material and wastes on par with a research reactor – not many of the existing SSM radiation protection regulations are directly applicable. The regulations that are applicable are the following:

- the Swedish Radiation Safety Authority's regulations on operation of accelerators and sealed radiation sources (SRSA, 2008c);
- the Swedish Radiation Safety Authority's regulations concerning basic provisions for the protection of workers and the general public in practices involving ionising radiation (SRSA, 2008a);
- the Swedish Radiation Safety Authority's regulations on external workers in practices involving ionising radiation (SRSA, 2008b).

SSM has identified a need for additional requirements. These additional requirements will be derived from the applicable aspects of SSM's regulations on nuclear facilities even though the Act on Nuclear Activities (SFS, 1984) is, in terms of legislation, not directly applicable to non-nuclear facilities.

ESS AB has stated that they will base their safety on among others the IAEA Safety Standards Safety of Nuclear Power Plants: Design, Requirements (IAEA, 2000) and the Safety Assessment for Facilities and Activities (IAEA, 2009).

Some key issues

For SSM, a number of key issues and concerns have arisen in connection with the review process of the ESS application. A selection of key issues is presented here.

When preparing for the review process of the ESS application, SSM was apprehensive about not covering all aspects of the rather complex facility that ESS will be. During this stage SSM went on a number of study visits to accelerator facilities in different parts of the world, to learn more about how the licensing procedures were performed in each case and to develop a better understanding for the kind of radiation protection issues occurring at this type of facility, among other things.

The first step in the review process is of key significance, as several important decisions are to be taken, for example relating to the selection of site. The chosen site for the ESS facility is on the outskirts of Lund, which is a rapidly expanding city. SSM has to ensure that, from a radiation safety point of view, the facility can be built at the suggested site.

Even though SSM should issue ESS AB a license for the ESS facility at Step 1, the process will not end here. The first step of the process, together with the following steps, will take several years. It is inevitable that a number of experts involved in the reviewing at SSM will leave and have to be replaced at intervals, which might pose problems regarding the continuum and efficiency of the review process.

SSM will review ESS AB's application and determine whether statutory requirements imposed on radiation safety are fulfilled. However, at this stage ESS AB cannot present all details in terms of construction and operation of the ESS facility, as it is still a conceptual design. ESS AB therefore must demonstrate at this step (and the following) that they are capable of constructing and running the facility in fulfilment of the requirements imposed. For SSM, it might be a challenge to decide what needs to be demonstrated by ESS AB at this stage, in order for the authority to feel confident that ESS AB has prerequisites to fulfil the requirements later on when the ESS is being constructed and in operation.

Significant volumes of radioactive waste will be generated at the ESS facility. The non-nuclear industry, hospitals and research centres in Sweden rely on the system for radioactive waste management created by the nuclear industry: the radioactive waste is sent to Studsvik Nuclear AB (SNAB), the only approved radioactive waste management facility in Sweden. After treatment, the radioactive waste is stored by SNAB, pending disposal in either SFR, the repository for short-lived low- and intermediate-level waste, or in SFL, the planned repository for long-lived low- and intermediate-level waste, which will be in operation in 2045 at the earliest. SFR and SFL are owned by the Swedish Nuclear

Fuel and Waste Management Co (SKB AB). SNAB has an agreement with SKB for the disposal of radioactive non-nuclear waste in SFR. SNAB and SKB AB are currently discussing a letter of intent for the disposal of radioactive non-nuclear waste in SFL. ESS AB is currently involved in a dialogue with both SNAB and SKB AB on how to manage the radioactive wastes generated by the ESS facility; it is not yet known if it will be possible to use the radioactive waste management system created by the nuclear industry for disposal of the ESS wastes.

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