Reducing the discharges from Studsvik to the Baltic Sea

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ABSTRACT

In 2009, HELCOM published an assessment over the radioactivity in the Baltic Sea (1). Data presented in the report indicate that the discharges of radionuclides from the Swedish nuclear facility Studsvik were higher than from other nuclear facilities in the Baltic Sea drainage area. However, the doses to man and the environment were still well below the authorized dose limits given in the Swedish regulation concerning discharges from nuclear facilities (2). In 2009, the Swedish Radiation Safety Authority, SSM, decided to carry out an inspection at the Studsvik facility in order to find out whether or not the facility was fulfilling the other requirements in the discharge regulation (2). As a result of the inspection the two responsible companies, Studsvik Nuclear AB and AB SVAFO, had to take measures in order to do so. For example, they had to improve their knowledge about the sources of the discharges and take suitable measures in order to reduce the discharges as low as reasonably achievable using the best available technique. SSM is following the implementation of the measures taken by Studsvik Nuclear AB and AB SVAFO. SSM believes that they will result in even lower discharges to the Baltic Sea in the future.

This paper describes the SSM regulations concerning discharges and discuss the measures taken by the two companies, as well as how to decide whether optimization and best available technique are being applied – or not.

KEYWORDS: (discharges, Baltic Sea, optimisation, BAT)

INTRODUCTION

In 2009 the MORS-project of the Helsinki Convention, HELCOM, published an assessment report concerning the radioactivity in the Baltic Sea covering the time period 1999-2006 (1). The data presented in the report showed that the discharges of radionuclides from the Swedish nuclear facility Studsvik were higher than from other nuclear facilities in the Baltic Sea drainage area. The figure below is borrowed from the assessment report.

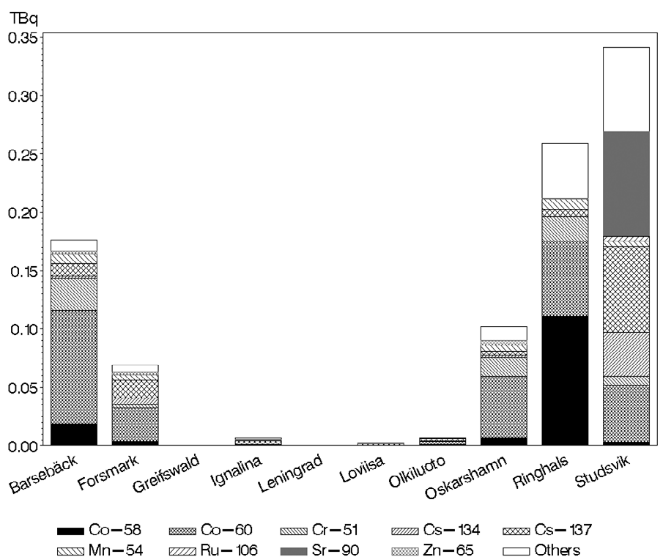

Fig.1 Total aquatic discharges from local nuclear power plants into the Baltic Sea 1999-2006 excl. H-3

However, the doses to man and the environment were still well below the authorised dose constraint 100 microsievert given in the Swedish regulation concerning discharges from nuclear facilities (2). This paper tries to give an explanation to this situation and some ways forward.

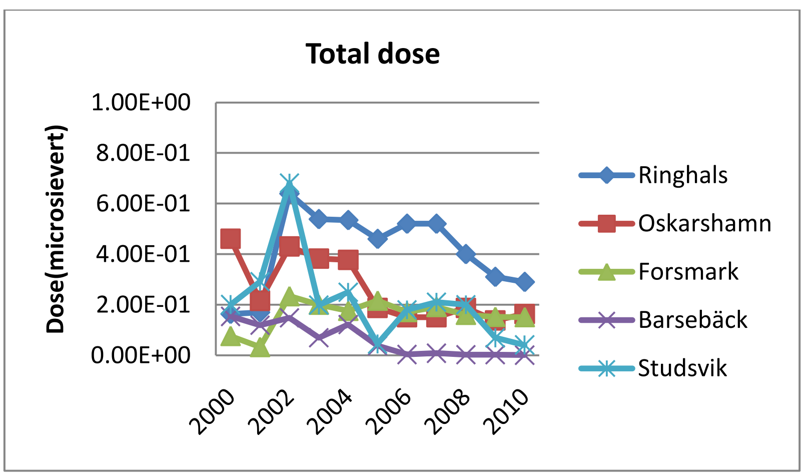

Fig.2. Total dose from releases to air and water fron Swedish Nuclear facilities.

