Development of working methods used inside reactor pressure vessel at Oskarshamn from the radiation protection point of view

Christer Solstrand
OKG Aktiebolag
S-572 38 Oskarshamn, Sweden

Introduction

When performing maintenance and repair work in the beginning of 1970´s conventional work tools and working methods mostly were used. The focus was on how to protect workers sufficiently in a proper way to keep the doses ALARA.

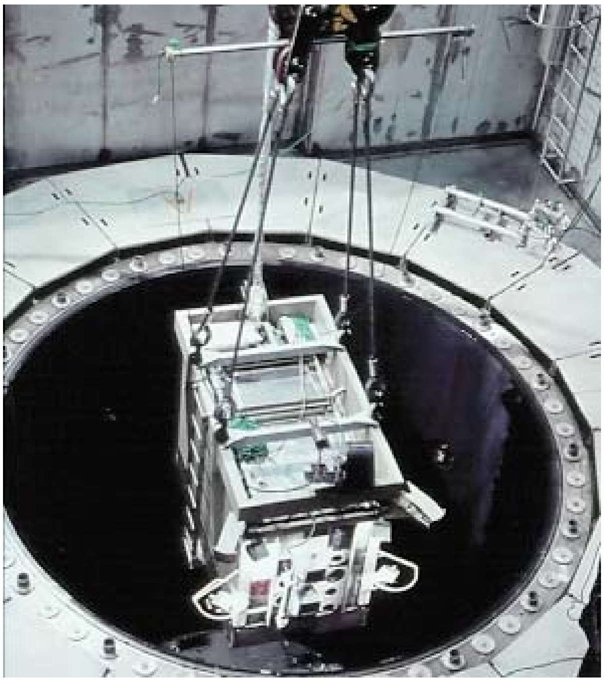
During the last years the focus has turned more towards construction of special work tools in order to minimise personnel doses without any special arrangements for radiation shielding.

Three examples will be presented to show that the optimisation of radiation protection can lead to the development of work tools and working methods, reducing the doses, time and money.

Replacement of the feed water ring at Oskarshamn 1

In 1974 the feed water ring at Oskarshamn 1 was replaced because of cracks found in the material. Initially all fuel was removed from the rector pressure vessel to the fuel pond. The water level in the RPV was kept 50 cm above the core grid as a radiation shielding. Though the dose rate was too high to perform the planned job. Complementary radiation shielding had to be provided in order to be able to perform the repair work in an acceptable way from the radiation protection point of view.

Therefore a lead box was constructed and manufactured of lead bricks with a thickness of 10 cm. In the lead box there were space for two workers. It was equipped with a window made of lead glass, holes for the arms and over pressure ventilation. The lead box was hanging in the reactor hall crane and moved up and down in the RPV. Using conventional work tools the feed water ring was cut away and four new feed water spargers were welded in place.



Picture 1: The lead box hanging in the reactor hall crane.

The work was performed on three shifts and a total of 107 workers were during shorter or longer times engaged in the work. Totally 55 workers took part in the work from the lead box. The total collective dose for the job was 440 mmanSv of which only 50 mmanSv received in the lead box. The rest of the dose was received in the reactor hall. The highest individual dose was 20 mSv and the highest hand dose was 34 mSv.

In-service inspections of the bottom nozzles of the RPV at Oskarshamn 1

In 1994 in-service inspections of the bottom nozzles of the RPV at Oskarshamn 1 was performed. In order to be able to perform this job using conventional equipment a system deceontamination of the RPV was performed. The system decontamination was very successful and the contamination levels and the dose rates at the bottom of the RPV were fairly low. The contamination levels varied between 500 and 10 000 kBq/m^2 and the dose rate level was about 0,04 mSv/h.

The workers were wearing only airflow protective suits in order to prevent inhalation of any particles and to minimise the spread of contamination. Anyhow the system decontamination cost a lot of money and time but the inspections could be performed by conventional equipment. The collective dose for the in-service inspection of the bottom nozzles of the RPV was 115 mmanSv.

Picture 2: Picture of the bottom nozzles of the reactor pressure vessel.