THE STUDSVIK FACILITY

The history of the Studsvik facility goes back to the 1950s. Initially, it was partially state owned but this has gradually changed and since the 1990s the Studsvik facility is privately owned. At the beginning, a number of laboratories and two experimental reactors were constructed at the Studsvik facility at the Baltic Sea shore south of Stockholm. In the 1960s Studsvik's reactors, R2 and R2-0, were commissioned. The reactors were used for experimental purpose as well as for radionuclide production. In June 2005 both reactors were taken out of operation and they are now facing decommissioning. Today, the Studsvik facility is mainly a waste treatment facility operated by Studsvik Nuclear AB. The company AB SVAFO has the responsibility for the decommissioning of the research reactors and the other old practices at the Studsvik facility.

At the facility there are many buildings and the waste water from these buildings all share the same waste water conduit and treatment system which originate from the 1950's.

THE SWEDISH REGULATION CONCERNING DISCHARGES OF RADIONUCLIDES INTO THE BALTIC SEA

The aim of the Radiation Protection Act (SFS 1988:220) is to protect man and the environment against harmful effects of radiation. In adhering to this general goal, licensees have the full responsibility to take the measures and precautions required to prevent or counteract injury to people and animals and damage to the environment. Furthermore, the licensee has to properly maintain the technical devices including the measuring and radiation protection equipment used in the activities. Accordingly, the operators of nuclear facilities have the responsibility for both control and measurements of the discharges of radioactive substances. The Radiation Protection Ordinance (SFS 1988:293) states that the Swedish Radiation Safety Authority, SSM, may issue regulations concerning the provisions in the Act as long as these do not conflict with the purpose of the Radiation Protection Act. The first general regulations concerning limitation of discharges of radioactive substances from nuclear power plants were issued in 1977. These regulations have been revised a couple of times since then and the latest and most extensive revision was conducted in the beginning of 2000. The main reasons for this revision were the need to implement the legislative demands in the Radiation Protection Act for protection of the environment, fulfilling the agreement with the national environmental quality goal for radiation established by the Swedish Parliament and fulfilling international conventions e.g. the OSPAR and HELCOM conventions and in particular the Sintra declaration from 1998.

The resulting regulations entered into force 1 January 2002. These regulations are valid for nuclear power reactors, research reactors, fuel fabrication facilities, storages for spent fuel and waste disposal facilities during their operating phase (shallow land burials are excluded). The previous regulations were only valid for nuclear power plants. Other facilities were regulated separately but basically in the same way. These regulations (The Swedish Radiation Safety Authority's Regulations on Protection of Human Health and the Environment in connection with Discharges of Radioactive Substances from certain Nuclear Facilities, SSMFS 2008:23) are still in place. They have just changed name to reflect the new authority SSM. SSM was formed in 2008 and is a merge between the two former authorities the Nuclear Power Inspectorate (SKI) and the Radiation Protection Authority (SSI).

The main purpose with the discharge regulations is to *limit and decrease* the discharges of radionuclides from nuclear facilities. The limitation of discharges of radioactive substances from nuclear facilities shall be based on optimisation of radiation protection and use of the best available technique.

The concept of Best Available Technology (BAT) shall be used as a complement to the ALARA-concept (As Low As Reasonably Achievable). In the regulations, BAT is defined as "the most effective measure available to limit the discharges of radioactive substances and the harmful effects of the discharges on human health and the environment which does not entail unreasonable costs". The similarities between ALARA and BAT are obvious but there are also differences making the two concepts complementary. ALARA focus on individual doses and stems from risk estimates proposed by the International Commission on Radiological Protection, ICRP. ALARA has proved to be an effective tool for managing human risks after low dose exposures taking into account individual doses, the number of exposed individuals and the likelihood that an exposure situation will occur. The precautionary principle, originating from the Rio-conference in 1992, suggests that in order to protect the environment positive actions may be required before scientific proof of harm has been established. The focus is therefore on methods that will reduce or eliminate the input of hazardous waste into the environment. A feature of the precautionary principle is that it will enable both present and future generations to meet their sustainable needs by reducing the input of pollutants into the environment. At present, it seems that the precautionary approach using BAT is more efficient than ALARA in taking actions to avoid any possible negative effects on the environment in the future.