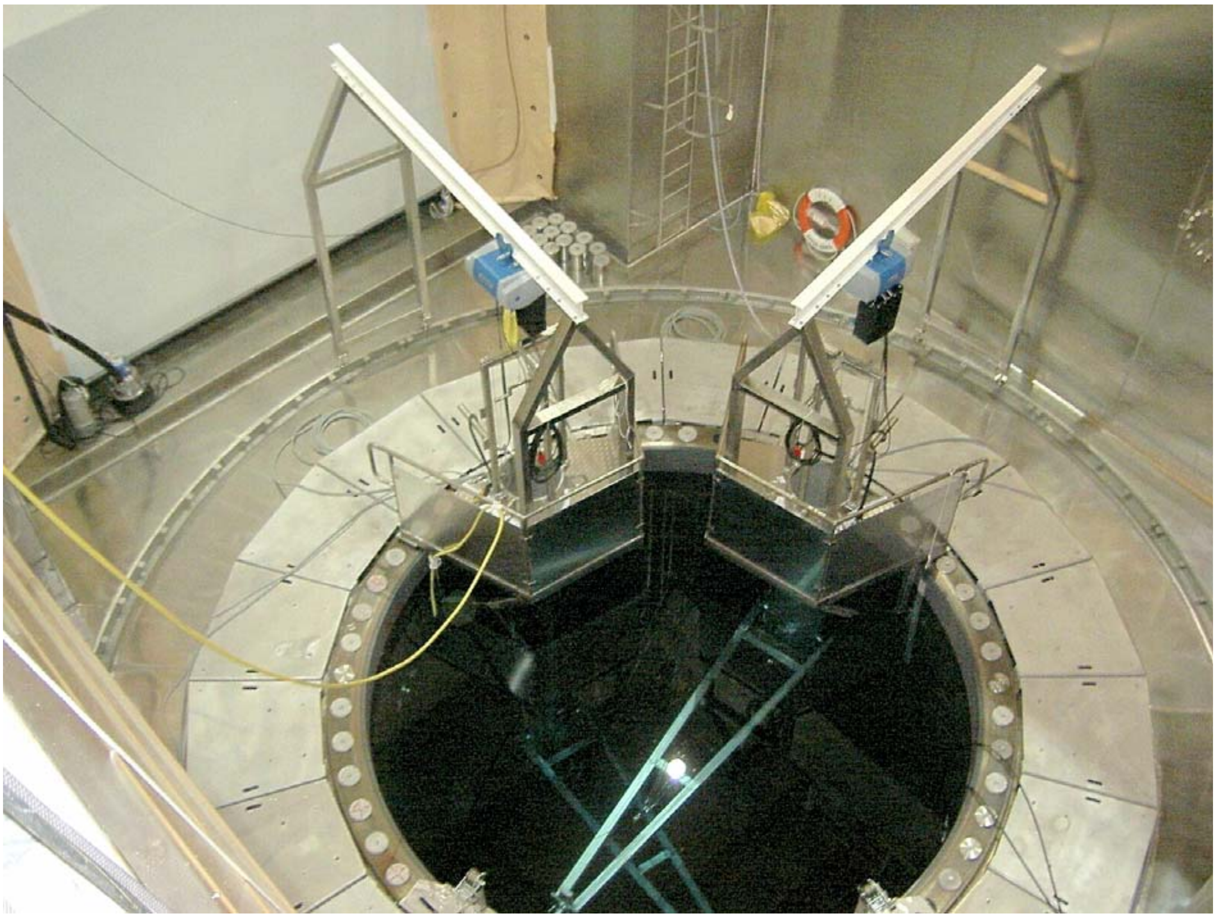
Repair of water level measuring nozzles of the RPV at Oskarshamn 2

During the outage period of Oskarshamn 2 in 2003 in-service inspection of the water level measuring nozzles (LMN) of the RPV was performed. Several indications were detected. In 8 indications of totally 15 LMN:s cracks were found and measures had to be taken. Because the results were expected a repair method had been carried out during the two months before the outage.

The LMN: s are situated on three different levels, 4, 6 and 14 m down from the RPV flange. Repair work was performed trough special designed shafts. These were attached to the flange of the RPV and went down to the LMN:s and attached to the wall of the RPV by a gasket covering the LMN:s. All water was evacuated from the shafts.

The diameter of the shafts was about 50 cm. Special equipments for milling, welding and testing were constructed to fit into these shafts. The function was tested on special designed mock-ups. Cameras were mounted on the equipment to make it possible to locate, observe and operate the equipment from TV-monitors. The equipments were hanging in wires in the shafts and operated electrically and pneumatically from the floor of the reactor hall.

The repair work started with milling of the flange of the LMN, after that welding and finally testing. It was possible to perform repair work parallel in two separate shafts.



Picture 3: Picture of the two work shafts attached to the flange of the reactor pressure vessel.

The repair work lasted for 30 days. The dose rates on the working area at the RPV flange varied between 0,07 and 0,2 mSv/h. The total collective dose of this job was only 47 mmanSv.

Discussion and conclusions

The two first presented jobs are examples on works that have been performed using conventional work tools and trying to find radiation protection measures to keep the personnel doses ALARA. Usually this means that some kind of radiation protection actions have to be adjusted to the actual situation.

In the third example the focus was on the work tools as well as on the dose reduction. Special equipment was constructed to solve the upcoming problem and to reduce the need for personnel protection and radiation shielding. The job was performed in a relatively short time and the resulting collective dose was low. If conventional work tools had been used, together with radiation shielding or decontamination, the collective dose would certainly have been higher. Surely it would also have taken longer time and costed more money.

Thanks to the aspects of radiation protection the work tools, for this type of work in the RPV, have gone through a development resulting in both lower doses and in saved time and money.