According to SSMs regulations (3) the dose limit for members of the public is 1 mSv per year from all contributing artificial radiation sources. This limit is also in accordance with EU BSS. Taking into consideration that an individual may be affected by dose contributions from more than one facility/source, a dose constraint for a particular site is set to 0,1 mSv per year in the regulations on discharges. This means that the facility has to show that the doses from discharges are below 0,1 mSv per year to the most affected individual. To take into account that some of the radionuclides will be present in the environment for a long time it is important to compare the dose constraint of 0,1 mSv with the dose commitment from a yearly discharge rather than with the dose from the discharge. SSM has chosen to set the integration time to 50 years when calculating the dose commitment. This time period is supposed to be conservative enough taking the expected operational time for NPPs in Sweden into consideration.

To make sure that the general public is sufficiently protected the most exposed individuals in the public are defined as the *critical group*. This is equivalent to the term *representative person* as described in ICRP Publication 103 (4). There are different methods for setting up the critical group. One is to identify the critical exposure pathways for each radionuclide and then identify the exposed individuals. Another method is to define a hypothetical group of individuals where all exposure pathways are represented. Guidance on this is given in ICRP Publication 101 (5). It's the responsibility of the facility to perform the calculations, but SSM will scrutinize the assumptions. For most facilities it's enough to use a general, more conservative approach because the calculated dose is far below the dose constraint. The choice of a hypothetical group will then be sufficient. If the calculated dose to the hypothetical group exceeds 10 microsievert (1/10 of the dose constraint) a real (existing) critical group together with more realistic assumptions shall be used. In doing that, the most affected area shall be defined, also taking into consideration future use of the areas.

Furthermore, according to the regulations, the releases of radioactive substances to the environment shall be measured. Airborne discharges shall continuously be measured nuclide specifically. Iodine and particle bound activity shall be collected continuously and the filter shall be measured. For NPPs, also all discharges of H-3 and C-14 to air have to be measured. Discharges to water shall be measured nuclide specific on representative samples taken from all discharge pathways. Environmental monitoring shall be performed according to a programme decided by SSM.

The discharge regulations are under revision again and 10 years have passed since the last revision. The experience gained up till now will be taken into account and some areas will be strengthened e.g. the dose models in use will have to be scrutinized and updated each ten years. Also the current EU recommendations concerning measurements of discharges of radionuclides will be included in the revised regulation. SSM will once again evaluate how to strengthen the application of BAT in connection with limitation and reducing and measuring discharges of radionuclides from all nuclear facilities to the environment.

THE SSM INSPECTION

After the HELCOM-MORS meeting in 2009, when Sweden got a lot of questions about the rather high discharges from the Studsvik facility, SSM decided to carry out an inspection at the Studsvik facility in order to find out whether or not the facility was fulfilling the other requirements in the discharge regulation (2).

The findings from the inspections confirm that there was a lack of knowledge about the actual source to and pathways for discharges at the Studsvik site. This was mainly due to Studsvik's history as an old research facility with a built in system for the handling of liquid waste – the old conduit system. The conduit system consists of a big concrete pipe or tunnel with a height of approximately 140 cm and a length of about 2 kilometres. Inside the tunnel there are three pipes , one for each waste water categories depending on the activity concentration. Each building at Studsvik has several outlets and each outlet is connected to a specific waste water pipe. Each waste water category is treated according to its expected content of radionuclides (filtration over ion exchangers, centrifugation, and sedimentation). The categories designated for release to the Baltic Sea are controlled and measured before release to the sea according to established routines. It is essential that the outlet is connected to the correct pipe and of course that this is changed when the practice changes in way that will influence the level of contaminated water being produced.

Another finding was that, at the majority of the facilities at the site, there were neither any control measurements of the activity levels in the waste water before it was released into the designated waste water pipe and diluted and mixed with waste water from other facilities at Studsvik, nor any routine in place to re-evaluate the choice of waste water if the practice in the building was changed. Many of the outlets were still connected to the pipe suited for the historical practice conducted in the building. This led to a non-optimization of the waste water treatment.

SSMs conclusion was that BAT (best available techniques) was not used to reduce the discharges. SSM deems that good knowledge of the source to the discharges and an optimized waste water treatment is fundamental for a successful implementation of the BAT concept. SSM also found that there was a lack of understanding in the organisation concerning the importance to further reduce the discharges as long as the dose constraint was obtained. There was also a need to improve the administrative routines at the Studsvik facility in order to follow up and continuously evaluate the effect different measures or practices have on the actual discharges.

As a result of the inspection the companies operating the facility, Studsvik Nuclear AB and AB SVAFO had to present a time set action plan in order to improve their knowledge about the sources to the discharges and to apply suitable measures in order to reduce the discharges as low as reasonably achievable using the best available technique. Examples of actions taken or on going are

- Survey of all outlets in all buildings at the Studsvik site
- Strengthening of routines
- Improved routines for follow-up
- Education of personnel
- Technique improvements, e.g. in the conduit system, rebuilding of outlet connections, ion exchanger

RECENT SITUATION AND THE FUTURE

SSM is following the implementation of the measures taken by Studsvik Nuclear AB and AB SVAFO and SSM believes that this will result in significantly lower discharges to the Baltic Sea in the future. The graph below shows the yearly discharges (Bq) from Studsvik to the Baltic Sea in Bq during 2003-2010.

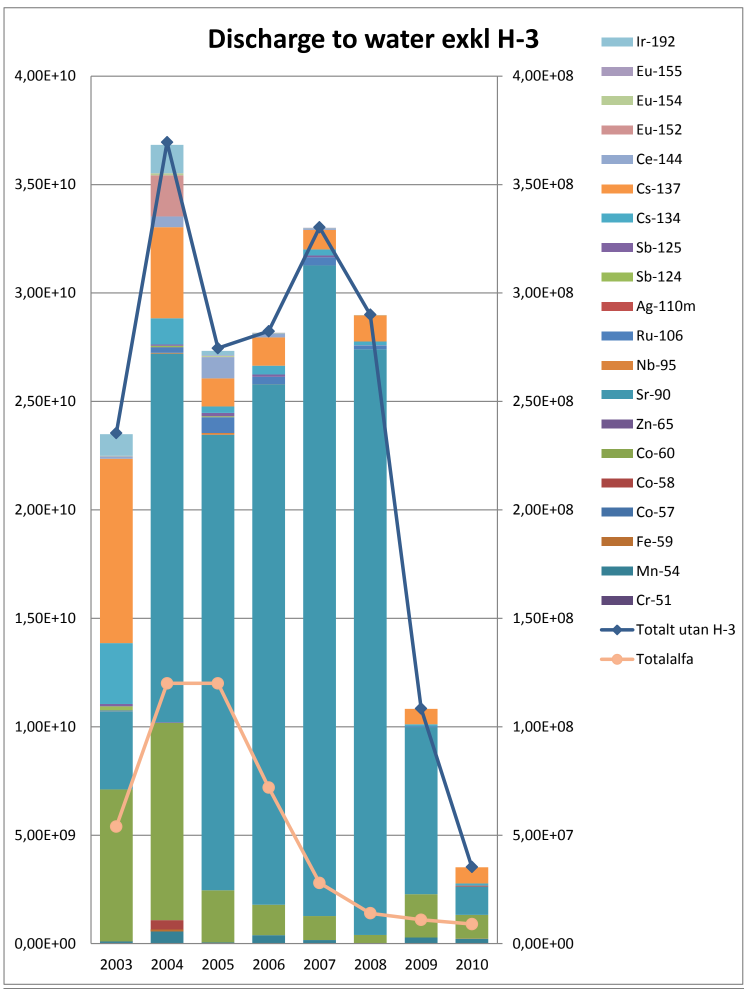

Fig.3 Discharges to the Sea from Studsvik during 2003-2010

DISCUSSION

SSM thinks that this example is interesting concerning the use of ALARA and BAT. It raises the question: What is considered to be the best available technique at an old, very special facility? The question is not if the public is protected or not. The incitement to further reduce the discharges from this facility is not for the protection of people but for the protection of the environment and it has its ground in the use of the Precautionary principle in the RIO-declaration from 1988 which is quite a long time ago now.

The decision on how far to goo is still left to make. Should the authority demand the operators to use only top of the line equipment? Demand of extensive rebuilding of the facility, or should it be enough to make more moderate improvements? What is good enough?

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(5) ICRP, 2006. Assessing dose of the representative person for the purpose of radiation protection of the public *and* The optimization of radiological protection: Broadening the process. ICRP Publication 101.